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SOUTHEAST ASIA
CONFERENCE

ORGANIZED BY

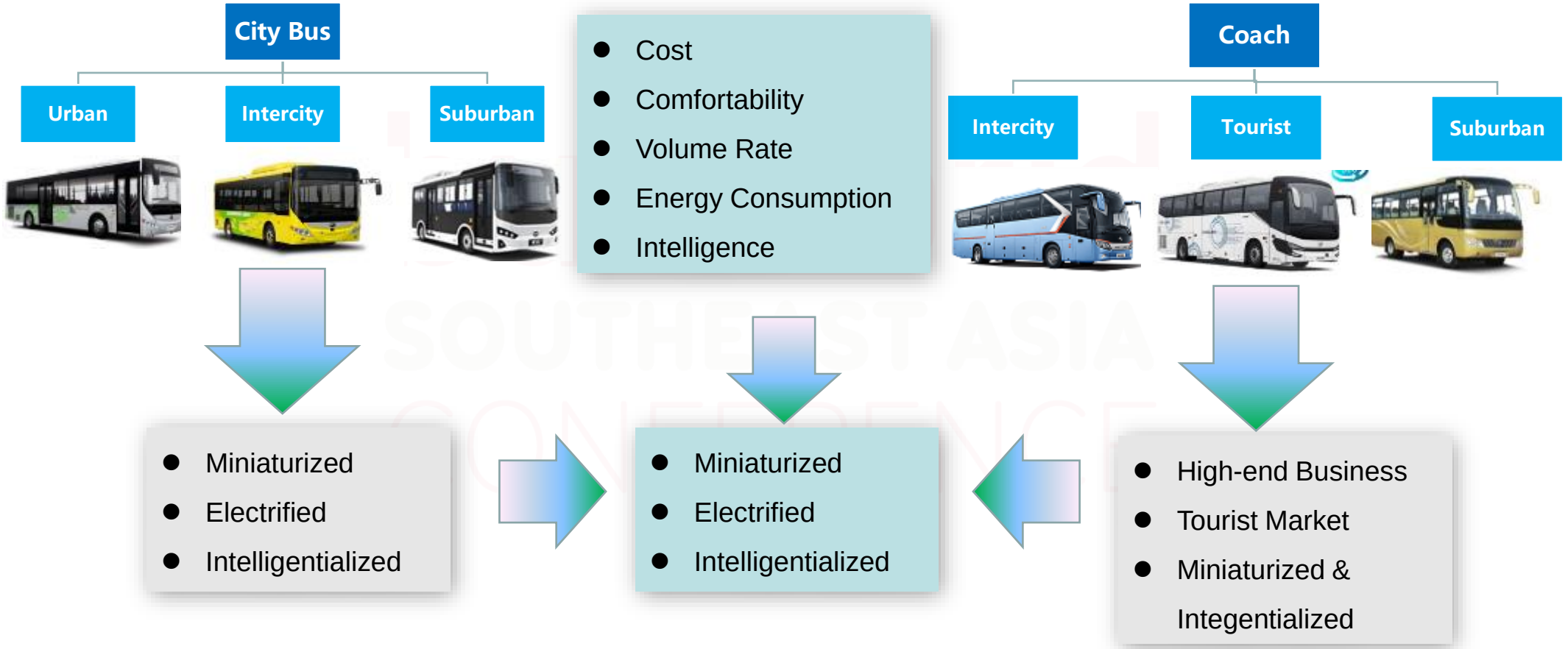
BUS FLEET
ELECTRIFICATION:
INSIGHTS FROM GLOBAL
PUBLIC TRANSPORT INNOVATORS

17 May 2024

Session 01

DDAC Electrification Solution

❑ Bus Application Scenarios



- ❑ **Penetration rate of electrification for city bus is to 90%，the electrification of coach is gradually started，small bus and minibus is obviously electrified.**
- ❑ **Due to obvious road-to-railway transit of passenger volume, TIV gradually decreases.**

