China Passenger Vehicle Fuel Consumption Development Annual Report 2017

Innovation Center for Energy and Transportation (*i*CET)

December 2017

Acknowledgements

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Report Title

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CONTENT

Executive Summary

China's total oil consumption in 2016 reached 556 million tons representing a rate of oil import dependence as high as 65.5%. Transportation accounted for more than half of total oil consumption last year, of which passenger car fuel consumption contributed 110 million tons, about 90% of total gasoline consumption (and about 20% of total oil demand). China's fuel economy standards and management regulation were approved as one of the most effective efforts to improve fuel efficiency and energy management regulation. The standards were meant to reduce oil consumption and advance China's energy security.

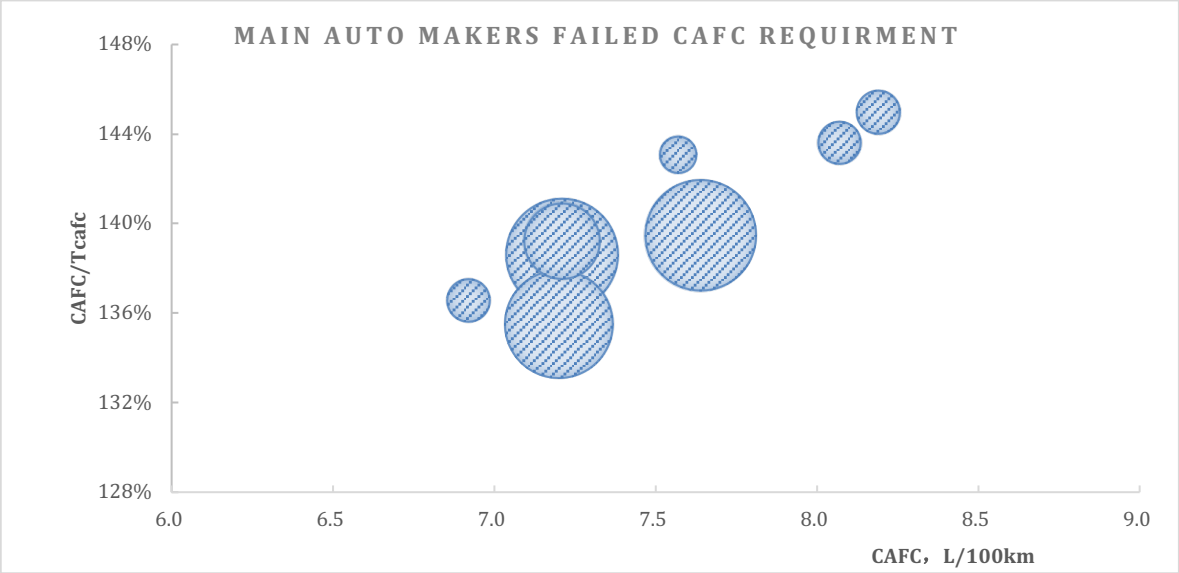
Since China implemented passenger vehicle fuel consumption standards in 2005, it underwent four phases. The most recent one (Phase IV) entered into effect in 2016. In 2013, China introduced the average corporate fuel consumption (CAFC) standard, as part of a series of flexibility mechanisms that were introduced in 2017. Also in 2017, China announced the formation of an NEV credits system that will operate under the CAFC standard regime, and enter into effect in 2019.

The Innovation Center for Energy and Transportation (*i*CET) has been involved in the drafting of China's fuel standards since its first iteration and has been tracking its development since. This report is the 7th *i*CET Annual Report evaluating China's CAFC standard implementation status with recommendations for policy. This year the report, although covering various aspects of China's corporate FC development, places considerable focus on the joint management mechanism of China's existing CAFC standard and the newly introduced NEV credits system.

The highlights of this year's report are grouped around three themes: (I) fuel efficiency and the CAFC standard regime, (II) NEV super-credits (flexibility mechanism) and CAFC performance, and, (III) the newly introduced NEV credits system and the CAFC standard regime.

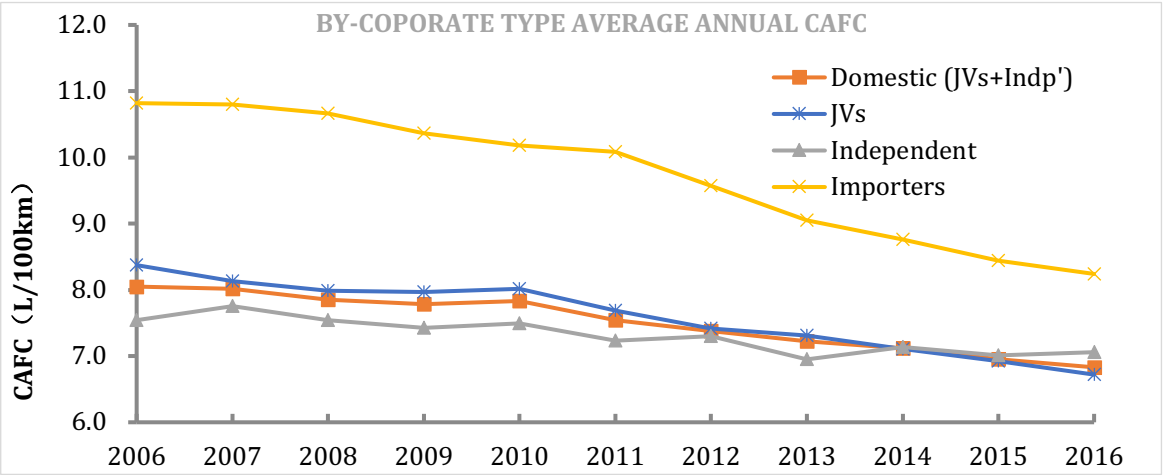
I. Fuel efficiency and CAFC:

