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NEW LIGHT COMMERCIAL VEHICLES IN CHINA, 2010

TECHNOLOGY ASSESSMENT AND INTERNATIONAL COMPARISONS

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1. EXECUTIVE SUMMARY

This paper assesses the status of fuel consumption (FC) levels and fuel efficiency technology adoption in China's light commercial vehicle (LCV) market in 2010, focusing on the differences among vehicle sub-categories and manufacturers. It also compares fleet features and technologies between similar vehicles from the United States, Europe, and China for model year 2010. The results provide insights that can be used to help develop the next phase of LCV (2015 and beyond) fuel consumption regulation in China.

Compared with passenger cars, China's LCVs have a smaller market (about 2.7 million new sales in 2010[1]) but higher per-vehicle fuel consumption. The fleet average fuel consumption in 2010 was 7.7 L/100km for passenger cars and 8.6 L/100km (gasoline equivalent) for LCVs.

China established two phases of fuel consumption standards for LCVs in 2007. The Phase I standard applied to new LCVs in 2008 and on continued models in 2009, while the Phase 2 standard applied to new vehicles in 2011 and continued models in 2012. In early 2014, the regulatory agency, the Ministry of Industry and Information Technology (MIIT), announced the launch of a program to revise the LCV fuel consumption standard and set out the basic requirements to develop the Phase 3 standard.[2]

As the previous standards are per-vehicle limits and the available data is limited, it is unclear how the entire LCV fleet performs in terms of fuel economy and how advanced vehicle efficiency technologies are adopted in the LCV market. It is also worthwhile to understand how the Chinese LCVs compare with similar vehicle types in other regions in terms of vehicle fuel economy and technology adoption.

Table ES.1 provides 2010 model year fleet profiles and technology adoption levels in China, EU and US as well as across vehicle categories for the Chinese LCV fleet. A brief summary of the findings follows:

» Technology application levels vary among LCV categories and fuel type. In general, N1 vehicles (mini and light trucks) show better fleet-average fuel consumption performance than M2 vehicles (minivans and vans). By further comparing sub-fleets by fuel type, we found that diesel M2 vehicles adopt more advanced efficiency technologies compared with other categories and fuel types.

» Vehicle characteristics and market profiles of LCVs vary widely among China, the US, and the EU. Among the three regions, Chinese LCVs on average show the smallest values in terms of engine size, curb weight, footprint, and power. In addition, gasoline and diesel LCVs share roughly an equal market in China, while diesel vehicles dominate the EU LCV fleet (accounting for 95.6% of it) and gasoline vehicles dominate the US light truck fleet (99%).

» Compared with the EU N1 diesel LCVs, China's N1 diesel fleet shows larger size of engine and smaller footprint, but fleet-average power is lower by 35%. China N1 diesel LCVs have adopted much less advanced engine technologies, such as multi-valve and turbocharging technologies, and show higher (by 19%) combined FC as well as higher emission levels. In contrast, about 90% of the EU fleet has adopted

1 LMC Automotive estimated that about 5 million LCV sales were sold in China in 2013: http://bestsellingcarsblog.com /2014/04/25/china-full-year-2013-discover-the-top-10-best-selling-lcvs/

2 http://www.miit.gov.cn/n11293472/n11293832/n11293907/n12246780/15820369.html

turbo- or super-chargers, compared with an adoption rate of less than 10% in China. This trend is one of the major contributors to lower fuel consumption in the EU than in China.

- The fleet-average fuel consumption (CO_2 emissions) of Chinese LCVs is 8.6 L/100km gasoline equivalent (or 202 g/km CO_2) under the New European Driving Cycle (NEDC) test, compared with 11.1 L/100km (264 g/km CO_2) in the US and 7.7 L/100km gasoline equivalent (180 g/km CO_2) in the EU.
- None of the LCVs sold in China are imported; they are all produced domestically because of the niche market of the vehicle type. Among a total of 30 LCV manufacturers, 11 major domestic manufacturers, including nine Chinese independent automakers and two joint ventures (JVs), account for 80% of China's 2010 LCV market and, thus, are the focus of our analysis. Unlike passenger cars,[3] JV automakers only have a small LCV market share. The fuel economy or technologies used by SAIC-GM-Wuling, one of the two JV manufacturers, tend to be similar to the levels of their Chinese-branded counterparts, while the other JV manufacturer, Zhengzhou-Nissan, has adopted more advanced technologies but has an average vehicle price more than 50% higher than those of other major manufacturers.
- A couple of manufacturers adopted more advanced efficiency technologies, such as direct injection and turbocharging, but most did not. Even within a given manufacturer/auto group, technologies used for LCVs tend to be less advanced than those used for its passenger cars. Zhengzhou-Nissan (not in the top 10), a pickup-truck-focused JV automaker, has the most advanced efficiency technology application among all 11 major LCV manufacturers. While most LCV manufacturers target small business owners and provide transportation tools primarily for carrying goods, Zhengzhou-Nissan targets high-end customers who are willing to pay much higher prices for pickups with advanced features such as towing, off-road, and high performance.
- In 2010, about 16% of the new LCV sales did not meet China's current fuel consumption standard that goes into effect in 2012 for the vehicle category. Regarding the compliance rates among major manufacturers, half of the top 10 manufacturers show 100% compliance rates with the Phase 2 standard.

The current FC limits are not stringent, and a long lead time was set to allow all manufacturers to meet the standard. This is reasonable as a first step in regulating LCVs, but in the meantime half of the top 10 manufacturers achieved 100% compliance in 2010, even though among them many less-advanced efficiency technologies continued to be used, such as carburetors, natural aspiration, and single-point fuel injection. This strongly suggests that more stringent standards need to be established to promote advanced efficiency technologies. In addition, current standard design using engine size as one of two attributes does not encourage manufacturers to improve fuel efficiency through downsized engines.

3 ICCT (2012). The New Passenger Car Fleet in China, 2010: Technology Assessment and International Comparisons.

Table ES.1 2010 model year fleet profiles and technology adoption by region and LCV category

Parameters	China					EU	US	
	Fleet	N1 diesel	N1 gasoline	M2 diesel	M2 gasoline	Fleet average (N1 diesel)	Fleet average (light truck)	Gasoline truck with GVW <= 3,500 kg
Market								
Sales (thousand)	2,678	1,397	1,112	30	138	1,481	4,014	1,287
Share	100%	52%	42%	1%	5%	-	-	-
Price (USD)	$4,826	$4,285	$4,396	$15,731	$11,355	-	-	-
Basic								
Engine size (cc)	1803	2220	1233	2466	2037	1932	3929	4799
Curb weight (kg)	1348	1596	999	1838	1540	1681	2067	2240
Footprint (sq m)	3.5	3.7	3.2	4.2	3.7	4.9	5.1	6
Utility								
Power (kW)	50	51	46	69	79	78	191	215
Power-to-weight ratio (W/kg)	39	32	32	38	50	44	92	96
Engine specific power (W/cc)	30	23	38	28	39	40	49	45
Fuel consumption[a]								
Combined FC (L/100km)	8.6[b]	8	7.8	9.4	9.7	6.9 (7.7[b])	9.9	11.1
Combined CO_2 g/km	202	215	182	250	228	180	238	264
Technology specifications								
Fuel type[c]								
Gasoline	47%	-	42%	-	5%	2%	100%	100%
Diesel	53%	52%	-	1%	-	96%	<1%	0%
Transmission								
Manual	100%	100%	100%	100%	100%	86%	2%	2%
Automatic	0%	0%	0%	0%	0%	3%	98%	98%
No. of gears								
4	14%	4%	25%	0%	19%	-	19%	18%
5	86%	96%	75%	68%	81%	-	30%	28%
6 and above	0%	0%	0%	32%	0%	-	51%	54%
Valve configuration								
DOHC	14%	14%	8%	50%	37%	-	50%	29%
SOHC	66%	47%	92%	50%	63%	-	29%	42%
Overhead valves	20%	0%	0%	0%	0%	-	21%	29%
No. of valves per cylinder								
2	81%	83%	84%	50%	51%	25%	29%	41%
4	19%	17%	16%	50%	49%	65%	71%	59%
Air intake								
Naturally aspirated	91%	84%	84%	21%	100%	4%	98%	100%
Turbo- or super-charging	9%	16%	16%	79%	0%	91%	2%	0%
Fuel supply								
Carburetor	6%	0%	14%	0%	0%	-	0%	0%
Multipoint injection	15%	0%	27%	32%	0%	-	91%	100%
Single-point Injection	25%	0%	58%	68%	0%	-	0%	0%
Common-rail (diesel)	15%	0%	0%	0%	79%	-	<1%	0%
Diesel injection	53%	100%	0%	0%	21%	-	0%	0%
GDI	0%	0%	0%	0%	0%	-	9%	0%
Drivetrain								
4WD & AWD	<1%	<1%	<1%	0%	0%	7%	60%	51%
FWD	0%	0%	0%	0%	0%	71%	19%	0%
RWD	100%	99%	100%	100%	100%	17%	18%	43%
Emissions standard								
Euro 1	2%	4%	0%	0%	0%	-	0%	0%
Euro 2	78%	90%	65%	68%	58%	-	0%	0%
Euro 3	18%	6%	32%	0%	21%	1%	0%	0%
Euro 4	3%	0%	3%	32%	20%	59%	0%	0%
Euro 5 & 6 / US Tier 2	0%	0%	0%	0%	0%	3%	100%	100%

a) Region-specific cycle used
b) Gasoline equivalent
c) Refers to market share of the region-specific fleet