❑ China Bus Market Trend

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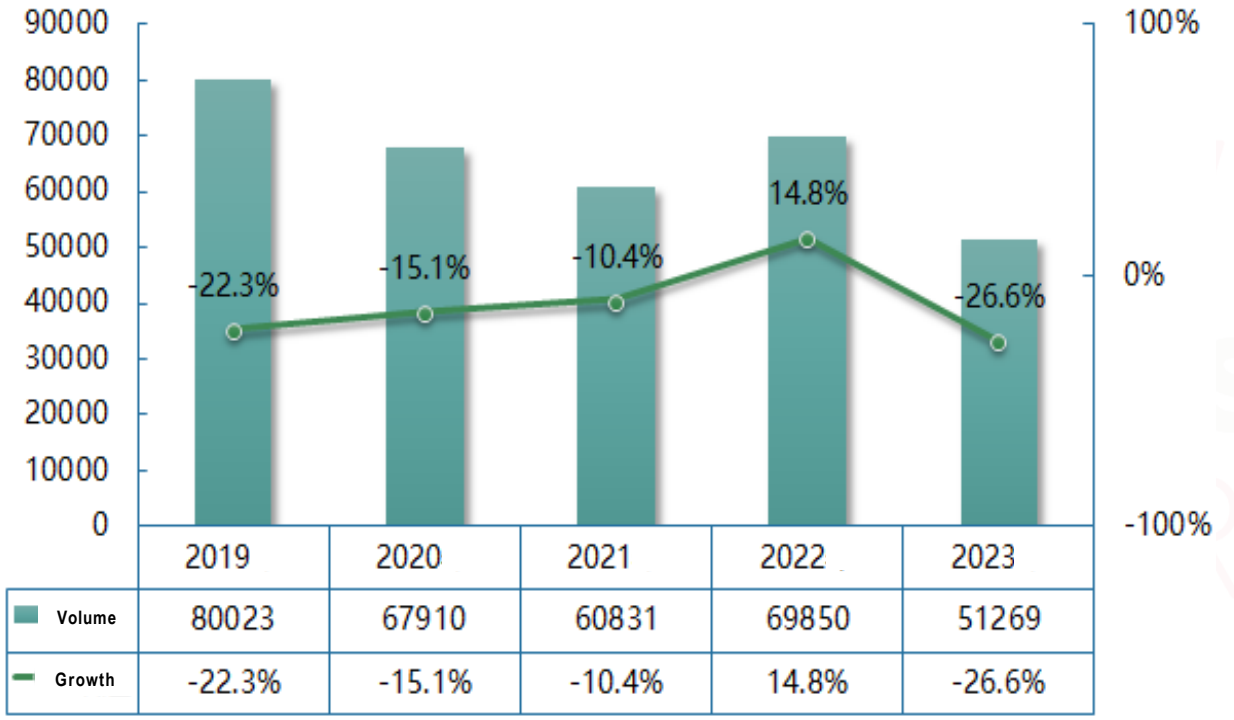
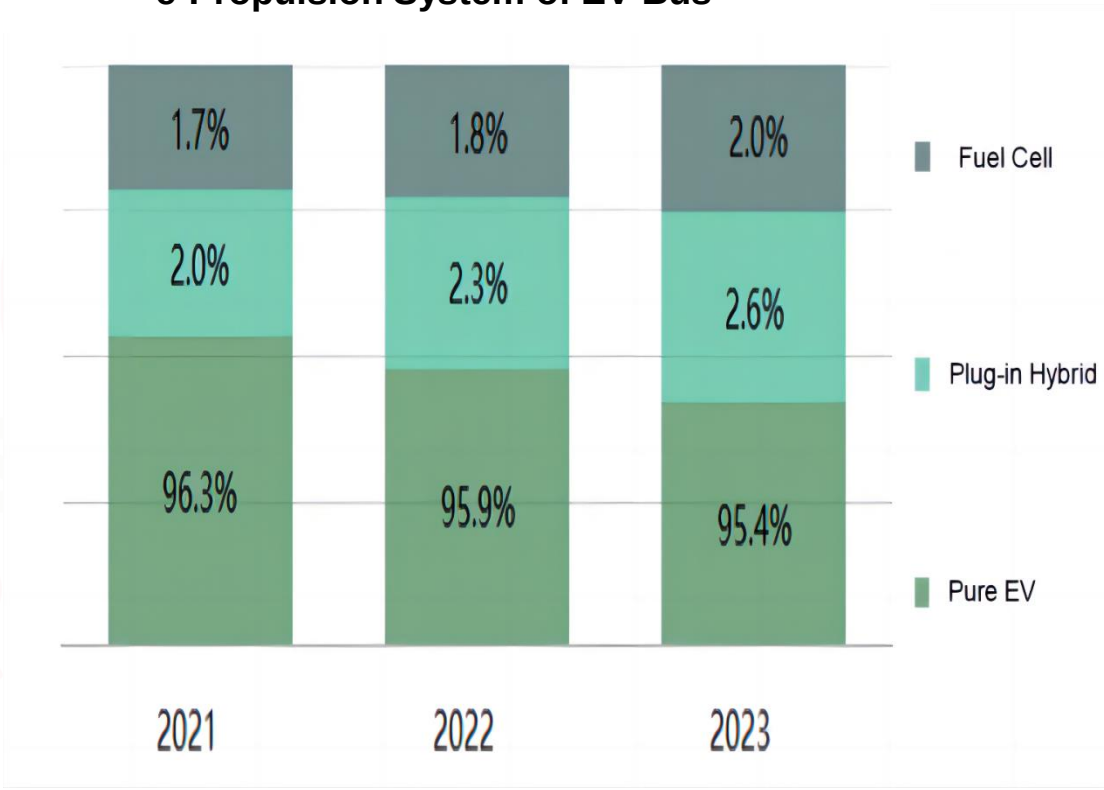
Sales Volume of EV Bus



