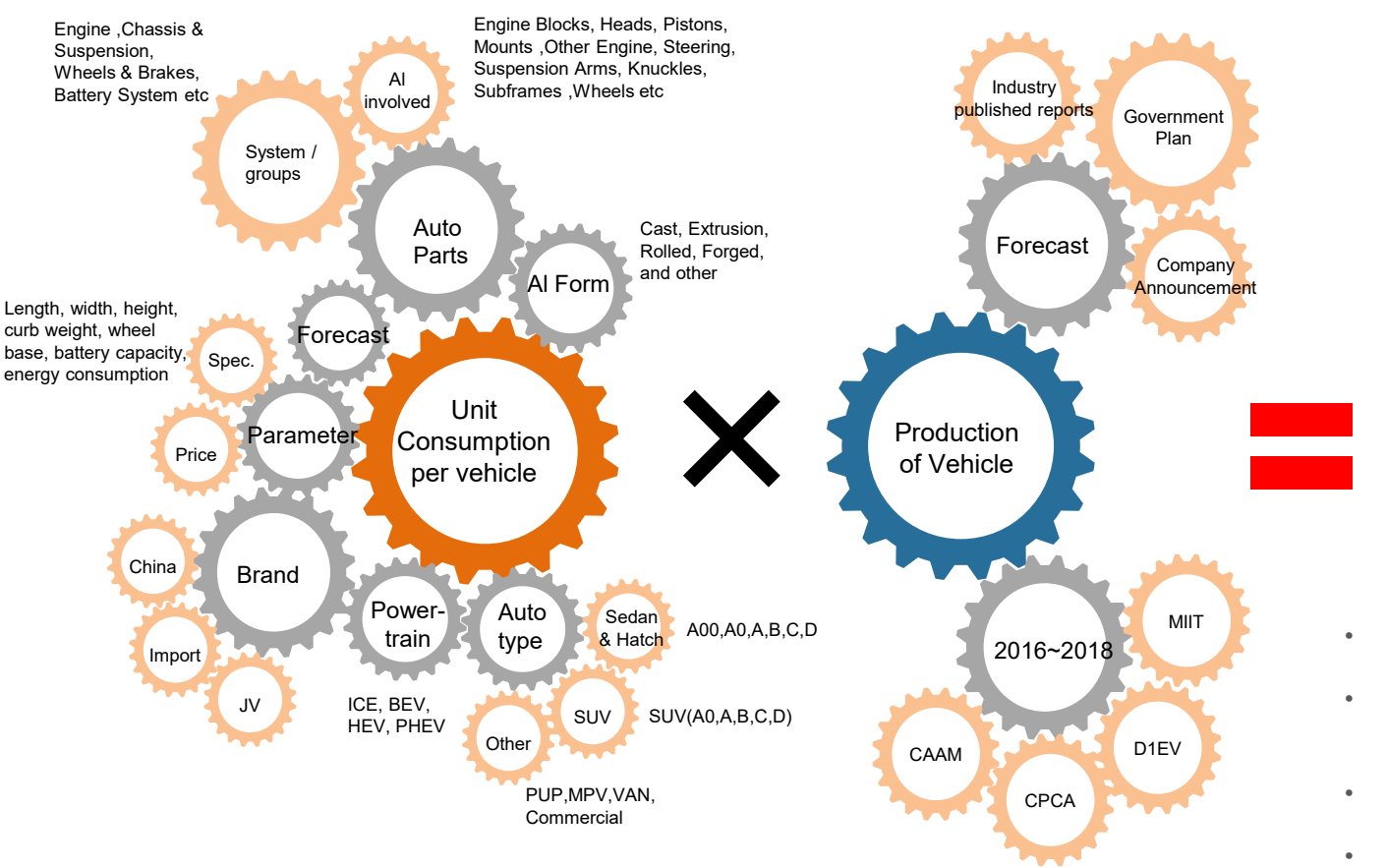
Assessment of Aluminium Usage in China's Automobile Industry 2016~2030

A confidential presentation prepared by CM Group

Picture: NIO ES8 Production Line in Hefei, Anhui, China

Table of Contents

CM Methodology



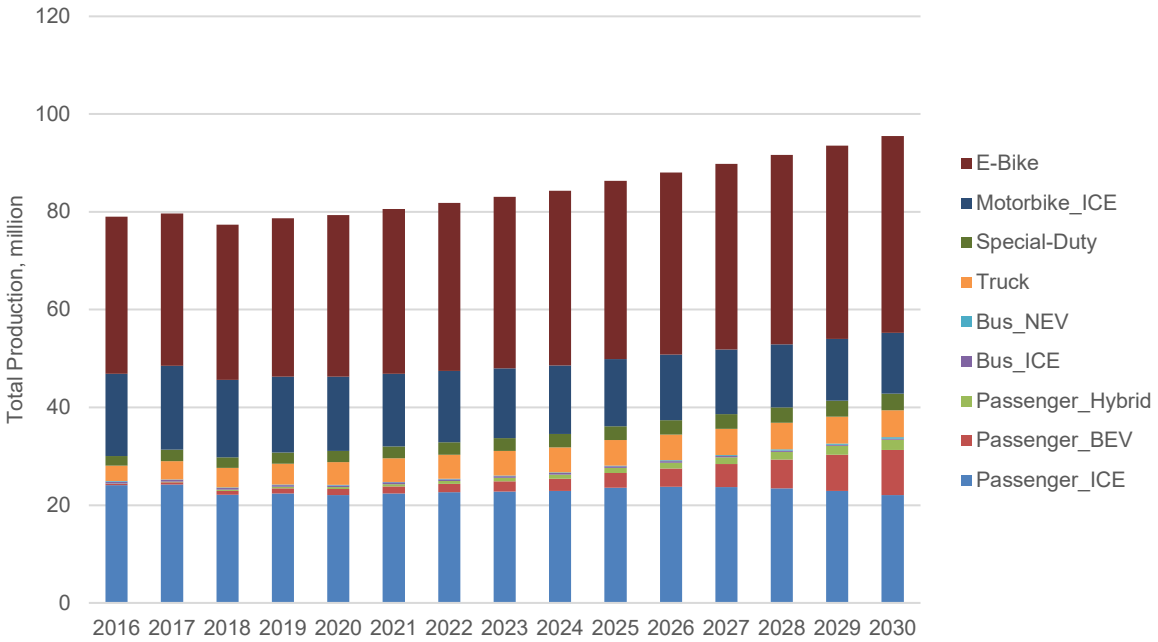
CM
Proprietary Database

Total Al Usage by Vehicle

- Over 1,000 rows of data entries
- Over 150,000 data points and accumulating
- Detailed breakdowns
- Extensive and deep-diving

Picture Source: BYD

Total Vehicle Production to Edge Higher, Growth Pivots on BEVs



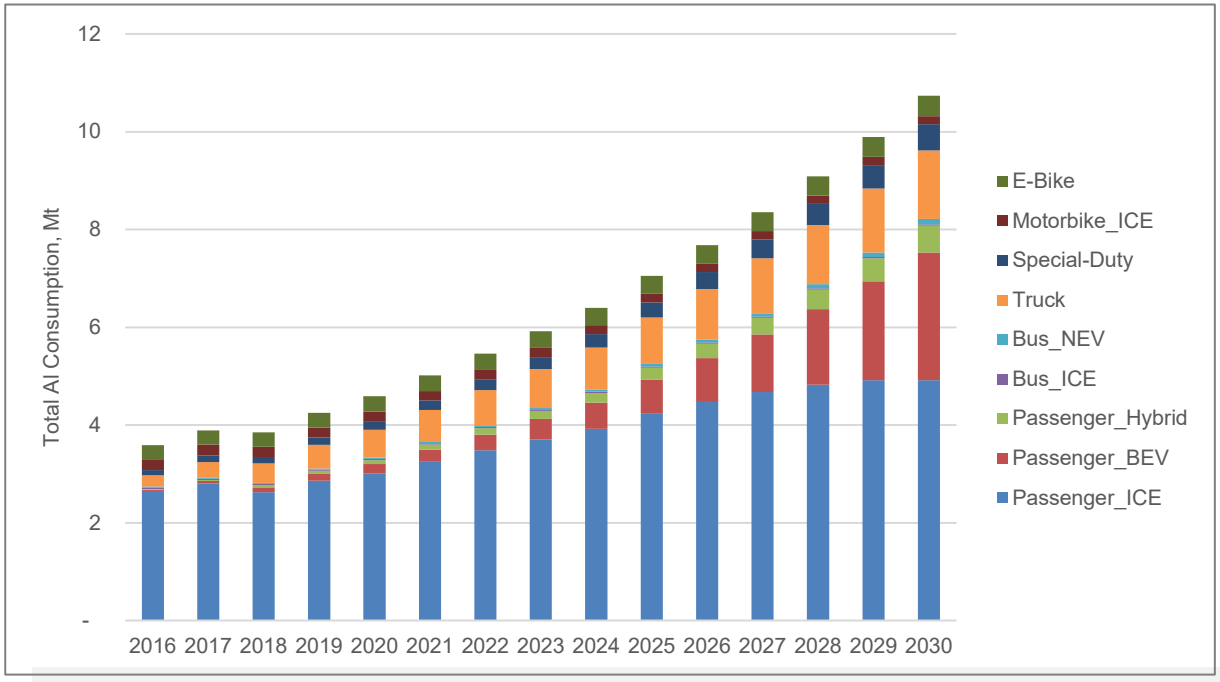
CAGR 2018~2030	
Passenger	3.08%
ICE	-0.02%
BEV	22.96%
Hybrid	18.76%
Commercial	2.63%
Bus	1.08%
ICE	-3.23%
NEV	9.53%
Truck	2.79%
Special-Duty	3.80%
2,3-Wheel	0.85%
ICE	-2.00%
E-Bike	2.00%

- We estimate China will produce ***77.4 million*** vehicles in 2018, including 47.6 million motor bikes and 29.8 million automobiles (23.2 million passenger cars, 4.4 million commercial vehicles and 2.2 million of special-duty trucks). We forecast the total production will slowly grow at a CAGR **1.77%** and reach ***95.5 million*** in 2030. The BEV and Hybrid passenger cars will increase the fastest at CAGR 22.96% and 18.76% respectively.

4

Source: CAAM, National Bureau of Statistics, Company Reports, Public sources, CM Group

Total AI consumption to see a CAGR 8.9% growth…



CAGR 2018~2030	
Passenger	9.32%
ICE	5.37%
BEV	31.35%
Hybrid	22.68%
Commercial	10.64%
Bus	10.1%
ICE	0.44%
NEV	15.77%
Truck	11.04%
Special-Duty	12.31%
2,3-Wheel	1.27%
ICE	-2.00%
E-Bike	3.01%
Total	8.8%%

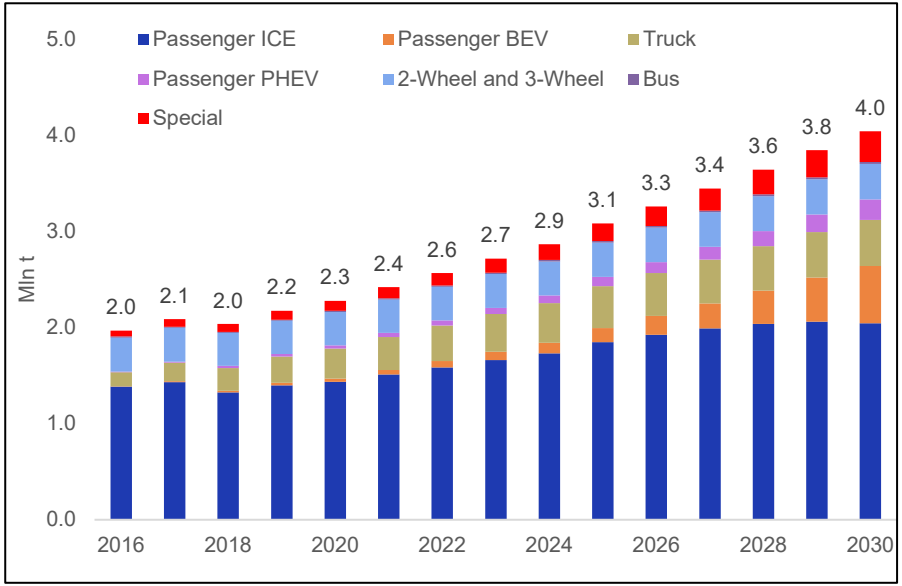
- We estimate China's Auto industry will consume a total of 3.8Mt of aluminium in 2018, 72% of which are consumed by passenger vehicles. We forecast the total aluminium consumption will grow at a CAGR 8.9% and reach ***10.7 Mt*** in 2030.
- New energy based vehicles, including passenger cars, buses and E-bikes will contribute to around ***34%*** of the total AI consumption, at ***3.7 mln*** tonnes.

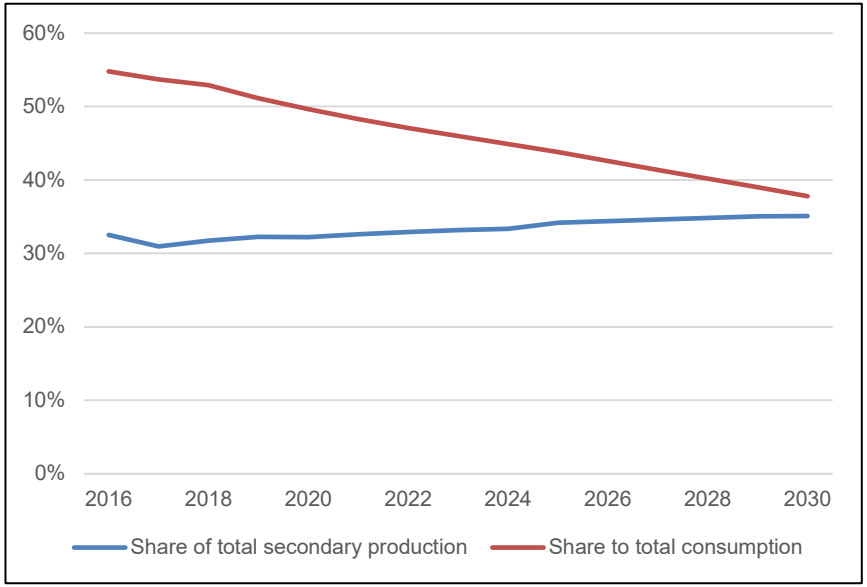
Unit Consumption Assessment, kg per vehicle

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Passenger	***110.4***	***115.9***	***119.7***	***129.1***	***138.6***	***148.1***	***157.7***	***167.4***	***177.4***	***187.1***	***197.3***	***207.9***	***219.0***	***230.7***	***242.2***
ICE	*110.3*	*115.7*	*118.7*	*127.6*	*136.4*	*145.2*	*153.9*	*162.5*	*171.2*	*179.8*	*188.5*	*197.2*	*205.8*	*214.5*	*222.8*
BEV	*107.1*	*117.9*	*128.4*	*143.0*	*157.9*	*173.1*	*188.2*	*201.9*	*215.5*	*226.8*	*238.1*	*249.8*	*261.8*	*274.2*	*283.5*
Hybrid	*147.4*	*160.0*	*179.6*	*188.8*	*198.1*	*206.8*	*215.5*	*224.2*	*232.9*	*238.3*	*243.7*	*249.0*	*254.4*	*259.8*	*265.2*
Commercial	***76.5***	***87.0***	***99.3***	***110.9***	***122.6***	***133.9***	***145.1***	***156.2***	***165.9***	***180.1***	***194.8***	***209.1***	***223.6***	***238.3***	***253.2***
Bus	*92.8*	*92.0*	*94.4*	*101.4*	*109.3*	*118.2*	*128.1*	*139.1*	*151.5*	*165.4*	*181.0*	*198.3*	*217.7*	*239.3*	*263.4*
ICE	*60.5*	*62.8*	*65.3*	*67.8*	*70.3*	*73.0*	*75.7*	*78.6*	*81.5*	*84.6*	*87.9*	*91.2*	*94.7*	*98.3*	*102.1*
NEV	*189.0*	*196.4*	*210.1*	*220.8*	*232.2*	*244.5*	*257.7*	*271.8*	*287.1*	*303.6*	*321.4*	*340.6*	*361.5*	*384.1*	*408.7*
Truck	*73.8*	*86.4*	*99.9*	*112.0*	*123.9*	*135.4*	*146.7*	*157.8*	*167.2*	*181.4*	*196.0*	*210.1*	*224.1*	*238.2*	*252.3*
Special-Duty	*53.2*	*58.6*	*61.6*	*67.7*	*74.0*	*80.6*	*87.5*	*94.8*	*102.4*	*110.5*	*119.0*	*128.1*	*137.6*	*147.8*	*158.6*
2,3-Wheel	*10.4*	*10.5*	*10.5*	*10.5*	*10.6*	*10.6*	*10.7*	*10.7*	*10.7*	*10.8*	*10.8*	*10.9*	*10.9*	*11.0*	*11.0*
ICE	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*
E-Bike	*9.1*	*9.2*	*9.3*	*9.4*	*9.5*	*9.6*	*9.7*	*9.8*	*9.9*	*10.0*	*10.1*	*10.1*	*10.2*	*10.3*	*10.4*

Source: CM Group

Secondary Al Usage in Vehicles in China





- Secondary Al is mainly used for manufacturing engines, transmission housing, and other small casting parts. Wheels are mostly made by primary casting due to he higher quality requirement. Affected the decline of ICE vehicles production, we forecast the share of secondary Al used in auto industry to to drop from 53% in 2018 to 38% in 2030.
- As production goes up, secondary Al usage in NEV is expected to go up, mainly in chassis & suspension, as well as driveline.
- In 2018, we estimate a total of 2Mt of recycled Al is used in the auto and motorbike industry, taking up 32% of the total secondary Al production. With the growing use of aluminium in the future, we forecast the recycled aluminium use will increase to 4 mln tonnes in 2030, takine ~35% of the total production.

Source: CM Group

Table of Contents

Key Takeaways (Passenger NEV)

China's Production

❖ **NEV**	**0.59 million**
– BEV	0.48 million
– Hybrid*	0.11 million

2017 consuming a total of **75kt** of aluminium
- **126kg** per NEV
- 118kg per BEV
- 160kg per Hybrid

Robust Production Growth

❖ **NEV**	**4.0 million**
- BEV	3.0 million
- Hybrid	1.0 million

2025 consuming a total of **0.9 mln t** of aluminium
- **230kg** per NEV
- 227kg per BEV
- 238kg per Hybrid

NEV Production Spike

❖ **NEV**	**11.3 million**
– BEV	9.2 million
– Hybrid	2.1 million

2030 consuming a total of **3.2 mln t** of aluminium
- **280kg** per NEV
- 284kg per BEV
- 265kg per Hybrid

BEV - the major contributor to Al consumption in this sector is **domestic mini (A00) cars,** which took up **58%** of the total consumption in 2017. The proportion is estimated to fall to **43%** in 2018 as a result of new developments in **A-segment cars and SUVs** (NIO Es8).

Hybrid - More high-end vehicles are seen in the hybrid market like Cadillac CT6, resulting in relatively a higher Al unit consumption of **160kgpv** compared to **126kgpv** in BEVs in 2017.

With the fast development of China's BEV sector, we forecast the unit consumption (UC) of BEV to increase significantly, gradually **catch up** the UC of Hybrid by 2025, and **surpass** the UC of Hybrid in 2030 (see data above).

**Hybrid – HEV & PHEV*

General trends

Aluminium is currently **the most preferred** light weighting material.

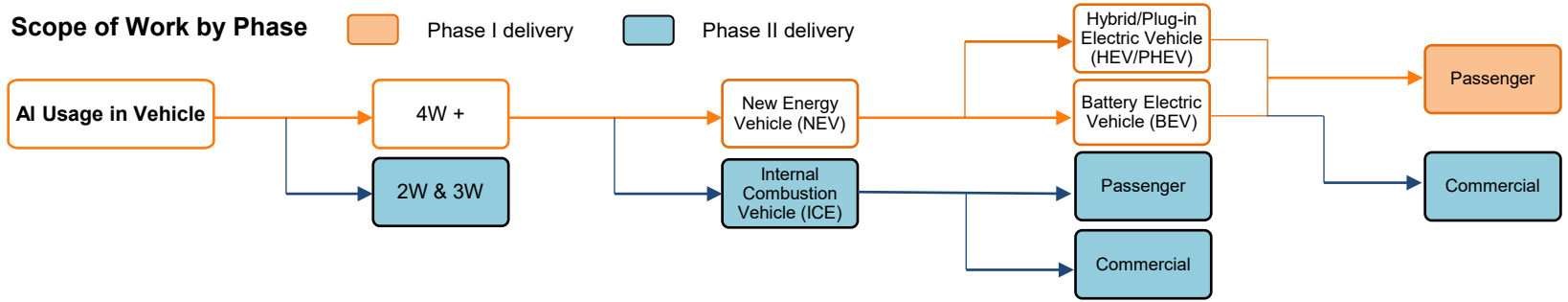
However, **high costs** and **technology constraints** are major factors restricting further application.

Aluminium Forms

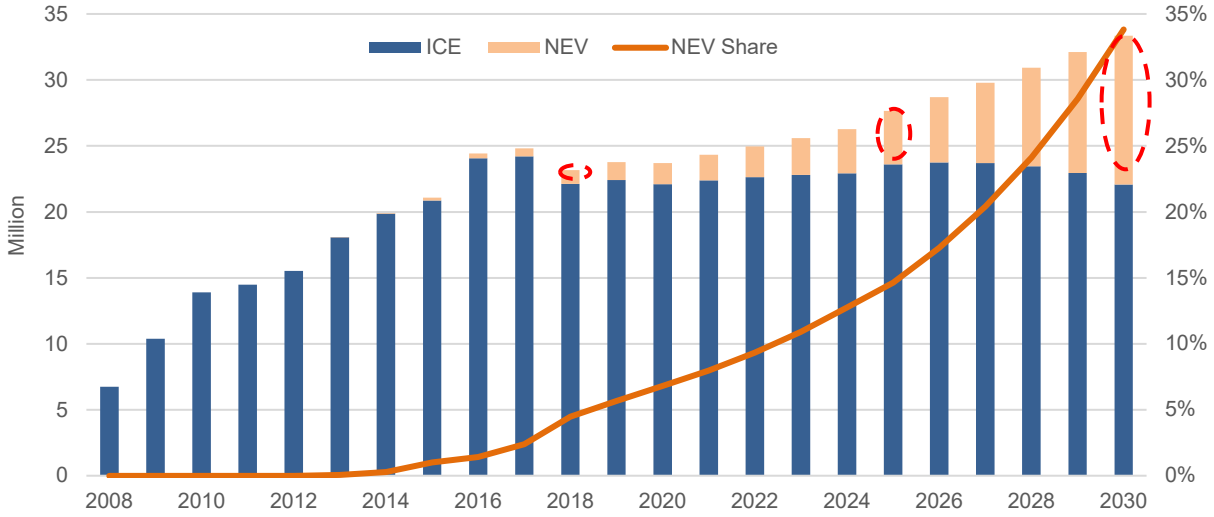
Main driver of future Al application will be **wider usage of rolled products** in manufacturing battery pack case and body closures.

Al casting will gradually lose its dominant position as the market share of ICEs drops.

China's NEV Production to Increase Sharply Next Decade



China Passenger Vehicle Production Outlook



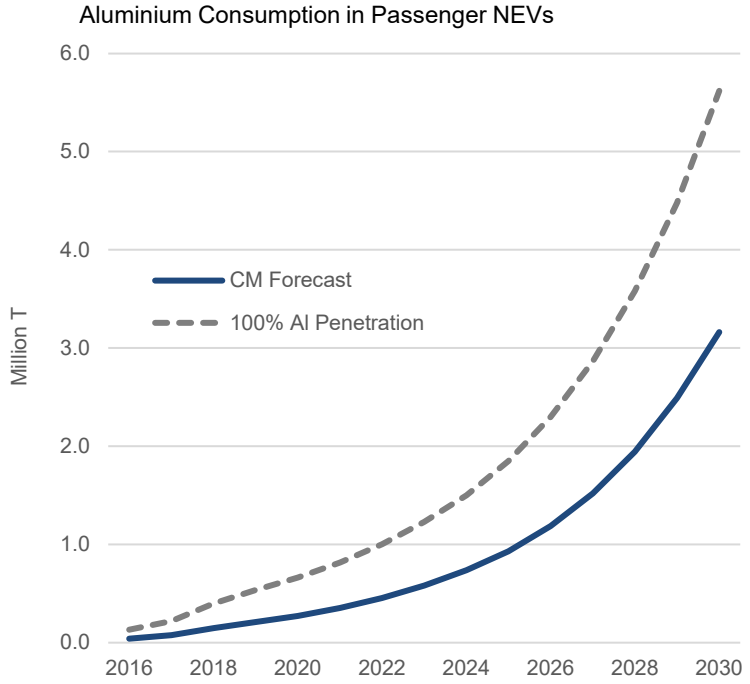
2017 0.6 mln NEV 2.4%

2025 4.0 mln NEV 14.6%

2030 11.3 mln NEV 33.8%

Source: CM, CAAM, MIIT, Company Reports, internet public sources

SWOT for Aluminium Usage in NEV



Strength	Weakness

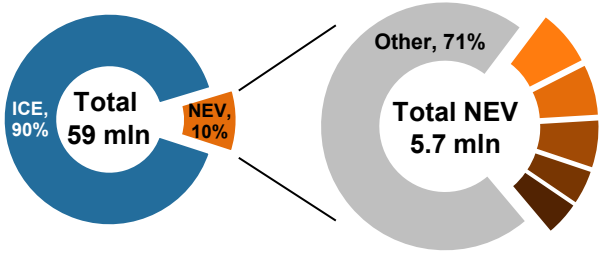
• Low density (light)
• Mature processing technology
• High recycling rate
• Structure strength
• Corrosion resistance
	• High processing requirements
	• High costs
	  ▪ Al production cost
	  ▪ Joining cost
	  ▪ Assembling cost
	• Relatively low melting point
	• Low elasticity

Opportunity	**Threats**
• Policy support to NEVs • Technology breakthrough • Global initiatives of emission control	• Other light-weighting materials such as hot press forming steel, Mg alloy and Carbon Fiber etc. • Other light weighting methods e.g. upgrading/redesigning the structure of parts. • Improvement of battery energy density

Robust outlook of aluminium usage, but facing with constraints including technology, alternative materials, metal characteristics, cost etc.