2. INTRODUCTION

2.1 OBJECTIVES

This project studies fuel-efficiency technology adoption status in the Chinese LCV fleet sold in 2010. It focuses on comparisons among LCV categories, between Chinese independent automakers and JV automakers, and side by side across the Chinese, EU, and US fleets. The findings could establish technology baselines and help regulators design future improvements to LCV fuel consumption regulations and standards by answering the following key questions:

- Do China's LCVs perform differently among different LCV categories in terms of technology adoption level and fleet-average fuel consumption?
- Do China's LCVs lag in terms of fuel-saving technologies from the EU and US, considering the difference in vehicle size, weight, and other major characteristics across the regions? If so, how far behind is the Chinese fleet?
- Who are the major LCV automakers in the current Chinese market and what are the market shares for import, independent, and JV automakers? Do they perform differently in terms of technology adoption level and fleet-average fuel consumption?
- How are China's LCVs performing under current fuel consumption regulations and standards? What might be considered to improve and enhance those regulations and standards in the near future?

2.2 BACKGROUND

In China's vehicle fuel consumption regulations, the term light commercial vehicles refers to passenger (M2 category per the European norms) and cargo vehicles (N1 category per the European norms) with gross vehicle weight (GVW)[4] below 3,500 kg. The M2 category refers to passenger vehicles with more than nine seats and GVW less than 5,000 kg (GB/T 15089-2001). Lighter M2 vehicles with GVW no more than 3,500 kg are considered LCVs, but compared with typical passenger cars, these vehicles have more seating capacity. For cargo vehicles, the maximum design speed must be 50km/h or higher.

LCVs are a niche market in China. Targeted consumers are primarily small business owners, farmers, and lower-income suburban residents. The vehicles are mainly used for urban light logistics transportation or carrying agricultural goods. Purchasers of LCVs also prefer multiple functions, so the vehicles are designed with flexible seating points that allow them to carry both cargo and passengers.[5] Due to the unique uses of LCVs and the fact that their primary targeted consumers are highly sensitive to overall vehicle cost,[6] these vehicles usually do not adopt very advanced fuel-efficiency technologies, and their utility performance is much lower than that of passenger cars. However, while fuel price becomes more expensive, more and more users consider fuel consumption as one of most influential factors to purchase the vehicle.[6] Very few foreign automakers invest in this segment. Most LCVs are upgraded low-speed vehicles or downgraded commercial vehicles. Compared with passenger cars, LCVs generally have higher fuel

4 Maximum vehicle weight, including cargo, designed by manufacturers (Code of Federal Regulation)
5 http://auto.sohu.com/20070419/n249555891.shtml
6 http://info.syc.hc360.com/2010/04/22091132881.shtml

consumption. In contrast, in the EU, LCVs are mainly used by small or medium-size companies, and consumers often seek out good fuel economy.[7]

In 2007, China established two phases of fuel consumption standards for new LCVs (Regulation No. GB20997-2007). Fuel consumption targets vary by vehicle category (N1 or M2), fuel type, GVW and engine displacement. Both standards are per-vehicle fuel consumption limits as shown in Tables 2.1 and 2.2, meaning each new model must meet its specific fuel consumption target applied to its characteristics and otherwise cannot be sold to the market. Phase 2 targets (phased in 2008 for new type approval and 2011 for all new LCVs) in general are 3–7% more stringent than those for Phase 1 (phased in 2009 for LCVs in production) for the various vehicle types.

Table 2.1 Phase 1 fuel consumption limits phased in 2009 for LCVs in production (L/100km)

Phase 1	N1								M2			
	Gasoline				Diesel				Gasoline		Diesel	
	M≤2	2~2.5	2.5~3	>3	M≤2	2~2.5	2.5~3	>3	M<= 3	M>3	M<= 3	M>3
V<=1.5	8	9	10	12.5	8	8.4	9.5	10.5	10.7	12.5	9.4	11.5
1.5<V<=2.0	8	10	10	12.5	8	8.4	9.5	10.5	10.7	12.5	9.4	11.5
2.0<V<=2.5	8	11.5	12	12.5	8	8.4	9.5	10.5	12.2	12.5	9.4	11.5
2.5<V≤3	8	13.5	14	14	8	9	10	11	13.5	14	10.5	11.5
3<V≤4	8	13.5	14	15.5	8	10	11	11.6	14.5	15.5	10.5	12.6
>4	8	13.5	14	15.5	8	10	11	12	14.5	15.5	10.5	12.6

Note: V represents engine displacement (L); M represents GVW (ton)

Table 2.2 Phase 2 fuel consumption standards phased in 2008 for new type approval and 2011 for all new LCVs (L/100km)

Phase 2	N1								M2			
	Gasoline				Diesel				Gasoline		Diesel	
	M≤2	2~2.5	2.5~3	>3	M≤2	2~2.5	2.5~3	>3	M<= 3	M>3	M<= 3	M>3
V<=1.5	7.8	8.1	9	11.3	7.8	8	9	10	9.7	11.3	8.5	10.5
1.5<V<=2.0	7.8	9	9	11.3	7.8	8	9	10	9.7	11.3	8.5	10.5
2.0<V<=2.5	7.8	10.4	10.8	11.3	7.8	8	9	10	11	11.3	8.5	10.5
2.5<V≤3	7.8	12.5	12.6	12.6	7.8	8.5	9.5	10.5	12.2	12.6	9.5	10.5
3<V≤4	7.8	12.5	12.6	14	7.8	9.5	10.5	11	13.1	14	9.5	11.5
>4	7.8	12.5	12.6	14	7.8	9.5	10.5	11.5	13.1	14	9.5	11.5

Note: V represents engine displacement (L); M represents GVW (ton)

In 2007, the China Automotive Technology and Research Center (CATARC) provided an explanatory document outlining background information for the establishment of the standards.[8] Basic market research on LCVs in China between 2004 and 2006 performed by the China Automotive Technology and Research Center suggested a strong correlation between vehicle engine size and fuel consumption. In addition, GVW is an important indicator of the loading capacity of LCVs. Therefore, both engine size and GVW were

7 http://www.researchandmarkets.com/reports/1197131/executive_analysis_of_the_european_light

8 CATARC (2007), Explanatory Document, National Standard "fuel consumption limits for light commercial vehicles"

used to establish the FC limits of LCVs. The first phase established a set of lenient standards aiming only to eliminate the laggards in the market; about 69% of N1 and 88% of M2 could meet the limits at the time. The second phase was more stringent, and only about half the models then on the market could meet it.

The explanatory document also highlights that diesel vehicles would have relatively lenient targets and LCVs generally would have less stringent targets (about 10% higher) than their passenger car counterparts with the same curb weight.

2.3 EXISTING LITERATURE AND ADDED VALUES OF THIS STUDY

While most existing literature relevant to this topic is on passenger vehicles, the European Commission released a report on LCV market analysis and evaluated the relevant CO_2 emission reduction regulations in April 2012. In the report, an analysis of the 2010 EU LCV market was conducted and cost curves for different LCV categories were developed. The report also evaluated the utility parameters, discussed other policy options, and compared them with those of the passenger vehicle market.[9]

In addition, the ICCT is producing annual reports on all vehicles in the EU, including LCVs, which compare the fleets in terms of fleet characteristics and vehicle technologies.[10] The Australian National Transport Commission also conducted international comparisons in terms of average CO2 emissions for LCVs.[11]

In 2013, the CATARC released a report evaluating LCV technology status in China.[12] The report provides sale-weighted average values for the main vehicle parameters and FC values, as well as the adoption level of some technologies. In addition, multi-year data were compared to analyze the technology development trend.

This report is a good complement to the above sources, as it provides more comprehensive technology adoption details of the Chinese LCV market and detailed comparisons with the similar fleets in other regions. It analyzes the distribution of key vehicle characteristics and technology adoption status in China at the aggregated fleet level, vehicle classification level, and manufacturer level. In addition, we compare China with the US and EU in terms of vehicle characteristics and a wide range of engine and transmission technologies, as listed below:

- Engine displacement
- Vehicle curb weight
- Vehicle size such as footprint
- Engine power
- Torque
- Maximum speed
- Power-to-weight ratio
- Specific power (ratio between power and displacement)

9 European Commission (2012). Support for the revision of regulation on CO2 emissions from light commercial vehicles, April 26, 2012. http://ec.europa.eu/clima/policies/transport/vehicles/vans/docs/report_co2_lcv_en.pdf.

