中国乘用车燃料消耗量发展年度报告

China Passenger Vehicle Fuel Consumption Development Annual Report

The Innovation Center for Energy and Transportation

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iCET

能源与交通创新中心

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Executive summary

China's passenger vehicle production and sales reached over 18 million units in 2013, which marked China's fifth consecutive year as the world's biggest auto market with an increase of 16.5%[1]over the previous year. Imported cars totaled 1.2 million units, which marked an annual increase of approximately 7.3%. Mandatory fuel economy standards have delivered an average of about 3% in fuel savings globally, which resulted in GHG emissions and air pollution reduction[2]. Unsurprisingly, in September 2013, several Chinese national and local level officials declared waragainstair pollution, where transportation was identified as one of seven key target sectors and was in some cases noted to account for as much as 31% of urban PM2.5[3].

China started implementing the first phase of its fuel economy standards in July 2005. Since then, it has introduced three more phases: extending the standard to include fuel consumption targets, corporate average fuel consumption targets and limits, and imported vehicles management (in preparation for including imported cars under the standard). Within 7 years since fuel economy standards implementation started, China's domestic[4] average fuel economy improved by 10.3%, from 8.05L/100km to 7.22L/100km. On average, the annual reduction in the past 7 years stood at 2.3%, which is lower than the reduction rates seen in most developed countries. China's fuel economy regulatory system has a unique distinction between limit and target values, as explained in the below table.

Explanation of Terminologies in China's Fuel Consumption Regulatory System

Individual cars (models)	**FC Limit for individual vehicle models**	N/A	Every individual vehicle models have to meet their corresponding weight-bin limit.	***Starting 2005:*** GB19578-2004 (Phase I) ***Starting 2016:*** GB19578-20XX* (Phase IV)

[1]中国汽车技术研究中心，中国汽车工业协会．中国汽车工业发展年度报告(2013).
[2]http://www.unep.org/transport/gfei/autotool/approaches/regulatory_policy/fuel_economy.asp
[3]http://www.bjepb.gov.cn/bjepb/323474/331443/331937/333896/396191/index.html
[4]Domestic manufacturers refer to domestically producing entities including JVs and independent manufacturers but excluding importing manufacturers.

	FC Target for individual vehicle model	N/A	Phase III implemented in 2012, also introduced a FC target value associated with each vehicle model(according to its weight-bin classification); There is no requirement for meeting the individual vehicle model FC targets.	***Starting 2012:*** GB27999-2011 (Phase III) ***Starting 2016:*** GB27999-20XX (Phase IV
Auto-makers	$T_{CAFC2015}$ $T_{CAFC2020}$	Target CAFC for the current phase period	Automakers have to meet their corporate average fuel consumption target (CAFC) for model year 2015 and 2020 respectively (See section 1.4 for calculation method).	***Starting 2011:*** GB27999-2011 (Phase III) ***Starting 2016:*** GB27999-20XX* (Phase IV)
	$CAFC_{xxxx}/T_{CAFC2015}$ $CAFC_{xxxx}/T_{CAFC2020}$	CAFC actual annual value/ Target CAFC value	By using this method calculation, one can track the annual CAFC % gap from meeting the ultimate target (Phase III 6.9L/100km by 2015; Phase IV 5L/100km by 2020).	***Starting 2011:*** GB27999-2011 (Phase III) ***Starting 2016:*** GB27999-20XX* (Phase IV)

China released its fuel economy Phase IV standardin 2014, which includes both fuel consumption limits and calculation methods that are planned to become law in 2016. Phase IV is designed to increase cars' fuel consumption limits by about20% and fuel consumption targets by 30%-40%. The new standard provides more detailed technology pathways for reducing fuel consumption, and further promotes new energy vehicles by detailing their relative fuel consumption calculation. The new standard requires an accelerated annual corporate average reduction rate of roughly 3% in the first year (2016) toabout 9% in the last two years (2019 and 2020, also see Figure 6.1).

The Ministry of Industry and Information Technology (MIIT) has published corporate average fuel consumption valuesof 79 domestically produced and 25 imported automakers, which advanced the standards management framework. However, although data provided by automakers was published, it was not scrutinized, and thus, the draft Phase IV standard is not providing more detailed and functional management framework that either penalizes or credits corporations.

The Innovation Center for Energy and Transportation (*i*CET) is a unique China-based non-profit third party organization that has been involved in the development of fuel economy policies in China since 2002. Leveraged by its deep market understanding and regulatory outreach, *i*CET developed China's first and most comprehensive vehicle database from 2006. This year's report is *i*CET's fourth annual report, which tracked China's fuel economy implementation status, trends and recommendations.

This year's report is unique in many aspects:

1. It examines the first-ever corporate reported average fuel consumption recently made publically available by the Ministry of Industry and Information Technology (MIIT)
2. Analyzes corporate average values in relation to individual automaker targets; places emphasis on manufacturers' capacity to meet their projected targets by 2020
3. Studies new energy vehicles potential contribution to auto manufacturers in meeting their limits and standards; highlights major standard implementation trends since 2006
4. Identifies trends and implementation issues by corporate type (importing, independent domestic manufacturers etc.)
5. Provides policy recommendations towards the new standard based on these analyses.

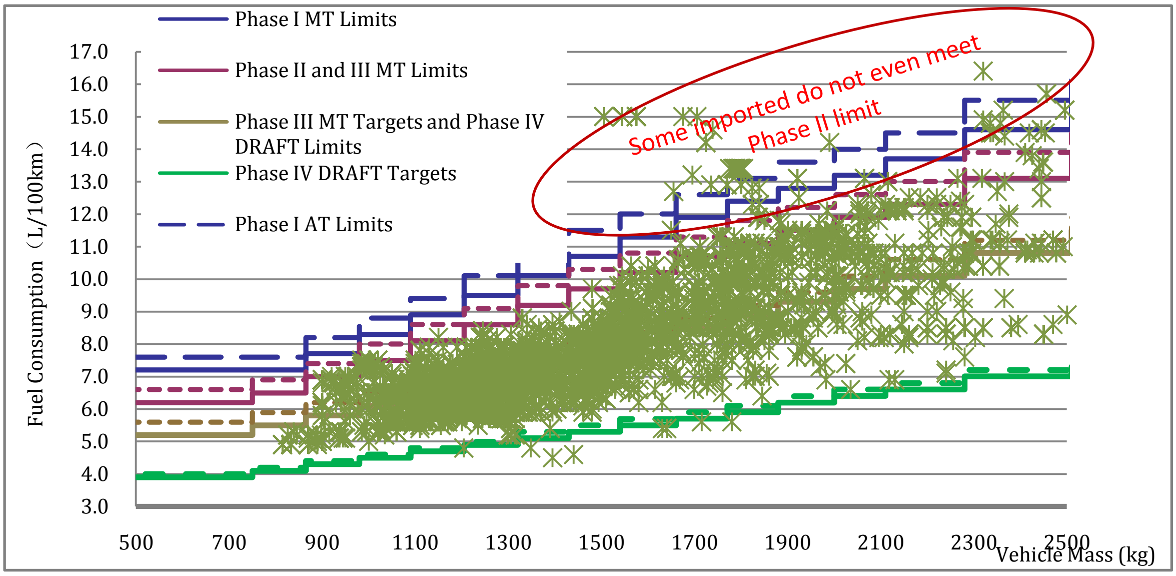
The analysis is based on fuel consumption and curb-weightdata, which is availablethroughvehicle labeling (based on official type-approval test results) andpublished on the Ministry of Industry and Information Technology (MIIT) website[5]. Imported vehicles data is based on information purchased from China Automobile trading[6] (overseeing vehicle importation in China). Sales and production data is based on China Auto Industry Development Annual Report provided by China Association of Automotive Manufacturers (CAAM) and China Automotive Technology Research Center (CATARC). This report's highlights include:

[5] http://chinaafc.miit.gov.cn/n2257/n2263/index.html(中国汽车燃料消耗量网站, 2014)
[6] http://www.ctcai.com.cn/

1. Most of today's vehicle models meet China's 2015 Phase III target.

The majority of passenger cars fuel consumption in China is well around the national fuel consumption 2015 Phase III standard target (also 2020 Phase IV limit values). However, almost none of today's vehicle models meet China's 2020 Phase IV target, as illustrated in **Figure 1**. This figure also shows that, since imported cars are excluded from the current mandatory fuel economy standard regime, some imported vehicles – mainly SUVs and luxury cars – do not even meet the current standard limit; therefore, they require greater regulatory and management scrutiny.

Figure 1: 2013 Car Fuel Consumption Scores in Relation to the Standard

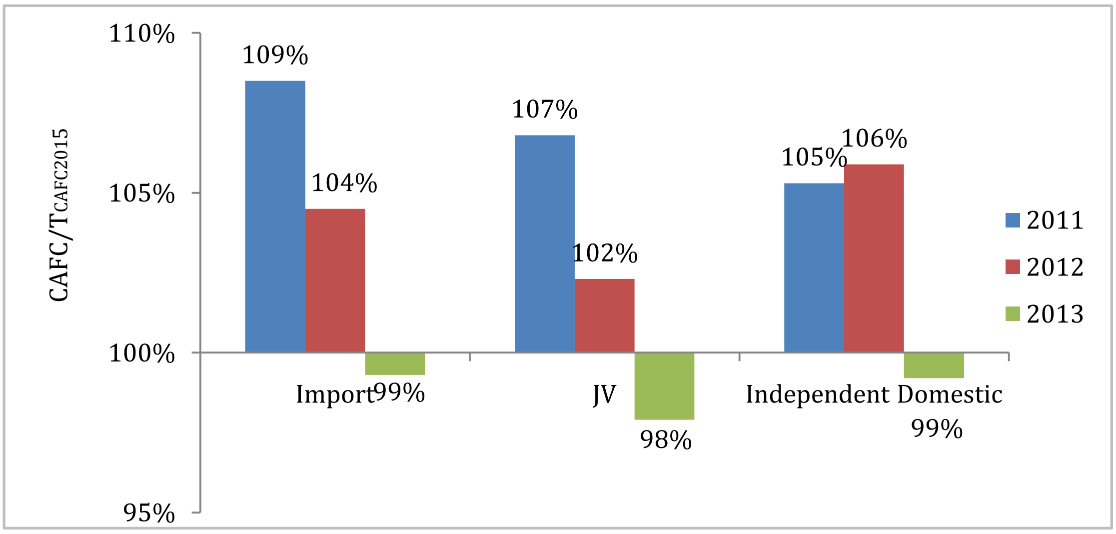


2. China's average corporate average fuel consumption reached its annual target, indicating corporate 2015 targets could be easily met.

China's annual corporate average fuel consumption values (including both importing and domestically produced automakers) averaged 7.33L/100km, marking 98.3% fulfillment of the annual target values ($CAFC_{2013}/T_{CAFC2015}$), much better than last year's 103.2% average score. Domestic automakers reached an average fuel consumption value of 7.22L/100km while importing corporations scored 9.06L/100km on average, which is below the annual target (with a $CAFC_{2013}/T_{CAFC2015}$ lower than 100%).In 2013, only about 10,000 New Energy Vehicles (NEVs) were produced, making little impact on China's annual fuel consumption and corporate average values.

During the past three years, the average actual corporate fuel consumption in relation to the target corporate fuel consumption ($CAFC/T_{CAFC2015}$) of Joint Ventures (JVs) was relatively modest, leading to a reduction of only 1.5%. However, independent domestic manufacturers and importing corporations alike all faced stringent targets leading to corporate fuel consumption increases of 4.8% and 4.5% respectively.

Figure 2: Corporate Actual Annual Fuel Consumption in Relation to Phase III Target Annual Requirement (**$CAFC/T_{CAFC2015}$**)

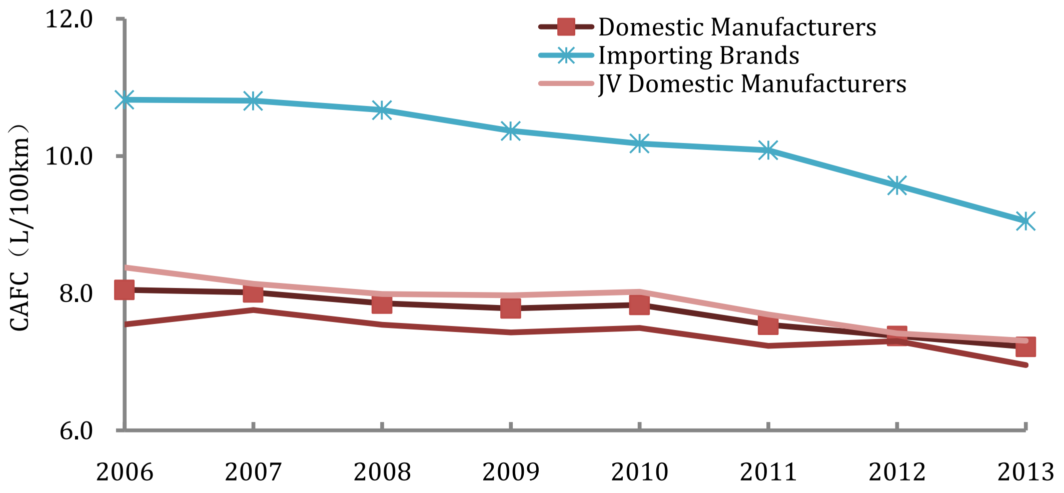


3. During the past 7 years – from 2006 to 2013 – China's corporate average fuel consumption reduction totaled 10.2%, not exceeding 2.3% on an annual average.

During the last 7 years – between 2006 and 2013 – although China's average corporate fuel consumption was reduced by 10.2%, its annual corporate average fuel consumption reduction did not exceed 2.3%(including imported manufacturers). However, since the implementation of China's Phase III standard in 2010,the annual pace of reduction has increased. Importing corporations saw a corporate average fuel consumption reduction of 16.4% in the last 7 years (while comprising only about 7% of the market), while JVs achieved 12.7% and independent domestic manufacturers achieved 8.9% reductions. Some auto manufacturers, such as the JV Shanghai Auto, independent domestic manufacturer Greatwall, and importers such as Jaguar Land Rover, BMW, Volkswagen, Mercedes, and Chrysler reached a corporate average fuel consumption reduction of as much as 20%.

Corporate average fuel consumption reduction is a result of either a shift to larger volume production of vehicle models with reduced fuel consumption or increased utilization of improved technologies in production volumes. For example, some corporations such as Great wall managed to reduce their corporate FC by as much as 29% primarily by shifting to smaller vehicle segments production, such as C30 and C50 SUVs. Furthermore, manufacturers such as Dongfeng-Nissan were able to achieve 21.4% reduction by producing large volumes of high-efficient technology vehicles (e.g. CTV) such as Sunny and Tenna that consume 20-30% less fuel.

Figure 3: 2006-2013 Corporate Average Fuel Consumption Trends

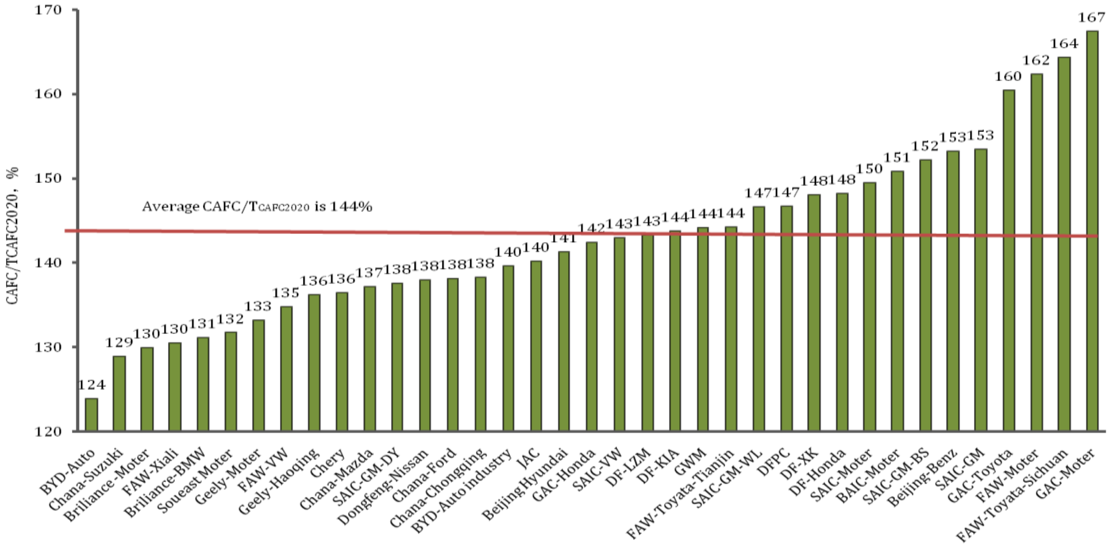


4. Most large manufacturers are faced with 4.3-5.8L/100km requirement in the Phase IV draft ($T_{CAFC2020}$), with their current fuel consumption level about 144% of the 2020 target ($CAFC_{2013}/T_{CAFC2020}$) on average.

China's domestic corporate average fuel consumption is currently 144% of the projected 2020 corporate target of 5L/100km ($CAFC_{2013}/T_{CAFC2020}$).Individual automaker targets range between 4.3-5.8L/100km, based on their corresponding production mix among weight bin categories. If the calculation is based on the last year of Phase III implementation (6.9 L/100 km in 2015), the gap measured as $CAFC_{2016}/T_{CAFC2020}$ ratio is still estimated to be as high as 134%.

Corporations producing over 10,000 vehicles per year are required to reduce their corporate average fuel consumption by 124%-167% in the next 7 years in order to meet the 2020 target. Manufacturers producing large volumes of small segment or high technology vehicles such as BYD, Changan-Suzuki, FAW-Volkswagen, and BMW-Brilliance are currently already at 134% of their projected 2020 target. Manufacturers producing large segment vehicles – Guangqi-Toyota, FAW-Car, Sichuan FAW-Toyota – are now facing a challenging 160% gap from their projected 2020 target.

Figure 4: Major Manufacturers Actual vs.2020 Target Gap (**$CAFC_{2013}/T_{CAFC2020}$**)

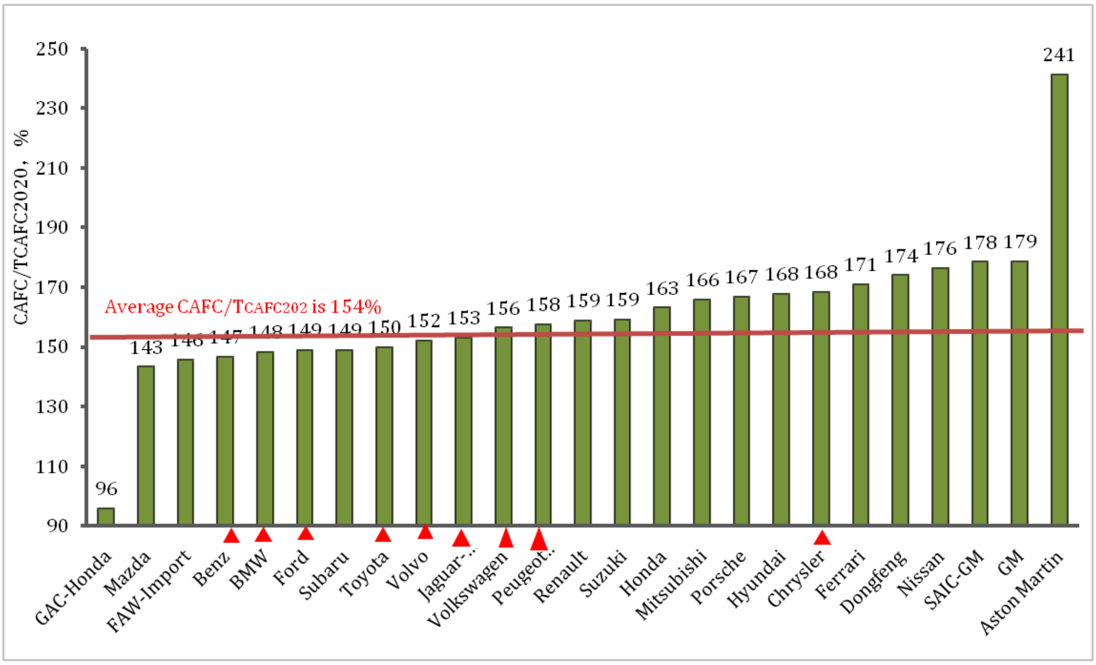


5. Imported manufacturers are facing a target of 5.93L/100km in 2020 ($T_{CAFC2020}$) and are currently meeting 155% of that target ($CAFC_{2013}/T_{CAFC2020}$), requiring steep improvements in the future.

Based on current vehicle segment and volumes of importing cars, importing manufacturers are projected to face a 5.93L/100km target in 2020, about 1L/100km above domestic manufacturers' target, and 55% lower than 2013 values. Although Phase

III had no binding targets for importing manufacturers, in Phase IV they are included. In 2016, importing manufacturers are projected to stand at 134% of the 2020 corporate average fuel consumption target ($CAFC_{2016}/T_{CAFC2020}$). 25 importing manufacturers, excluding Guangqi-Honda, have their$CAFC_{2013}/T_{CAFC2020}$ ratios higher than 140%, and large importers of over 50k vehicle per year have an average ratio of 146%-156%. This segment faces a great fuel consumption reduction challenge and is subsequently expected to have a proportionally large impact on China's overall fuel consumption reduction going forward.

Figure 5: Importing Manufacturer's Actual CAFC vs. projected 2020 Target **$CAFC_{2013}/T_{CAFC2020}$**



6. **In order to meet the 2020 target of 5L/100km, which translates to an overall corporate average fuel consumption reduction of 30.7% in the coming 7 years (2014-2020), China must rely on the combined efforts of vehicle efficiency technologies, NEVs commercialization and incentivizing trading programs.**

According to new revisions to the Phase IV standard draft, (detailed in **Figure 6.1**) the annual corporate average fuel consumption (FC) target will gradually increase in stringency. Should Phase IV's annual target been according to Phase III approach, a constant annual percentage points reduction would determine the pace of fuel consumption reduction, as illustrated in Approach I in **Figure 6.2**; however this new revision to the standard enables slower FC reductions earlier during the standard period and more stringent reductions towards its end, as illustrated by Approach II in **Figure 6.2**.

While the annual reduction in the CAFC/$T_{CAFC2020}$ ratio required in the first year of Phase IV is 2.9%, the annual reduction in the last year of Phase IV (2019-2020) can be translated into an annual reduction of about 9.1% in fuel consumption values. During the last two years, an annual decrease of 10 percentage points from the previous year CAFC/$T_{CAFC2020}$ ratio is required, translating to about a 0.5L/100km decrease in absolute fuel consumption value. This pace of implementation may allow for massive investments in NEVs rather than ICE during the first years, followed by the inception of NEVs production in the following years.

During Phase IV, running from 2016 to 2020, a strict average annual FC reduction of 6.2% is anticipated. Should manufacturers start preparing towards implementation for next year (from 2014 to 2020), the annual average reduction rateis projected to be about 5.1%, much higher than theaverage reduction of 2.3% seen over the pastseven years (2006-2013). That is why solutions such as vehicle efficiencytechnologies, NEVs commercialization and incentivizing trading programs are needed to enable China to meet its fuel economy target for 2020.

The projected Phase IV annual CAFC reduction increases gradually, which goes well beyond thetypical market technology adoption and implementation cycle. China's vehicle sector needs to implement advanced technologies as earliest as possible in order to meet the national 2020 target, according to the new binding pace demonstrated by Approach II in **Figure 6.2**.

Figure 6.1:2014-2020 Annual CAFC Reduction

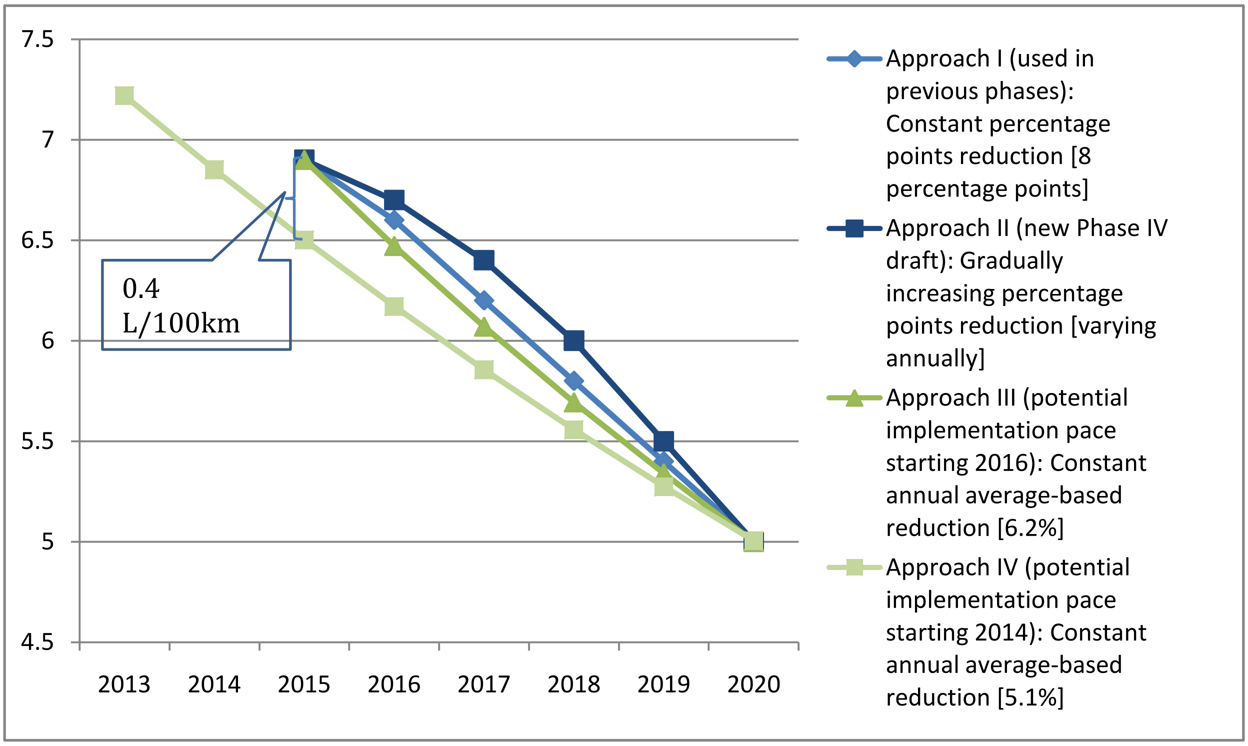
Year	**CAFC/ $T_{CAFC2020}$**	Annual CAFC Reduction**	CAFC L/100km	L/100km	Relative Annual FC Reduction (%)
2013*	144%	5	7.22	0.16	-2.1%
2014*	141%	3	7.06	0.16	-2.2%

2015*	138%	3	6.90	0.16	-2.3%
2016	134%	4	6.70	0.20	-2.9%
2017	128%	6	6.40	0.30	-4.5%
2018	120%	8	6.00	0.40	-6.3%
2019	110%	10	5.50	0.50	-8.3%
2020	100%	10	5.00	0.50	-9.1%
		2016-2020 CAFC Annual Average Reduction			-6.2%
		2014-2020 CAFC Annual Average Reduction			-5.1%

* *i*CET's calculations.

