



# Analysis and Expected Effect of the Phase III Fuel Consumption Standard for Light Duty Commercial Vehicles

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**Abstract.** The process of formulating the Phase III fuel consumption limit standard for light duty commercial vehicles in China is described. The gap between the level of fuel consumption of China's light duty commercial vehicles and the international advanced level is analyzed. The process of determining the overall energy saving target of the standard and the determination basis of the limit program are introduced, and the reasons for the change of the standard evaluation parameters are also explained. Finally, the energy saving effect brought about by the implementation of the third phase standard is predicted based on parameters such as output, fuel consumption level, annual mileage, and years of service.

**Keywords:** Light duty commercial vehicle · Energy saving · Fuel consumption

## 1 Introduction

Light duty commercial vehicles refer to N1 and M2 with a maximum design total mass of not more than 3.5 tons, including light trucks, pick-up trucks, and light buses. In recent years, the Chinese auto industry has continued to maintain a high-speed development trend. The total amount of fuel consumed by automobiles has continued to grow and has become the main body of China's new oil consumption. In 2015, China's apparent oil consumption was about 541 million tons, of which net imports of crude oil were 330 million tons, and the foreign dependency was 60.9%, and it can be predicted that the proportion of auto fuel consumption in China's oil consumption will continue to increase. The energy and environmental problems caused by fuel consumption have become increasingly prominent. How to properly deal with the rapid development of the auto industry, the continued expansion of the scale of car ownership and the resulting energy and environmental issues are not only related to the future competitiveness and sustainable development of the Chinese auto industry, but also affect the energy of China in the future period of time.

The "Limits of Fuel Consumption for Light-duty Commercial Vehicles" was issued in 2007, which has played an important role in reducing the fuel consumption of light commercial vehicles. The development of regulations on fuel consumption in the world is under way, major countries and regions in the world are working to develop more

stringent energy conservation laws and regulations. China's "Energy-saving and New Energy Vehicle Industry Development Plan" issued in 2012 clearly stated that commercial vehicles should also meet the international advanced level by 2020.

The Phase III fuel consumption standard for LCV, which is "Limits of Fuel Consumption for Light-duty Commercial Vehicles" standard (GB 20997-2015) was officially released in 2015. The standard states that from January 1, 2018, all new certification vehicles must meet the requirements of the Phase III standard, and from 2020, all vehicles must meet the standard requirements.

## **2 Determination of Overall Energy-Saving Targets**

### **2.1 Effect of Different Evaluation Systems on Fuel Consumption**

The fuel consumption evaluation system has an important influence on the standard implementation effect and the actual fuel consumption level. Under the enterprise average fuel consumption evaluation system, it is not required that all products meet the target value, but rather that the fuel consumption of some products exceeds the target value is allowed. Therefore, the actual average fuel consumption is generally equivalent to the target value. But under the fuel consumption limit system for individual models, the limit value is a constraint index for the vehicle, that is, all vehicle fuel consumption must meet the limit value, so the actual average fuel consumption level is usually better than the limit value.

This has also been demonstrated in the evaluation and analysis of the standards for the fuel consumption limit of passenger cars and light-duty commercial vehicles in China.

As shown in Fig. 1, taking passenger cars as an example, the average fuel consumption level of passenger cars is 10–15% lower than the limit value after the Fuel Consumption Limits for Passenger Cars (GB 19578-2004, Phase II) are fully implemented.

As shown in Fig. 2, similar conclusions can be obtained for the analysis of light commercial vehicles. Taking N1 diesel vehicles, which account for a major market share in China, as an example, after the 2011 standard was fully implemented, the fuel consumption level of N1 diesel vehicles was about 12% lower than the Phase II limits.

This means that when the fuel consumption limit value and the target value index value are the same, the actual requirement of the fuel consumption limit evaluation system is 10–15% stricter than the corporate average fuel consumption evaluation system targets, and as a result, its actual fuel consumption level is 10–15% lower than the corporate average fuel consumption evaluation system targets.