10 ICCT. European Vehicle Market Statistics, Pocketbook, 2011, 2012 and 2013.

11 Australian NTC (2013). Carbon Dioxide Emissions from New Australian Vehicles 2012, Information Paper, March 2013.

12 CATARC (2013). China Light Commercial Vehicle Fuel Consumption and Technology Condition Report.

- Fuel consumption rate under NEDC combined test cycles
- Fuel type
- Transmission type and number of gears
- Fuel supply system
- Air intake system
- Drivetrain technology

2.4 ORGANIZATION

Section 3 describes the data sources, coverage, and completeness, providing a basis for the analysis and discussion in this paper. Section 4 analyzes vehicle features and fuel efficiency technology application levels of the Chinese domestic fleet by four LCV categories. Section 5 compares the fleet-average vehicle features and technology adoption status across the China, EU, and US markets. Section 6 analyzes corporate-average vehicle features and technology adoption rates of 11 major domestic LCV automakers. Section 7 summarizes the main findings and provides preliminary policy recommendations.

3. DATA DESCRIPTION

The analysis conducted in this paper is based on the following data sources:

» China 2010 Light Commercial Vehicle database, provided by Segment Y[13]

» EU-27 2010 Light Commercial Vehicle database, compiled by the ICCT

» 2010 EPA database for supporting the US 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards

» US EPA Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2012[14]

Table 3.1 shows that the raw database for China's fleet provides good data availability, except for a few parameters highlighted in the table. We set the bar for good data fill-in rate at 75%. Only four parameters fail to provide meaningful data: torque (N.m), torque (rpm), acceleration speed (0-100km/h), and valvetrain system. As opposed to passenger vehicles, it is very difficult to obtain the valvetrain system information for LCVs. In this study, the power-to-weight ratio is used as an alternative to acceleration for analyzing the vehicle performance.

Table 3.1 Data availability of key parameters by vehicle category in China

	M2		N1	
	Diesel	Petrol	Diesel	Petrol
Engine Size (cc)	100%	100%	100%	100%
Curb Weight (kg)	100%	100%	100%	100%
Wheel Base (mm)	100%	100%	100%	100%
Front Track Width (mm)	97%	92%	97%	99%
Rear Track Width (mm)	97%	92%	97%	99%
HP (kW)	100%	100%	100%	100%
Torque (N.m)	100%	100%	67%	97%
Torque (rpm)	100%	100%	61%	97%
Max Speed (km/h)	97%	83%	79%	93%
Acceleration Time (0-100km/h)	0%	0%	0%	0%
Compression Ratio	85%	100%	99%	98%
Drivetrain	100%	100%	100%	100%
Fuel Type	100%	100%	100%	100%
Transmission Type	100%	100%	100%	100%
Engine Type	100%	100%	100%	100%
Valve Configuration	100%	100%	100%	100%
No. of Cylinders	100%	100%	100%	100%
No. of Valves per Cylinder	100%	100%	100%	100%
Fuel Supply	100%	100%	100%	100%
Air Intake	100%	100%	86%	85%
Valvetrain System	0%	0%	0%	0%
Fuel Consumption (combined)	100%	100%	86%	85%
Emissions Standard	100%	100%	100%	100%
Footprint (sqm)	97%	92%	97%	99%
Data Fill-in Rate				
Color Code	<25%	25%-50%	50%-75%	>75%

13 http://www.segmenty.com

14 http://www.epa.gov/otaq/fetrends.htm, accessed on April 26, 2013.

The Chinese LCV database used in this study was provided by Segment Y, an independent international automotive data supplier. Some of the data values were crosschecked with other sources for accuracy. Fuel consumption values for some of the high-sales models were checked with those provided on the MIIT website[15] for the same vehicle/engine specifications. In addition, fleet-average vehicle specification and fuel consumption data were cross-checked against data from a leading automotive research institute. Sales data were compared with statistics from the China Association of Automobile Manufacturers (CAAM).

15 The website of Automobile Fuel Consumption of China: http://chinaafc.miit.gov.cn/

4. TECHNOLOGY ADOPTION BY LCV VEHICLE CATEGORY

This section analyzes Chinese LCV fleet features and fuel efficiency technology application levels by vehicle category. By conducting by-category analysis, we can better understand the technology adoption status and fuel economy levels of typical LCV categories in the Chinese market.

As previously described, separate limits were established in the standards for four types of LCVs, including diesel and gasoline vehicles for the N1 and M2 categories (GB/T15089-2001). This study uses these individual sub-fleets for our by-category analysis. For each category, we evaluated the fleet average vehicle characteristics and technology adoption status.

However, the raw database adopted a different classification that is roughly consistent with the classification used for road safety regulations and commercial statistics (GB/T3730.1-2001). We scrutinized the raw database categories and, depending on the usage of the vehicles, grouped certain vehicle types into the N1 and M2 system.

Note that in the EU LCV market, there is only one category: N1. Therefore, understanding the LCV classifications in China will be useful for understanding the next section of this paper, which undertakes a comparative analysis among different regions.

4.1 DESCRIPTION OF VEHICLE CLASSIFICATIONS

The raw database uses different vehicle types, rather than vehicle categories such as N1 or M2. Table 4.1 provides the classifications for the raw database and this study. Figure 4.1 shows the market shares of various vehicle types under the N1 and M2 categories.

Table 4.1 LCV classifications in this study

This Study	Raw Database	Example Vehicle
N1	Mini-truck: a small truck that traces its roots to the Kei class in Japan, such as the Suzuki Carry; for China, we also include the smaller trucks that are cheap (about RMB 23,000 for the lowest) with low-powered engines below 2.0 liter and a GVW below 2,000 kg, which is a bit bigger than the mini-trucks derived from Japanese designs; the Kama Light Truck could be classified as a mini truck, given its lower GVW, even though it is not derived from a Kei class vehicle	
	Van pickup: mostly built on ladder frames, with an engine of 2.0 liter or more, and a distinct "nose" (as opposed to a forward cab)	
	Truck: a GVW above 2,000 kg, and a forward cab above the front wheels, and normally not derived from a Japanese Kei class	
M2	Van: a GVW above 2,000 kg, an engine of 2.0 liter or more, and 10 seats or more in the case of buses, in the mold of a Toyota Hiace	
	Minivan: also derived from Japanese Kei-class vans; the Gonow Minibus is erroneously classified as a minivan	

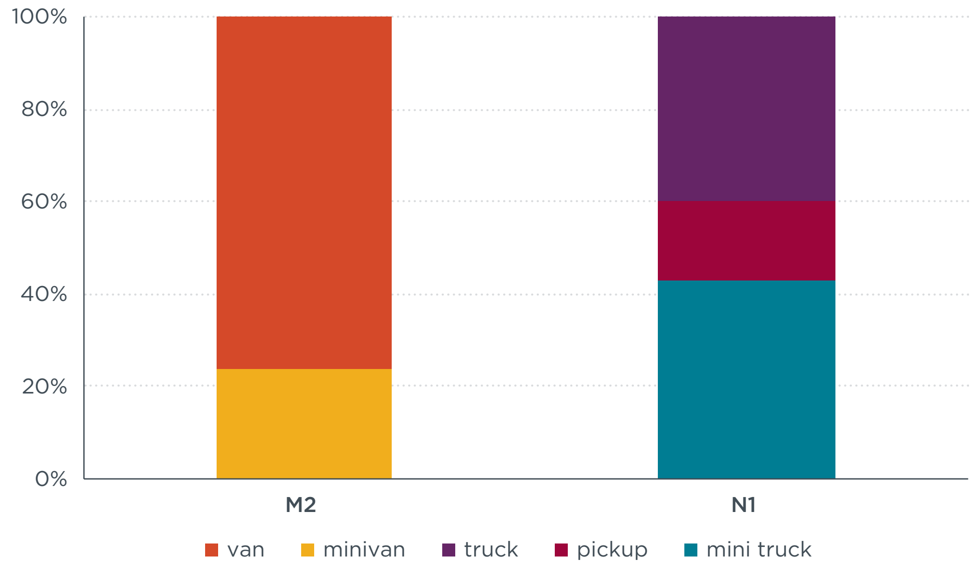

Figure 4.1 Vehicle type shares by vehicle category

4.2 PROFILE OF MAJOR VEHICLE SPECIFICATIONS BY VEHICLE CATEGORY

In this section, for each of the four vehicle categories and fuel types—N1 and M2; gasoline and diesel—we analyze three vehicle characteristics (curb weight, gross weight, and footprint, defined as the area between the four wheels), two engine characteristics (engine displacement and engine specific power, defined as power-to-engine-displacement ratio), three vehicle performance indicators (engine horsepower, designed maximum speed, and power-to-weight ratio), and fuel consumption.

Table 4.3 provides a snapshot of the maximum and minimum values and the sales-weighted averages for each parameter. Figure 4.2 shows the market share of the four vehicle categories. The findings from Table 4.3 and Figure 4.2 are summarized as follows:

» N1 diesel is the largest vehicle category in the Chinese LCV market, representing 52% of total sales in 2010. Among the four vehicle categories, it has the largest average values in terms of engine size, footprint, curb weight, and GVW.