** Annual reduction according to newly stated revisions to Phase IV standard.

Figure 6.2: Paths towards Meeting CAFC 2020 Target

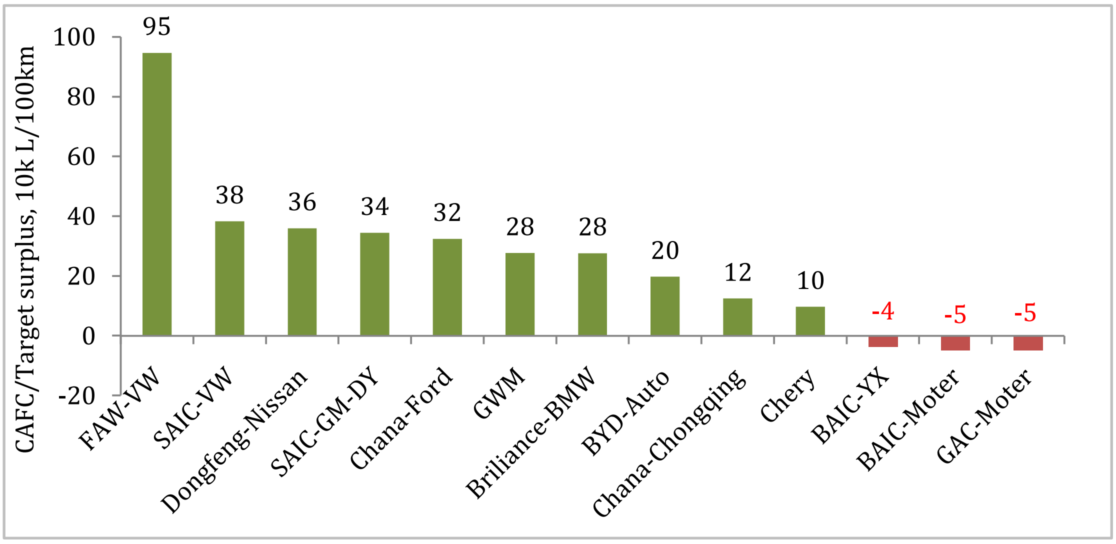


7. **China is considering introducing fuel consumption credits and trade mechanisms during the Phase IV implementation stage. *i*CET is focused on tracking individual automakers' performance for informing effective regulatory framework.**

In March 2013, MIIT announced in their reported titled, "Accounting Approach for Passenger Vehicle Corporate Average Fuel Consumption", that auto manufacturers going beyond their CAFC requirement are entitled to receive credits that will allow for flexibility in meeting their requirements towards following years. In 2013, 39 manufacturers had their actual CAFC better than their annual target, totaling in 3.97 million L/100km, about 4 times the previous year. The leading manufacturers are primarily JVs, led by FAW-Volkswagen, Shanghai-Volkswagen and Dongfeng-Nissan. Importers also contributed about a total of 304,000L/100km.Meanwhile, about 310,000L/100km deficits were produced by automakers that did not meet their targets, representing a reduction of 40% from last year.

It's important to note, however, that the credits and deficits mechanism have yet to be implemented and thus lacks teeth. Strategic deployment of effective management and an enforcement mechanism is key for incentivizing market adherence and rewarding first movers. *i*CET has begun dedicating much of its work to such the market incentivizing mechanism, including trading programs aimed at high-end technology improvement and NEVs commercialization.

Figure 7: 2013 CAFC 10 Top Performing Manufacturers and 3 Worst Manufacturers



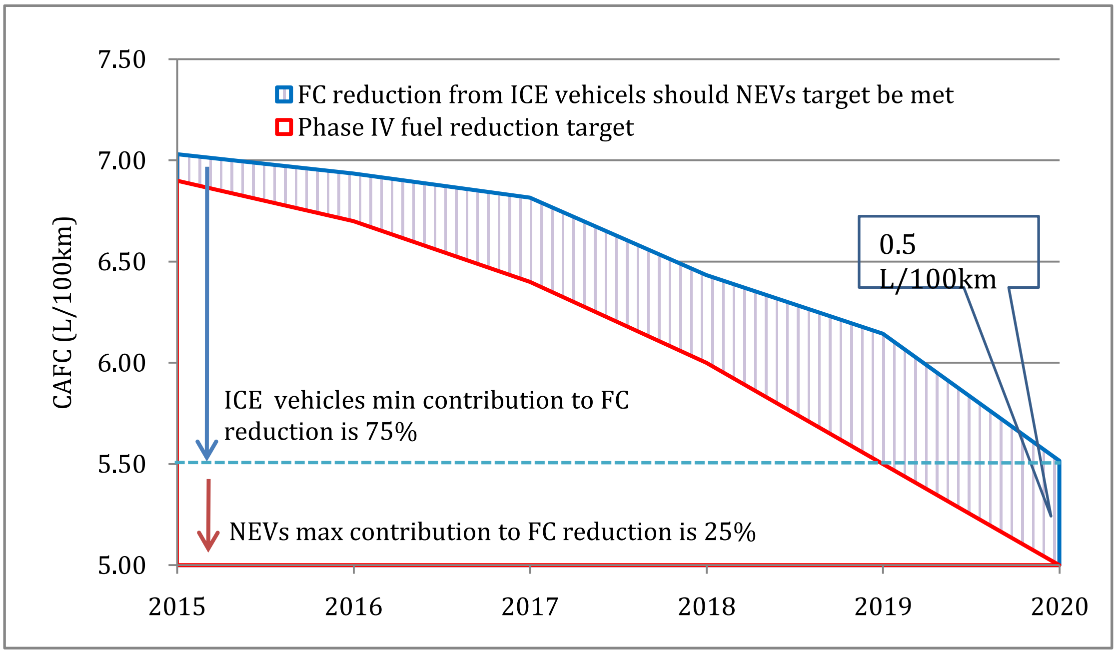
8. If China's NEV targets internalize, NEVs would contribute as much as 25% in meeting the 2020 CAFC target, indicating that efficiency technologies would still be instrumental for Phase IV implementation

The Chinese government is considering the inclusion of New Energy Vehicles (NEVs) into the CAFC calculations. If NEVs' cumulative sales reach 5 million units by 2020, their annual production capacity reaches2 million units, 1.6 million of which are passenger vehicles. As NEVs are counted as zero fuel consumption vehicles, and their annual growth rate is projected to have a varying multiplier of 2-5 every year by 2020, resulting in China's 2020 CAFC requirement for conventional technology vehicles reducing about 5.5 L/100km for meeting the overall CAFC target of 5L/100km.

The reduction of 0.5L/100km in stringency from China's 2020 CAFC requirement was a result of aggressive introduction of NEV credits. This could contribute to about 25% towards Phase IV CAFC reduction of 1.9L/100km from 6.9L/100km in 2015, and to 5L/100km in 2020. In this case, advanced fuel consumption efficiency technologies are still instrumental for meeting China's stringent 2020 target as it could contribute at least 75%.

Under the above assumption, an annual average CAFC reduction of 4.8% would be required, which is a much more feasible reduction from the current 6.2% average reduction required, as illustrated in **Figure 8**. However, there is strong debate regarding the level of incentives required for the inclusion of NEVs into CAFC calculations. For your reference, the most likely scenarios will fall into the shaded area below.

Figure 8: ICE vehicles fuel consumption reduction towards Phase IV CAFC target should NEVs production targets be met



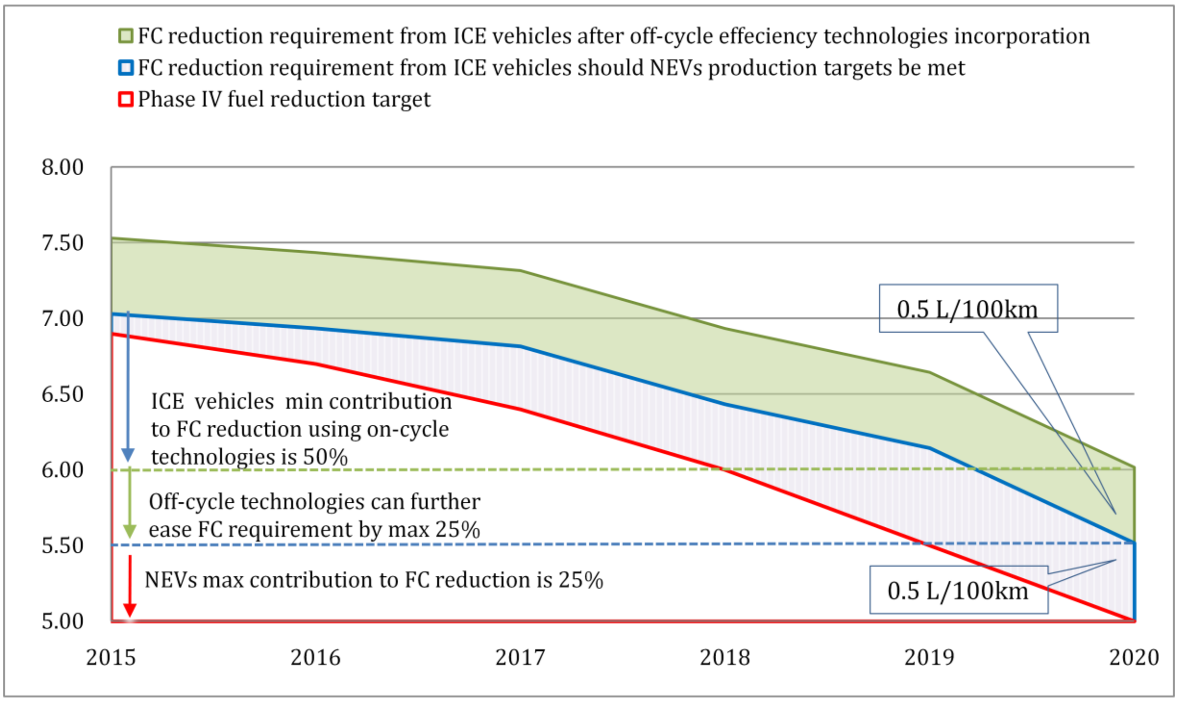
9 **Off-cycle energy-saving technologies and NEV sales credits create uncertainties as for how stringent the 2020 target really is.**

China's Phase IV fuel consumption standard draft also provides additional incentives for installing "off-cycle" energy-saving technologies such as tire pressure monitoring systems, efficient air conditioning, idle start-stop system, and shift reminder. Vehicles that implemented one or more of these technologies will be rewarded with a fuel saving credits of up to 0.5 L/100km from their Test-Approval FC value. From a standard implementation perspective, 0.5L/100km credits represent over 25% of the overall required reduction from the 2015 6.9L/100km benchmark to the 2020 5L/100km requirement.

By adding both off-cycle energy-saving technologies and NEV sales credits China's vehicle fleet could be rewarded a total of 50% reduction in FC requirement, reaching about 1L/100km from the reference requirement of 1.9L/100km. Looking at the most optimistic scenario illustrated by the green line in **Figure 9**, China's automakers could face an average annual reduction requirement of 4.3% (from a theoretical 7.53L/100km in 2015 to 6.02L/100km in 2020) rather than 6.2% by simply complying with the Test-Approval results.

It is still unclear exactly how much off-cycle energy-saving vehicle technologies can contribute in achieving China's 2020 fuel consumption target. Combined with the uncertainties associated with NEVs commercialization, evaluating the 2020 fuel consumption target and implementation effectiveness is a challenging task. Policy-makers' quantifications and clarifications of these energy-saving and new-energy vehicle technologies credits are crucial for ensuring effective market responses.

Figure 9: ICE vehicles fuel consumption reduction towards Phase IV CAFC target should NEVs production targets be met and off-cycle technologies fully implemented


FC reduction requirement from ICE vehicles after off-cycle effeciency technologies incorporation
FC reduction requirement from ICE vehicles should NEVs production targets be met
Phase IV fuel reduction target
8.00
7.50
7.00
6.50
6.00
5.50
5.00
2015
2016
2017
2018
2019
2020
0.5 L/100km
ICE vehicles min contribution to FC reduction using on-cycle technologies is 50%
Off-cycle technologies can further ease FC requirement by max 25%
NEVs max contribution to FC reduction is 25%
0.5 L/100km

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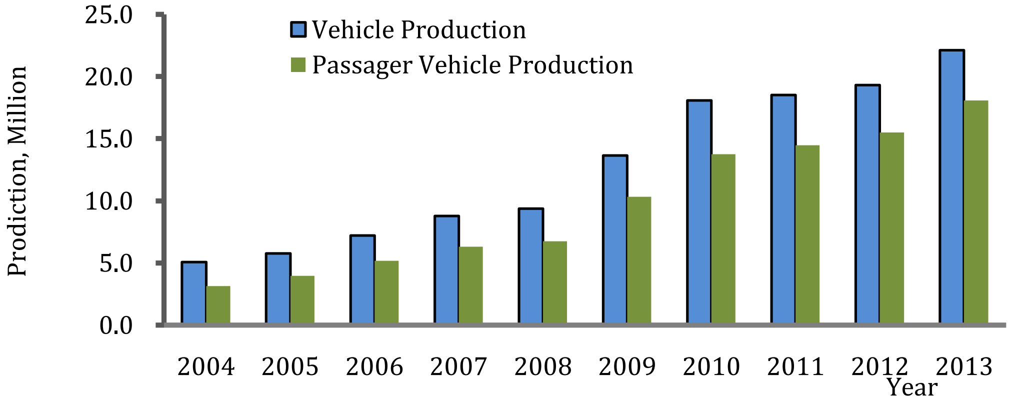
Foreword

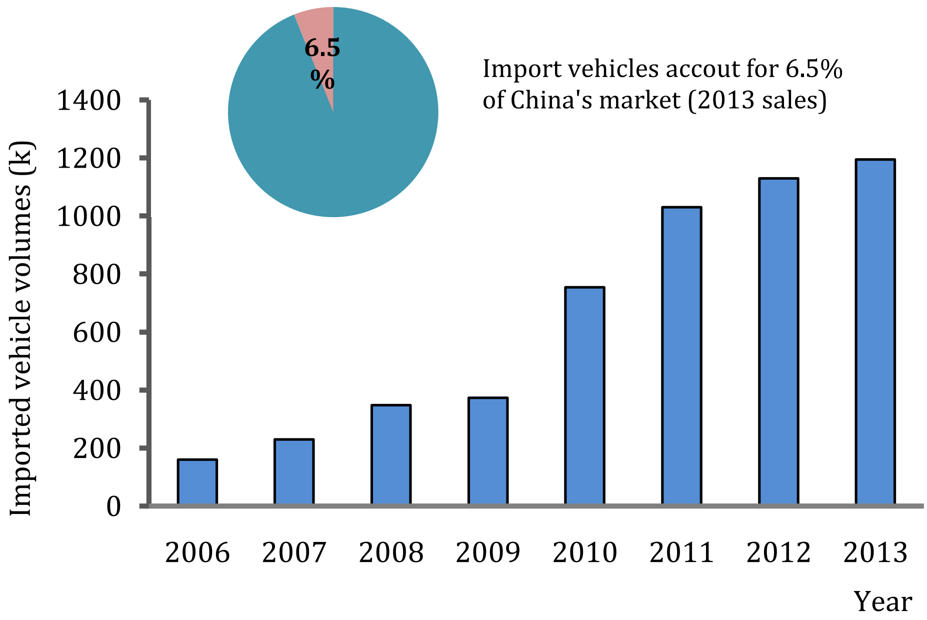
China's passenger vehicle production and sales reached over 18 million units in 2013, which marked China's fifth consecutive year as the world's biggest auto market with an increase of 16.5%[7]. Last year, China regained its high auto market growth pace after three years of relatively moderate annual increases in production and sales (**Figure 1**).

Figure 1: China's annual vehicle production and sales volumes



Last year, China's imported cars amounted to 1.171 million vehicles, an annual increase of 7.3% and accounting for 6.5% of 2013 annual new car sales. Interestingly, small cars importation has increased, which is illustrated by 2.2% reduction in average vehicle weight. Yet, the majority of imported cars are still mainly luxury and sports utility vehicles (SUVs), which accounts for 61.9% of the market.

Figure 2: China's annual passenger vehicle import volumes



In recent years, China's dependence on foreign oil is constantly rising, reaching over 58% last year[7]. The consumption of gasoline and diesel fuel totaled to 150 million tons, which accounts for over 60% of the apparent consumption of refined oil[8] as well as representing some 70% of China's total oil consumption growth[9]. With the continuous and rapid growth of China's car ownership, vehicle fuel consumption is expected to further drive China's oil demand and dependency on foreign oil. In addition, vehicles have become a major source of urban air pollution, estimated to account for over 30% of PM2.5[10].

In order to alleviate energy security and environmental issues driven by China's growing car ownership, the government recognized that vehicle fuel consumption should be reduced while vehicle energy efficiency should be increased. The State Council set clear objectives through its recently announced "Energy-Saving and New-Energy Automotive Industry Development Plan (2012-2020)" stating that by 2015 and 2020 the average fuel consumption of passenger cars should reach 6.9 L/100km and 5.0 L/100km, respectively[11].

Both domestic and international experience confirms that the implementation of fuel consumption standards is instrumental for improving vehicle fuel efficiencies and advancing technological upgrades. China started implementing the first phase of its fuel economy standards in July 2005, since then, domestic passenger car average fuel consumption was reduced from 8.05 L/100 km to 7.22 L/100km[12]. During the 7 years since fuel economy standards implementation started, China's overall fuel economy improved by 10.3%. In the last two years since China has entered its third phase of fuel economy standards in 2012, fuel consumption of imported cars reached an average annual decline of 5%[13]. China is gradually forming an effective management system for overseeing the sound implementation of passenger car fuel consumption standards.

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2. Analyzes corporate average values in relation to individual automaker targets; places emphasis on manufacturers' capacity to meet their projected targets by 2020;

3. Studies new energy vehicles potential contribution to auto manufacturers in meeting their limits and standards; highlights major standard implementation trends

[7] http://finance.ifeng.com/a/20140120/11507968_0.shtml
[8] http://www.miit.gov.cn/n11293472/n11293832/n12845605/n13916913/n15852446.files/n15851861.pdf
[9] http://chinaafc.miit.gov.cn/n2257/n2783/c86526/content.html
[10] http://www.zhb.gov.cn/gkml/hbb/qt/201112/t20111219_221495.htm
[11] http://chinaafc.miit.gov.cn/n2257/n2260/c80857/content.html
[12] Based on research results of this report, as well as *i*CET's previous fuel economy annual reports.
[13] Based on research results of this report, as well as *i*CET's previous fuel economy annual reports.

since 2006;

4. Identifies trends and implementation issues by corporate type (importing, independent domestic manufacturers, joint-venture domestic manufacturers);

5. Provides policy recommendations towards the new standard based on these analyses.

The analysis is based on fuel consumption and curb-weight data, which is available through vehicle labeling (based on official type-approval test results) and published on the Ministry of Industry and Information Technology (MIIT) website. Imported vehicles data is based on information purchased from China Automobile trading (overseeing vehicle importation in China). Sales and production data is based on China Auto Industry Development Annual Report provided by China Association of Automotive Manufacturers (CAAM) and China Automotive Technology Research Center (CATARC).

1. China's Fuel Economy Development

This section will:

1. Review China's fuel economy standard development.
2. Compare previous, current and projected fuel consumption targets and limits.
3. Highlight the standard management framework and describes corporate average fuel consumption (CAFC) calculation methods.

1.1. Fuel consumption standards development

There are two standards that govern passenger vehicles fuel economy in China:

1. "**Vehicle fuel consumption limit standard**" (GB19578) is the first and core standard, which outlines fuel consumption limitations for passenger cars, steering China's fuel economy as of 2004.
2. "**Passenger car fuel consumption evaluation methods and indicators**" (GB27999) introduces evaluation methods and indicators for passenger car fuel consumption, as well as introduces corporate average fuel consumption, governing the current standards as of 2011.

The "vehicle fuel consumption limit" (GB19578-2004), is China's first mandatory vehicle fuel consumption management standard, which was implemented in two phases: the first phase ran from July 1st 2005 and July 1st 2006 steering the production of new vehicles and existing vehicles respectively, while the second phase commenced in January 1st 2008 and January 1st 2009, steering the new vehicles and existing bards production respectively. The two phases grouped vehicles into 16 weight-bins according to each car's curb weight, therefore fuel consumption limits and requirements are less for lower curb-weight vehicles.

By the end of 2011, China issued the "passenger car fuel consumption evaluation methods and indicators" (GB27999-2011) which included the first-ever introduction of corporate average fuel consumption (CAFC) standards. Again, according to a cars' curb weight-bin, a 2015 target was set and subsequently, the first-ever CAFC accounting methods and indicators were outlined. The CAFC targets all manufacturing enterprises (including domestic and imported) and sets corporate target as well as an annual gap from the target. These are determined and calculated according to the manufacturer's vehicles actual fuel consumption and corresponding production volume. Manufacturers can therefore flexibly adjust their vehicles technologies (and weight) and vehicles' production volume in order to meet the required annual CAFC. China's Phase III sets the implementation requirements for 2015 CAFC at 6.9 L/100km.Table 1 outlines China's passenger car fuel economy standards development.

Table 1: China's passenger car fuel economy standards development

Serial Number	Standard Title	Issuance Date	Implementation Date	Comments
GB/T15089-2001	Vehicle Classification			Replaced GB/T 15089-1994
GB/T 19233-2003	Measurement methods of fuel consumption for light duty vehicles	16/2/2006	1/4/2006	
GB19578-2004	Fuel consumption limits for passenger cars	2/9/2004	New vehicles: Phase I from 1/7/2005 Phase II from 1/1/2008; In-use vehicles in the following year	First of its kind; Governing gasoline and diesel fueled vehicles with minimum speed of 50km/h and maximum weight of 3500kg
GB20997-2007	Fuel consumption limits for light commercial duty vehicles	1/2/2008	1/1/2011	First of its kind; Governing gasoline and diesel fueled vehicles with curb weight equal to or above 2000kg which are meant for commercial use
GB19233-2008	Measurement methods of fuel consumption for light duty vehicles	3/2/2008	1/8/2008	Replaced GB19233-2003; Details for the implementation of GB19578-2004; Governing gasoline and diesel powered M1, M2, N1 vehicles not exceeding 3500kg
GB27999-2011	Fuel consumption evaluation method and targets for passenger cars	30/12/2011	1/1/2012	Details for the implementation of GB19578-2004; Governing gasoline and diesel powered passenger vehicles not exceeding 3500kg
GB19578-XXXX DRAFT	Fuel consumption limits for passenger cars	17/1/2014 (Public consultation)	TBD	Draft for replacing GB19578-2011; Governing gasoline and diesel powered passenger vehicles not exceeding 3500kg
GB 27999—XXXX DRAFT	Fuel consumption evaluation methods and	17/1/2014 (Public consultatio	TBD	Draft for replacing GB 27999—2011;

	targets for passenger cars	n)

In January 2014, a proposed revision to both the "vehicle fuel consumption limit standard" and "passenger car fuel consumption evaluation methods and indicators" were published. It was aimed at setting a more stringent China's Phase IV fuel economy standard: by 2020 a CAFC of 5.0 L/100km is set forth, projected to be implemented as of 2016.Phase IV is designed to increase cars' fuel consumption limits by about20% and fuel consumption targets by 30%-40%. The new standard provides more detailed technology pathways for reducing fuel consumption and further promotes new energy vehicles by detailing their relative fuel consumption calculation. The new standard requires an accelerated annual corporate average reduction rate of roughly 3% in the first year (2016) to about 9% in the last two years (2019 and 2020).

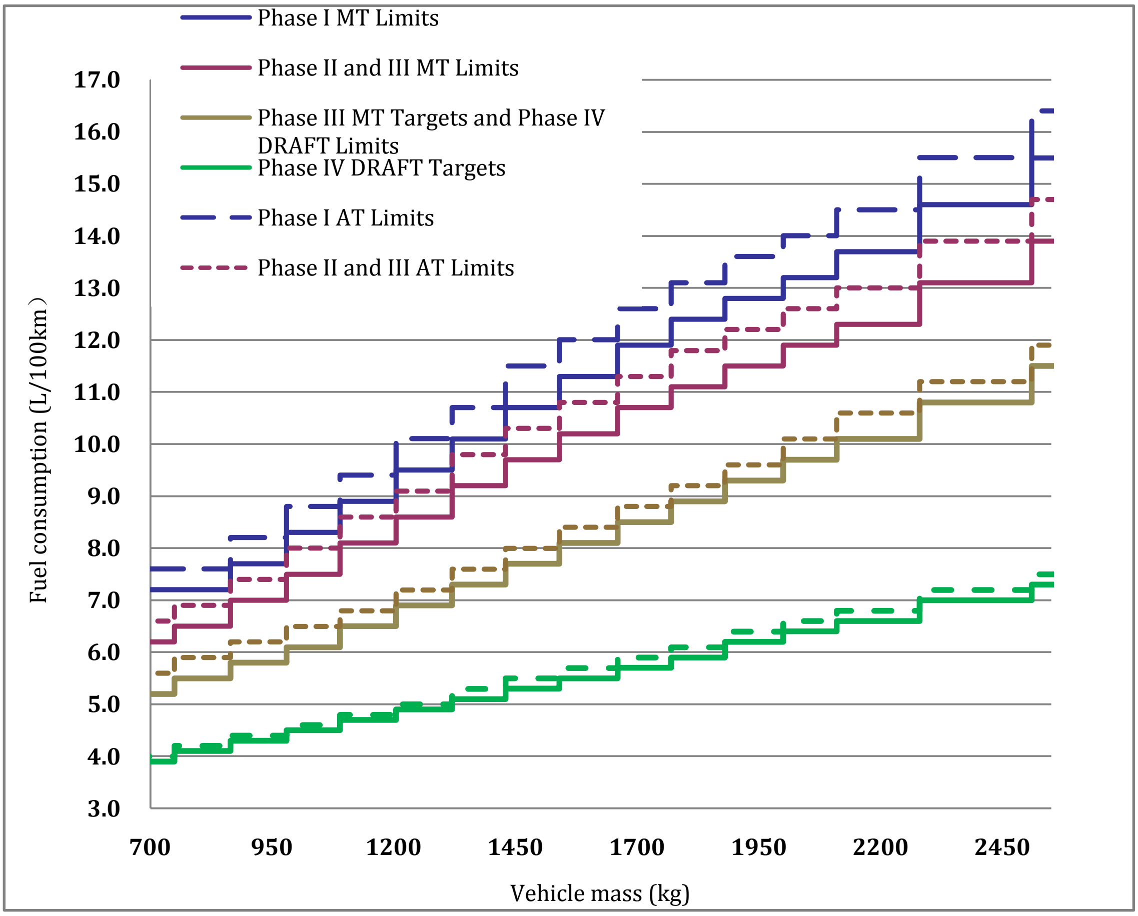
Table 2: Explanation of Terminologies in China's Fuel Consumption Regulatory System

Individual cars (models)	**FC Limit for individual vehicle models**	N/A	Every individual vehicle models have to meet their corresponding weight-bin limit.	***Starting 2005:*** GB19578-2004 (Phase I) ***Starting 2016:*** GB19578-20XX* (Phase IV)
	FC Target for individual vehicle model	N/A	Phase III implemented in 2012, also introduced a FC target value associated with each vehicle model(according to its weight-bin classification); There is no requirement for meeting the individual vehicle model FC targets.	***Starting 2012:*** GB27999-2011 (Phase III) ***Starting 2016:*** GB27999-20XX (Phase IV
Auto-make	$T_{CAFC2015}$ $T_{CAFC202}$	Target CAFC for	Automakers have to meet their corporate average fuel consumption target (CAFC) for	***Starting 2011:*** GB27999-2

rs	0	the current phase period	model year 2015 and 2020 respectively (See section 1.4 for calculation method).	011 (Phase III) ***Starting 2016:*** GB27999-20XX* (Phase IV)
	$CAFC_{xxxx}$/ $T_{CAFC2015}$ **$CAFC_{xxxx}$/ $T_{CAFC2020}$**	CAFC actual annual value/ Target CAFC value	By using this method calculation, one can track the annual CAFC % gap from meeting the ultimate target (Phase III 6.9L/100km by 2015; Phase IV 5L/100km by 2020).	***Starting 2011:*** GB27999-2011 (Phase III) ***Starting 2016:*** GB27999-20XX* (Phase IV)

China's passenger vehicle fuel economy standards have quickly evolved in the past decade and continue to advance vehicle efficiency technology improvements by aligning China's vehicle market with global fuel economy standards by 2020. **Figure 3** shows the four current phases of the governing framework of fuel economy (more details can be found in **Appendix II**).