1. **Phase IV requirements have increased in stringency from 2016 to 2020, and the number of companies that failed to meet the corporate average fuel consumption requirements has grown in 2016 when the flexibility mechanism was excluded from CAFC calculations.** About 30% of domestic manufacturers and 20% of importers failed to meet the standard (the latter is up from a mere 4% in 2015, the final year of Phase III). These non-compliant companies cumulatively sold over 5.68 million cars in 2016, led by Changan (Chana Ford, Chana Auto) and GreatWall.



***Note**: Only corporations with above 100,000 unit per year included; bubble size indicative of production volume; NEV credits excluded from CAFC calculations.*

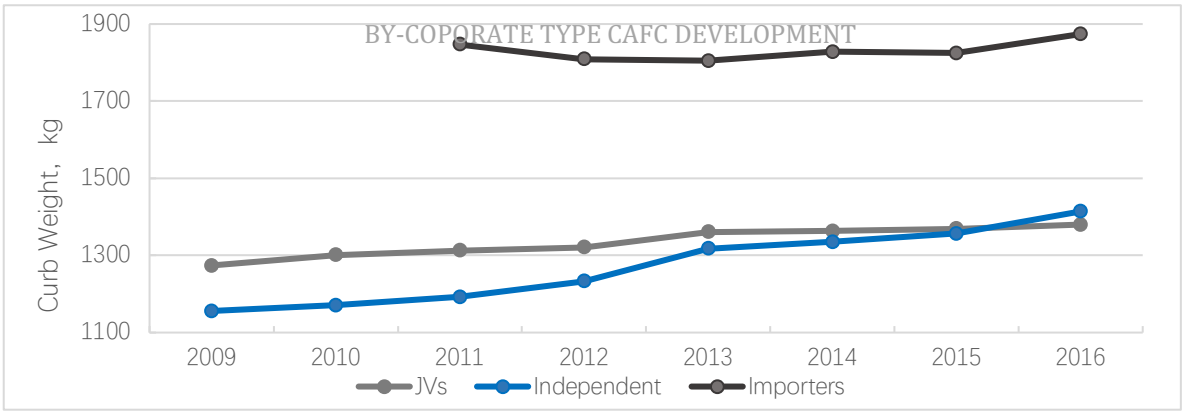
Improvements in the FC rate decreased in pace since Phase IV was implemented. For domestic independent manufacturers, average FC even increased from 2013 to 2016 (when the flexibility mechanism was excluded from calculations). Based on FC data reported by manufacturers and published by MIIT, an annual average reduction of 1.7% was achieved during a decade of implementation, with importers, JVs, and independent manufacturers reaching an annual average reduction rate of 2.7%, 2.2%, and less than 1%, respectively.



***Note**: NEV credits excluded from CAFC calculations.*

2. **The increase of average vehicle weight is stymieing further reductions in passenger car fuel consumption rates,** which translates to FC increase of 0.5-1L/100km per 100kg. Over the past decade, China's average fleet weight has increased by 13% (163kg). Domestic independent manufacturers saw an increase of 22% over the period (258kg). Independent

