



灼识咨询

China Insights Consultancy

# Industry Report on China's New Energy Engineering Machinery Industry

April 2025



2025.4.25

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# CIC introduction, methodologies and assumptions

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China Insights Consultancy was commissioned to conduct research, provide an analysis of, and produce a report on China's new energy engineering machinery industry. The commissioned report has been prepared by China Insights Consultancy independent of the influence of Breton and other interested parties.

China Insights Consultancy is an investment consulting company initially established in Hong Kong. Its services include industry consulting services, commercial due diligence, strategic consulting, and so forth. Its consultant team has tracked the latest market trends in consumer goods, healthcare, marketing and advertising, culture and entertainment, energy and industry, agriculture, chemicals, finance and services, TMT, and transportation. It possesses the most relevant and insightful market intelligence regarding these industries.

China Insights Consultancy undertook both primary and secondary research using various resources. Primary research involved consumer survey, interviewing key industry experts and leading industry participants. Secondary research involved analyzing data from multiple publicly available data sources, including the National Bureau of Statistics of China, Chinese Government releases, annual reports published by relevant industry participants, industry associations, China Insights Consultancy's own internal database, etc.

The market projections in the commissioned report are based on the following key assumptions: (i) that the overall global social, economic, and political environment is expected to maintain a stable trend over the next decade; (ii) that related key industry drivers are likely to continue driving growth in China's new energy engineering machinery industry during the forecast period; and, (iii) that there is no extreme force majeure or set of industry regulations in which the market situation may be affected either dramatically or fundamentally. All forecasts concerning market size are based on the general economic conditions as of the Latest Practicable Date, which would be adjusted if the COVID-19 outbreak persists or escalates and has an unpredicted negative impact on the general economy.

All statistics are reliable and based on information available as of the date of this report. Other sources of information include those from the government, industry associations, and market participants. These may have provided some information on which the analysis or its data is based.

All the information about Breton is sourced from Breton 's own audited report or management interviews. China Insights Consultancy is not responsible for verifying the information obtained from Breton.

# Terms and abbreviations

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**AI:** Artificial Intelligence 人工智能

**BMS:** Battery Management System 电池管理系统

**CAN:** Controller Area Network 控制器局域网络

**CAGR:** Compound Annual Growth Rate 复合年均增长率

**CFC<sub>s</sub>:** Chlorofluorocarbon 氯氟烃

**CO<sub>2</sub>:** Carbon dioxide 二氧化碳

**COVID-19:** Coronavirus 新冠病毒肺炎

**CTC:** Cell to Chassis 电池车身一体化技术

**CTP:** Cell to Pack 无模组技术

**DC/AC:** 交直流电源转换

**DC/DC:** 直流转直流电源

**ECU:** Electronic Control Unit 电子控制单元

**EEA:** Electrical/Electronic Architecture 电子电气架构

**HC:** Hydrocarbon 碳氢化合物

**HMI:** Human Machine Interface 人机界面

**LIN:** Local Interconnect Network 局域互联网络

**L1, L2, L2+ , L3, L4:** Level 1, Level 2, Level 2+, Level 3, Level 4 一级, 二级, 二级+, 三级, 四级

**MCU:** Motor Control Unit 电机控制器

**MIIT:** Ministry of Industry and Information Technology of the People's Republic of China 中华人民共和国工业和信息化部

**NO<sub>x</sub>:** Nitrogen oxides 氮氧化物

**PM:** Particulate matter 颗粒物

**RFID:** Radio-frequency identification 射频识别

**SO<sub>2</sub>:** Sulfur dioxide 二氧化硫

**VCU:** Vehicle Control Unit 整车控制器

**5G:** 5th Generation Mobile Communication Technology 第五代移动通信技术

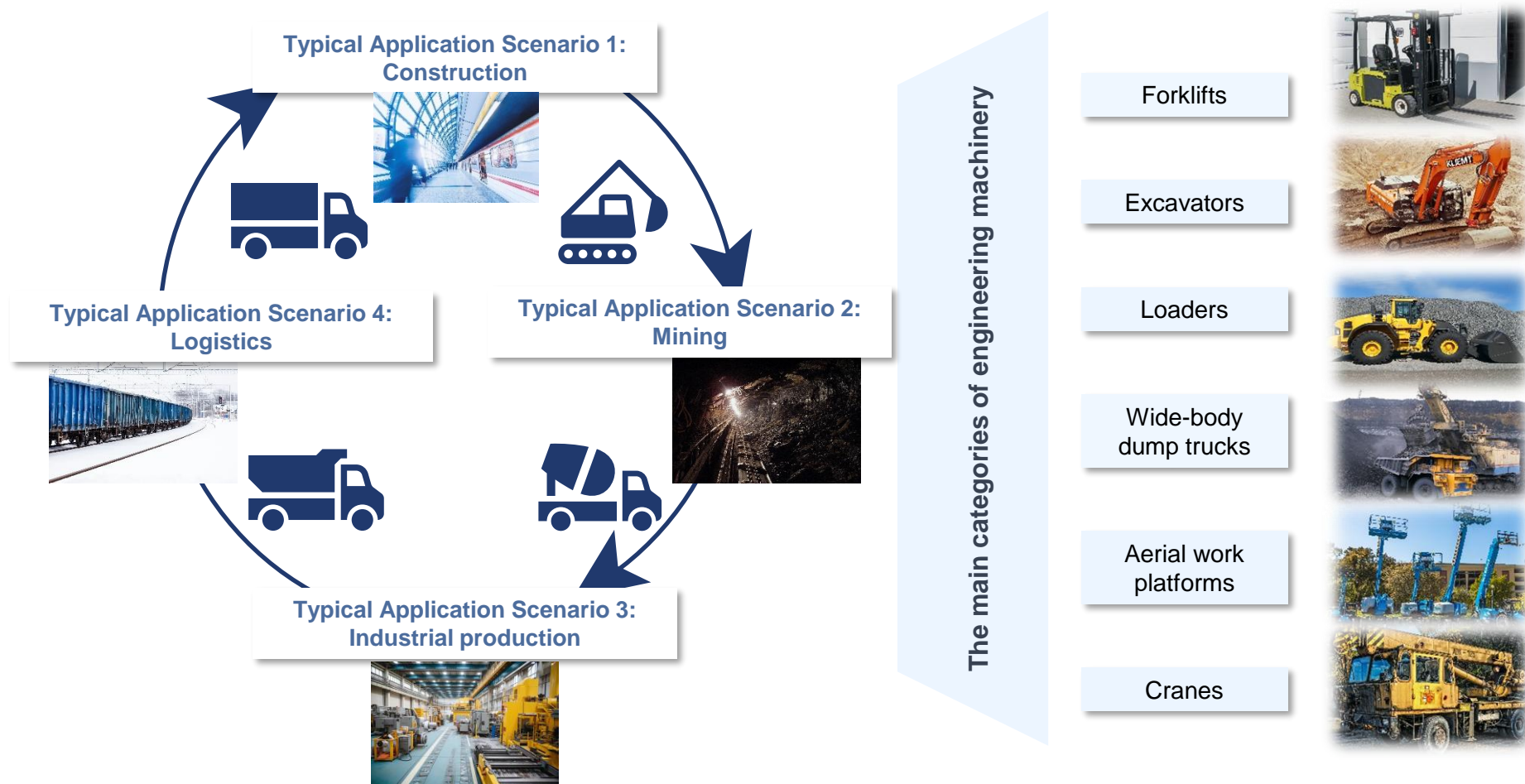


1. **Overview of China's Engineering Machinery Industry**
2. Overview of China's New Energy Engineering Machinery Industry
3. Overview of Global New Energy Tractor Trucks Industry

**Chinese engineering machinery companies manufacture a wide range of engineering machinery categories, including loaders, wide-body dump trucks and others.**

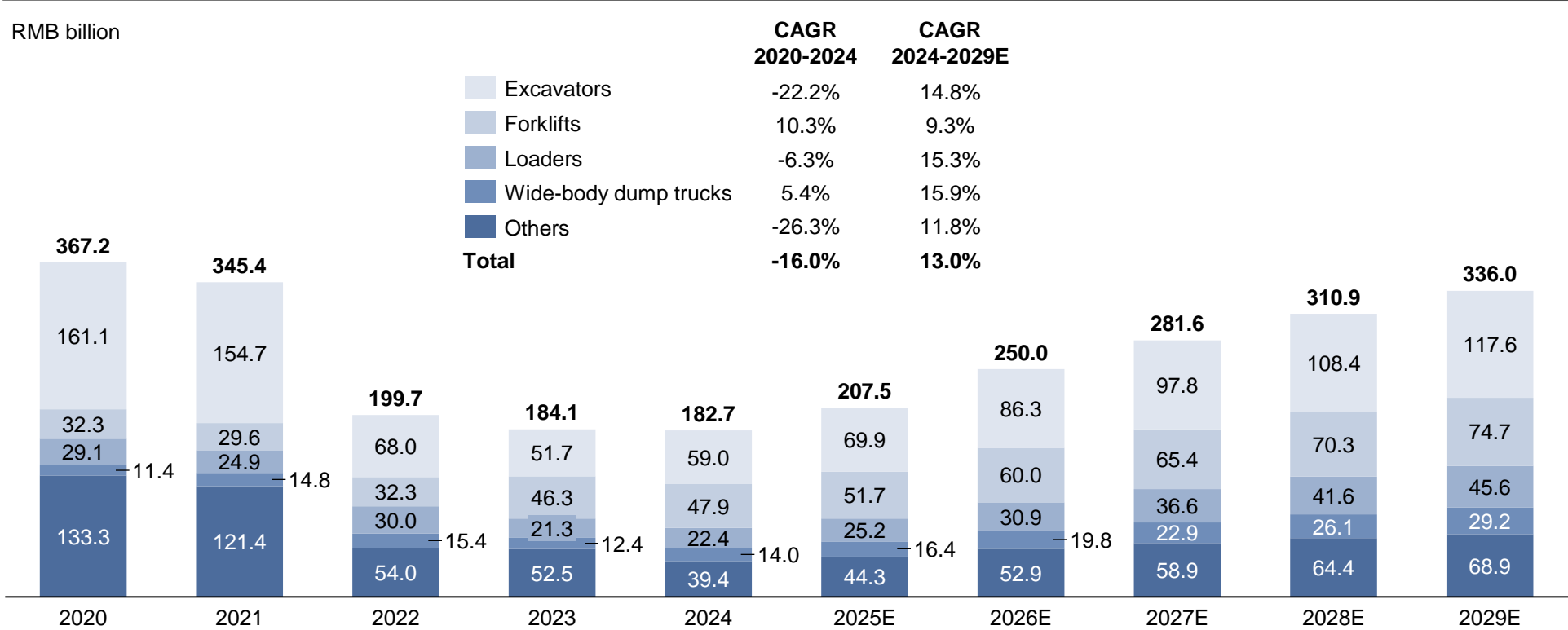
### Definition of China's engineering machinery and classifications

- Engineering machinery encompasses a broad spectrum of mechanical equipment, tools and vehicles that are purposefully designed and employed for diverse activities across multiple industries, including construction, mining, logistics, industrial production, and port operations. The categories of engineering machinery are extensive, including loaders, wide-body dump trucks, forklifts, excavators, aerial work platforms, and cranes, among others.



As China's economy gradually rebounds, the Chinese engineering machinery market is expected to recover and maintain a growing trend. By 2029, the market size of major categories in China is expected to reach RMB336.0 billion.

Market size of major engineering machinery categories in China<sup>1</sup>, 2020-2029E

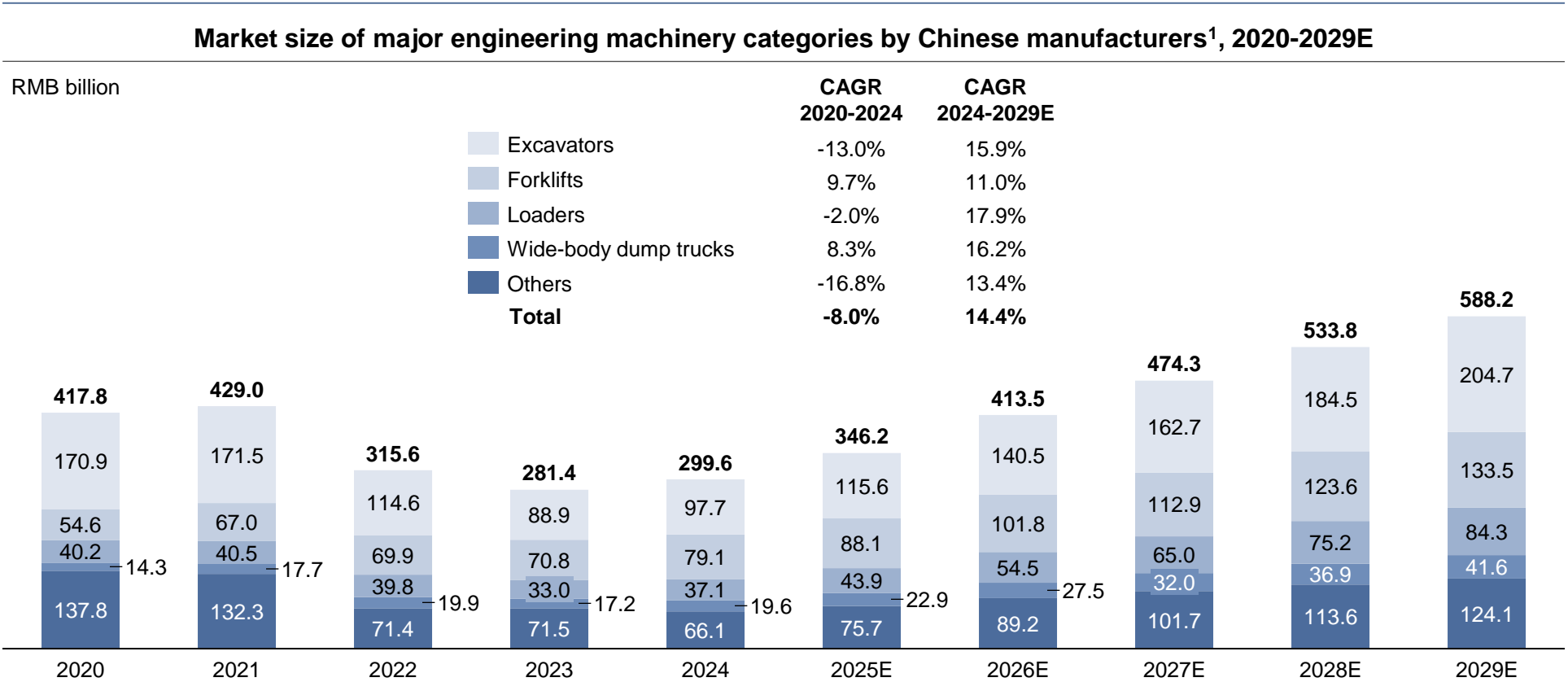


Key analysis

The development of the economy, the progress of urbanization and the supportive policies in engineering machinery industry and other relevant industries have been exert material impacts on the development of China's engineering machinery industry. The sales of engineering machinery experienced a decline from 2020 to 2023, largely attributed to the adverse impact of COVID-19 and the downturn of the macroeconomic situation. The market for engineering machinery is expected to gradually rebound to the pre-COVID-19 level from 2024 to 2029, due to the optimization of China's industrial structure and improved products' quality. The market size of major engineering machinery categories in terms of revenue generated by both Chinese and foreign manufacturers in China is expected to increase from RMB182.7 billion in 2024 to RMB336.0 billion in 2029, representing a CAGR of 13.0%. The following chart illustrates the actual and forecasted market size of major engineering machinery categories in terms of revenue in China for the period indicated.

Note: 1. The market size encompasses the revenue generated from shipments of all engineering machinery major categories that occur within mainland China, including domestic shipments and imports. Major engineering machinery categories include excavators, forklifts, loaders, wide-body dump trucks, and others.

China is a top-tier player in the global engineering machinery manufacturing industry, the market size of major engineering machinery categories by Chinese manufacturers is expected to keep increasing.



**Key analysis**

- With a versatile product portfolio, marked by excellent quality and price competitiveness of the products, China has become a leading player in the global engineering machinery market in terms of production and export volume. This success is also underpinned by continual enhancement in post-sale service capabilities of Chinese manufacturers abroad, leading to a steady growth in the export volume of China's engineering machinery in recent years. The export amount of Chinese engineering machinery manufacturers increased from RMB64.8 billion in 2020 to RMB124.1 billion in 2024, representing a CAGR of 17.6%, and is expected to steadily increase to RMB257.8 in 2029, representing a CAGR of 15.7%. As the export amount steadily increase, the corresponding market size by Chinese manufacturers also sees a consistent rise. In 2023, the market size of major engineering machinery categories by Chinese manufacturers is expected to increase from RMB299.6 billion in 2024 to RMB588.1 billion in 2029, representing a CAGR of 14.4%.

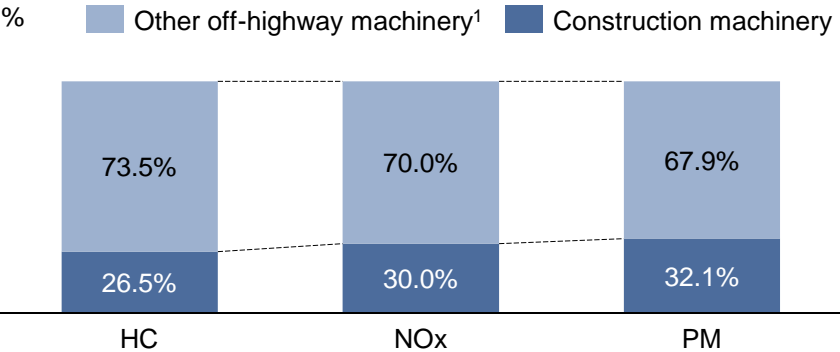
Note 1: The market size by Chinese manufacturers encompasses the revenue generated from shipments of all engineering machinery major categories by Chinese manufacturers on a global scale, including domestic shipments and overseas exports. Major engineering machinery categories include excavators, forklifts, loaders, wide-body dump trucks, and others.

China's traditional engineering machinery relies on diesel internal combustion engine for power, which has presented multiple challenges, necessitating urgent need to pave the way for the industry's sustainable development in the future.

Main challenges in China's engineering machinery industry

Increasing Environmental Concerns

Proportion of emissions from off-highway mobile machinery, 2022



- The traditional engineering machinery generates significant carbon emissions and other harmful substances, such as sulphur dioxides, hydrocarbons, nitrogen oxides, and particulate matter, during its operations. The shift from diesel to cleaner energy resources has been recognized as a vital and irresistible trend in the engineering machinery industry. For example, the Implementation Plans on Synergizing the Reduction of Pollution and Carbon Emissions (《減污降碳協同增效實施方案》) were jointly published by the NEA and MEE and other relevant government authorities in 2022, which promotes the development of green resources. In 2021, MIIT unveiled the “14th Five-year Green Industrial Development Plan” (《“十四五”工業綠色發展規劃》), which emphasizes the pursuit of a green and low-carbon path to the development and promotion of green and environmental-friendly machinery.

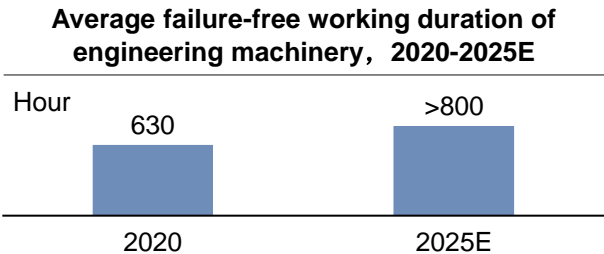
High Operational Costs



- The operational expenses associated with traditional engineering machinery are relatively high, primarily due to their fuel consumption caused by complex operation scenarios and large loading capacity. Operators also face challenges in monitoring and managing fuel consumption accurately.