Source: CM Group

China Auto Capacity 2018(f), Million Passenger Cars



BYD, 7.2%

DMC, 6.5%

Yogomo, 6.1%

SAIC, 4.4%

BAIC, 4.4%

Hebei, Shandong, Hunan, Guangdong, Guizhou

Jiangsu, Hubei, Guangxi

Hebei, Jiangsu, Shandong

Shanghai

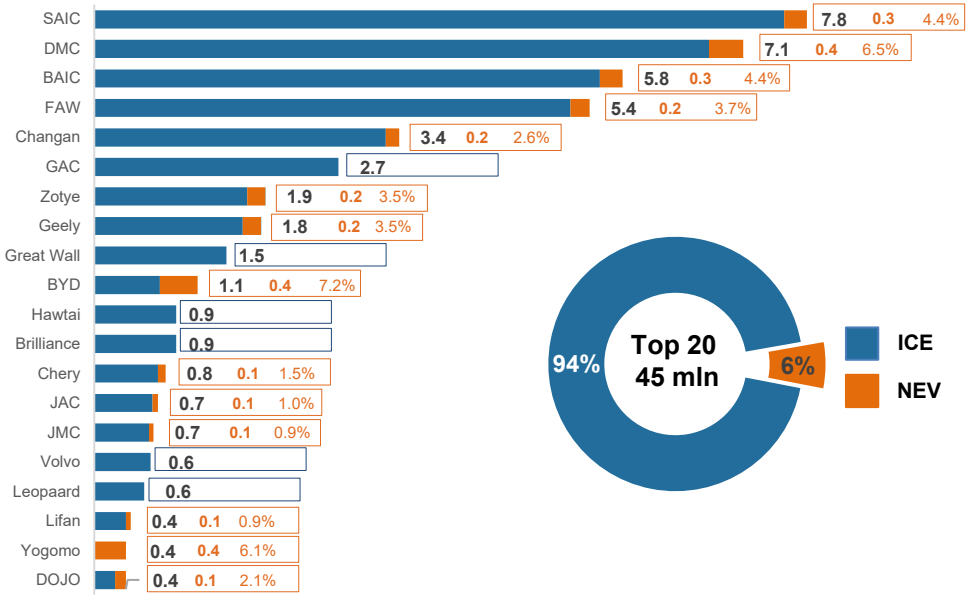
Beijing, Jiangsu, Jiangxi, Shandong, Chongqing

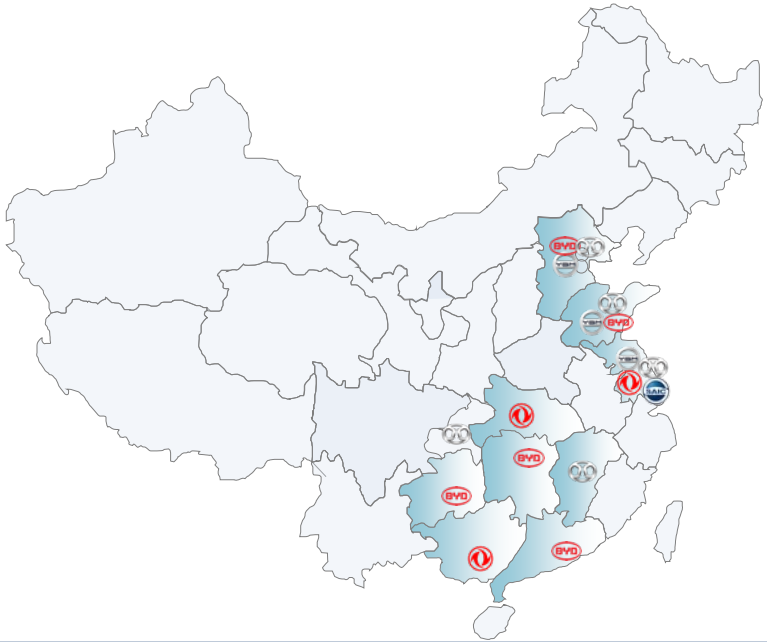
Top Five NEV Producers – 29%

China's top five NEV producers account for a combined 29% of China's total NEV capacity

There are in total over 100 NEV producers in China at present.

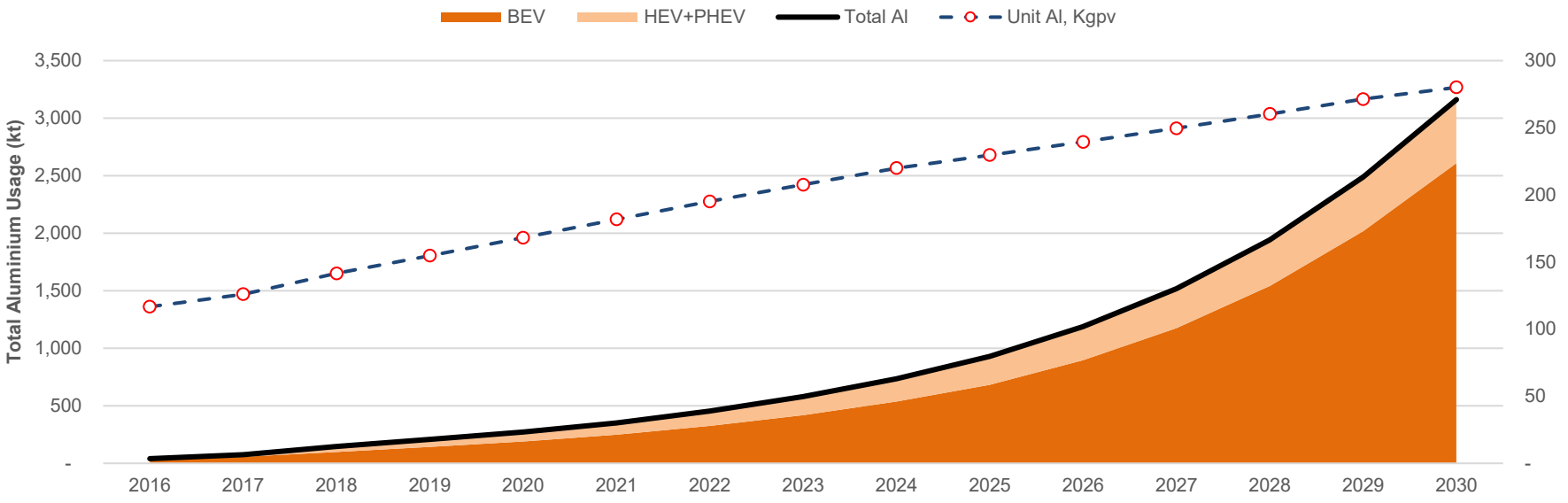
China's Top 20 Auto Producers (combined capacity **45 mln**, **NEV 3 mln**)





Source: CM Group, Company reports

Total and Unit AI Usage in NEV – Historical and Forecast



2012~2016 Generation I

<100kgpv

2017~2019 Generation II

~120kgpv

2020~2030 Generation III

130~240kgpv

BEV Evolution

BEV manufacturing has gone from simple modification on the traditional ICE platform in Generation I to a transitional stage of further improvements (Generation II), and will evolve to the use of its own platform (Generation III).

Source: CM Group

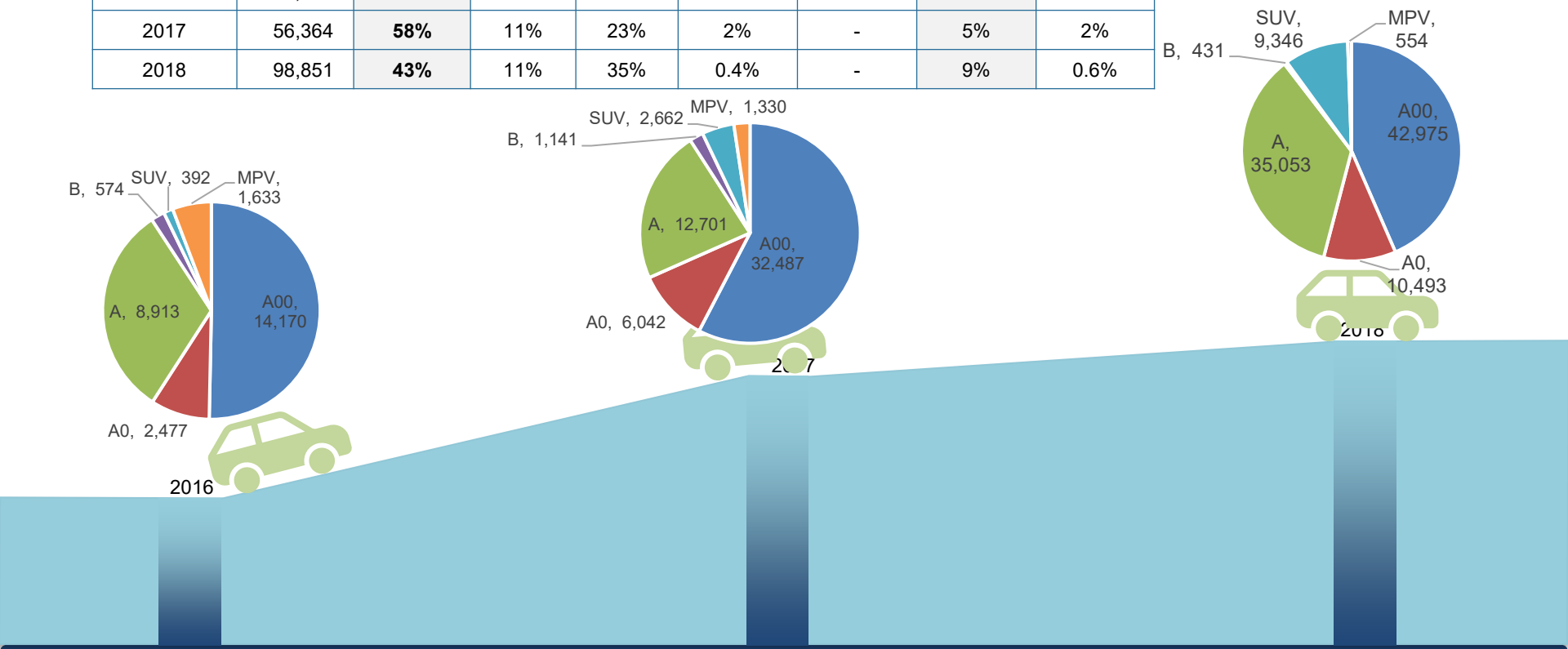
Auto Classification

China *(adopted in this analysis)*		**A00**	**A0**	**A**	**B**	**C**	**SUV** (5 types)	**MPV**
EU		A	B	C	D	E	J	M
USA		Microcar	Economy	Compact	Mid-size	Full-size	SUV (4 types)	MPV
Wheel Base, mm		2000~2300	2300~2500	2500~2700	2700~2900	2800~3000		
Length, mm		4000	4000~4300	4200~4600	4500~4900	4800~5000		
Curb Weight, kg		800~1200	1000~1300	1200~1500	1300~1800	1600~2000		
Engine Displacement, L		1.0~1.3	1.0~1.5	1.6~2.0	1.8~2.4	>2.4		
Example	China	Chery QQ3	JAC iEV	BYD Qin	ZOTYE Z500EV	BAIC BJEV	NIO ES8	BYD e6
								
	Non-China	Fiat 500	Honda Jazz	Ford Focus	Toyota Camry	BMW 5 Series	Tesla ModelX	Honda Odyssey
								

Source: U.S. Gov., EU Commission, CAAM

Mini Autos (A00) Dominate China's BEV Market

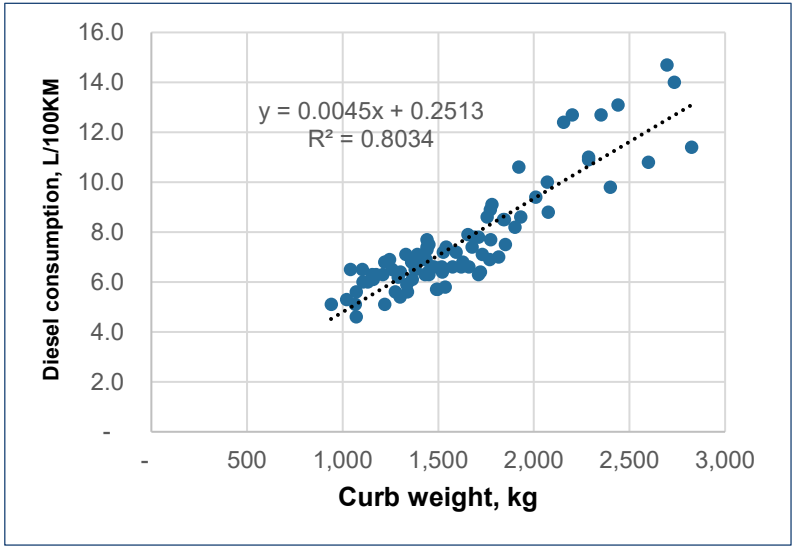
Category	Total AI Usage	A00	A0	A	B	C	SUV	MPV
2016	28,159	**50%**	9%	32%	2%	-	1%	6%
2017	56,364	**58%**	11%	23%	2%	-	5%	2%
2018	98,851	**43%**	11%	35%	0.4%	-	9%	0.6%



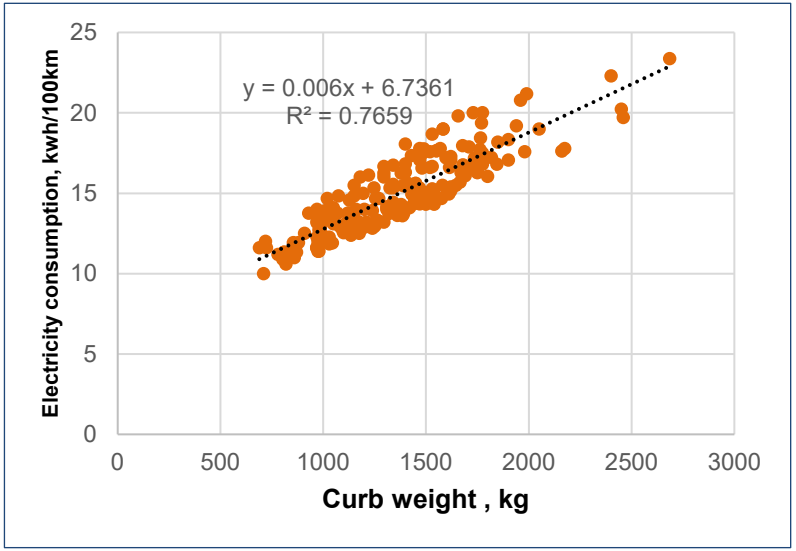
Source: CM Group

The More AI Consumption, the Lighter, Hence Less Energy Usage

Diesel Consumption vs. Curb Weight



Electricity Consumption vs. Curb Weight



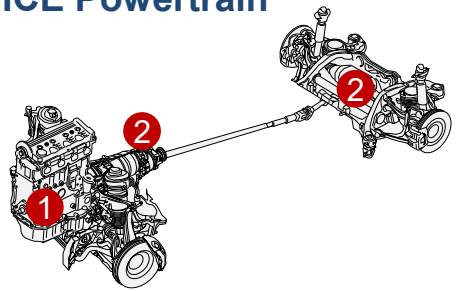
- Curb weight is the key factor affecting the energy (diesel and electricity) among many influencing factors (body design, technology, or even traffic situation, etc).
- MIIT Data shows every 100kg of weight reduction will result in a saving of 0.4 litre of diesel or 0.6 kwh of electricity per 100km of distance.
- Average producing cost of battery in China is about RMB1,500/kwh.

Source: MIIT, CM Group

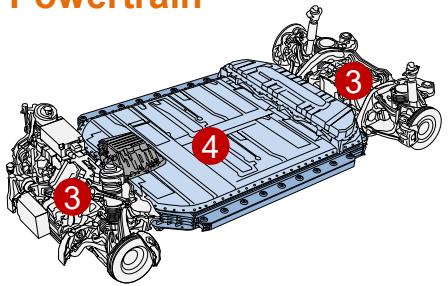
BEV, Usually Heavier than ICE, Has Stronger Incentive for Lightweighting

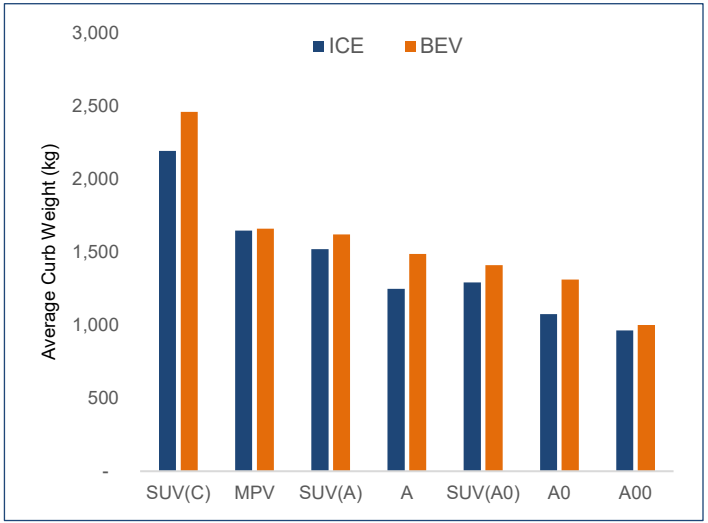
- On average, curb weight of **BEV** is 100~250kg heavier than ICE.
- By vehicle type, three types have larger differences between ICE and BEV
  - ✓ A
  - ✓ A0
  - ✓ SUV (C)

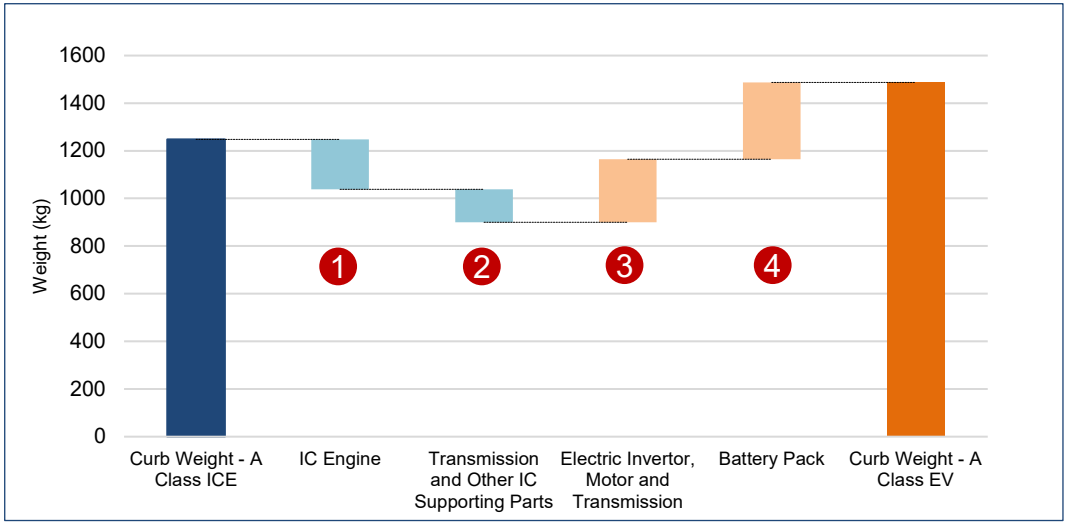
ICE Powertrain



BEV Powertrain



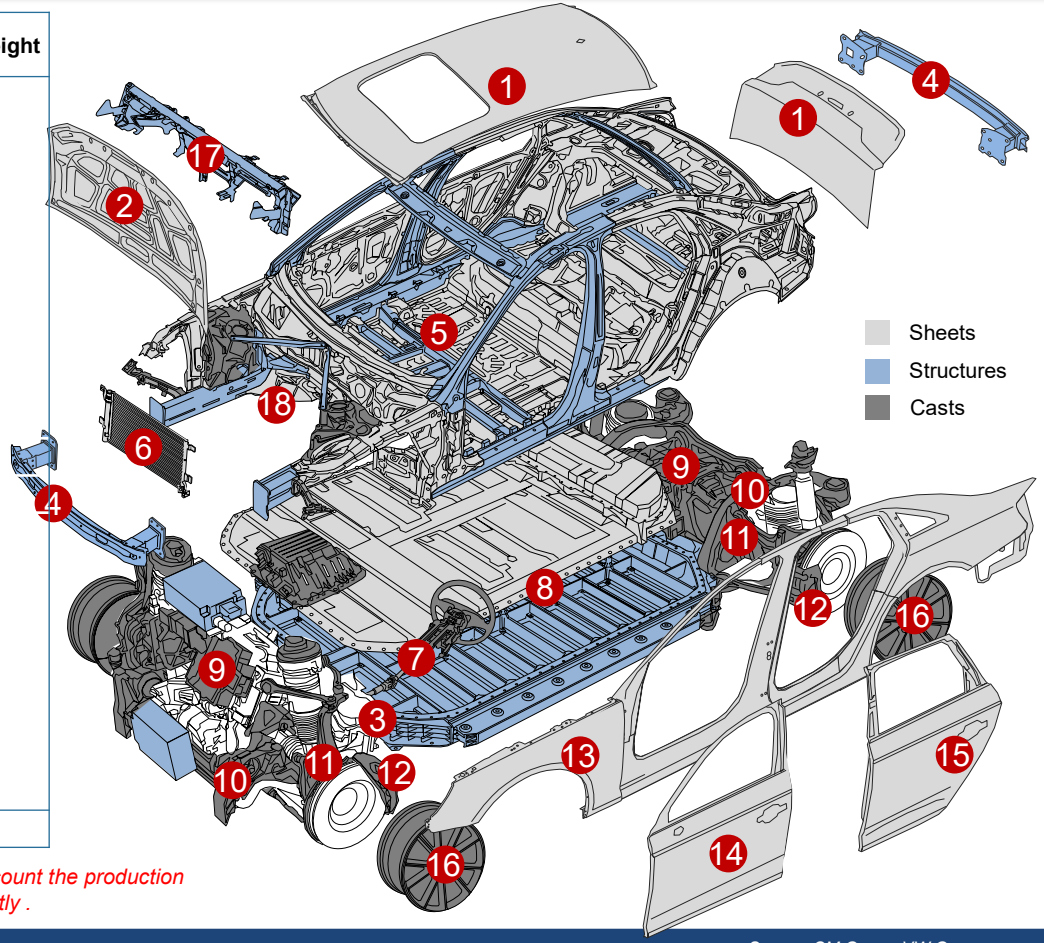




Source: MIIT, CM Group, autohome.com.cn, VW Group

Different Forms of Al in Different BEV * parts

	Part Name	Max Aluminium Usage (kg)	% of curb weight
1	Roof and Trunklid	8.9	0.8%
2	Hood	9.3	0.9%
3	Knuckles	10.2	1.0%
4	Bumper Beam and Crush Boxes	10.4	1.0%
5	BIW excl. closures	123.9	11.6%
6	Heat Exchanger	7.5	0.7%
7	Steering	1.7	0.2%
8	Battery Pack	42.2	3.9%
9	Driveline	14.9	1.4%
10	Subframe	25.5	2.4%
11	Suspension Arm	7.5	0.7%
12	Brake	10.2	1.0%
13	Fenders / Wings	7.0	0.7%
14	Front Doors	18.9	1.8%
15	Rear Doors	15.0	1.4%
16	Wheels	26.8	2.5%
17	IP Beam	4.8	0.4%
18	Heat Shields	4.8	0.4%
	Other	11.8	1.1%
	Total	**361.3**	**33.7%**



** The number shows here is a weighted average of BEV in 2018, taking into account the production of different types of car. With the big cars getting more, the max could vary slightly .*

Source: CM Group, VW Group

Limited Al Usage in Charging Infrastructure

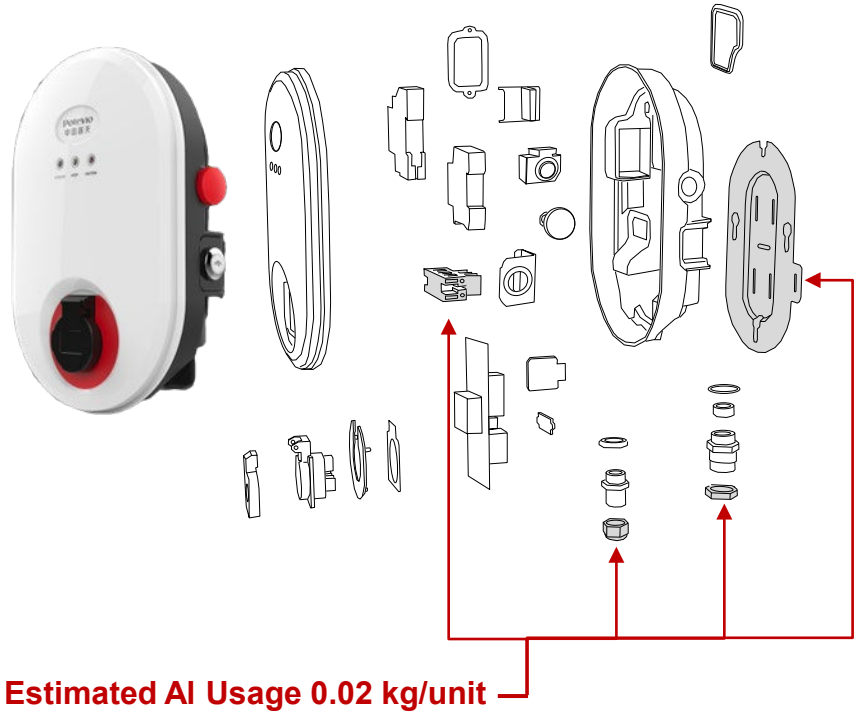
High strength plastic is the best choice for charging infrastructure in China in view of costs and electric insulativity of shell material.

Copper is usually preferred over aluminium for making power wires for charging piles, mainly due to two reasons:

- Power wires are buried underground and thicker aluminium wires are required to get the same conductivity as copper wires. Copper wires are more economic than aluminium cords in terms of capital investment and maintenance costs.
- Charging piles need stable conductivity in paid charge, copper wires are much more competitive than aluminium

Aluminium usage, therefore, in charging facilities is limited.