» The second largest vehicle category in the Chinese LCV market is N1 gasoline, which accounted for 42% of total sales in 2010. The average engine size, curb weight, and engine power of this category are close to the fleet average, but it has the highest average fuel consumption level, 9.7L/100km.

» Both M2 diesel and M2 gasoline account for a small amount of total sales in China's 2010 LCV market. However, M2 diesel is the closest vehicle category to China's LCV fleet average values in most of the key vehicle characteristics.

Table 4.3 Extreme values and sales-weighted averages for nine vehicle and engine features by vehicle category

		M2		N1		
		Diesel	Gasoline	Diesel	Gasoline	Fleet
Engine size (cc)	Min	1998	797	1357	797	797
	Max	2771	3199	3856	2559	3856
	Ave	2466	2037	2220	1233	1803
Curb weight (kg)	Min	1600	870	1090	700	700
	Max	2135	2350	2150	1700	2350
	Ave	1838	1540	1596	999	1348
Footprint (sqm)	Min	3.7	2.2	2.7	2.4	2.2
	Max	5.1	5.2	5.1	5.0	5.2
	Ave	4.2	3.7	3.7	3.2	4
Horsepower (kW)	Min	46	29	28	28	28
	Max	85	140	98	110	140
	Ave	69	79	51	46	50
Max speed (km/h)	Min	100	100	75	90	75
	Max	130	160	140	170	170
	Ave	124	123	97	109	104
Fuel consumption (L/100km)*	Min	7.6	4.9	5.9	4.9	4.9
	Max	10.3	13.0	10.7	11.3	13.0
	Ave	9.4	9.7	8.0	7.8	8.6
HP/engine displacement (W/cc)	Min	21	34	18	25	18
	Max	35	50	39	52	52
	Ave	28	39	23	38	30
Gross weight (kg)	Min	2600	1480	1710	1350	1350
	Max	3300	3480	3495	2785	3495
	Ave	2931	2497	2657	1823	2320
HP/curb weight (W/kg)	Min	26	33	20	32	20
	Max	44	78	60	77	78
	Ave	38	50	32	46	39

* Fleet values refer to gasoline equivalent values

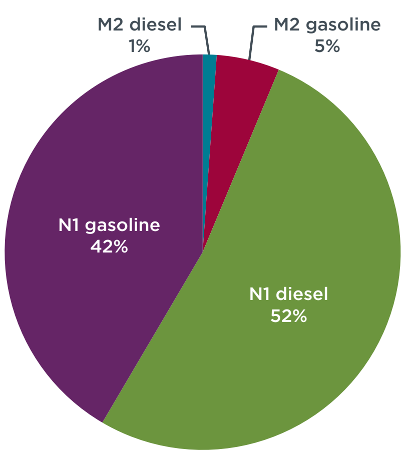

Figure 4.2 Market share of each LCV category

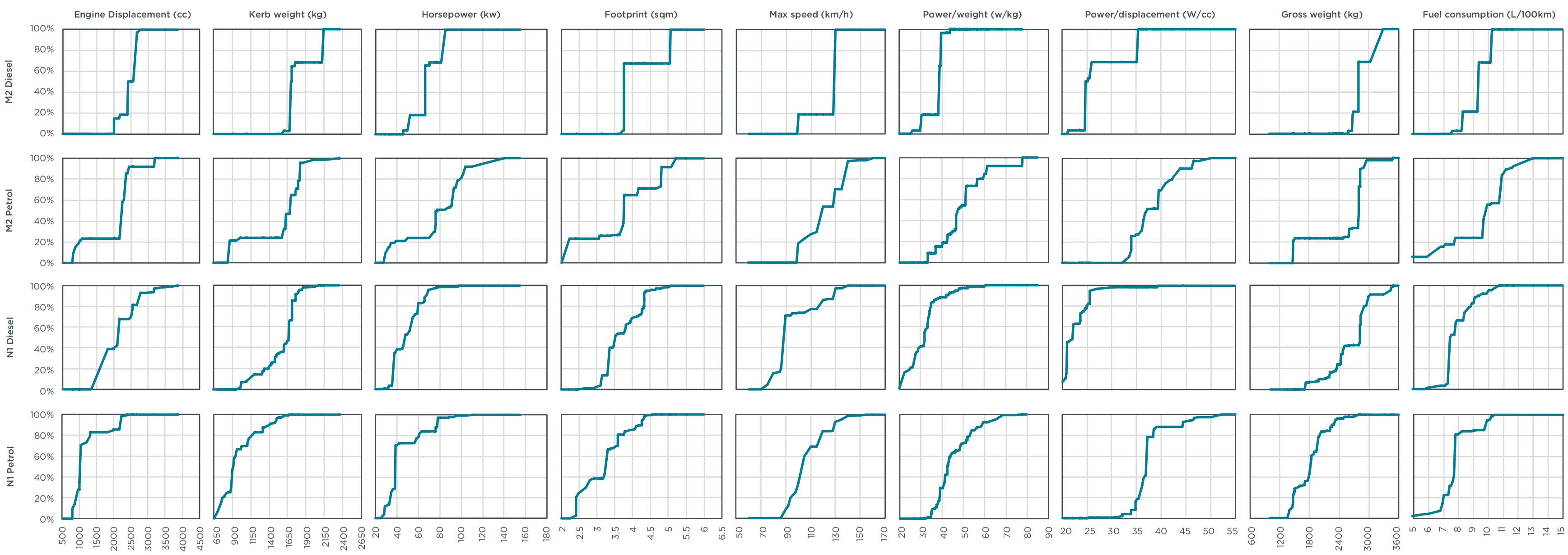

Figure 4.3 Cumulative distributions of engine displacement, curb weight, horsepower, footprint, designed maximum speed, power-to-weight ratio, gross weight, and fuel consumption levels by LCV category

4.3 FUEL-EFFICIENCY TECHNOLOGY ADOPTION BY VEHICLE CATEGORY

In this section, we investigate the application of various engine and transmission technologies by vehicle category, as shown in Figure 4.4. As shown in Figure 4.2, more than half of the 2010 Chinese LCVs were powered by diesel, while the remaining were powered by gasoline.

Seven engine technologies and characteristics were evaluated: engine configuration (v-type versus inline), valve configuration, number of cylinders, number of valves per cylinder, fuel supply system, air intake system, and emissions standard. Some highlights are as follows:

» Regarding valve configuration, M2 LCVs have a higher adoption rate for multi-valve technologies, while most N1 LCVs have only two valves per cylinder.

» For fuel supply systems, most diesel LCVs in China use diesel direct injection, instead of the higher technology common rail systems, while single-point fuel injection is the most common type for gasoline LCVs, instead of the higher technology multi-point fuel injection.

» N1 gasoline falls behind the other three groups in terms of the fuel supply system technology, as about 14% of N1 vehicles still used the old-technology carburetor, which negatively affects fuel efficiency. In addition, only about 16% of N1 diesel LCVs adopted turbocharging technology, while all gasoline LCVs (both M2 and N1) used naturally aspirated air intake technology. If turbocharging was adopted, the engine could be downsized to maintain the same performance, which could significantly reduce fuel consumption. These indicate that as the major LCV market, N1 LCVs offer a large opportunity to improve fuel efficiency.

Two transmission technologies were also evaluated: transmission type and number of gears. All LCVs in China use manual transmissions, so we did not show the graphic in Figure 4.4. Most N1 and M2 vehicles use five-speed manual transmission systems. M2 diesel is the only category in the Chinese LCV market that has transmissions with six gears.

In general, M2 LCVs have adopted more advanced technologies than N1 LCVs. M2 LCVs were designed more like passenger cars but with higher seating capacity. Thus, performance features similar to those of passenger cars were adopted, such as faster acceleration and higher gear count for the transmission so the vehicle can be driven faster and more smoothly. It appears such features might not be of major concern for cargo LCVs, or N1 LCVs, used by small-business owners.

The upfront costs of purchasing a vehicle are likely a major concern for most small-business owners. As shown in Table 4.4, the cost of N1 vehicles on average is significantly lower (less than half) than that of M2 vehicles. Given the low price constraint, N1 vehicles usually do not adopt many advanced efficiency technologies.