Complex Operational Conditions



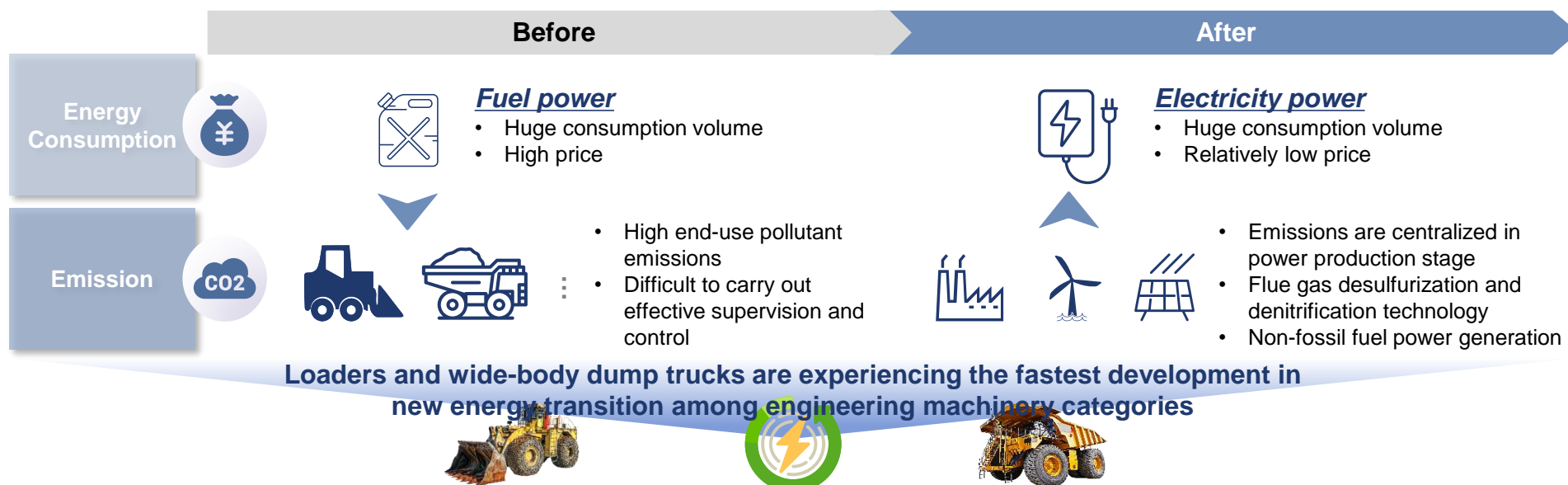
- Traditional engineering machinery generally has complex structures and configurations, resulting in higher accident rates and challenges in maintenance and repair. This leads to lower equipment utilization rates, increased costs associated with maintenance and repair for traditional engineering machinery and relatively high human costs.

Note: 1. Other off-highway mobile machinery refers to agricultural machinery, vessels, railway internal combustion locomotives and aircraft.

**As an ideal measurement to face the challenges, new energy transition is on the rise, especially in loaders and wide-body dump trucks, for its significant economic benefits, limited range anxiety and mass manufacturing prerequisites.**

### New energy transition in China's engineering machinery industry

- The new energy transition for engineering machinery involves replacing of conventional energy sources that have a negative impact on the environment with new and more sustainable energy sources. Taking new energy loaders and wide-body dump trucks as examples, new energy engineering machinery typically incurs 50%–85% less energy consumption costs than traditional fuel engineering machinery under the same working conditions. Therefore, using new energy engineering machinery is significantly cost-efficient in terms of energy consumption, thereby imparting a substantial favorable economic influence on enterprises. More than 99% of the new energy engineering machinery is battery-electric engineering machinery, which is characterized by low end-use pollutant emissions.



#### Significant economic benefits

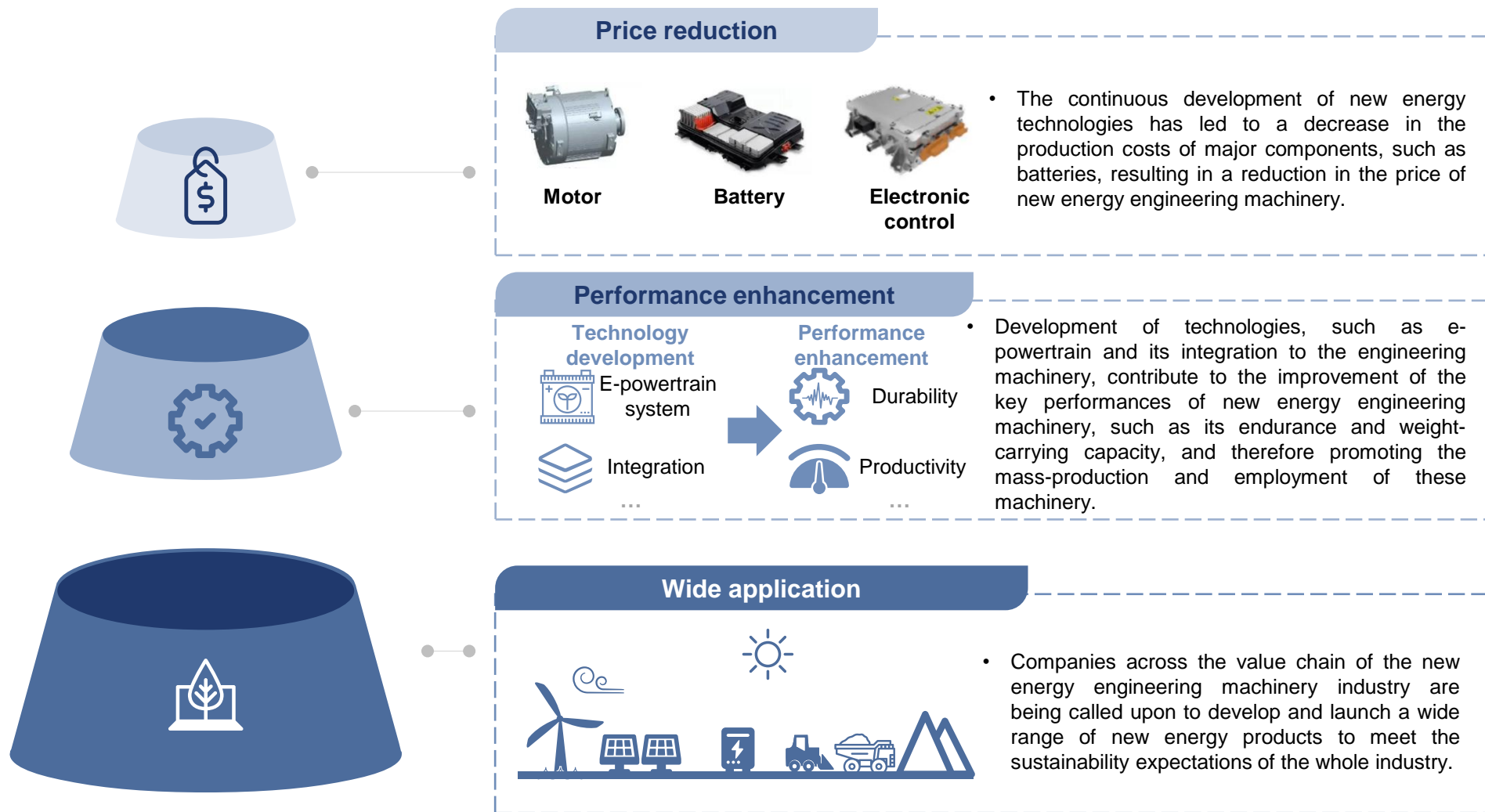
- Energy-intensive engineering machinery categories include loaders due to their high work intensity and wide-body dump trucks due to their enormous payloads. The economic benefits of new energy loaders and wide-body dump trucks are particularly significant as a result of the reduction in energy consumption. For example, new energy five-tonne loaders can save approximately RMB0.3 million annually in terms of average energy consumption costs compared to their fuel-powered counterparts. For new energy 105-tonne wide-body dump trucks in heavy-load uphill operations, the cost savings are approximately RMB0.7 million annually as calculated by average energy consumption costs compared to conventional wide-body dump trucks.

#### High usage efficiency

- Loaders and wide-body dump trucks are typically used in off-highway fixed operating environments. The deployment of compatible charging infrastructure expedites the energy replenishment for the machinery. High mobility speeds reduce commuting time between work sites and charging stations, minimizing impact on effective working time of engineering machinery.

As new energy technologies advance is emerging in the process of new energy transition, consumer acceptance keeps increasing, leading to the sustainable and high-quality development of new energy transition.

### Sustainable and high-quality development of new energy transition

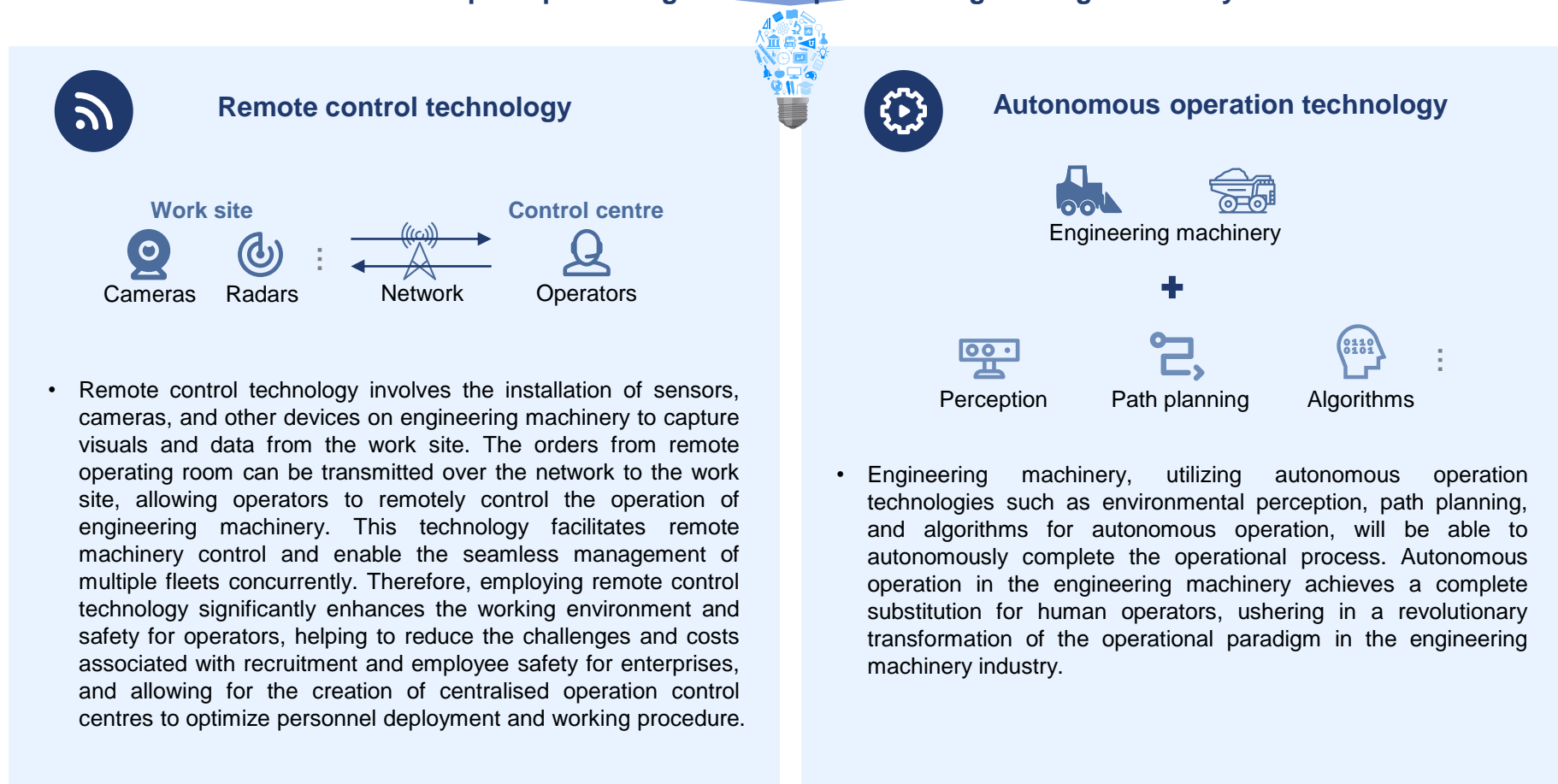


**Intelligentization of engineering machinery is expected to assist enterprises in achieving a reduction in personnel or unmanned operation on job sites, especially through remote control technology and autonomous operation technology.**

### Intelligentization in China's engineering machinery industry

- The intelligentization of engineering machinery refers to the upgrading of engineering machinery equipment through intelligent technologies such as intelligent sensing and autonomous operation algorithms, to achieve varying degrees of remote or autonomous control. By utilizing intelligent engineering machinery, companies can reduce the need for personnel or enable unmanned operations at work sites, effectively addressing challenges like high safety risks and labour costs and improve the operational efficiency at the same time.

**Remote control technology and autonomous operation technology constitute the principal intelligent development of engineering machinery**



**With the advancement of intelligent technologies, the intelligent operation capabilities keep enhancing, resulting in improving of the application scenarios, categories, and levels of application for intelligent technologies.**

### Enhancement of intelligent operation capabilities

#### Ongoing development of standalone intelligent technologies

##### Development of intelligent technologies:



**Environment perception**



**Path planning**



**Autonomous algorithms**

- Autonomous operation capabilities are becoming adept at handling a greater number and more challenging operational tasks.



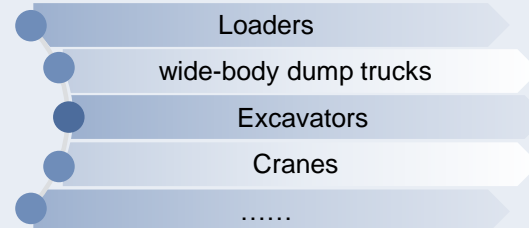
- Autonomous operation of wide-body dump trucks requires relatively low technical requirements due to their enclosed application environments and simple interaction with the surroundings. Therefore, autonomous operations for wide-body dump trucks have been successfully commercialized. However, there are more technological challenges for other categories of engineering machinery to operate autonomously due to their complex working environments, especially those that require advanced algorithms and intelligent sensors. Currently, there are no other commercially available engineering machinery for the autonomous operation, and achieving commercial deployment in the short term is a significant challenge in the industry.

#### Enabling collaborative operations across diverse machine types

##### Operational scenarios



##### Engineering machinery demands



- With the continuous development of standalone intelligent technologies and collaborative operations across diverse machinery, the intelligent capabilities of engineering machinery operations will continue to enhance in the future, contributing to the continuous expanding of the application scenarios, categories, and improving levels of application of intelligent technologies.



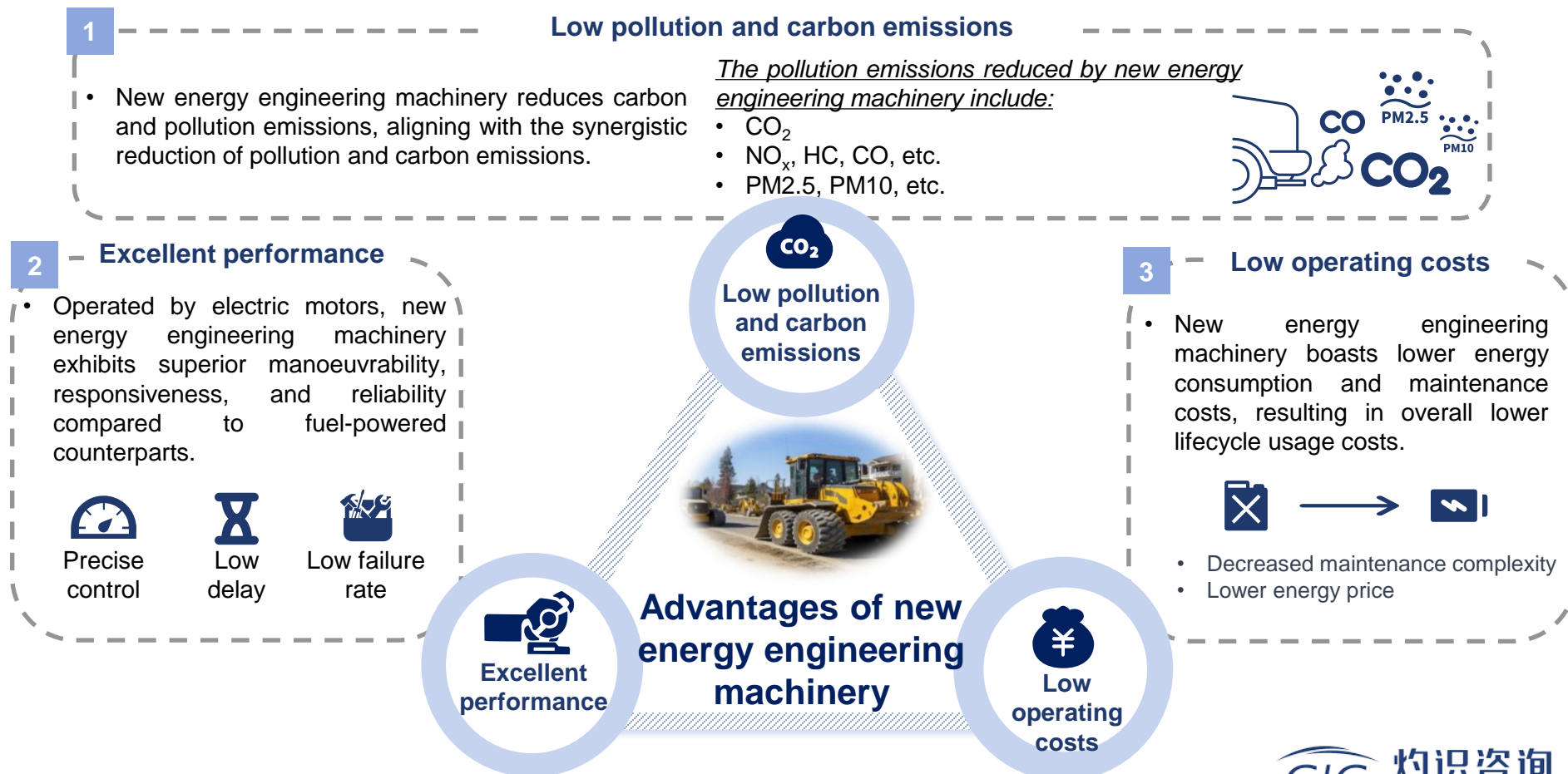


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# New energy engineering machinery is primarily or fully driven by new energy sources, with significant advantages on carbon emissions, operating performance, and operating costs.