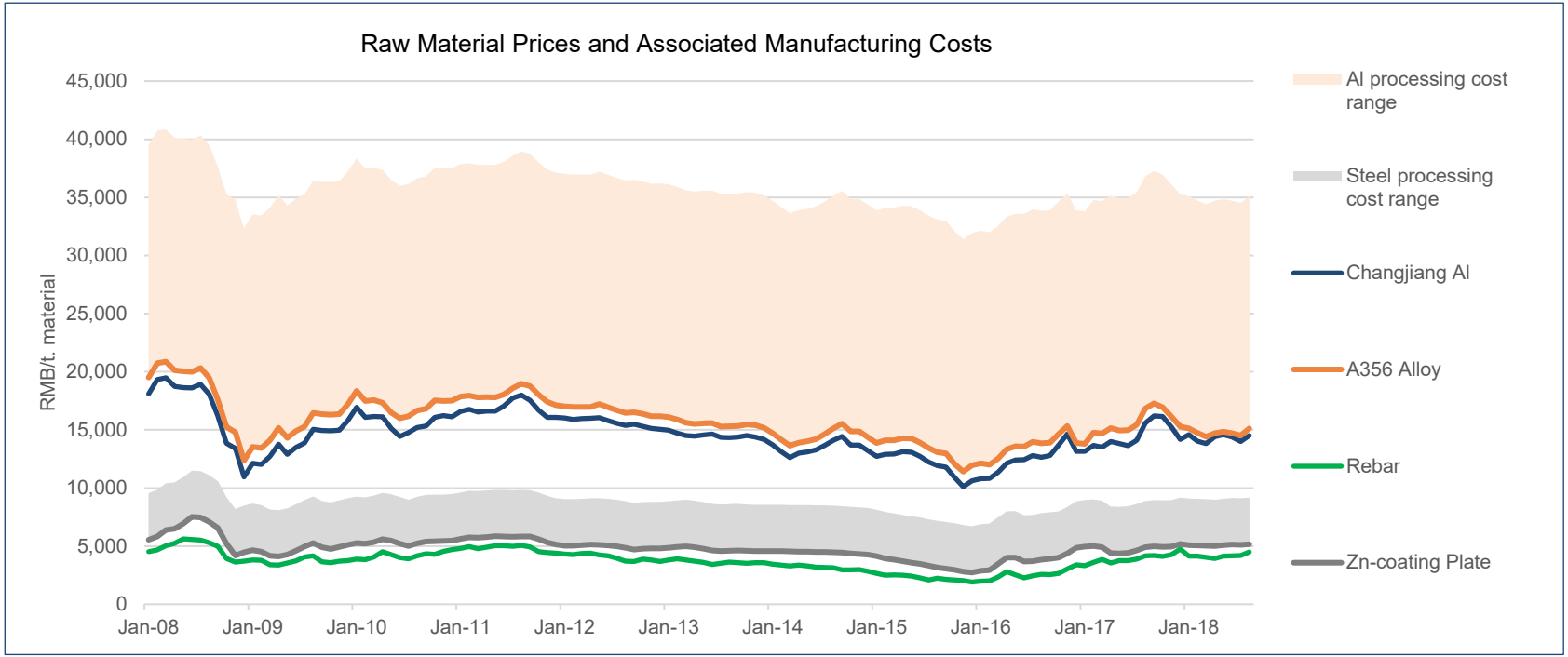
Components of a Wall Mounted EV Charger



Estimated Al Usage 0.02 kg/unit

Source: CM Analysis, Potevio

Cost is Still a Key Problem

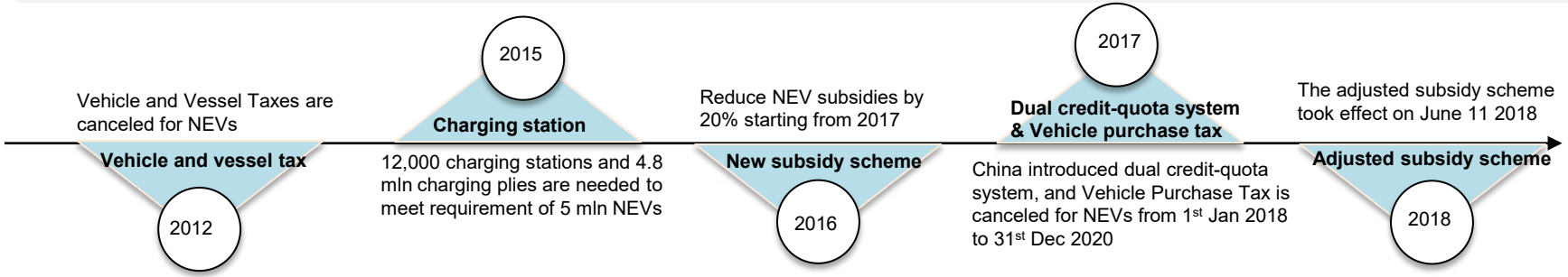


- Aluminium prices have remained well above steel prices. In fact, for **typical 5xxx and 6xxx** aluminium sheet mainly used for closures, prices can reach above RMB30,000/t, which is over **6 times** of that of Zn-coating plates, the current main materials for closures.
- Apart from price, **conversion costs** of aluminium products are nearly twice as expensive as steel, and **assembly costs** are 20%~30% higher. Meanwhile, the welding is a key technology barrier while manufacturing body structures.

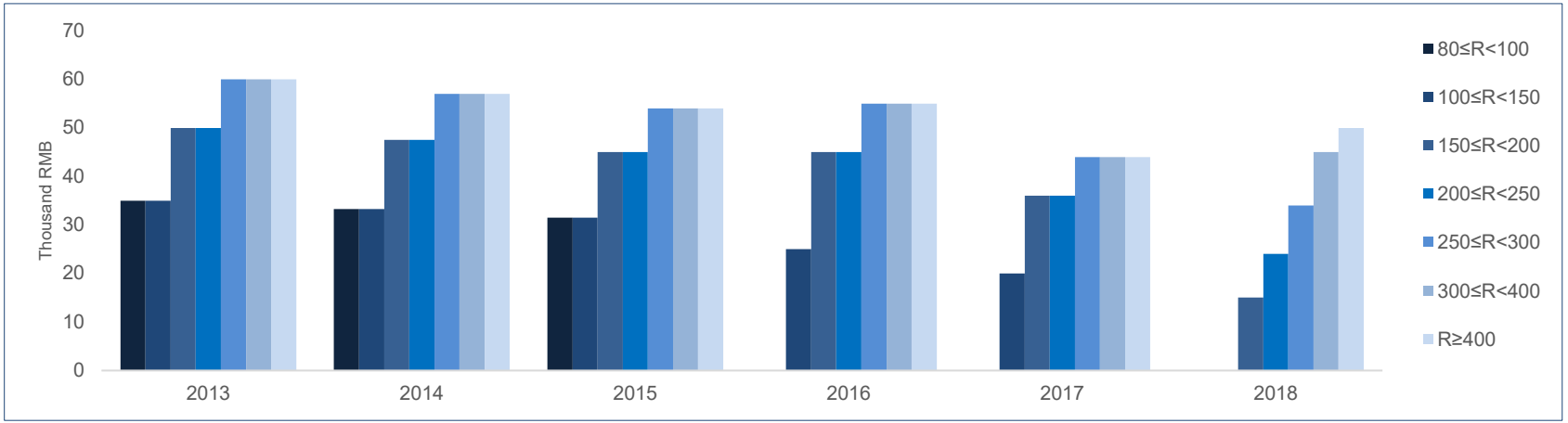
Source: CM Group

China's NEV Policy Overview (Cautiously Supportive)

China has implemented a series of measures to encourage the NEV industry, which pushed up NEV sales significantly from over 10,000 units in 2013 to 770,000 units in 2017. However, China's subsidy for NEVs has been decreasing recent years.



Subsidy varies by enduring ranges (km); generally cars with longer range get higher subsidy. However, the overall subsidy is reducing.



Source: MIIT, NDRC, MOC

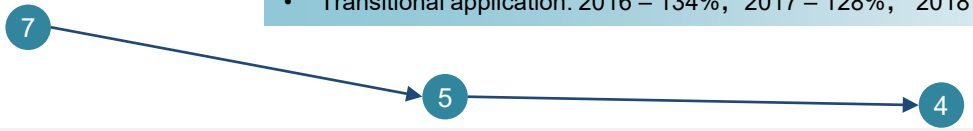
A Bullish Outlook under Strong Incentives for Energy Efficiency

2025 Fuel Consumption Standard (C_s) set at **4 liter**/100 km

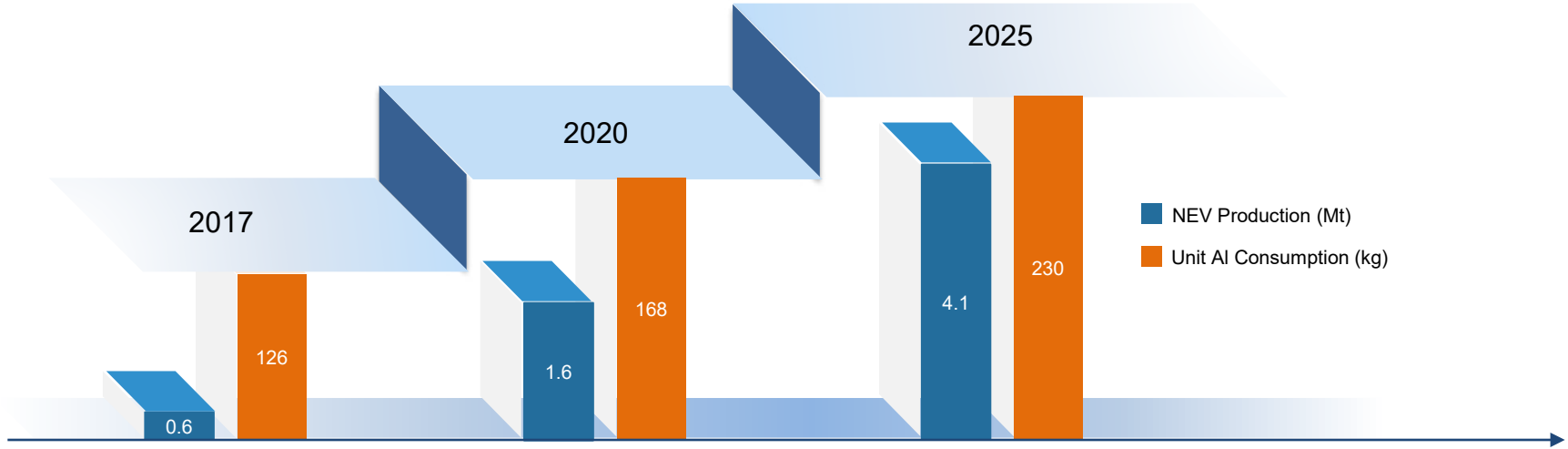
2025 total passenger vehicle production to reach 28 mln units with **4 mln NEVs**

Unit AI consumption to increase to 230kg in 2025 and 280kg in 2030.

- China's 2020 target National Fuel Consumption Standard at 5 L/100 km has put many producers under pressure.
- Transitional application: 2016 – 134%，2017 – 128%， 2018 – 120%， 2019 – 110%, 2020 and after – 100% of C_s



C_s: Fuel Consumption Standard (L/100 km)

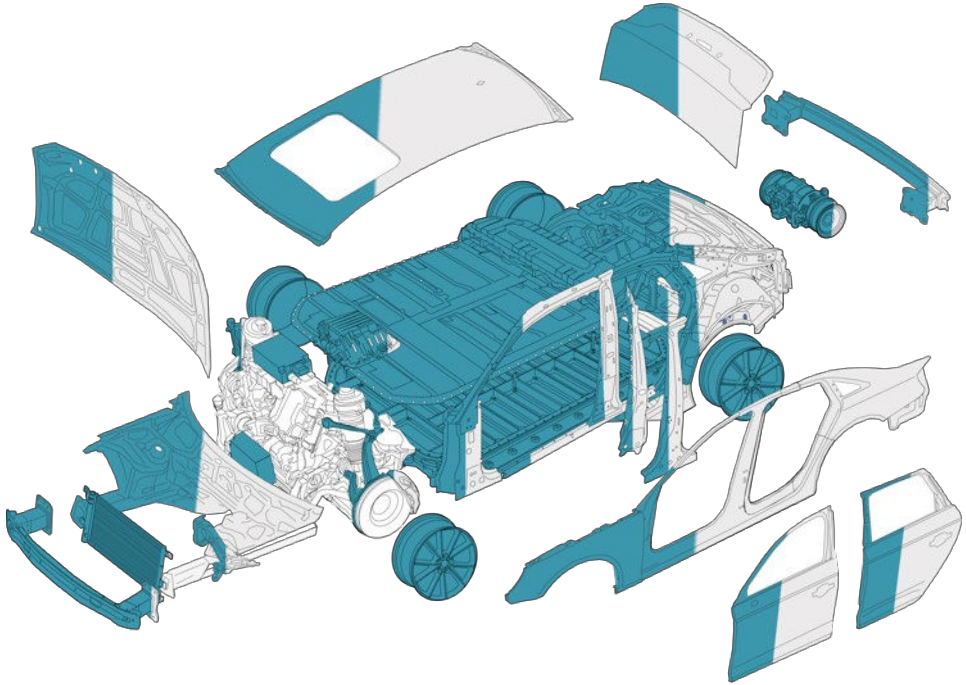


Source: MIIT, NDRC, MOC

Aluminium Penetration Rate in BEVs 2018 - 2030

Al Penetration*	2018 (kgpv, %)		2025 (kgpv, %)		2030 (kgpv, %)	
Chassis & Suspension	11.6	26%	39.5	70%	59.4	94%
Wheels & Brakes	24.6	66%	44.7	96%	49.7	96%
Battery System	42.2	100%	53.3	100%	59.3	100%
Driveline	9.8	66%	17.4	93%	19.4	93%
Heat Transfer	11.1	90%	14.9	96%	16.6	96%
Body Structures	9.9	8%	18.5	11%	25.3	14%
Body Closures	8.0	12%	23.3	28%	36.3	39%
Crash Management Systems	6.9	66%	9.4	71%	11.1	75%
Other Component	4.4	93%	5.8	97%	6.4	97%
Total	**128.4**	**31%**	**226.8**	**50%**	**283.5**	56%

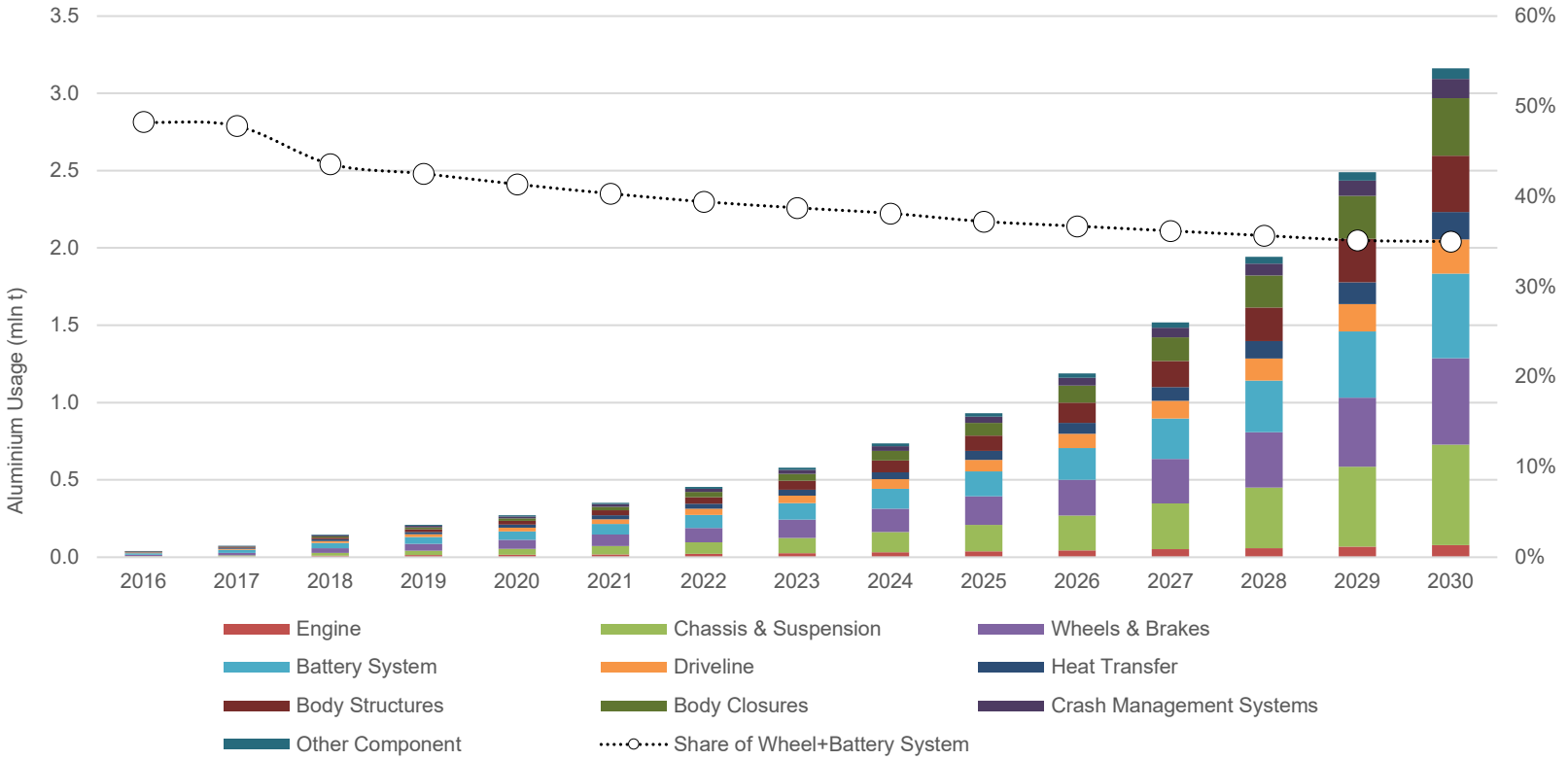
2030 BEV Production 9.2 mln



* **Al Penetration** = $\frac{\text{Actual Kg of Al used}}{\text{Kg could be used (max)}}$

Source: CM Group

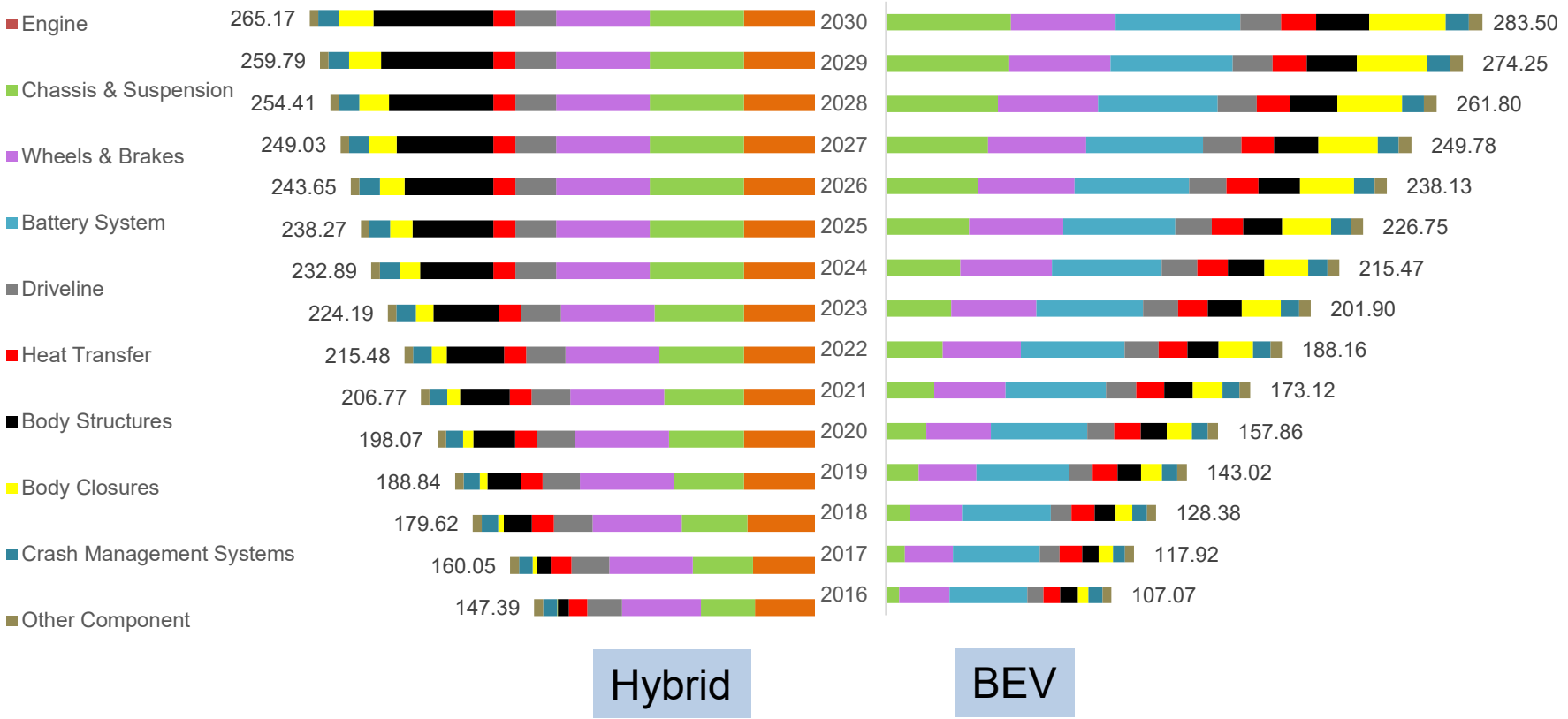
Diversified Application of AI Usage in NEV by Parts



- Aluminium in **wheels and battery system** took up majority (48%) of the 2017 total usage. However, we forecast this proportion to drop, to 35% by 2030, as AI usage in other parts are estimated to increase, particularly in **body structures and closures**.

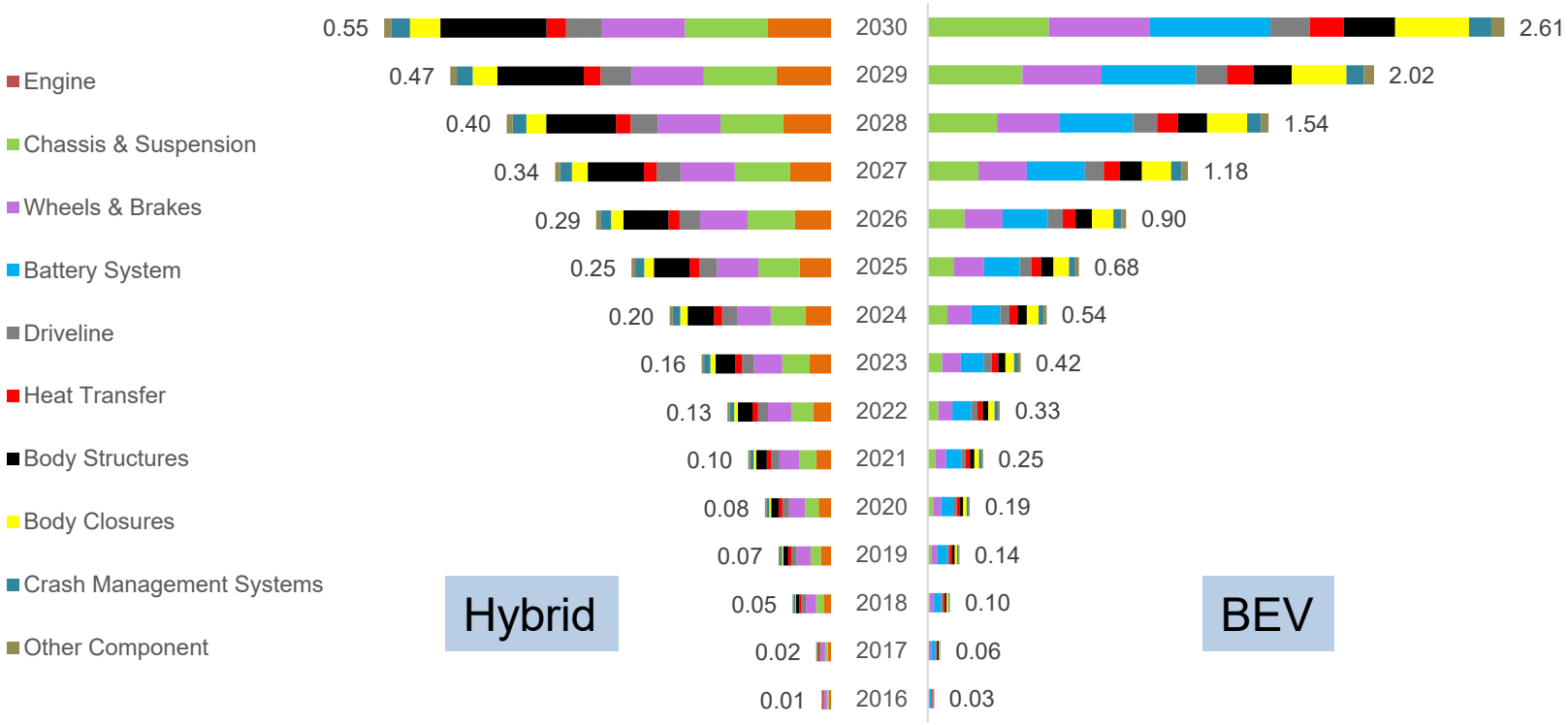
Source: CM Research, CAAM

Unit AI Usage in NEV by Part, kgpv



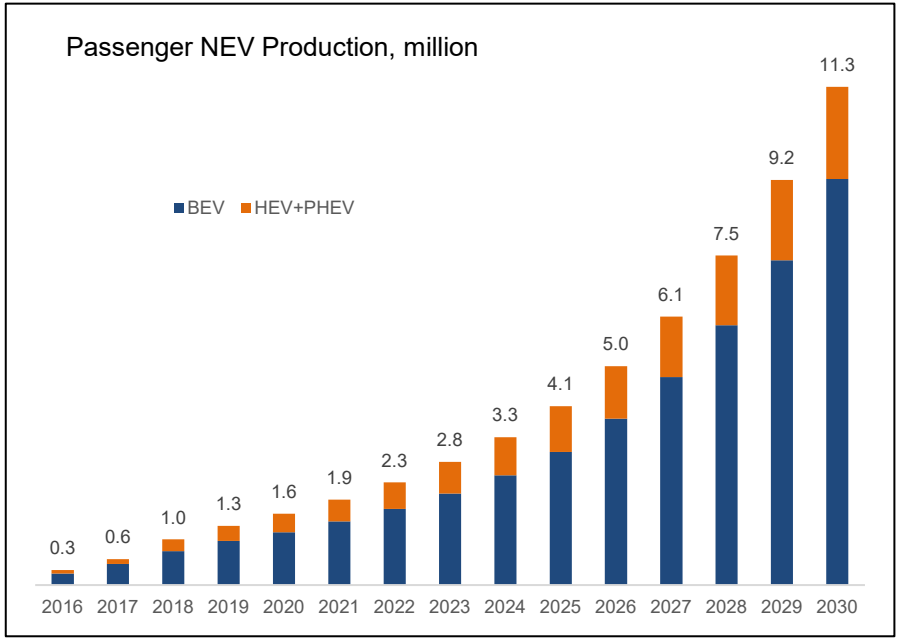
Source: CM Group

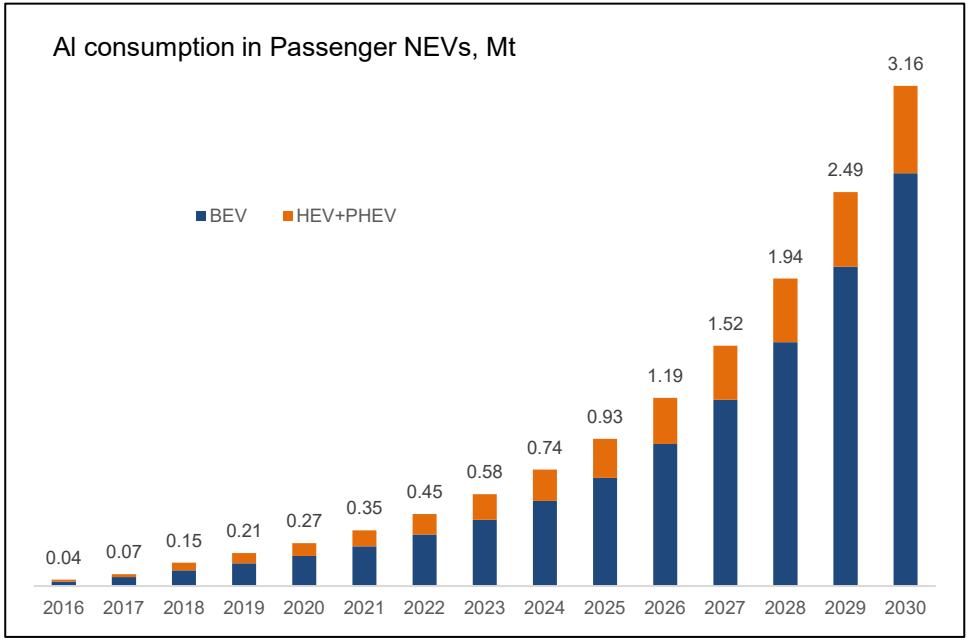
Diversified Application of AI Usage in NEV by Parts, Mt



Source: CM Group

Al Consumption by NEVs (Passenger) to Reach 3.16 Mt in 2030

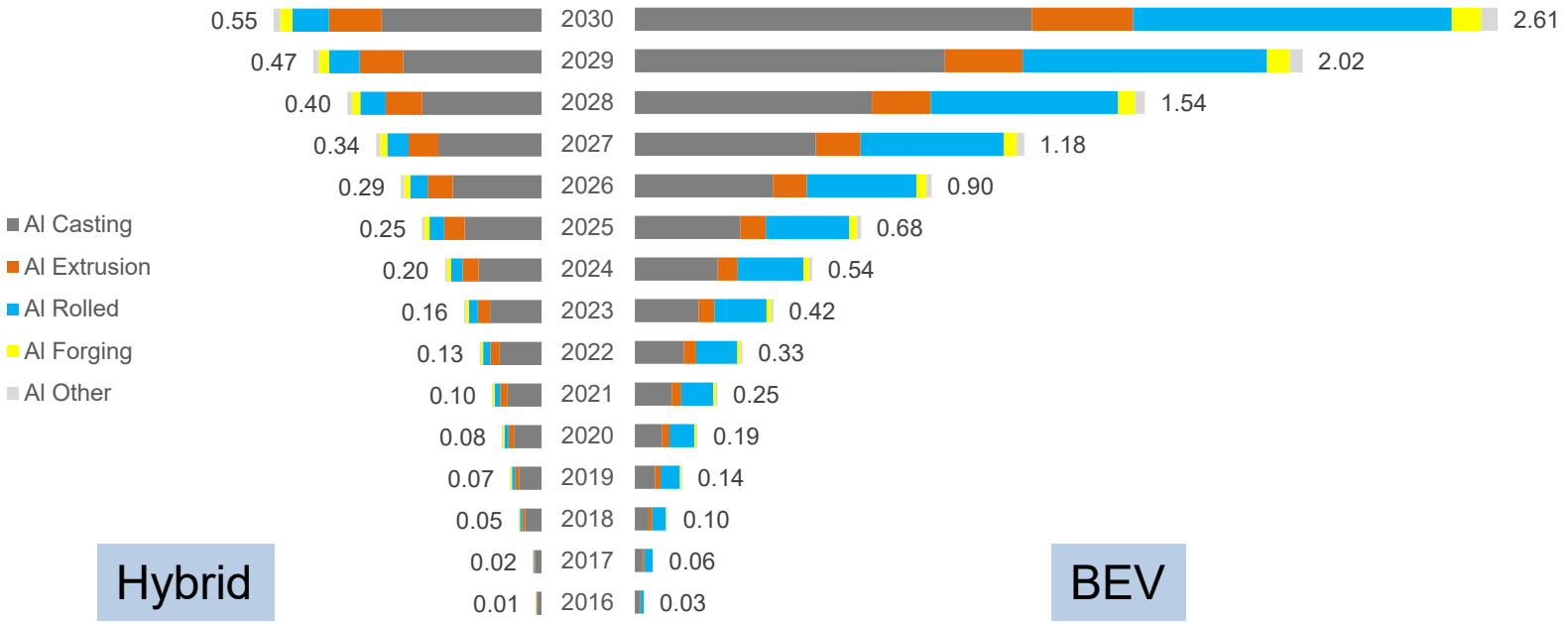




1. China produced a total of 0.59 million NEVs in 2017, including 0.48 million BEVs and 0.11 million hybrid (HEVs+PHEVs), consuming a total of 75kt of aluminium, with the average unit Al consumption at 126 kgpv.