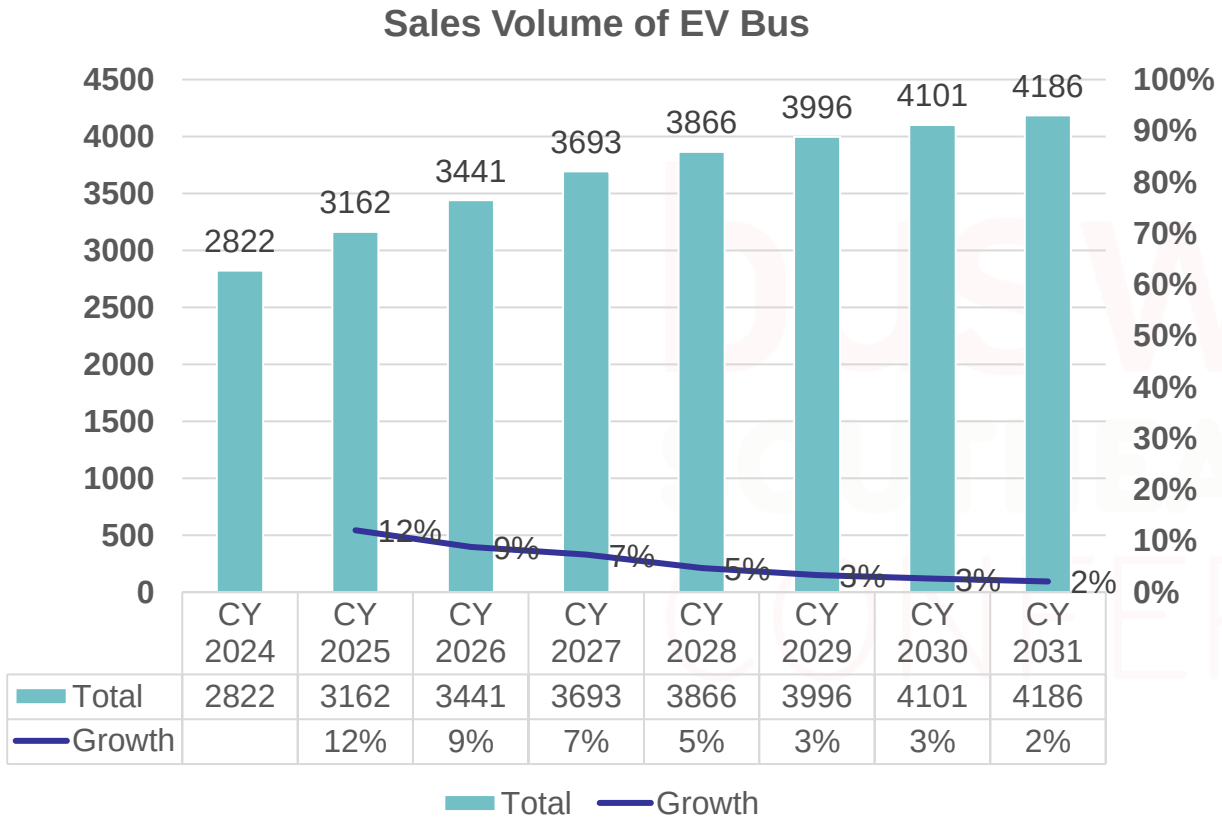
	2019	2020	2021	2022	2023
Volume	80023	67910	60831	69850	51269
Growth	-22.3%	-15.1%	-10.4%	14.8%	-26.6%