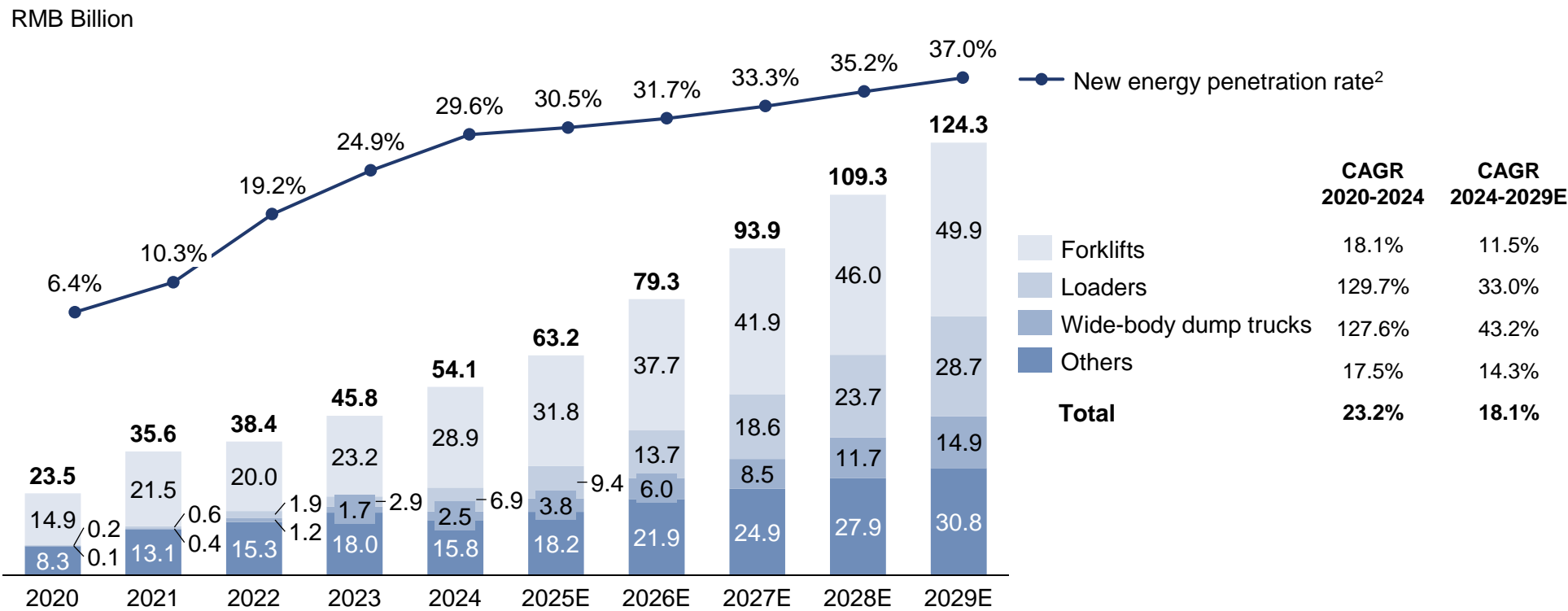
## Definition of new energy engineering machinery in China

- New energy engineering machinery is predominantly built on innovative power systems driven by new energy sources. At this stage, electric engineering machinery boasts the higher technological maturity and represents as the mainstream product in the new energy engineering machinery industry. New energy engineering machinery, largely powered by electricity, typically yields 20%–50% less carbon than conventional fuel-powered engineering machinery. In particular, new energy wide-body dump trucks yield more than 70% less carbon than traditional wide-body dump trucks in heavy-load downhill operations. Powered by electric motors, new energy engineering machinery offers superior maneuverability, responsiveness, and reliability when compared to its conventional counterparts. Moreover, it boasts reduced energy consumption and maintenance expenses, resulting in lower overall lifecycle usage costs.



The implementation of environmental policies, and advancements in new energy technologies propel the expansion of the new energy engineering machinery market.

Market size of new energy major engineering machinery categories in China<sup>1</sup>, 2020-2029E

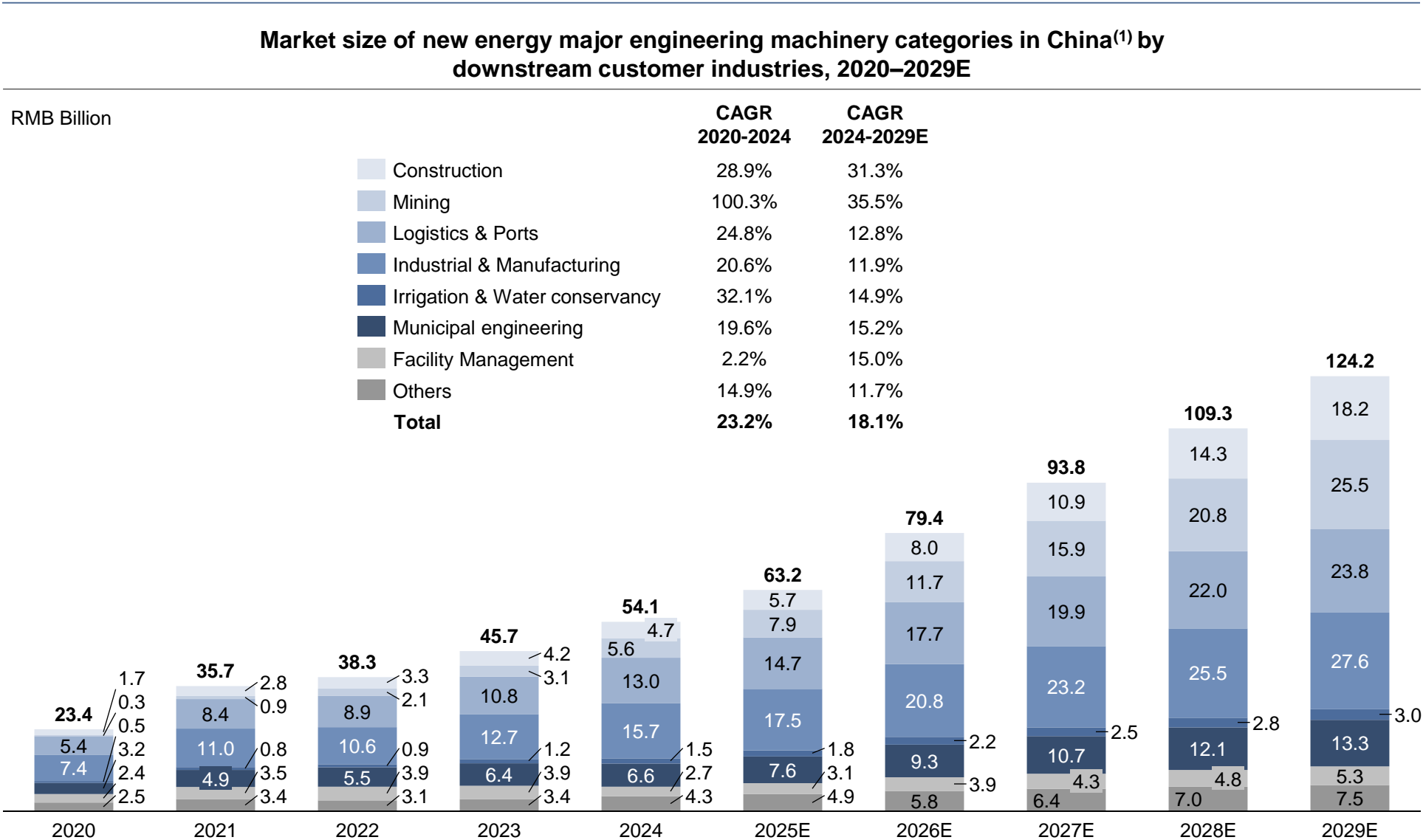


Key analysis

- Due to the advancements of new energy engineering machinery, coupled with the development of electrification technologies and implementation of environmental policies, China’s new energy engineering machinery industry has been evolving and is expected to rapidly develop over the following years. Its market size in terms of revenue generated by both Chinese and foreign manufacturers in China increased from RMB23.5 billion in 2020 to RMB54.0 in 2024, representing a CAGR of 23.2%, and is expected to increase to RMB124.2 billion in 2029, representing a CAGR of 18.1%.

Note: 1. New energy major engineering machinery categories include forklifts, loaders, wide-body dump trucks, and others.  
2. The new energy penetration rate is calculated by dividing the market size of new energy engineering machinery by the market size of major engineering machinery categories in China.

# The new energy engineering machinery is widely used in diversified industries.

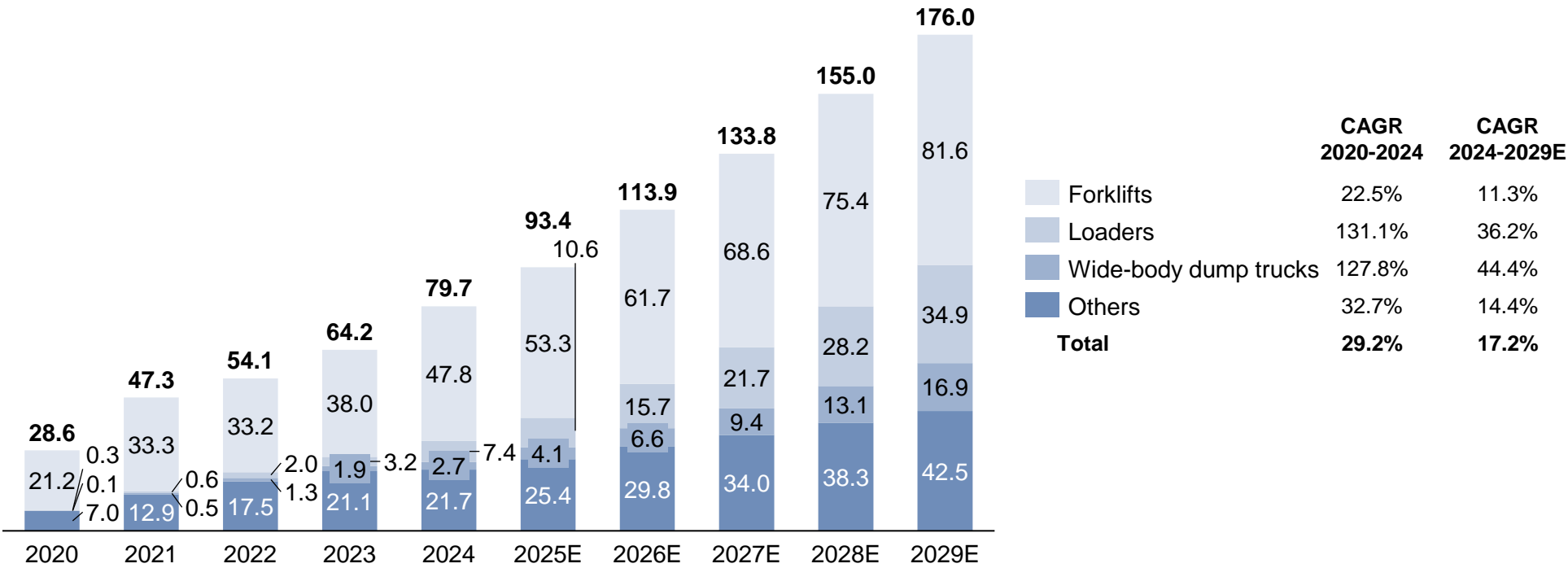


Source: China Insights Consultancy

The export market has become a new growth driver for the new energy engineering machinery industry in China, propelling the market size of new energy major engineering machinery categories by Chinese manufacturers to grow rapidly.

Market size of new energy major engineering machinery categories by Chinese manufacturers<sup>1</sup>, 2020-2029E

RMB Billion



Key analysis

- The rapid development of China’s new energy engineering machinery industry has led to an expanding presence and acclaim for Chinese products in international markets. In 2024, the market size of new energy major engineering machinery categories in terms of revenue of both domestic and export sales of Chinese manufacturers reached RMB79.7 billion, representing a CAGR of 29.2% from 2020 to 2024. It is expected that the market size will reach RMB176.0 in 2029, representing a CAGR of 17.2% from 2024 to 2029. With innovation in products and technologies and expansion of global sales channels, Chinese new energy engineering machinery will have a more notable presence in international markets.

Note: 1. New energy major engineering machinery categories include forklifts, loaders, wide-body dump trucks, and others.

## Main drivers of new energy engineering machinery market in China



### 1 Continued growth in demand from downstream industries

- Engineering machineries are widely used in industries such as mining. With the continuous development of downstream industries and supporting policies, demand for new energy engineering machineries has also increased steadily. In particular, in the mining industry, engineering machineries such as loaders and wide-body dump trucks, are the key carriers for transporting ore. As the world's second largest economy, China has a huge demand for mineral products. In the post-epidemic era, as the global supply chain undergoes structural adjustments due to the continued shocks, China has generated more demand for local mineral products, promoting the development of the mining industry. Furthermore, the official implementation of favorable policies, such as the "Notice on Further Strengthening the Construction of Green Mines" (《關於進一步加強綠色礦山建設的通知》) issued by the Ministry of Natural Resources in April 2024 and "Notice of the Implementation Plan for Promoting the Renewal of Construction and Municipal Infrastructure Equipment" (《推進建築和市政基礎設施設備更新工作實施方案的通知》) issued by the Ministry of Housing and Urban-Rural Development of PRC, continuously drives the demand growth in the new energy engineering machinery industry.



### 2 Enhanced economic efficiency

- The decrease in costs driven by supply chain optimization leads to reduced procurement costs of new energy engineering machinery. Coupling with relatively minimal maintenance and operation costs and a high cost-performance efficiency, new energy engineering machinery has become an increasingly attractive option for customers. The cost-effectiveness and reliability of new energy engineering machinery products have been thoroughly verified by numerous successful application cases. Moreover, with the ongoing iteration and advancement of new energy technologies, energy-efficiency of new energy engineering machinery are continually improving, thereby amplifying the economic benefits of these products. Identifying these economic benefits and successful application cases, key players in industries such as construction, mining, and port operations are showing their preferences to adopt new energy engineering machinery over conventional fuel-powered engineering machinery. As a result, the new energy penetration rate of engineering machinery market is poised for a rapid growth in the forthcoming years.



### 3 Technological advancements

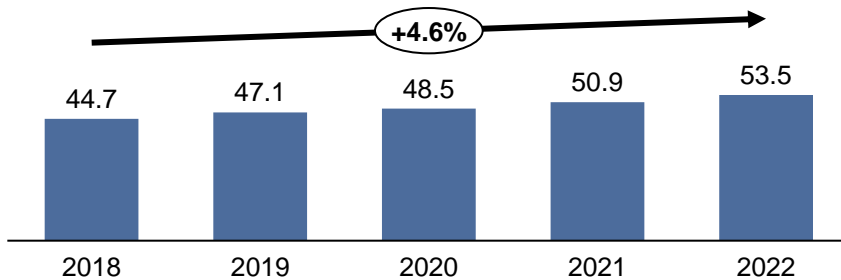
- Chinese engineering machinery companies have been committed to innovating technologies and enhancing functionalities for engineering machinery. This makes them well-positioned to offer cost-efficient and high-quality products. Furthermore, development in electrification technologies enhances the performance of new energy engineering machinery while decreases production costs. This addresses the concerns related to limited working hours, inadequate power, and high initial procurement costs of new energy engineering machinery. These advancements contribute to a higher acceptance and broader utilization of new energy engineering machinery across various application scenarios.

# Continuous growth in fixed asset investment and the the development of new types of infrastructure will drive demand for new energy engineering machinery.

## Increased investment in fixed assets to drive up demand for engineering machinery

### Investment in fixed asset (excluding rural households), 2018-2022

RMB trillion



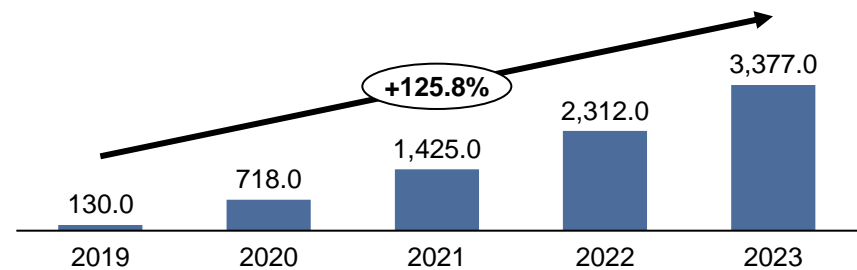
### Fixed-asset investment-related policies in the '14th Five-Year Plan' are gaining momentum

Major and specialized planning priorities	Expanding the investment space	'Two New, One Major'
<ul style="list-style-type: none"> <li>Proposing 102 major engineering projects</li> </ul>	<ul style="list-style-type: none"> <li>Optimize structure</li> <li>Improve efficiency</li> <li>maintain reasonable growth</li> </ul>	<ul style="list-style-type: none"> <li>New infrastructure construction</li> <li>New urbanization</li> <li>Transportation and other major projects</li> </ul>
<ul style="list-style-type: none"> <li>In recent years, China's fixed asset investment structure is facing adjustment and optimization, and the growth rate has slowed down compared with the past, while the investment in new production capacity for fixed asset investment has not yet been fully released. In the future, it is expected that the fixed asset investment activities will increase, and the demand for the engineering machinery industry will be maintained at a high level.</li> </ul>		

## China's new infrastructure will drive demand for engineering machinery

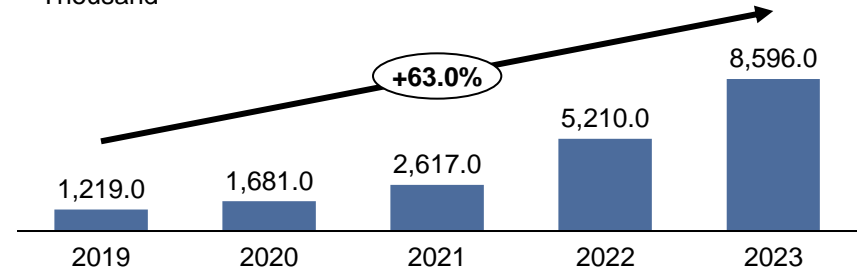
### Cumulative number of 5G base stations built in China, 2019-2023

Thousand



### China Charging Pile Ownerships, 2019-2023

Thousand



- China's new infrastructure industry is in its booming period. In 2023 China has built a total of 3,377.0 thousand 5G base stations, charging pile retention of more than 8.6 million. As an important equipment for infrastructure development, the new energy engineering machinery industry is bound to become the mainstay of building construction in the new infrastructure.

# New energy as a promising renewable energy products will continue to benefit from the national energy transition strategy and synergetic reduction of pollution and carbon emissions.

## Engineering machinery for mining applications

Mining industry is an important downstream industry of engineering machinery, loaders and wide-body dump trucks are one of the main engineering machinery for mining applications.

### Major engineering machinery for mining applications

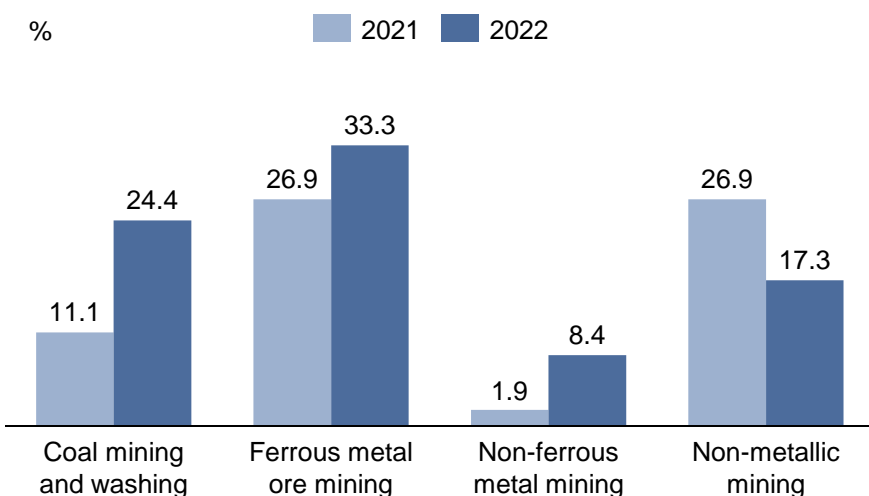


- Wheel loader is a kind of earthwork engineering machinery widely used in mining and other construction projects, it is mainly used for shoveling soil, gravel, lime, coal and other bulk materials



- Mining dump truck is a kind of heavy-duty dump truck used in open-pit mines for completing the tasks of rock earth stripping and ore transportation

### Growth rate of fixed asset investment (excluding farmers) in mining industry, 2021-2022



## National Green Mine Construction Specifications promotes the development of new energy engineering machinery

PRC centralized policy	Summary of policy content
<b>Specification for the Construction of Green Mines in the Coal Industry</b>	<ul style="list-style-type: none"> <li>Coal mines should be equipped with noise measuring instruments to regularly monitor the noise of coal miners, roadheaders, etc. in shaft coal mines, and excavators, perforators, mining vehicles, etc. in open-pit coal mines.</li> </ul>
<b>Sand and gravel industry green mine construction specification</b>	<ul style="list-style-type: none"> <li>Promote the application of new types of transportation means such as clean energy and hybrid oil-electric vehicles in mine transportation. For mining areas with large drop-offs, promote the use of downward belt potential energy generation technology to save electricity.</li> </ul>
<b>Specification for green mine construction in non-metallic mining industry</b>	<ul style="list-style-type: none"> <li>Mines should utilize energy-efficient new technologies, processes, equipment and materials, eliminate high-energy-consuming, high-polluting and low-efficiency processes and equipment, and make rationally use clean energy.</li> </ul>
<b>Specification for green mine construction of hydraulic limestone</b>	<ul style="list-style-type: none"> <li>The integrity rate of transportation vehicles should be no less than 80%, and the filling coefficient should be no less than 90%; vehicle cleaning should be done well.</li> </ul>
<b>Non-ferrous metal industry green mine construction norms</b>	<ul style="list-style-type: none"> <li>Open-pit mines give priority to mechanized equipment for mining, stripping, transporting and discharging with a high degree of automation.</li> </ul>

## The rapid rise in the number of successful cases involving new energy engineering machinery and the flourishing development of the new energy vehicle industry have garnered increased attention and acceptance from enterprises.