Table 4.4 Market share and fleet average cost by vehicle category

Parameters	Fleet	N1 diesel	N1 gasoline	M2 diesel	M2 gasoline
Sales (thousands)	2,678	1,397	1,112	30	138
Share	100%	52%	42%	1%	5%
Price (USD)	$4,826	$4,285	$4,396	$15,731	$11,355

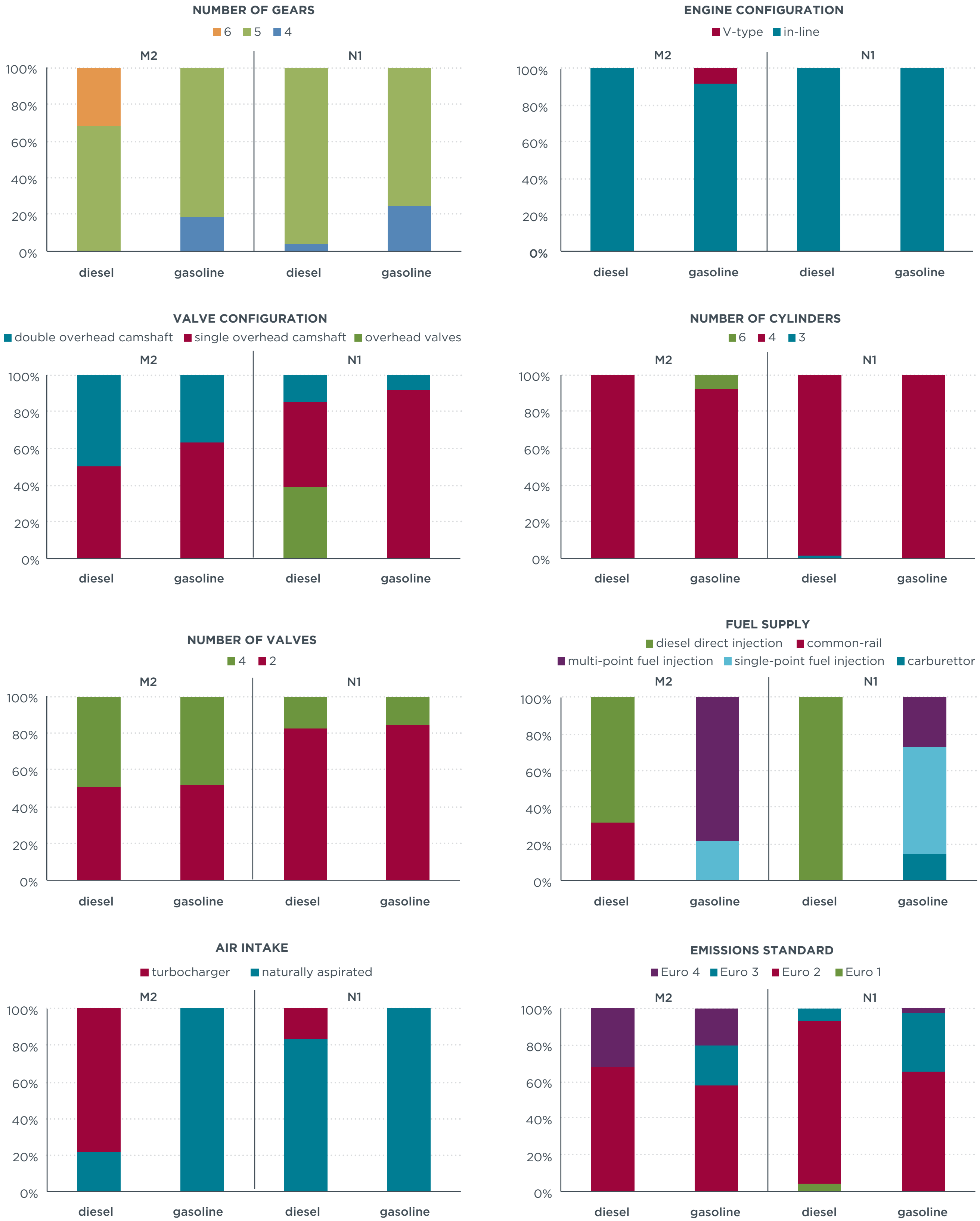

Figure 4.4 Engine and transmission technologies by LCV category

5. COMPARISONS AMONG LCV FLEETS FROM DIFFERENT REGIONS

This section compares the fleet characteristics and technology adoption of LCVs among the EU, US, and China. The results are shown in Table 5.1.

The definition of LCVs is different among the different regions. According to the European Commission, "Light-commercial vehicles are defined as vehicles primarily intended for the transport of goods with a gross weight of less than 3.5 metric tons, or N1 vehicles under 3.5 tons of GVW." In the US, LCVs are not a regulatory vehicle class. According to the Environmental Protection Agency (EPA), the closest vehicle type in the US to LCVs in China and Europe is the light truck (LT) or light duty truck (LDT), referring to trucks or truck-based vehicles with maximum 8,500 lb (3,856 kg) GVW, maximum 6,000 lb (2,722 kg) curb weight, and maximum 45 ft^2 (4.2 m^2) frontal area.

In this study, we first compared the US LT fleet with the LCV fleets in China and Europe. This assessment was then used to establish comparable N1 LCVs in the three regions. Since LTs in the US also include premium SUVs, minivans, and trucks with GVW heavier than 3.5 metric tons, a subset of the US LT fleet (LTs with GVW of less than 3.5 metric tons and not including SUVs or minivans) was selected for better comparability of "N1 LCV sub-fleets" among the three regions.

Table 5.1 shows that 47% of China's LCVs are powered by gasoline and 53% are powered by diesel, while more than 99% of LTs in the US are powered by gasoline and 96% of LCVs in the EU are powered by diesel. Therefore, China's N1 diesel LCV fleet was compared with the EU LCV fleet, while China's N1 petrol LCV fleet was compared with the selected US LT fleet.

Table 5.1 shows that China had a higher LCV sales volume in 2010 than the EU or US. The selected US LT fleet is significantly larger, heavier, and more powerful than those of the other two regions.

Compared with the China N1 diesel fleet, the EU N1 diesel fleet has smaller engine size (by 13%), heavier weight, larger footprint (by 31%), and significantly higher power (by 54%). The EU fleet also shows greater power-to-weight ratio (by 37%), indicating better performance in terms of acceleration, than its Chinese counterpart. In addition, the engine specific power of the EU fleet is higher than that of China by 76%, indicating that the EU has much higher penetration rates of advanced engine technologies. As studied by the EPA,[16] engine specific power is usually a good indicator of advanced engine technologies.

Table 5.1 also shows that majority of the EU and US fleets adopted multi-valve technologies, while more than 80% of China's LCVs still used two valves per cylinder. In addition, more than 90% of the EU fleet adopted turbocharging technologies, compared with just 16% for the Chinese N1 diesel fleet. The lower adoption levels of these technologies might be one of the primary contributors to the higher (by 19%) fleet-average FC of the China N1 diesel fleet when compared with its EU counterpart.

16 US Environmental Protection Agency (2012). Light-duty automotive technology, carbon dioxide emissions, and fuel economy trends: 1975 through 2011.

As noted previously, a small percentage of China's LCVs still use an outdated fuel supply method: the carburetor, which is no longer used in the other two markets.

Regarding transmission technologies, more than half of the US fleet employed transmissions with at least six speeds, while none of China LCVs used this technology. All the LCVs in China were equipped with manual transmissions in 2010, while more than 95% of the selected LTs in the US were automatic transmissions.

The vehicle features and typical utility of LCVs in China are different from those of LTs in the US and LCVs in the EU. This partially explains the differences in design and technology features of LCVs among the three markets. As previously described, China LCV markets are targeted at small-business owners and rural or suburban consumers. These customers primarily use the vehicle to carry goods to run businesses. One of their major concerns might be the upfront cost of the vehicle, rather than advanced features. Most of them likely minimize investment in the vehicle so that more profits can be made from their small businesses. Low vehicle costs constrain the introduction of advanced technologies. In the US and EU, meanwhile, in addition to the ability to carry goods, LCV users might expect higher fuel efficiency, better performance, and more comfort from the vehicle.

Table 5.1 Fleet profiles and technology adoption by region for model year 2010

Parameters	China					EU	US	
	Fleet	N1 diesel	N1 gasoline	M2 diesel	M2 gasoline	Fleet average (N1 diesel)	Fleet average (light truck)	Gasoline truck with GVW <= 3,500 kg
Market								
Sales (thousand)	2,678	1,397	1,112	30	138	1,481	4,014	1,287
Share	100%	52%	42%	1%	5%	-	-	-
Price (USD)	$4,826	$4,285	$4,396	$15,731	$11,355	-	-	-
Basic								
Engine size (cc)	1803	2220	1233	2466	2037	1932	3929	4799
Curb weight (kg)	1348	1596	999	1838	1540	1681	2067	2240
Footprint (sq m)	3.5	3.7	3.2	4.2	3.7	4.9	5.1	6
Utility								
Power (kW)	50	51	46	69	79	78	191	215
Power-to-weight ratio (W/kg)	39	32	32	38	50	44	92	96
Engine specific power (W/cc)	30	23	38	28	39	40	49	45
Fuel consumption[a]								
Combined FC (L/100km)	8.6[b]	8	7.8	9.4	9.7	6.9 (7.7[b])	9.9	11.1
Combined CO_2 g/km	202	215	182	250	228	180	238	264
Technology specifications								
Fuel type[c]								
Gasoline	47%	-	42%	-	5%	2%	100%	100%
Diesel	53%	52%	-	1%	-	96%	<1%	0%
Transmission								
Manual	100%	100%	100%	100%	100%	86%	2%	2%
Automatic	0%	0%	0%	0%	0%	3%	98%	98%
No. of gears								
4	14%	4%	25%	0%	19%	-	19%	18%
5	86%	96%	75%	68%	81%	-	30%	28%
6 and above	0%	0%	0%	32%	0%	-	51%	54%
Valve configuration								
DOHC	14%	14%	8%	50%	37%	-	50%	29%
SOHC	66%	47%	92%	50%	63%	-	29%	42%
Overhead valves	20%	0%	0%	0%	0%	-	21%	29%
No. of valves per cylinder								
2	81%	83%	84%	50%	51%	25%	29%	41%
4	19%	17%	16%	50%	49%	65%	71%	59%
Air intake								
Naturally aspirated	91%	84%	84%	21%	100%	4%	98%	100%
Turbo- or super-charging	9%	16%	16%	79%	0%	91%	2%	0%
Fuel supply								
Carburetor	6%	0%	14%	0%	0%	-	0%	0%
Multipoint injection	15%	0%	27%	32%	0%	-	91%	100%
Single-point Injection	25%	0%	58%	68%	0%	-	0%	0%
Common-rail (diesel)	15%	0%	0%	0%	79%	-	<1%	0%
Diesel injection	53%	100%	0%	0%	21%	-	0%	0%
GDI	0%	0%	0%	0%	0%	-	9%	0%
Drivetrain								
4WD & AWD	<1%	<1%	<1%	0%	0%	7%	60%	51%
FWD	0%	0%	0%	0%	0%	71%	19%	0%
RWD	100%	99%	100%	100%	100%	17%	18%	43%
Emissions standard								
Euro 1	2%	4%	0%	0%	0%	-	0%	0%
Euro 2	78%	90%	65%	68%	58%	-	0%	0%
Euro 3	18%	6%	32%	0%	21%	1%	0%	0%
Euro 4	3%	0%	3%	32%	20%	59%	0%	0%
Euro 5 & 6 / US Tier 2	0%	0%	0%	0%	0%	3%	100%	100%