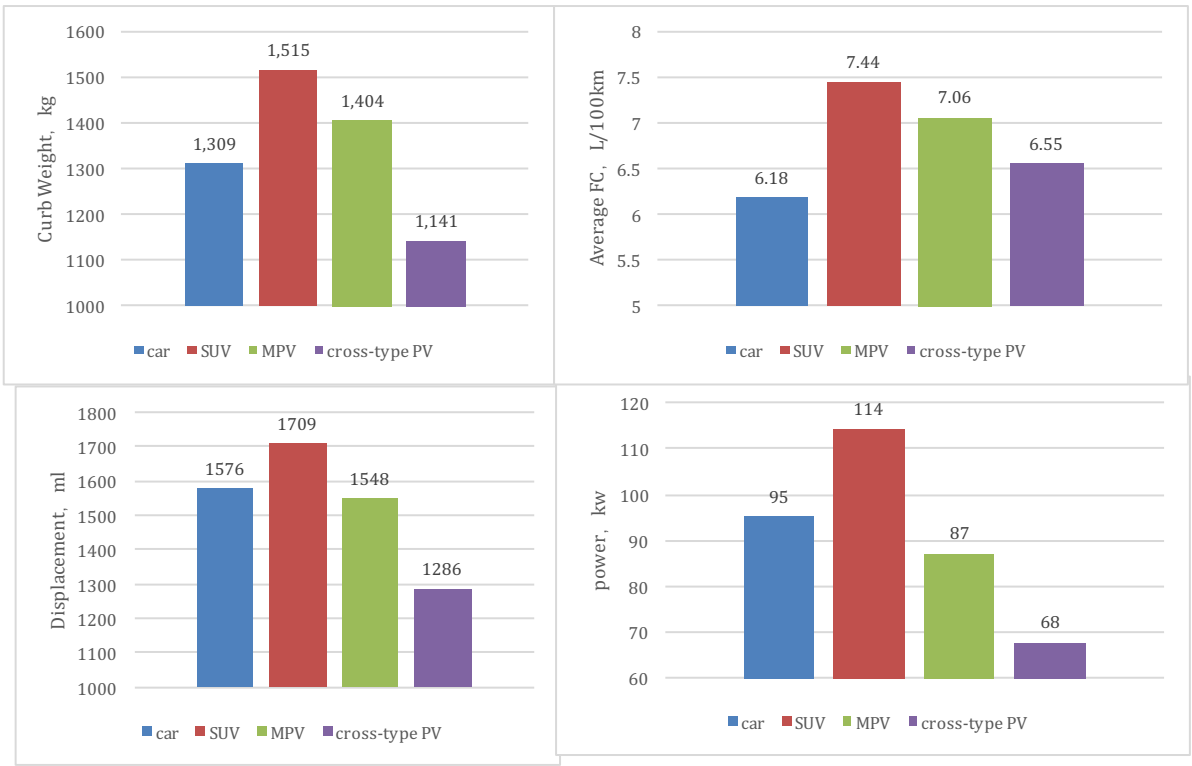
and importers also experienced a significant increase in average fleet weight over the past year.



***Note**: NEV credits excluded from CAFC calculations.*

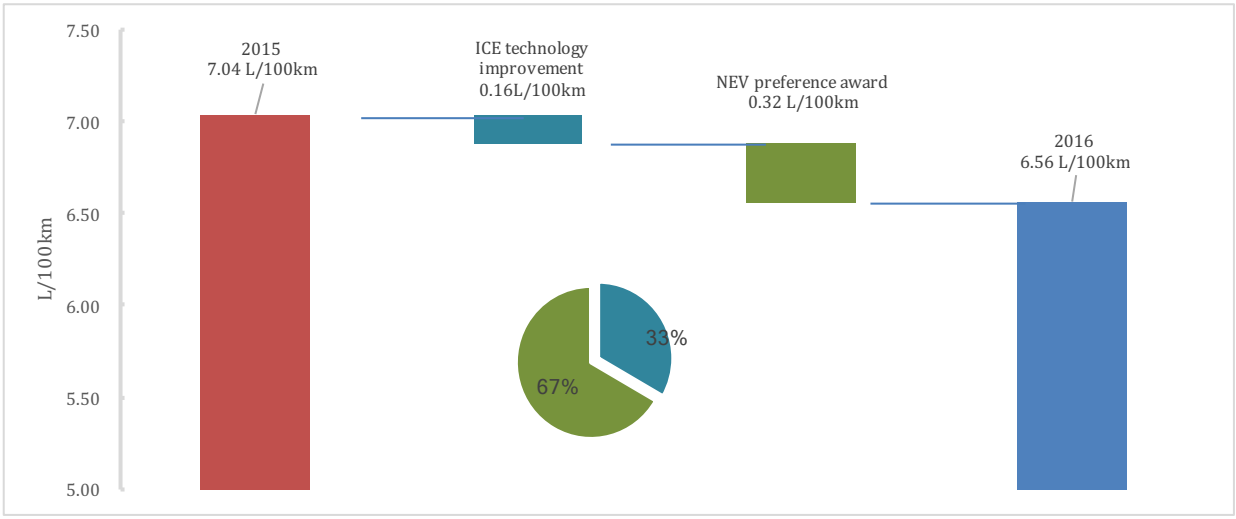
3. **The trend of weight and engine size increase is evidently driven by the increasing market share of SUVS and large models**. In 2016, SUVs and MPVs together accounted for nearly half of China's passenger car market, with SUVs market share increasing from 15% in 2012 to 40% in 2016. The average FC of SUVs is 1.2L/100km higher than that of the average sedan. Its weight is 215kg higher and its engine displacement is 130ml larger.