- The economic advantages of new energy engineering machinery will be further magnified, attracting a growing number of enterprises to transition from conventional fuel-powered machinery to new energy engineering machinery. With the rapid rise in the number of successful cases of new energy engineering machinery and the booming development of new energy automobile industry, enterprises are increasingly willing to accept new energy engineering machinery.

### Successful application cases of new energy engineering machinery

#### ① Breton delivered the 7-ton pure electric loader BRT970 in Mianyang, Sichuan Province



- On June 6, 2023, Breton delivered the 7-ton pure electric loader BRT970 equipped with a 423kWh high-capacity battery pack, significantly reducing power consumption and saving fuel costs. The battery control system is independently developed by Breton, which has less than 7% degradation after 10,000 hours of high-intensity operation.

#### ② XCMG delivered pure electric loaders(XC958-EV) in Northwest China Coal Base



- At the beginning of 2024, 20 sets of pure electric loaders XCMG XC958-EV was successfully delivered. In order to fight against the severe cold and heat of the delivery place, XC958 is equipped with a battery thermal management system intelligently controlled by BMS, which has stable performance and is safe and reliable.

#### ③ A mining enterprise in Anshan introduced 10 sets of LiuGong electric mining wide-body trucks



- On February 18, 2023, 10 sets of LiuGong pure electric mining wide-body trucks were delivered in bulk to a mining company in Anshan, Liaoning province. The trucks will serve the customer's mining project material transportation, contributing to the healthy and sustainable development of mining.

#### ④ SANY Heavy Industry delivered heavy-duty electric dump trucks to a mining company in Shaoyang



- In October 2023, SANY delivered 8 heavy-duty electric wide-body dump trucks to a mining company in Shaoyan, Hunan Province. The trucks have the characteristics of strong power, loading more and high safety, which perfectly fits the actual operation scenario.

# The upgrade of electric motor technology greatly improves the motor performance and reduces the costs, contributing to the rapid development of new energy engineering machinery.

## The development of new energy engineering machinery technology

- Along with the technological innovation of product performance and functions, Chinese new energy engineering machinery manufacturers will provide better-priced and better-quality products in more scenarios in the future, promoting the further development of Chinese new energy engineering machinery. In addition, the innovation of electric motor technology improves motor performance and reduces motor cost, gradually solving the concerns of short range, insufficient power and high cost of new energy engineering machinery, helping the industry to develop further.



### Upgrading trend of electric motor

	DC Motor	AC Asynchronous Induction Motor	Permanent Magnet Synchronous Motor
Motor power density	Low	Medium	High
Working load efficiency	80%-87%	90%-92%	85%-97%
Rotational speed	4000-6000	12000-15000	4000-15000
Reliability	medium	Relatively high	High
Volume	Big	Medium	Small
Weight	Heavy	Medium	Light
Motor cost	Low	Medium	High

- Higher motor power**
- Hairpin technology is a winding technology for stators in electric motors. In contrast to conventional winding technologies, the effective area of copper can be increased more than 20%, resulting in 20%-30% improvement of motor power.

- Diversified cooling mode**
- Water cooling is currently the mainstream solution, while oil cooling is expected to be the future trend for electric motors.

- Higher level of integration**
- Integration is a future development trend. Integrating components or functional parts together can help to save space, and some components can be shared for multiple uses, improving the motor efficiency.

## Entry barriers of China's new energy engineering machinery industry



### 1 Technology capability

- Product reliability and quality are paramount considerations for enterprise users when acquiring new energy engineering machinery. Market players in the industry must possess substantial expertise and technological proficiency to demonstrate advanced capabilities in product research, development and manufacturing. Strong research and development capability and deep understanding of the market demand enable the established market players to achieve strong product iteration capability.



### 2 Industry experience and reputation

- New energy engineering machinery companies often rely on past successful cases and industry reputation to gain customers' trust due to the lack of uniform industry standards and complexity of product application scenarios. Leading players in the industry have established brand recognition and customer bases in the market. This poses a challenge for new entrants, especially when competing against established market leaders with scale and branding advantages.



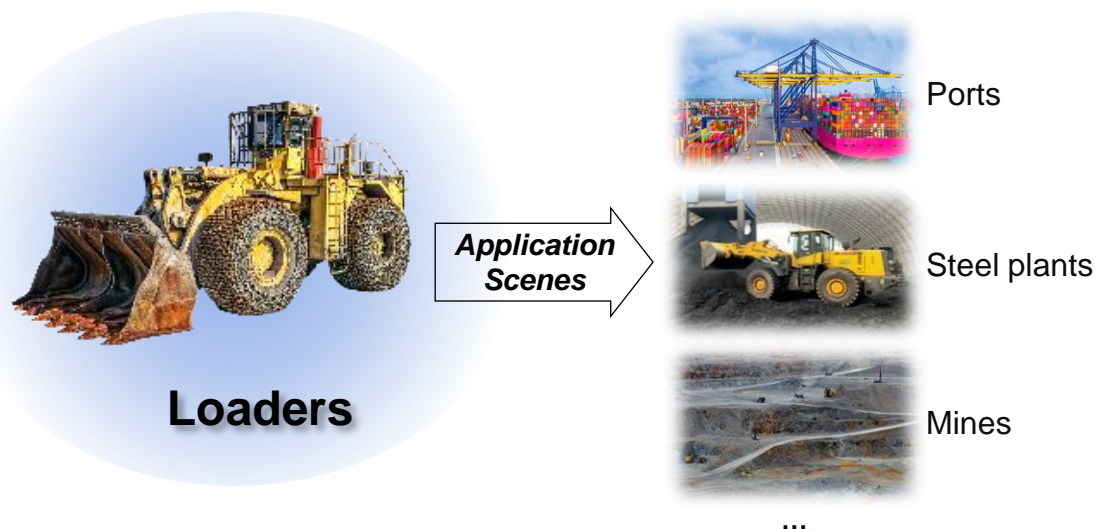
### 3 Supply chain capability

- The production and manufacturing of new energy engineering machinery involve a diverse array of components and raw materials, including steel, hydraulic elements, electrical components. The stability and efficiency of the supply chain play a pivotal role in determining product quality, costs, and delivery timelines. Furthermore, due to the significant size and weight of most new energy engineering machinery categories, it is imperative for companies to establish a well-organized logistics network to ensure the prompt and secure delivery of products to customers.

**Due to the high energy consumption and large ownerships, loaders rank at the forefront in terms of carbon dioxide and particulate matter emissions, resulting in the urgent need for the adoption of new energy.**

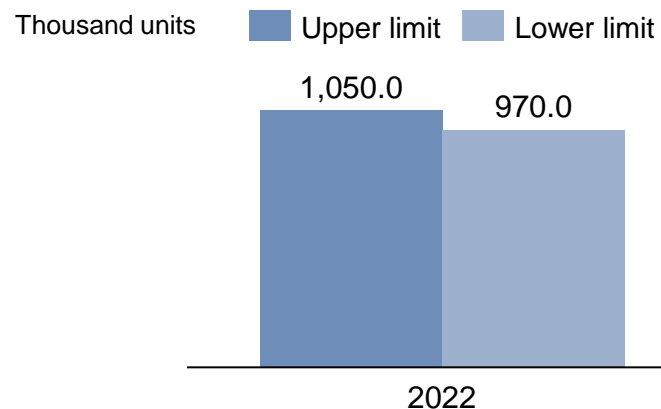
### The overview of loaders

- Loaders are primarily used for shoveling and loading operations. Thanks to their compatibility to various buckets, loaders are applied in various settings, including mining, factories, ports, and other enclosed or semi-enclosed sites, making them one of the major categories of engineering machinery. However, loaders are associated with high energy consumption and they stand at the forefront in terms of carbon dioxide and particulate matter emissions among the engineering machinery. Therefore, there is an urgent need to apply new energy technologies to facilitate their transition into environment-friendly alternatives.



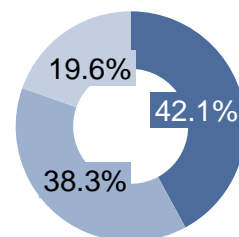
### Significant loader product ownerships

Loader product ownerships in China, 2022

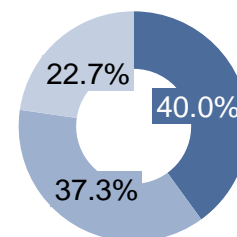


### High environmental pressure and urgent policy momentum

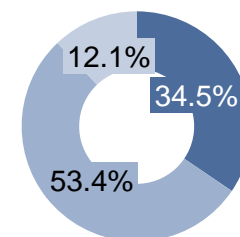
Composition of HC Emissions from Engineering machinery, 2022



Composition of NOx Emissions from Engineering machinery, 2022



Composition of PM Emissions from Engineering machinery, 2022



■ Loaders ■ Excavators ■ Others\*

\* Others include forklifts, road rollers, bulldozers, pavers, and graders.

**New energy loaders primarily rely on electricity, offering a significant cost advantage over fuel loaders, for a 5-tonne loader, the new energy version can save approximately RMB1.0~1.5 million in terms of total costs during the overall lifecycle.**

### Economic calculations of fuel and electric 5-tonne loaders

- New energy loaders primarily utilize electricity as their power source, resulting in a significant reduction in carbon dioxide and particulate matter emissions, as well as operational costs, when compared to traditional loaders. Taking a loader with a five-tonne load capacity as an example, assuming a service lifespan of five years, the new energy five-tonne loader generally can save approximately RMB1.0 million to 1.5 million in terms of total costs during the overall lifecycle as compared to traditional loaders.

#### Energy consumption analysis of five-tonne loader

	Fuel	Electric
Average unit price of energy consumption	RMB7.59/L	RMB0.635/kWh
Average energy consumption volume per hour	17L (Diesel)	45kWh (Electricity)
Average hours of use per day	10h	
Average energy consumption costs per day	RMB1,290	RMB286
Average days of use per year	300 days	
Average energy consumption costs per year	RMB387,090	RMB85,725
<b>Annual energy consumption cost savings</b>	<b>RMB301,365</b>	

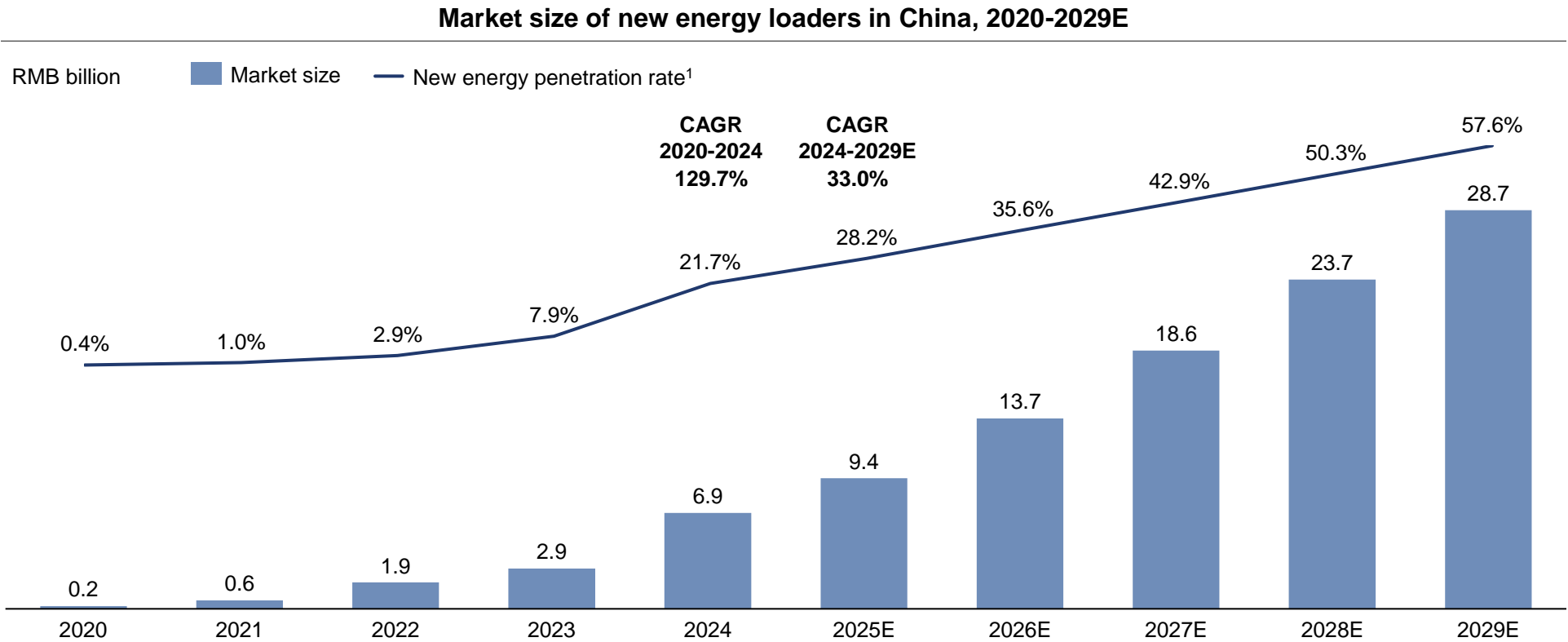
#### Full lifecycle costs analysis of five-tonne loader

	Fuel	Electric
Service life	5 years	
Full lifecycle energy consumption costs	RMB1,935,450	RMB428,625
Full lifecycle maintenance costs	RMB152,000	RMB76,500
Full lifecycle usage costs	RMB2,087,450	RMB505,125
Full lifecycle usage cost savings	RMB1,582,325	
Acquisition costs	RMB350,000	RMB760,000
<b>Full lifecycle cost savings</b>	<b>RMB1,172,325</b>	

#### Key assumptions

- Assuming that the unit price of No. 0 diesel fuel in China is RMB 7.59/liter and the unit price of commercial electricity in China is RMB 0.635/kWh;
- Assuming that the loader operates 10 hours/day excluding repair and maintenance time, and operates for 300 days in a year, i.e., 3,000 hours of use per year;
- Pure electric loader batteries, motors and other key components have a shelf life of 5-8 years, maintenance is relatively simple, each time only need to check the circuit system and connectors maintenance.

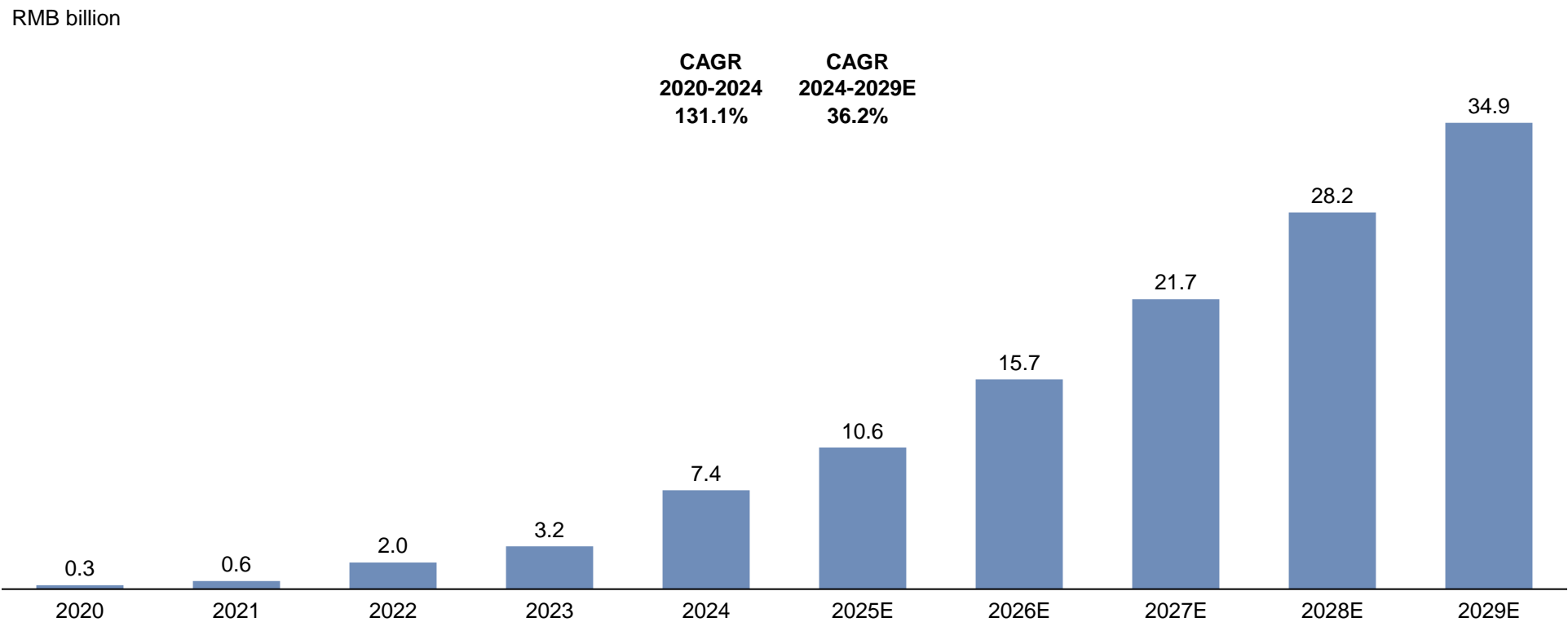
Existing technology has already enabled the commercial deployment of new energy loaders, driving the rapid growth of the new energy loader market. By 2029, the market size of new energy loaders in China is expected to reach RMB 28.7 billion.



- Key analysis
- The new energy loader market in China has experienced rapid growth driven by the rising demand attributable to new energy loaders' economic benefits and convenience of construction of charging stations and piles. The market size of new energy loaders in China increased from RMB0.2 billion in 2020 to RMB6.9 billion in 2024, representing a CAGR of 129.7%. With continual development of electrification technologies, enhanced economic efficiency and favorable policies, the new energy loader market in China is expected to continue to rapidly grow, with its market size increasing from RMB6.9 billion to RMB28.7 billion in 2029, representing a CAGR of 33.0%. The new energy penetration rate experienced increase from 0.4% in 2020 to 21.7% in 2024, and is expected to continue to increase to 57.6% in 2029.

Chinese manufacturers’ product capabilities are in the global top tier, leading to the significant overseas business growth. By 2029, the market size of new energy loader by Chinese manufacturers is expected to reach RMB 34.9 billion.

Market size of new energy loaders by Chinese manufacturers, 2020-2029E



Key analysis

- The international market has witnessed a rapid growth of Chinese new energy loader manufacturers. The market size of new energy loaders by Chinese manufacturers reached RMB7.4 billion in 2024 compared to RMB0.3 billion in 2020, representing a CAGR of 131.1%, and is expected to reach RMB34.9 billion in 2029, representing a CAGR of 36.2%.

Based on the shipments of new energy loaders in 2024, Breton is the biggest pure-play new energy engineering machinery company in China’s new energy loader market.

Competition landscape of China’s new energy loader market, 2024						
Ranking	Company	Principal Business	Shipments (units)	Market share	Revenue (billion)	Market share
1	Company A	Traditional engineering machinery company	~2900	24.5%	~1.6	23.6%
2	Company B	Traditional engineering machinery company	~2800	23.6%	~1.7	25.0%
3	Company C	Traditional engineering machinery company	~1500	12.6%	~0.9	12.8%
4	Company D	Traditional engineering machinery company	~1100	9.3%	~0.6	9.1%
5	Company E	Traditional engineering machinery company	~1000	8.4%	~0.6	8.1%
6	Company F	Traditional engineering machinery company	~520	4.4%	~0.3	4.2%
7	Breton	Pure-play new energy engineering machinery company	~450	3.8%	~0.3	4.1%
Total				86.6%		86.9%

Notes:

1. Company A is established in 1985, with headquarters in Jiangsu, China. Its products mainly include road engineering machinery, mechanical scrapers, and road machinery. It is a listed company on Shenzhen Stock Exchange.