a) Region-specific cycle used
b) Gasoline equivalent
c) Refers to market share of the region-specific fleet

6. FLEET CHARACTERISTICS AND TECHNOLOGY ADOPTION BY MAJOR DOMESTIC MANUFACTURERS

This section analyzes fleet characteristics, technology adoption, and fuel consumption levels among Chinese domestic manufacturers with the highest sales volume in 2010. Table 6.1 provides market share for the major manufacturers. Highlighted are the two JV automakers. The top ten (by sales) manufacturers were selected for the following analysis, including one JV automaker. We also observed that the other JV automaker, Zhengzhou-Nissan, though it represents only 1% of the market, has adopted far more advanced technologies than the other brands and would be an interesting case to be included in our comparison. Therefore we included in our analysis a total of 11 manufacturers that account for more than 80% market share. Unlike passenger cars, where JV automakers dominate the market, very few foreign automakers invest in the LCV market; JV automakers have market share below 20%.

It is noted that all of the selected top ten LCVs manufacturers are also top manufacturers for N1 LCVs, with more than 80% of N1 LCV market share. Four of these top ten manufacturers, Changhe, Brilliance Jinbei, BAIC (Beiqi Futon), and Chang'an, produced both N1 and M2 LCVs. These four manufacturers are also top manufacturers of M2 LCVs, with about 74% of M2 LCV market share.

Table 6.1 Sales share of major domestic manufacturers, 2010

Manufacturers	Fleet		N1		M2	
	Sales	Share	Sales	Share	Sales	Share
BAIC (Beiqi Foton)	561798	21.0%	537987	21.4%	23811	14.1%
Dongfeng	474319	17.7%	474319	18.9%	-	-
Chang'an	304215	11.4%	270700	10.8%	33515	19.9%
Brilliance Jinbei	185885	6.9%	147693	5.9%	38192	22.7%
Changhe	128328	4.8%	98851	3.9%	29477	17.5%
Jianghuai (JAC)	122115	4.6%	122115	4.9%	-	-
Great Wall	103180	3.9%	103180	4.1%	-	-
Kama	99243	3.7%	99243	4.0%	-	-
SAIC-GM-Wuling	98905	3.7%	98905	3.9%	-	-
Dong'an Heibao	78098	2.9%	78098	3.1%	-	-
Zhengzhou-Nissan	25958	1.0%	25958	1.0%	-	-

6.1 FLEET CHARACTERISTICS COMPARISON

This section compares the sales-weighted average fleet profile of each top manufacturer in terms of engine size, gross weight, power, engine specific power, max speed, power-to-weight ratio, combined FC (gasoline equivalent), and vehicle size (footprint), as shown in Figure 6.1. Figure 6.2 shows the vehicle types produced by major manufacturers.

Figure 6.1 Corporate average values of key parameters for selected major manufacturers (lighter bars represent values for JVs)

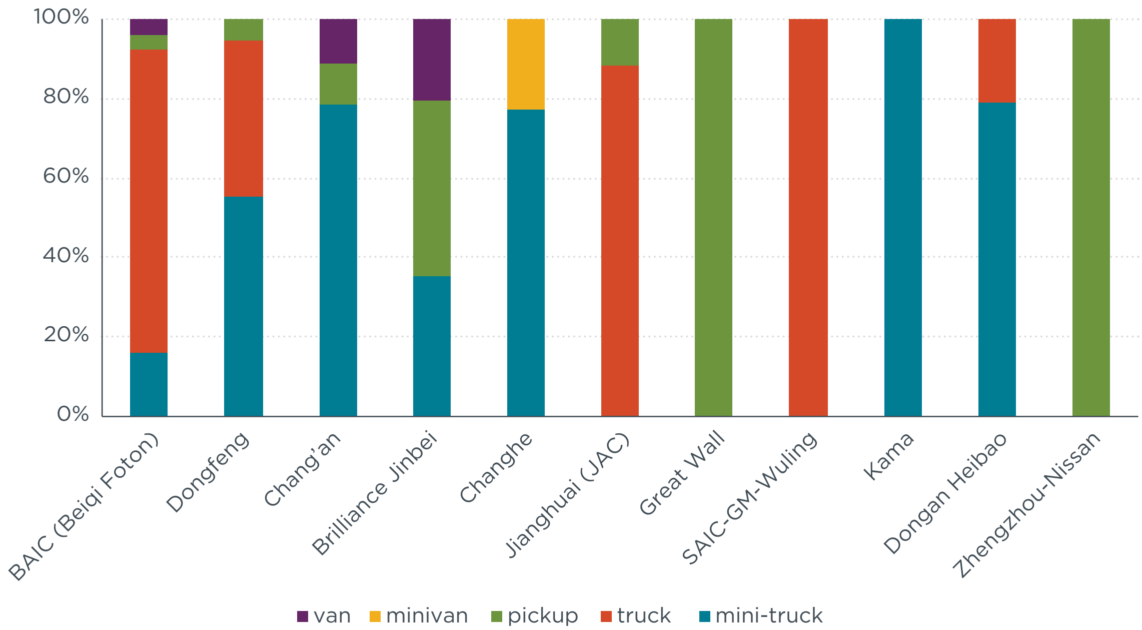

Figure 6.2 Vehicle types produced by major manufacturers

The main findings from Figure 6.1 and Figure 6.2 are as follows:

- Zhengzhou-Nissan has the largest engine size at 2.5 liters, followed by Jianghuai (JAC) at 2.4 liters. Changhe and SAIC-GM-Wuling have relatively small engine size at 1.0 liters.
- Kama, JAC, and BAIC are truck-dominated automakers in China's LCV market, with trucks accounting for 100%, 88%, and 76% of their own total sales respectively. The mini-truck is another popular LCV type among China's major manufacturers, led by SAIC-GM-Wuling, Chang'an, and Changhe, with mini-trucks accounting for 100%, 78%, and 77% of their total sales respectively. Most automakers have average gross weight around the fleet average of 2,320 kg; the exceptions are Chang'an, Changehe, and SAIC-GM-Wuling, with average gross weight less than 1,900 kg.
- The fleet average power is 50 kW. The highest power output is from Zhengzhou-Nissan, which has more than twice the fleet average value. Great Wall has the largest power output among the Chinese independent automakers, followed by Brilliance Jinbei and JAC.
- Similar to the power output characteristic, Zhengzhou-Nissan and Great Wall have the highest fleet-average maximum speed among all of the automakers, at 144 km/h and 131 km/h, respectively. Among major manufacturers, Kama shows the lowest fleet-average maximum speed (below 90 km/h).
- The fleet average power-to-weight ratio is 39 W/kg. The power-to-weight ratio of the two JV automakers is above the overall fleet average. Great Wall has the highest power-to-weight ratio among all the Chinese independent automakers. Beiqi Foton shows the lowest power-to-weight ratio. This is possibly because the company primarily produces trucks or mini-trucks whose buyers do not expect high performance. On the other hand, Great Wall focuses on pickups, which are used to carry not only goods but also passengers.

- The two JV automakers in this study, SAIC-GM-Wuling and Zhengzhou-Nissan, have the largest specific engine power among all of the major automakers. More than half of major automakers have specific engine power larger than the fleet average of 30 W/cc.
- The fleet-average combined gasoline equivalent fuel consumption is 8.6 L/100km. The Chinese independent automaker Great Wall has the highest average at 9.9 L/100km.