Figure 3: China weight-based passenger vehicle fuel consumption limits (Phases I, II and III) for automatic transmission (AT) and manual transmission (MT) vehicles: Graphic illustration



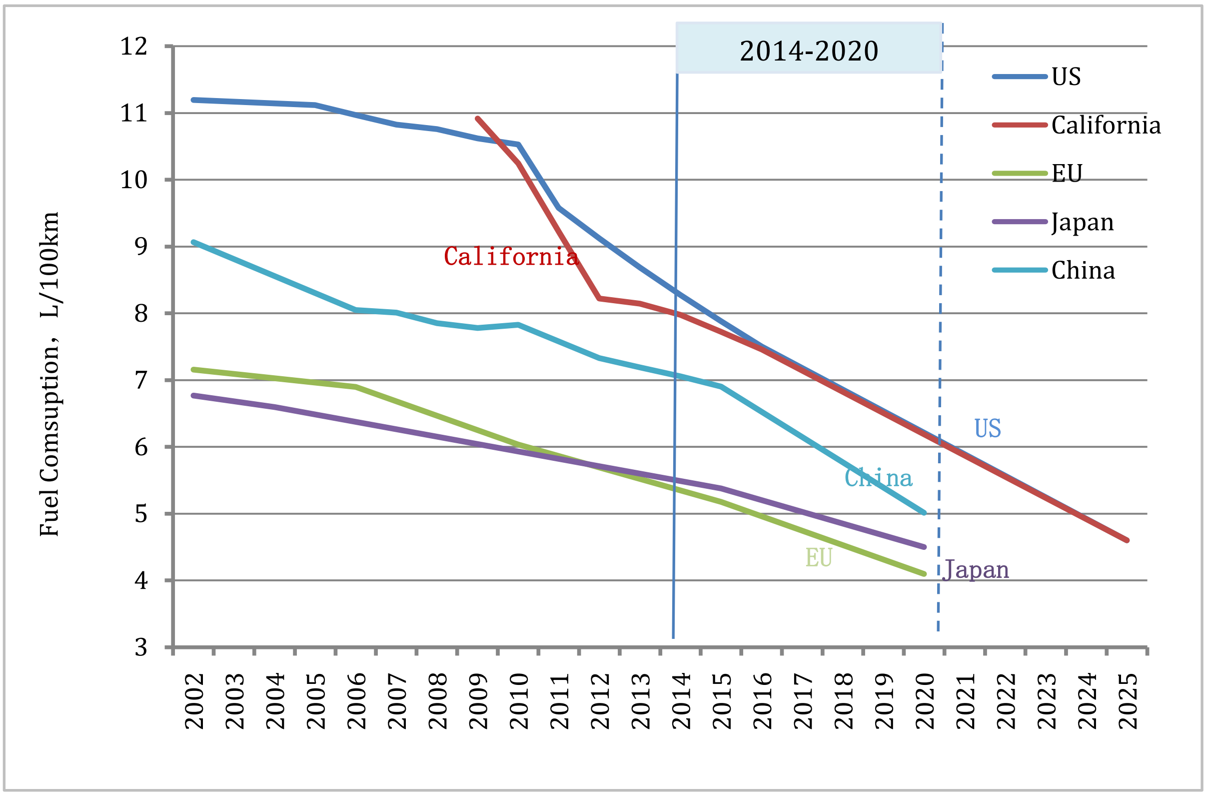
1.2. A comparison between China and global fuel economy standards

Europe, the US, Japan and other developed countries are all advancing their fuel economy standards framework towards more stringent 2020 standard requirements and beyond. This includes technology roadmaps development for ensuring market effectives, implementation and enforcement mechanism for steering technological improvements, and even creatingcorrespondingCO2emissions standards for ensuring linkage to policy-makers' pollution reduction commitments and goals.

The EU replaced the voluntaryCO2emissions reduction agreement with mandatory legal standards in 2009, including CO2emission limits and labeling requirements. These set a target requirement of 130g/km by 2015 (the equivalent of 5.6L/100k) and 95g/km by 2020 (the equivalent of 4.1L/100k).Japan has proposed the 2020 light vehicle fuel economy standards target to be set at20.3 km/L (the equivalent of 4.5L/100k), representing a 20.3% reduction from Japan's average of16.3 km/L (the equivalent of 5.5L/100k). In April 2010 and August 2012, the United States issued light vehicle fuel economy and green house gases (GHG) standards for governing 2012-2016 (first phase) and2017-2025(second stage) vehicle development. The standards are aimed at restricting 2025US light vehicle average fuel economy at 54.5mpg (the equivalent of 4.6L/100k).

Each country's fuel consumption test conditions are different, so is the standard expression unit; therefore, all were transformed into the next level of the European conditions, namely the L/100km units to allow the annual comparison illustrated in **Figure 4**. Although China's fuel economy standard has a stringent 2020 target of 5L/100km, its stringency is moderate in relation to the advanced EU and Japanese standards.

Figure 4: A comparison between China's and global fuel economy standards development



Note: All countries' fuel economy representation is normalized to the EU test and measurement unitL/100km

1.3. An introduction to China's Phase IV fuel economy

In February 2014 the draft of the fourth stage of China's fuel economy standard was published for public review, and included two standards drafts: "Vehicle fuel consumption limits"[14] and "Passenger car fuel consumption evaluation methods and indicators"[15]. In July 2014, the draft has been slightly modified following stakeholder discussions.

The new "passenger car fuel consumption limits" draft still sets curb weight bins as the basis of fuel consumption limits classification (unlike the US new fuel economy standards that uses vehicle's footprint as a basis[16]), and points to limits in line with the third stage. Some of these limits are some 20% stricter than the second phase standard. The standard is suggested come into effect in January 1st 2016 for new production models

[14]http://www.miit.gov.cn/n11293472/n11293832/n12845605/n13916913/n15852446.files/n15851861.pdf
[15]http://www.miit.gov.cn/n11293472/n11293832/n12845605/n13916913/n15852446.files/n15851862.pdf
[16]iCET (February 2014), *Performance of the Chinese New Vehicle Fleet Compared to Global Fuel Economy and Fuel Consumption Standards",*http://icet.org.cn/english/news3.asp?Cataid=A00040002

and January 1st2017 for all vehicle models.

The new "Passenger Car Fuel Consumption Evaluation Methods and Indicators” draft provides 30% lower fuel consumption target requirements for most vehicles and over 35% lower requirements for vehicles exceeding the 1660kg curb-weight. The new draft differs from the current GB27999-2011 standard mainly through the following additions and updates:

1) Expanding the scope of the standard to include electric vehicles, plug-in hybrid vehicles and gas-powered vehicles.
2) Encouraging the use of off-cycle energy-saving technologies such as tire pressure monitoring systems, efficient air conditioning, idle start-stop system, and shift reminder, by rewarding vehicles that implemented one or more of these technologies with a fuel saving credits of up to 0.5 L/100km from their Test-Approval FC value.
3) Although the new standards draft is not differentiating between automatic or manual models, it provides 3-5% reduction in fuel consumption for passenger cars with three seat rows and above.
4) In advancing the adoption of new-energy and energy-saving vehicles, production or import volumes are encouraged to be gradually reduced as shown in **Table 3**. However, power conversion solutions designed for diesel and gasoline passenger cars are not addressed in the new standards draft.
5) In advancing the adoption of new-energy and energy-saving vehicles, each unit produced is equivalent to more units using a gradually decreasing multiplier over the standard period, as detailed in **Table 3**.

Table 3: New Energy and Energy Saving Vehicles’ Preferential Policies (each unit multiplier for CAFC calculation)

	EV	Full Cell EV	Plug In EV*	NSV**
~2015	5	5	5	3
2016-2017	5	5	5	3
2018-2019	3	3	3	2.5
2020	2	2	2	1.5

* Plug-in electric vehicle are defined as vehicles that have electric range of at least 50km.

** Energy Saving Vehicles are defined as cars with fuel consumption lower than 2.8L/100km.

6) The annual corporate average fuel consumption (FC) target will gradually increase in stringency, as detailed in **Table 4**. If Phase IV’s annual target been according to Phase III approach, a constant annual percentage points reduction would determine the pace of fuel consumption reduction, as illustrated in Approach I in **Figure 5**. However this new revision to the standard enables slower FC reduction earlier during the standard period and more stringent reductions towards its end, as illustrated by Approach II in **Figure 6**. While the annual reduction in the CAFC/$T_{CAFC2020}$ ratio is required in the first year of Phase

IV is 2.9%, the annual reduction in the last year of Phase IV (2019-2020) can be translated into an annual reduction of about 9.1% in fuel consumption values. During the last two years, an annual decrease of 10 percentage points from the previous year CAFC/$T_{CAFC2020}$ratio is required, translating to about a 0.5L/100km decrease in absolute fuel consumption value.

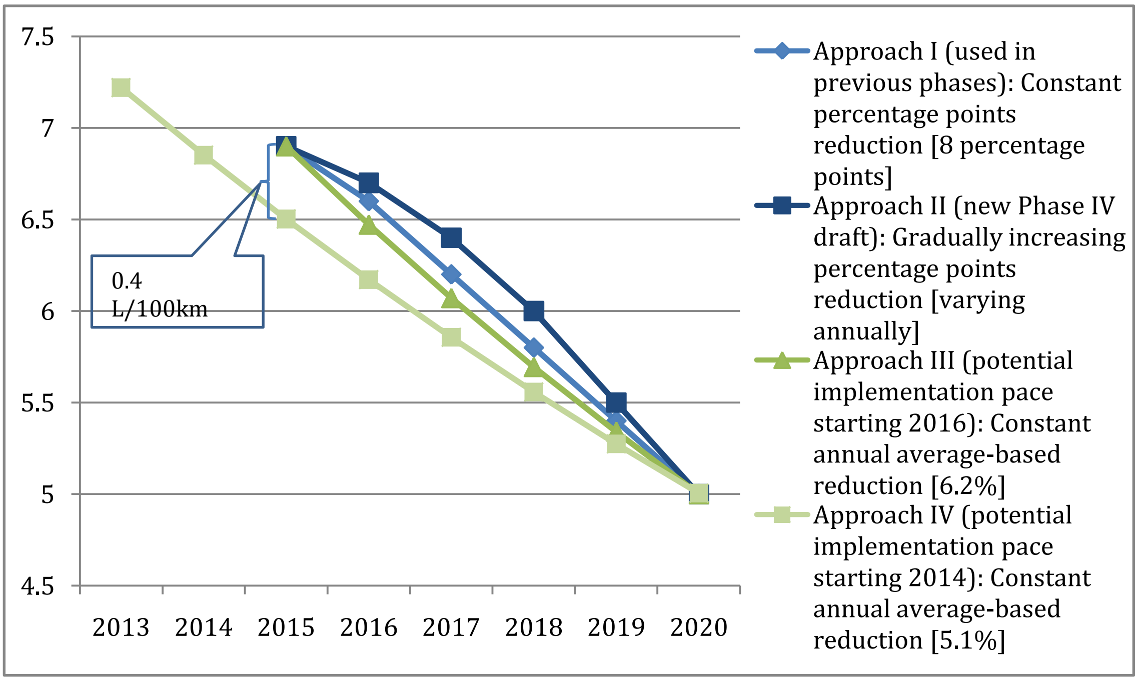
Table 4: 2014-2020 Annual CAFC Reduction

Year	**CAFC/ $T_{CAFC2020}$**	Annual CAFC Reduction**	CAFC L/100km	L/100km	Relative Annual FC Reduction (%)
2013*	144%	5	7.22	0.16	-2.1%
2014*	141%	3	7.06	0.16	-2.2%
2015*	138%	3	6.90	0.16	-2.3%
2016	134%	4	6.70	0.20	-2.9%
2017	128%	6	6.40	0.30	-4.5%
2018	120%	8	6.00	0.40	-6.3%
2019	110%	10	5.50	0.50	-8.3%
2020	100%	10	5.00	0.50	-9.1%
		2016-2020 CAFC Annual Average Reduction			-6.2%
		2014-2020 CAFC Annual Average Reduction			-5.1%

* *i*CET's calculations.

** Annual reduction according to the newly stated revisions to Phase IV standard.

Figure 5: Paths towards Meeting CAFC 2020 Target



1.4. Corporate average fuel consumption calculation method

The CAFC uses vehicle model, year, and annual sales to calculate a weighted average for fuel consumption based on the New European Driving Cycle (NEDC), as shown in the formula below:

$$CAFC = \frac{\sum_{i}^{N} FC_i \times V_i}{\sum_{i}^{N} V_i}$$

***N**: the vehicle model code number*
***FC**: fuel consumption of the "i"th model*
***V**: annual sales of the "i"th model*

The CAFC Target is based on individual vehicle fuel consumption targets, which uses the quantity of annual sales of each model to calculate a weighted average. See the formula below:

$$T_{CAFC} = \frac{\sum_{i}^{N} T_i \times V_i}{\sum_{i}^{N} V_i}$$

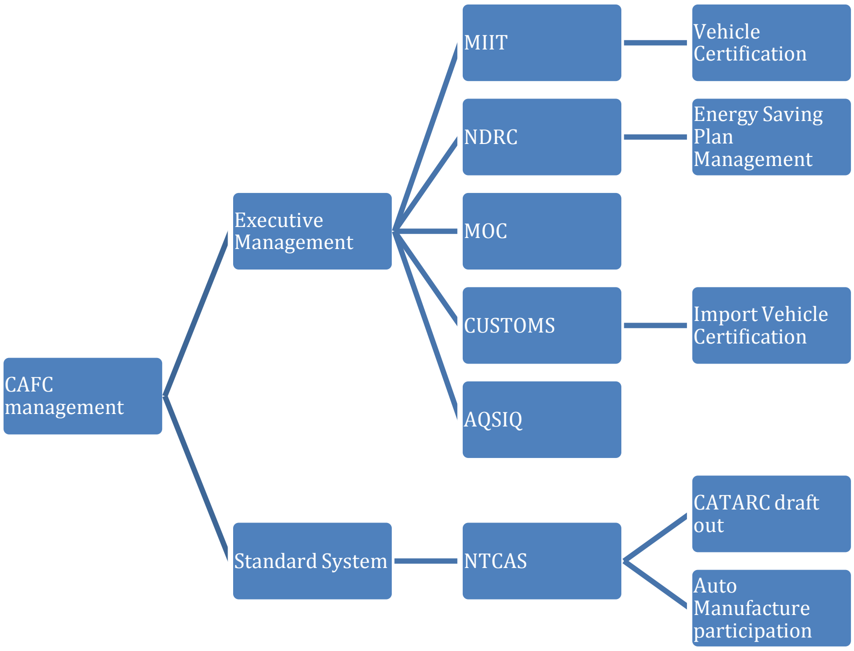
***N**: the vehicle model code number*
***FC**: fuel consumption of the "i"th model*
***V**: annual sales of the "i"th model*

These fuel consumption targets also account for the time that vehicle manufacturers need for product planning, technology upgrades, and developing new vehicle models. The CAFC requirement was enacted in 2012 and allows automotive manufacturers until 2015 to gradually reduce their fuel consumption levels and meet the target.

1.5.CAFC's Governing Framework

Currently, China's average corporate fuel consumption standard implementation for passenger car is jointly governed by several ministries: Ministry of Industry and information Technology (MIIT), the National Development and Reform Commission (NDRC), Ministry of Commerce (MOFCOM), General Administration of Customs, and the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ), as illustrated in Figure 7. MIIT governs motor vehicles verification, such as domestic manufacturers' fuel consumption and manufacturing volume. The Customs Administration, AQSIQ and MOFCOM are responsible for imported passenger car fuel consumption, import volumes and importing entities verification, while NDRC is mainly responsible for the planning the dissemination and development of energy-saving and new energy cars.

Figure 6: China's fuel consumption governing framework



In order to improve vehicle management and in accordance with the 2012 "State Council's energy-saving and new energy automotive industry development plan (2012-2020)", a joint-ministerial effort comprised of the Ministry of industry and Information Technology (MIIT), the National Development and Reform Commission (NDRC), the Ministry of Commerce (MOFCOM), and Customs General Administration (AQSIQ) developed an "Accounting Approach for Passenger Vehicle Corporate Average Fuel Consumption"[17]. The accounting approach was announced in March 2013 and came into effect in May 1st 2013.

China's new accounting approach sets forth the following binding industry reporting requirements: vehicle manufacturers are obliged to report the Ministry of Industry and Information technology (MIIT) on their expected calendar year corporate annual average fuel consumption by December 20 of each year; By August 1st of each calendar year, the first year-half actual average corporate fuel consumption results should be reported; By February 1st of each calendar year, the actual corporate average fuel consumption of the previous year should be reported. The approach does not specify penalties in case of lack of, inadequate, or false reporting, nor does it provide specific enforcement measurements.

[17]http://chinaafc.miit.gov.cn/n2257/n2783/c86525/content.html

Corporations that fail to provide inadequate reporting are subject to legal procedures as stated by the court of law. The enforcement authority is not specified.

On May 5th 2014, the MIIT published for the first time a list of auto manufacturers' average corporate fuel consumption scores for the year 2013[18]. The list introduces average fuel consumption data directly provided by the submitting companies (totaling 104), as well as a list of 7 manufacturers that failed to submit their corporate average fuel consumption data as required. The announcement is aimed at increasing transparency towards this year's 106% average requirement from 2015 targeted 6.9L/100km. The announcement also serves as an official call for comments, which was due by June 7th 2014.

On May 15, 2014, the MIIT further announced that a working group led by its industry division and equipment department would inspect approval testing to ensure sound implementation of China's third phase fuel consumption aimed at an average of 6.9L/100km by 2015[19]. For the first time, the Ministry had officially announced that penalties would occur; however, no specifications of prices or process have been announced.

[18]http://www.miit.gov.cn/n11293472/n11293832/n12845605/n13916913/15988846.html
[19]http://www.vecc-mep.org.cn/news/news_detail.jsp?newsid=62260

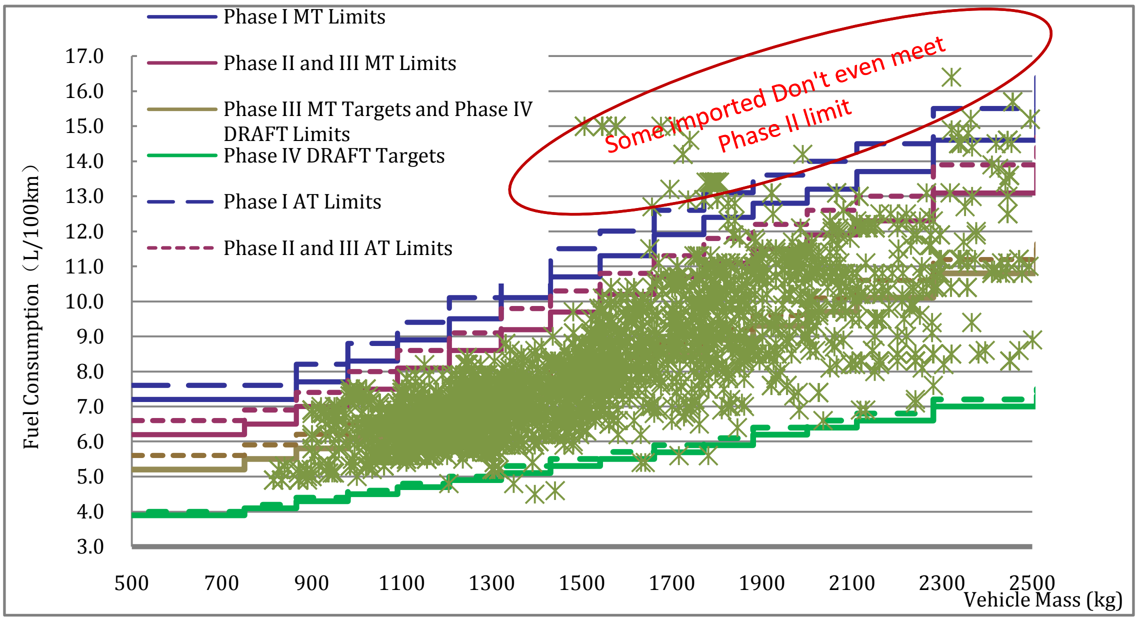
2. 2013 CAFC Analyses

This section is dedicated to China's 2013 corporate average vehicle fuel consumption analyses. The analysis data is based on fuel consumption and curb-weight data available through vehicle labeling (based on official type-approval test results) and published on the Ministry of Industry and Information Technology (MIIT) website[20]. Imported vehicles data is based on information purchased from China Automobile trading[21], who overseeing vehicle importation in China. Sales and production data is based on China Auto Industry Development Annual Report provided by China Association of Automotive Manufacturers (CAAM) and China Automotive Technology Research Center (CATARC).

2.1. 2013 Vehicle Fuel Consumption by Curb-Weight Distribution

In 2013, MIIT published the fuel consumption data of 6845 vehicles on its China Fuel Economy Website, which included 2862 passenger cars(M1) including 836 imported cars. As illustrated in **Figure 8**, half of the vehicles' fuel consumption is in line with China Phase III 2015 target (also 2020 Phase IV limit values), however, almost none of today's vehicle models meet China's 2020 Phase IV target. The below figure also shows that, as imported cars are excluded from the current mandatory fuel economy standard regime, some imported vehicles – mainly SUVs and luxury cars – do not even meet the current standard limit, requiring greater regulatory and management scrutiny.

Figure 7: 2013 Car Fuel Consumption Scores in Relation to the Standard



[20]http://chinaafc.miit.gov.cn/n2257/n2263/index.html(中国汽车燃料消耗量网站, 2014)
[21]http://www.ctcai.com.cn/

2.2. Domestic Manufacturers

2.2.1 2013 Annual Targets Meeting Analysis

According to the "Passenger Cars Corporate Fuel Consumption Accounting Methods", each corporation should report their corporate average fuel consumption to MIIT by February 1st. On May 2014, MIIT published the reporting companies' CAFC self-reported scores, including 79 domestic and JVs, and 25 importing corporations. As the published data has yet to be scrutinized by the regulator, *i*CET assumes the data may be carrying accountability issues.

The reported 79 domestic auto manufacturers represent 17.07 million cars produced, which accounts for over 90% of China's passenger vehicle sales, including 33 JVs and 46 independent manufacturers. Only 40 companies reached their Phase III annual CAFC target, 19 of which are JVs and 21 independent domestic manufacturers. 57 companies maintained their annual CAFC within the limit standard (106% of the 2015 target), 30 of which are JVs and 27 independent domestic manufacturers. As much as 27 brands did not meet the standards limit, of which 3 JVs and as much as 19 independent domestic manufacturers.

Table 5: 2013 Domestic Passenger Vehicle Manufacture Standard Implementation

Standard Implementation	Manufacturers Volume	JV Manufacture	Independent Domestic Manufacture
≤100%Target	40	19	21
≤106%Target	57	30	27
>106%Target	22	3	19

According to *i*CET analysis, China's actual corporate average fuel consumption for the year 2013 was 7.22L/100km, which is 98.2% of the annual corporate average fuel consumption target of 7.35/100km and 6.2 percentage points better than last year's results. JVs CAFC reached 7.31L/100km, which is97.9% of their annual target of 7.47L/100km. Independent domestic manufacturers CAFC reached 6.95L/100km, which is only 99.2% of their annual target of 7.01L/100km. Overall CAFC scores of 2013 reached their targets, representing a significant improvement from 2012 scores, which averaged 103% from the then annual target.

Table 6: 2013 Domestic Manufactures' Actual vs. Target CAFC

Manufacture Type	Real CAFC （L/100 km）	CAFC Target （L/100km）	Real value divided by CAFC Target
Domestic Manufacture	7.22	7.35	98.2%
JV Manufacture[22]	7.31	7.47	97.9%
Independent Domestic Manufacture[23]	6.95	7.01	99.2%

Chinese JV manufacturers' CAFC performance surpasses independent domestic manufacturers' performance. In the MIIT's May 2014 released data, as much as 14 out of 20 the best performing manufacturers were independent domestic brands. These include several small models manufacturers, such as Tianjin FAW-Xiali, Changhe-Suzuki, Changan-Suzuki scoring5.74 L/100 km, 5.93 L/100 km, 5.98 L/100 respectively.

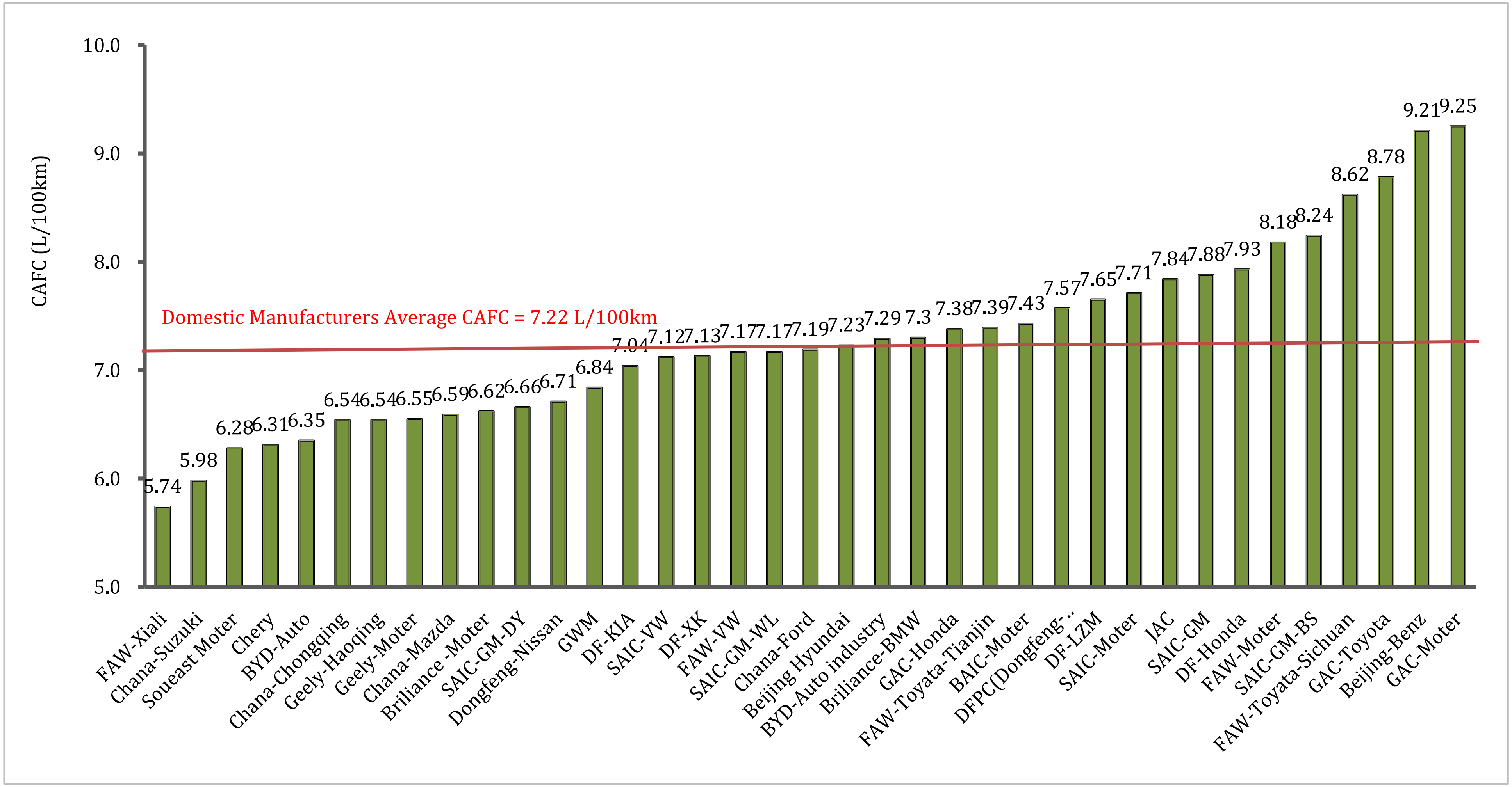
From vehicle size perspective, in 2013 China's JV average curb weight was 1361kg, 3.2% higher than the independent manufacturers' curb weight averaging 1318kg. Unsurprisingly, JVs engine displacement of 1670mLwas 5.6% higher than independent brands' average of 1580mL. Clearly, lightweight small vehicle production is a major path for achieving CAFC decline.