2. We forecast China's NEV production to grow robustly in the future, with total production to reach 4.1 million in 2025 and to hit 11.3 million in 2030, with the total aluminium consumption by NEVs estimated at 0.9 million tonnes and 3.2 million tonnes respectively.

Mix of AI Usage by AI Form



Source: CM Group

- For traditional ICEs, the aluminium casting is widely used to manufacture engines, roughly taking up to 70% of the total usage. For BEVs, Al casting only takes up ~50% of the usage in 2018, followed by Al sheets as more sheets are used to manufacture battery pack case.
- In the future, with the development of BEVs, aluminium casting, although remains a dominant form, is forecast to take a lower proportion, while the proportion of Al rolled product is estimated to increase.

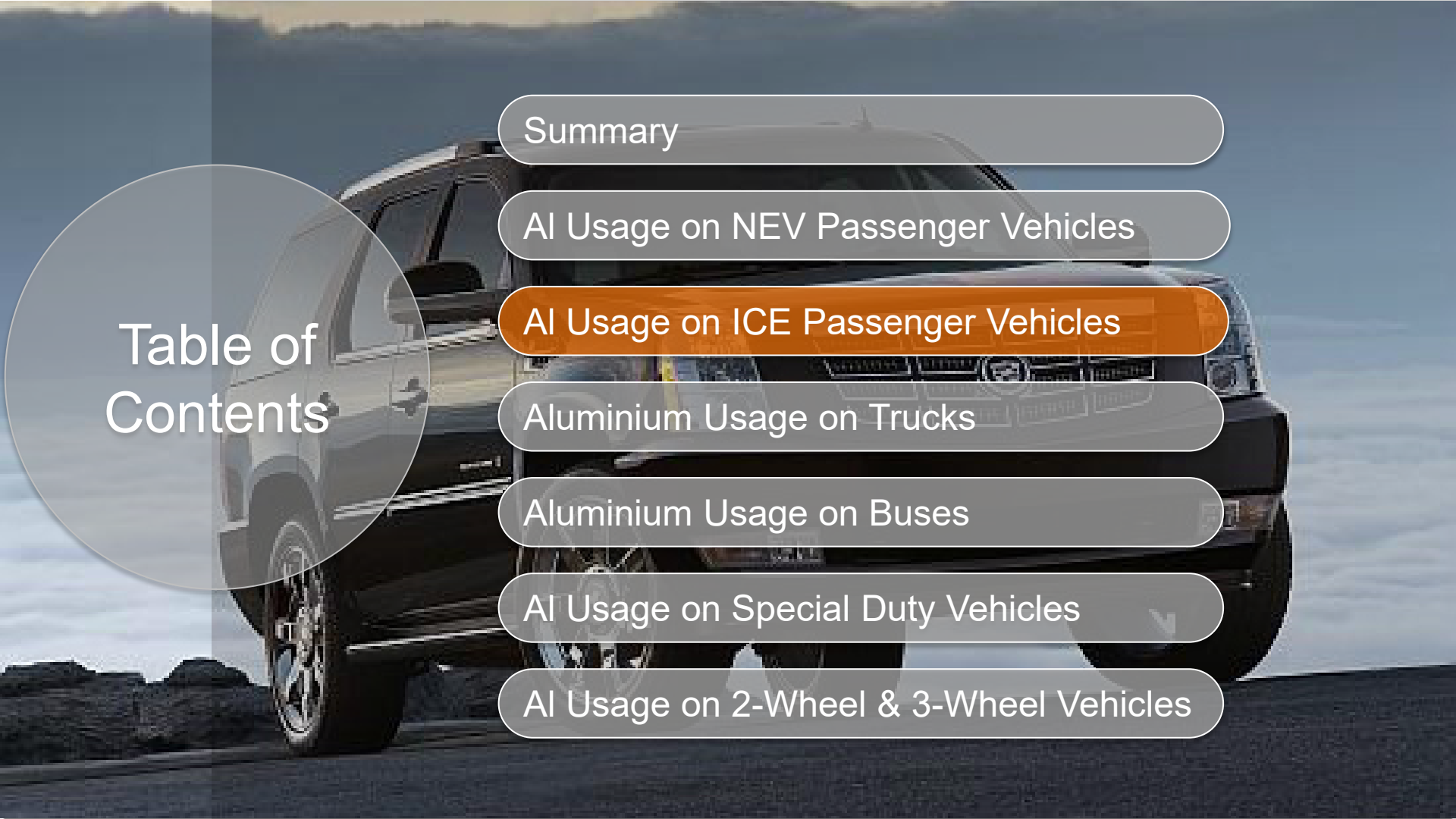
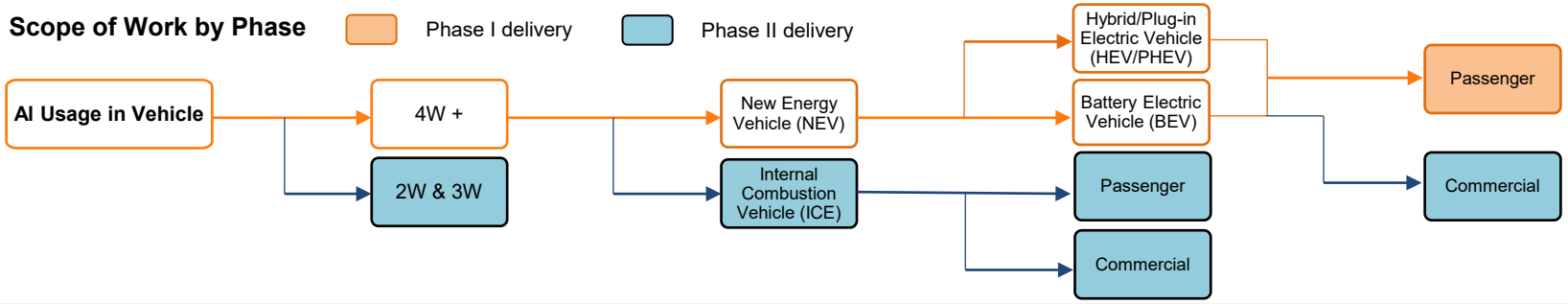
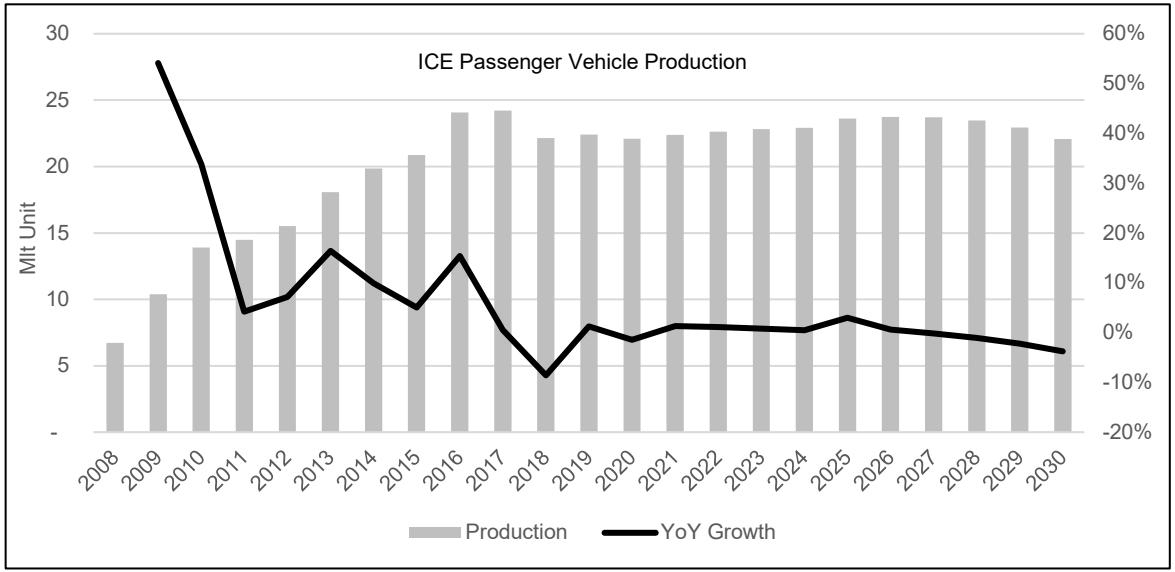


Table of Contents

ICE Production to Stagnate with Govt's Policies on Emission Control





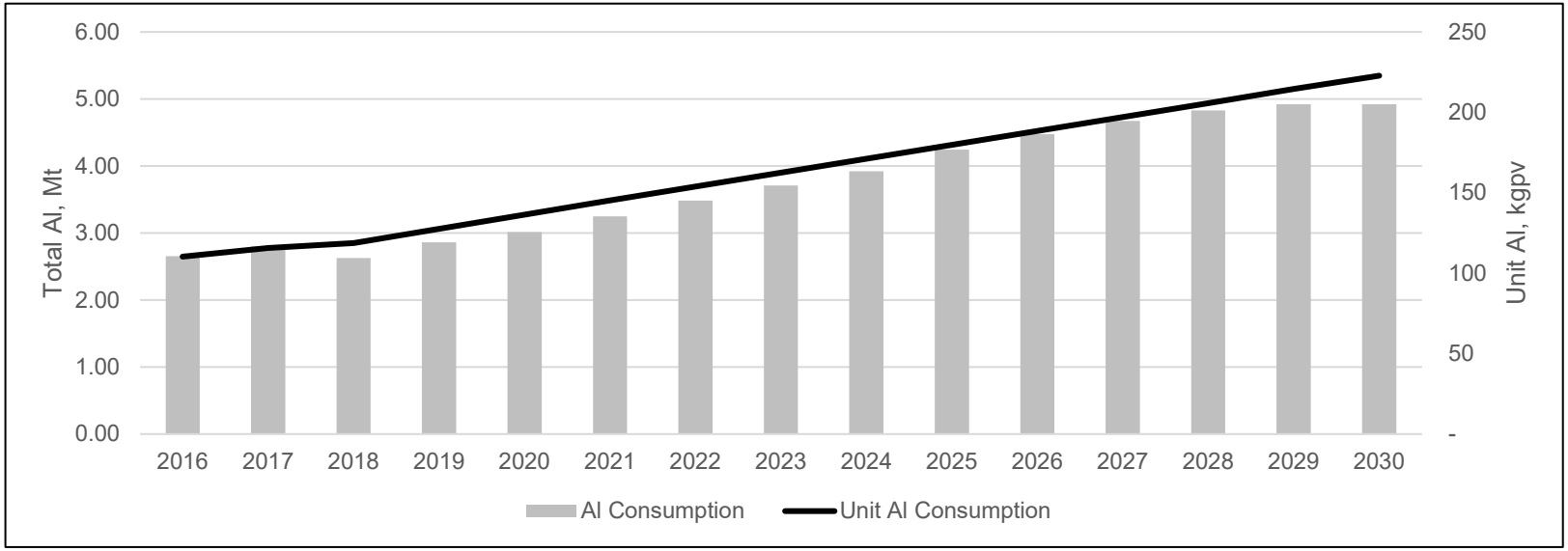
2017 24.2 mln ICE
97.6% total

2025 23.6 mln ICE
85.4% Total

2030 22.1 mln ICE
66.2% total

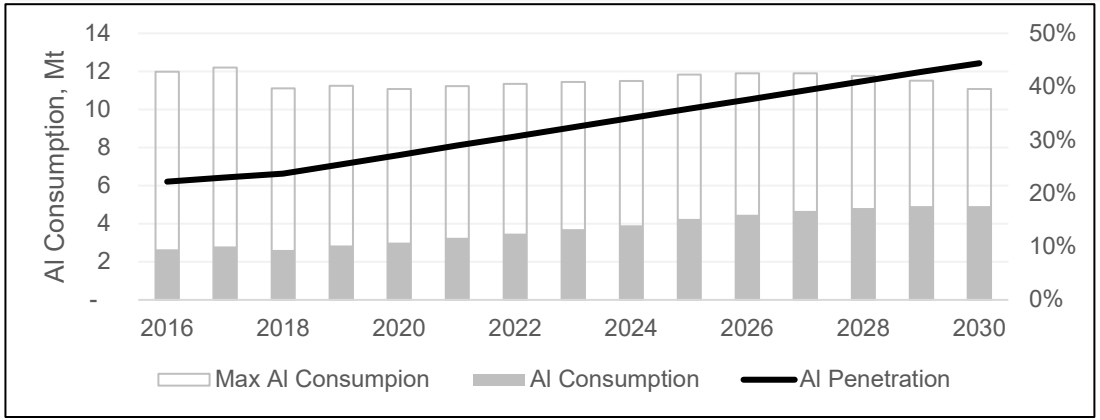
Source: CAAM, National Bureau of Statistics, Company Report, Public sources, CM Group

Unit Consumption to Go up, but Total Use to be Capped…



- Aluminium use in ICE passengers will continuously grow due to the government's regulation on light weighting. We forecast the unit aluminium use on ICE passengers to reach 180kgpv in 2025 and further grow to 223 kgpv in 2030 (as compared to 119 kgpv in 2018).
- Total aluminium consumption is expected to increase from 2.6 mln tonnes in 2018 to 4.9 mln tonnes in 2030.

Various Methods will be Adopted for Light Weighting…



- The maximum aluminium consumption on an ICE passenger vehicle is about 502kgpv. We believe the production mix of vehicles are unlikely to change, hence, production volume is the only key factor affecting the max Al consumption.
- The aluminium penetration is forecast to grow from 24% in 2018 to 44% in 2030.

Aluminium is expensive, various methods will be adopted for light weighting…

BAIC D50

For a low-cost China-made car, the manufacturers will try to optimize the parts' structure or use substitute material like hot-formed steel.

VW Magotan

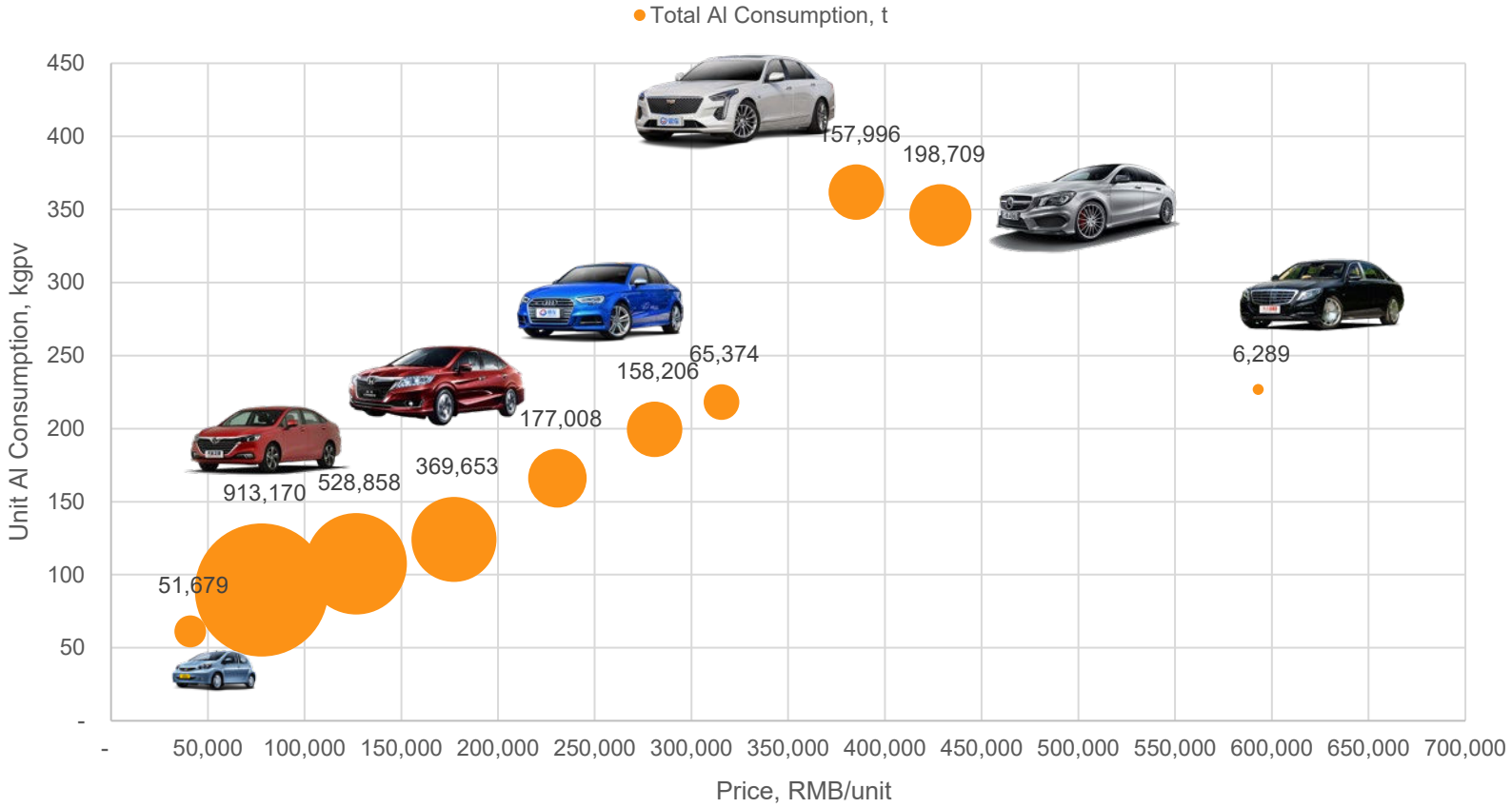
For a typical Type-B car, light material like hot-formed steel and Al/Mg alloy will be widely used for light weighting.

Jaguar XEL

For a high-end vehicles, Al or Mg or even carbon fiber (CF) will be widely used.

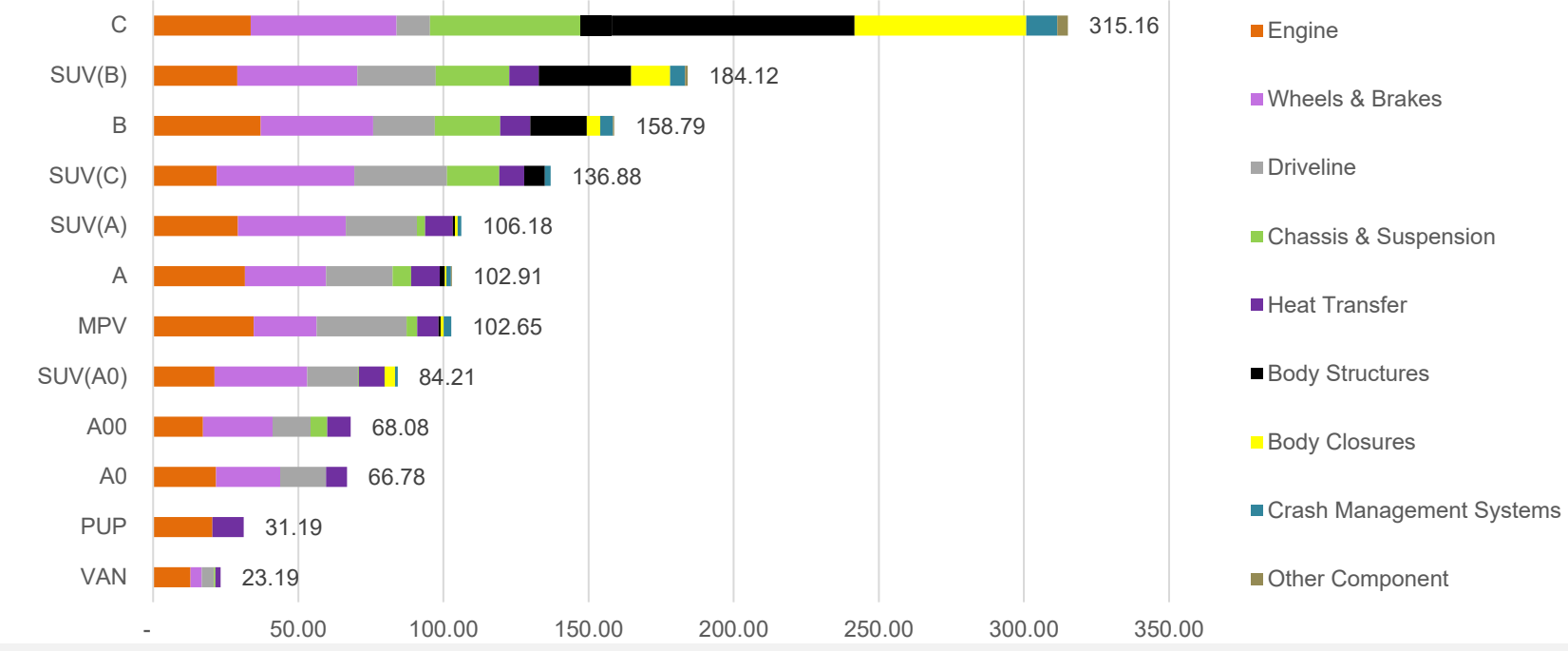
Source: CM Group

It's All About Price…



Source: CM Group

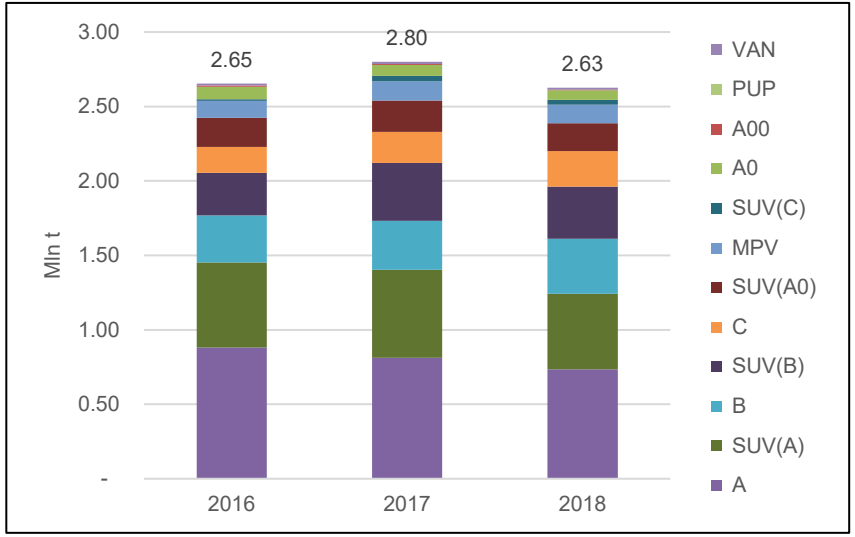
High-end Cars Use More Al (2018)

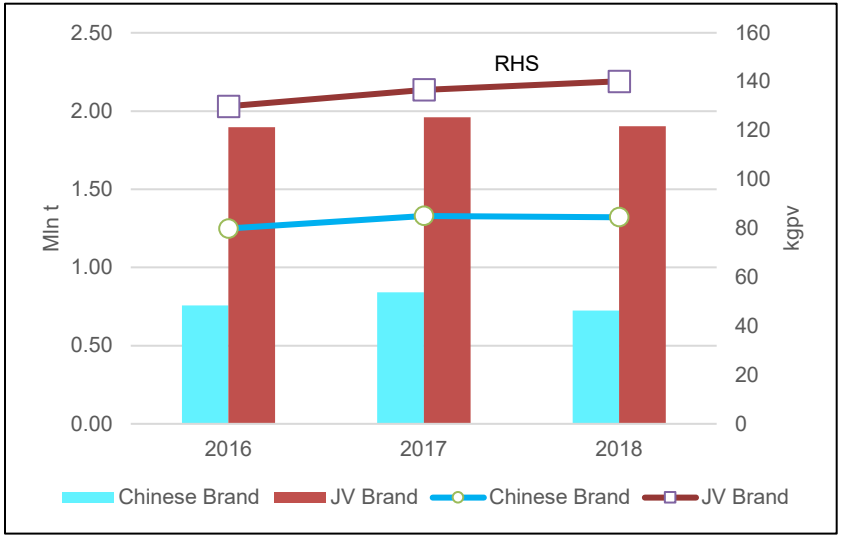


- Generally, larger cars consume more aluminium, as they have larger parts and are often more expensive.
- Al use on body structure and closures are still low on many cars, but it is widely used on luxurious Type-C cars. We believe these two fields have the most potential for growth in aluminium use in the future.