### **2.2 Energy Saving Targets for Light-Duty Commercial Vehicles in China**

In the standard pre-research, it was found that the decline in the fuel consumption of light-duty commercial vehicles in recent years was very limited, as shown in Fig. 3. Therefore, in setting the overall energy saving target for 2020, we must not only take into account the sustainable and healthy development of the industry, but also consider

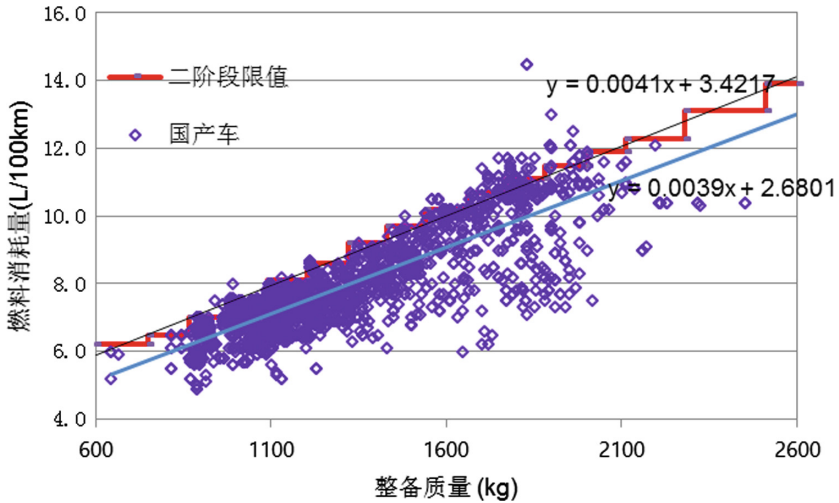


Fig. 1. Comparison of average fuel consumption and limits of passenger cars in 2010

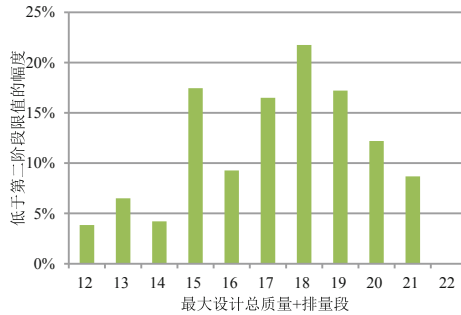
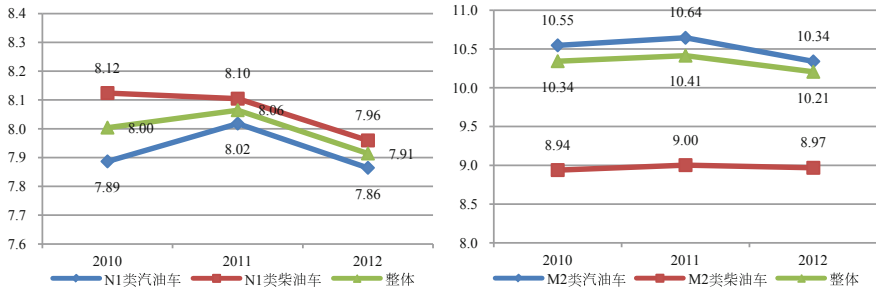


Fig. 2. The extent that average fuel consumption of N1 diesel vehicles is lower than the Phase II limit

the national overall energy-saving work expectations and requirements. Considering the adaptability of the existing technologies and the prediction of the development of future energy-saving technologies, combining the specificity of light-duty commercial vehicle market in China, we will follow the principle of consistent energy-saving targets and that in the Plan to determine the tightening of the limits.

As mentioned above, the major countries and regions in the world have set energy saving targets for 2020 and later for the fuel consumption of light-duty commercial vehicles, while a basic 20% reduction in the level of fuel economy in 2012 is basically the same for all countries and regions.

The target of 147 g/km for the 2020 new light-duty commercial vehicle in EU is also a huge challenge for the relevant companies. Although no implementation measures have been announced at present, but comprehensive information and reference to the 2017 implementation of energy-saving targets, it can be expected that the gradual



**Fig. 3.** The trend of fuel consumption of light-duty commercial vehicle in China from 2010 to 2012

introduction plan will continue to be used, and increase the proportion of models that need to reach the target year by year. This means that by 2020, the EU’s target requirements for fuel consumption of light commercial vehicles will not be fully implemented.