Corporate average fuel consumption target is aimed at reaching 100% fulfillment by 2015. Whereas every year prior has a set flexibility in place in the form of percentages above the 2015 target, such as 106% fulfillment requirement for 2013. The best performing automakers in 2013 in terms of reaching the target were BMW-Brilliance, BYD and Shanghai-GM, who achieved 85.0%, 89.9% and 91.2% of the target respectively. Over 100k models that did not meet the standards limit were manufactured by independent domestic brands. The worst performing auto manufacturers were FAW, BAIC and Guangzhou Auto.

Figure 8: Actual CAFC Value of Leading Domestic Passenger Vehicle Manufacturers

[22]由中方与外方共同出资生产，采用外方品牌的汽车企业。同一企业既生产合资品牌汽车、也生产自主品牌汽车，按合资企业处理。

[23]中方独资生产，采用中方品牌的汽车企业。


10.0
9.0
8.0
7.0
6.0
5.0
CAFC (L/100km)
Domestic Manufacturers Average CAFC = 7.22 L/100km
5.74
5.98
6.28
6.31
6.35
6.54
6.54
6.55
6.59
6.62
6.66
6.71
6.84
7.04
7.12
7.13
7.17
7.17
7.19
7.23
7.29
7.3
7.38
7.39
7.43
7.57
7.65
7.71
7.84
7.88
7.93
8.18
8.24
8.62
8.78
9.21
9.25
FAW-Xiali
Chana-Suzuki
Soueast Moter
Chery
BYD-Auto
Chana-Chongqing
Geely-Haoqing
Geely-Moter
Chana-Mazda
Briliance -Moter
SAIC-GM-DY
Dongfeng-Nissan
GWM
DF-KIA
SAIC-VW
DF-XK
FAW-VW
SAIC-GM-WL
Chana-Ford
Beijing Hyundai
BYD-Auto industry
Briliance-BMW
GAC-Honda
FAW-Toyata-Tianjin
BAIC-Moter
DFPC(Dongfeng-…
DF-LZM
SAIC-Moter
JAC
SAIC-GM
DF-Honda
FAW-Moter
SAIC-GM-BS
FAW-Toyata-Sichuan
GAC-Toyota
Beijing-Benz
GAC-Moter

2.2.2. Corporate Target Credits Shortage/Surplus

According to the MIIT "corporate average fuel consumption of passenger cars accounting approach" released in March 2013, auto manufacturers can earn credits if their actual CAFC goes beyond the annual target and be penalized if they do not meet the target. If manufacturers surpass the target, then the fleet production is multiplied by the gaps between each vehicle CAFC target and real value, which is eligible for credits that can be kept and transferred to the following year. Similarly, companies failing to meet their CAFC threshold(106% of 2015 target in 2013) are penalized and are required to compensate for the missed gap in the following year (however there is no enforcement mechanism to ensure implementation):

Calculation	Indication	Eligibility
(CAFC-T $_{CAF(}$ $\sum_{i}^{N} V_i$	$CAFC < T_{CAFC}$	Credits Surplus
(CAFC-T $_{CAF(}$ $\sum_{i}^{N} V_i$	$CAFC = T_{CAFC}$	N/A
(T $_{CAFC}$-CAF($\sum_{i}^{N} V_i$	$T_{CAFC} > CAFC > 106\%$	Credits Shortage

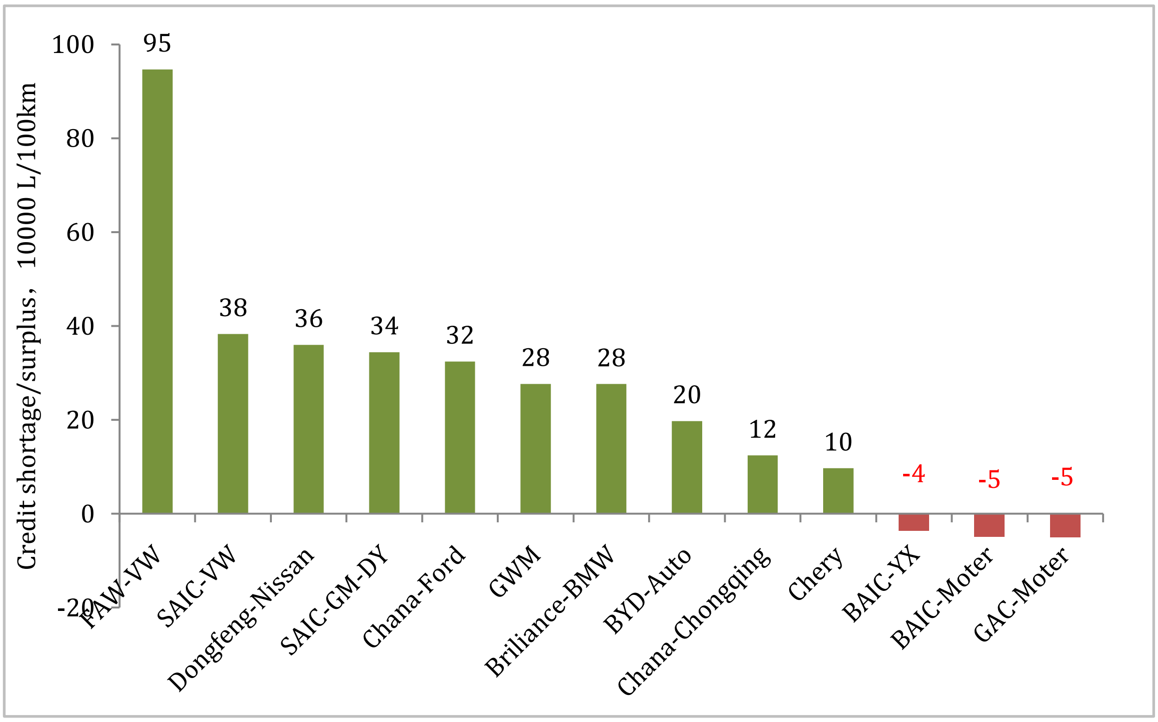
Note: CAFC and T_{CAFC} Calculation method is elaborated in section1.4.

During 2013, a total of 39 companies surpassed the national fuel consumption annual target totaling 3,970,000 L/100km, which is four times the total amount of year 2012.Of which, 19 JVs produced 3.06 million L/100kmwhile independent brands produced 910,000 L/100km. 10 auto manufacturers produced 100,000 L/100km more than the target amount, followed by FAW-Volkswagen, Shanghai-Volkswagen, and Dongfeng-Nissan, which reached 946,000, 383,000 and 340,000 L/100km respectively as presented in **Figure 9**.

However, 22 auto manufacturers failed to meet the CAFC standard, reaching 310,000L/100km compared with the previous years' 110,000L/100km. Three JVs alone were responsible for 19% of this figure (totaling 60,000L/100km) and independent domestic manufacturers are accountable for as much as 250,000L/100km.Sincecorporatecredit shortage totals 500,000L/100km, technological improvements should be sufficient for achieving the target. The poorest performing manufacturers were BAIC Yinxiang, BAIC Motor, and GEC Motor, all of which are independent domestic auto manufacturers.

In 2013, the number of auto manufacturers that did not meet the target represents only 1/10 of the auto manufacturers, which surpassed the target and indicated an overall market improvement from 2012.

Figure 9: Leading Domestic Manufacturers with Target Surplus Credits



The ability of Chinese auto manufacturers to meet national standards and the CAFC target depends on technological capacity (most transferred from developed countries' auto manufacturers), which in turn translates to adequate regulatory framework and flexibility. In 2013, China released the "corporate average fuel consumption of passenger cars accounting approach", which proposed that an excess of points that were achieved after meeting the target could be carried forward to enable more flexibility; however, the 2014 "Strengthening corporate average fuel consumption of passenger management" draft excludes such mechanism. *i*CET believes such regulatory conditions would be sufficient for enabling market players to develop and integrate significant technological improvements, particularly to independent domestic manufacturers.

2.2.3 Corporate 2020 Target Analysis

The 2014 "Passenger Car Fuel Consumption Evaluation Methods and Indicators" draft proposed a 2020 target based on vehicle curb-weight, where an annual corporate average fuel consumption target is based to ultimately meet the 2020 target of

5L/100km. This section will analyze the distance between actual corporate average fuel consumption (CAFC) values and their projected 2020 target in order to better understand the stringency of the new standards draft and potential issues stemming from its design and implementation.

Since the MIIT's recent corporate average fuel consumption score publication does not include per vehicle production and fuel consumption values, this section analysis utilizes data from the official sources stated in **Table 7**, which is also consistent with *i*CET's annual CAFC reports from previous years. Therefore, there is a gap between *i*CET's CAFC figures and the recently published MIIT figures. However this gap leads to similar evaluation results as illustrated in **Table 8**. In cases where specific model data was not available, a model average fuel consumption and weight were used. **Tables 9 and 10** are meant to demonstrate this analysis calculation method using Beijing Benz Automotive example.

Table 7: Domestic Manufacturers' CAFC vs. 2020 Target Analysis Data Sources[24]

Organization	Data Type	Data Source
中国汽车工业协会 China Association Of Automobile Manufacturers	Annual Production	China Auto Industry Development Annual Report
中国汽车燃料消耗量网站 the website of Automobile Fuel Consumption of China	Vehicle Fuel Consumption (FC)	Passenger Vehicle Fuel Consumption Data

Table 8: MIIT and *i*CET's CAFC Results Gap

	*i*CET Calculation*	MIIT Release*	Similarity
2013 CAFC （L/100km）	7.16	7.22	99.3%
2013 T_{CAFC}（L/100km）	7.30	7.35	99.1%
2013 CAFC/ T_{CAFC}	98.2%	98.1%	100.0%

*iCET calculated based on the data sources listed in Table 5.

Table 9: Actual Corporate Average Fuel Consumption (CAFC) Calculation Method - Beijing Benz Automotive Example

Automaker	Car Model	Production	Test Fuel Consumption（L/100km）	Production×Fuel Consumption	2013CAFC（L/100km）
Beijing-Benz	GLK300	41252	10.9	449647	=B1/A=8.95
	E400L MH	87	6.9	600	
	E400L	3629	8.5	30847	

[24]中国汽车燃料消耗量网站.http://chinaafc.miit.gov.cn/index.html
中国汽车技术研究中心.中国汽车工业协会．中国汽车工业发展年度报告 2014 版. 2014 年 5 月.
中国进口汽车市场数据库，海关乘用车进口量. http://www.ctcai.com/. 2014.06 内部数据购买

	E300L	3629	9.6	34838
	E260L	35747	7.7	275252
	C300	612	9.9	6059
	C260	19161	7.8	149456
	C180K	14702	7.9	116146
Total		118819（A）		1062844（B1）

Note: Vehicle production data is based on CAAM publications.

Table 10: Target Corporate Average Fuel Consumption (CAFC) Calculation Method - Beijing Benz Automotive Example

Automaker	Car Model	Production	Fuel Consumption Target（L/100km）	Production×Fuel Consumption	$T_{CAFC2020}$（L/100km）
Beijing-Benz	GLK300	41252	6.2	255762	=B2/A=5.84
	E400L MH	87	6.2	539	
	E400L	3629	6.2	22510	
	E300L	3629	5.9	21411	
	E260L	35747	5.7	203758	
	C300	612	5.5	3366	
	C260	19161	5.5	105385	
	C180K	14702	5.5	80861	
Total		118819（A）		693583（B2）	

Note: Vehicle production data is based on CAAM publications.

Overall, China's domestic 2013 CAFC is 144% of 2020 target of 5L/100km on average. JVs achieved 143.8% of their 2020 target this year, while independent manufacturers reached 141.5%.

Individual automaker targets range between 4.3-5.8L/100km, based on their corresponding production mix among weight bin categories. If the calculation is based on the last year of Phase III implementation (6.9 L/100 km in 2015), the gap measured as $CAFC_{2016}/T_{CAFC2020}$ ratio is still estimated to be as high as 134%.

Corporations producing over 10,000 vehicles per year are required to reduce their corporate average fuel consumption by 124%-167% in the next 7 years in order to meet the 2020 target. Manufacturers producing large volumes of small segment or high technology vehicles such as BYD, Changan-Suzuki, FAW-Volkswagen, and BMW-Brilliance are currently at 134% of their projected 2020 target. Manufacturers producing large segment vehicles – Guangqi-Toyota, FAW-Car, Sichuan FAW-Toyota – are now facing a challenging 160% gap from their projected 2020 target.

Table 11: 2013 Domestic Corporate Average Fuel Consumption (CAFC) vs. 2020 Target

	$CAFC_{2013}$ (L/100km)	$T_{CAFC\ 2020}$ (L/100km)	$CAFC_{2013}/T_{CAFC2020}$
Domestic Automaker	7.22	5.03	143.5%
JV	7.31	5.08	143.8%
Independent Domestic	6.95	4.91	141.5%

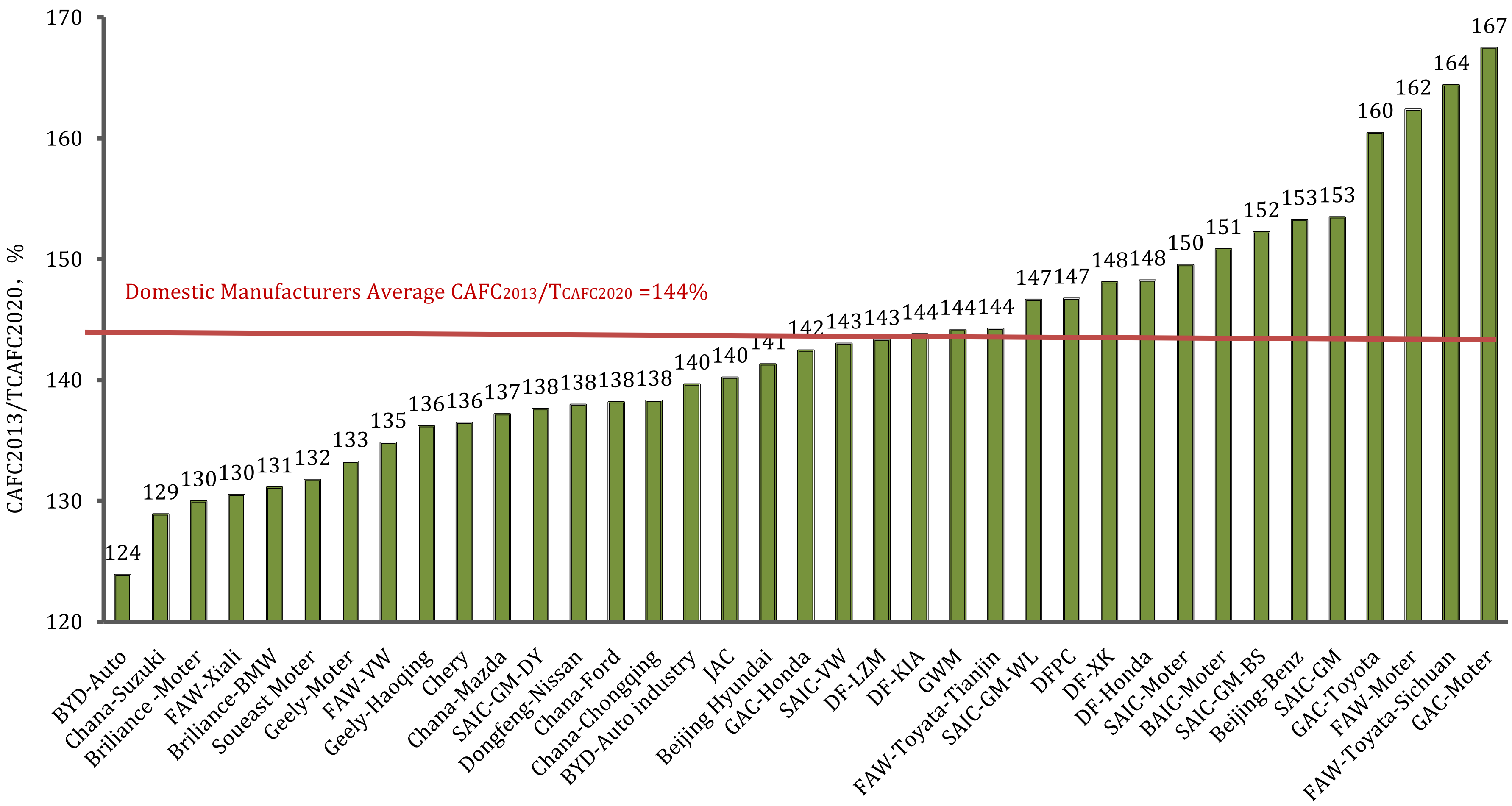
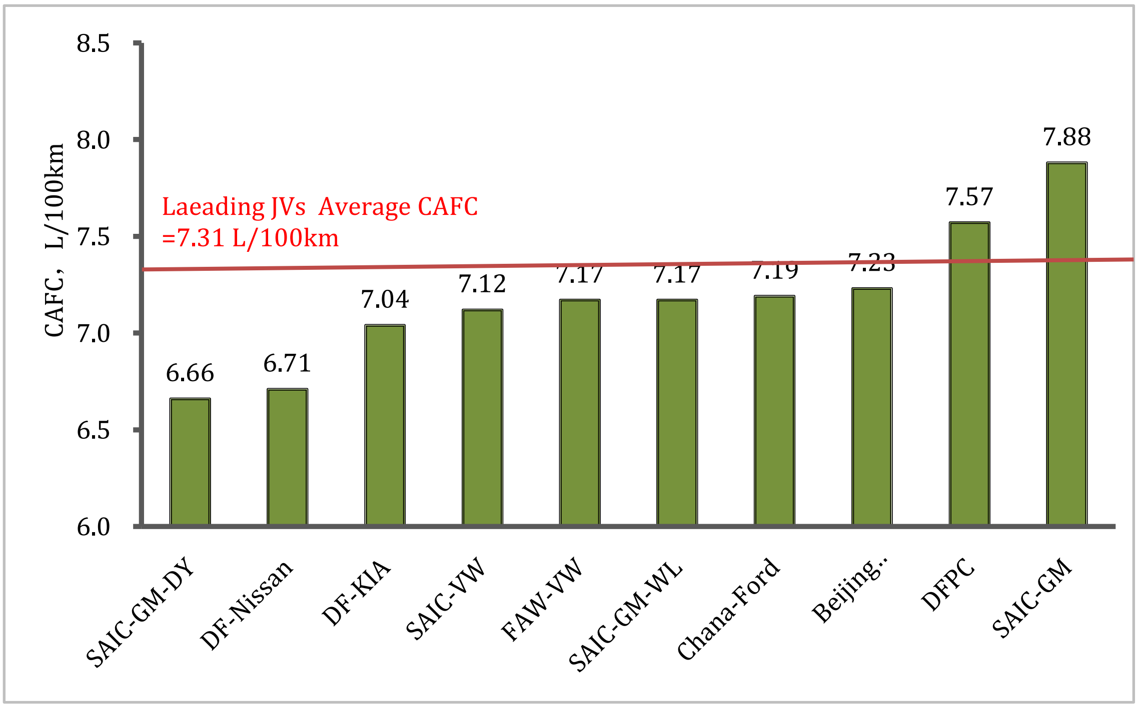


Figure 10: Domestic Manufacturers 2013 CAFC vs. their 2020 Target

2.2.3.1 China's 2013 10 Leading Domestic Manufacturers

In 2013, China's Top 10 passenger car producer JVs (by production), which accounts for the production of 9.4 million cars and captures 55% of China's vehicle market, were: Shanghai Volkswagen, FAW-Volkswagen, GM-Wuling, Beijing Hyundai, Nissan, Ford, Shanghai GM, Dongfeng Shenlong, DYK, Shanghai GM Dong Yue. These Top 10JVs had annual CAFC values between 6.66L/100km and 7.88L/100km, with GM Dongyue having the lowest absolute CAFC value and Shanghai GM having the highest CAFC value.

Figure 11: China's Top 10 JVs 2013 CAFC Values



FAW-Volkswagen achieved the best performance in 2013 in relation to its 2020 target, with a ratio of 134.8%. However, its core production brands, such as the Jetta, Magotan, Sagitar, the new Bora, etc., are not dominating technologically with a relatively high displacement of 1.72L, an average curb weight of 1432 liters, and the average power of 103kw (as illustrated in **Table 12**). FAW-Volkswagen mainly utilizes energy-saving technologies such as multi-speed dual-clutch transmission and turbo. Shanghai GM Dong Yue and Nissan, which are characterized by their small-displacement and lightweight production, are well performing in terms of CAFC value as of their 2020 target.

Figure 12: China 2013 Top 10 JVs CAFC vs. their 2020 Target

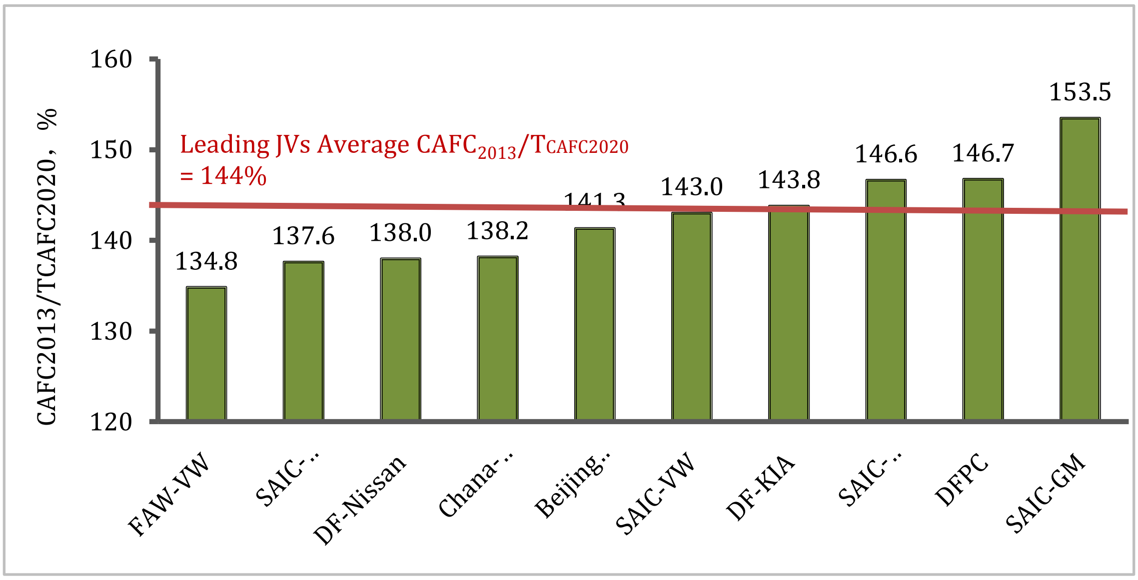


Table 12: China's 2013 Top 10 JVs Vehicle Features and Technology Evaluation

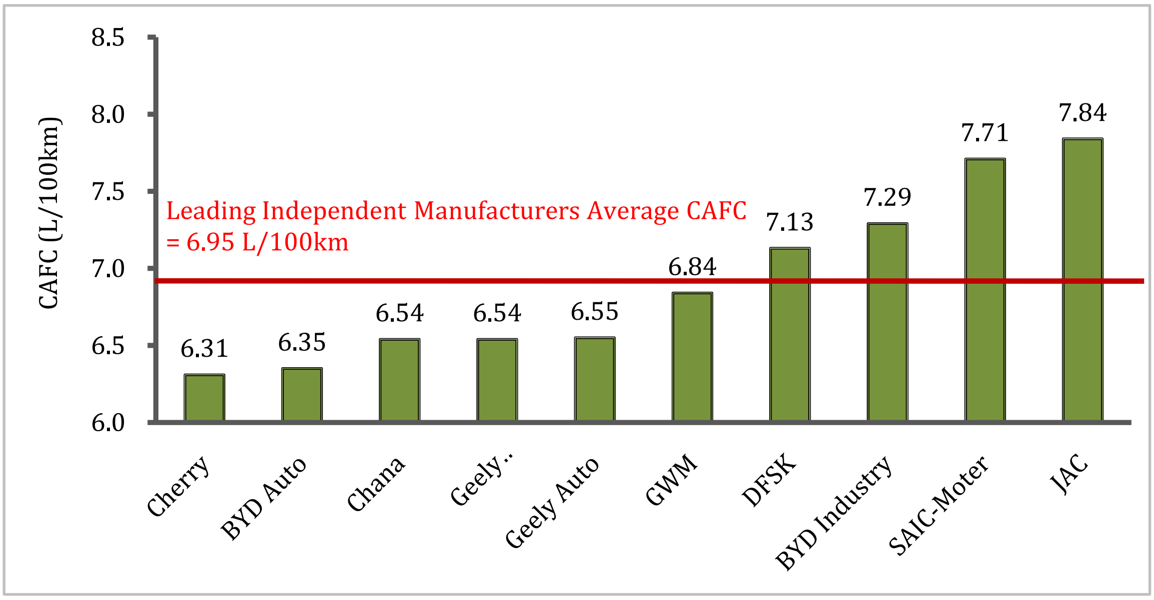
Automaker	Displacement（L）	Mass（kg）	Power（kw）
FAW-VW	1.72	1432	103
SAIC-GM-DY	1.44	1241	82
DF-Nissan	1.72	1254	95
Chana-Ford	1.70	1415	107
Beijing Hyundai	1.75	1319	101
SAIC-VW	1.62	1343	92
DF-KIA	1.69	1275	103
SAIC-GM-WL	1.27	1180	67
DFPC	1.70	1356	94
SAIC-GM	1.80	1435	109

2.2.3.2 China's 2013 10 Leading Independent Brands

In 2013, China's Top 10independent domestic manufacturers produced a cumulative total of 2.93 million cars, which accounted for 17.1% of the market. They are Chery, BYD Automobile, Chang'an Automobile, Geely pride, Geely, Great Wall Motor, Dongfeng well-off, BYD auto industry, SAIC shares, and JAC.

Independent brands' CAFC vary, ranging from 6.31L/100km to 7.84L/100100km, with Chery scoring the lowest CAFC value and JAC scoring the highest. In comparison to 2012 values, independent brands' annual CAFC versus their 2020 targets has improved from 105.9% to 99.2%, reflecting major energy-saving technology upgrades. Many independent companies were recorded to integrate start-stop, turbo pressure, variable valve timing system (VVT) and other advanced fuel-saving technologies. Yet, in comparison to JVs technological capacity, which brings better relative improvements per vehicle weight and size, independent brands still lag behind.

Figure 13: China's 2013 Top 10 Independent Manufacturers' CAFC Values



However, in relation to their 2020 target, independent manufacturers such as BYD Auto already scored 124% of their 2020 target, so the new standard may not be stringent enough. In the case of BYD, its New Energy Vehicles (NEVs) production capacity, new standards' reliefs on NEVs manufacturers, and further ICE energy-saving technologies promotion may be missing for bringing about more significant local capacity-building and longer-term results.