Source: CM Group

JV Brand Cars to Dominate the Al Consumption in China



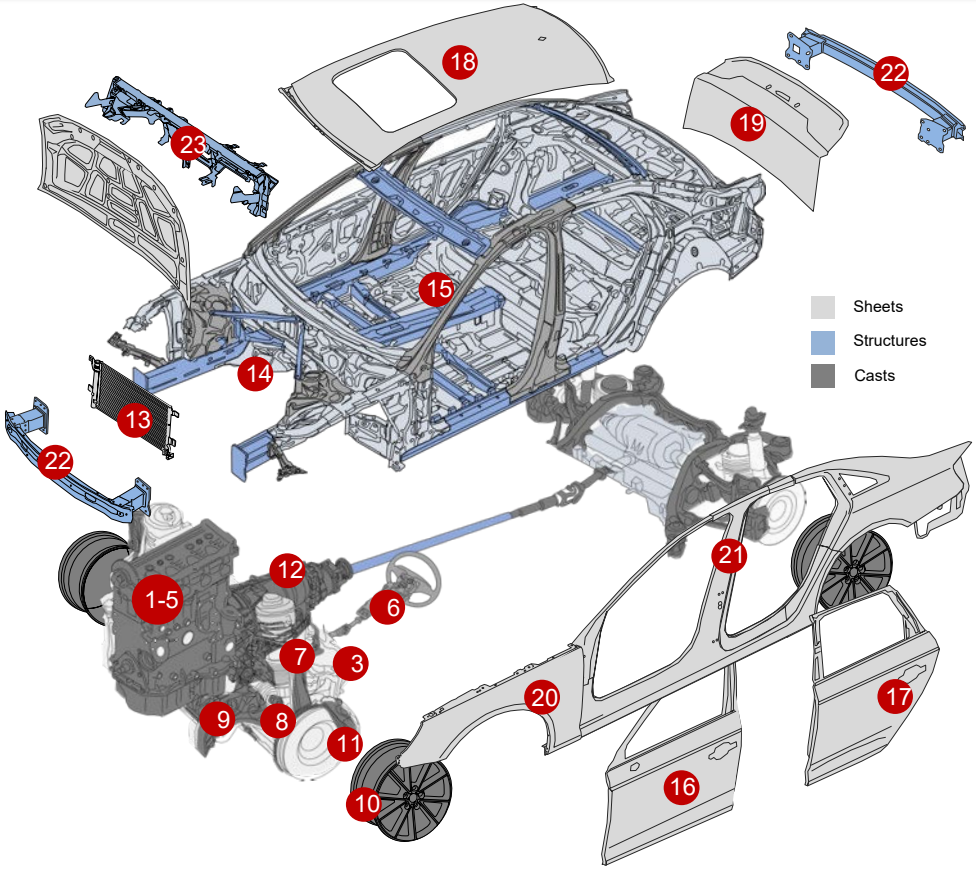


- The ICE passenger vehicle is estimated to consume 2.63 Mt of aluminium in 2018, almost ¾ is taken up by A-segment (28%), SUV(A)(20%), B-segment (14%) and SUV(B) (13%).
- Chinese brand cars still have a long way to go in light weighting compared to JV brand cars. The unit consumption of Chinese brand is 85kgpv while a JV brand car will consume 140kgpv in 2018. For aluminium consumed, JV brand cars takes up 72% of the total in 2018.

Source: CM Group

Different Forms of Al in Different ICE * parts

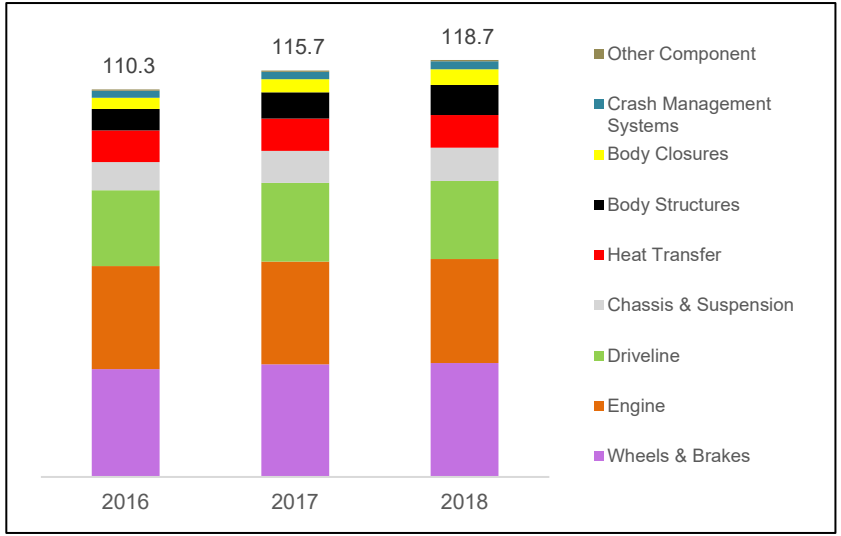
	Part Name	Max Al (kg)	Unit Al (2018)	% of Max
1	Engine Blocks	20.5	15.0	72.9%
2	Heads	8.0	7.9	99.5%
3	Pistons	2.6	2.4	92.7%
4	Mounts	4.8	3.0	62.9%
5	Other Enging	1.7	1.3	78.2%
6	Steering	2.0	0.3	16.9%
7	Suspension Arms	7.9	1.5	18.8%
8	Knuckles	11.1	2.4	21.2%
9	Subframes	31.3	5.3	17.0%
10	Wheels	32.8	31.6	96.4%
11	Brakes	10.2	0.8	7.6%
12	Driveline	25.8	22.3	86.4%
13	Heat Exchagers	6.5	6.1	93.7%
14	Heat Shields	3.4	3.2	94.0%
15	Body Sturctures	234.9	8.0	3.4%
16	Front doors	22.0	0.8	3.5%
17	Rear doors	17.6	0.8	4.3%
18	Hood	12.8	1.1	8.8%
19	Tailgte/Liftgate/Decklid	9.1	0.7	8.1%
20	Fenders	6.7	0.5	8.0%
21	Other	7.7	0.5	6.3%
22	Bumper Beam and Crash Box	12.0	2.3	19.2%
23	IP Beam	5.6	0.5	9.2%
24	Other	4.7	0.4	7.9%
	Total	**501.7**	**118.7.**	**23.7%**

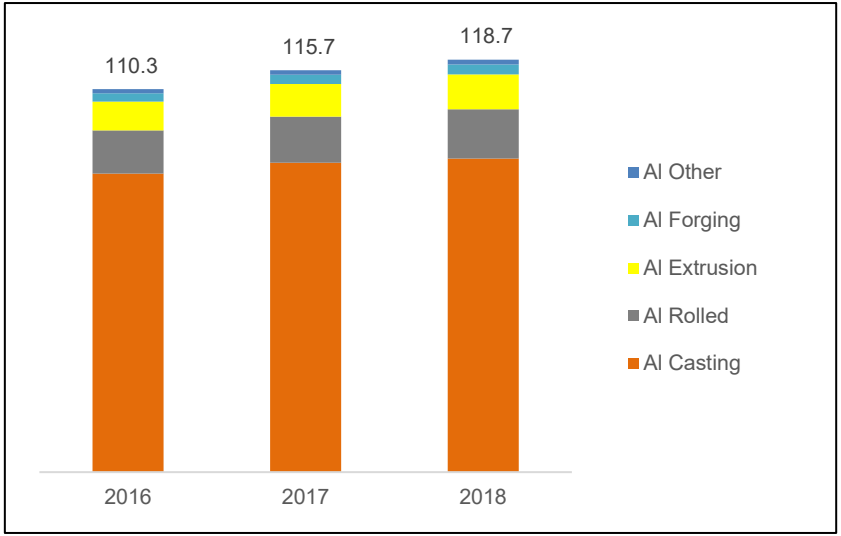


** The number shows here is a weighted average of BEV in 2018, taking into account the production of different types of car. We think the types of ICEs are already fixed, we think the max will stabilize..*

Source: CM Group, VW Group

Al Casting Products is Still the Key, Wrought Al to Catch Up, kgpv

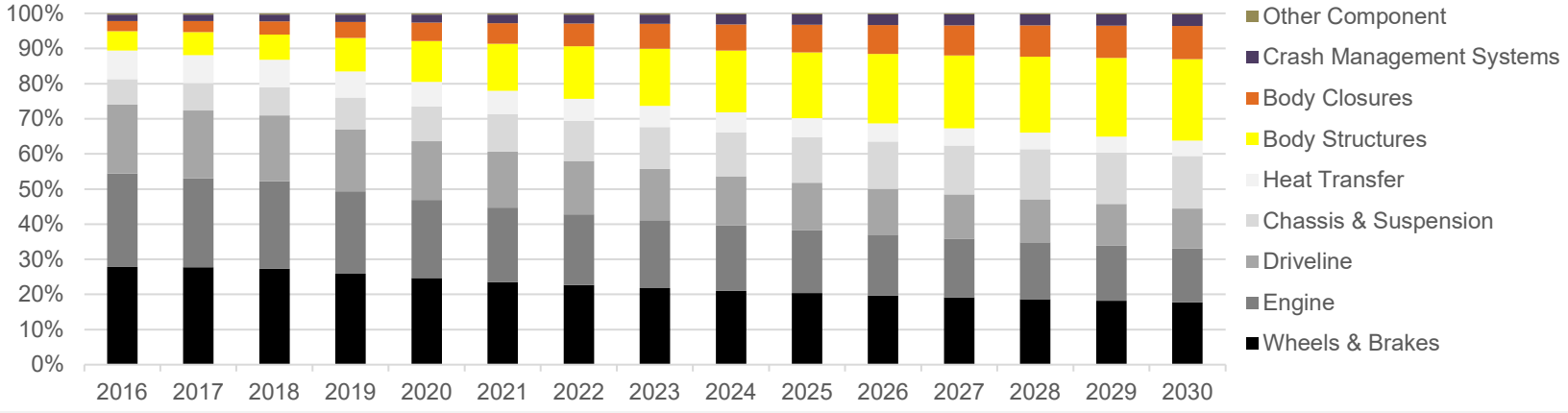


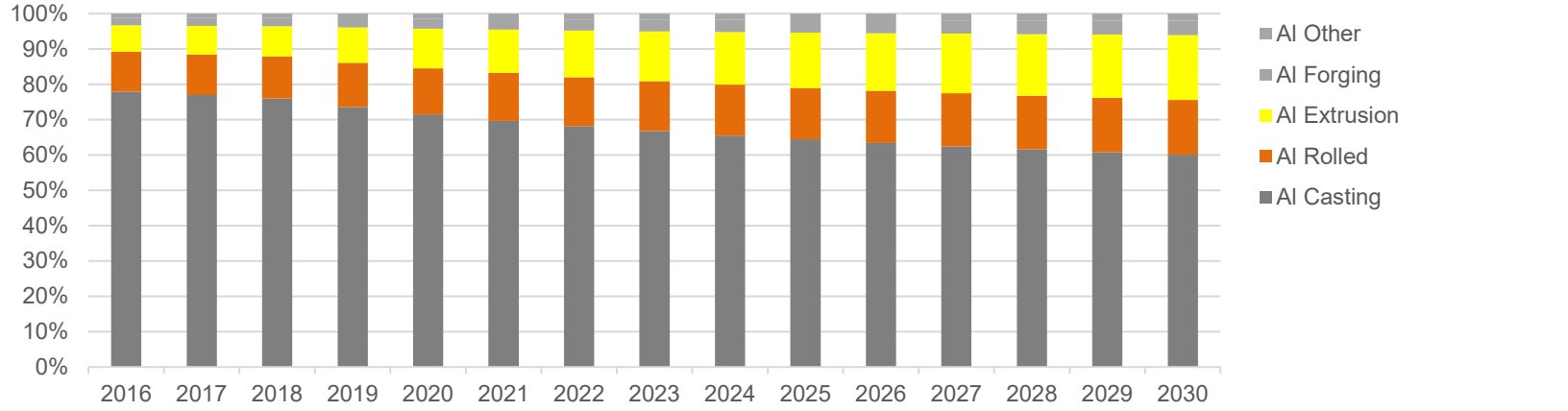


- Aluminium is widely used in manufacturing wheels, engine head, block and transmission box, as well as heat exchanger parts. The three systems, wheels and brakes system, Engine and driveline, took up 74% of the total usage in 2016, 72% in 2017 and is estimated to take up 71% of the total usage in 2018. In the future, we estimate the proportion will keep going down.
- As these parts are mainly manufactured by Al casting, Al casting is the largest contributor to aluminium consumption, taking up 78% of the total consumption in 2016, 77% in 2017 and 76% in 2018. In the future, we forecast this proportion to further decline.

Source: CM Group

Potential Growth in Car Body Using Al sheet and Extrusion



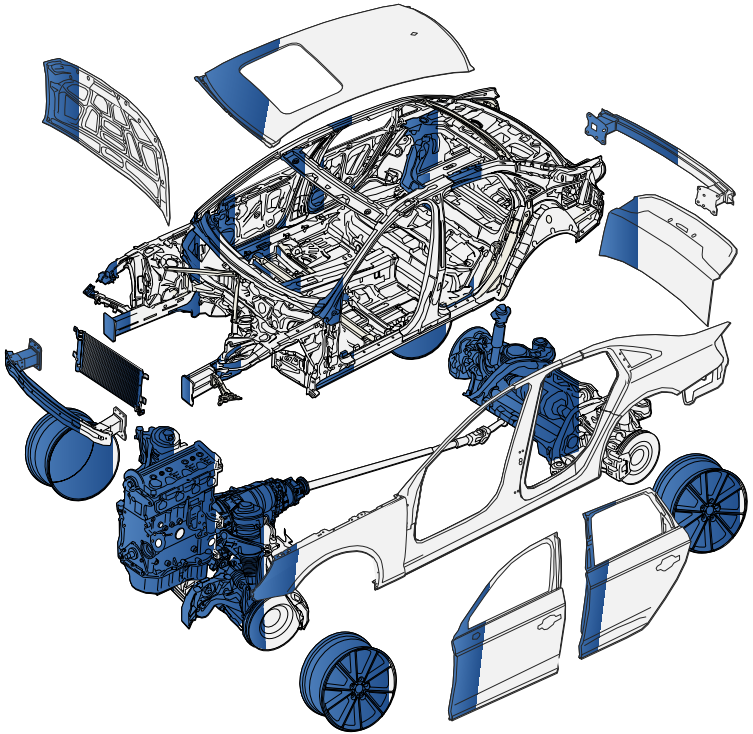


Source: CM Group

Aluminium Penetration Rate in ICEs 2018 - 2030

Al Penetration*	2018 (kgpv, %)		2025 (kgpv, %)		2030 (kgpv, %)	
Engine	29.6	79%	32.2	86%	34.1	91%
Chassis & Suspension	9.5	18%	23.4	45%	33.3	64%
Wheels & Brakes	32.4	75%	36.6	85%	39.5	92%
Driveline	22.3	86%	24.3	94%	25.4	99%
Heat Transfer	9.3	94%	9.7	98%	9.7	98%
Body Structures	8.6	4%	33.7	14%	51.6	21%
Body Closures	4.4	6%	14.2	19%	21.1	28%
Crash Management Systems	2.3	19%	5.2	44%	7.3	61%
Other Component	0.4	8%	0.5	11%	0.6	13%
Total	**118.7**	**24%**	**179.8**	**36%**	**222.8**	**44%**

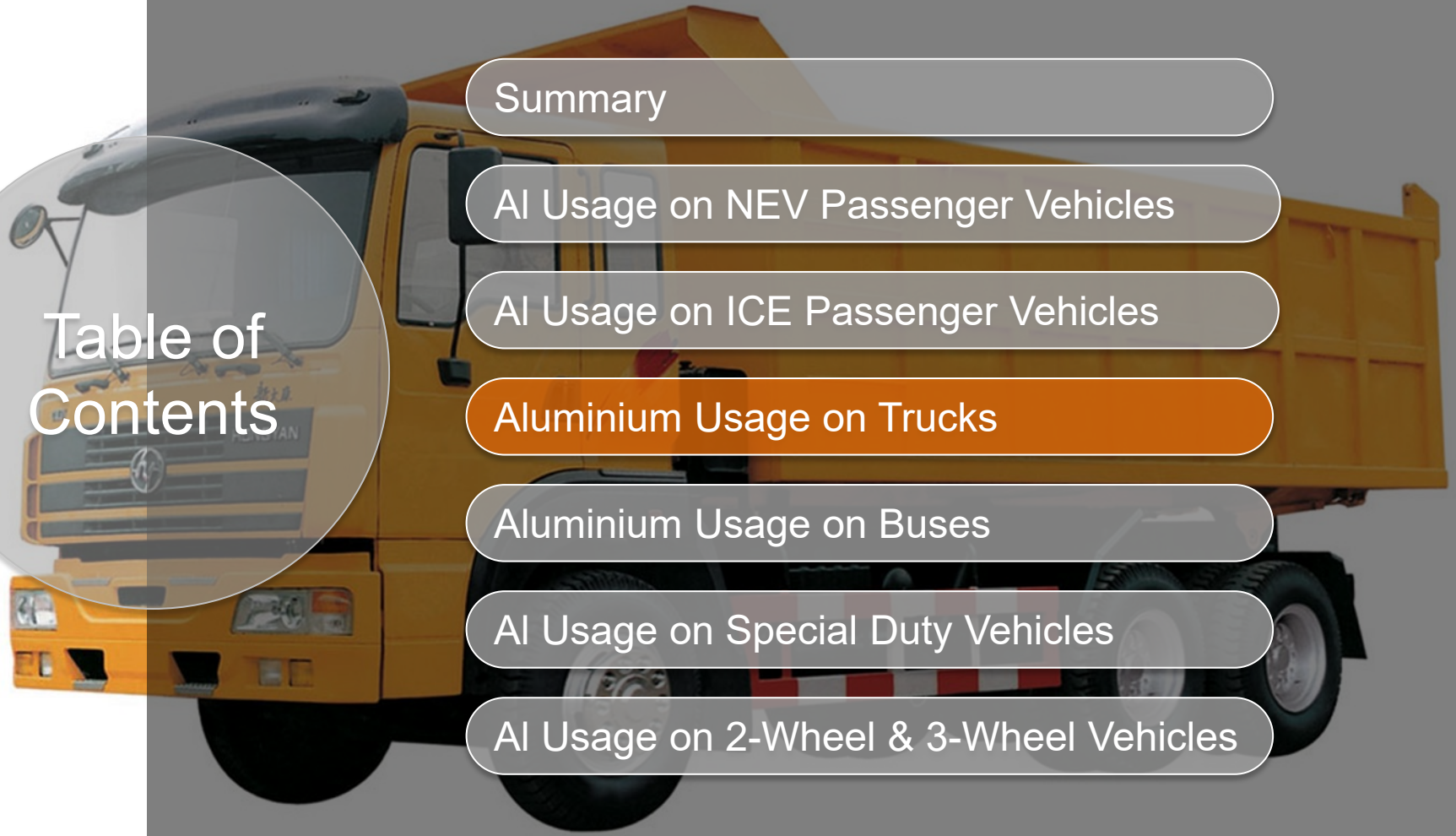
2030 ICE Production 22.1 mln



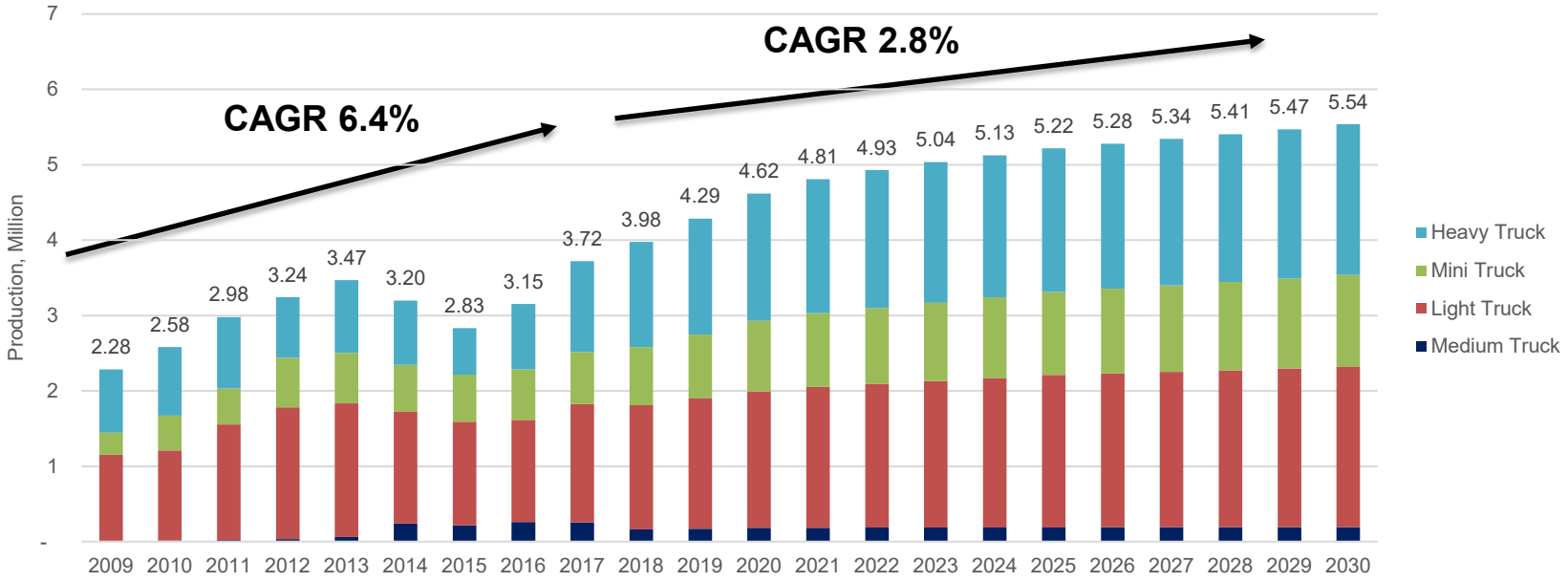
* **Al Penetration** = $\frac{\text{Kg of Al used currently}}{\text{Kg could be used (max)}}$

Source: CM Group

Table of Contents



China’s Truck Production Growth to Slow Down



- China’s truck production saw a 6.4% CAGR in the past nine years, rising from 2.28 million in 2009 to 3.98 million units in 2018. As China’s trucking market matures, demand for trucks is more likely to come from fleet replacement, therefore we forecast the CAGR in the next 12 years till 2030 to be 2.8%.
- Production is mainly contributed by by heavy-duty truck and light truck.

Source: CAAM, Company Reports, CM Group

Light Weighting Means Profit

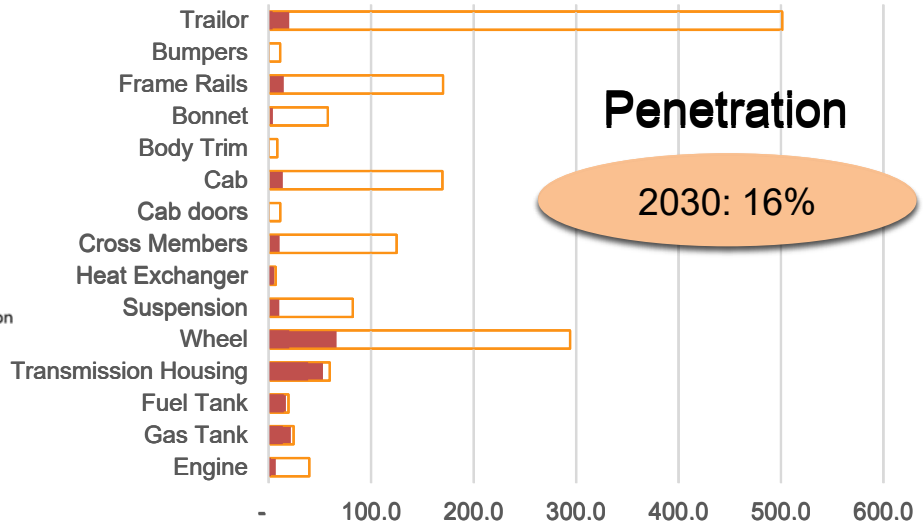
Truck Type			Max Gross Weight (kg)
Trailer Truck	Semi-trailer	1 shaft	18000
		2 shaft	35000
		3 shaft	40000
	Draw-bar Trailer	2 shaft, single wheel on each shaft and each side	12000
		2 shaft, one wheel on one shaft while two wheels on another shaft	16000
		2 shaft, two wheels on each shaft and each side	18000
	Centre-axle Trailer	1 shaft	10000
		2 shaft	18000
		3 shaft	24000
Combined Truck		3 shaft	27000
		4 shaft	36000
		5 shaft	43000
		6 shaft	49000

		Truck No.1	Truck No.2
Weight Limit	Tonne	49	49
Curb Weight	Tonne	18	***16***
Cargo Weight	Tonne	31	***33***
Freight	RMB/t.km	0.25	0.25
Total km	km/year	150,000	150,000
Income	RMB/year	1,162,500	1,237,500

- According to the China's National Standard (GB1589-2016), the total weight of trucks is limited by truck type. Weight of the most prevailing heavy truck (6-shaft) is 49 tonnes. If the truck's curb weight is lighter, it could carry more cargoes and make more profit.

Source: MIIT, Public sources, CM Group

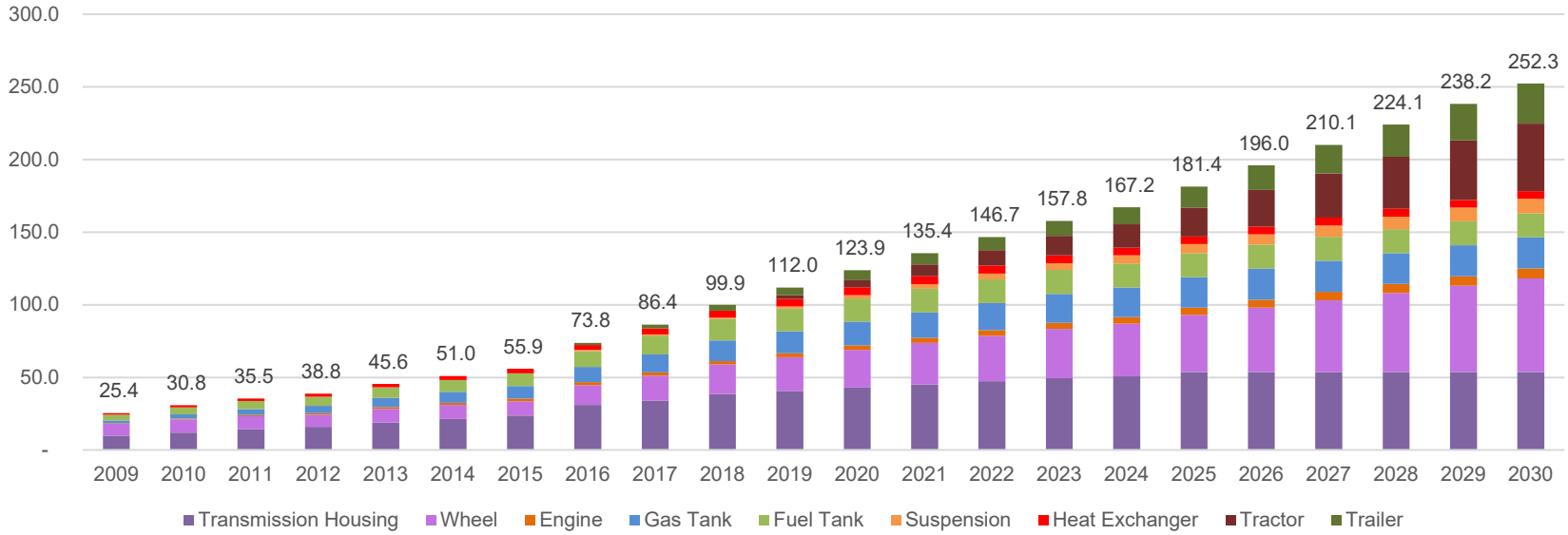
Still a Very Low Al Penetration, but Outlook is Bullish



- Despite truck has great potential to use aluminium, the current penetration level is still very low. According to our survey, the unit consumption of aluminium on truck in 2018 is ***99.9*** kgpv, as compared to a maximum penetration of 1,580 kgpv. Specifically, the unit consumption in heavy trucks is 124kgpv, while on the light and mid-size truck the unit consumption is only 87~88kgpv.
- Aluminium is now widely used for manufacturing transmission housing, fuel tank, gas tank and heat exchanger. However, the use on other parts like the body and trailer will becoming more prevailing in the future.