In addition, considering the coordination of fuel consumption and emission standards, light-duty commercial vehicle fuel consumption standards plan to implement on new certification vehicle models from 2018 onwards. Therefore, when comparing the fuel consumption requirements of light-duty commercial vehicles in China and the EU, it is more appropriate to use 2018 as the benchmark. According to the previous analysis of the relationship between the limits and the targets, light-duty commercial vehicle limits is about 15% less than the targets of Europe in 2018 means that it achieves the same energy saving targets.

On this basis, considering the actual situation of light-duty commercial vehicle market in China, and following the principle of consistent energy saving targets and that in the Plan, the working group negotiated that the fuel consumption of new vehicles for China’s 2020 new commercial vehicles is at least 20% lower than that of 2012, and use the EU’s 2018 target as a reference setting.

### 2.3 Limits Proposal

The light-duty commercial vehicle fuel consumption limit proposal is based on the 2010–2014 light vehicle fuel consumption label record database, and is determined through systematic analysis of the key features, energy-saving technologies, and fuel consumption level of light-duty commercial vehicles in China.

#### 2.3.1 Compare N1 Diesel Vehicles with International Advanced Level

According to the fact that China’s light-duty commercial vehicles in China are mainly based on N1, and almost all new commercial vehicles in the EU are diesel products, which is the basis for setting CO<sub>2</sub> emission targets, therefore, in determining the N1 diesel vehicle is taken as the object and compared with the EU target.

Based on the mentioned analysis method, taking 2012 as the reference year and the European target as the benchmark, the average level of decline in the fuel consumption

of N1 diesel vehicles was 27%; corresponding to the decline of N1 gasoline vehicles, M2 gasoline vehicles and M2 diesel vehicles were 23, 18, and 18%, respectively.

### 2.3.2 Limits Compliance Rate Analysis

The 2012 N1 gasoline vehicles have a compliance rate of approximately 10.5%, diesel vehicles is about 8.4%, M2 gasoline vehicles is with a compliance rate of 0%, and diesel vehicles is 9.9%; the compliance rate of N1 gasoline vehicles is approximately 27% in 2015, that of diesel vehicles is about 18.5%, M2 gasoline vehicles is 5.8%, and that of diesel vehicles is about 20.5%. The 2012 fuel consumption distribution and limit proposal for commercial vehicles is shown in Fig. 4.