2. Company B is established in 1989, with headquarters in Guangxi, China. It mainly designs and manufactures construction, industrial, agricultural, and robotics machinery. It is a listed company on the Shenzhen Stock Exchange.

3. Company C is a private company established in 2003, with headquarters in Shandong, China. Its products mainly include loaders, excavators, and road machinery, among others.

4. Company D is established in 1993, with its headquarters in Fujian, China. It mainly designs and manufactures loaders, rollers, excavators, forklifts, and relative components. It is a listed company on the Hongkong Stock Exchange.

5. Company E is established in 2000, with headquarters in Hunan, China. Its products mainly include construction and mining equipment, port machinery, and oil drilling machinery, among others. It is a listed company on the Shanghai Stock Exchange.

6. Company F is established in 1993, with its headquarter in Shandong, China. Its products mainly include bulldozers, road machinery, loaders, excavators, and concrete machinery. It is a listed company on the Shenzhen Stock Exchange.

## With environmental requirements continuously increasing, the electrification of wide-body dump trucks has become a crucial measure for building green mines.

### The overview of wide-body dump trucks

#### Definition and main functions



Wide-body dump trucks are heavy-duty off-road dump trucks mainly used to transport heavy materials, such as rock and ore. These over-sized machines are usually utilized in mining, energy and water conservancy projects. In particular, the significant growth of demand from open-pit mining industry further drives the development of wide-body dump truck industry.

#### Mining scenario

##### Complex terrain

The wide-body dump trucks have a large carrying capacity, and combined with the fact that many mining sites are located in mountainous areas with steep roads, frequent heavy-load uphill and downhill operations occur. This places higher demands on power, leading to high fuel consumption and maintenance costs for traditional wide-body dump trucks.



##### Road restrictions

As open-pit mines gradually transition to deep-pit mining, the mining conditions worsen, resulting in a reduction of the mining area and making it extremely challenging to lay out the routes. This leads to smaller curve radii and a higher number of turns in the route, which increases energy consumption.

##### External interference

Due to the open operation nature, wide-body dumping trucks are greatly affected by weather conditions such as high temperatures, heavy rain and snow. Adverse weather conditions can impact the energy consumption of trucks.

#### Policy trends

##### Policy drives green transformation

###### Policy Support

Some local governments proactively implement policies to incentivize the transition from traditional fuel-powered wide-body dump trucks to new energy products because of the economic benefits and the practical deployment of charging stations.

In May 2023, the government of Jungar Banner in Inner Mongolia Autonomous Region promulgated the "Jungar Banner New Energy Mining Truck and Heavy-duty Trucks Replacement Three-Year Action Plan" 《准格爾旗新能源礦卡重卡替換燃油礦卡重卡三年行動方案》. This initiative mandates all energy-related enterprises, including coal mines and power plants within the jurisdiction, to complete the replacement of 28,000 fuel-powered mining trucks with new energy counterparts by June 2026.

In December 2023, the "Jungar Banner New Energy Mining Truck Three-Year Replacement Implementation Plan" 《准格爾旗新能源礦卡重卡三年替代實施方案》 is released for solicitation of comments, furnishing a more comprehensive framework for the phased replacement.

**New energy wide-body dump trucks effectively reduce energy consumption costs, for a 105T wide-body dump truck on heavy-load uphill scenarios, new energy truck can save approximately RMB1.8~2.5 million in full lifecycle costs.**

### Economic calculations of fuel and electric 105T wide-body dump trucks on heavy-load uphill scenarios

- The complex working conditions in mining operations lead to high fuel consumption and maintenance costs for traditional wide-body dump trucks. In contrast, new energy wide-body dump trucks, powered by electricity, have significantly reduced operational and maintenance costs and therefore are increasingly adopted by the mining companies. For example, assuming a service lifespan of five years, a 105-tonne new energy wide-body dump truck in heavy-load uphill operations can save approximately RMB1.8 to 2.5 million in total costs during its entire lifecycle as compared to the traditional fuel-powered counterparts.

#### Energy consumption analysis of 105T wide-body dump truck

	Fuel	Electric
Average unit price of energy consumption	RMB7.59/L	RMB0.635/kWh
Average energy consumption volume per kilometer	2.8L (Diesel)	10.7kWh (Electricity)
Average mileage of use per day	150km	
Average energy consumption costs per day	RMB3,188	RMB1,019
Average days of use per year	300 days	
Average energy consumption costs per year	RMB956,340	RMB305,753
<b>Annual energy consumption cost savings</b>	<b>RMB650,588</b>	

#### Full lifecycle costs analysis of 105T wide-body dump truck

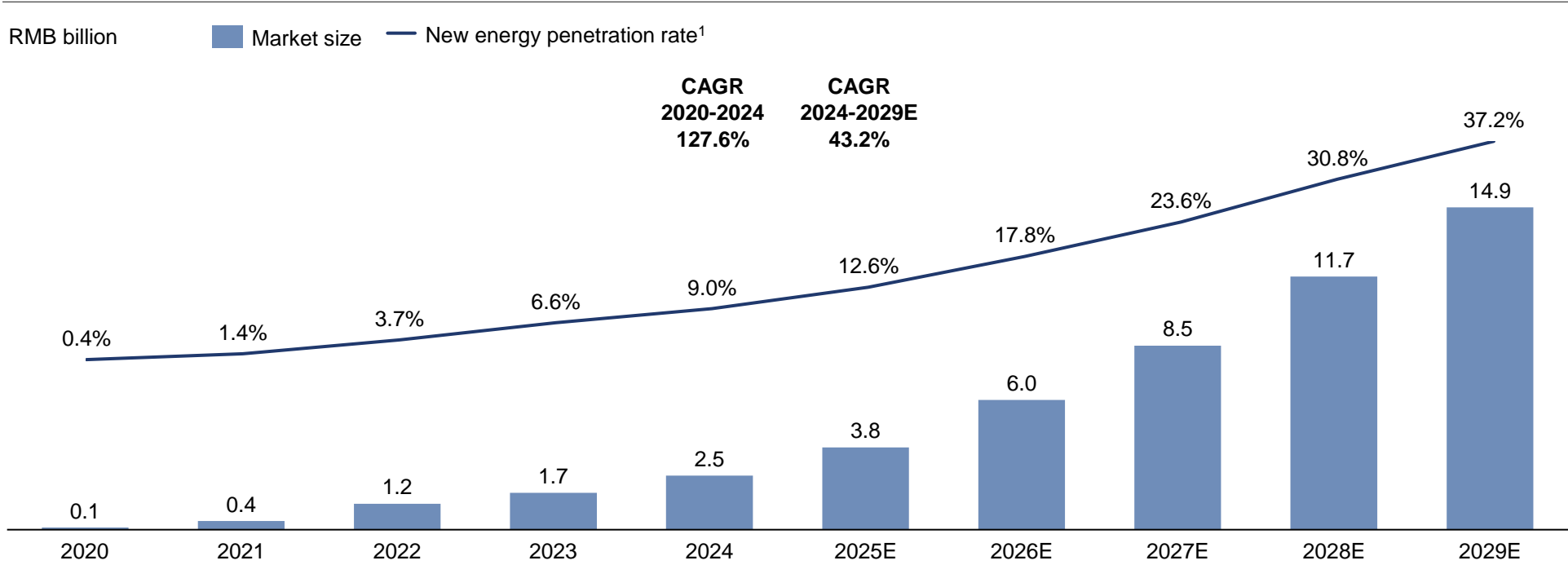
	Fuel	Electric
Service life	5 years	
Full lifecycle energy consumption costs	RMB4,781,700	RMB1,528,763
Full lifecycle maintenance costs	RMB200,000	RMB125,000
Full lifecycle usage costs	RMB4,981,700	RMB1,653,763
Full lifecycle usage cost savings	RMB3,327,938	
Acquisition costs	RMB800,000	RMB2,050,000
<b>Full lifecycle cost savings</b>	<b>RMB2,077,938</b>	

#### Key assumptions

- Assuming that the unit price of No. 0 diesel fuel in China is RMB 7.59/liter and the unit price of commercial electricity in China is RMB 0.635/kWh;
- Assuming that a 105T wide-body dump truck with an average daily operational distance of 150 kilometers, and operates for 300 days in a year;
- Pure electric wide-body dump trucks batteries, motors and other key components have a shelf life of 5-8 years, maintenance is relatively simple, each time only need to check the circuit system and connectors maintenance.

With the implementation of environmental policies and advancements in technology, the new energy wide-body dump truck market in China keeps growing. By 2029, the market size is expected to reach RMB 14.9 billion.

Market size of new energy wide-body dump trucks in China, 2020-2029E



Key analysis

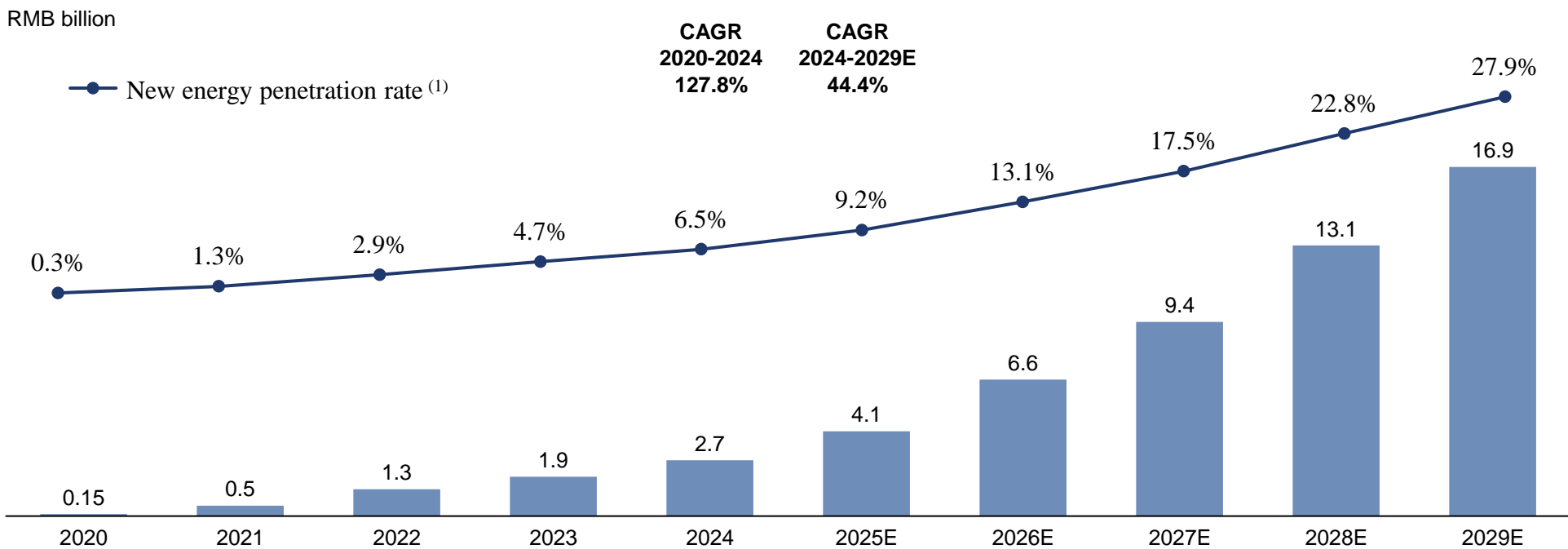
- China's new energy wide-body dump truck market has experienced rapid growth driven by the increasing acceptance by customers in the mining industry thanks to its economic benefits. As wide-body dump trucks typically operate in mines and quarries, the design and installation of charging stations for these machines are manageable and affordable. The practical deployment of charging stations enables a higher utilization rate of new energy wide-body dump trucks, further promoting the transition from traditional fuel-powered engineering machinery to its new energy alternatives. Furthermore, some local governments proactively implement policies to incentivize the transition from traditional fuel-powered wide-body dump trucks to the new energy alternatives.
- In 2024, the market size of new energy wide-body dump trucks in terms of revenue generated by both Chinese and foreign manufacturers in China reached RMB2.5 billion as compared to RMB0.1 billion in 2020, representing a CAGR of 127.6%, and is expected to further reach RMB14.9 billion in 2029, representing a CAGR of 43.2%. The new energy penetration rate observed increase from 0.4% in 2020 to 9.0% in 2024, and is expected to further increase to 37.2% in 2029.

Note 1: The new energy penetration rate is calculated by dividing the shipments of new energy wide-body dump trucks by the shipments of all wide-body dump trucks in China.

Source: China Insights Consultancy

Chinese new energy wide-body dump trucks are steadily expanding their presence in the international market, leading to the significant overseas growth. By 2029, the market size by Chinese manufacturers is expected to reach RMB 16.9 billion.

Market size of new energy wide-body dump trucks by Chinese manufacturers, 2020-2029E

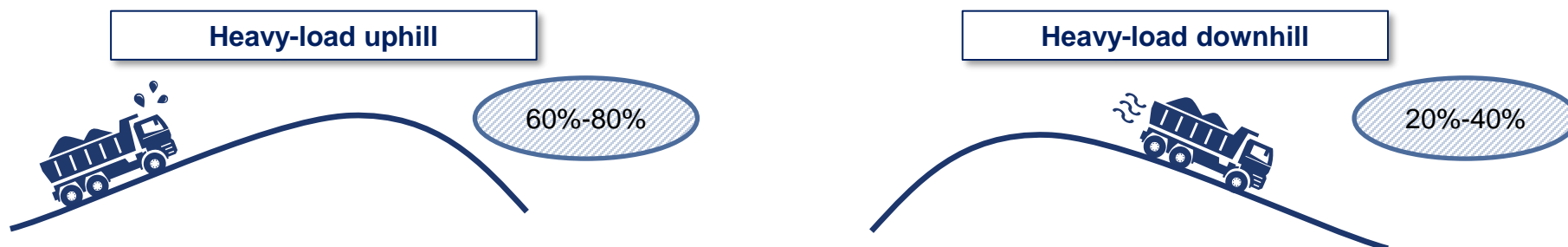


Key analysis

- New energy wide-body dump trucks produced by Chinese manufacturers are steadily expanding their presence in the international market. This is attributable to their impressive achievements, such as robust driving stability control system, heightened safety features, and competitive prices. In 2024, the market size of new energy wide-body dump trucks in terms of revenue of both domestic and export sales by Chinese manufacturers reached RMB2.7 billion as compared to RMB0.1 billion in 2020, representing a CAGR of 127.8%. As Chinese new energy wide-body dump truck manufacturers continue to enhance their product capabilities and establish a broader network of marketing channels, the market size is expected to further increase to RMB16.9 billion in 2029, representing a CAGR of 44.4%.

**With most players focusing on the heavy-load down hill scenario, wide-body dump trucks that overcome the major scenario of heavy-load uphill will gain market opportunity.**

#### Overview of main operating scenarios for wide-body dump trucks



- Heavy-load downhill and uphill are two main operating scenarios for wide-body dump trucks. In the heavy-load downhill operation, such as sand and gravel mines, the requirements for motor power of wide-body dump trucks are lower and the regenerative braking system can be effectively utilized, resulting in better economic efficiency performance. The majority of new energy wide-body dump truck companies primarily target customers in heavy-load downhill operations. Heavy-load uphill operations, primarily in mining operations, represent 60% to 80% of all wide-body dump truck application operations. In heavy-load uphill operations, new energy wide-body dump trucks operate for long periods with high power consumption, placing higher demands on their energy storage systems than operating in the heavy-load downhill operation.
- New energy wide-body dump trucks primarily address the requirements of heavy-load uphill operations through two technological approaches, including i) enhancing battery capacity to extend the single-charge range, and ii) improving the effective operational duration of new energy wide-body dump trucks through battery swapping technology. Leading companies are actively investing in research and development to ensure their new energy wide-body dump trucks deliver outstanding performance in heavy-load uphill operations. Enhancing battery capacity for new energy wide-body dump trucks requires lower initial capital investment as compared to application of battery swapping technology. As a result, enhancing battery capacity becomes the primary technological approach for new energy wide-body dump truck manufacturers to equip their products for heavy-load uphill operations. Generally, long-endurance 105-tonne new energy wide-body dump trucks with batteries exceeding approximately 650 kWh capacity could effectively balance customers' demands for extended endurance and efficient procurement cost, as of the Latest Practicable Date. Consequently, the majority of leading new energy wide-body dump truck manufacturers are actively investing in the development of longendurance new energy wide-body dump trucks equipped with batteries of at least 650 kWh capacities. However, as of the Latest Practicable Date, only a few market players had launched commercialized wide-body dump trucks for heavy-load uphill operations with more than 650kWh battery capacity. In consideration of the wide applications of wide-body dump trucks for heavy-load uphill operations, the capability to launch wide-body dump trucks for heavy-load uphill operations leads to a greater market opportunity for the market players over their peers.

**Breton is the biggest pure-play new energy engineering machinery company in the new energy wide-body dump truck market, with the ability to achieve the commercial deployment of heavy-load uphill scenarios.**

Competition landscape of China's new energy wide-body dump truck market, 2024

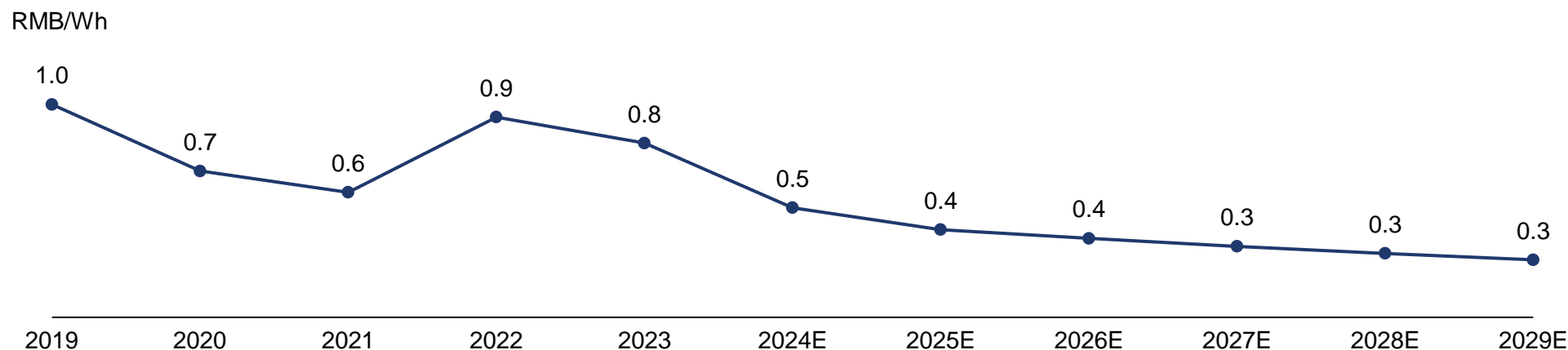
Ranking	Company	Principal Business	Shipments (units)	Market share	Revenue (billion)	Market share
1	Company G	Traditional engineering machinery company	~420	25.0%	~0.6	25.2%
2	Company H	Traditional engineering machinery company	~400	23.9%	~0.6	24.3%
3	<b>Breton</b>	<b>Pure-play new energy engineering machinery company</b>	<b>~307</b>	<b>18.3%</b>	<b>~0.4</b>	<b>18.2%</b>
4	Company E	Traditional engineering machinery company	~170	10.1%	~0.2	9.5%
5	Company I	Traditional engineering machinery company	~100	6.0%	~0.1	5.7%
<b>Total</b>				<b>83.3%</b>		<b>82.9%</b>

## Notes:

1. Company G is established in 2003, with headquarters in Henan, China, and focuses on manufacturing buses, trucks, specialized vehicles, components, and engineering machinery. It holds ownership of two entities listed on the Shanghai Stock Exchange.
2. Company H is established in 2005, with headquarters in Shaanxi, China, and focuses on manufacturing mining dump trucks. It is a listed company on Beijing Stock Exchange.
3. Company I is a private company established in 2005, with headquarters in Shandong, China. Its products mainly include mining machinery, mining trucks, aerial work platforms, excavators, and road machinery, among others.