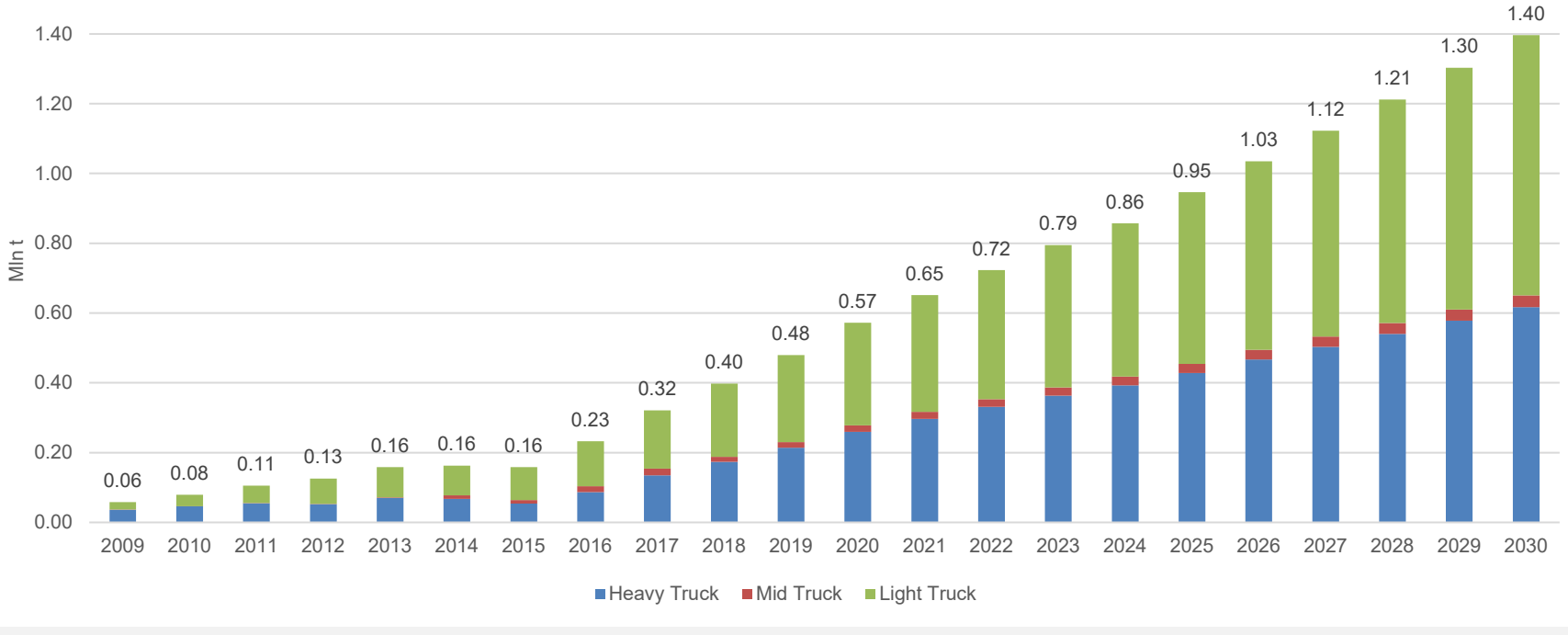
Source: CM Group

Bullish Outlook on Strong Desire for Light Weighting (kgpv)



- Government's mandate to light weighting, as well as economic incentives will support the long-term bullish outlook for aluminium usage in trucks.
- We forecast the unit aluminium consumption on trucks will grow at a robust CAGR 7.7% till 2030 from current 99.9 kgpv to 252 kgpv.
- Specifically, light and mini truck will grow at a CAGR 8.2%, and heavy truck will grow at 7.9%, while the middle truck will only grow at CAGR 5.8%.

Total Al Consumption in Trucks

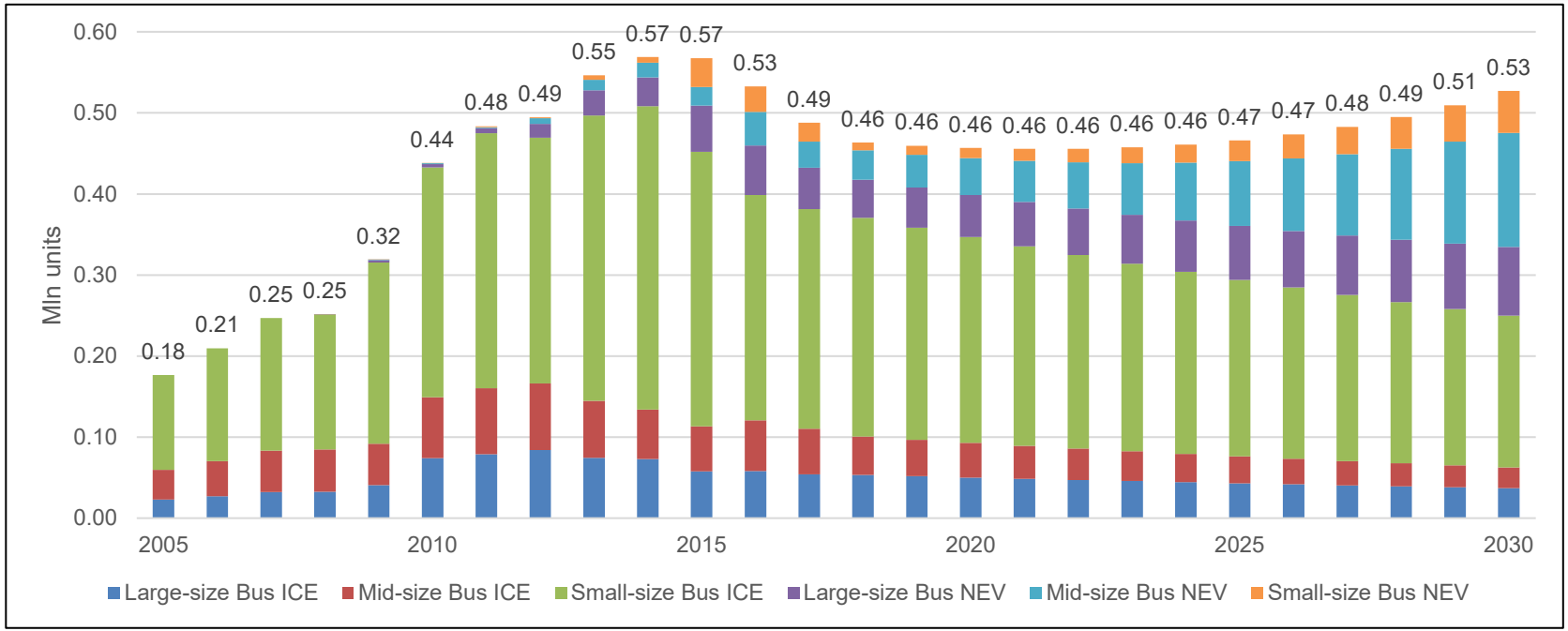


- With the growth of truck production and unit consumption, we forecast the aluminium consumption in trucks will grow robustly at a CAGR of 11% and reach 1.4Mt by 2030.
- Consumption will still mainly be contributed by light and heavy truck, taking up 98% of the total consumption.

Source: CM Group

Table of Contents

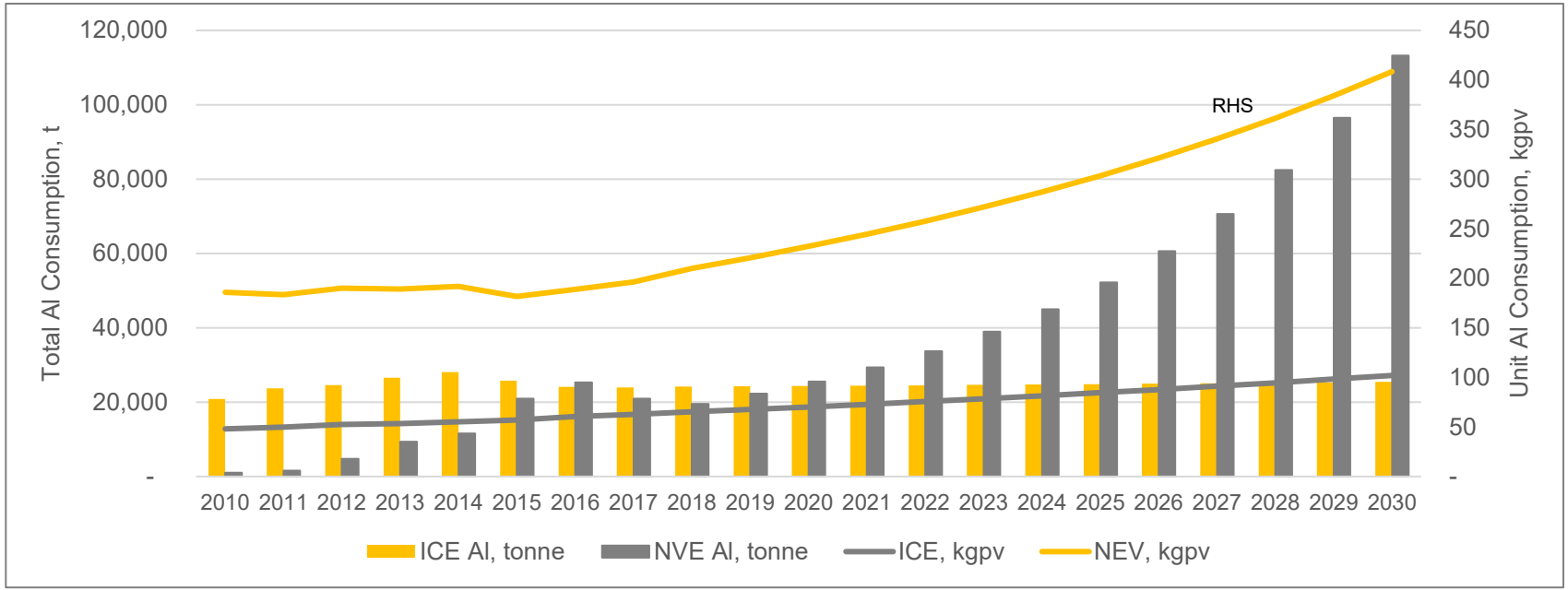
Bus Production to Drop in the Short Term, but Will Pick Up Slowly



- China's bus production peaked in 2014 and 2015, and started to trend downwards as a result of weak demand and several producers being ordered to suspend production for quality issue.
- In the outlook period, we believe the bus market will continue to be impacted by the development of high-speed railway but production will pick up thanks to the expanding tourism industry and the promotion of NEV buses.

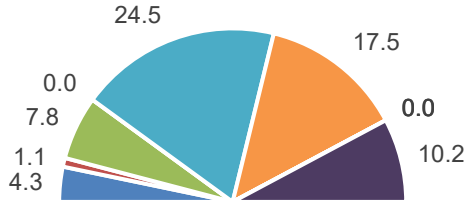
Source: CAAM, Company Reports, CM Group

NEV Buses Have Great Potential in Al Consumption

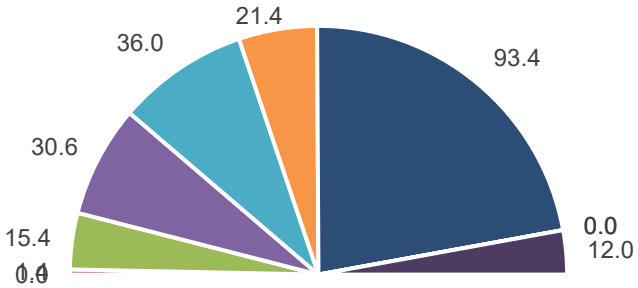


- With the growth in production, we forecast the total aluminium consumed by buses will grow at a CAGR of 10.1% from 43.7kt in 2018 to 138.8kt in 2030.
- Specifically, usage by ICE will only grow at CAGR 0.44% from 24kt to 26kt and NEV will grow at CAGR 15.77% from 20kt to 113kt.
- ICE's unit consumption will increase from 65kgpv in 2018 to 102kgpv in 2030 and NEV will go from 210kgpv to 409kgpv.

Breakdown of AI Usage in Buses



Unit AI Consumption in ICE Buses, 65.3kgpv



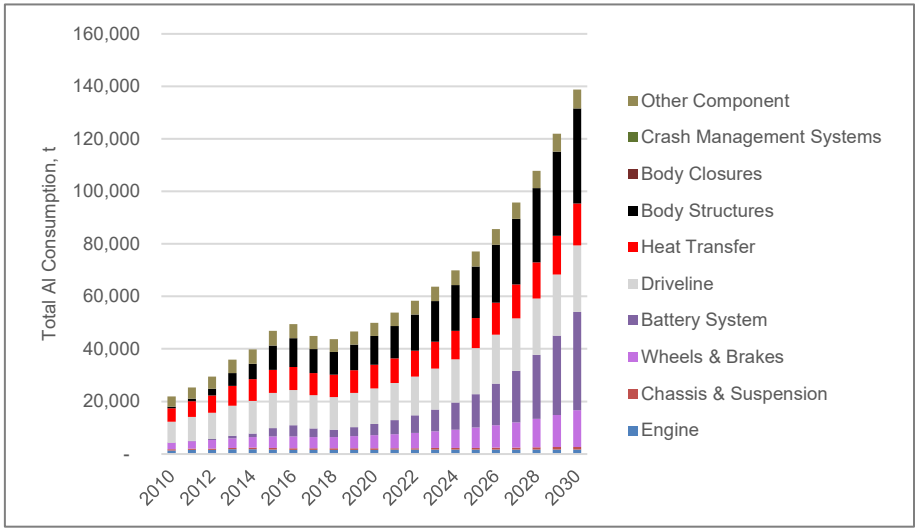
Unit AI Consumption in NEV Buses, 210kgpv

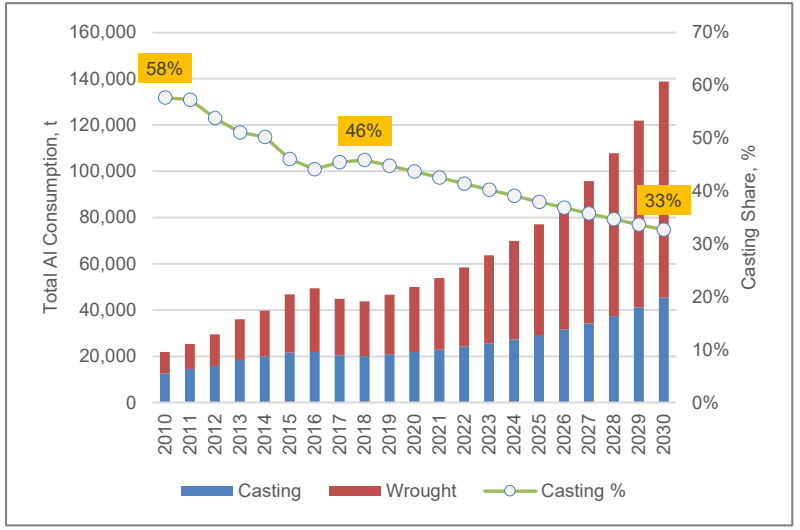
- Engine
- Chassis & Suspension
- Wheels & Brakes
- Battery System
- Driveline
- Heat Transfer
- Body Structures
- Body Closures
- Crash Management Systems
- Other Component

- The average aluminium consumption in ICE buses is 65.3 kgpv in 2018, still a very low penetration as most of the parts especially body and wheels are steel-made. The aluminium wheels are mainly seen on large buses used for long-distance transportation and some NEV public buses made by BYD or Yinlong corp. Aluminium use on bus body due to the good corrosion resistance character that will enhance the export market.
- The low aluminium use on buses in China is mainly attributed to three factors:
  - Cost
  - Technology
  - Government's policy

Source: CM Group

Casting is No Longer the Key

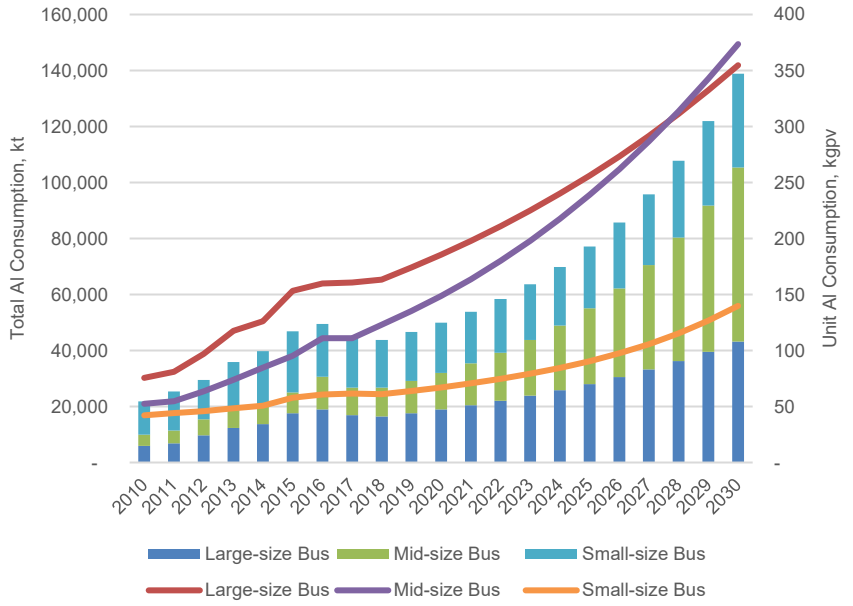




- Aluminium is now mainly using in wheels (forged), battery housing, body closures and rand rails, most of which are manufactured by aluminium extrusions and aluminium sheet.
- Compared to the 70%~80% share of Al casting on passenger vehicles, the Al casting used in buses is about 46% in 2018, sliding from 58% in 2010. With the increasing use on body structures and closures, we estimate the share will further decline to 33% in 2030.

Source: CM Group

Al Body is a Trend…



- Tourist bus and city public bus (mostly medium and large size) are the two most important channels of bus sales. Several tier-1 cities in China have already seen Al-body buses in recent years. We forecast this trend to sustain given the government's determination on environmental (air) protection, which will be the main driver for aluminium use in the future.

Key Al-body Buses	Brand	Widely used in…
	Haier	Suzhou
	Sunlong	Shanghai
	Foton-AUV	Beijing
	Sunwin	Shanghai
	Shudu	Chengdu
	Golden Dragon	Longyan
	Yinlong	Changchun

Source: CM Group

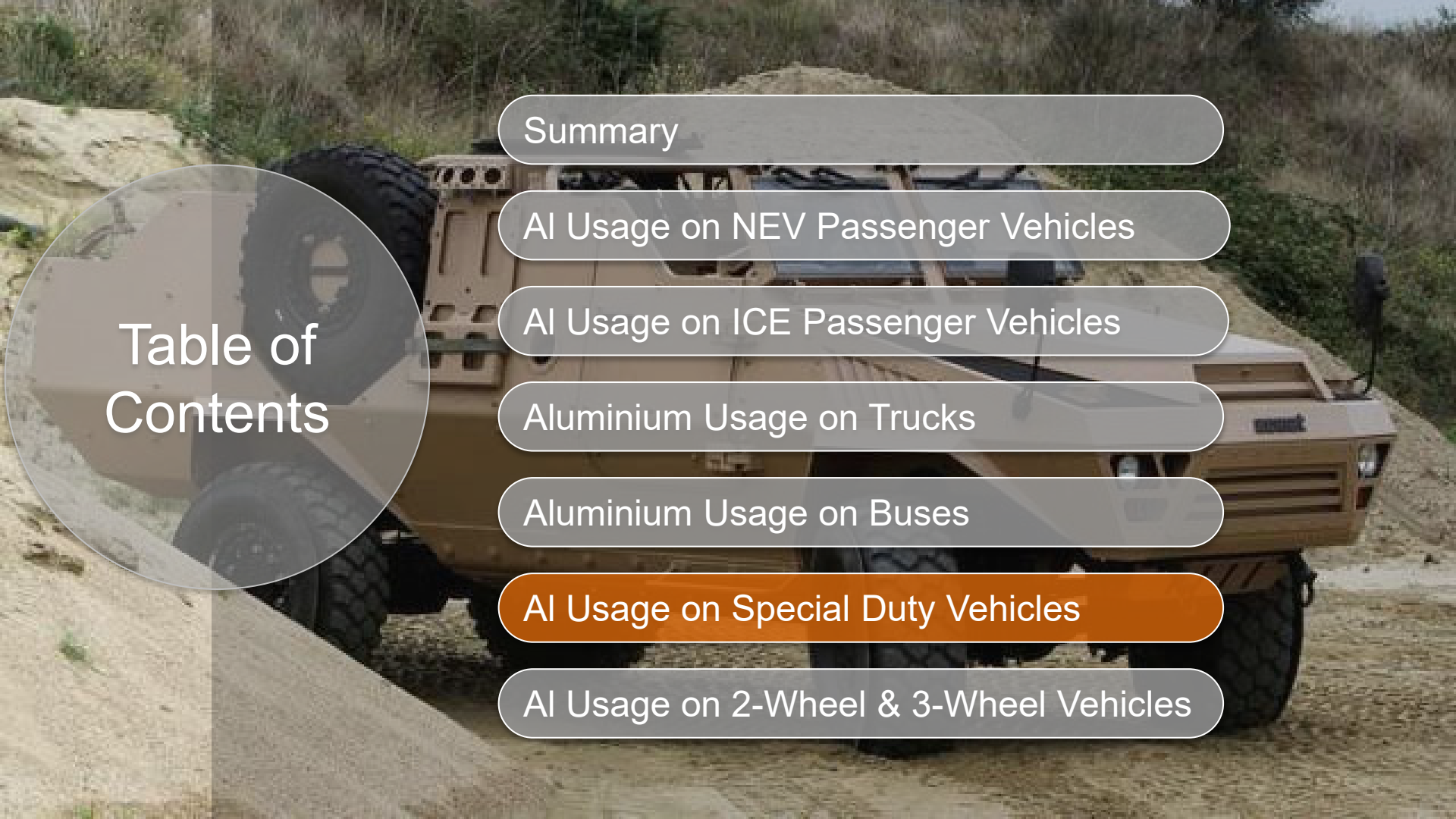
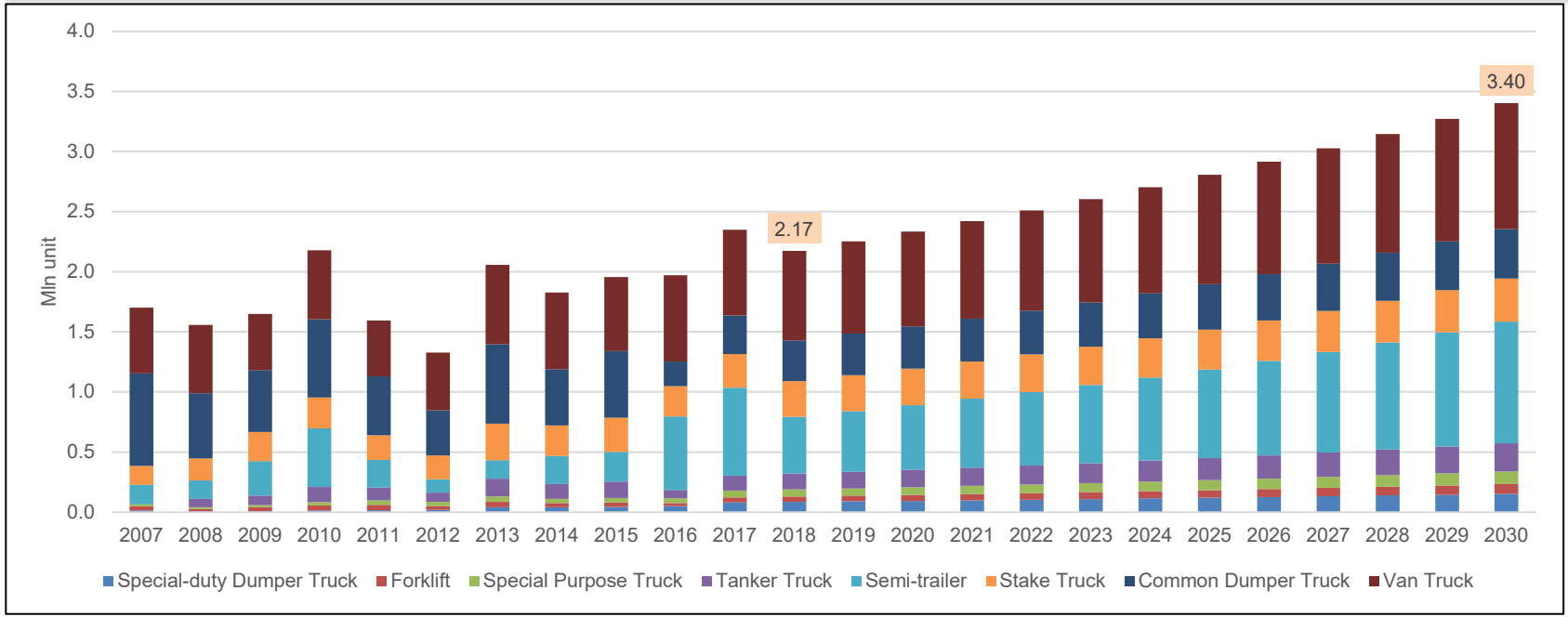


Table of Contents

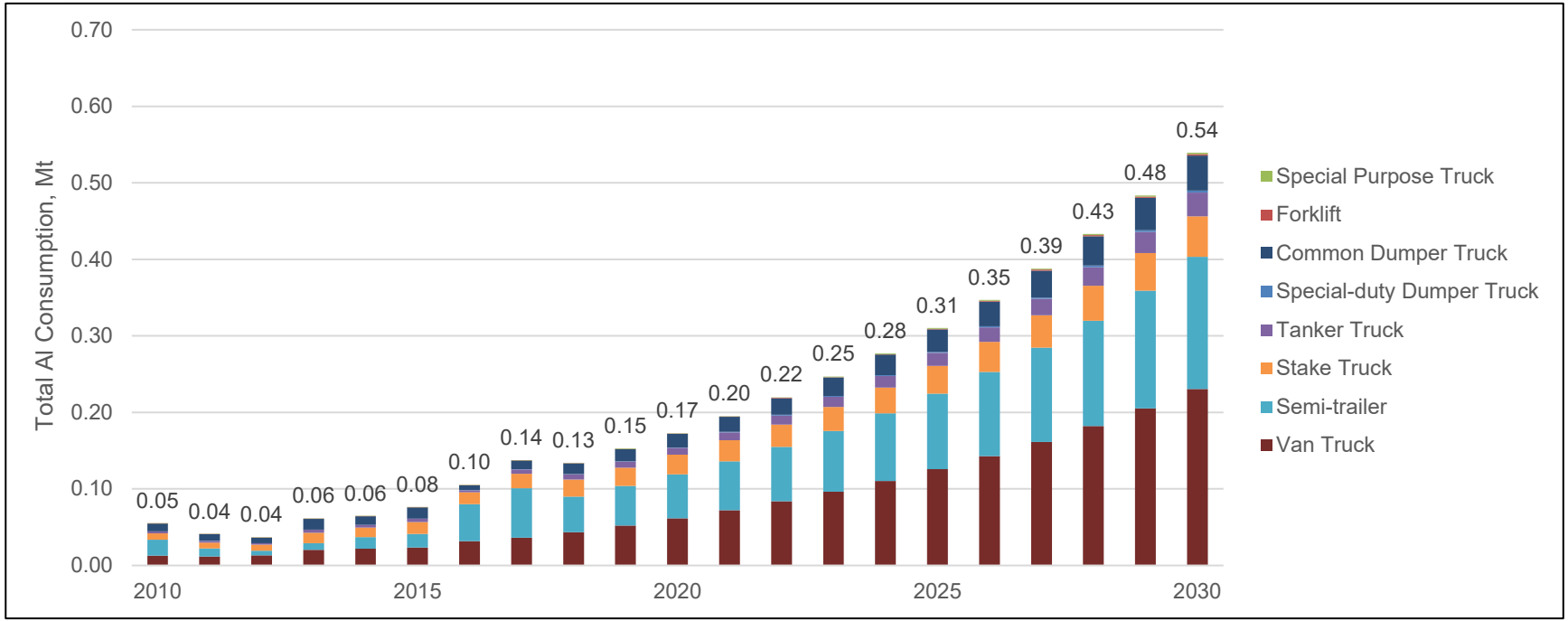
Special-duty Vehicles Production to Edge Up



- China's special duty vehicles saw an increase of CAGR1.6% during 2007~2018. We forecast a CAGR of 3.8% to 2030 thanks to the potential rapid growth of high-end special-duty trucks like forklifts and special-purpose trucks, as well as the growth of semi-trailers, driven by the new regulation on weight control (GB1589-2016). We forecast the production to reach 3.40 million units in 2030.
- China produced 2.17 million special-duty trucks in 2018, most of which are low-end simple semi-trailer, van truck, stake truck and common dumper, taking up 85% of the total production.