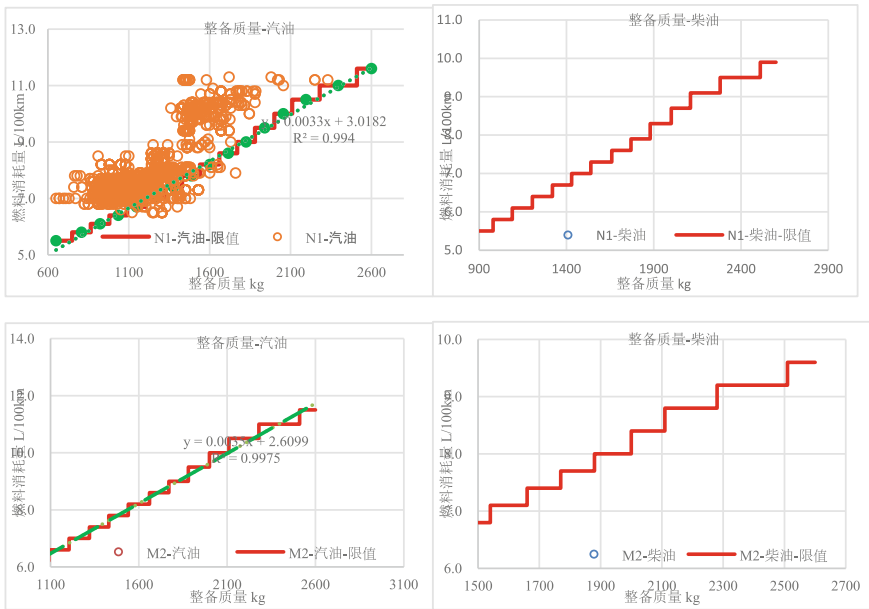


Fig. 4. The fuel consumption data in 2012 and the limit proposal

From the perspective of technical reserves, light-duty commercial vehicles rely on price competition for a long time and technological progress is very slow. Overdue engines such as the 491 and 4JB1 that have been introduced from Japan for nearly 30 years and have long been eliminated abroad are still the main force in the market, seriously affects marketing process of new technologies and new products. This has actually formed a vicious circle of bad money driving out good money, and has led to high levels of fuel consumption for light-duty commercial vehicles in China for a long time. It must take decisive and effective measures to promote its comprehensive technological innovation.

In addition, in order to further verify the technical feasibility of the limit proposal, during the drafting of the standard, the statistical analysis for the best 5, 10, and 15% of the fuel consumption values of the existing database were also performed in a “top

runner” manner, and compared with the models with the lowest fuel consumption in the existing products of major light-duty commercial vehicle companies. The results show that the “top runner” and the fuel consumption models provided by the company have a high degree of agreement with the limits proposal and can meet the requirements of the new standard.

### 2.4 Comparison with European Fuel Consumption Target

As shown in Figs. 5 and 6, from a numerical point of view, the fuel consumption limits for most of the mass segments of N1 and M2 diesel vehicles in China are on average looser 16 and 12% than the targets in the EU, but in the heavy mass segments is slightly stricter than the targets in the EU.

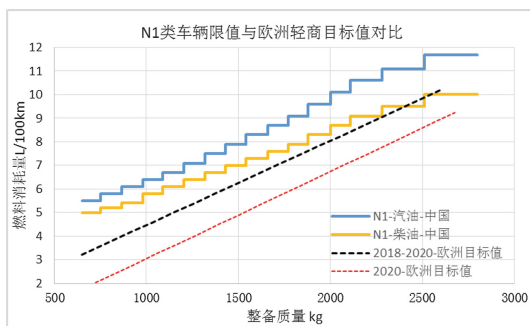


Fig. 5. Comparison of N1 limits and targets in the EU

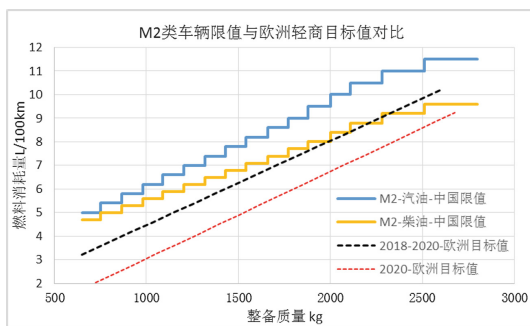


Fig. 6. Comparison of M2 limits and targets in the EU

In the previous analysis, fuel consumption limit value is 10–15% higher than the corporate average fuel consumption targets because of the difference in the actual binding force between the individual vehicle limits and the average corporate targets. With regard to the mass distribution characteristics of N1 and M2 diesel vehicles in China, it can be considered that the “Limit of Fuel Consumption for Light-duty

Commercial Vehicles” further narrows the gap between China and the international advanced level, and is close to the CO<sub>2</sub> emission regulations in the EU in 2018.

### 3 Expected Effect of the Standard

The specific measurement process is: First, use the existing data as a basis for the deduction, and analyze the average fuel consumption levels of various types of vehicles from 2015 to 2030 according to the conclusions of economic analysis of energy-saving technologies, the planning results in industrial policy documents, and the results of industry surveys; Secondly, according to the market development level and industry analysis research, forecasting the production of various types of vehicles from 2015 to 2030; then, according to the investigation results, parameters such as the running time of the vehicle and the average annual mileage will be set according to different vehicle types, and finally put the parameters in the calculation model and generate the results. The light-duty commercial vehicles are classified into gasoline and diesel according to the type of fuel, and are classified into N1 vehicles and M2 vehicles.