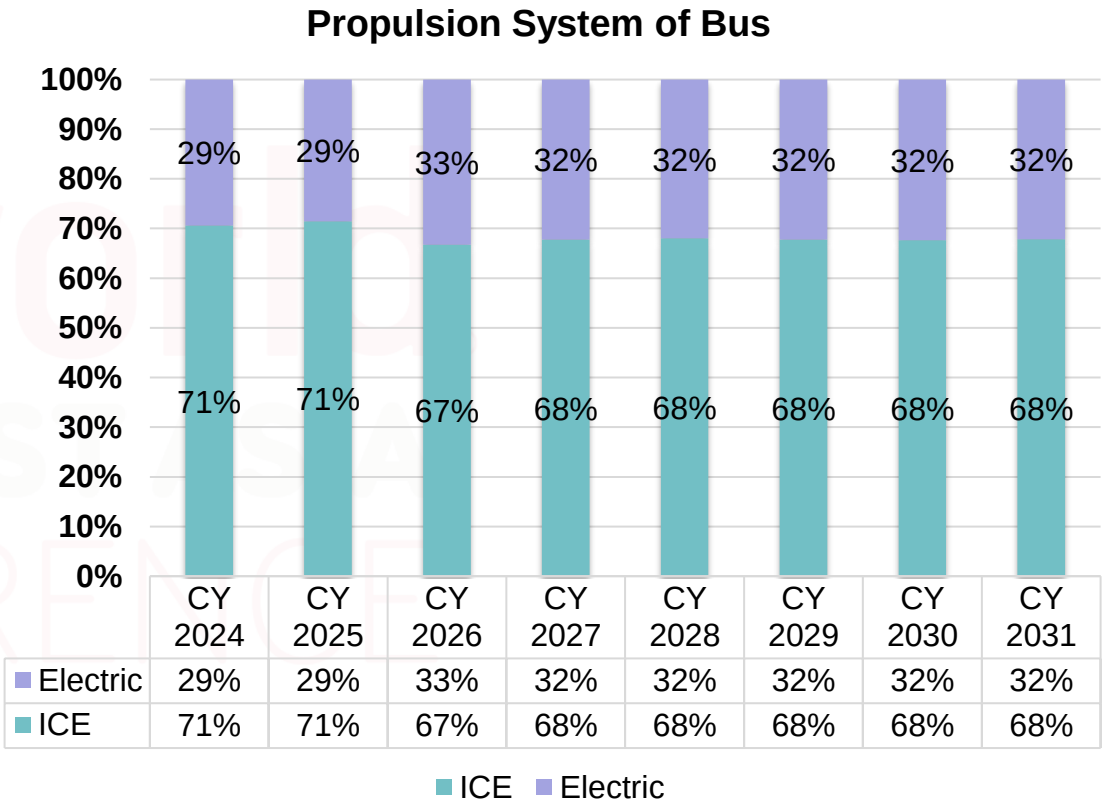
e-Propulsion System of EV Bus



- ❑ Driven by carbon neutralization and zero emission, the pace of electrification is getting faster, and pure electric power will dominate in the medium and long term.
- ❑ The overall capacity of the bus market has decreased, but the electrification rate has steadily increased that attributed to national and local government subsidy policies, carbon reduction credits, and electricity charge infrastructure.

❑ ASEAN Bus Market Trend



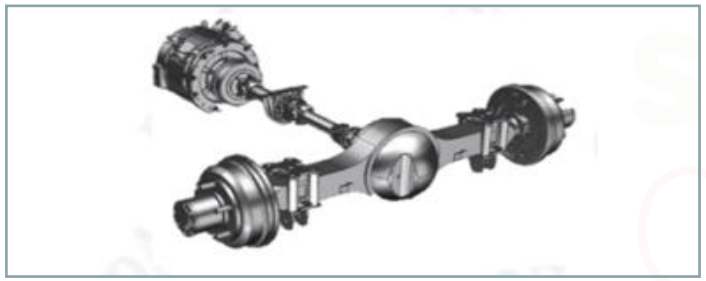


Note: Original data cited from 2024 S&P Global.The data of ASEAN EV bus only includes Indonesia, Thailand and Vietnam. The data of ASEAN bus only includes Indonesia, Malaysia, Thailand, Vietnam and Philippines.