Source: National Bureau of Statistics, CAAM, CM Group

Van Trucks Are the Key to AI Consumption



- Thanks to the rapid development of China's E-commerce, van truck production has reached 0.74 million in 2018 and accounting for 34% of the total production. Van truck is at the same time a key contributor of the aluminium consumption, taking up 1/3 (43kt) of the total. We forecast the aluminium use on the van truck will grow at CAGR 14.9% and reach 230kt in 2030.

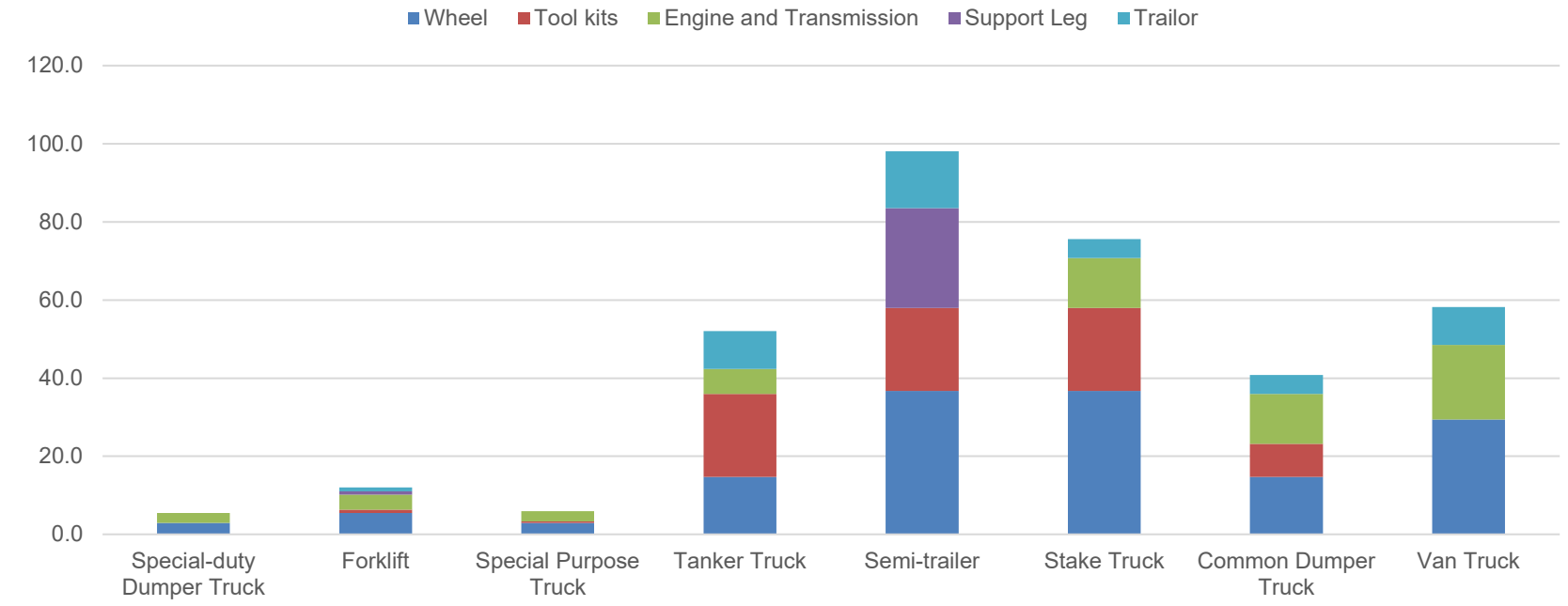
Semi-trailers are Also of Great Potential in Using Aluminium

To comply with the new regulation on weight control of trucks, the semi-trailer manufacturers are also active in light weighting. In 2018, semi-trailer trucks consume 46.5kt of aluminium, taking up 35% of the total.

- Aluminium has already been widely used to manufacture wheels, tool kit box and standing legs. Although the van has great potential for aluminium use, the manufacturers have to consider at least two factors:
  - Cost
  - The clients' cargo requirement

Source: CM Group

Still a Long Way to Go for Hight-end Special-duty Trucks 2018



- Aluminium use on high-end special duty trucks like special-duty dumper truck, forklift and special purchase truck is very low due the the high cost of maintenance.

Source: CM Group

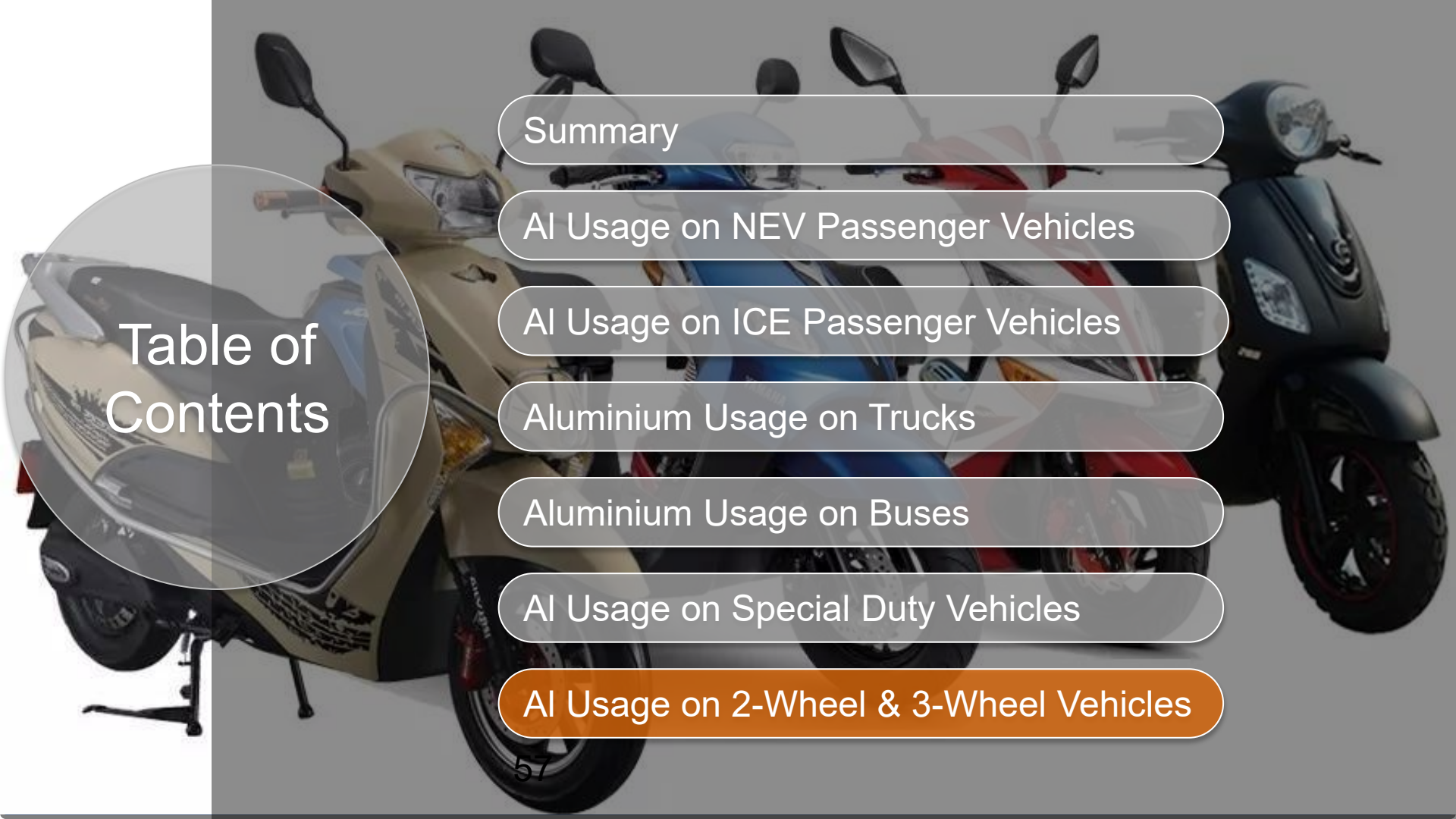
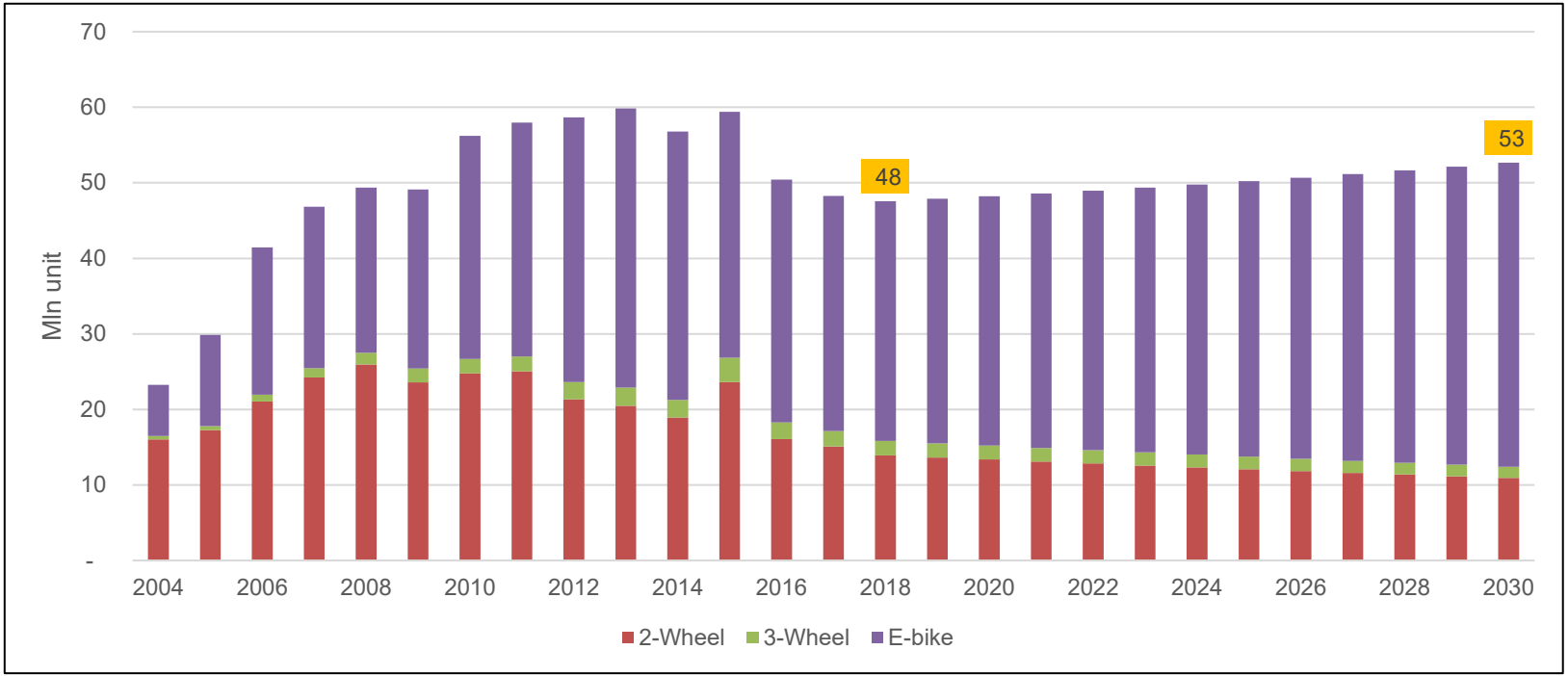


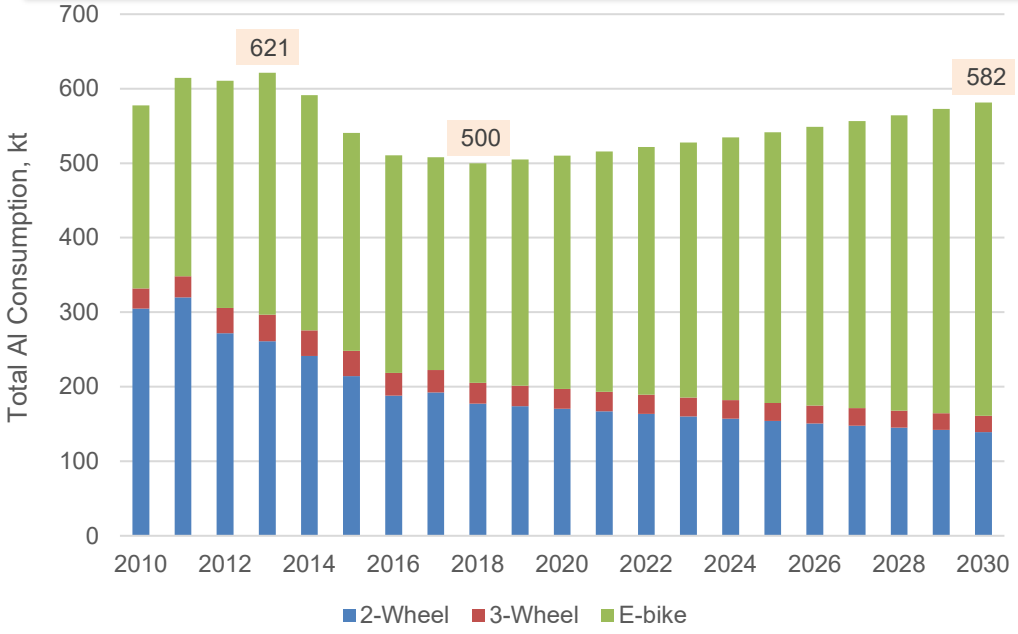
Table of Contents

Motorbike Production Growth to Flatten Out



- China's 2-wheel motorbike production reached peak at 26 million in 2008, and started to slide ever since. In 2018, the 2-wheel motorbike production has dropped to 14 million. In the future, we forecast the production of 2-wheel and 3-wheel to continue sliding as more and more families could afford a car. At the same time, the E-bike production will slightly increase given the steady domestic demand and the export demand.

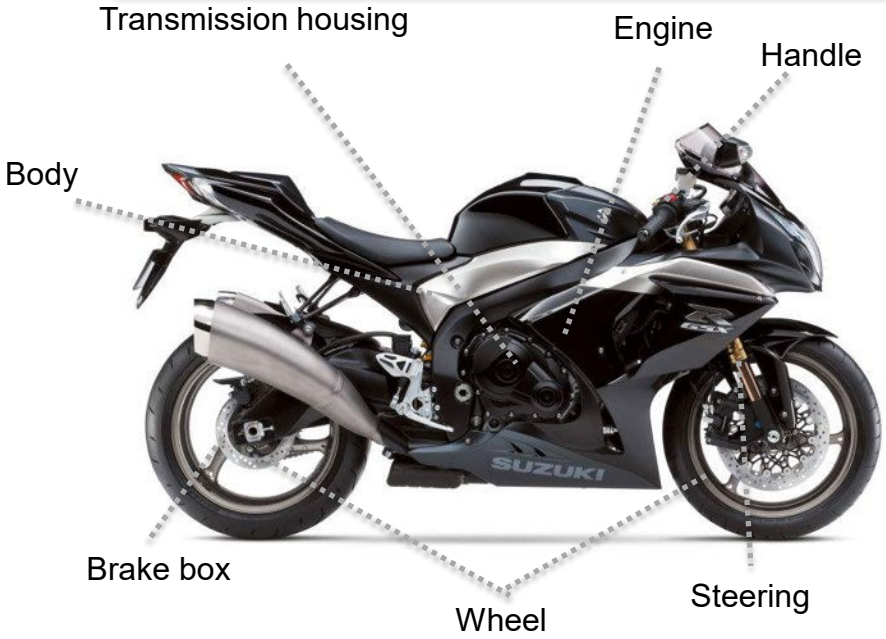
E-bike is the Key Driver for Aluminium Use

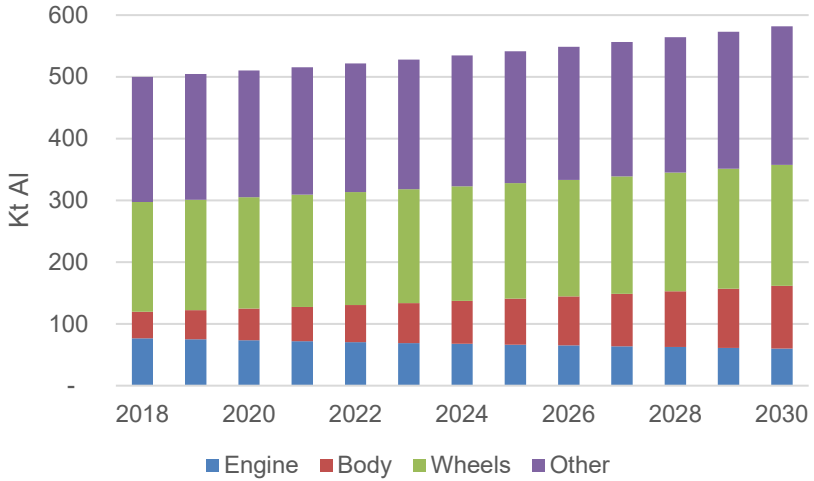


Al Parts, kg	2-wheel	3-wheel	E-bike
Engine	6 Block (4)+head (2)	6 Block (4)+head (2)	0
Wheel	4.54 (2.27 each)	6.81 (2.27 each)	4.54 (2.27 each)
Body	0	0	10
Other	3	3	4
Total	13.54	15.81	18.54

- We estimate motorbikes will consume a total of 500kt of Al in 2018, almost 59% (294kt) is contributed by E-bikes.
- The share of traditional ICE 2-wheel motorbikes has dropped from 53% in 2010 to 36% in 2018, reaching 177kt.
- We forecast the total Al consumption to reach 582kg in 2030, by then 72% of which will be contributed by E-bikes.

More Aluminium to be Used for Bodies





- Aluminium is mainly used for manufacturing engine block, transmission housing and wheels. Aluminium is also used for manufacturing some E-bike's body, but the proportion is still very low. However, we are bullish on this field and forecast it to drive the total aluminium use growth in the future.

Appendix

Backup Slides

Glossary

A/C system	Air Condition System	JMC	Jiangling Motors Corporation Limited
ABS	Anti - locked Braking System	kgpv	Kilogram per vehicle
Al	Aluminium	Kt	Kilotonnes
BAIC	Beijing Automotive Group Co., Ltd	Mg	Magnesium
BEV	Battery Electric Vehicle	MIIT	Ministry of Industry and Information Technology of PRC
BIW	Body-In-White	MOC	Ministry of Commerce of PRC
CAAM	China Association of Automobile Manufactures	MOF	Ministry of Finance of PRC
CF	Carbon Fiber	MPV	Multi-Purpose Vehicle
CPCA	China Passenger Car Association	Mt	Million Tonnes
DMC	Dongfeng Motor Corporation	NDRC	National Development and Reform Commission of PRC
FAW	First Auto Work	NEV	New Energy Vehicle (BEV, HEV & PHEV)
GAC	Guangzhou Automobile Group Co., Ltd.,	PHEV	Plug-In Hybrid Electric Vehicle
HEV	Hybrid Electric Vehicles	PUP	Pickup
HSS	High-strength Steel	SAIC	SAIC Motor Corporation Limited
ICE	Internal Combustion Engine	SUV	Sport Utility Vehicle
IP Structure	Instrument Panel Structure	SXQC	Shaanxi Automobile Group
JAC	Anhui Jianghuai Automobile Co., Ltd.	2W, 3W, 4W	Two, Three, Four Wheelers

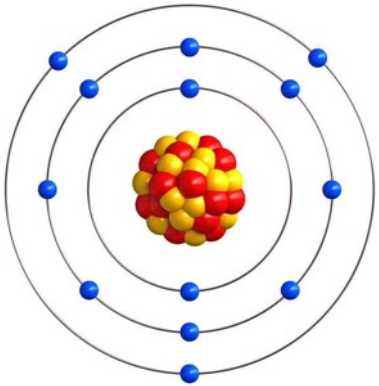
Why Aluminium

Abundant Reserve

Highest reserve of metal in the Earth

High Recycle Rate

Recycle rate > 90%



High Machinability

Can be extruded and casted into complicated forms

Light Weight

2/3 lighter than steel

Key Materials for Light Weighting

Material	Density (kg/cm^3)	Compressive Strength (MPa)	Material Cost	Technology Difficulty	Development in China	Outlook
Steel	7.8	552	Very Low	Very Low	Widely used	★
High-strength Steel (HSS)	7.85	1,379	**Low**	**Low**	Increasing	★★★★
Al Alloy	2.7	310	Mid	Mid	Slow	★★★★★
Mg Alloy	1.74	275	Mid	Mid	Slow	★★
Carbon Fiber (CF)	**1.5**	**2,069**	High	High	Very Slow	★

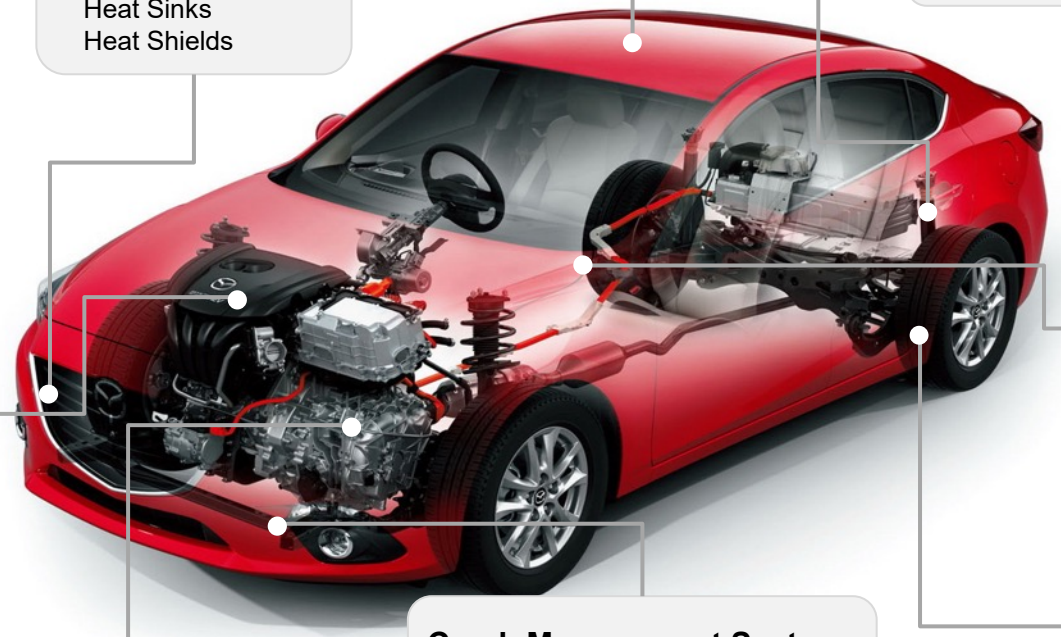
Source: CM Group

About a Car…

Body Closures
Hoods
Fenders
Boots
Front Doors
Rear Doors
Window Frames
Door Intrusion
Beams
Roofs

Heat Transfer
Heat Exchangers
Heat Sinks
Heat Shields

Chassis & Suspension
Suspension arms Knuckles Sub-frames



Body Structures
Complete Body Structure
Shock Towers Rails
Radiator Support
Structural Members
IP-Structures
Floor Group
Body Side Panels
Other

Engine*
Engine Block
Heads
Pistons
Mounts
Anti-Vibration
Other Engine

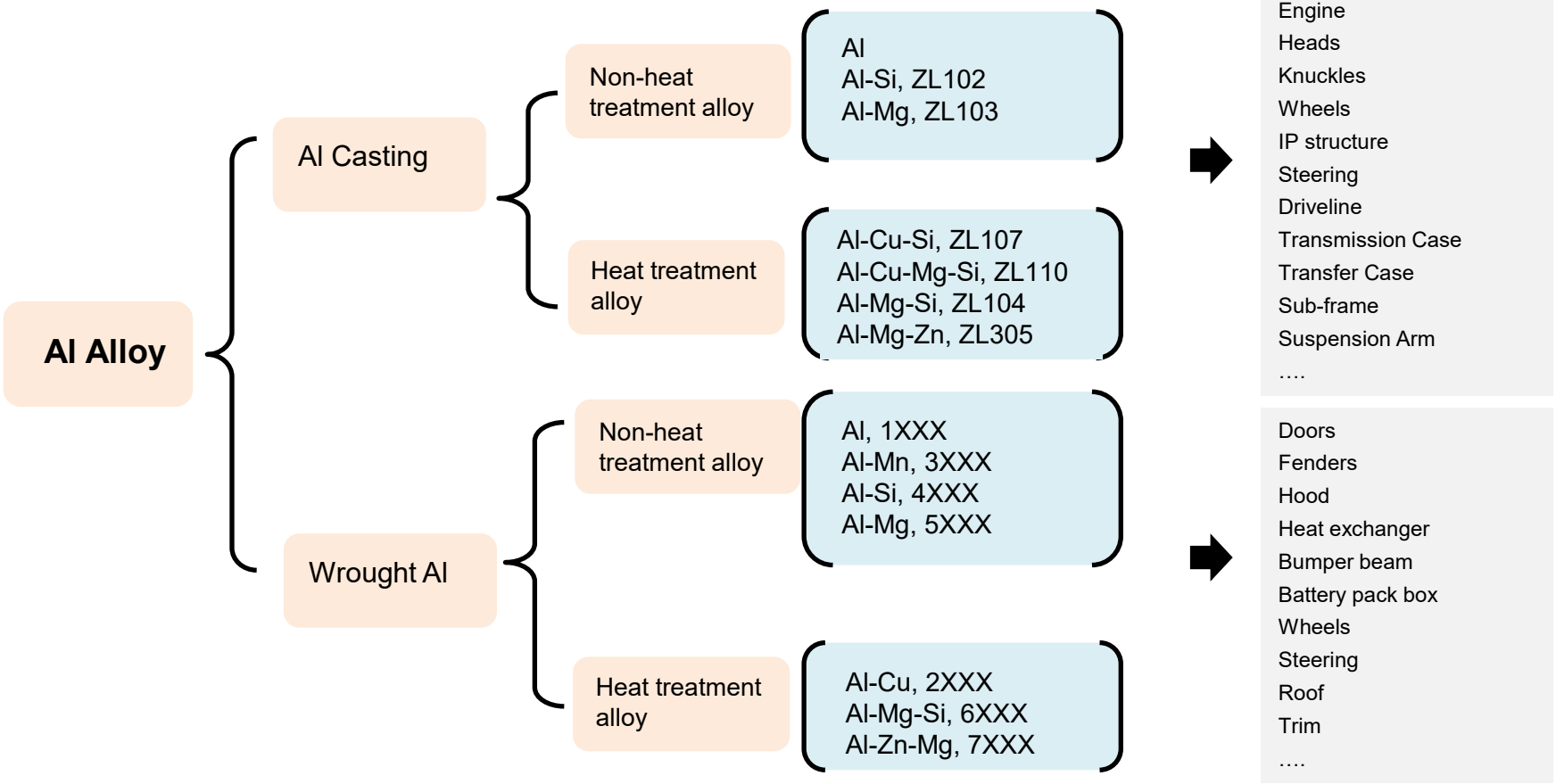
Driveline*
Transmission Case
Transfer Case
Other Transmission