BY-SEGMENT 2016 AVERAGE CURB-WEIGHT, FC, DISPLACEMENT AND POWER

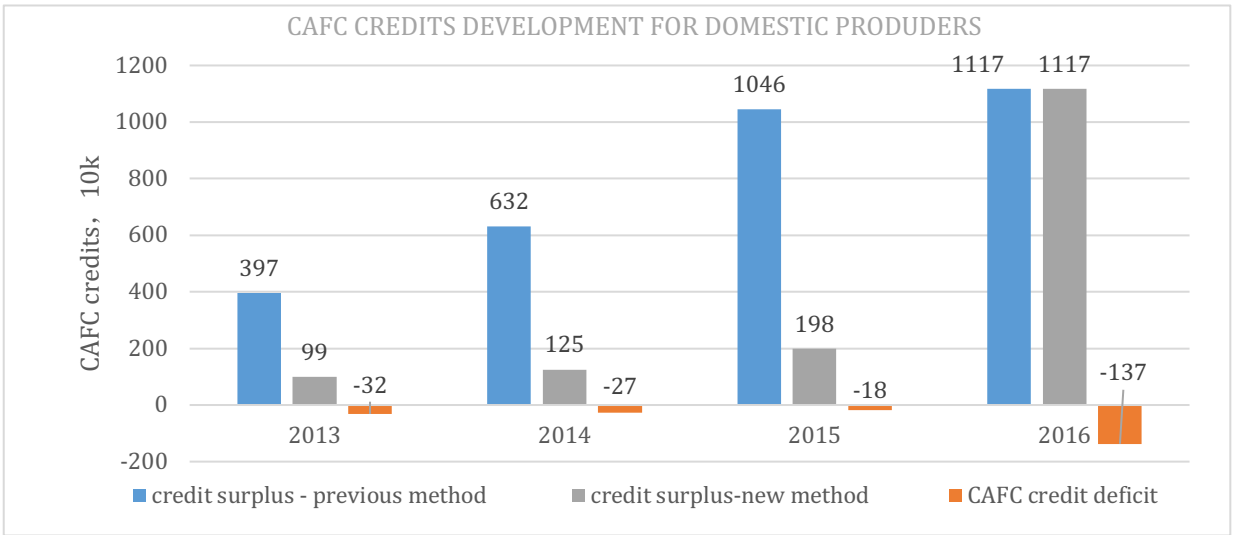


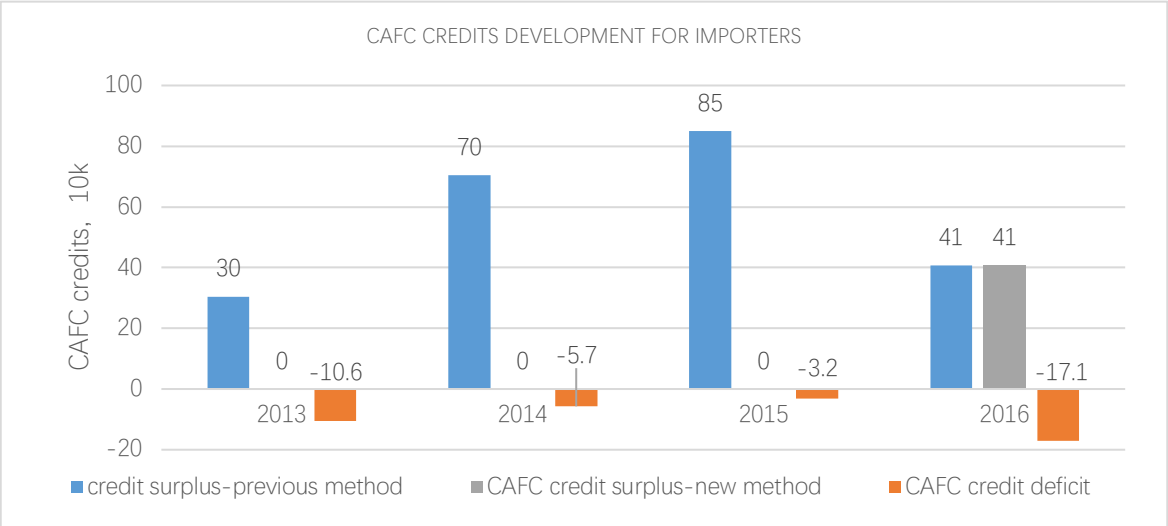
II. New Energy Vehicle (NEV) super credits and CAFC:

4. **About two-thirds of China's FC reduction comes from the incorporation of NEV super credits.** China's national average FC rate decreased from 7.04L/100km in 2015 to 6.56L/100km in 2016, with fuel saving technologies accounting for 33% (0.16L/100km) of this reduction and the rest (0.32/100km) from flexibility mechanism calculations of NEV production (each EV is considered five vehicles with 0L/100km in CAFC calculations).