❑ **EV bus will increase in high/medium growth rate during 2024-2028 and later in low growth rate. The penetration rate of EV bus will rise and be flat at ~32%.**

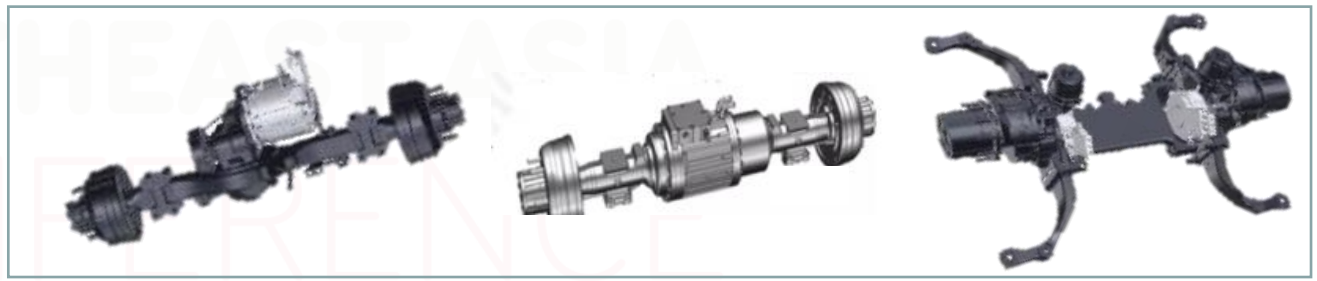
❑ E-propulsion System Trend

➢ Oil to Electricity—Direct Drive



- Traditional ICE bus chassis, low entry
- Low-speed & high-torque motor plus conventional axle
- Heavier system weight

➢ EV Chassis ——Integrated E-axle



- Chassis layout based on integrated E-drive axle (short rear suspension or distributed)
- High speed motor with E-axle
- Lighter system weight
- The interior space is improved significantly, with low floor.

Characteristics of E-axle

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➢ Parallel-axis

- Cost Advantage
- Mature Supplier Resource
- Rapid and Flexible

➢ Coaxial

- Space Saving
- System Weight
- Cost Challenges
- Supplier Resource Challenges

➢ Distributed

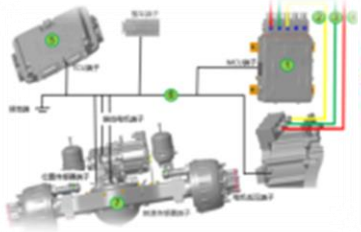
- Space Saving
- System Weight
- Cost Challenges
- Technology Maturity

❑ Product Planning——technology & industrialization

Inverter Application

System Integrated

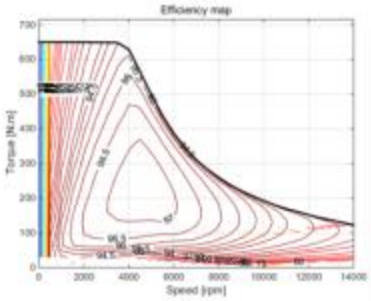
High-Speed Gear

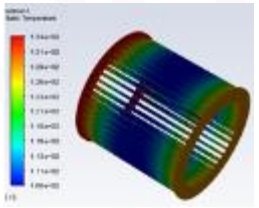


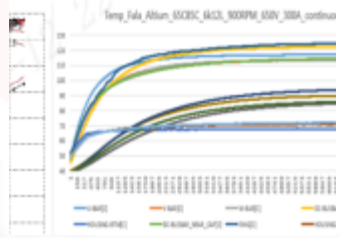
High Performance Motor

AMT

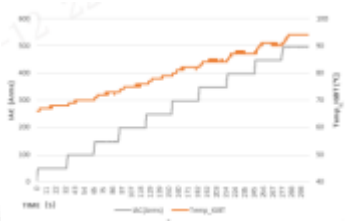
- E-axle industrialization —— high-precision gear machining, E-axle assembly and end-off-line test
- More automated







- Motor Development & Application



- Invertor Strategy & Application

- Flat wire and oil cooling motor will become the mainstream
- Based on rich application scenarios, motor power density to be improved.
- Motor speed will be stabilized at around 12,000 rpm
- SIC inverter
- Coach will apply E-axle with 2-gear AMT.