Figure 14: China 2013 Top 10 Independent Manufacturers CAFC vs. their 2020 Target

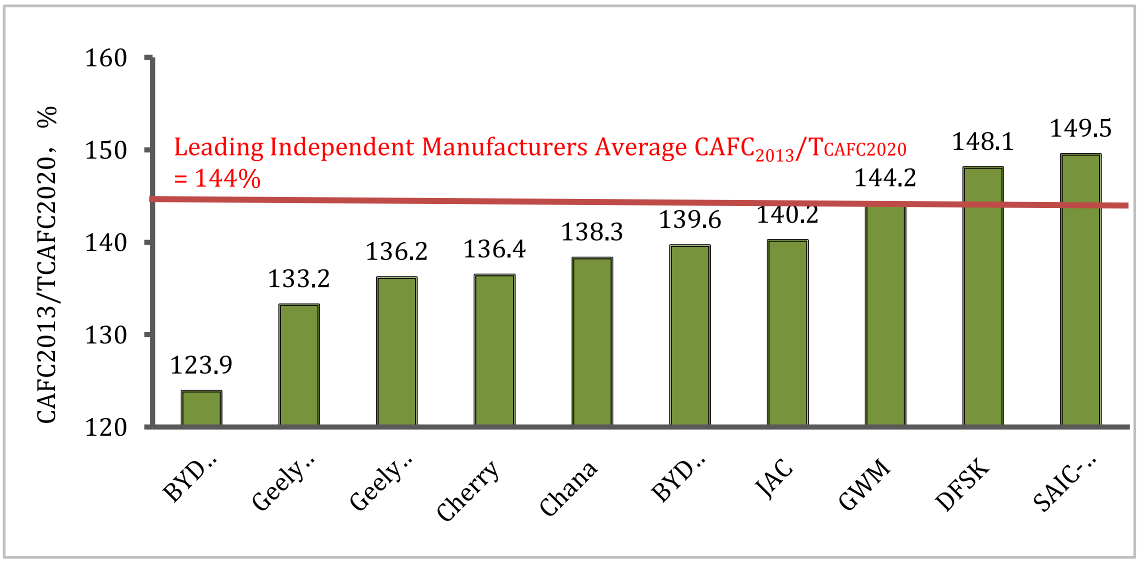


Table 13: China's 2013 Top 10 Independent Manufacturers' Vehicle Features and Technology Evaluation

Automaker	Displacement （L）	Mass（kg）	Power （kw）
BYD Auto	1.50	1268	84
Geely Auto	1.54	1245	83
Geely Haoqing	1.50	1149	78
Cherry	1.41	1186	74
Chana	1.28	1161	71
BYD Industry	1.65	1406	91
JAC	1.70	1442	97
GWM	1.70	1375	98
DFSK	1.20	1139	62
SAIC-Moter	1.58	1368	96

2.3 Importing Brands

2.3.1 2013 Annual Targets Meeting Analysis

In 2013,MIIT announced for the first time China's corporate average fuel consumption annual values, including 25-passenger car importing brands. Importing brands' CAFC in 2013 averaged 9.05L/100km, about 25.3% higher than domestic passenger car manufacturers' CAFC. While the gap between these corporate segments is gradually being reduced, importing brands' annual CAFC decline is maintaining high rates, and peaked with an annual reduction of 5.4% in the past year.

China started including importing brands into its fuel economy regulation only when the standards' Phase III was implemented on 2012; however, it only requires importing manufacturers to meet the corporate average fuel economy target and exempt importing cars from meeting the weight-based limit. In 2013, some 800 imported models were recorded, of which about 10% did not meet China's weight-based vehicle fuel consumption limit.

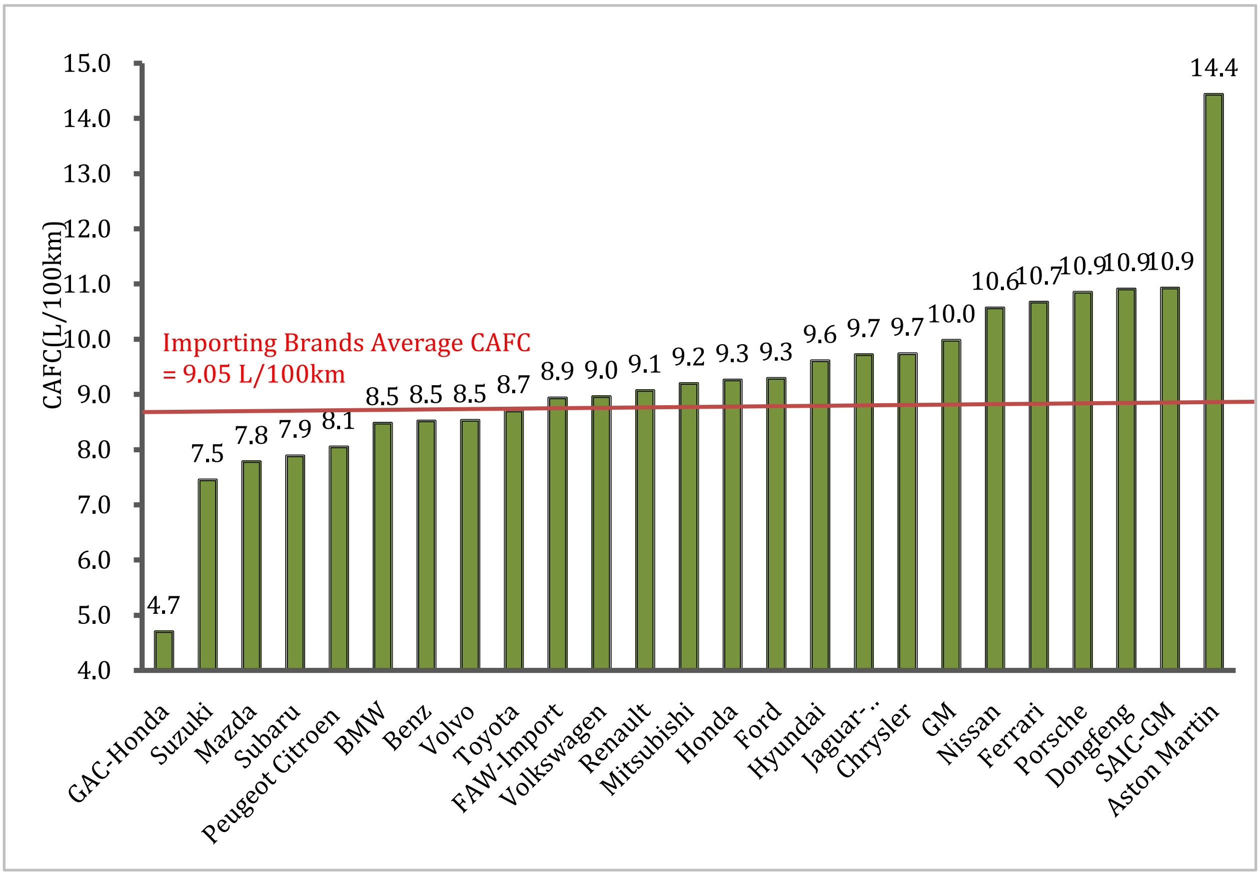
China's importing vehicles' average CAFC in 2013 was 9.12L/100km, similar to the previous year. On average, importing manufacturers achieved CAFC of 99.3% from the annual target, among which 11 cars importers reached the target while 12 importers did not reach the target. This indicated 48% compliance and very stringent FC reduction requirements going forward.

Importers that have reached the lowest annual CAFC were Guangqi Honda

Automobile, Suzuki (China) Investment, Mazda (China) Enterprise Management, achieving 4.7L/100km, 7.5L/100km, and 7.8L/100kmrespectively. Honda only imported 20 car models, of which its hybrid series played a major role (e.g. Honda CR-Z) in leading with a very low ratio from its annual CAFC target with a score of 65%. Aston Martin averaged 14.4L/100km, above the annual target by 156%, indicating more pressure towards meeting the standard targets lies ahead. Luckily, Aston Martin only imported 500 models last year, which had little impact on China's overall market performance.

In recent years, importing manufacturers have changed their imported vehicle models features to better match China's regulatory framework and perhaps also to better meet changing consumers' requirements. This resulted with an overall better environmental performance using smaller engine displacement and lower curb infiltration. According to MIIT's May 2014 "Corporate Average Fuel Consumption of Passenger Cars Management strengething" announcement, penalties targeting customs and inspection authorities were mentioned rather than the importing brands liability. This indicates weak and incomplete enforcement system.

Figure 15: China's 2013 Importing Brands' CAFC Values

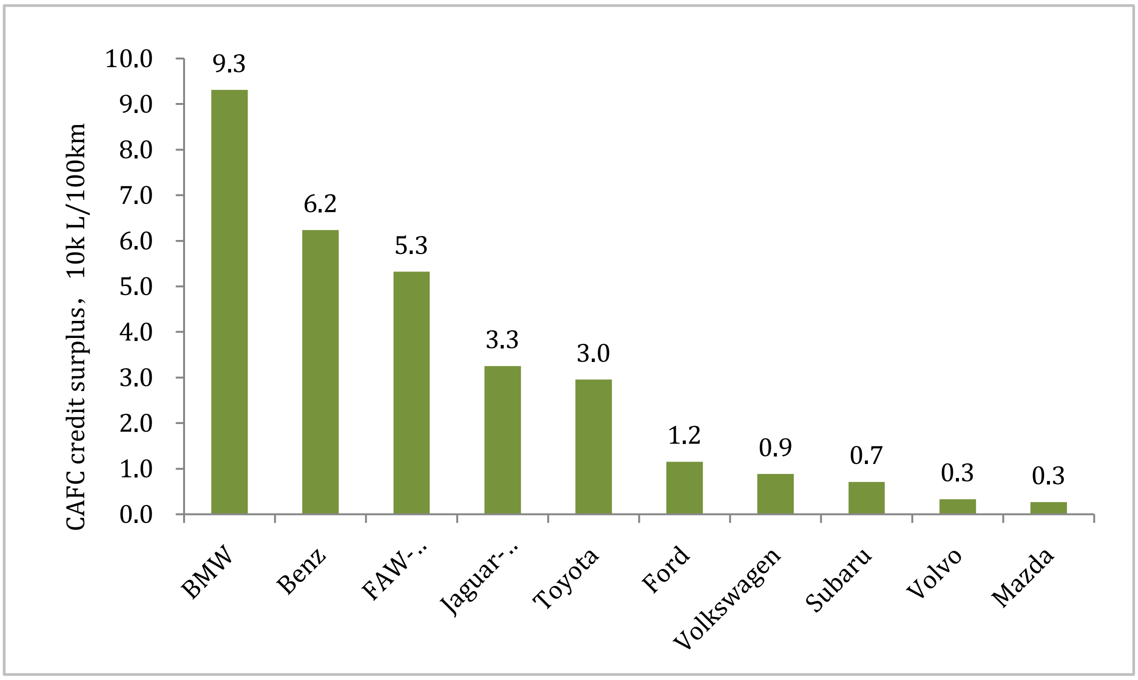


2.3.2 Corporate Target Credits Shortage/Surplus

In 2013, 11 importing brands met their annual CAFC target totaling 304,000L/100km.

BMW Auto Trade, Mercedes Benz, and FAW achieved a total of 93,000, 68,000, and 53,000 respectively, ranked best. 12 companies did not meet the target, totalling 78,000L/100km, however outperforming the previous year, which scored 17 times worst.

Figure 16: Leading Importing Manufacturers with Target Surplus Credits



2.3.3 Corporate 2020 Target Analysis

The data underlying this section's analysis is outlined in **Table 14**, and relays on *i*CET's assumption regarding corporate annual vehicle import volumes, models' curb-weight and fuel consumption values.

Table 14: Import Vehicle CAFC vs. 2020 Target Analysis Data Sources[25]

Data Source	Data Type
国机集团 中国进口汽车贸易有限公司 CHINA AUTOMOBILE TRADING CO., LTD	Annual Import*
中国汽车燃料消耗量网站 the website of Automobile Fuel Consumption of China	Vehicle Fuel Consumption (FC)

Table 15: MIIT and *i*CET's CAFC Results Gap

	*i*CET Calculation*	MIIT Release*	Similarity

[25]中国汽车燃料消耗量网站.http://chinaafc.miit.gov.cn/index.html
中国汽车技术研究中心.中国汽车工业协会．中国汽车工业发展年度报告 2014 版. 2014 年 5 月.
中国进口汽车市场数据库，海关乘用车进口量. http://www.ctcai.com/. 2014.06 内部数据购买

2013 CAFC （L/100km）	9.16	9.05	101.2%
2013 T_{CAFC}（L/100km）	9.22	9.12	101.2%
2013 CAFC/ T_{CAFC}	99.4%	99.3%	100.0%

*Calculated based on the data sources listed in Table 5.

According to *i*CET's estimations, importing brands would be faced with an average 2020 target of 5.93L/100km, approximately1L/100km higher than the target domestic manufacturers will be facing, which ranges between 4.5L/100km and 6.5L/100km. Suzuki is projected to be faced with the lowest 2020 target of 4.6L/100km, while Jaguar Land Rover, Porsche and other ultra-luxury cars importers are projected to be faced with a relaxed 2020 target of about 6.4L/100km, as illustrated in **Figure 17.**

2013 CAFC average value of importing brand's projected 2020 target was 155%, some 10 percentage points higher than that of domestic manufacturers. As of China's Phase IV standards' first implementation year, importing brands' CAFC2016/TCAFC2020 is projected to be 134%,which indicates an immediate reduction in average FC as of 2014. It would ease the annual reduction pace towards meeting the importing brand's stringent 2020 target.

Figure 17: China 2013 importing brands' CAFC

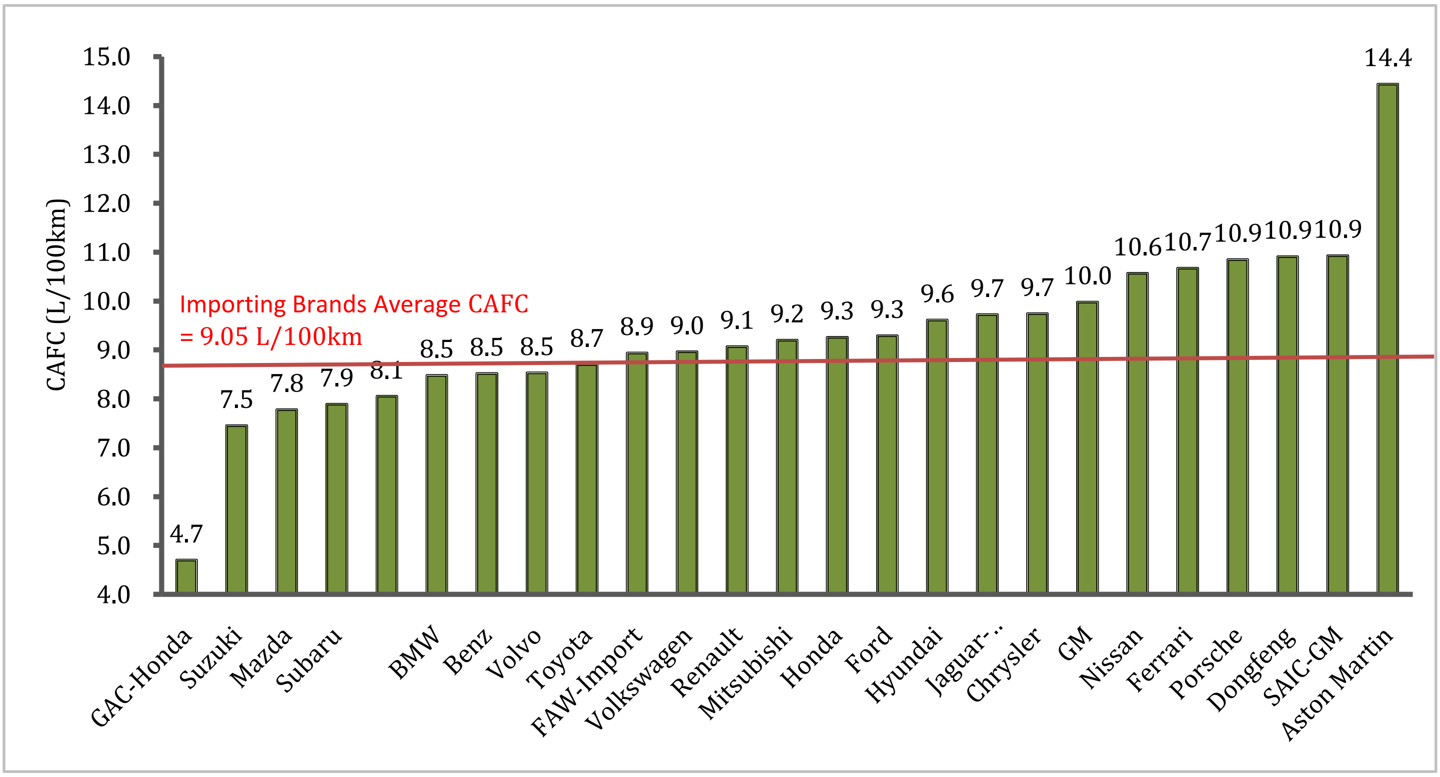


Figure 18: China's Importing Brands' 2013 CAFC vs. their 2020 Target

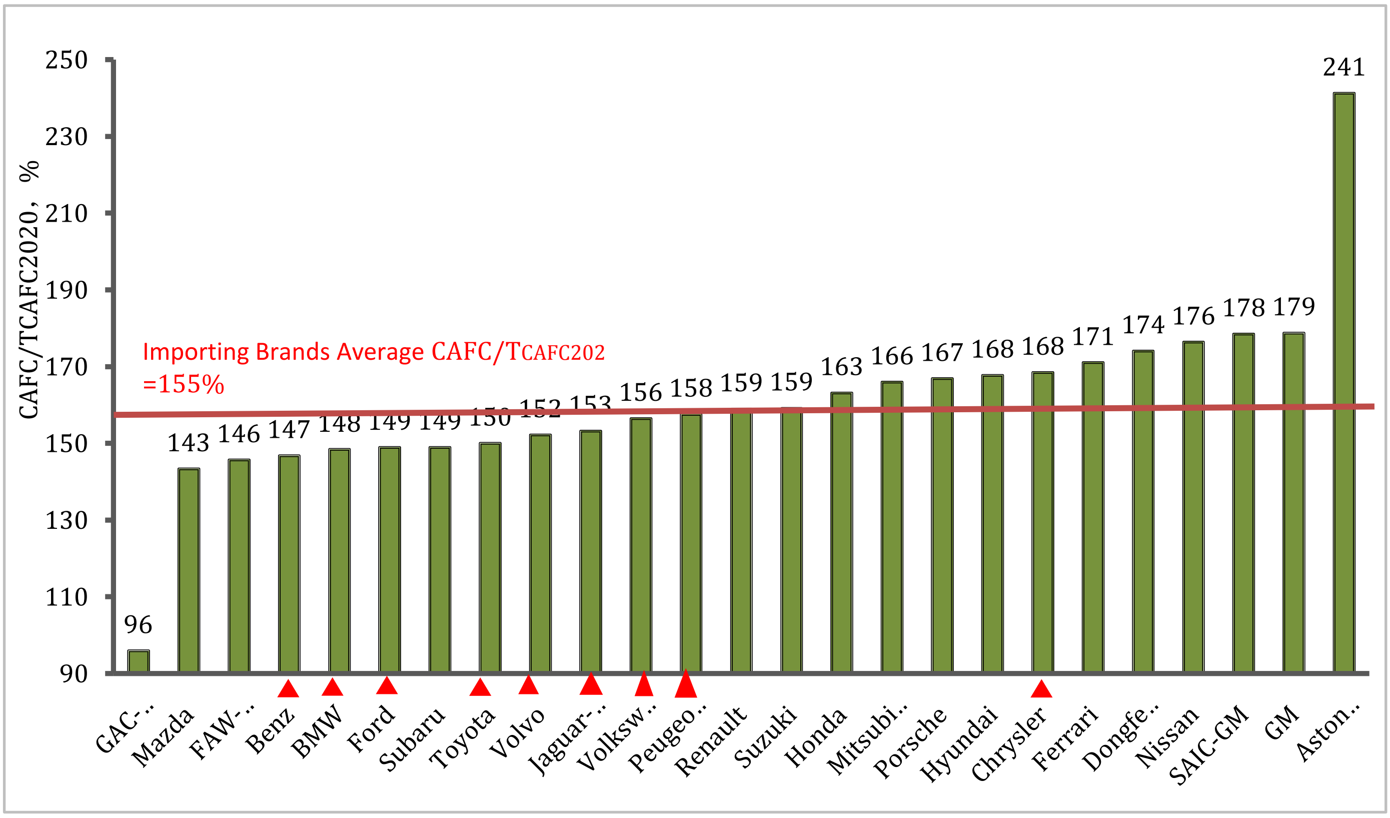


Figure 18 shows importing brands' 2013CAFCpercentage values of their projected 2020 target (CAFC/TCAFC2020), where "▲" marks brands importing over 50,000 vehicles. These large volume importers FC gap from their projected 2020 targets is between 146% and 156%, and only Chrysler has reached a gap of as much as 168%.

In order for importing brands to reduce their corporate average fuel consumption from the current 9.15L/100km level down to their projected 2020 5.93L/100km level, they should reach a steep annual decline of 6% in the following years. Since the past year, importing brands have seen an annual CAFC reduction of 5%, and since importing brands have greater access to high technologies developed abroad and higher bargaining power than domestic manufacturers, this stringent target is believed to be achievable.

China's Top 10 importers of 2013 are currently characterized by high engine displacement rate, high vehicle curb weight, and high power voltage. While importers such as Chrysler and Mercedes-Benz have fairly average technical parameters, their annual CAFC versus 2020 target was 14.3 percentage points higher than that of Mercedes-Benz, reaching as much as 168%.

Table 16: China's 2013 Top 10 Importing Brand's Vehicle Features and Technology Evaluation

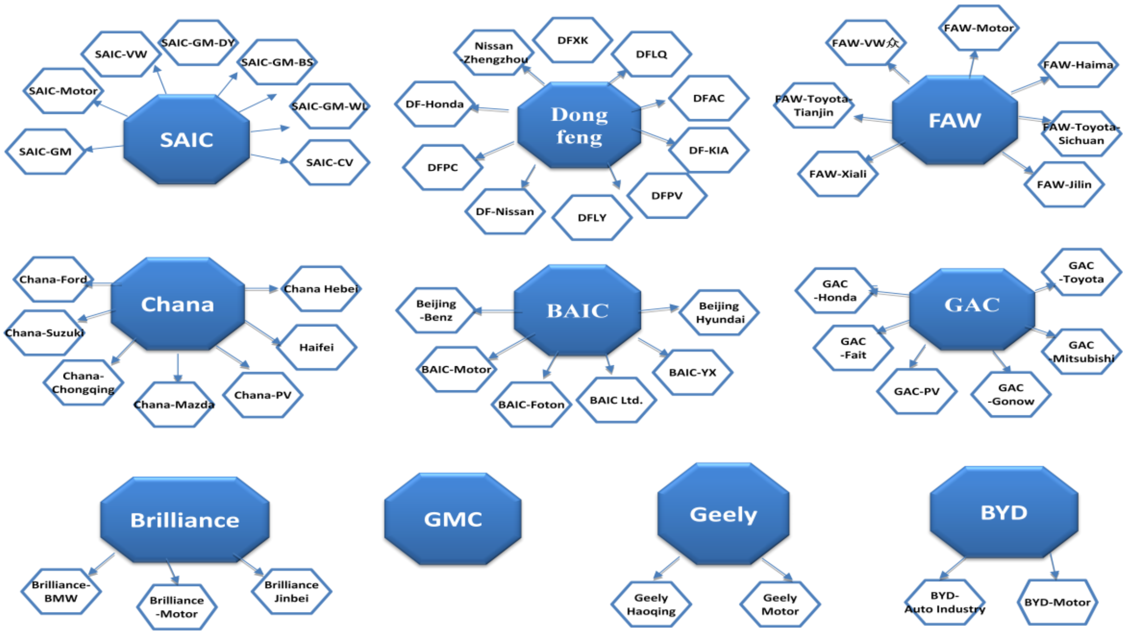
Importer	Displacement（L）	Mass（kg）	Power（kw）
BMW	2.38	1852	201
Benz	2.64	1857	173
Jaguar-Land Rover	2.54	1784	208
Chrysler	2.61	1711	144
Volkswagen	2.30	1783	153
FAW-Import	2.49	1880	174
Toyota	2.73	1774	142
Volvo	2.09	1698	189
Subaru	2.23	1540	152
Hyundai	2.45	1723	201

2.4 China's Top 10 Vehicle Corporations

2.4.1 Top 10 Vehicle Corporations Introduction

Extending beyond an analysis of China's vehicle domestic manufacturers and importing brands, this section is aimed at highlighting the fuel consumption performance and trends of China's leading vehicle manufacturers, which accounts for 94% of China's vehicle market and governing 51 vehicle manufacturers.

Figure 19: China's Top 10 Corporations



2.4.2 Top 10 Corporations 2013 Annual CAFC

China's Top 10 corporations'2013 average CAFCwas8.0L/100km, with Geely Automobile Group, BYD Auto Group, Changan automobile Group leading CAFC performance with 6.55L/100km 6.70L/100km and 6.75L/100kmrespectively as shown in **Figure 20**. Only 2 corporations did not comply with their 2013's target, indicating that from a corporate perspective even more stringent standards could be achieved.

In the "Passenger Cars Corporate Average Fuel Consumption Management Strengthening Notice", it was noted that China's corporations should be accountable for the management of their manufacturers' compliance efforts, technological capacities and performance achievements. By shifting the accountability from a manufacturers-based approach to a corporate-based approach, more manufacturers would potentially be able to comply with China's exsiting standards and perhaps even with more stringent standard requirements. Moreover, technological improvements would be able to serve a larger market share by providing for local innovation economics of scale.

China's Top 10 corporations CAFC scores of their projected 2020 values averages 140%, with GAC reciving the worst score of 150%, whicle BYD received the best performing score of 125%, as illustrated in **Figure 21**.