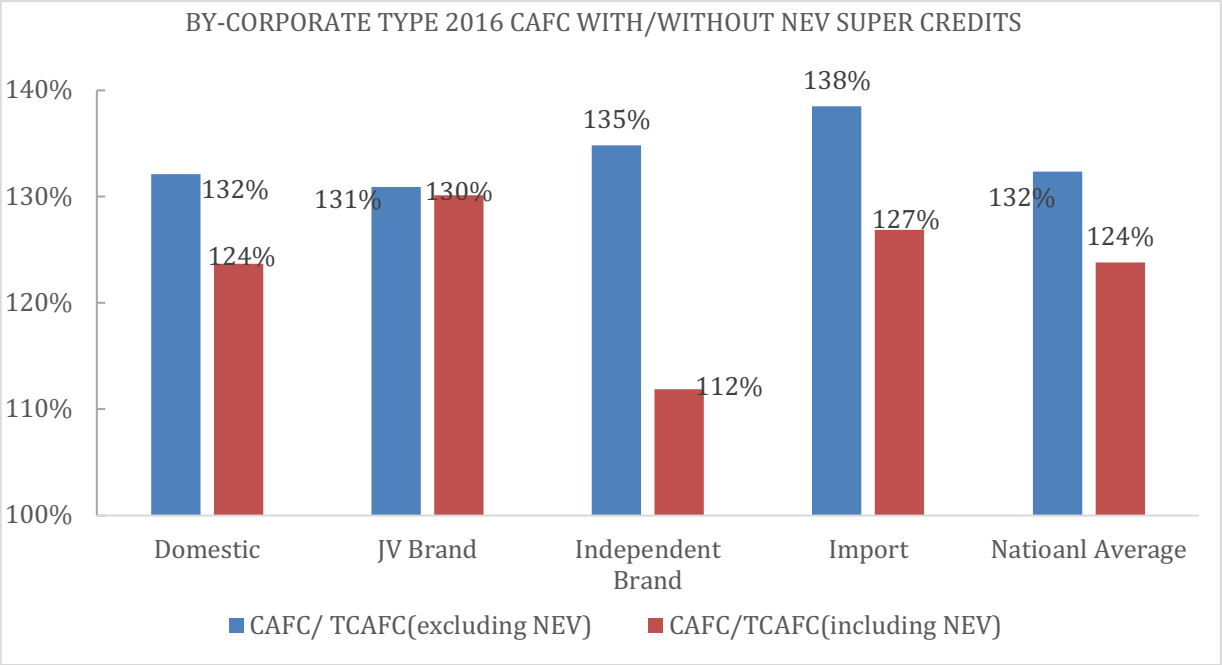


5. **In 2016, the industry generated a total of 1.54 million CAFC credits deficit, while CAFC credits surplus was seven times larger**. Over 7 times of CAFC surplus were produces in 2016 and over 2 million CAFC credits surplus were carried from 2013 to 2015 by domestic manufacturers (no credits were forwarded by importers), therefore it is not a heavy burden for companies to meet CAFC credit requirement.

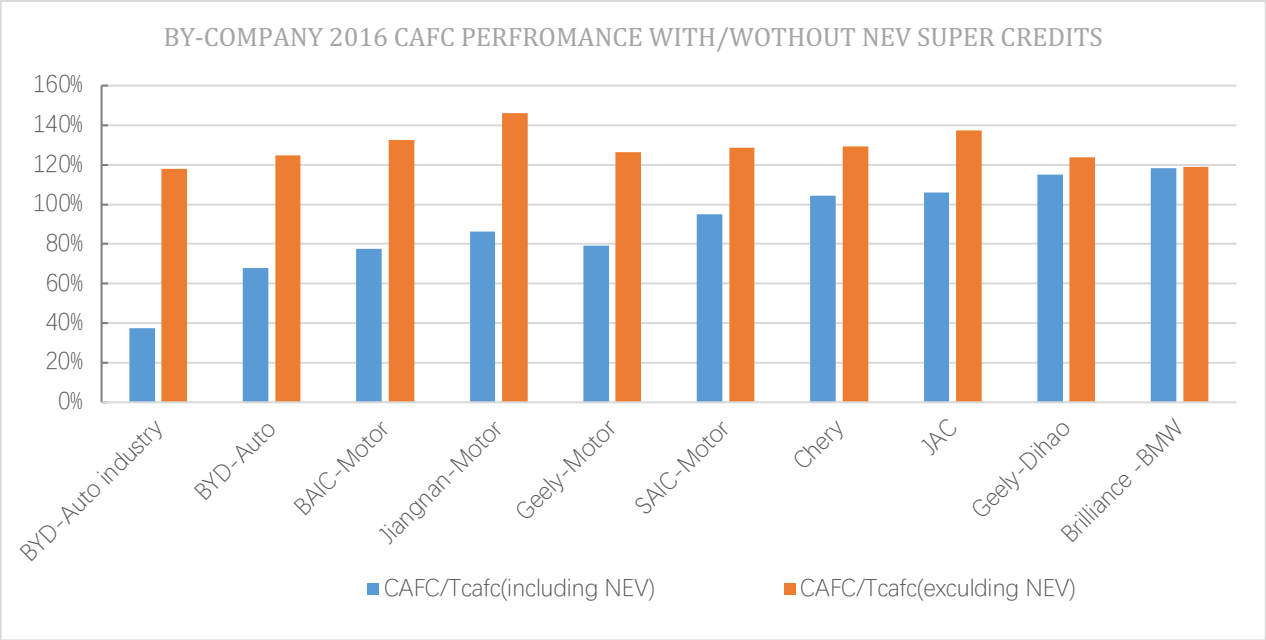




6. **The flexibility mechanism introduced in Phase IV has dramatically reduced the difficulty of meeting the CAFC standard**. While companies may almost meet the annual requirement if CAFC is based on their ICE vehicles alone (134% of the 2020 target), they actually easily meet 2016 target if NEV super credits are included - achieving 124% of the 2020 target! The 2017 target of 128% was therefore already met in 2016, due to the fact that calculations included NEVs.