❑ E-axle Product Planning

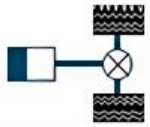
- Parallel-axis E-axle is prevalent in short term.
- Based on the pursuit of space and light weight, coaxial E-axle being applied and will be dominant for 6-8m bus in medium & long term.
- Distributed E-axle is best idealized architecture. Once the technology be mature and cost be down, will be gradually used in 8-10m bus.

Bus Length (meter)

❑ Traditional axle solution for EV Bus

□ 5-6m Citybus

◆ Direct Drive Solutions

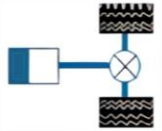


Low Entry: 3.5t Portal Steer Axle+4t Rear Axle

Multi Steps: 3t Steer Axle+4t Rear Axle

□ 6.6–7m City Bus

◆ Direct Drive Solutions



Low Entry: 3.5t Portal Steer Axle+5.5t Rear Axle

Multi Steps: 3.5/4.2t Steer Axle+5.5t Rear Axle

❑ Traditional axle solution for EV Bus

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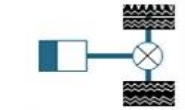
8–9 m City Bus

Direct Drive Solutions



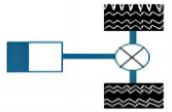
Low Floor: 5.5t Portal Steer Axle+9.5t Portal Drive Axle

Low Entry: 5.5t Portal Steer Axle+8.5t Rear Axle

Multi Steps: 4.5/5.5t Steer Axle+8.5t Rear Axle

10–12m City Bus

Direct Drive Solutions



Low Floor: 7.5t Portal Axle+13t Portal Rear Axle

Low Entry: 7.5/5.5t Portal Axle+13t/11t Rear Axle

Multi Steps: 6.5/5.5t Front Axle+13t Rear Axle

- 10+ years mature applications, Optimized design for regeneration, proved durability and reliability, 3- or 5-years warranty.

❑ Parallel-axis E-axle Application

- Lower Cost

——Reduce initial purchase cost USD 150-400 than direct drive

- Mature Supplier Resource

——Share the most of design with truck E-axle and some parts of conventional axle be carry-on, rapid response for the delivery

- Lowe Energy Consumption

——2-3KWh per 100 kilometers lower than direct drive

——Save USD 200-350 per year

- Repair-friendly

——Good serviceability

- **5-6m Mini-bus, 7m city bus / coach, and 10-12 coach. 25, 000+ pcs being operated in trucks & buses from 2020 and running over 1.25 billion kilometers at the end of Apr.2024.**

❑ Coaxial E-axle Application

- Larger Space

——Additional 60 liters

- Less Lubricant

——3-7 liters less

- Lightweight

——EP13 is 350kg lighter than direct drive, and 50-150kg lighter than the competitors'