The formula is:

$$C_p = \sum_{i=1}^N \frac{(\overline{FC_R} - \overline{FC_i}) \times V_i \times \overline{D}}{100 \times 1000} \times \rho \quad (1)$$

in which:

- C<sub>p</sub> saved fuel consumption compared to the base year;
- i the no. of the year;
- N average year of running;
- V<sub>i</sub> sales in the year i;
- $\overline{FC_i}$  average fuel consumption in the year i;
- $\overline{FC_R}$  average fuel consumption in the reference year;
- $\overline{D}$  average annual mileage;
- ρ fuel density.

The formula of CO<sub>2</sub> emission:

$$C_{CO_2} = C_p \times k_f \quad (2)$$

in which:

- C<sub>CO<sub>2</sub></sub> total CO<sub>2</sub> emission;
- k<sub>f</sub> conversion factor of fuel and CO<sub>2</sub>, for gasoline is 23.8, diesel is 26.1.

Through the investigation and visit, this paper collected and analyzed the data of production, sales, population, and annual mileage of light-duty commercial vehicles, and established a calculation model based on this. The calculation model can be used to generate the fuel consumption saved by all vehicles based on a given year after the implementation of the standard.

The Phase III standard for light-duty commercial vehicles was released in 2015 and will be implemented for new certified vehicles in 2018. Therefore, 2016 will be set as the import year of calculating savings of each manufacturer. The parameters will be set as follows according to the input conditions of the calculation model. The results are shown in Table 3:

- (1) Production data for 2015 and 2016 comes from the “China Automotive Industry Yearbook”. The average annual growth rate for 2017–2030 is forecast at 4%, and the output forecast results for each year are shown in Table 1.

**Table 1.** Forecast of light-duty commercial vehicle production 2015–2030 (Unit: 10,000)

Year	N1-gasoline	N1-diesel	M2-gasoline	M2-diesel
2015	16.2	146.0	34.5	6.1
2016	16.9	151.9	35.9	6.3
2017	17.5	157.9	37.3	6.6
2018	18.2	164.2	38.8	6.8
2019	19.0	170.8	40.3	7.1
2020	19.7	177.7	41.9	7.4
2021	20.5	184.8	43.6	7.7
2022	21.3	192.1	45.4	8.0
2023	22.2	199.8	47.2	8.3
2024	23.1	207.8	49.1	8.7
2025	24.0	216.1	51.0	9.0
2026	25.0	224.8	53.1	9.4
2027	26.0	233.8	55.2	9.7
2028	27.0	243.1	57.4	10.1
2029	28.1	252.9	59.7	10.5
2030	29.2	263.0	62.1	11.0

According to statistics, N1 and M2 respectively account for 80 and 20% of all light-duty commercial vehicles. The proportion of gasoline and diesel N1 vehicles is 10 and 90% respectively, and the proportion of gasoline and diesel M2 vehicles is 85 and 15% respectively.

The fuel consumption in 2020 is in accordance with the objectives set out in the “Energy-saving and New Energy Vehicle Industry Development Planning (2012–2020)” and “Made in China 2025” and the expected effect of “Limits of Fuel Consumption for Light-duty Commercial Vehicles” implementation, which is 20% decline compared with 2012. As Europe has not yet established the energy-saving target for the 2025 light-duty commercial vehicles, it is predicted that the average fuel consumption of light-duty commercial vehicle in China will reach the level of 2020 in Europe by 2023 and reach the international advanced level in 2025, and make the interpolation calculations in the middle of each year. After 2025, the average annual decline in fuel consumption is set at 2.5%. Table 2 shows the fuel consumption levels of light commercial vehicles in each year.