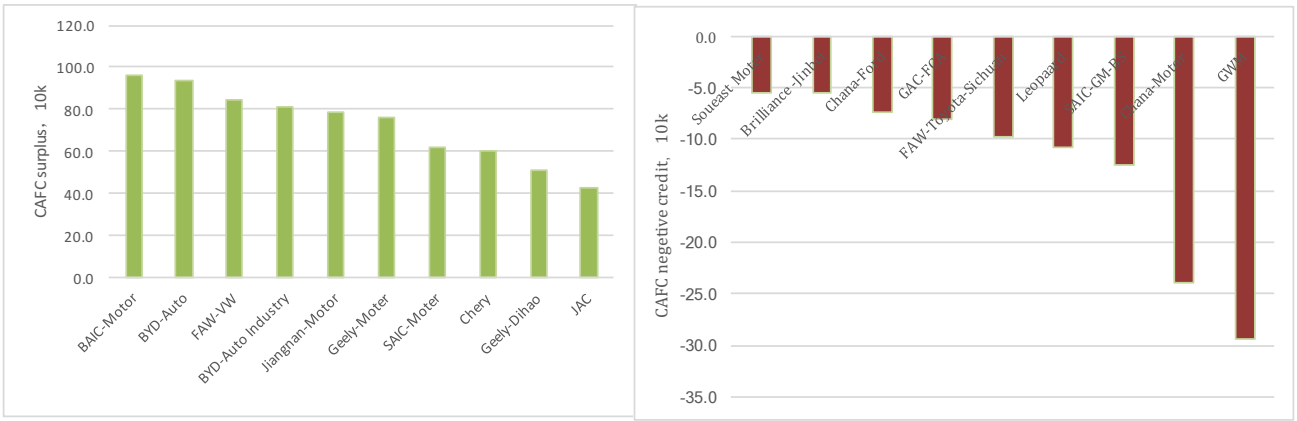


7. **Leading NEV companies (e.g. BYD, BAIC, Geely, SAIC, GAC) benefitted greatly from the incorporation of NEV super credits into CAFC caluclations (zero FC and 5 time for production for NEV).** Even auto companies that failed to meet their CAFC requirement achieved compliance with the help of NEV super credits (for exmaple JMC holdings).



8. **BAIC and BYD lead CAFC credits surplus (over 950k points each), while Great Wall and Changan, also SUVs dominators, lead in credits deficit (over minus 200k points each).**

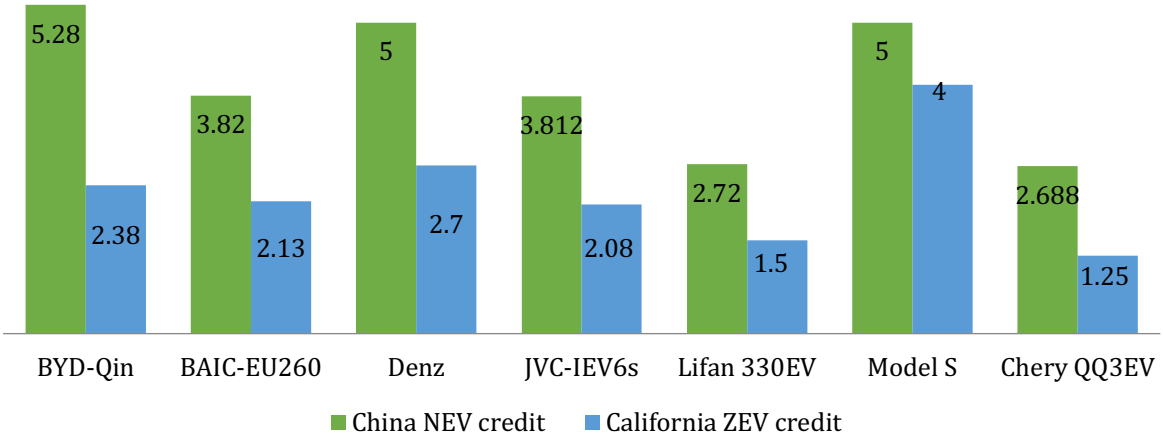
TOP NEV CREDITS SURPLUS AND SHORTFALL HOLDERS OF 2016

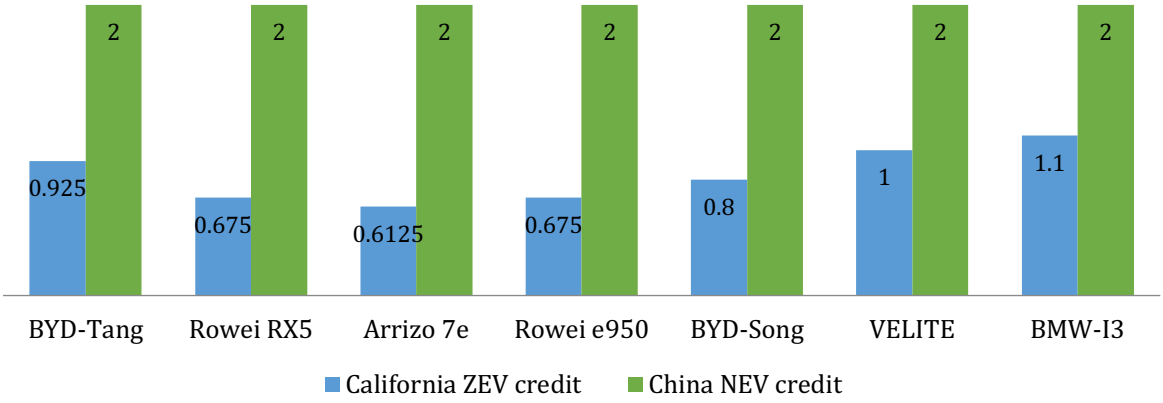


III. The newly introduced NEV credits system and CAFC:

9. **China's new NEV credits system, slated to go into effect in 2019, is rewarding PEVs and PHEV with double the credits these vehicles would have been given under the Californian ZEV credits system**. However, the practice of over-rewarding credits downgrades the impact of both the new NEV credits and the CAFC standard to which it is linked.