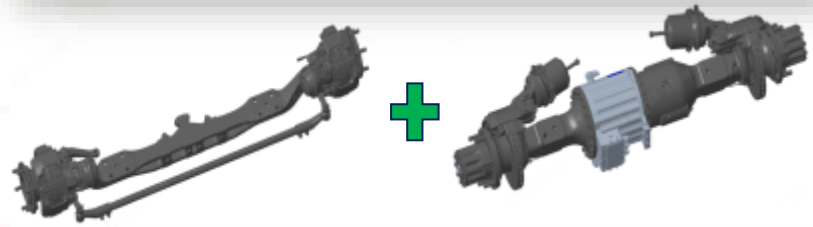
- Lower Energy Consumption

——1-2KWh per 100 kilometers lower than the competitors', save USD 200 per year

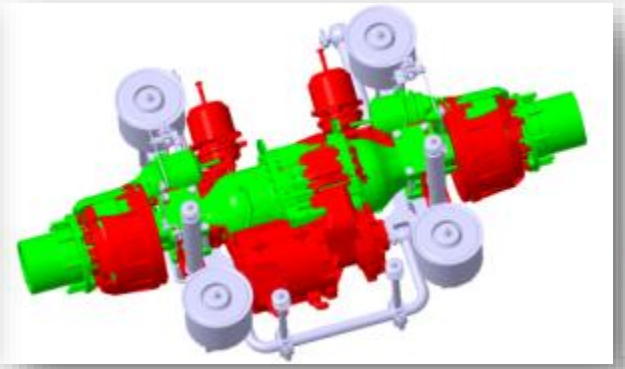
- Cost Saving for Lubricant Change

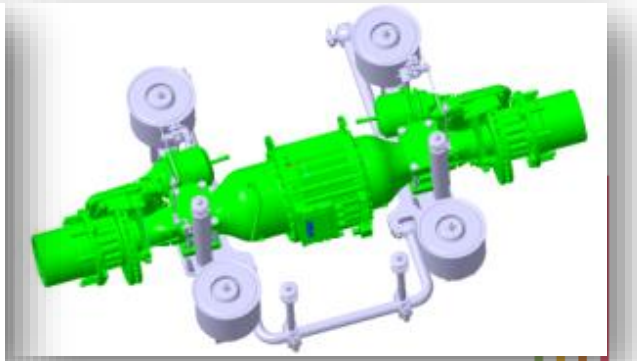
——USD 10-20 per year

- Higher reliability requirements



- **5.5-8.5m city bus, 7m coach. 1,500+ pcs being operated in buses from 2018 and running over 120 million kilometers at the end of Apr.2024.**





❑ Distributed E-axle Application

- Lager Space

——Passage width to 850mm

- Better NVH

——2-3dB lower than the competitors @ acceleration

- Less Lubricant

——9 liter less

- Lightweight

——500Kg lighter than direct-drive solution

- Completely low floor

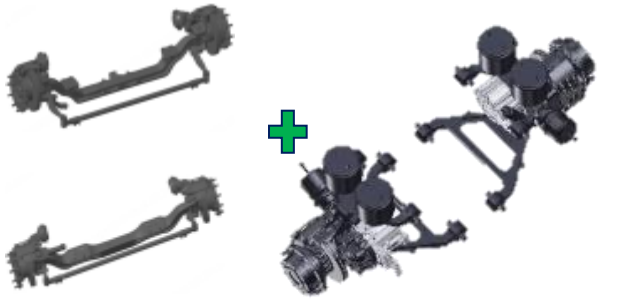
—— Higher go-on/off efficiency

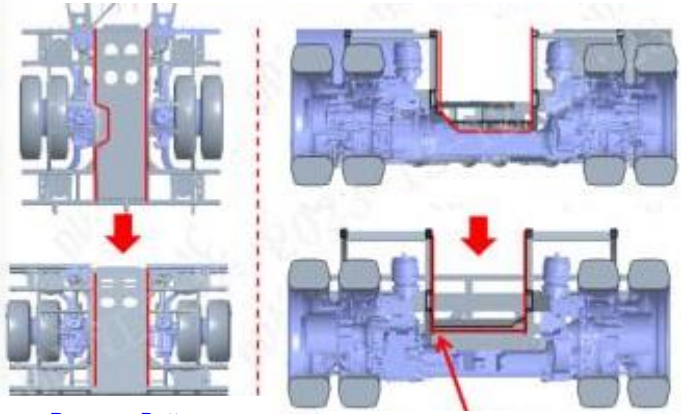
- Lower Energy Consumption

——3KWh lower per 100 kilometers than the competitors，electricity saving USD 240 per year