**Due to LFP power battery's technological advances, decreased manufacturing costs and increased production volume, LFP power battery price is anticipated to maintain a declining trend in the future.**

Average LFP power battery price in China, 2019-2028E

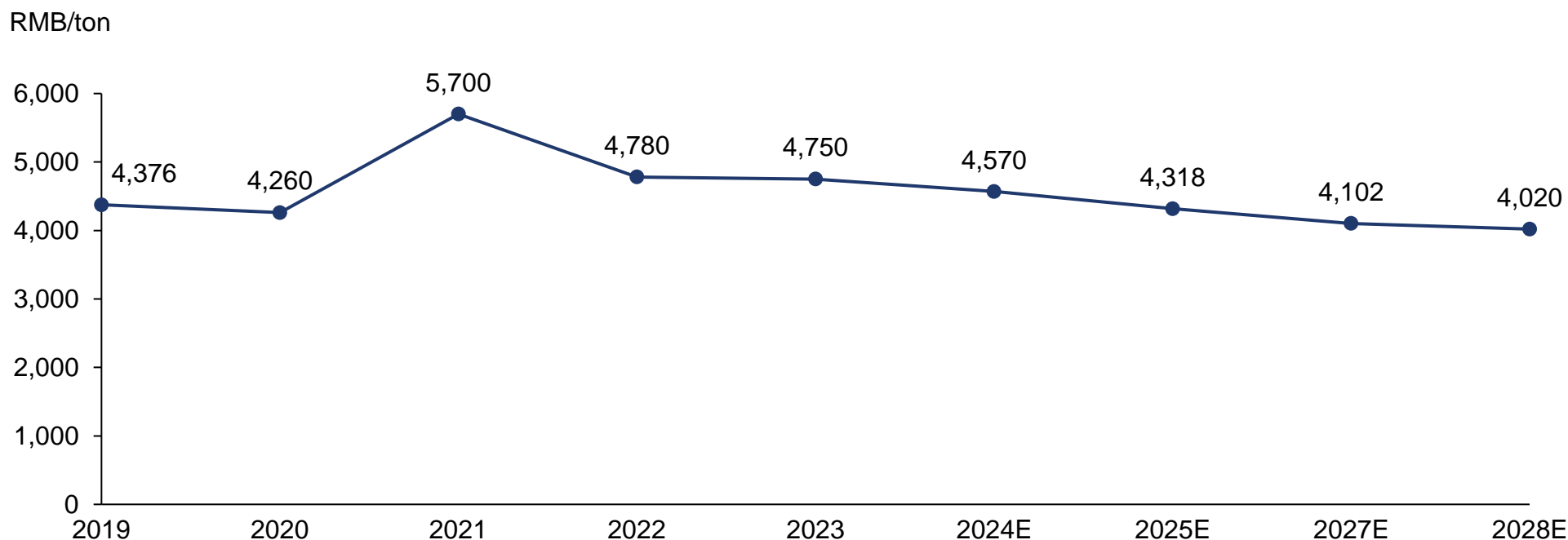


### Key analysis

- The key components and raw materials for new energy engineering machinery mainly include: (i) battery cells; (ii) metal, such as copper, aluminum and stainless steel; and (iii) e-powertrains. The operating results of new energy engineering machinery companies can be adversely affected by price hikes or supply fluctuations of raw materials as a result of changes in macroeconomic conditions, supply and demand, as well as market prospects.
- At present, lithium iron phosphate(LFP)batteries have emerged as the dominant battery technology employed by new energy engineering machinery. The LFP battery's price experienced fluctuations during 2020 to 2024. Due to LFP battery's technological advances, decreased manufacturing costs and increased production volume, its price decreased from RMB0.7 per watt-hour in 2020 to RMB0.6 per watt-hour in 2021. Its price increased to RMB0.9 per watt-hour in 2022, due to the rising costs of its raw materials and increasing downstream demand. In particular, the price of lithium carbonate, a critical upstream material for the LFP battery, surged rapidly from 2021 to 2022.
- Since the end of 2022, the price of battery-grade lithium carbonate, a key raw material for LFP batteries, has continued to fluctuate downward, dropping from approximately RMB570 thousand per tonne in December 2022 to around RMB75 thousand per tonne in December 2024, showing a decrease of over 80%. In the year ended December 31, 2024, the average LFP battery price in China amounted to RMB0.52 per watt-hour, showing a decrease of 37.1% compared to that in the year ended December 31, 2023. Considering the continuous growth in the supply of battery-grade lithium carbonate and the expected launch of low-cost salt lake lithium carbonate projects in the future, a supply surplus of battery-grade lithium carbonate is anticipated to persist. In addition to the declining raw material prices, advancements in low-cost technological pathways for LFP batteries are driving sustained production capacity expansion, expected to result in oversupply. Therefore, it is expected that the price of LFP batteries will maintain a declining trend in the future. According to CIC, the average LFP battery price in China is expected to further decrease to around RMB0.3 per watt-hour in 2029.

**Breton utilizes steel as its primary metal in production, with Q355B being the most commonly used grade, while the e-powertrains constitute approximately 30%-50% of the overall cost of the new energy engineering machinery on average.**

Average Q355B Steel Price in China, 2019-2023



#### Key analysis

- The Company utilizes steel as its primary metal in production, with Q355B being the most commonly used grade. Metal is the primary raw material used in the production of key components for engineering machinery, such as chassis, structural components, frames, and axles, aside from LFP batteries. The prices of these components are largely influenced by metal prices. The diagram below shows the average prices of Q355B steel in China during the specified periods. Driven by increasing iron ore production, global oversupply of steel is expected to keep steel prices declining from approximately RMB4,750 per ton in 2023 to approximately RMB4,020 per ton 2028.
- Given the variance in machinery types and specifications, the configuration and associated costs of the components of the e-powertrains are diversified, thereby complicating the establishment of a uniform pricing model.

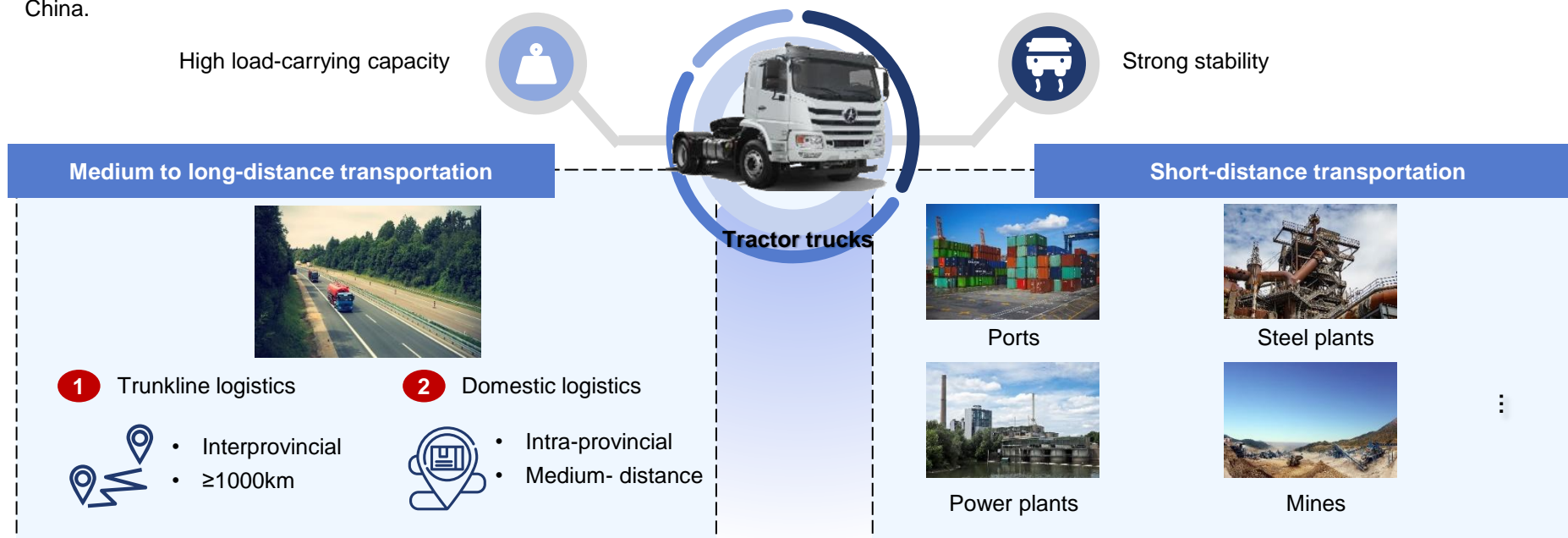


1. Overview of China's Engineering Machinery Industry
2. Overview of China's New Energy Engineering Machinery Industry
- 3. Overview of Global New Energy Tractor Trucks Industry**

**Tractor trucks are widely used in long-distance transportation on highways and for short-distance transportation scenarios. With heavy loads, tractor trucks cause significant pollution emissions and energy consumption costs.**

### Definition, characteristics and applications of tractor trucks

- Tractor trucks refer to vehicles with the ability to provide motive power and designed for towing trailers, which are widely used in long-distance and short-distance transportation with heavy loads. Tractor truck is a category of commercial vehicles. The Regulations for Commercial Vehicle Manufacturers and Product Admission Management (《商用车生产企业及产品准入管理规则》) published by MIIT imposes stringent requirements on production capabilities of the commercial vehicles and their critical components. Tractor truck manufacturers shall possess the requisite qualifications to produce tractor truck vehicles in China.



**80%+** carbon emissions in the entire transportation sector are from road transportations



**60%+** carbon emissions in the entire transportation sector are from **road freight transportations**

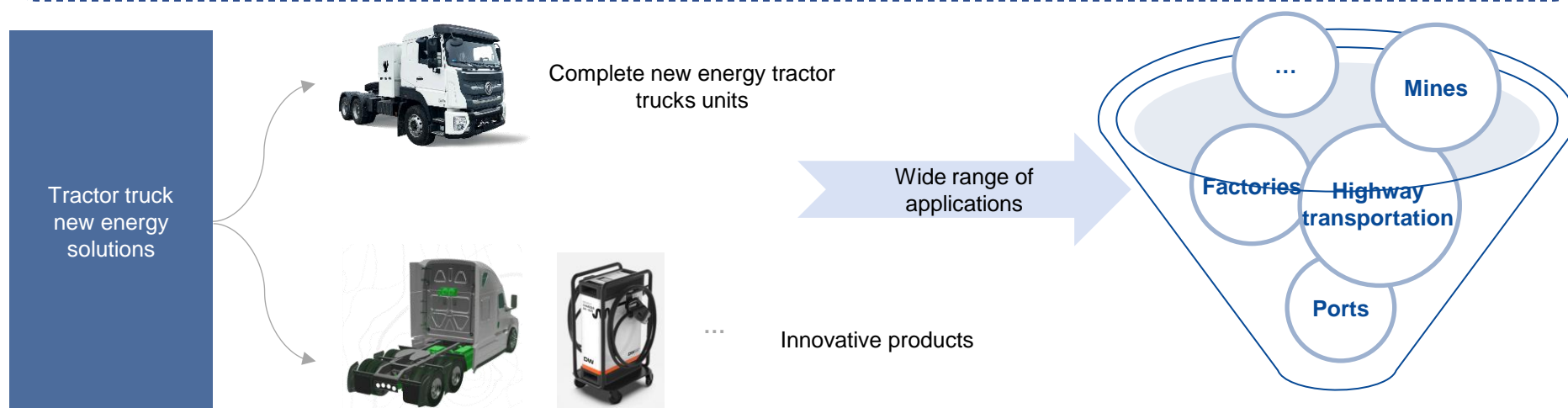


**48.6%** of vehicles applied in China's highway freight transportation are tractor trucks in 2022

**Currently, many new-energy solutions for tractor trucks are sold in the form of complete new energy tractor truck units, while leading players are actively developing innovative products.**

### Definition and features of tractor truck new energy solutions

- New energy tractor truck industry entails the conversion of traditional fuel-powered tractor trucks into vehicles powered by new energy sources. These solutions predominantly encompass new energy tractor trucks, components for tractor truck electrification, and other fittings. Due to the multitude of technical capabilities involved in the production of new energy tractor truck industry, it is challenging for a single enterprise to comprehensively possess all the requisite technological capabilities. Consequently, most clean energy solution providers for tractor trucks choose to externally source certain components to enhance product stability and expedite the mass production process. Typically, the externally sourced components encompass remote operation system, battery system and power system.



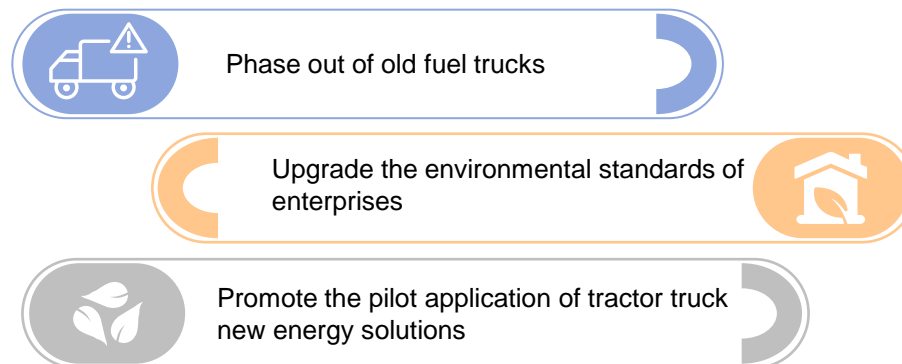
### Driving factors of tractor truck new energy solutions:

#### Environmental policy requirements

- With the synergistic reduction of carbon and pollution emissions, traditional tractor trucks are facing more environmental pressure, and tractor truck new energy transition becomes a prominent trend.

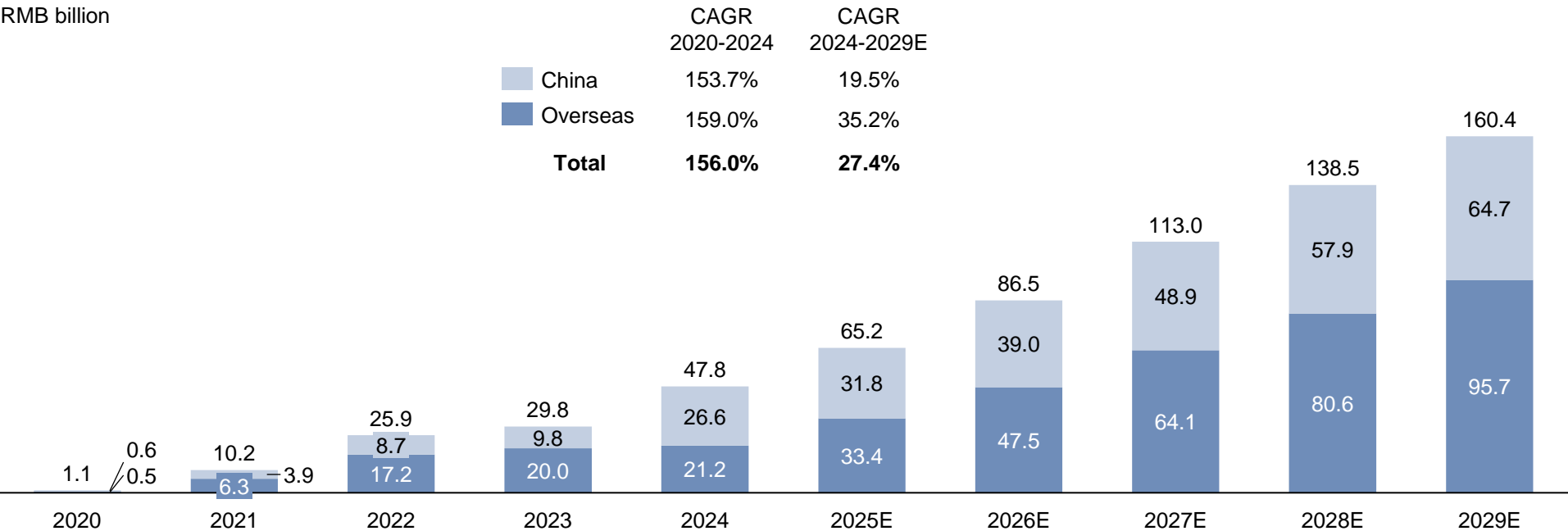
#### Economical advantages

- Compared with traditional tractor trucks, new energy tractor trucks have lower costs for daily use, leading to a better product economy.



The application of new-energy solutions for tractor trucks is continuously increasing, and the global market is entering a period of rapid growth. By 2029, the market size is expected to reach RMB 160.4 billion.

Market size of global new energy tractor trucks, 2020-2029E



Key analysis

- With the continuous implementation of supportive policies for new energy tractor trucks, advancements in new energy technologies, industry and the innovation of new energy products, the new energy tractor truck industry has experienced exponential growth. In 2024, the market size of global new energy tractor truck in terms of revenue reached RMB47.8 billion, representing a CAGR of 156.0% from 2020 to 2024, and is expected to reach RMB160.4 billion in 2029, representing a CAGR of 27.4% from 2024 to 2029.
- Additionally, some companies in the new energy tractor truck industry provide an auxiliary e-powertrain as the complementary new energy transition solution for fuel-powered tractor trucks, providing an independent power system to work with the existing internal combustion engine. This device enables fuel-powered tractor trucks to gain additional electric propulsion, thereby achieving the operational effect of a hybrid tractor truck without any modifications to the original internal power system. Currently, the market size for this type of complementary products accounts for no more than 0.5% of the global new energy tractor truck market in terms of revenue in 2024.

# Verifications

The following statements disclosed in the Prospectus are correct and accurate based on our checking of industry data and /or our research.

- According to CIC, we ranked third and seventh among all manufacturers of new energy wide-body dump trucks and loaders in China, with a market share of 18.3% and 3.8% in terms of shipments in 2024, respectively, being the only pure-play manufacturer among the top manufacturers of these two types of new energy engineering machinery. In 2024, we achieved a market share of 3.2% in the wide-body dump truck market and 1.3% in the loader market in China in terms of revenue. We also design and develop e-powertrain kits for battery-electric tractor trucks and collaborate with manufacturers to bring these vehicles to market.
- According to CIC, we ranked first in shipments of battery-electric wide-body dump trucks with battery capacities exceeding 650 kWh for three consecutive years from 2022 to 2024.
- This innovation makes us the first in the market to enable a 700-kWh battery to be fully charged within approximately 70 minutes under standard working conditions, according to CIC.
- Moreover, we are the first manufacturer in China to bring autonomous battery-electric wide-body dump trucks and remote-operate battery-electric loaders to the market, according to CIC.
- According to CIC, the number of engineering machines in operation in 2022 is less than 3% of the number of registered cars. However, the engineering machinery industry emits substantially higher levels of pollutants compared to the automobile industry. Specifically, in China, emissions of carbon dioxide, nitrogen oxide and particulate matter from engineering machinery in 2022 are equivalent to 13%, 20% and 109% of those from automobiles, respectively, according to CIC.
- According to CIC, while new energy passenger vehicles took eight years to reach a 5.5% market penetration rate from a negligible base, new energy loaders and wide-body dump trucks achieved the same in less than six years.
- Furthermore, these machines operate at lower noise levels, with our battery-electric loaders and wide-body dump trucks averaging 70 decibels and 74 decibels, respectively, substantially quieter than the 86 decibels and 82 decibels typically produced by their fuel-powered counterparts, according to CIC.
- According to CIC, the BRT105E, a 105-tonne battery-electric wide-body dump truck with a 700-kWh battery, is the first in China capable of performing uphill tasks for over 5.5 hours continuously on a single charge.
- The average price of an LFP battery increased from RMB0.6 per watt-hour in 2021 to RMB0.9 per watt-hour in 2022, and then decreased to RMB0.8 per watt-hour and RMB0.5 per watt-hour in 2023 and 2024, according to CIC.
- According to CIC, the market size of new energy major engineering machinery categories in China in terms of revenue increased from RMB23.5 billion in 2020 to RMB54.0 billion in 2024, representing a CAGR of 23.2%, and is expected to increase to RMB124.2 billion in 2029, representing a CAGR of 18.1%.
- According to CIC, the market size of new energy major engineering machinery categories in China's mining, logistics and ports, industrial and manufacturing, and construction industries reached RMB5.6 billion, RMB13.0 billion, RMB15.7 billion, and RMB4.7 billion in 2024, respectively, expected to reach RMB25.4 billion, RMB23.8 billion, RMB27.6 billion, and RMB18.2 billion in 2029, at a CAGR of 35.5%, 12.8%, 11.9%, 31.3%, respectively.
- For the next five years, according to CIC, lithium carbonate prices are expected to gradually decline and steel prices to remain stable, while costs for key components such as gearboxes and electric motor controls are projected to decrease, provided supply-demand dynamics and logistic costs remain steady.
- According to CIC, in some overseas mining operations, underdeveloped power infrastructure has historically limited the adoption of electrified equipment. Regions with unreliable grid connectivity or insufficient energy storage capacity face challenges in deploying high-voltage charging systems for battery-electric machinery.
- The average price of LFP battery is expected to maintain a decrease trend in the near future, according to CIC.
- According to the CIC Report, the market size of major engineering machinery categories in terms of revenue generated by both Chinese and foreign manufacturers in China is expected to increase from RMB182.7 billion in 2024 to RMB336.0 billion in 2029, representing a CAGR of 13.0%.