Figure 6.3 shows the corporate-average gasoline equivalent fuel consumption of major N1 and M2 LCV manufacturers as a function of their corporate-average gross weight and their corporate-average footprint, with their sales volume indicated by the bubble sizes.

Each manufacturer is also compared with the fleet-average gasoline equivalent FC, as indicated by the straight dashed lines. Most N1 LCV manufacturers are below the fleet-average FC value. Three of the four M2 LCV manufacturers are above the fleet-average combined FC, although the fourth, Changhe, has the lowest corporate-average fuel consumption amongst all the vehicles.

In addition, Figure 6.3 demonstrates that FC correlates more strongly with footprint than with gross weight. Further investigation was conducted to evaluate the correlation between curb weight and FC based on model-by-model data. It found that curb weight shows a stronger correlation with the FC than footprint does.

Table 6.2 shows that BAIC, Changhe, Dong'an Heibao, Dongfeng, Kama, and Zhengzhou-Nissan had already achieved an 100% compliance rate for China's Phase 2 targets as of 2010. Great Wall fell behind all other major manufacturers, with less than 50% compliance rate. Eight of the selected 11 major manufacturers had compliance rates above 70%.

Table 6.2 Compliance rates of Phase 2 FC limits by selected major manufacturers

Manufacturers	Phase 2 compliance rate
BAIC (Beiqi Foton)	100.0%
Brilliance Jinbei	55.1%
Chang'an	89.5%
Changhe	100.0%
Dongan Heibao	100.0%
Dongfeng	100.0%
Great Wall	49.0%
Jianghuai (JAC)	71.0%
Kama	100.0%
SAIC-GM-Wuling	71.7%
Zhengzhou-Nissan	100.0%

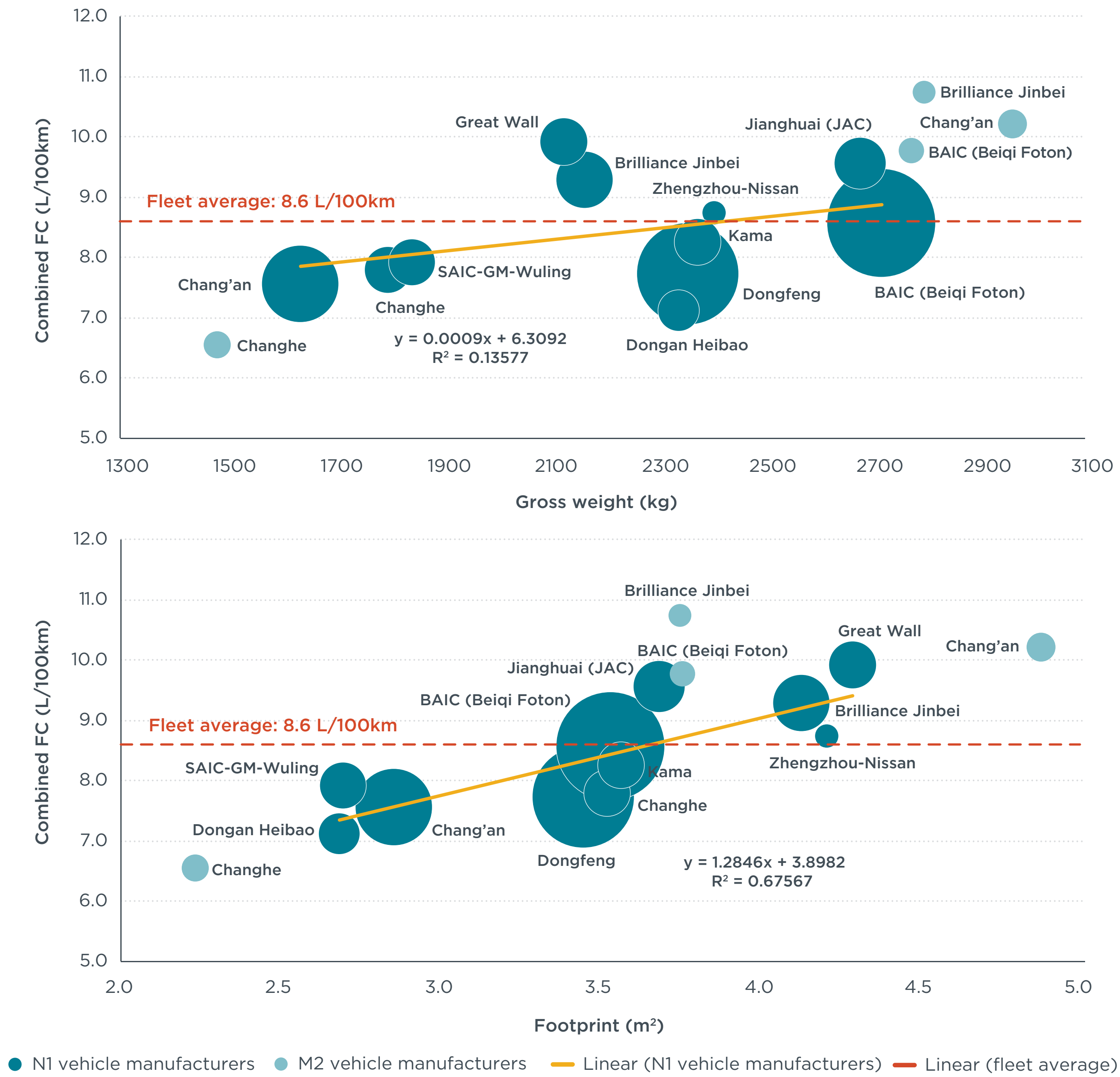

Figure 6.3 Combined FC vs. gross weight and footprint of major manufacturers

6.2 TECHNOLOGY ADOPTION BY MANUFACTURERS

In this section, we investigate the application of various engine and transmission technologies by major domestic automakers. Figures 6.4 and 6.5 compare technology adoption rates of major N1 and M2 LCV manufacturers, respectively. The findings from Figure 6.4 and Figure 6.5 are as follows:

For N1 LCV manufacturers:

» Most major manufacturers produce a mix of diesel and gasoline N1 LCVs, except Kama, which only makes diesel N1, and Changhe and SAIC-GM-Wuling, which only produce gasoline N1.

» For fuel supply systems, Chang'an, Changhe, Dongfeng, and SAIC-GM-Wuling are still using single-point injection or even carburetion and thus lag behind other automakers. Gasoline direct injection (GDI) technology had not been applied to the Chinese LCV market as of 2010.

» For air intake technologies, most manufacturers did not adopt turbocharged engines; the exceptions were Great Wall, JAC, and Zhengzhou-Nissan.

» All N1 LCVs have adopted manual transmission with four or five speeds.

» For drivetrain technologies, rear-wheel drive dominated the market; Zhengzhou-Nissan is the only automaker that produces a small number of four-wheel-drive vehicles.

» JV automaker Zhengzhou-Nissan overall showed the highest adoption rates of advanced technologies, including 100% installation of the double overhead camshafts (DOHC) and four valves per cylinder.

For M2 LCV manufacturers:

» Three of four major M2 LCV manufacturers produce a mix of diesel and gasoline M2 LCVs, except Changhe, which only makes gasoline M2.

» Changhe overall lags behind the other three automakers, as all of its M2 LCVs use older technologies such as single overhead camshaft (SOHC), single-point fuel injection, two valves per cylinder, and naturally aspirated air intake.

» On the other hand, among major manufacturers, Chang'an has adopted a relatively higher percentage of advanced technologies for M2 products; all of its M2 LCVs use transmissions of five or more speeds, DOHC, and four valves per cylinder.

Figure 6.4 Technology applications by major manufacturers (N1)