- Cost Saving for Lubricant Change

——USD 30 per year

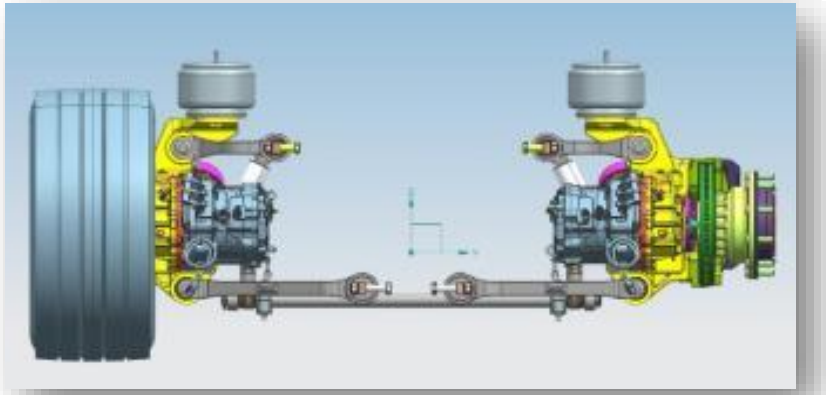




Passage Bottom Completely Straightened

Remove Drive-head Bulge

- **8-12m city bus, 8-10m coach, with electric differential. 21 demonstration buses built and being operated.**



❑ Future Application

Motor

- ➢ Oil cooling
- ➢ Flat wire
- ➢ Less/No rare earth
- ➢ Lightweight
- ➢ High speed

Inverter

- ➢ Higher IP Level
- ➢ High voltage
- ➢ Multiples integrated
- ➢ Software strategy
- ➢ Preventive diagnose
- ➢ Heat management

e- Propulsion System

- Higher efficiency
- Smaller cubage
- Lightweight
- Better NVH
- More intelligent

Bus

- Safer
- Longer driving range
- Low energy consumption
- Bigger space
- More comfortable

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东风德纳车桥有限公司
DONGFENG DANA AXLE CO., LTD.

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- **Founded in** Dec 2002
- **Total Assets:** RMB 2.6 billion
- **Area Covered**: 830,000 m²
- **Shareholders**: DFCV 50% & DANA 50%
- **Headcounts**: 3,356 (by 2023)
- **Headquarter**: Xiangyang, Hubei, China
- **TC**： Xiangyang TC/ Wuhan TC Branch
- **Factories**: Shiyan, Xiangyang, Xiamen
- **Production Capacity**: 1 million pcs axle and 1 million gear sets.

Shiyan Plant

Area covered: 437,000 m²,

Products: HD & MD truck axles

Production capacity: 500,000 pcs axle per year, 1 million gear sets per year

Wuhan Technology Branch

Area covered: 660 m²

Location: DFCV Technology Center Complex

e-Propulsion system R&D

Xiamen Plant

Area covered: 30,000 m²

Products: large & medium bus axles

Production capacity: 50,000 pcs axle per year

Headquarter & R & D center

Area covered: 30,000 m²

Xiangyang Plant

Area covered: 333,000 m²,

Products: bus axle, truck axle & E-axle

Production capacity: 450,000 pcs axle per year

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❑ Product Portfolios

Large Drop Steer Axle

Steer Axle

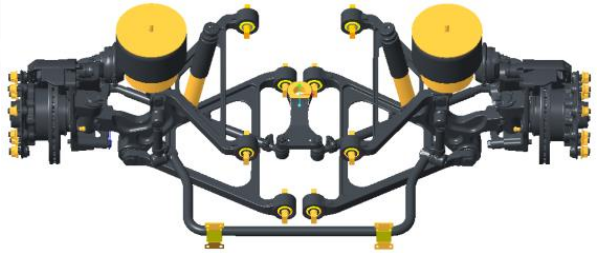
Tandem Drive Axle

Low Floor Axle

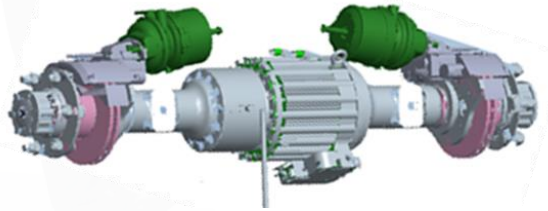
Single Drive Axle

Tandem Hub Reduction Axle

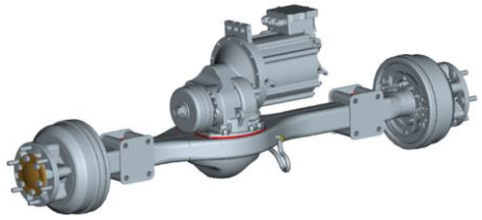
Steer Drive Axle



IFS Steer Axle



Coaxial E-axle



Parallel Axis E-axle

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❑ E-axle Production Lines

Head Assembly Line

Gear Machining Line

Axle Assembly Line

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Create the Most Reliable & Desirable Axle Company!

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