# Verifications

- According to CIC, driven by increasing iron ore production, global oversupply of steel is expected to keep steel prices declining from approximately RMB4,750 per ton in 2023 to approximately RMB4,020 per ton 2028.
- According to CIC, we ranked third and seventh among all manufacturers of new energy wide-body dump trucks and loaders in China, with a market share of 18.3% and 3.8% in terms of shipments in 2024, respectively, being the only pure-play manufacturer among the top manufacturers of these two types of new energy engineering machinery.
- According to CIC, we ranked first in shipments of battery-electric wide-body dump trucks with battery capacities exceeding 650 kWh for three consecutive years from 2022 to 2024.
- This innovation makes us the first in the market to enable a 700-kWh battery to be fully charged within approximately 70 minutes under standard working conditions, according to CIC.
- Moreover, we are the first manufacturer in China to bring autonomous battery-electric wide-body dump trucks and remote-operated battery-electric loaders to the market, according to CIC.
- According to CIC, while new energy passenger vehicles took eight years to reach a 5.5% market penetration rate from a negligible base, new energy loaders and wide-body dump trucks achieved the same in less than six years.
- According to CIC, the number of engineering machines in operation in 2022 is less than 3% of the number of registered cars. However, the engineering machinery industry emits substantially higher levels of pollutants compared to the automobile industry. Specifically, in China, emissions of carbon dioxide, nitrogen oxide and particulate matter from engineering machinery in 2022 are equivalent to 13%, 20% and 109% of those from automobiles, respectively, according to CIC.
- According to CIC, while new energy passenger vehicles took eight years to reach a 5.5% market penetration rate from a negligible base, new energy loaders and wide-body dump trucks achieved the same in less than six years.
- Furthermore, these machines operate at lower noise levels, with our battery-electric loaders and wide-body dump trucks averaging 70 decibels and 74 decibels, respectively, substantially quieter than the 86 decibels and 82 decibels typically produced by their fuel-powered counterparts, according to CIC.
- According to CIC, the BRT105E, a 105-tonne battery-electric wide-body dump truck with a 700-kWh battery, is the first in China capable of performing uphill tasks for over 5.5 hours continuously on a single charge.
- Our battery-electric loaders are the first of their kind to receive certification from the Quality Inspection and Testing Center of Construction Machinery of the PRC in July 2020, according to CIC, which validates their quality and paves the way for commercial success.
- According to CIC, we ranked third and seventh among all manufacturers of both new energy wide-body dump trucks and loaders in China, with a market share of 18.3% and 3.8% in terms of shipments in 2024, respectively, being the only pure-play manufacturer among the top manufacturers of these two types of new energy engineering machinery.
- According to CIC, we ranked first in shipments of battery-electric wide-body dump trucks with battery capacities exceeding 650 kWh for three consecutive years from 2022 to 2024.
- The charging time, according to CIC, is comparable to that of a model equipped with a 350-kWh battery available in the market. According to the same source, we are also the first in China to develop and commercialize a dual-motor design for engineering machinery, which addresses the technical issue of mutual interference and power diversion between the drive and working motors, thereby significantly reducing energy consumption and lowering repair and maintenance costs. Moreover, we are the first manufacturer in China to bring autonomous battery-electric wide-body dump trucks and remote-operated battery-electric loaders to the market, according to CIC.

# Verifications

- Utilizing our expertise in e-powertrain and electrical and electronic architecture, we introduced a charging circuit design for our battery-electric wide-body dump trucks that integrates four-branch parallel charging circuits, making us the first in the market to enable a 700-kWh battery to be fully charged within approximately 70 minutes under standard working conditions, according to CIC.
- Furthermore, our loaders operate at low noise levels, averaging approximately 70 decibels, much quieter than the 86 decibels typically generated by traditional fuel-powered loaders, according to CIC.
- According to CIC, the average lifespan of both fuel-powered and battery-electric loaders is five years.
- Fuel-powered loaders incur annual maintenance cost of RMB30,000 due to their mechanical structures. In contrast, battery-electric loaders have annual maintenance cost of RMB15,000, according to CIC.
- The purchase cost of a five-tonne fuel-powered loader from a typical Chinese machinery manufacturer is RMB350,000, according to CIC.
- According to CIC, the selling prices of three-tonne to seven-tonne fuel-powered loaders in China range from approximately RMB0.25 million to RMB0.8 million, with an average lifespan comparable to our battery-electric loaders at approximately five years.
- According to CIC, the average lifespan of both fuel-powered and battery-electric wide-body dump trucks is approximately five years.
- Fuel-powered wide-body dump trucks incur annual maintenance cost of RMB40,000 due to their mechanical structures. In comparison, battery-electric wide-body dump trucks have annual maintenance cost of RMB25,000, according to CIC.
- The purchase cost of a 105-tonne fuel-powered wide-body dump truck from a typical Chinese machinery manufacturer is RMB800,000, according to CIC.
- According to CIC, the selling prices of fuel-powered wide-body dump trucks in China range from approximately RMB0.7 million to RMB0.9 million, with an average lifespan comparable to our battery-electric wide-body dump trucks at approximately five years.
- We have developed a full stack of proprietary software for the autonomous and remote operations of our engineering machinery, making us the first in China to commercialize remote-operated battery-electric loaders and autonomous battery-electric wide-body dump trucks, according to CIC.
- According to CIC, end users generally prefer replacing the entire machine rather than just the battery, as component wear over time can impact overall machinery stability.
- According to CIC, the production and procurement cycle for fuel-powered loaders typically ranges from 40 to 60 days.
- According to CIC, the production and procurement cycle for fuel-powered wide-body dump trucks typically ranges from 40 to 60 days.
- We find this arrangement to be more cost-effective, as it allows us to focus on supplying e-powertrain kits and distributing the assembled tractor trucks, rather than obtaining manufacturing qualifications ourselves. According to CIC, this collaboration arrangement is common in the new energy tractor truck industry.
- According to CIC, the new energy loader market in China is projected to grow from RMB6.9 billion in 2024 to RMB28.7 billion in 2029, with a CAGR of 33.0% from 2024 to 2029. According to the same source, the new energy wide-body dump truck market in China is expected to grow from RMB2.5 billion in 2024 to RMB14.9 billion in 2029, with a CAGR of 43.2% from 2024 to 2029.
- We extend our market reach beyond direct sales by leveraging a network of distributors across China, a prevalent strategy in the new energy engineering machinery industry in China, according to CIC.
- According to CIC, the associated distributorship model is a widely accepted practice in the engineering machinery industry.
- According to CIC, many leading players in engineering machinery industry also adopt a strategy to leverage associated distributors to strengthen their regional sales coverage.
- The referral fee was determined based on the difference between the final selling prices of our products and our target selling prices, adjusted for any value-added tax differences, which is in line with industry practice, according to CIC.
- According to CIC, it is common in the new energy engineering machinery and tractor truck industries for all participants along the supply chain, such as manufacturers, distributors, end users, and component suppliers, to utilize each other's engineering and post-sale service capabilities within their respective regions, which facilitates to provide timely and efficient repair and maintenance services for products or components as needed.

# Verifications

- According to CIC, we ranked third and seventh among all manufacturers of new energy wide-body dump trucks and loaders in China, with a market share of 18.3% and 3.8% in terms of shipments in 2024, respectively, being the only pure-play manufacturer among the top manufacturers of these two types of new energy engineering machinery. In 2024, we achieved a market share of 3.2% in the wide-body dump truck market and 1.3% in the loader market in China in terms of revenue.
- The average price of LFP battery is expected to maintain a decrease trend in the near future, according to CIC.
- The average price of LFP battery increased from RMB0.6 per watt-hour in 2021 to RMB0.9 per watt-hour in 2022, and then decreased to RMB0.8 per watt-hour and RMB0.5 per watt-hour in 2023 and 2024, according to CIC.
- According to CIC, the market size of new energy major engineering machinery categories in China in terms of revenue increased from RMB23.5 billion in 2020 to RMB54.0 billion in 2024, representing a CAGR of 23.2%, and is expected to increase to RMB124.2 billion in 2029, representing a CAGR of 18.1%. The new energy penetration rate of engineering machinery industry is currently modest, especially that of loaders and wide-body dumptrucks, but is expected to rise in the future. According to CIC, the additional procurement cost of battery-electric loaders and wide-body dump trucks compared to fuel-powered products can typically be recovered within approximately two years, thanks to the energy savings. The economic advantages of new energy engineering machinery are anticipated to drive a substantial increase in the penetration rate, which would be further accelerated by the entry of additional industry players. According to CIC, the new energy penetration rate of loader and wide-body dump trucks in China was 21.7% and 9.0% in 2024, respectively, and is expected to increase significantly and reach 57.6% and 37.2% in 2029, respectively.
- According to CIC, the market size of new energy major engineering machinery categories in China's mining, logistics and ports, industrial and manufacturing, and construction industries reached RMB5.6 billion, RMB13.0 billion, RMB15.7 billion, and RMB4.7 billion in 2024, respectively, expected to reach RMB25.5 billion, RMB23.8 billion, RMB27.6 billion, and RMB18.2 billion in 2029, at a CAGR of 35.5%, 12.8%, 11.9%, and 31.3%, respectively.
- The average price of LFP battery is expected to maintain a decrease trend in the near future, according to CIC.
- For the next five years, according to CIC, lithium carbonate prices are expected to gradually decline and steel prices to remain stable, while costs for key components such as gearboxes and electric motor controls are projected to decrease, provided supply-demand dynamics and logistic costs remain steady.
- From 2022 to 2024, our shipments of battery-electric wide-body dump trucks grew from 59 to 307 units, and shipments of battery-electric loaders increased from 326 to 450 units, achieving a CAGR of 128.1% and 17.5%, respectively.
- Additionally, it is typical for existing customers to introduce new ones to manufacturers in exchange for referral fees, and for suppliers of raw materials and components to purchase finished products from their downstream manufacturers for their own use.

## Verifications

- The market penetration rate of battery-electric forklifts in China increased from 22.7% in 2010 to 41.0% in 2017 and further to 67.9% in 2023, as detailed in the following table.

Market penetration rate	2010	2011	2012	2013	2014	2015	2016
Battery-electric forklifts	22.7%	26.5%	27.7%	27.1%	30.6%	36.7%	38.2%
Market penetration rate	2017	2018	2019	2020	2021	2022	2023
Battery-electric forklifts	41.0%	47.1%	49.1%	51.3%	59.8%	64.4%	67.9%

- The market penetration rate of battery-electric aerial work platforms in China increased from approximately 10% in 2000 to 60.0% in 2018 to 91.7% in 2023, as detailed in the following table.

Market penetration rate	2000	2018	2019	2020	2021	2022	2023
Battery-electric aerial work platforms	~10%	60.0%	67.8%	75.5%	83.3%	91.0%	91.7%

# Verifications

- The shipment, sales revenue and average selling price of the peers of the Company was obtained by CIC through interviews with distributors of the peer companies.

## The approximate shipment of battery-electric wide-body dump trucks of Breton and its peers, 2021-2023

Company Name	2021	2022	2023	CAGR from 2021 to 2023
		(units)		%
Zhengzhou Yutong Group Co.,Ltd. (鄭州宇通集團有限公司)	150	300	450	73.2
Shaanxi Tonly Heavy Industries Co., Ltd. (陝西同力重工股份有限公司)	70	100	250	89.0
Sany Group Co.,Ltd. (三一集團有限公司)	50	100	150	73.2
Breton	12	59	96	182.8
Linyi Lingong Machinery Group Co., Ltd. (臨沂臨工機械集團有限公司)	20	40	70	87.1

# Verifications

The approximate revenue from sales of battery-electric wide-body dump trucks of Breton and its peers, 2021-2023

Company Name	2021	2022	2023	CAGR from 2021 to 2023
	(RMB in millions)			%
<b>Zhengzhou Yutong Group Co.,Ltd. (鄭州宇通集團有限公司)</b>	228.4	453.4	675.0	71.9
<b>Shaanxi Tonly Heavy Industries Co., Ltd. (陝西同力重工股份有限公司)</b>	110.1	156.2	387.5	87.6
<b>Sany Group Co.,Ltd. (三一集團有限公司)</b>	71.1	141.1	210.0	71.9
<b>Breton</b>	10.1	76.3	126.5	254.6
<b>Linyi Lingong Machinery Group Co., Ltd. (臨沂臨工機械集團有限公司)</b>	27.4	54.4	94.5	85.7

# Verifications

The approximate average selling price of battery-electric wide-body dump trucks of Breton and its peers, 2021-2023

Company Name	2021	2022	2023
<i>(RMB in thousands)</i>			
<b>Zhengzhou Yutong Group Co.,Ltd. (鄭州宇通集團有限公司)</b>	1,523	1,511	1,500
<b>Shaanxi Tonly Heavy Industries Co., Ltd. (陝西同力重工股份有限公司)</b>	1,573	1,562	1,550
<b>Sany Group Co.,Ltd. (三一集團有限公司)</b>	1,421	1,411	1,400
<b>Breton</b>	914	1,293	1,437
<b>Linyi Lingong Machinery Group Co., Ltd. (臨沂臨工機械集團有限公司)</b>	1,370	1,360	1,350

# Verifications

The approximate shipment of battery-electric loaders of Breton and its peers, 2021-2023

Company Name	2021	2022	2023	CAGR from 2021 to 2023
		(units)		%
Guangxi Liugong Group Co.,Ltd. (廣西柳工集團有限公司)	300	650	1200	100.0
Xuzhou Construction Machinery Group Inc. (徐州工程機械集團有限公司)	80	260	850	226.0
Breton	140	326	525	93.6
Sany Group Co.,Ltd. (三一集團有限公司)	60	320	480	182.8
Shandong Lingong Construction Machinery Co.,Ltd. (山東臨工工程機械有限公司)	60	230	440	170.8

# Verifications

The approximate revenue from sales of battery-electric loaders of Breton and its peers, 2021-2023

Company Name	2021	2022	2023	CAGR from 2021 to 2023
	(RMB in millions)			%
<b>Guangxi Liugong Group Co.,Ltd. (廣西柳工集團有限公司)</b>	247.4	528.6	804.0	80.3
<b>Xuzhou Construction Machinery Group Inc. (徐州工程機械集團有限公司)</b>	66.0	211.4	569.5	193.8
<b>Breton</b>	84.7	183.7	281.2	82.1
<b>Sany Group Co.,Ltd. (三一集團有限公司)</b>	47.0	247.2	314.4	165.7
<b>Shandong Lingong Construction Machinery Co.,Ltd. (山東臨工工程機械有限公司)</b>	48.0	181.4	286.0	144.1

## Verifications

The approximate average selling price of battery-electric loaders of Breton and its peers, 2021-2023

Company Name	2021	2022	2023
<i>(RMB in thousands)</i>			
<b>Guangxi Liugong Group Co.,Ltd. (廣西柳工集團有限公司)</b>	825	813	670
<b>Xuzhou Construction Machinery Group Inc. (徐州工程機械集團有限公司)</b>	825	813	670
<b>Breton</b>	673	623	581
<b>Sany Group Co.,Ltd. (三一集團有限公司)</b>	783	773	655
<b>Shandong Lingong Construction Machinery Co.,Ltd. (山東臨工工程機械有限公司)</b>	800	789	650

# Verifications

## Energy consumption analysis of Breton's five-tonne loader

	Fuel	Electric
Average unit price of energy consumption	RMB7.59/L	RMB0.635/kWh
Average energy consumption volume per hour	17L (Diesel)	40kWh (Electricity)
Average hours of use per day	10h	
Average energy consumption costs per day	RMB1,290	RMB254
Average days of use per year	300 days	
Average energy consumption costs per year	Approximately RMB387,000	Approximately RMB76,000
<b>Annual energy consumption cost savings</b>	<b>Approximately RMB311,000</b>	

### Key assumptions

- Assuming that the unit price of No. 0 diesel fuel in China is RMB 7.59/liter and the unit price of commercial electricity in China is RMB 0.635/kWh;
- Assuming that the loader operates 10 hours/day excluding repair and maintenance time, and operates for 300 days in a year, i.e., 3,000 hours of use per year.

Note:

- The price of diesel refers to the average price of China's 0# diesel in 2023, based on the 0# diesel price released by regional Development and Reform Commission. The price of electricity refers to the average commercial and industrial business electricity price in China in 2023, in line with the price released by State Grid.
- The average energy consumption volume data illustrates the common performance metrics of both a five-tonne fuel-powered loader and a five-tonne battery-electric loader within typical operational environments. The data featured in the prospectus charts is also in line with the results detailed in an inspection report provided by the National Engineering Machinery Quality Inspection and Testing Center (國家工程機械品質檢驗檢測中心).
- Loaders are versatile engineering machines suitable for a wide range of operational scenarios. Typically, a workday of 10 hours reflects the common industry practice, according to CIC.
- Average energy consumption costs per day = Average unit price of energy consumption \* Average energy consumption volume per hour \* Average hours of use per day.
- Due to the necessity for personnel to observe holidays and the inherent requirement for loaders to undergo periodic maintenance and repairs, the annual operational days for loaders typically do not span the full 365 days of the year. It is common for loaders to operate for an average of 300 days per year, according to CIC.
- Average energy consumption costs per year = Average energy consumption costs per day \* Average days of use per year
- Annual energy consumption cost savings are calculated by comparing "Average energy consumption costs per year" of a fuel-powered loader and a battery-electric loader.

# Verifications

Full lifecycle costs analysis of Breton's five-tonne loader

	Fuel	Electric
Service life	5 years	
Full lifecycle energy consumption costs	Approximately RMB1,935,000	Approximately RMB380,000
Full lifecycle maintenance costs	Approximately RMB150,000	Approximately RMB75,000
Full lifecycle usage costs	Approximately RMB2,085,000	Approximately RMB455,000
Full lifecycle usage cost savings	Approximately RMB1,630,000	
Acquisition costs	Approximately RMB350,000	Approximately RMB760,000
<b>Full lifecycle cost savings</b>	<b>Approximately RMB1,220,000</b>	

## Key assumptions

- Pure electric loader batteries, motors and other key components have a shelf life of 5-8 years, maintenance is relatively simple, each time only need to check the circuit system and connectors maintenance.

### Note:

- Average energy consumption costs per year are calculated by the "Energy Consumption Saving Comparison".
- Typically, the service life of a diesel-powered loader is about 5-8 years. For battery-electric loaders, the service life is predominantly contingent upon the battery's longevity, with battery suppliers commonly warranting a minimum health level of 70% for 5 years. In practice, electric loaders can continue to operate beyond the battery supplier's warranty period, which is often 5 years. The lifespan of 5 years for both fuel-powered and battery-electric loaders is a conservative assumption, as an extension of this assumed lifespan would result in additional savings in the total lifespan cost savings for battery-electric loaders, according to CIC.
- Total energy consumption cost across the lifespan = Average energy consumption costs per year \* Typical lifespan
- Fuel-powered loaders, due to their more complex mechanical structures, incur relatively higher annual maintenance costs, typically amounting to RMB 30,000 per year. In contrast, battery-electric loaders have lower annual maintenance costs, usually around RMB 15,000 per year, according to CIC.
- Total usage cost savings across the lifespan is calculated by comparing "Total energy consumption cost across the lifespan" and "Total maintenance cost across the lifespan" of a fuel-powered loader and a battery-electric loader.
- The procurement cost of five-tonne fuel-powered loader is generally around RMB350,000, according to CIC.
- Total lifespan cost savings is calculated by comparing "Total usage cost savings across the lifespan" and "Procurement cost" of a fuel-powered loader and a battery-electric loader.