Figure 20: China's Top 10 Corporations 2013 Annual CAFC

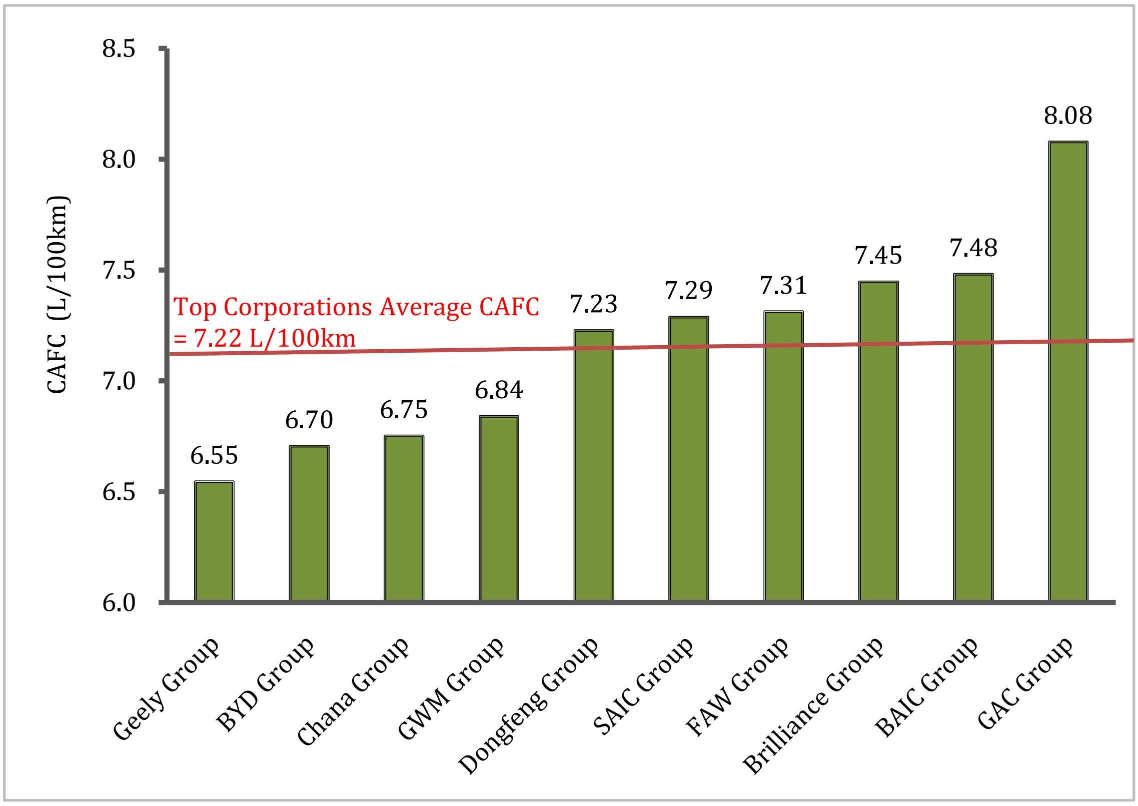


Figure 21: China's Top 10 Corporations 2013 CAFC vs. their 2015 Target

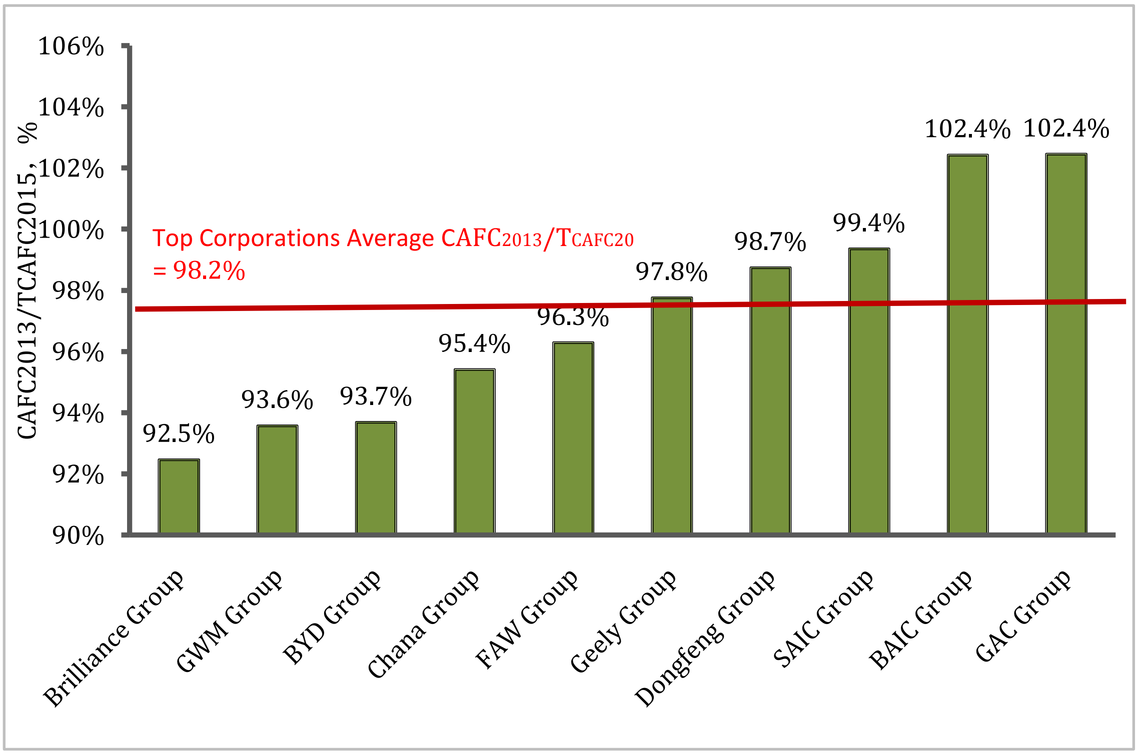


Figure 22: China's Top 10 Corporations 2013 CAFC vs. their 2020 Target

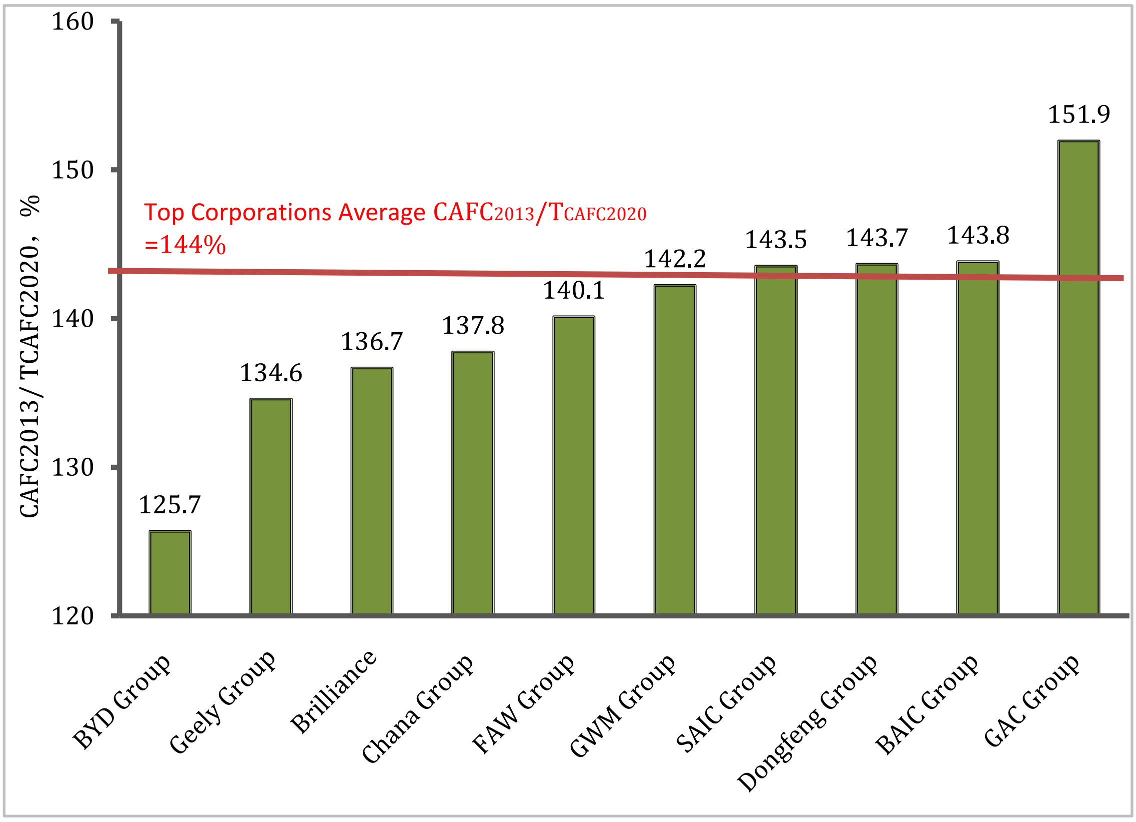


Table 17: Different Calculations Methods Result in Different CAFC/T2020 Values

Auto Group	Total Credit Calculated (Unit: 10k L/100km)	
	Based on Group Results	Based on Cumulated Groups' Manufacturers Results
SAIC Group	22.4	84.1
Dongfeng Group	26.6	40.7
FAW Group	73.9	93.2
Chana Group	54.8	55.2
BAIC Group	0	-10.4
GAC Group	0	1.8
GWM Group	25.5	30.2
BYD Group	27.7	27.7
Brilliance Group	19.9	19.9
Geely Group	4.8	4.8
Total	255.7	347.1

2.5 Comparative Analysis of 2012 and 2013 CAFC

China's 2013 CAFC average value decreased by 2.7% from 2012 CAFC average value, while increasing from the previous year 2.16% annual reduction in average annual CAFC, as shown in **Table 18**. China's corporate average fuel consumption target has changed from 2012 to 2013 by some 2.9%, excluding importing brands, as outlined in **Table 19**. Importing brands maintained high annual reduction rate of over 5% for two consecutive years, while independent domestic manufacturers increased their annual FC reduction rate to 4.8%.

Table 18: Annual CAFC Comparison between 2012 and 2013

	2013	2012	2013vs.2012
Average(Domestic&Import)	7.33	7.53	*-2.7%*
Domestic Manufacturers	7.22	7.38	*-2.2%*
1. JV	7.31	7.42	*-1.5%*
2.Independent	6.95	7.30	*-4.8%*
Importing Brands	9.05	9.57	*-5.4%*

Table 19: Annual CAFC Target Comparison between 2012 and 2013

	2013	2012	2013vs.2012
Average (Domestic& Import)	7.46	7.27	*+2.6%*
Domestic Manufacturers	7.35	7.14	*+2.9%*
1. JV	7.46	7.25	*+2.9%*
2.Independent	7.01	6.90	*+1.6%*
Importing Brands	9.12	9.16	*-0.4%*

As shown in Table 20, actual CAFC and target values ratio decreased by 5% between 2013 and 2012, which exceeded the standard required annual decline of 3%. The improvement is meeting targets due to the increased annual target and the decrease in annual CAFC values. Although China's standard is based on curb-weight bins requirements, Chinese vehicle models FC may be largely impacted from the integration of high-end technology solutions, in terms of better meeting national standards, consumer preferences and corporate development.

Table 20: A Comparison of Actual CAFC and Target CAFC between 2013 and 2013

	2013(A)	2012(B)	2013subtract2012 (A-B)
Average (Domestic&Importing)	98.2%	103.5%	5.3%
Domestic Manufacturers	98.2%	103.4%	5.2%
1. JV	97.9%	102.3%	4.4%
2.Independent	99.2%	105.9%	6.7%
Importing Brands	99.3%	104.5%	5.2%

Table 21 shows that in China's 2013 domestic average vehicle curb weight rose by 3% to 39kg. Independent manufacturers' average vehicle curb-weight rose by 7% to 85kg, while importing brands average vehicle weight slightly decreased. According to **Table 22**, China's domestic vehicle engine displacement experienced only slight annual changes, mainly because while independent brands experienced an annual increase of 2.3% to 1710mL, importing brands experienced an annual decrease of 2.2% to 2580mL.

Curb weight and displacement values positively correlated with vehicle CAFC values. Imported vehicles' high curb and displacement state dilutes their energy saving technologies.

Table 21: China's Annual Average Vehicle Curb-Weight Changes (kg)

	2013	2012	2013vs.2012
Domestic Manufacturers	1334	1295	+3.0%
1. JV	1361	1321	+3.0%
2.Independent	1318	1233	+6.9%
Importing Brands	1805	1809	-0.2%

Table 22: China's Annual Average Vehicle Engine Displacement Changes (ml)

	2013	2012	2013vs.2012
Domestic Manufacturers	1640	1630	0.6%

1. JV	1670	1710	2.3%
2.Independent	1580	1480	0.7%
Importing Brands	2524	2580	-2.2%

2.6 NEVs Contribution to China's CAFC Targets

In 2013, about 17,600 New Energy Vehicles (NEVs) were produced in China, which was an annual increase of 37.9%. This figure includes 14,000 pure electric vehicles and 3,038 plug-in hybrid cars. New regulations and plans are aiming at promoting the commercial vehicle adoption and an expansion of investments and products development from public domain to the private domain.

According to the China's Auto Industry Annual Report, new energy passenger car production was 12,093 in 2013.Chery QQ3-EV, BAIC E150, BYD E6, F3DM (plug-in), Qin (plug-in), JAC Wyatt-EV, Dongfeng Kai Chen C30-EV, and Great Wall CX30 are typical EV electric car models. According to the new standard accounting methods for energy saving and new energy vehicles, the production of pure electric vehicles and plug-in hybrids (with over 50kmmileage) would be eligible to account for five times the actual volume for increasing its positive impact on corporate actual fuel consumption values. New energy vehicles will therefore be able to reduce actual CAFC by 0-0.4 L/100km, which leads to automakers CAFC changes between 0-7%.

In 2013, Chery QQ3EV led annual electric passenger car sales with over 5,800 vehicle sales, which accounted for 1.3% of Chery Automobile total sales, thus positively impacting its CAFC by 6.2%. Beiqi E150 led to 4.3% CAFC reduction and second NEV by sales. While BYD's electric car technology is relatively mature as well as the introduction of three new energy vehicles (E6, plug-in electric vehicle F3DM and Qin), the company's structure does not enable impact evaluation but rather, an estimate of 1.6% and 2.6% (BYD's sales of these vehicles is being split between three of BYD's companies).

Table 23: NEVs Impact on China's 2013 CAFC

Manufacture	EV-models	Type	2013 Production	CAFC Decrease L/100km	CAFC Changes
Cherry	QQ3 EV	EV	5857	0.41	6.2%
	M1 EV	EV	160		
BAIC-Moter	E150	EV	1466	0.32	4.3%
JAC	Tongyu	EV	1279	0.23	3.0%
BYD Auto	E6	EV	1460	0.16	2.6%
	Qin	Plug-in	292		

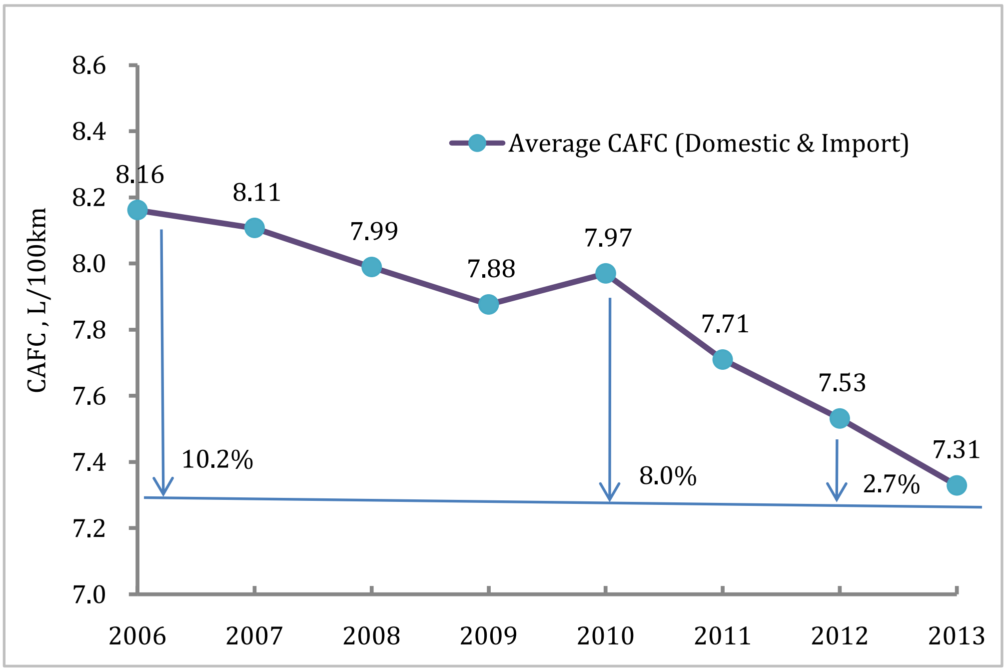
BYD- Industry	F3DM	Plug-in	1005	0.12	1.6%
DF-Nissan	C30-EV	EV	234	0.01	0.2%
GWM	CX30-EV	EV	217	0.01	0.1%
Beijing-Hyundai	500e	EV	105	0.00	0.0%

3. 2006-2013 CAFC Development Trends Analysis

3.1 2006-2013 CAFC Trends

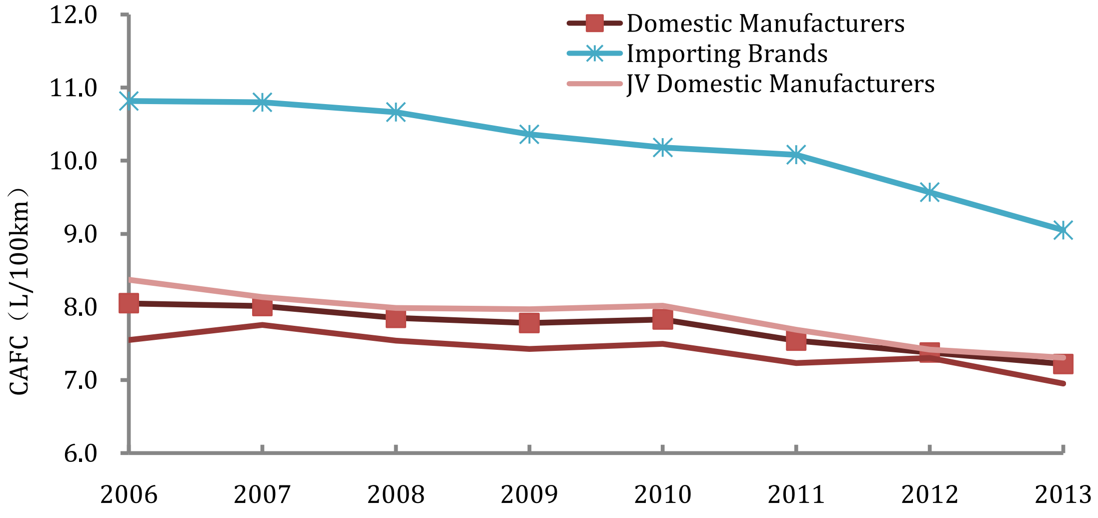
In the "Energy-Saving and New Energy Automotive Industry Development Plan (2012-2020)",the State Council highlighted that vehicle fuel consumption should reach China's fuel economy standard of 6.9L/100km by 2015 and 5L/100km by 2020. According *i*CET's study, during the 11th Five Year Plan (FYP) period from 2006 to 2010, the average fuel consumption of passenger cars fell with a moderate annual decline of less than 1.5%. As of 2010, and in conjunction with the shift to China's Phase II standard, an annual decline of about 3% was evidenced in the past four years. In 2013, China's passenger car average fuel consumption (including domestic cars and imported cars) reached 7.33L/100km, down 2.7% from the previous year, 8% from 2010, and 10.2% from 2006 as illustrated in **Figure 23**.

Figure 23: 2006-2013 Average Annual CAFC Trend



As shown in Figure 23, both domestic (JVs and independent manufacturers) and importing brands have experienced CAFC reduction between 2006 and 2013. If the average CAFC decline can be maintained over the next two years, China will meet its 2015 standard target of 6.9L/100km; however, in order to achieve the 2020 goal of 5L/100km, an annual decline of as much as 5.1% should be maintained over the next seven years, from 2014 to 2020. It typically takes 3-5 years to integrate new on-cycle vehicle technologies, as seen from the gradual increase in FC reduction rate in **Figure 24**; therefore, the auto sector should plan and act accordingly towards China's 2020 CAFC target.

Figure 24: 2006-2013 Annual CAFC Trends by Corporate Type



3.2 Domestic Manufacturers' CAFC Trends

China's domestic manufacturers experienced a total CAFC reduction of 10.3% from 2006,8.05L/100km to 2013 7.22 L/100km value (**Figure 25**). Although the average annual reduction was 2.7%, when China's Phase III fuel economy standards were introduced in 2011 (or 5 years since fuel economy standards were introduced), domestic manufacturers experienced sharper annual CAFC decrease followed by a moderate decrease in the past two years.

JVs experienced sharp CAFC reduction of 12.7% from 8.37L/100km in2006 to 7.35L/100km in 2013 (**Figure 26**). JVs CAFC reduction can be broken into four periods: 2006-2008 with an overall decline of 4.6%; 2008-2010 with a negative cumulative decline (the second year increase had offset the first year's decline); 2010-2012 with a sharp overall decline of 7.6%; and 2011-2013 moderate decline of only 1.43%. This periodic decline rate shifts may suggest a relatively high response rate potential of JVs to regulatory modifications, stemming from access to advanced global technologies and market margins.

Independent manufacturers experienced CAFC reduction of 8% from 7.55L/100km in 2006 to 6.95L/100km in 2013. Between 2006 and 2010, independent manufacturers managed to only moderately decrease corporate average fuel consumption, while in 2011 and 2013 they have experienced more significant annual improvements (**Figure 26**).

Figure 25: 2006-2013 Domestic Manufacturers' Annual CAFC Trends

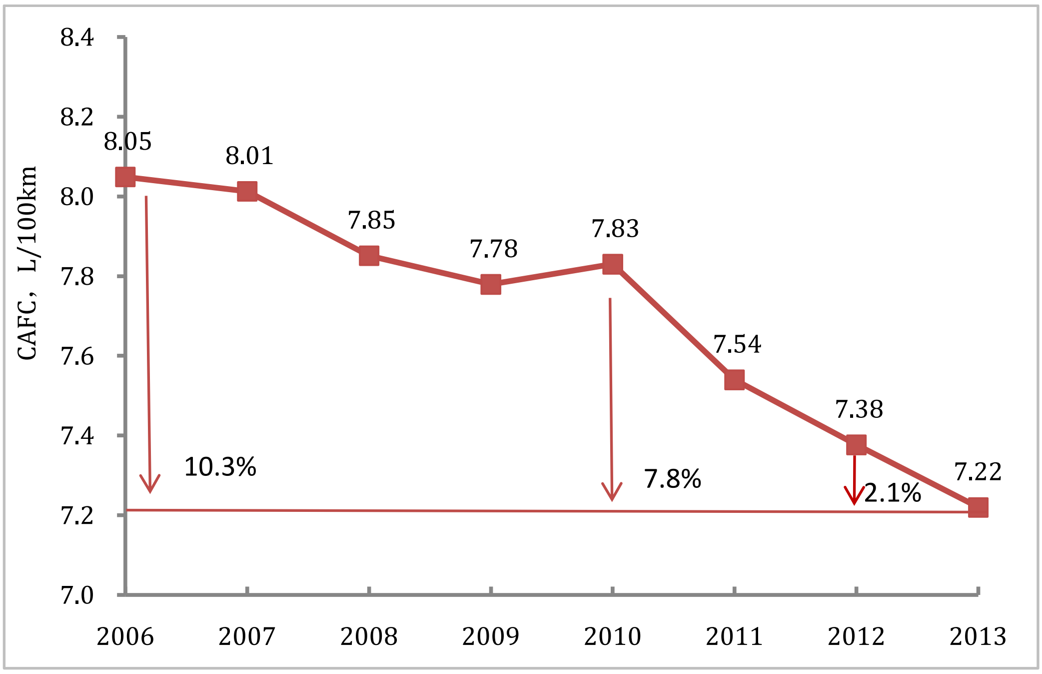
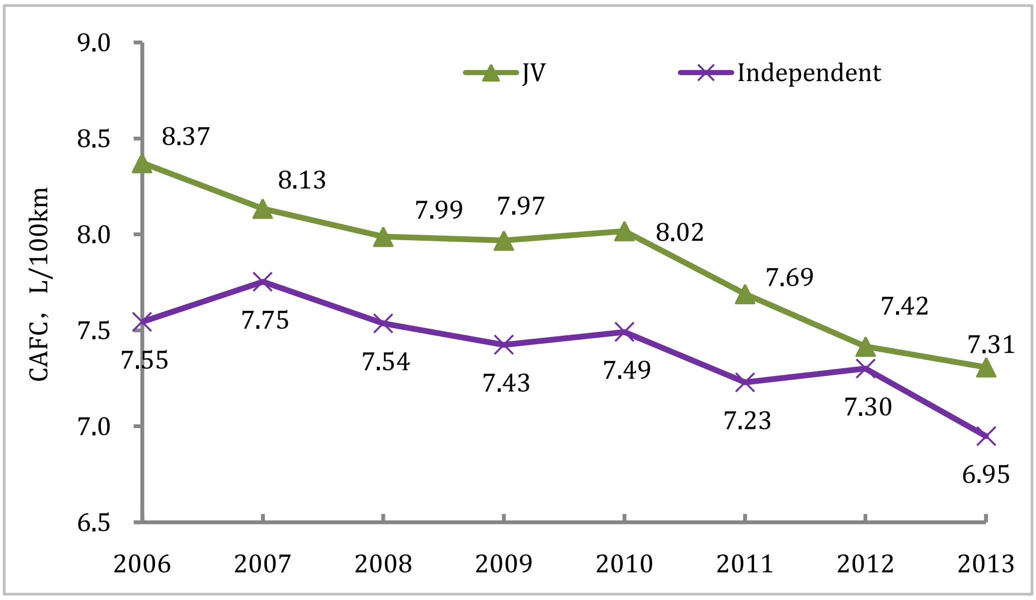


Figure 26: 2006-2013 Domestic Manufacturers' Annual CAFC Trends, by Corporate Type



As illustrated in **Figure 27**, 2006-2013 CAFC reduction of major JVs vary: while Dongfeng-Nissan, Shanghai-Volkswagen, and FAW-Volkswagen's experienced relatively sharp declines of up to 21.4%. Other manufacturers such as Dongfeng-Peugeot-Citroen FC dropped a fifth of this reduction amount. Sharp reduction by Dongfeng-Nissan is stemming from a reduction in average vehicle curb-weight as well as fuel-saving technologies (e.g. CVT), demonstrated by the increase market share of its new Sunshine model, which experienced a reduction of 0.5L in engine displacement, 300kg reduction in curb weight and 3L/100km decrease in its fuel consumption between 2006 and 2013.

Independent brands also have varying reduction values in CAFC between 2006 and

2013. GreatWall CAFC dropped by as much as 29% from 9.64L/100km to 6.84L/100km during this period. Primarily thanks to its models' diversity increase, which included the decrease in SUV models and increase in small vehicle models (e.g. C50, C30), as well as improvement in SUV fuel efficiency and curb-weight (e.g.M6 5.9L/100km).

Figure 27: Major JVs 2006-2013 CAFC Reduction

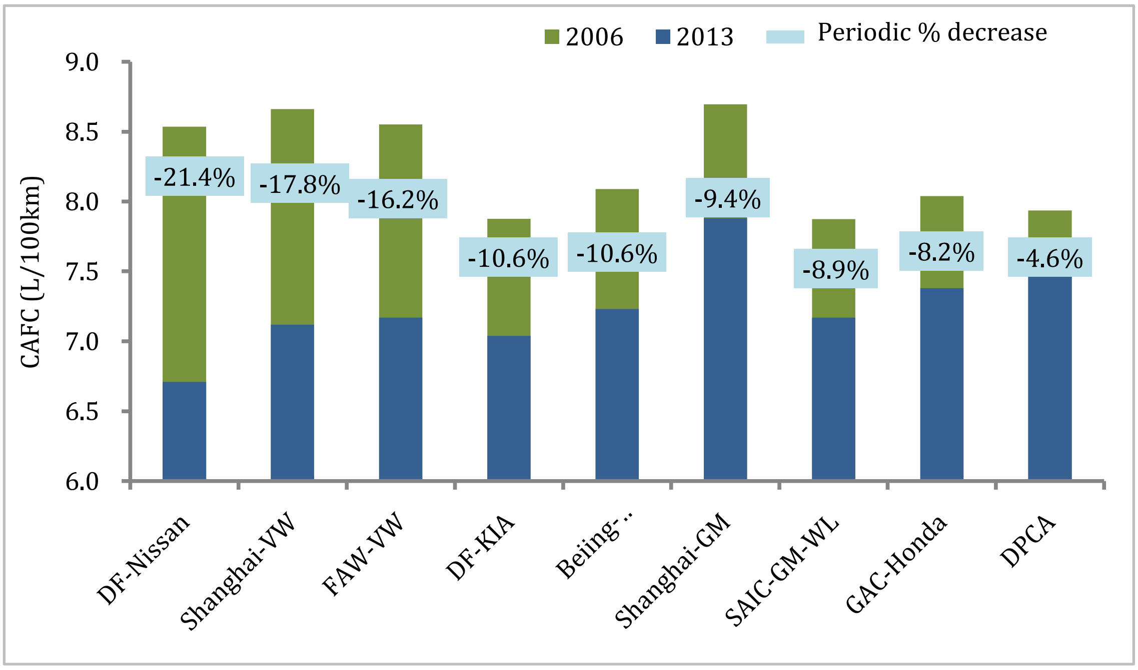
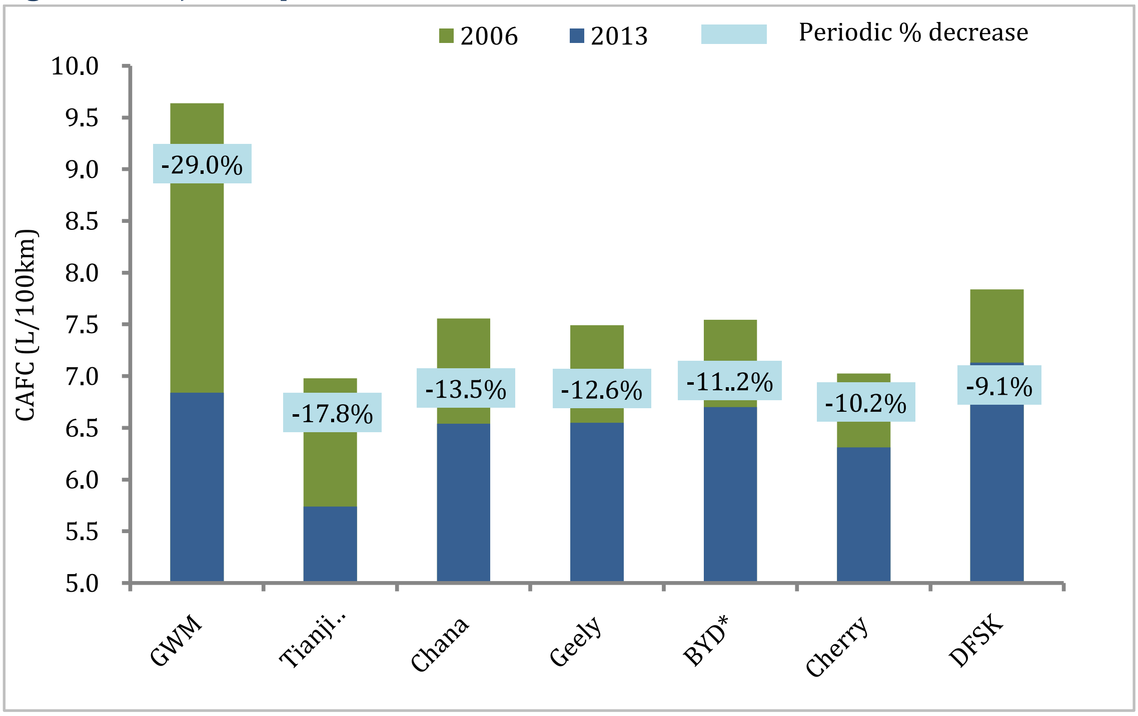


Figure 28: Major Independent Manufacturers' 2006-2013 CAFC Reduction



3.3 Importing Brands' CAFC Trends

Since imported models are mainly comprised of SUVs, luxury and sports vehicles, they are typically characterized by having large engine displacement and low fuel efficiency, which results in some 30% higher CAFC values than domestic manufacturers. However over the last six years, importing brands experienced a sharp decrease of 16.4% in CAFC values from 10.82 L/100km in 2006 to 9.05L/100km in 2013 (**Figure 29**).