COMPARISON OF PEV AND PHEV CREDITS GENERATED IN THE CA AND IN CHINA





10. **The integration of the new NEV credits system with the CAFC standard regime is very likely to drive companies to abandon their fuel saving investment in favor of new energy vehicle investments**, and likely not in the form of direct R&D but rather through the merging and acquisition of existing NEV manufacturers.

11. **In order to ensure that NEVs are making real contribution to China's emission reduction goals, the following is suggested**:

    (1) ***The NEV credit system should be a stand-alone mechanism*** in order to clarify corporate responsibilities and enable sound implementation and enforcement. Even before the NEV credits policy was introduced, the CAFC regime has proven to be too complex to manage well, given China's vast industrial and inter-ministerial structures.

    (2) ***Longer term requirements and a predictable baseline of the NEV credits policy should be presented*** as soon as possible to enable proper market strategic planning, reduce market failure risks and promote steady investment streams, and sound gradual improvements of the quality of NEVs.

    (3) ***Introduce well informed and effective penalty mechanisms*** to ensure the NEV credits policy is as powerful as it can be. This includes fee levels, supplementary penalties (for

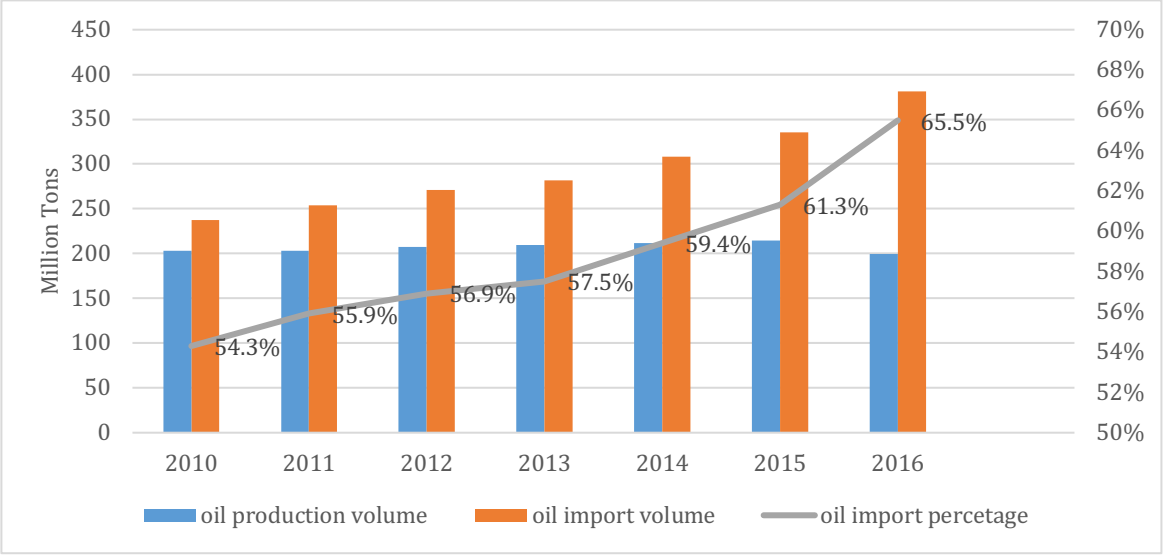
example, credit owed will still be owed regardless of penalties paid), and efficient and transparent policy scrutiny and panelizing process.

(4) ***Consider simplification of the policy to ease its management***. For example, eliminate the practice of forwarding credits to corporate actors.