**Table 2.** Forecast of fuel consumption level in 2015–2030 (Unit: L/100 km)

Year	N1-gasoline	N1-diesel	M2-gasoline	M2-diesel
2015	7.31	7.40	9.60	8.58
2016	7.11	7.20	9.37	8.37
2017	6.91	7.00	9.14	8.17
2018	6.72	6.80	8.91	7.96
2019	6.52	6.60	8.68	7.75
2020	6.32	6.40	8.45	7.54
2021	6.01	6.16	8.14	7.36
2022	5.71	5.92	7.84	7.18
2023	5.40	5.68	7.54	7.00
2024	5.27	5.54	7.35	6.83
2025	5.13	5.40	7.17	6.65
2026	5.01	5.26	6.99	6.49
2027	4.88	5.13	6.81	6.33
2028	4.76	5.00	6.64	6.17
2029	4.64	4.88	6.48	6.01
2030	4.52	4.76	6.32	5.86

The average annual mileage and average running time of N1 vehicles are 50,000 km and 8 years, respectively, for M2 are 70,000 km and 8 years. Considering that new vehicles are produced in the different months of the year, therefore the mileage of the first year was calculated as half (Table 3).

As mentioned above, the conversion factor for gasoline consumption (L/100 km) and CO<sub>2</sub> emissions (g/km) is 23.8, and the density is calculated as 0.725 kg/L. It can be concluded that CO<sub>2</sub> emissions from 1 kg gasoline consumption is about 3.283 kg; the conversion factor for diesel is 26.1, and the density is 0.835 kg/L, the CO<sub>2</sub> emission from 1 kg diesel consumption is about 3.126 kg.

According to the calculation results in Table 5, it can be concluded that with 2016 as the base year, until the standards will be fully implemented by 2020, a total of 3.130 million tons of fuel can be saved and CO<sub>2</sub> emissions can be reduced by 9.533 million tons; by 2025, a total of 33.665 million tons of fuel can be saved. tons, reduce CO<sub>2</sub> emissions 106.798 million tons.

## 4 Conclusions

The “Limits of Fuel Consumption for Light-duty Commercial Vehicles” (GB 20997-2015), which is called Phase III fuel consumption standards, is an important measure to implement the industrial policies such as “Energy Conservation and New Energy Vehicle Industry Development Planning (2012–2020)” and “Made in China 2025”.

The setting of the overall energy-saving targets for the Phase III light-duty commercial vehicle fuel consumption standard is under the guidance of relevant national documents concerning energy-saving management and industrial development. It not

**Table 3.** Total amount of fuel consumption saved for light-duty commercial vehicles in each year (Unit: 10,000 tons)

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
2017	9.8													
2018	19.6	20.4												
2019	19.6	40.8	31.8											
2020	19.6	40.8	63.7	44.2										
2021	19.6	40.8	63.7	88.3	60.1									
2022	19.6	40.8	63.7	88.3	120.1	77.2								
2023	19.6	40.8	63.7	88.3	120.1	154.4	95.6							
2024	19.6	40.8	63.7	88.3	120.1	154.4	191.1	108.9						
2025	5.2	40.8	63.7	88.3	120.1	154.4	191.1	217.8	122.9					
2026	5.2	10.8	63.7	88.3	120.1	154.4	191.1	217.8	245.8	137.6				
2027		10.8	16.8	88.3	120.1	154.4	191.1	217.8	245.8	275.2	153.0			
2028			16.8	23.3	120.1	154.4	191.1	217.8	245.8	275.2	306.1	169.2		
2029				23.3	31.8	154.4	191.1	217.8	245.8	275.2	306.1	338.4	186.2	
2030					31.8	40.8	191.1	217.8	245.8	275.2	306.1	338.4	372.4	204.0

only considers the product structure, technical status and market development of light-duty commercial vehicles in China, but also refers to the international development trend. At the same time, it is also set in keeping with the stringency of fuel consumption standards for passenger cars and heavy-duty commercial vehicles, taking into account the operability and executability of the standard. The final overall energy saving target, fuel consumption indicator, evaluation system proposed in the standard are in line with the requirements of national energy saving and emission reduction strategy, which is beneficial to the sustainable and healthy development of the automotive industry.

It is estimated that the implementation of standards will result in cumulative savings of 3.104 million tons of fuel and a reduction in CO<sub>2</sub> emissions of 9.533 million tons by 2020 with 2016 as the reference year, with significant social and economic benefits.

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