Among major importing brands, a more even CAFC reduction can be seen (in relation to domestic manufacturers) as illustrated in **Figure 30**. Jaguar Land Rover, Mercedes-Benz, Volkswagen, BMW, and Chrysler led importing brands' CAFC reduction with over 20% reduction over the last six years. This was due to advanced technology improvements, increased integration, new smaller vehicle models were introduced, and maintaining their high-end consumers (e.g. Mini Cooper).

Figure 29: Importing Brands' 2006-2013 Average CAFC Reduction Trend

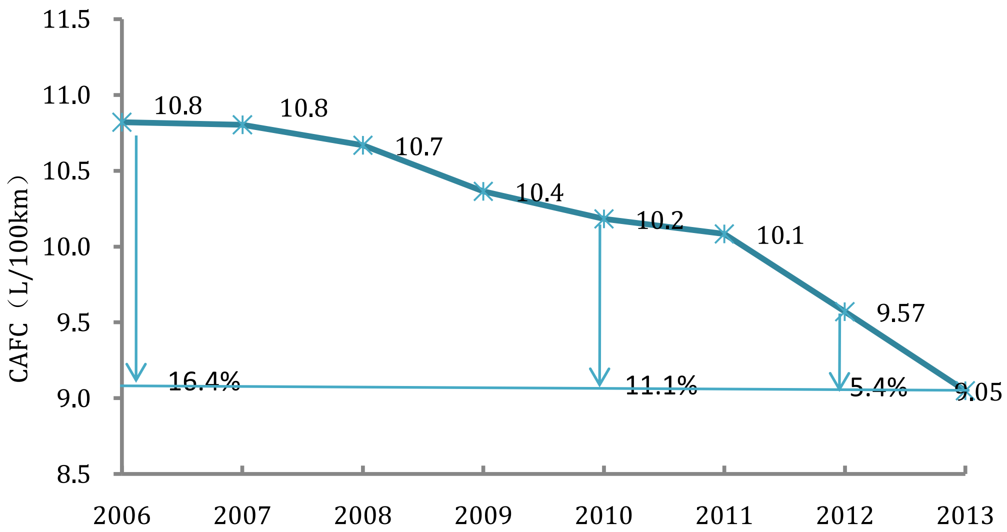
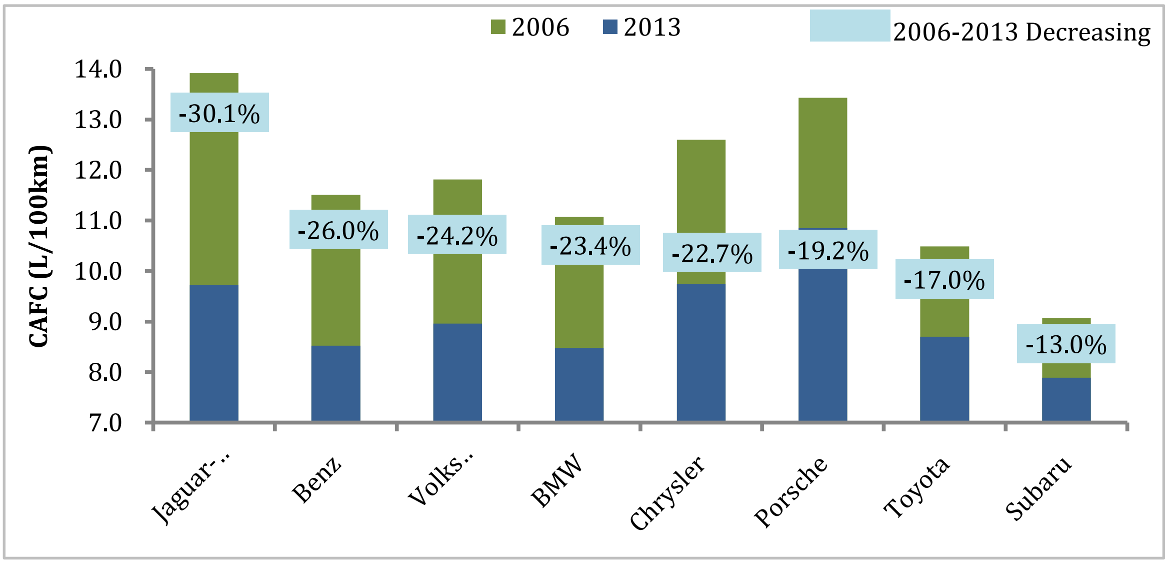


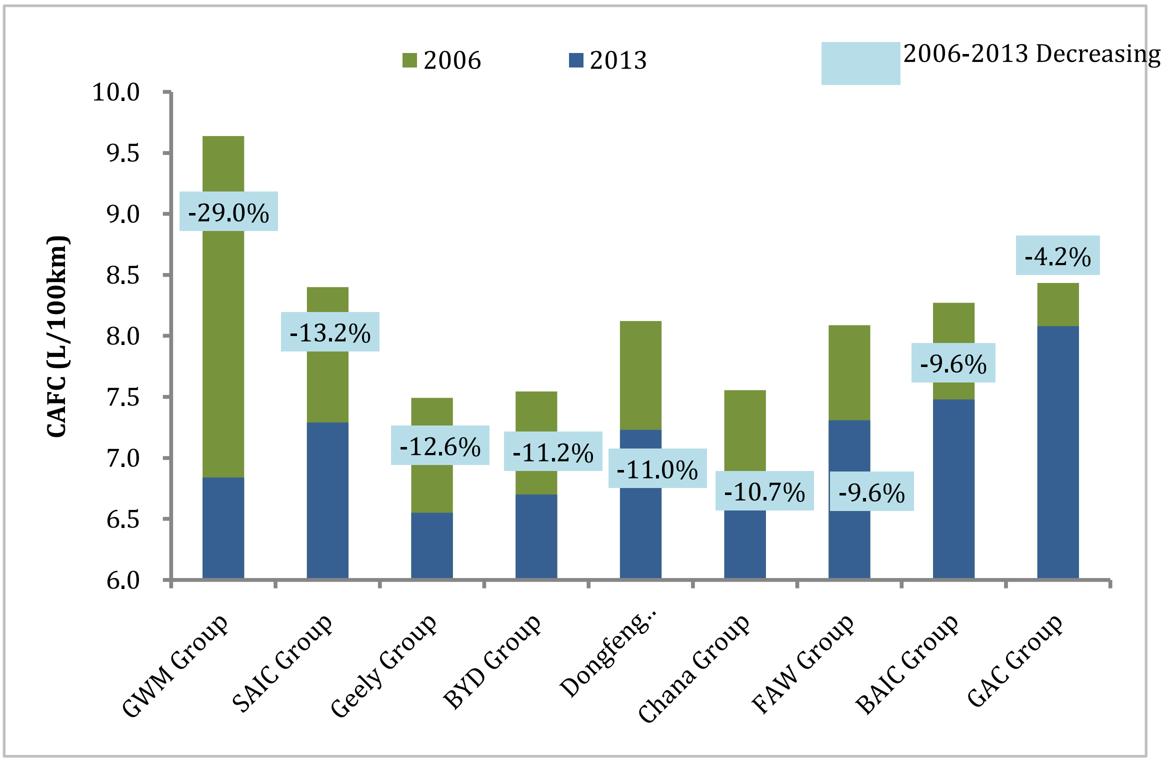
Figure 30: Major Importing Brands' 2006-2013 CAFC Reduction



3.4 Top Corporations' 2006-2013 CAFC Trends

As illustrated in Figure 30, China's leading corporations perspective saw that the past six years has brought moderate overall CAFC reduction of some 10%, while GreatWall Group has led improvements with a periodic CAFC reduction of 29%.

Figure 31: Top Corporations' 2006-2013 CAFC Reduction



4. 2020 Target Meeting

4.1 China's 2020 Target

The "Energy-Saving and New-Energy Automotive Industry Development Plan (2012-2020)" requires passenger vehicle's fuel consumption to drop to 5.0 L/100km. In comparison to 2013 domestic passenger car average fuel consumption level of 7.22L/100km, current fuel consumption level is of 143.5% of the 2020 target. By adding importing brands' average fuel consumption, China's total current average fuel consumption is 7.33L/100km, the relative value is 146.6%.

Under Phase IV of the standard, which is increasing in stringency between 2016 and 2020 as illustrated in **Table 24**, the last couple of years would require a reduction of as much as 0.5L/10kmor 9% annual decrease. On average, an annual decrease of 6.2% is required during Phase IV implementation period, which can be eased to 5.1% if implementation starts two years prior (2014-2020). Either way, this annual decrease is much more demanding than the annual average of 2.3% evidenced between 2006 and 2013.Phase IV is projected to be very challenging as it requires the integration of advanced energy-saving technology and the development of commercial new energy vehicle. Market incentives and market-based programs for promoting long-term adjustments are of increasing importance.

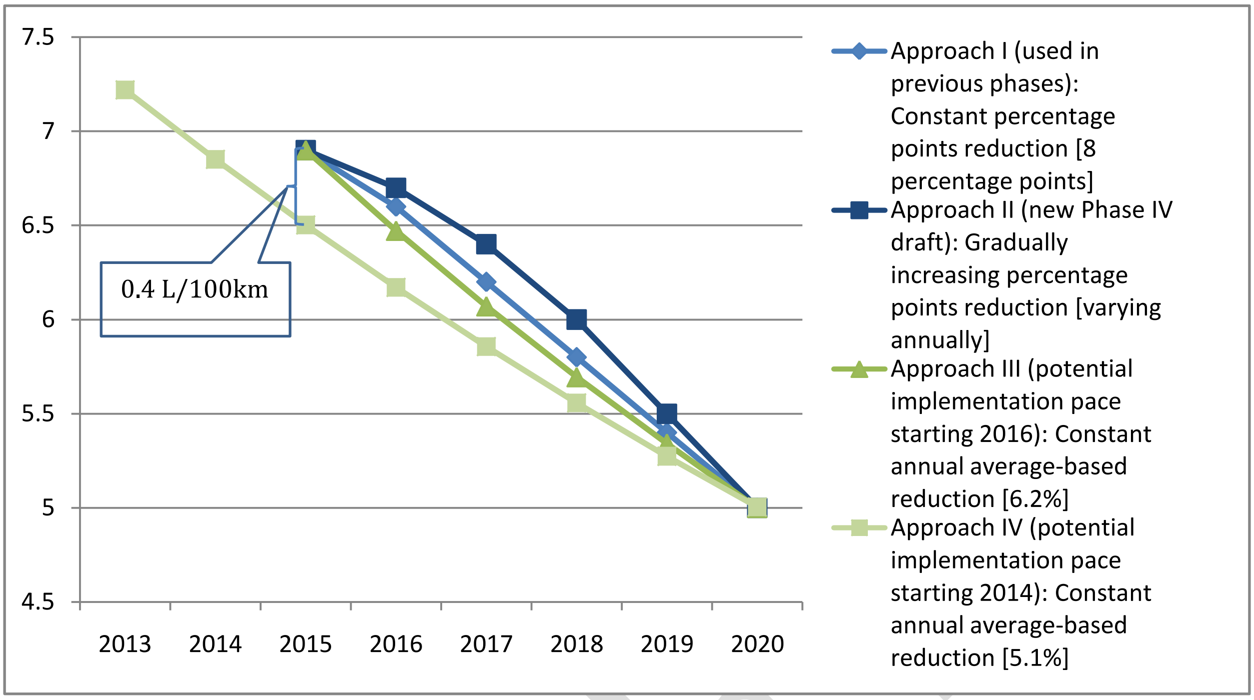
Table 24: 2014-2020 Annual CAFC Reduction

Year	**CAFC/ $T_{CAFC2020}$**	Annual CAFC Reduction**	CAFC L/100km	L/100km	Relative Annual FC Reduction (%)
2013*	144%	5	7.22	0.16	-2.1%
2014*	141%	3	7.06	0.16	-2.2%
2015*	138%	3	6.90	0.16	-2.3%
2016	134%	4	6.70	0.20	-2.9%
2017	128%	6	6.40	0.30	-4.5%
2018	120%	8	6.00	0.40	-6.3%
2019	110%	10	5.50	0.50	-8.3%
2020	100%	10	5.00	0.50	-9.1%
		2016-2020 CAFC Annual Average Reduction			-6.2%
		2014-2020 CAFC Annual Average Reduction			-5.1%

* *i*CET's calculations.

** Annual reduction according to newly stated revisions to Phase IV standard.

Figure 32: Pathways towards Meeting CAFC 2020 Target

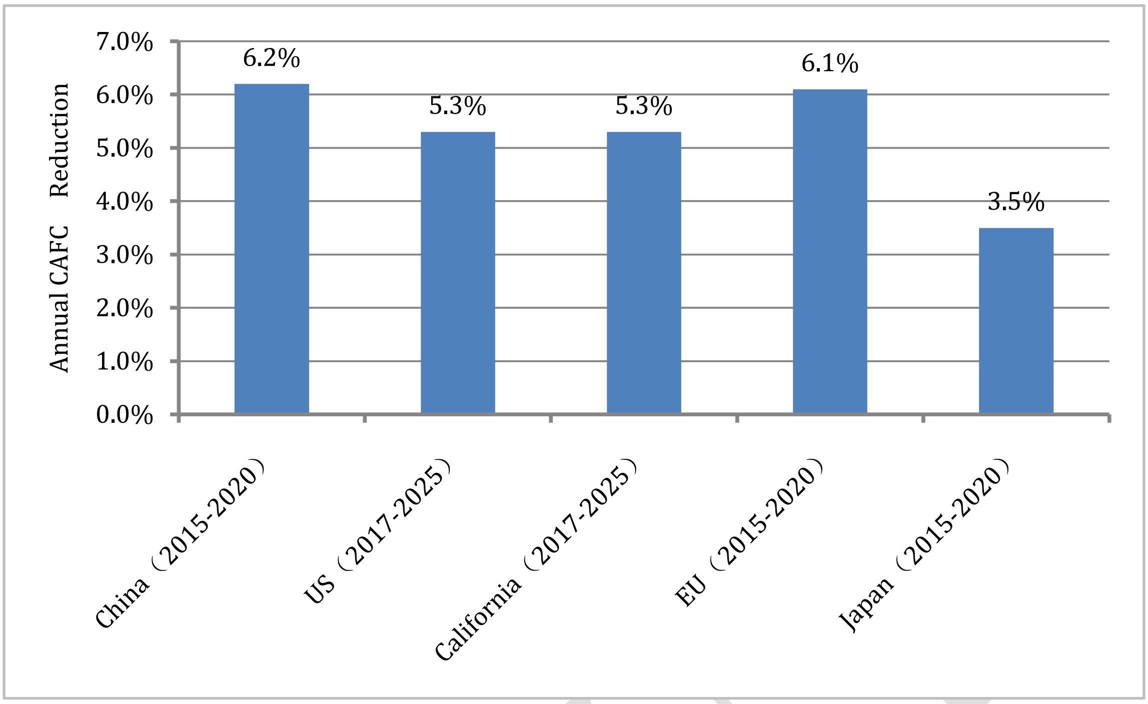


The implementation of new standards requires a significant amount of time. However, strategizing market growth and adjusting production for enabling increasing improvement can increase efficiency. Since most manufacturers can easily achieve the 2015 goal of 6.9L/100km, this analysis suggests that Phase IV should already advise industry development for the next year due to the increasing likelihood of sound implementation, as illustrated in **Figure 32**.

4.2 Global Fuel Economy Challenges Comparison

As illustrated in **Figure 33**, an annual decrease of 6.2% in fuel consumption is required for achieving China's 2020 target: an annual improvement, which is more demanding than the current and projected fuel economy standard of the United States, European Union and Japan. If the standard began implementation this year, its annual average reduction stringency would be 5.1%, stricter than that of Japan and similar to that of the US and California.

Figure 33: A Global Comparison of Average Annual FC Reduction Standard Requirement



4.3 The Contribution of New Energy Vehicles

According to the "Energy-Saving and New-Energy Automotive Industry Development Plan (2012-2020)", the national government plans to reach a production capacity of as much as 2 million pure electric vehicles and plug-in hybrid vehicles as well as the cumulative sales of over 5 million new-energy vehicles by 2020. In an attempt to promote these goals, Phase IV of China's fuel standard presents incentives for new energy vehicles production - each such vehicle is weighted as several vehicles (using a multiplier).

In order to evaluate the impact of energy-saving and new energy vehicles (NEVs) on the CAFC target value, the following assumptions were made: (i) new-energy passenger vehicles account for 80% of total NEVs, while cumulative sales volume would reach 400,000 in 2015 and 4,000,000 in 2020; (ii) the annual growth rate of traditional passenger cars would average 8%, cumulating to the production of 21 million passenger vehicles in 2015 and 31 million in 2020; (iii)NEVs fuel consumption is counted zero therefore, maximizing its positive impact on CAFC performance.

Table 25: NEVs Market Growth Assumptions

Year	NEVs (10k)	ICE Vehicles (10k)
~2013	4	1809
2014	4	1953
2015	8	2110

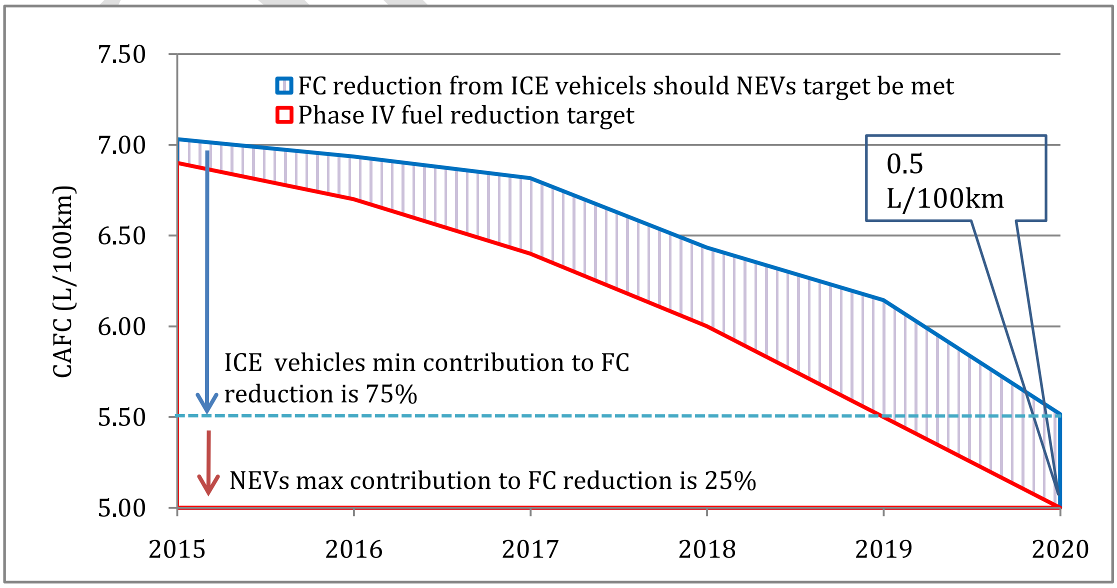
2016	24	2278
2017	40	2461
2018	64	2658
2019	96	2870
2020	160	3100
2020 Cumulative	400	19241

As NEVs are counted as zero fuel consumption vehicles, their annual growth rate is projected to have a varying multiplier of 2-5 every year by 2020, which results in China's 2020 CAFC requirement for conventional technology vehicles - reducing about 5.5 L/100km for meeting the overall CAFC target of 5L/100km.

The reduction of 0.5L/100km in stringency from China's 2020 CAFC requirement resulted from an aggressive introduction of NEV credits and would contribute about 25% towards Phase IV CAFC reduction of 1.9L/100km from 6.9L/100km in 2015 to 5L/100km in 2020. In this case, advanced fuel consumption efficiency technologies are still instrumental for meeting China's stringent 2020 target, and would contribute at least 75%.

Under these assumptions, an annual average CAFC reduction of 4.8% would be required, which a much more relaxed reduction from the current 6.2% average reduction required, as illustrated in **Figure 34**. However, there is strong debate regarding the level of incentives required for including NEVs into CAFC calculations. Therefore, the most likely scenarios will fall into the shaded area below.

Figure 34: ICE vehicles fuel consumption reduction towards Phase IV CAFC target should NEVs production targets be met



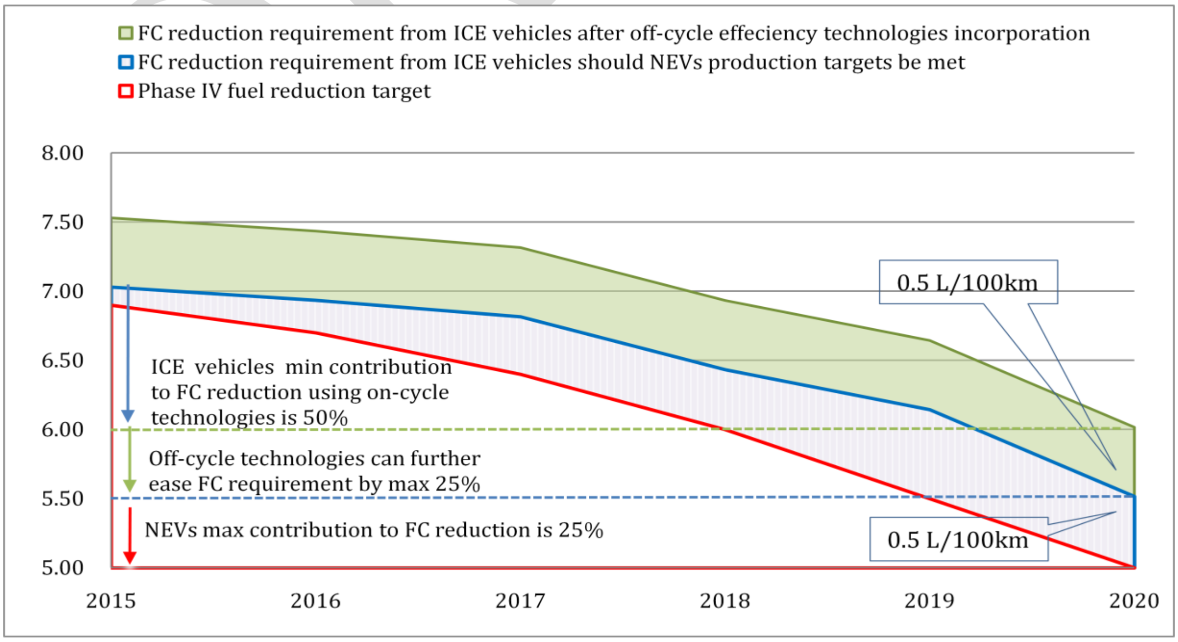
4.4 Energy Efficiency Technologies Contribution

China's Phase IV fuel consumption standard draft also provides additional incentives for installing "off-cycle" energy-saving technologies such as tire pressure monitoring systems, efficient air conditioning, idle start-stop system, and shift reminder, Vehicles that implemented one or more of these technologies will be rewarded with a fuel saving credits of up to 0.5 L/100km from their Test-Approval FC value. From a standard implementation perspective, 0.5L/100km credits represent over 25% of the overall required reduction from the 2015 6.9L/100km benchmark to the 2020 5L/100km requirement.

By adding both off-cycle energy-saving technologies and NEV sales credits, China's vehicle fleet could be rewarded a total of 50% reduction in FC requirement reaching about 1L/100km from the reference requirement of 1.9L/100km. Looking at the most optimistic scenario illustrated by the green line in **Figure 35**, China's automakers could face an average annual reduction requirement of 4.3% (from a theoretical 7.53L/100km in 2015 to 6.02L/100km in 2020) rather than 6.2% by simply complying with the Test-Approval results.

It's still unclear exactly how much off-cycle energy-saving vehicle technologies can contribute to achieving China's 2020 fuel consumption target. Combined with the uncertainties associated with NEVs commercialization, evaluating the 2020 fuel consumption target and implementation effectiveness is a challenging task. Policy-makers' quantification and clarification of these energy-saving and new-energy vehicle technologies credits is crucial for ensuring effective market responses.

Figure 35: ICE vehicles fuel consumption reduction towards Phase IV CAFC target should NEVs production targets be met and off-cycle technologies fully implemented



By comparing technological integrations of global top ten best-selling light trucks such as, the strength of Japanese manufacturers in hybrid powertrain, engine valve technology, start-stop technology is evidenced, while EU technologies are broadly using engine valves, turbocharger technology, and start-stop technology advanced diesel technologies. ICCT and other international organizations have highlighted that advanced energy-saving technologies could potentially bring vehicle fuel consumption improvements of up to 50%, and incur an average cost of less than $1200 per vehicle. Global markets are developing vehicle technology roadmaps for better informing policy-making of actual market capacities and ensuring constant yet effective improvements in vehicle performance.

4.5 Market Trading: Facilitating FC Credits Exchange

Phase III of China's fuel consumption standards establishes credits that can be earned by manufacturers that outperform their annual CAFC target and can be used in the following years toward the ultimate 2015 target. Phase IV draft is further supporting this method; however no management mechanism has been put in place for enabling the capitalization of the initial credits incentive.

Experiences from other countries, such as California's ZEV credits, show that credits trading programs work well in creating market demand and incentives for technology development and integration. Further research is required for assessing credits and trading programs' potential impact on the Chinese market and design programs that would be suited for the local market. *i*CET believes that the establishment of a corporate average fuel consumption credit trading mechanism would have a great impact on the implementation of advanced energy-saving technologies and the development of new energy vehicles.