Crash Management Systems
Crash Boxes
Bumpers Beams

Wheels & Brakes
Wheels
Brakes
Other

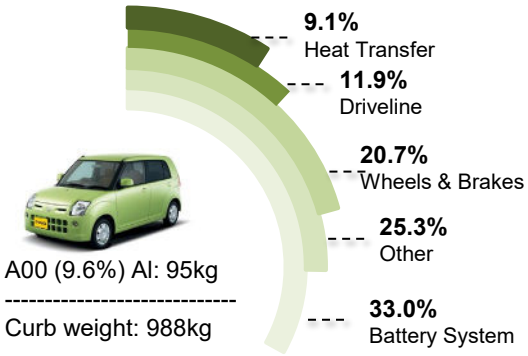
** A BEV doesn't have Engine and Driveline, instead, it has battery, electric motor and controller.*

Al Alloys for Vehicle…



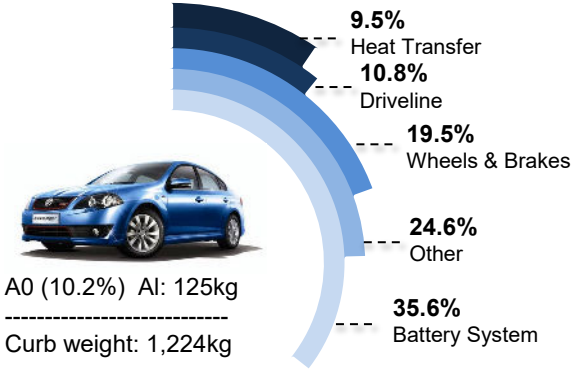
Source: CM Group

AI Usage in Difference Types of Vehicles



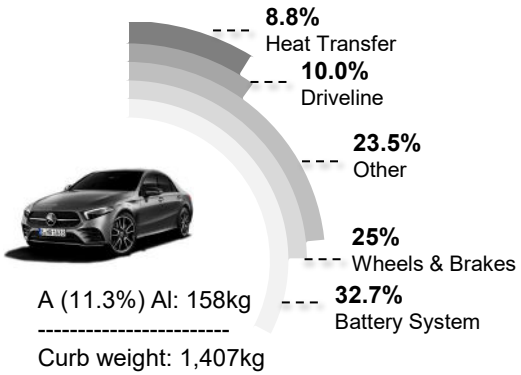
A00 (9.6%) AI: 95kg

Curb weight: 988kg



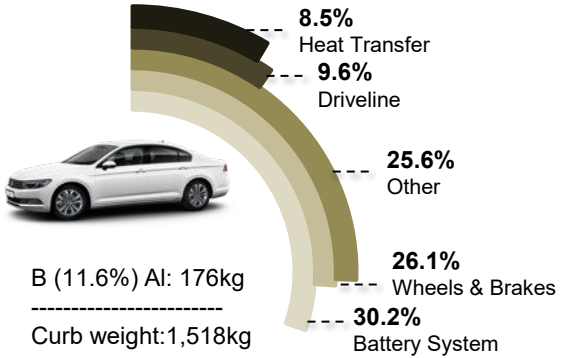
A0 (10.2%) AI: 125kg

Curb weight: 1,224kg



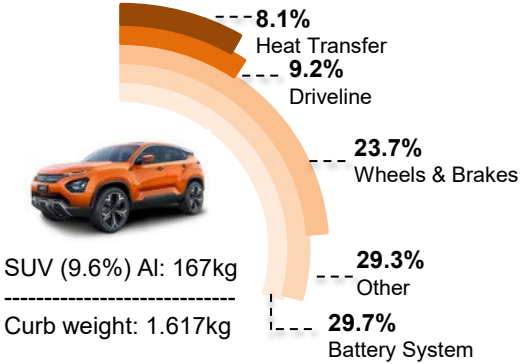
A (11.3%) AI: 158kg

Curb weight: 1,407kg



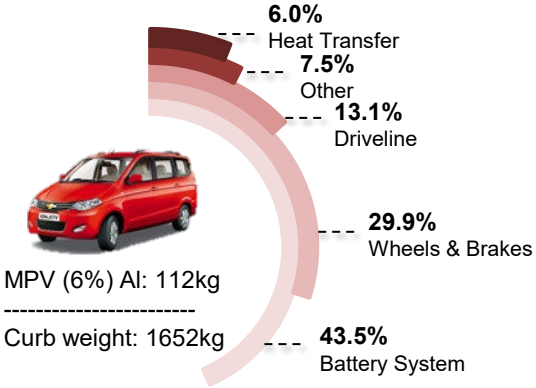
B (11.6%) AI: 176kg

Curb weight:1,518kg



SUV (9.6%) AI: 167kg

Curb weight: 1.617kg



MPV (6%) AI: 112kg

Curb weight: 1652kg

Source: CM Group, Autohome.com.cn

Typical BEVs in China

	2012~2016 Generation I	2017~2019 Generation II	2020~2030 Generation III
			

Name	BAIC EX	Chery eQ	Nio ES8
Generation	I Transfer from traditional ICE platform	II *Traditional ICE platform, further improvement*	III *BEV platform*
Auto Type	A0	A00	SUV
Price, RMB/unit	170,000~200,000	160,000~180,000	400,000~600,000
Sales 2017	3,757	25,784	0, scale sales since 2018
Curb Weight, kg	1,410	985	2,460
Al usage, kg	93	128	725
BIW	Steel	Al	Al
Closures	Steel	Steel	Steel
Wheels	Al	Al	Al

Source: CM Group

“Dual-Credit” Policy - A Discouraging Environment for ICEs

“Dual-Credit” System for Passenger Vehicle Producers (2018)

CAFC Credit

$(C_s-C_a) * (P_i – Exp. + Imp.)$

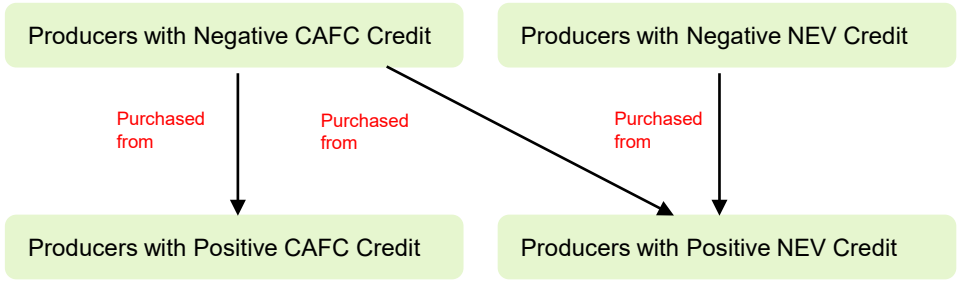
C_s: National Fuel Consumption Standard (next slide)
C_a: Corporate Average Fuel Consumption
P_i: ICE Production

NEV Credit

S_n: 0.12 *Range+0.8 for BEV (max.5)
2 points for Hybrid (max.2)
*10%: in 2019 (0 for 2018), and 12% for 2012 (Prod.+Imp.)>30kt

$\sum S_n * P_n – P_i * 10\%*$

S_n: Point for NEVs
P_n: NEVs Production
P_i: ICE Production



National fuel consumption standard is set to decrease

For BEV, the longer mileage and higher energy efficiency, the higher credits for each vehicle.

Producer with negative NEV credit cannot purchase credit CAFC credit to achieve above zero balance.

80% of year end credits can be carried over the next year for a maximum of years before 2018, and 90% for 2019 and after.

- MIIT policy dictates that those producers with negative credits must buy credits from those with positive credits in order to keep their score balance above zero, which provides incentives for traditional ICE producers to either upgrade their technology to lower the energy consumption or install new production line of NEVs.
- This policy is forcing two major manufacturers – VW and Ford – to seek joint venture with JAC and ZOTYE respectively.

Source: MIIT, NDRC, MOC

NEV Projects Coming on Stream: Bullish, but Cautious…

No.	Project	Company	Capacity, mln per year	Status	Remark
1	NEV	Qihe Baoya	0.4	Constructing	2019 to Produce
2	NEV	Baoneng	1	Constructing	2020 to Produce
3	NEV	Zhengdao	1	Constructing	2020 to Produce
4	NEV	Haihai	0.3	Constructing	2020 to Produce
5	NEV	Geely	0.9	Constructing	2019 to Produce
6	NEV	Xiexin Tongjie	0.3	Constructing	2020 to Produce
7	NEV	Hengyi	0.6	Cancelled	Capital Issue
8	NVE	Zhuhai Yinlong	0.67	Delayed	Capital Issue
9	NEV	Chehejia	0.1	Delayed	Switch to produce SUV (2020)
10	NEV	Hanlong	0.5	Cancelled	Capital Issue
11	NEV	Changhe Suzuki	1	Cancelled	Capital Issue
12	NEV	Leshi	0.3	Cancelled	Capital Issue

- At least 200 NEV projects have been either planned or announced so far, but anticipate most of these projects will not come on stream. With the government's compensate policy narrowed, more and more investors who are bearish about the industry will step out and those projects will have to be cancelled due to capital issue.
- However, we still anticipate a stable growth of China's NEV industry in the next 10.

Unit Consumption of Secondary Al Assessment, kg per vehicle

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Passenger	***57.0***	***58.4***	***58.8***	***61.1***	***63.4***	***65.8***	***68.3***	***70.7***	***73.2***	***75.6***	***77.8***	***80.0***	***82.1***	***84.1***	***85.4***
ICE	*57.4*	*59.0*	*59.8*	*62.3*	*64.9*	*67.4*	*70.1*	*72.7*	*75.5*	*78.2*	*81.1*	*83.9*	*86.9*	*89.8*	*92.6*
BEV	*17.6*	*20.6*	*22.8*	*26.5*	*30.3*	*34.3*	*38.5*	*41.8*	*45.1*	*48.3*	*51.5*	*55.0*	*58.6*	*62.4*	*64.7*
Hybrid	*65.7*	*70.5*	*76.9*	*80.3*	*82.8*	*85.4*	*88.0*	*90.7*	*93.5*	*94.7*	*96.0*	*97.2*	*98.5*	*99.9*	*101.2*
Commercial	***43.2***	***49.2***	***56.1***	***59.9***	***63.7***	***67.3***	***70.8***	***74.1***	***76.2***	***79.5***	***80.6***	***81.2***	***81.8***	***82.4***	***83.0***
Bus	***23.9***	***24.6***	***25.6***	***26.6***	***27.7***	***28.8***	***30.0***	***31.3***	***32.6***	***34.0***	***35.4***	***36.9***	***38.4***	***40.1***	***41.7***
ICE	*22.9*	*23.7*	*24.6*	*25.5*	*26.4*	*27.4*	*28.4*	*29.5*	*30.6*	*31.8*	*32.9*	*34.2*	*35.5*	*36.8*	*38.2*
NEV	*26.8*	*28.0*	*29.6*	*30.6*	*31.7*	*32.8*	*34.0*	*35.2*	*36.4*	*37.7*	*39.1*	*40.5*	*41.9*	*43.4*	*45.0*
Truck	*46.5*	*52.4*	*59.6*	*63.5*	*67.3*	*71.0*	*74.5*	*78.0*	*80.1*	*83.6*	*84.6*	*85.2*	*85.8*	*86.4*	*87.0*
Special-Duty	*31.2*	*34.2*	*37.2*	*40.7*	*44.4*	*48.2*	*52.3*	*56.5*	*60.9*	*65.5*	*70.4*	*75.6*	*81.1*	*86.8*	*93.0*
2,3-Wheel	***7.2***	***7.3***	***7.2***	***7.2***	***7.2***	***7.2***	***7.1***	***7.1***	***7.1***	***7.1***	***7.1***	***7.1***	***7.1***	***7.0***	***7.0***
ICE	*10.3*	*10.3*	*10.3*	*10.3*	*10.3*	*10.3*	*10.3*	*10.3*	*10.3*	*10.3*	*10.3*	*10.3*	*10.3*	*10.3*	*10.3*
E-Bike	*5.7*	*5.7*	*5.7*	*5.7*	*5.8*	*5.8*	*5.8*	*5.8*	*5.9*	*5.9*	*5.9*	*6.0*	*6.0*	*6.0*	*6.0*

Source: CM Group

Unit Consumption of Primary AI Assessment, kg per vehicle

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Passenger	***53.3***	***57.6***	***60.9***	***68.0***	***75.1***	***82.3***	***89.4***	***96.7***	***104.2***	***111.6***	***119.5***	***127.9***	***136.9***	***146.6***	***156.8***
ICE	*52.8*	*56.6*	*58.9*	*65.2*	*71.5*	*77.8*	*83.8*	*89.8*	*95.7*	*101.6*	*107.4*	*113.2*	*119.0*	*124.7*	*130.3*
BEV	*89.4*	*97.3*	*105.6*	*116.5*	*127.6*	*138.8*	*149.7*	*160.1*	*170.4*	*178.5*	*186.6*	*194.8*	*203.2*	*211.8*	*218.8*
Hybrid	*81.7*	*89.5*	*102.7*	*108.5*	*115.2*	*121.4*	*127.5*	*133.5*	*139.4*	*143.6*	*147.7*	*151.8*	*155.9*	*159.9*	*164.0*
Commercial	***33.3***	***37.8***	***43.3***	***51.0***	***58.9***	***66.6***	***74.3***	***82.1***	***89.7***	***100.6***	***114.2***	***127.9***	***141.8***	***155.9***	***170.2***
Bus	***69.0***	***67.4***	***68.8***	***74.8***	***81.6***	***89.3***	***98.0***	***107.8***	***118.9***	***131.5***	***145.6***	***161.5***	***179.3***	***199.3***	***221.6***
ICE	*37.6*	*39.1*	*40.7*	*42.3*	*43.9*	*45.5*	*47.3*	*49.1*	*50.9*	*52.9*	*54.9*	*57.0*	*59.2*	*61.5*	*63.9*
NEV	*162.2*	*168.4*	*180.6*	*190.2*	*200.5*	*211.7*	*223.7*	*236.6*	*250.7*	*265.8*	*282.3*	*300.2*	*319.6*	*340.7*	*363.7*
Truck	*27.3*	*34.0*	*40.3*	*48.5*	*56.6*	*64.4*	*72.1*	*79.8*	*87.0*	*97.8*	*111.4*	*124.9*	*138.3*	*151.8*	*165.3*
Special-Duty	*22.0*	*24.4*	*24.5*	*27.0*	*29.6*	*32.3*	*35.2*	*38.3*	*41.5*	*45.0*	*48.6*	*52.5*	*56.6*	*60.9*	*65.6*
2,3-Wheel	***3.2***	***3.2***	***3.3***	***3.3***	***3.4***	***3.4***	***3.5***	***3.6***	***3.6***	***3.7***	***3.8***	***3.8***	***3.9***	***3.9***	***4.0***
ICE	*2.7*	*2.7*	*2.7*	*2.7*	*2.7*	*2.7*	*2.7*	*2.7*	*2.7*	*2.7*	*2.7*	*2.7*	*2.7*	*2.7*	*2.7*
E-Bike	*3.4*	*3.5*	*3.6*	*3.6*	*3.7*	*3.8*	*3.8*	*3.9*	*4.0*	*4.1*	*4.1*	*4.2*	*4.3*	*4.3*	*4.4*

Source: CM Group

Unit Consumption of Al Casting Assessment, kg per vehicle

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Passenger	***85.6***	***88.4***	***89.4***	***93.1***	***96.8***	***100.6***	***104.5***	***108.4***	***112.3***	***116.1***	***119.8***	***123.5***	***127.3***	***131.2***	***134.4***
ICE	*86.0*	*89.1*	*90.2*	*93.9*	*97.6*	*101.2*	*104.9*	*108.5*	*112.2*	*115.8*	*119.5*	*123.1*	*126.8*	*130.4*	*133.8*
BEV	*45.3*	*48.6*	*53.3*	*61.2*	*69.1*	*77.3*	*85.7*	*93.1*	*100.4*	*105.6*	*110.8*	*116.1*	*121.6*	*127.3*	*130.5*
Hybrid	*111.2*	*118.8*	*129.2*	*135.3*	*138.6*	*141.9*	*145.2*	*148.5*	*151.7*	*152.9*	*154.0*	*155.1*	*156.2*	*157.4*	*158.5*
Commercial	***52.9***	***59.7***	***67.7***	***72.6***	***77.3***	***82.0***	***86.5***	***90.9***	***93.8***	***98.1***	***100.0***	***101.4***	***102.9***	***104.4***	***105.9***
Bus	***41.0***	***41.9***	***43.3***	***45.5***	***47.8***	***50.3***	***53.1***	***56.0***	***59.3***	***62.8***	***66.7***	***70.9***	***75.6***	***80.6***	***86.2***
ICE	*35.8*	*37.2*	*38.6*	*40.0*	*41.5*	*43.0*	*44.6*	*46.2*	*47.9*	*49.7*	*51.5*	*53.4*	*55.4*	*57.5*	*59.6*
NEV	*56.3*	*58.6*	*62.1*	*64.8*	*67.7*	*70.8*	*74.1*	*77.6*	*81.3*	*85.3*	*89.6*	*94.2*	*99.1*	*104.4*	*110.1*
Truck	*55.0*	*62.1*	*70.5*	*75.5*	*80.3*	*85.0*	*89.5*	*94.0*	*96.9*	*101.3*	*103.0*	*104.2*	*105.4*	*106.6*	*107.7*
Special-Duty	*18.0*	*20.5*	*22.3*	*23.9*	*25.5*	*27.2*	*29.0*	*30.9*	*32.9*	*34.9*	*37.1*	*39.4*	*41.8*	*44.4*	*47.1*
2,3-Wheel	***9.9***	***10.0***	***9.9***	***9.9***	***9.8***	***9.8***	***9.8***	***9.8***	***9.8***	***9.7***	***9.7***	***9.7***	***9.7***	***9.7***	***9.7***
ICE	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*	*13.0*
E-Bike	*8.3*	*8.3*	*8.3*	*8.4*	*8.4*	*8.4*	*8.4*	*8.5*	*8.5*	*8.5*	*8.6*	*8.6*	*8.6*	*8.6*	*8.7*

Source: CM Group

Unit Consumption of Al Rolled Assessment, kg per vehicle

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Passenger	***12.7***	***14.0***	***15.5***	***17.8***	***20.1***	***22.5***	***24.8***	***27.3***	***29.9***	***32.6***	***35.9***	***39.5***	***43.7***	***48.5***	***54.0***
ICE	*12.4*	*13.3*	*14.2*	*16.0*	*17.8*	*19.6*	*21.3*	*22.9*	*24.6*	*26.3*	*27.9*	*29.6*	*31.3*	*32.9*	*34.6*
BEV	*43.5*	*51.5*	*54.1*	*58.4*	*62.9*	*67.5*	*71.7*	*75.9*	*79.9*	*83.8*	*87.8*	*91.8*	*96.0*	*100.4*	*104.6*
Hybrid	*12.9*	*16.0*	*18.2*	*19.0*	*21.1*	*22.8*	*24.4*	*26.0*	*27.6*	*29.0*	*30.4*	*31.9*	*33.3*	*34.7*	*36.1*
Commercial	***4.0***	***3.4***	***3.4***	***4.5***	***5.6***	***6.9***	***8.2***	***9.6***	***11.0***	***13.2***	***15.8***	***18.6***	***21.4***	***24.4***	***27.7***
Bus	***25.1***	***22.9***	***22.7***	***25.9***	***29.5***	***33.6***	***38.4***	***43.8***	***50.1***	***57.2***	***65.3***	***74.5***	***84.9***	***96.7***	***109.9***
ICE	*3.1*	*3.2*	*3.3*	*3.4*	*3.4*	*3.5*	*3.6*	*3.7*	*3.8*	*3.9*	*4.1*	*4.2*	*4.3*	*4.4*	*4.5*
NEV	*90.7*	*93.5*	*100.3*	*105.7*	*111.4*	*117.7*	*124.4*	*131.7*	*139.7*	*148.3*	*157.7*	*168.0*	*179.2*	*191.4*	*204.8*
Truck	*0.4*	*0.8*	*1.2*	*2.2*	*3.3*	*4.3*	*5.4*	*6.5*	*7.5*	*9.3*	*11.4*	*13.5*	*15.6*	*17.7*	*19.8*
Special-Duty	*13.5*	*14.1*	*16.9*	*19.2*	*21.6*	*24.1*	*26.7*	*29.4*	*32.2*	*35.2*	*38.4*	*41.7*	*45.2*	*48.9*	*52.7*
2,3-Wheel	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
ICE	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
E-Bike	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*

Unit Consumption of Al Extrusion Assessment, kg per vehicle

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Passenger	***8.4***	***9.4***	***10.4***	***13.0***	***15.6***	***18.2***	***20.8***	***23.3***	***25.9***	***28.4***	***30.8***	***33.1***	***35.4***	***37.6***	***39.5***
ICE	*8.3*	*9.3*	*10.1*	*12.7*	*15.3*	*17.8*	*20.4*	*23.0*	*25.6*	*28.1*	*30.7*	*33.3*	*35.8*	*38.4*	*41.0*
BEV	*13.4*	*12.5*	*15.0*	*16.7*	*18.2*	*19.8*	*21.5*	*22.9*	*24.4*	*25.8*	*27.2*	*28.7*	*30.3*	*31.9*	*33.2*
Hybrid	*15.7*	*16.8*	*22.4*	*24.0*	*26.9*	*29.9*	*32.8*	*35.8*	*38.7*	*40.9*	*43.1*	*45.4*	*47.6*	*49.8*	*52.0*
Commercial	***2.0***	***2.4***	***2.9***	***5.5***	***8.0***	***10.6***	***13.3***	***15.9***	***18.6***	***22.5***	***27.3***	***32.0***	***36.7***	***41.4***	***46.1***
Bus	***6.3***	***6.1***	***6.2***	***6.7***	***7.3***	***7.9***	***8.7***	***9.5***	***10.5***	***11.6***	***12.8***	***14.2***	***15.8***	***17.5***	***19.5***
ICE	*3.3*	*3.4*	*3.5*	*3.6*	*3.7*	*3.8*	*3.9*	*4.0*	*4.1*	*4.2*	*4.3*	*4.4*	*4.5*	*4.7*	*4.8*
NEV	*15.4*	*15.8*	*16.9*	*17.7*	*18.6*	*19.6*	*20.6*	*21.7*	*22.9*	*24.2*	*25.7*	*27.2*	*28.9*	*30.7*	*32.7*
Truck	*1.2*	*1.9*	*2.5*	*5.3*	*8.1*	*10.9*	*13.7*	*16.5*	*19.3*	*23.5*	*28.5*	*33.6*	*38.6*	*43.6*	*48.7*
Special-Duty	*13.9*	*15.2*	*14.0*	*15.4*	*16.9*	*18.4*	*20.0*	*21.7*	*23.5*	*25.4*	*27.5*	*29.7*	*32.0*	*34.5*	*37.2*
2,3-Wheel	***0.5***	***0.6***	***0.6***	***0.7***	***0.7***	***0.8***	***0.9***	***0.9***	***1.0***	***1.0***	***1.1***	***1.2***	***1.2***	***1.3***	***1.3***
ICE	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
E-Bike	*0.8*	*0.9*	*1.0*	*1.0*	*1.1*	*1.2*	*1.2*	*1.3*	*1.4*	*1.4*	*1.5*	*1.6*	*1.6*	*1.7*	*1.8*

Source: CM Group

Unit Consumption of AI in other form Assessment, kg per vehicle

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Passenger	***3.6***	***4.0***	***4.3***	***5.2***	***6.0***	***6.8***	***7.6***	***8.4***	***9.2***	***10.1***	***10.9***	***11.7***	***12.6***	***13.4***	***14.3***
ICE	*3.6*	*4.0*	*4.2*	*5.0*	*5.8*	*6.6*	*7.3*	*8.1*	*8.9*	*9.6*	*10.4*	*11.2*	*11.9*	*12.7*	*13.5*
BEV	*4.9*	*5.3*	*6.0*	*6.8*	*7.6*	*8.4*	*9.2*	*10.1*	*10.9*	*11.6*	*12.3*	*13.1*	*13.9*	*14.7*	*15.2*
Hybrid	*7.6*	*8.3*	*9.8*	*10.5*	*11.4*	*12.2*	*13.1*	*14.0*	*14.8*	*15.4*	*16.1*	*16.7*	*17.3*	*18.0*	*18.6*
Commercial	***17.6***	***21.6***	***25.3***	***28.4***	***31.6***	***34.4***	***37.2***	***39.9***	***42.4***	***46.2***	***51.7***	***57.1***	***62.6***	***68.1***	***73.6***
Bus	***20.4***	***21.1***	***22.2***	***23.4***	***24.8***	***26.3***	***27.9***	***29.7***	***31.7***	***33.8***	***36.1***	***38.7***	***41.5***	***44.5***	***47.8***
ICE	*18.3*	*19.1*	*20.0*	*20.8*	*21.7*	*22.7*	*23.6*	*24.7*	*25.7*	*26.8*	*28.0*	*29.2*	*30.5*	*31.8*	*33.2*
NEV	*26.6*	*28.4*	*30.9*	*32.7*	*34.5*	*36.5*	*38.6*	*40.8*	*43.2*	*45.7*	*48.4*	*51.3*	*54.3*	*57.6*	*61.1*
Truck	*17.2*	*21.7*	*25.7*	*28.9*	*32.2*	*35.2*	*38.0*	*40.8*	*43.4*	*47.3*	*53.1*	*58.8*	*64.6*	*70.3*	*76.0*
Special-Duty	*7.9*	*8.7*	*8.5*	*9.2*	*10.1*	*10.9*	*11.8*	*12.8*	*13.8*	*14.9*	*16.0*	*17.3*	*18.6*	*20.0*	*21.5*
2,3-Wheel	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
ICE	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
E-Bike	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*

Unit Consumption Assessment of Special Vehicle, kg per vehicle