# Verifications

## Energy consumption analysis of Breton's 105T wide-body dump truck on heavy-load uphill operations

	Fuel	Electric
Average unit price of energy consumption	RMB7.59/L	RMB0.635/kWh
Average energy consumption volume per kilometer	2.8L (Diesel)	9.5kWh (Electricity)
Average mileage of use per day	150km	
Average energy consumption costs per day	RMB3,188	RMB905
Average days of use per year	300 days	
Average energy consumption costs per year	Approximately RMB956,000	Approximately RMB271,000
<b>Annual energy consumption cost savings</b>	<b>Approximately RMB685,000</b>	

### Key assumptions

- Assuming that the unit price of No. 0 diesel fuel in China is RMB 7.59/liter and the unit price of commercial electricity in China is RMB 0.635/kWh;
- Assuming that a 105T wide-body dump truck with an average daily operational distance of 150 kilometers, and operates for 300 days in a year.

Note:

- The price of diesel refers to the average price of China's 0# diesel in 2023, based on the 0# diesel price released by regional Development and Reform Commission. The price of electricity refers to the average commercial and industrial business electricity price in China in 2023, in line with the price released by State Grid.
- The average energy consumption volume data illustrates the common performance metrics of both a 105-tonne fuel-powered wide body dump truck and a 105-tonne battery-electric wide body dump truck within typical operational environments. The data featured in the prospectus charts is also in line with the results detailed in an inspection report provided by the National Engineering Machinery Quality Inspection and Testing Center (國家工程機械品質檢驗檢測中心).
- Wide-body dump trucks are primarily utilized in transportation scenarios, particularly in heavy-load uphill operations within mining environments. Generally, wide-body dump trucks are required to cover a distance of 150 kilometers daily, according to CIC.
- Average energy consumption costs per day = Average unit price of energy consumption \* Average energy consumption volume per kilometer \* Average mileage of use per day.
- Due to the necessity for personnel to observe holidays and the inherent requirement for wide-body dump trucks to undergo periodic maintenance and repairs, the annual operational days for loaders typically do not span the full 365 days of the year. It is common for wide-body dump trucks to operate for an average of 300 days per year, according to CIC.
- Average energy consumption costs per year = Average energy consumption costs per day \* Average days of use per year
- Annual energy consumption cost savings are calculated by comparing "Average energy consumption costs per year" of a fuel-powered wide-body dump truck and a battery-electric wide-body dump truck.

# Verifications

## Full lifecycle costs analysis of Breton's 105T wide-body dump truck on heavy-load uphill operations

	Fuel	Electric
Service life	5 years	
Full lifecycle energy consumption costs	Approximately RMB4,780,000	Approximately RMB1,355,000
Full lifecycle maintenance costs	Approximately RMB200,000	Approximately RMB125,000
Full lifecycle usage costs	Approximately RMB4,980,000	Approximately RMB1,480,000
Full lifecycle usage cost savings	Approximately RMB3,500,000	
Acquisition costs	Approximately RMB800,000	Approximately RMB2,050,000
<b>Full lifecycle cost savings</b>	<b>Approximately RMB2,250,000</b>	

### Key assumptions

- Pure electric wide-body dump trucks batteries, motors and other key components have a shelf life of 5-8 years, maintenance is relatively simple, each time only need to check the circuit system and connectors maintenance.

#### Note:

- Average energy consumption costs per year are calculated by the "Energy Consumption Saving Comparison".
- Typically, the service life of a 105-tonne fuel-powered wide-body dump truck is about 5-8 years. For battery-electric wide-body dump truck, the service life is predominantly contingent upon the battery's longevity, with battery suppliers commonly warranting a minimum health level of 70% for 5 years. In practice, electric wide-body dump truck can continue to operate beyond the battery supplier's warranty period, which is often 5 years. The lifespan of 5 years for both fuel-powered and battery-electric wide-body dump truck is a conservative assumption, as an extension of this assumed lifespan would result in additional savings in the total lifespan cost savings for battery-electric wide-body dump truck, according to CIC.
- Total energy consumption cost across the lifespan = Average energy consumption costs per year \* Typical lifespan
- Fuel-powered wide-body dump truck, due to their more complex mechanical structures, incur relatively higher annual maintenance costs, typically amounting to RMB 40,000 per year. In contrast, battery-electric wide-body dump truck have lower annual maintenance costs, usually around RMB 25,000 per year, according to CIC.
- Total usage cost savings across the lifespan is calculated by comparing "Total energy consumption cost across the lifespan" and "Total maintenance cost across the lifespan" of a fuel-powered wide-body dump truck and a battery-electric wide-body dump truck.
- The procurement cost of 105-tonne fuel-powered wide-body dump truck is generally around RMB800,000, according to CIC.
- Total lifespan cost savings is calculated by comparing "Total usage cost savings across the lifespan" and "Procurement cost" of a fuel-powered wide-body dump truck and a battery-electric wide-body dump truck.

# Verifications

## Energy consumption analysis of Breton's 105T wide-body dump truck on heavy-load downhill operations

	Fuel	Electric
Average unit price of energy consumption	RMB7.59/L	RMB0.635/kWh
Average energy consumption volume per kilometer	1.8L (Diesel)	1.0kWh (Electricity)
Average mileage of use per day	100km	
Average energy consumption costs per day	RMB1,366	RMB64
Average days of use per year	300 days	
Average energy consumption costs per year	Approximately RMB410,000	Approximately RMB19,000
<b>Annual energy consumption cost savings</b>	<b>Approximately RMB391,000</b>	

### Key assumptions

- Assuming that the unit price of No. 0 diesel fuel in China is RMB 7.59/liter and the unit price of commercial electricity in China is RMB 0.635/kWh;
- Assuming that a 105T wide-body dump truck with an average daily operational distance of 100 kilometers, and operates for 300 days in a year.

Note:

- The price of diesel refers to the average price of China's 0# diesel in 2023, based on the 0# diesel price released by regional Development and Reform Commission. The price of electricity refers to the average commercial and industrial business electricity price in China in 2023, in line with the price released by State Grid.
- The average energy consumption volume data illustrates the common performance metrics of both a 105-tonne fuel-powered wide body dump truck and a 105-tonne battery-electric wide body dump truck within typical operational environments. The data featured in the prospectus charts is also in line with the results detailed in an inspection report provided by the National Engineering Machinery Quality Inspection and Testing Center (國家工程機械品質檢驗檢測中心).
- Wide-body dump trucks are primarily utilized in transportation scenarios, particularly in heavy-load downhill operations within mining environments. Generally, wide-body dump trucks are required to cover a distance of 100 kilometers daily, according to CIC.
- Average energy consumption costs per day = Average unit price of energy consumption \* Average energy consumption volume per kilometer \* Average mileage of use per day.
- Due to the necessity for personnel to observe holidays and the inherent requirement for wide-body dump trucks to undergo periodic maintenance and repairs, the annual operational days for loaders typically do not span the full 365 days of the year. It is common for wide-body dump trucks to operate for an average of 300 days per year, according to CIC.
- Average energy consumption costs per year = Average energy consumption costs per day \* Average days of use per year
- Annual energy consumption cost savings are calculated by comparing "Average energy consumption costs per year" of a fuel-powered wide-body dump truck and a battery-electric wide-body dump truck.

# Verifications

Full lifecycle costs analysis of Breton's 105T wide-body dump truck on heavy-load downhill operations

	Fuel	Electric
Service life	5 years	
Full lifecycle energy consumption costs	Approximately RMB2,050,000	Approximately RMB95,000
Full lifecycle maintenance costs	Approximately RMB125,000	Approximately RMB100,000
Full lifecycle usage costs	Approximately RMB2,175,000	Approximately RMB195,000
Full lifecycle usage cost savings	Approximately RMB1,980,000	
Acquisition costs	Approximately RMB800,000	Approximately RMB1,550,000
<b>Full lifecycle cost savings</b>	<b>Approximately RMB1,230,000</b>	

## Key assumptions

- Pure electric wide-body dump trucks batteries, motors and other key components have a shelf life of 5-8 years, maintenance is relatively simple, each time only need to check the circuit system and connectors maintenance.

### Note:

- Average energy consumption costs per year are calculated by the "Energy Consumption Saving Comparison".
- Typically, the service life of a 105-tonne fuel-powered wide-body dump truck is about 5-8 years. For battery-electric wide-body dump truck, the service life is predominantly contingent upon the battery's longevity, with battery suppliers commonly warranting a minimum health level of 70% for 5 years. In practice, electric wide-body dump truck can continue to operate beyond the battery supplier's warranty period, which is often 5 years. The lifespan of 5 years for both fuel-powered and battery-electric wide-body dump truck is a conservative assumption, as an extension of this assumed lifespan would result in additional savings in the total lifespan cost savings for battery-electric wide-body dump truck, according to CIC.
- Total energy consumption cost across the lifespan = Average energy consumption costs per year \* Typical lifespan
- Due to the relatively lower load demands in heavy-load downhill scenarios, the maintenance costs for wide-body dump trucks are consequently lower than those incurred by trucks operating in heavy-load uphill scenarios. Fuel-powered wide-body dump truck, due to their more complex mechanical structures, incur relatively higher annual maintenance costs, typically amounting to RMB 25,000 per year. In contrast, battery-electric wide-body dump truck have lower annual maintenance costs, usually around RMB 20,000 per year, according to CIC.
- Total usage cost savings across the lifespan is calculated by comparing "Total energy consumption cost across the lifespan" and "Total maintenance cost across the lifespan" of a fuel-powered wide-body dump truck and a battery-electric wide-body dump truck.
- The procurement cost of 105-tonne fuel-powered wide-body dump truck is generally around RMB800,000, according to CIC.

# Verifications

## Economic calculations of fuel and electric 105T wide-body dump trucks on heavy-load downhill scenarios

### Energy consumption analysis of 105T wide-body dump truck on heavy-load downhill operations

	Fuel	Electric
Average unit price of energy consumption	RMB7.59/L	RMB0.635/kWh
Average energy consumption volume per kilometer	1.8L (Diesel)	2.0kWh (Electricity)
Average mileage of use per day	100km	
Average energy consumption costs per day	RMB1,366	RMB127
Average days of use per year	300 days	
Average energy consumption costs per year	RMB409,860	RMB38,100
<b>Annual energy consumption cost savings</b>	<b>RMB371,760</b>	

### Full lifecycle costs analysis of 105T wide-body dump truck on heavy-load downhill operations

	Fuel	Electric
Service life	5 years	
Full lifecycle energy consumption costs	RMB2,049,300	RMB190,500
Full lifecycle maintenance costs	RMB125,000	RMB100,000
Full lifecycle usage costs	RMB2,174,300	RMB290,500
Full lifecycle usage cost savings	RMB1,883,800	
Acquisition costs	RMB800,000	RMB1,550,000
<b>Full lifecycle cost savings</b>	<b>RMB1,133,800</b>	

### Key assumptions

- Assuming that the unit price of No. 0 diesel fuel in China is RMB 7.59/liter and the unit price of commercial electricity in China is RMB 0.635/kWh;
- Assuming that a 105T wide-body dump truck with an average daily operational distance of 100 kilometers, and operates for 300 days in a year;
- Pure electric wide-body dump trucks batteries, motors and other key components have a shelf life of 5-8 years, maintenance is relatively simple, each time only need to check the circuit system and connectors maintenance.

# Verifications

## Terminology

Used Terms/ Concepts	Definitions
battery capacity	the total amount of electrical energy a battery can store, which impacts the duration the engineering machinery can operate before needing a recharge
battery thermal management system	a system that regulates the temperature dynamics of battery, maintaining optimal temperature for battery health
battery-electric loader	a category of loaders partially or fully powered by electricity
battery-electric wide-body dump truck	a category of wide-body dump trucks partially or fully powered by electricity
catalog company	a company possessing prerequisite vehicle manufacturing qualification that we collaborate with for the manufacturing of battery-electric tractor trucks
chassis	the frame on which an engineering machinery is mounted, forming the lower part of an engineering machinery
dual motor design	a design of a battery-electric loader that contains both a drive motor and a working motor, or a design of a battery-electric wide-body dump truck that contains two drive motors
dump truck	an off-highway machine with a spacious cabin designed for efficient unload and transport of materials loaded by other machines
forward design and engineering	the process of designing and engineering of starting from high-level abstractions to concrete implementations, which involves employing high-level models or designs

# Verifications

Used Terms/ Concepts	Definitions
four inter-branch paralleling design	a charging design that uses four charging guns simultaneously to charge a single electric engineering machinery
greenhouse gas	the gas in the atmosphere that absorb and emit heat, or infrared radiation, resulting in the greenhouse effect
hydrocarbon	an organic compound composed of hydrogen and carbon atoms, which can become a type of air pollution during the combustion of fuel sources
internal combustion engine	a heat engine where the combustion of a fuel occurs with an oxidizer in a combustion chamber to convert the chemical energy stored in fuel into mechanical energy or power
LFP power battery	lithium iron phosphate power battery, a type of lithium-ion battery that uses lithium iron phosphate as the cathode material, which demonstrates low cost, stable performance, safety and long cycle life
loader	the self-propelled tracked or wheeled machinery. The front end is equipped with a working device mainly used for loading operations with a bucket, and loading or excavation is carried out by the forward movement of the machine
new energy loader	a loader partially or fully powered by new energy systems
new energy tractor truck	a tractor truck partially or fully powered by new energy systems
new energy wide-body dump truck	a wide-body dump truck partially or fully powered by new energy systems

# Verifications

Used Terms/ Concepts	Definitions
new energy	energy derived from clean sources, such electricity, solar power, wind energy, hydroelectric power, and other sustainable resources
nitrogen oxides	a mixture of nitric oxide and nitrogen dioxide, which are gases produced from natural sources, motor vehicles and other fuel burning processes
particulate matter	a mixture that contains microscopic solids or liquid droplets that can be inhaled and cause serious health problems
payload	the maximum allowable weight that an engineering machinery can safely carry in addition to its own empty weight
pure-play new energy engineering machinery company	an engineering machinery company that focuses primarily on the development of new energy engineering machinery, generating more than 80% of its revenue from sales of new energy engineering machinery
range-extended wide-body dump truck	a type of wide-body dump truck that are equipped with an additional energy generator, which functions as a range extender
remote operation	the ability of an engineering machine to be operated from a distance, enabled by advanced technologies such as intelligent sensing, real-time video stitching algorithms, optimized video streaming strategies and three-dimensional mapping
sensor	a device designed to detect events or changes in its environment and transmit this information to other electronics, often to a computer processor
thermal management system	a system that manages the temperature of the cabin, battery, motor and motor controller, among others

# Verifications

Used Terms/ Concepts	Definitions
tractor truck	a heavy-duty commercial vehicle consisting of a tractor unit, including the engine, cab and front axle, which can connect to a trailer for loading cargo
VCU	vehicle control unit, a central domain controller within our machines that receives signals from various sensors located throughout the machine, including those connected to the brakes, accelerator pedal, battery system, and charging connections
wide-body dump truck	a variant of the dump truck characterized by a larger load capacity and is wider than a road vehicle, used in off-highway operations, such as mining and construction
working motor	a motor that powers the working function of an engineering machine, such as hydraulic lifting, bucket tipping and steering, among others
AGV	Automated Guided Vehicle, a self-guided automated vehicle designed to autonomously transport raw materials in industrial manufacturing
autonomy solution	a suite of services that enable the remote and autonomous operation of engineering machinery, which includes subscription-based licensing of remote and autonomous operation systems and end-to-end intelligent mining solutions
battery-electric loader	a loader that uses an electric battery as its sole source of power
battery-electric wide-body dump truck	a wide-body dump truck that uses an electric battery as its sole source of power
BIM	Building Information Modeling, a modeling technology used in industrial manufacturing that generates digital representations of the physical and functional characteristics of architectural design

# Verifications

Used Terms/ Concepts	Definitions
cabin	the enclosed space in the engineering machinery where operators are seated and operate the engineering machinery
carbon footprint	a calculated index of the total amount of greenhouse gases that an activity emits to the atmosphere
charging time	the time required to charge a battery from 20% to 100%, reflecting charging efficiency
CFD	Computational Fluid Dynamics, a fluid mechanics analysis method that uses numerical analysis and data structures to solve problems involving fluid flows
cycle time	the time required for a loader to complete an entire operational cycle of lifting, unloading and lowering, a key metric of a loader's productivity
direct current	the one-directional flow of electric charge from high electron density area to low electron density area
direct lease	a type of finance lease arrangement where the lessor (the finance lease company) acquires an asset and leases it directly to the lessee (the customer)
drive motor	a type of electric motor used to create motion, converting electrical energy into mechanical energy, driving engineering machinery to move
driving range	the distance that a an engineering machine can travel on a single charge

# Verifications

Used Terms/ Concepts	Definitions
energy density	the amount of energy a battery contains per unit weight, measured in Wh/kg
electrical and electronic architecture	the technical design of an engineering machine which includes all the hardware, software, controllers, electronic and electrical distribution systems on the engineering machinery, while integrating all these contents together through system integration tools
e-powertrain	a system within a machine or vehicle that generates power and propel the movement of the machine and vehicle
finance lease	a type of lease arrangement in which the lessee effectively takes on many of the risks and rewards of ownership, even though legal ownership remains with the lessor
gear shifting	the act of changing the gear ratio in an engineering machine's transmission, which adjusts the balance between speed and torque
gearbox	a mechanical device used in engineering machinery to adjust the speed and torque based on road conditions and operator requirements by shifting gears
hydraulic cycle time	The sum of the loader's boom lifting time, bucket unloading time and boom lowering time, a key metric of a loader's productivity
Integrated Manufacturing System	a modern system of manufacturing that integrates advanced manufacturing and inspection equipment, digital and automation technologies and collaborative robots to achieve the best possible manufacturing outcome
maximum breakout force	the maximum vertical force a loader can exert to break through or lift a load

# Verifications

Used Terms/ Concepts	Definitions
maximum power output	the highest level of engine power that an engineering machine can produce under its specified operating conditions
modular approach	a method in product development where technologies are broken down into independent components or modules that can be universally applied across products
OTA	Over-The-Air, the remote software updating through cloud networks
peak traction force	the maximum force a loader can exert to move forward, overcoming all resisting forces
perception fusion algorithm	a type of sensor fusion algorithm that combines sensory data from multiple sources to reduce uncertainty and help the autonomous operation system make more informed decisions
photovoltaic energy system	a system that uses photovoltaic cells to convert sunlight into electricity
e-powertrain component	the core system of an electric machine or vehicle including the motor, motor controller, gearbox and gear control system
real-time video stitching	a process that combines multiple videos with overlapping fields of view to produce a segmented panorama video in real time
regenerative braking system	the braking system featuring regenerative braking with motor feedback and mechanical braking, supplemented by an emergency brake system for added redundancy

# Verifications

Used Terms/ Concepts	Definitions
repurchase guarantee	a commitment made by the seller of an asset to buy back the asset from the buyer at a later date
short-haul operation	a work or an activity of transporting goods over short distances
structural components	Fundamental parts forming the structure of an engineering machinery, such as chassis, frame and cabin, which provide support and ensure structural integrity of the engineering machinery
telematics	an interdisciplinary field that integrates telecommunications and informatics for application in the engineering machinery and vehicles
tier center turning radius	the distance from the center of a loader to the outer edge of its turning circle, which indicates the degree of tightness of the loader's turning and is a measure of the loader's maneuverability in confined spaces
torque	a rotating or twisting force generated by an engine's crankshaft
wheelbase	the distance from the center of an engineering machine's front wheel to the rear wheel, which affects the stability and maneuverability of a loader



**Thanks!**

**April 2025**

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