5. Discussion and conclusions

6. In 2013, MIIT's published fuel consumption data of 6845 vehicles on its China Fuel Economy Website, of which 2862 passenger cars(M1) including 836 imported cars. Half of the vehicles' fuel consumption is in line with China Phase III 2015 target (also 2020 Phase IV limit values), however, almost none of today's vehicle models meet China's 2020 Phase IV target. As imported cars are excluded from the current mandatory fuel economy standard regime, some imported vehicles – mainly SUVs and luxury cars do not even meet the current standard limit and require greater regulatory and management scrutiny.
7. In 2013 domestic corporate average fuel consumption (CAFC) decreased annually by 2.1% to 7.22L/100km, of which JVs CAFC was 7.31L/100km and independent companies CAFC was 6.95 L/100km. Importing brands CAFC was 9.05 L/100km. Looking at the average fuel consumption in recent years as percentage of the Phase III target value (CAFC/TCAFC2015) shows that JVs have an annual FC decrease average requirement of only 1.5% while independent and importing brands are faced with an annual decline of 4.8% and 5.4% respectively. Overall, domestic manufacturers should have no difficulty reaching their 2015 target averaging 6.9 L/100km.
8. Actual corporate average fuel consumption as a portion of the target year value (CAFC2013/TCAFC2015) of domestic manufacturers and importing brands was 98.2% and 99.3% respectively, an annual improvement of 5 percent points on average. As the 2013 annual target was 106% of the ultimate 2015 target, it is clear that the overall passenger market has already made the required improvements for meeting the national target of 6.9L/100km by 2015. Although in actual figures the following year's fuel consumption averaged 7.22 L/100km, it is estimated that by-segment production volumes may be sufficient for internalizing corporate targets.
9. China's average CAFC decreased by 10.2% from 8.16L/100km to 7.31L/100km between 2006 and 2013. While importing brands experienced a sharp decrease of 16.4% in CAFC values from 10.82 L/100km in 2006 to 9.05L/100km in 2013, during the past 7 years China's average annual CAFC decline was only 2.3%. However, some manufacturers experienced a notable annual decline of some 20%(JVs – e.g. Shanghai Volkswagen, independent brands–e.g. Great Wall Motor, importing brands – e.g. Jaguar Land Rover, Mercedes-Benz). Such decline in some cases stemmed from vehicle segmentation diversity (e.g. the notorious SUV and pick-up manufacturer GreatWall which started producing C30 and C50 vehicle models) and some have integrated advanced energy-saving technology upgrades and reduced vehicle weight(e.g. Dongfeng-Nissan with its improved Sunshine and Angels with 30% FC reduction).
10. China's overall $CAFC_{2013}/T_{CAFC2020}$ average ratio was 144%, indicating $CAFC_{2016}/T_{CAFC2020}$ average ratio is projected to be 134%. Corporate reduction requirement over the 2013-2020 period ranges between 124 and 167%. Small vehicle manufacturers are faced with a periodic FC reduction requirement of 134% (e.g. BYD Auto, Changan Suzuki, Brilliance Holdings, Xiali, BMW Brilliance, Southeast

automobile) while large passenger car manufacturers are faced with reduction requirements of as much as 160% (e.g. Guangzhou Toyota, FAW, Sichuan FAW Toyota, GAMC).

11. Importing brands' structure led to actual CAFC of 5.93L/100km, higher than domestic manufacturers' actual CAFC by as much as 1L/100km. Importing brands' $CAFC_{2013}/T_{CAFC2020}$ratio is of 153%, higher than the domestic passenger car business by nearly 10 percentage points. As of Phase III, annual targets bind importing vehicle however FC limits do not. Importing brands $CAFC_{2016}/T_{CAFC2020}$is projected to reach 134%, which is a 20 percentage points reduction during the coming three years - four times the reduction pressure faced by domestic manufacturers. Major importers importing over 50k vehicles per year would be facing an achievable periodic decline of 146-156% between 2013 and 2020.

12. During 2013, a total of 39 companies surpassed the national fuel consumption annual target totaling 3,970,000 L/100km, four times the total amount of year 2012.19 JVs produced 3.06 million L/100km while independent brands produce 910,000 L/100km. 10 auto manufacturers produced 100,000L/100km more than the target amount, topped by FAW-Volkswagen, Shanghai-Volkswagen, and Dongfeng-Nissan, which reached 946,000, 383,000 and 340,000 L/100km respectively. While 22 auto manufacturers failed to meet the CAFC standard, reaching 310,000L/100km compared with the previous years' 110,000L/100km. Three JVs alone were responsible for some 19% of this figure (totaling 60,000L/100km) and independent domestic manufacturers are accountable for as much as 250,000L/100km.In 2013, the number of auto manufacturers not meeting the target represents only 1/10 of the auto manufacturers, which surpassed the target, indicating overall market improvement from 2012.

13. During Phase IV, running from 2016 to 2020, a strict average annual FC reduction of 6.2% is anticipated. If manufacturers start preparing towards implementation for next year (from 2014 to 2020), the annual average reduction rateis projected to be about 5.1%, which is much higher than theaverage reduction of 2.3% seen over the pastseven years (2006-2013). This explains why solutions such as, vehicle efficiencytechnologies, NEVs commercialization and incentivizing trading programs are needed to enable China to meet its fuel economy target for 2020. As the projected Phase IV annual CAFC reduction increases gradually, which can go well beyond the typical market technology adoption and implementation cycle, China's vehicle sector needs to implement advanced technologies as earliest as possible in order to meet the national 2020 target.

14. While in 2013, NEVs affected corporate average fuel consumption reduction by up to 7%, the predominant electric car sales champion Chery QQ3 reduced CAFC by 6.2%. Should NEVs' cumulative sales reach 5 million units by 2020, China's 2020 CAFC requirement for conventional technology vehicles would be reduced by about 5.5L/100km for meeting the overall CAFC target of 5L/100km. The reduction of 0.5L/100km in stringency from China's 2020 CAFC requirement resulted from an aggressive introduction of NEV credits, would contribute about 25% towards Phase IV CAFC reduction of 1.9L/100km from 6.9L/100km in 2015 to 5L/100km in 2020. In

this case, advanced fuel consumption efficiency technologies are still instrumental for meeting China's stringent 2020 target, and would contribute at least 75%.

15. Phase IV for China's fuel economy standard discounts vehicle with energy-saving off-cycle technologies such as tire pressure monitoring systems, efficient air conditioning, idle start-stop device, and shift reminder with up to 0.5L/100km reduction from their Type-Approval FC values.This discount, combined with NEVs FC requirement flexibility, translates to 1L/100km reduction in requirements, or an average annual FC reduction of about 3.3% - well below the basic average 6.2% decrease requirement. Although, such method incentivizes quick solutions integration, they also affect the know-how and capacity-building of the auto industry as well as their actuall ability to meet the original 5L/100km 2020 target.

Appendix

Appendix I: 60 Auto Manufacturers and core models (production >10k)

Company	Full Name in Chinese	JV or ID*	Models in 2013
Beijing-Benz	北京奔驰汽车有限公司	JV	BENZ-GLK, BENZ-E200,BENZ-C200
Beijing Hyundai	北京现代汽车有限公司	JV	ELANTRA,VERNA,ix35
BAIC-Foton	北汽福田汽车股份有限公司	ID	MP-X,MIDI
BAIC-Moter	北京汽车股份有限公司	ID	Weiwang, E150, E130
BAIC-YX	北汽银翔汽车有限公司	ID	M20
BYD-Auto	比亚迪汽车有限公司	ID	F3,L3,G3
BYD-Auto industry	比亚迪汽车工业有限公司	ID	Sirui,G6,M6,F0,F6
Changhe-Suzuki	江西昌河铃木汽车有限责任公司	JV	X5,Furuida,Liana
Chana-Ford	长安福特汽车有限公司	JV	KUGA,MONDEO,VOLVO S80, FOCUS
Chana-Suzuki	重庆长安铃木汽车有限公司	JV	Alto, Lingyang ,Swift
Chana-Mazda	长安马自达汽车有限公司	JV	Mazda series,CX5,Fiesta
Chana-Chongqing	重庆长安汽车股份有限公司	ID	Star, EADO, Benni, Honor
Chana-Hebei	河北长安汽车有限公司	ID	Xingguang, Ruixing
GWM	长城汽车股份有限公司	ID	Voleex C30,C50,HAVAL M, HAVAL H
DF-Honda	东风本田汽车有限公司	JV	CR-V, CIVIC,SPIRIOR
DF-Moter	东风汽车公司	JV	S30,H30,A60

DF-LZM	东风柳州汽车有限公司	JV	Lingzhi,Jingyi
Dongfeng-Nissan	东风汽车有限公司	JV	Tiida, Sunny,QASHQAI ,SYLPHY
DPCA (Dongfeng-Peugeot-Citroen)	神龙汽车有限公司	JV	C-Elysee,C-Quatre
DFSK	东风小康汽车有限公司	ID	Xiaokang
DF-YL	东风裕隆汽车有限公司	JV	Luxgen
DF-KIA	东风悦达起亚汽车有限公司	JV	K2,K5,Sportage
Soueast Moter	东南（福建）汽车工业有限公司	JV	LIONVEL,LANCEREX, V5
GAC-Honda	广汽本田汽车有限公司	JV	CITY,ACCORD,Crosstour
GAC-Moter	广州汽车集团乘用车有限公司	ID	Trumpchi
GAC-Fiat	广汽菲亚特汽车有限公司	JV	Viaggio
GAC-Toyota	广汽丰田汽车有限公司	JV	Camery, Yaris,Highlander
GAC-Gonow	广汽吉奥汽车有限公司	ID	Xia'ao,Aoxuan,GX5
GAC-Mitsubishi	广汽三菱汽车有限公司	JV	PAJERO,AXR
Hafei-Moter	哈飞汽车股份有限公司	ID	Alsvin, Luzun,Xinminyi
Haima-Moter	海马轿车有限公司	ID	M3
Hawtai-Moter	荣成华泰汽车有限公司	ID	Aishang,Wangzi,
Haima-Commecial Motor	海马商务汽车有限公司	ID	FSTAR
Briliance-BMW	华晨宝马汽车有限公司	JV	BMW5,BMW3,BMWX1
Briliance -Jinbei	沈阳华晨金杯汽车有限公司	ID	Junjie
Briliance -Moter	华晨汽车集团控股有限公司	ID	V5,H530

Haipu Motor	上海华普汽车有限公司	ID	Haijing
Geely-Haoqing	浙江豪情汽车制造有限公司	ID	Yuanjing,GLEAGLE
Geely-Moter	浙江吉利汽车有限公司	ID	Dihao,Ziyoujian
JAC	安徽江淮汽车股份有限公司	ID	Heyue, Ruifeng,Tongyue
JMC-Landwind	江铃控股有限公司	JV	Landwind X8，X5
JMC	江铃汽车股份有限公司	JV	Yusheng
Jiangnan-Motor	湖南江南汽车制造有限公司	ID	Z300,TT
Chery	奇瑞汽车股份有限公司	ID	Ruihu,QQ,E5
SAIC-VW	上海大众汽车有限公司	JV	Passat, LAVIDA,Tiguan
SAIC-GM	上海通用汽车有限公司	JV	LaCrosse, Malibu
SAIC-GM-DY	上海通用东岳汽车有限公司	JV	ENCORE,AVEO,Excelle
SAIC-Moter	上海汽车集团股份有限公司	ID	MG3,Rongwei 550,MG6
FAW-Toyata-Sichuan	四川一汽丰田汽车有限公司	JV	RAV,LAND CRUISER, PRADO
FAW-Toyata-Tianjin	天津一汽丰田汽车有限公司	JV	Vios,REIZ,COROLLA
SAIC-GM-BS	上海通用（沈阳）北盛汽车有限公司	JV	Cruze,Captiva
SAIC-GM-WL	上汽通用五菱汽车股份有限公司	JV	Wulingzhiguagn, Baojun 630
FAW-VW	一汽-大众汽车有限公司	JV	Jetta, Audi A4, Audi Q5
FAW-Haima	一汽海马汽车有限公司	ID	Family,Freema
FAW-Jinlin	一汽吉林汽车有限公司	ID	Jiabao, Yasen
FAW-Moter	中国第一汽车集团公司	JV	BESTURN,Mazda6,Hongqi
FAW-Xiali	天津一汽夏利汽车股份有限公司	ID	Xiali, Weizhi

DF-Nissan-Zhengzhou	郑州日产汽车有限公司	JV	Shuaike,NV200,Paladin
Lifan-Car	重庆力帆乘用车有限公司	ID	Lifan320,620,520
Linfan-Moter	重庆力帆汽车有限公司	ID	Xinshun, Fushun

*ID: Independent Domestic Company; JV: Joint Venture Company

Appendix II: 25 Registered Vehicle Importing Brands

Company	Chinese Full name of Registered Vehicle Importers	Agent brands
Aston Martin	阿斯顿马丁拉共达（中国）汽车销售有限公司	Aston Martin
BMW	宝马（中国）汽车贸易有限公司	BMW, Mini-cooper, Rolls-Royce
Porsche	保时捷（中国）汽车销售有限公司	Porsche
Honda	本田技研工业（中国）投资有限公司	Acura
Peugeot Citroen	标致雪铁龙（中国）汽车贸易有限公司	Peugeot, Citroen
Volkswagen	大众汽车（中国）销售有限公司	VW, Lamborghini ,Seat, Skoda, Bentley
Dongfeng	东风汽车有限公司	Nissan
Ferrari	法拉利玛莎拉蒂汽车国际贸易（上海）有限公司	Ferrari, Maserati
Toyota	丰田汽车（中国）投资有限公司	Toyota, Lexus
Ford	福特汽车（中国）有限公司	Ford
GAC-Honda	广汽本田汽车有限公司	Honda
Jaguar-LandRover	捷豹路虎汽车贸易（上海）有限公司	Jaguar, Land Rover
Chrysler	克莱斯勒（中国）汽车销售有限公司	Chrysler, Dodge, Jeep
Renault	雷诺（北京）汽车有限公司	Renault
Suzuki	铃木（中国）投资有限公司	Suzuki
Mazda	马自达（中国）企业管理有限公司	Mazda
Benz	梅赛德斯-奔驰（中国）汽车销售有限公司	Smart, Benz
Nissan	日产（中国）投资有限公司	Infiniti
Mitsubishi	三菱汽车销售（中国）有限公司	Mitsubishi
SAIC-GM	上汽通用汽车销售有限公司	Buick, Cadillac, Chevrolet
Subaru	斯巴鲁汽车（中国）有限公司	Subaru
GM	通用汽车（中国）投资有限公司	Opel

Volvo	沃尔沃汽车销售（上海）有限公司	Volvo
Hyundai	现代汽车（中国）投资有限公司	Hyundai, KIA
FAW-Import	一汽进出口有限公司	Audi

Appendix III: China Passager Vehicle Fuel Limit and Target by Standard Phase

Curb-weight (kg)	Phase I: FC Limit (L/100km)		Phase II,III: FC Limit (L/100km)		Phase IV: Limit (L/100km)		Phase III: Target (L/100km)		Phase IV: Target (L/100km)
	MT	AT or/and above 3 seat rows	MT	AT or/and above 3 seat rows	MT	AT or/and above 3 seat rows	MT	AT or/and above 3 seat rows	普通乘用车*
Implementation	7/2005-1/2008 (New Cars) 7/2006-1/2009 (Entire Production)		1/2008-current (New Cars) 1/2009-current (Entire Production)		1/2016-Ｎ／Ａ(New Cars) 1/2017 (Entire Production)		1/2012-2015		2016-2020
CM≤750	7.2	7.6	6.2	6.6	5.2	5.6	5.2	5.6	3.9
750＜CM≤865	7.2	7.6	6.5	6.9	5.5	5.9	5.5	5.9	4.1
865＜CM≤980	7.7	8.2	7	7.4	5.8	6.2	5.8	6.2	4.3
980＜CM≤1090	8.3	8.8	7.5	8	6.1	6.5	6.1	6.5	4.5
1090＜CM≤1205	8.9	9.4	8.1	8.6	6.5	6.8	6.5	6.8	4.7
1205＜CM≤1320	9.5	10.1	8.6	9.1	6.9	7.2	6.9	7.2	4.9
1320＜CM≤1430	10.1	10.7	9.2	9.8	7.3	7.6	7.3	7.6	5.1
1430＜CM≤1540	10.7	11.5	9.7	10.3	7.7	8.0	7.7	8.0	5.3
1540＜CM≤1660	11.3	12	10.2	10.8	8.1	8.4	8.1	8.4	5.5
1660＜CM≤1770	11.9	12.6	10.7	11.3	8.5	8.8	8.5	8.8	5.7
1770＜CM≤1880	12.4	13.1	11.1	11.8	8.9	9.2	8.9	9.2	5.9
1880＜CM≤2000	12.8	13.6	11.5	12.2	9.3	9.6	9.3	9.6	6.2
2000＜CM≤2110	13.2	14	11.9	12.6	9.7	10.1	9.7	10.1	6.4
2110＜CM≤2280	13.7	14.5	12.3	13	10.1	10.6	10.1	10.6	6.6
2280＜CM≤2510	14.6	15.5	13.1	13.9	10.8	11.2	10.8	11.2	7.0
2510＜CM	15.5	16.4	13.9	14.7	11.5	11.9	11.5	11.9	7.3

* For vehicles with 3 row not exceeding 1090 kg, vehicle target is 105% the per-weight target; over 3 rows vehicles target is 103% of the per-weight target.

Appendix IV: CAFC of Major Vehicle Manufacturers (production >10k)

Company	CAFC/$T_{CAFC2020}$	$T_{CAFC2020}$	CAFC/$T_{CAFC2015}$	Credits	2013 CAFC	$T_{CAFC2013}$	2013 Production	2013 Vehicle Mass	2013 Displacement
	%	L/100km	%	L/100km	L/100km	L/100km		Kg	L
BYD-Auto	123.9%	4.98	89.8%	197461	6.35	7.07	274,251	1.50	1268
Chana-Suzuki	128.9%	4.48	96.5%	31169	5.98	6.20	141,676	1.28	1012
Briliance -Moter	130.0%	4.99	93.1%	52700	6.62	7.11	107,550	1.54	1292
FAW-Xiali	130.5%	4.34	98.3%	12274	5.74	5.84	122,739	1.25	942
Briliance-BMW	131.1%	5.71	85.0%	276155	7.30	8.59	214,074	2.23	1704
Soueast Moter	131.7%	4.82	93.2%	54353	6.28	6.74	118,158	1.55	1184
Geely-Moter	133.2%	4.88	96.6%	36625	6.55	6.78	159,237	1.54	1245
Haima-Moter	133.9%	4.78	90.7%	28593	5.88	6.48	47,655	1.48	1164
FAW-VW	134.8%	5.23	92.0%	946432	7.17	7.79	1,526,503	1.72	1432
Changhe-Suzuki	135.5%	4.38	100.5%	0	5.93	5.90	84,990	1.20	971
Geely-Haoqing	136.2%	4.77	98.9%	11093	6.54	6.61	158,468	1.50	1149
Chery	136.4%	4.79	95.2%	96853	6.31	6.63	302,666	1.62	1343
Jiangnan-Motor	136.7%	4.64	97.7%	10738	6.32	6.47	71,588	1.31	1106
Chana-Mazda	137.2%	4.93	92.3%	62174	6.59	7.14	113,043	1.75	1282
SAIC-GM-DY	137.6%	4.87	91.2%	344166	6.66	7.30	537,760	1.44	1241
Dongfeng-Nissan	138.0%	4.92	94.6%	359805	6.71	7.09	946,855	1.72	1254
Chana-Ford	138.2%	5.18	93.4%	324328	7.19	7.70	635,938	1.70	1415
Chana-Chongqing	138.3%	4.75	97.5%	124108	6.54	6.71	730,048	1.28	1161

BYD-Auto industry	139.6%	5.22	99.9%	1662	7.29	7.30	166,221	1.65	1406
JAC	140.2%	5.32	98.2%	23613	7.84	7.98	168,665	1.70	1442
GAC-Fiat	140.4%	5.20	94.2%	20974	7.35	7.80	46,609	1.40	1448
FAW-Haima	140.6%	5.14	98.1%	13729	7.17	7.31	98,066	1.70	1366
Beijing Hyundai	141.3%	5.02	100.3%	0	7.23	7.21	1,039,742	1.75	1319
Chana-Hebei	142.0%	4.90	97.7%	8064	6.75	6.91	50,397	1.30	1235
FAW-Jinlin	142.1%	4.75	111.2%	-25730	7.36	6.62	75,676	1.27	1178
DF-Moter	142.2%	4.90	99.1%	4310	6.91	6.97	71,833	1.55	1228
GAC-Honda	142.4%	5.08	98.4%	52627	7.38	7.50	438,560	1.87	1354
DF-Nissan-Zhengzhou	142.9%	5.43	102.1%	0	7.94	7.78	60,288	1.62	1519
SAIC-VW	143.0%	5.04	96.7%	382878	7.12	7.36	1,595,325	1.62	1343
DF-LZM	143.3%	5.55	96.7%	47203	7.65	7.91	181,549	1.74	1612
DF-KIA	143.8%	4.92	99.6%	16552	7.04	7.07	551,732	1.69	1275
GWM	144.2%	5.15	93.6%	276716	6.84	7.31	588,758	1.70	1375
FAW-Toyata-Tianjin	144.2%	4.94	100.8%	0	7.39	7.33	419,157	1.25	942
Hafei-Moter	144.5%	4.68	104.5%	0	6.77	6.48	12,468	1.27	1091
Haima-Commecial Motor	144.7%	4.70	95.8%	3135	6.32	6.60	11,198	1.00	1100
Hawtai-Moter	145.5%	5.77	109.3%	-9488	9.28	8.49	33,884	1.82	1687
SAIC-GM-WL	146.6%	4.75	105.4%	0	7.17	6.80	1,422,243	1.27	1180
DFPC(Dongfeng-Peugeot-Citroen)	146.7%	5.10	101.2%	0	7.57	7.48	552,118	1.70	1356
JMC-Landwind	147.3%	5.75	104.1%	0	8.70	8.36	23,798	1.31	1106

JMC	147.3%	6.20	94.7%	9840	8.87	9.37	19,679	1.31	1106
DF-XK	148.1%	4.70	105.9%	0	7.13	6.73	163,767	1.20	1139
DF-Honda	148.2%	5.34	99.6%	9775	7.93	7.96	325,848	2.04	1515
SAIC-Moter	149.5%	5.06	105.8%	0	7.71	7.29	214,714	2.44	1991
Haipu Motor	149.8%	4.82	96.3%	13616	6.47	6.72	54,464	1.69	1224
BAIC-Moter	150.8%	4.87	110.9%	-49173	7.43	6.70	149,009	1.33	1212
SAIC-GM-BS	152.2%	5.29	98.0%	59586	8.24	8.41	350,503	1.84	1495
Beijing-Benz	153.2%	5.84	102.4%	0	9.21	8.99	118,819	2.27	1760
SAIC-GM	153.5%	5.23	98.9%	53082	7.88	7.97	589,800	1.80	1435
GAC-Mitsubishi	153.8%	5.37	102.6%	0	7.93	7.73	40,862	2.05	1530
Linfan-Moter	155.3%	4.70	111.4%	-7972	7.84	7.04	20,979	1.00	1100
BAIC-YX	159.1%	4.63	115.6%	-36896	7.40	6.40	59,509	1.16	1099
Lifan-Car	159.4%	4.71	98.9%	3741	6.33	6.40	53,444	1.56	1050
GAC-Gonow	159.6%	4.98	112.6%	-5132	8.31	7.38	10,474	1.97	1530
GAC-Toyota	160.4%	5.47	105.3%	0	8.78	8.34	303,246	2.28	1563
FAW-Moter	162.4%	5.21	106.8%	-14967	8.18	7.66	249,458	1.85	1445
Briliance -Jinbei	163.8%	4.70	109.5%	-26583	8.67	7.92	98,455	1.47	1325
FAW-Toyata-Sichuan	164.4%	5.67	102.0%	0	8.62	8.45	129,643	2.48	1687
GAC-Moter	167.5%	5.51	111.4%	-50157	9.25	8.30	111,460	1.98	1604
BAIC-Foton	177.0%	5.92	113.2%	-11995	10.30	9.10	18,454	2.02	1826
DF-YL	178.8%	5.82	117.2%	-30674	10.27	8.76	31,300	2.06	1750

Sources: CAFC $_{2013}$, $T_{CAFC2015}$ and car production data source is: http://www.miit.gov.cn/n11293472/n11293832/n12845605/n13916913/15988846.html; For $T_{CAFC2020}$ and CAFC/ $T_{CAFC2020}$ calculations, production volumes were retrieved from China Association of Auto Manufacture (CAAM) official data.

Appendix V: CAFC of Major 25 Importing Brands

Company	CAFC/$T_{CAFC2020}$	$T_{CAFC2020}$	CAFC/$T_{CAFC2015}$	Credits	2013 CAFC	$T_{CAFC2013}$	2013 Production	2013 Vehicle Mass	2013 Displacement
	%	L/100km	%	L/100km	L/100km	L/100km		Kg	L
GAC-Honda	95.9%	4.90	65.3%	50	4.70	7.20	20	1.50	1220
Mazda	143.3%	5.47	93.7%	2675	7.78	8.30	5,144	2.08	1549
FAW-Import	145.7%	6.10	93.4%	53199	8.94	9.57	84,443	2.49	1880
Benz	146.8%	5.98	93.3%	62380	8.52	9.13	102,263	2.64	1857
BMW	148.4%	5.97	94.4%	93093	8.48	8.98	186,186	2.38	1852
Ford	148.9%	6.24	95.3%	11546	9.29	9.75	25,101	2.49	1991
Subaru	149.0%	5.43	98.3%	7125	7.89	8.03	50,896	2.23	1540
Toyota	150.1%	5.80	96.1%	29542	8.70	9.05	84,407	2.73	1774
Volvo	152.2%	5.68	99.3%	3319	8.53	8.59	55,315	2.09	1698
Jaguar-Land Rover	153.2%	6.36	96.7%	32523	9.72	10.05	98,556	2.54	1784
Volkswagen	156.5%	5.80	98.9%	8823	8.96	9.06	88,232	2.30	1783
Peugeot Citroen	157.5%	5.34	104.3%	0	8.05	7.72	5,198	1.95	1479
Renault	158.9%	5.55	108.4%	-6784	9.07	8.37	33,922	2.28	1621
Suzuki	159.1%	4.61	112.5%	-1833	7.45	6.62	4,262	1.43	1139
Honda	163.2%	5.70	109.2%	-774	9.26	8.48	2,868	2.93	1689
Mitsubishi	166.0%	5.57	105.7%	0	9.20	8.70	15,229	2.55	1621

Porsche	166.8%	6.35	107.9%	-6507	10.85	10.06	34,246	3.06	2088
Hyundai	167.7%	5.81	106.5%	0	9.61	9.02	47,800	2.45	1723
Chrysler	168.5%	5.73	109.6%	-30266	9.74	8.89	94,582	2.61	1711
Ferrari	171.0%	6.17	107.6%	-668	10.67	9.92	4,450	3.36	1950
Dongfeng	174.1%	6.39	108.7%	-179	10.91	10.04	663	3.70	2084
Nissan	176.4%	6.03	113.0%	-10141	10.57	9.35	15,365	3.03	1879
SAIC-GM	178.5%	6.33	113.0%	-17457	10.93	9.67	25,672	2.96	2061
GM	178.7%	5.84	111.6%	-2202	9.98	8.94	4,404	2.21	1777
Aston Martin	241.3%	5.94	155.8%	-1438	14.44	9.27	312	5.69	1832

Sources: 2013 CAFC and T_{CAFC} data is retrieved from http://www.miit.gov.cn/n11293472/n11293832/n12845605/n13916913/15988846.html; $T_{CAFC2020}$ and CAFC/ $T_{CAFC2020}$ calculation production volume figures were purchased from China Import & Export Company.

Appendix VI: CAFC of China's Top 10 Auto Groups

Auto Group	CAFC/$T_{CAFC2020}$ %	$T_{CAFC2020}$ L/100km	CAFC/$T_{CAFC2015}$ %	Credits/Deficits: take Group as a unity L/100km	Credits/Deficits: sum of credit from each cooperate L/100km	CAFC L/100km	$T_{CAFC2015}$ L/100km	2013 Production
BYD	125.7%	5.00	93.7%	199123	199123	6.70	7.16	440,472
Geely	134.6%	4.83	97.8%	47717	47717	6.55	6.70	317,705
Brillance	136.7%	5.34	92.5%	255014	302272	7.45	8.05	420,079
Chana	137.8%	4.90	95.4%	548112	551727	6.75	7.08	1,686,610
FAW	140.1%	5.15	96.3%	739528	931738	7.31	7.59	2,621,242
GMC	142.2%	5.15	93.6%	276716	276716	6.84	7.31	588,758
SAIC	143.5%	4.97	99.4%	224512	840922	7.29	7.34	4,711,141
Dongfeng	143.7%	5.04	98.7%	265939	407372	7.23	7.32	2,889,296
BAIC	143.8%	5.06	102.4%	0	-104305	7.48	7.30	1,391,156
GAC	151.9%	5.28	102.4%	0	18312	8.08	7.88	951,211
Total				**2556661**	**3471594**			**16,017,670**