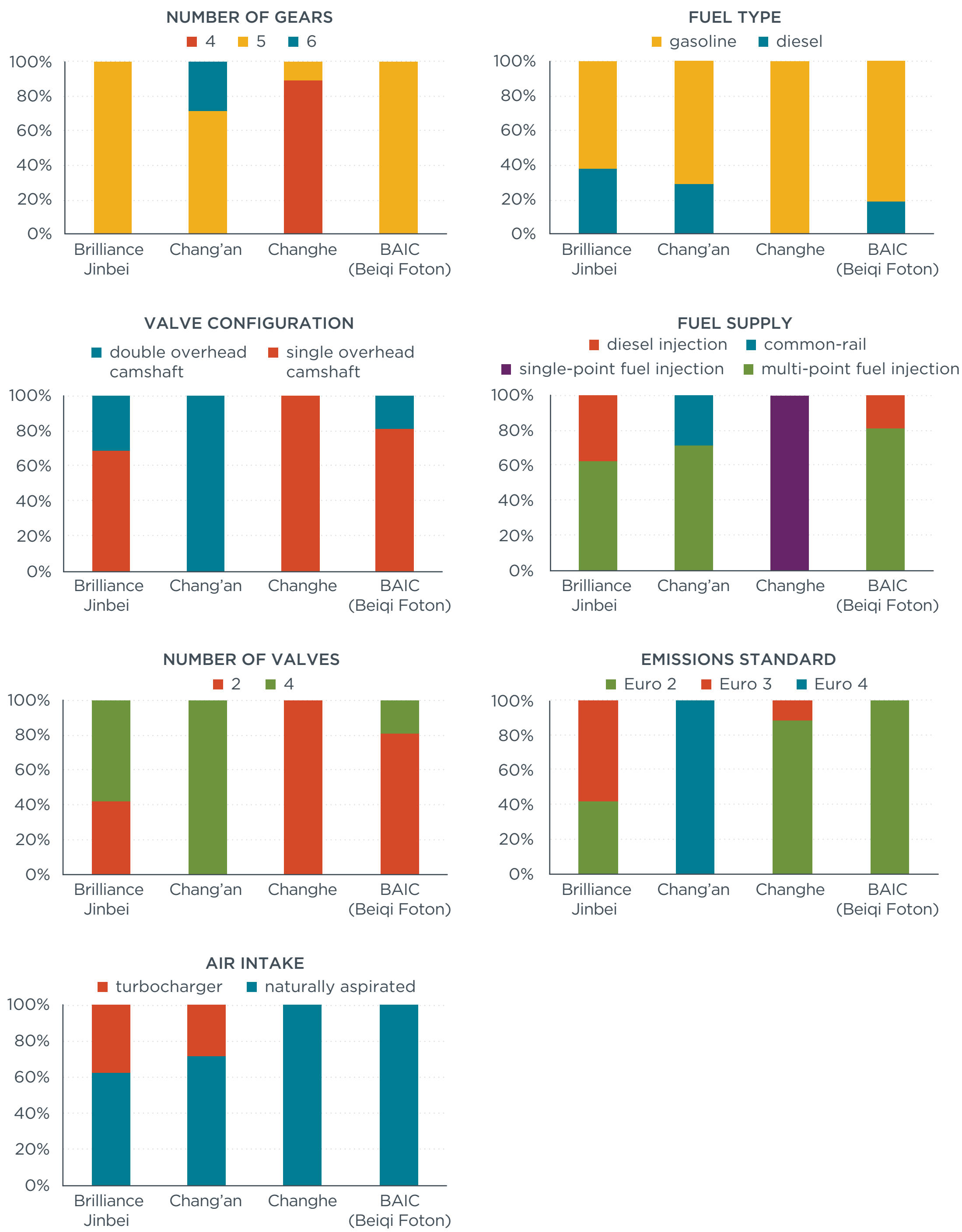

Figure 6.5 Technology applications by major manufacturers (M2)

While most LCV manufacturers target small business owners and provide them transportation tools primarily for carrying goods, Zhengzhou-Nissan targets the high-end pickup market, whose customers pay much higher prices for advanced features such as towing, off-road ability, and high performance. Table 6.3 compares the fleet-average sales prices of major manufacturers. Zhengzhou-Nissan's fleet-average sale price was nearly twice as expensive compared to a Chinese independent automaker counterpart—Great Wall, which also produced only pickups for its LCV market in 2010.

These two automakers have comparable fleet-average values in terms of engine size and footprint. Zhengzhou-Nissan primarily produced diesel pickups, while Great Wall focused on gasoline pickups. Compared with Great Wall, Zhengzhou-Nissan overall had higher application rates of advanced technologies, leading to much higher fleet-average performance and significantly lower fleet-average gasoline equivalent fuel consumption. A more detailed comparison between Great Wall and Zhengzhou-Nissan is given in Table 6.4.

Table 6.3 Average sales prices for China's major LCV automakers

Manufacturers	Average Price (USD)
Zhengzhou-Nissan	$17,677
Brilliance Jinbei	$11,633
Great Wall	$9,611
Chang'an	$7,772
Jianghuai (JAC)	$5,765
SAIC-GM-Wuling	$5,168
Changhe	$5,090
Dongfeng	$4,858
BAIC (Beiqi Foton)	$4,538

Table 6.4 Comparison between Zhengzhou-Nissan and Great Wall

Parameters	Zhengzhou-Nissan	Great Wall
Sales	25958	103180
Price (USD)	$17,677	$9,611
Engine size (cc)	2466	2306
Footprint (sqm)	4.2	3.6
Power (kW)	101	76
Max speed (km/h)	144	131
Power-to-weight ratio (W/kg)	63	54
Engine specific power (W/cc)	41	33
Combined FC (L/100km)[a]	8.7	9.9
Gasoline	22%	87%
Diesel	78%	13%
Transmission		
Manual	100%	100%
No. of gears		
5	100%	100%
Valve configuration		
DOHC	100%	13%
SOHC	0%	87%
No. of cylinders		
4	100%	100%
No. of valves per cylinder		
2	0%	87%
3	100%	14%
Fuel supply		
Multipoint injection	22%	87%
Diesel injection	78%	13%
Air intake		
Naturally aspirated	22%	96%
Turbo- or supercharging	78%	4%
Drivetrain		
4WD & AWD	11%	4%
FWD	0%	0%
RWD	89%	96%
Emissions standard		
Euro 2	0%	100%
Euro 3	100%	0%

a) Gasoline equivalent

7. CONCLUSIONS AND POLICY RECOMMENDATIONS

Based on the above detailed comparative analysis by vehicle category, region, and major manufacturers, we have the following findings and recommendations.

» Technology application levels vary among the four LCV categories (N1 diesel, N1 gasoline, M2 diesel, M2 gasoline). In general, LCVs in the M2 diesel category have more advanced efficiency technologies, such as multi-valve use and turbocharging, than other categories.

» Vehicle characteristics and market profiles of LCVs varies widely among China, the US, and the EU. The selected US LT fleet has significantly larger size of engine, larger footprint, and higher power than the EU or China's fleets. Among three regions, Chinese LCVs on average show the smallest values in terms of engine size, curb weight, footprint, and power. In addition, gasoline and diesel LCVs share roughly equal market in China, while in the EU LCV fleet diesel vehicles dominate (95.6%) and the US LT fleet is almost entirely (99%) gasoline vehicles.

» Compared with the EU N1 diesel LCVs, China's N1 diesel fleet shows larger size of engine and smaller footprint, but fleet-average power is lower by 35%. China N1 diesel LCVs adopted much less advanced engine technologies, such as multi-valve and turbocharging technologies, and show higher (by 19%) combined FC as well as higher emission levels.

» The fleet-average fuel consumption (CO_2 emissions) of Chinese LCVs is 8.6 L/100km gasoline equivalent (or 202 g/km CO_2) under NEDC, compared with 11.1 L/100km (264 g/km CO_2) in the US and 7.7 L/100km gasoline equivalent (180 g/km CO_2) in the EU.

» Among the selected 11 major Chinese domestic manufacturers, which account for 80% of China's 2010 LCV market, nine of them are independent automakers and the other two are JVs. Unlike passenger vehicles, JV automakers only produce a small amount of LCVs in China's market, and their performance on average is not superior to Chinese independent automakers in terms of fleet-average fuel consumption.

» Zhengzhou-Nissan, a pickup-focused JV automaker targeting high-end users, overall has the highest application rates among the 11 major LCV manufacturers of advanced efficiency technologies such as number of gears, number of valves, and air intake technology. However, its market share is only 1%.

» Regarding compliance rates, about 16% of LCVs could not meet the fuel consumption standards in 2010, and half of top 10 manufacturers show 100% compliance rates.

Chinese LCVs are mainly used by small business owners and suburban and rural consumers. These consumer groups are highly price-sensitive and do not require as much utility performance, drivability, or conformability as passenger car owners do. As a result, manufacturers are pursuing extremely low cost, and the penetration of advanced fuel efficiency technologies is significantly limited.

The current FC limits are not stringent, and a long lead time was set to allow all manufacturers to meet the standard. This is reasonable as a first step in regulating LCVs, but in the meantime half of the top 10 manufacturers achieved 100% compliance in 2010, even though many less advanced efficiency technologies were still used, such as carburetors, natural aspiration, and single-point fuel injection. This strongly suggests that more stringent standards need to be established to promote advanced efficiency technologies.

In addition, current standard design using engine size as one of two attributes does not encourage manufacturers to improve fuel efficiency through downsized engines. Under the current regulation, a LCV with a smaller size of engine generally corresponds to a more stringent target FC value when compared with a vehicle with a larger size of engine within the same vehicle weight bin. As a result, manufacturers are not given credits due to adoption of smaller engine for the vehicles in the same weight bin.

8. REFERENCES

1. China Automotive Technology and Research Center (CATARC) (2011). 2011 China Automotive Industry Yearbook.
2. Hui He and Jun Tu (2012). The New Passenger Car Fleet in China, 2010: Technology Assessment and International Comparisons. International Council on Clean Transportation.
3. U.S. Environmental Protection Agency (2012). Strategic Sustainability Performance Plan FY 2010 – FY 2020. Retrieved June 7, 2013, from http://www.epa.gov/oaintrnt/documents/sspp2012full_508.pdf.
4. European Commission (2012). Support for the revision of regulation on CO_2 emissions from light commercial vehicles. Retrieved June 7, 2013, from http://ec.europa.eu/clima/policies/transport/vehicles/vans/docs/report_co2_lcv_en.pdf.