1. INTRODUCTION: THE DRIVING FORCE BEHIND CHINA'S PASSANGER VEHICLE ENERGY MANAGEMENT

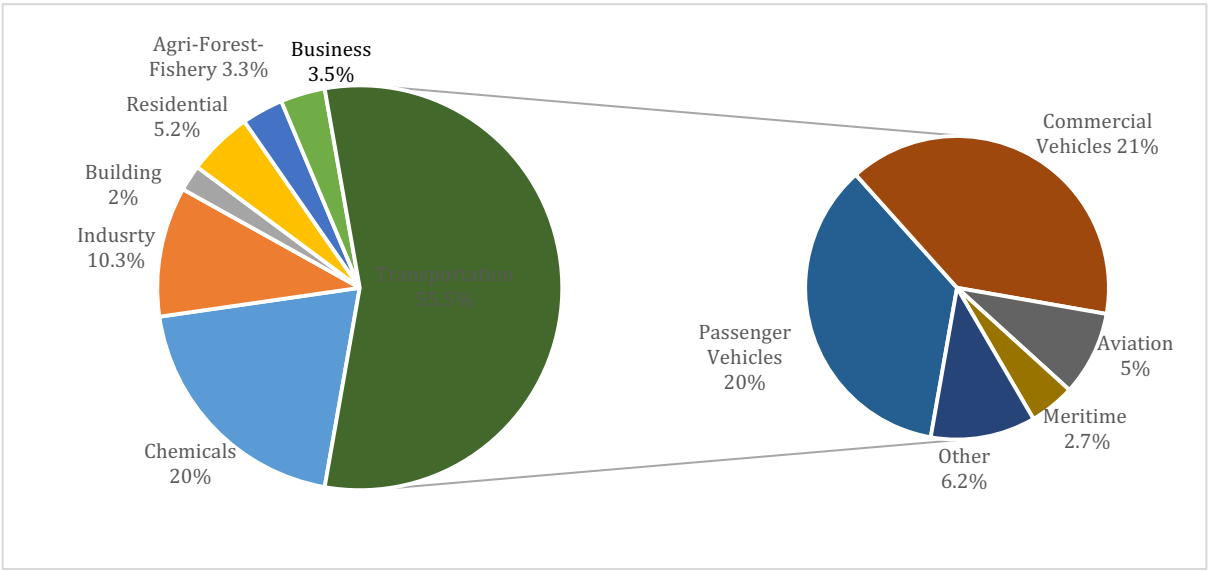
China's total oil consumption in 2016 reached 556 million tons, translating to an oil import dependence rate as high as 65.5%, as demonstrated in Figure 1. Transportation accounted for more than half of the total oil consumption last year, of which passenger car fuel consumption contributed 110 million tons, accounting for about 90% of total gasoline consumption (and about 20% of total oil demand). As demonstrated in Figure 2, China's car energy savings potential is still very large. Therefore, China's vehicle energy management is meant to reduce oil consumption and improve energy security.

Figure 1: China's oil imports growth trend



Source: China Petroleum Institute of Economics and Technology.

Figure 2: By-source split of China's oil imports in 2016

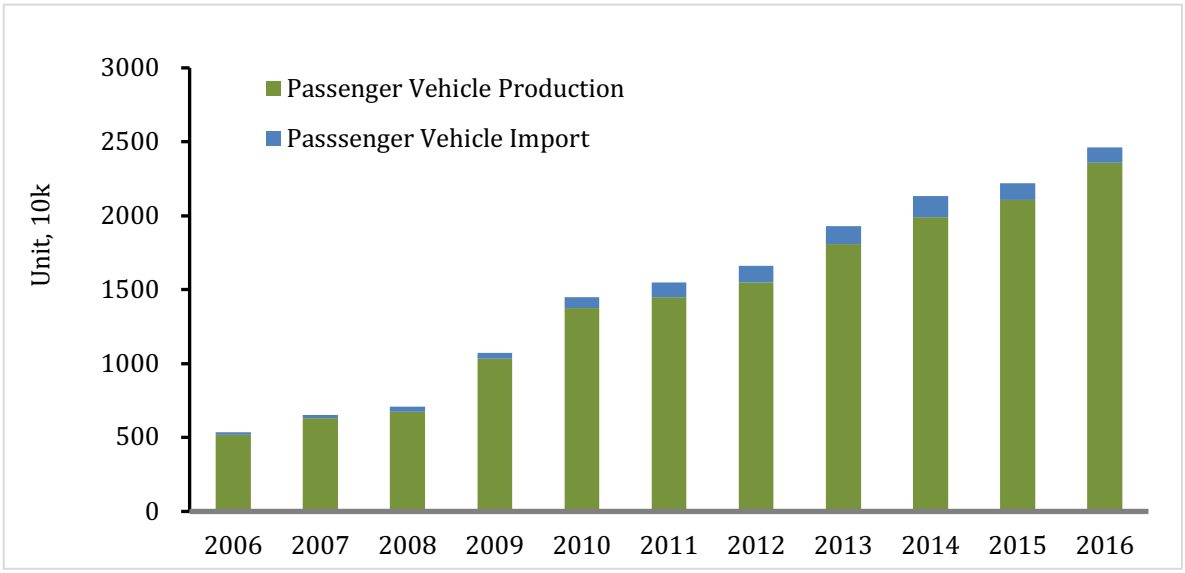


Source: iCET compiled the figure based on data sources from CNOOC Technology Research Institute, China Automotive Technology Research Center and National Bureau of Statistics .

In addition, China is the largest automobile market in the world for eight consecutive years. Over 24 million passenger cars have been produced in China and an additional 1 million were imported over the past year, as shown in Figure 3. Although the market is already large, the rate of car ownership per capita is still low (less than 118 for 1000 people[1]). China's State Council, in its "Made in China 2025" plan, has put forward a national passenger vehicle average FC rate target of 5.0L/100km by 2020 and 4L/100km by 2025.

In the "China Motor Vehicle Environmental Management Annual Report (2017)," released last year by China's Ministry of Environmental Protection (MEP), it is noted that motor vehicles account for 30%-40% of urban PM2.5 pollutants in Beijing, Shanghai, Hangzhou, Guangzhou, Shenzhen and other major cities. Passenger cars in particular are a predominant source of carbon monoxide (CO) and hydrocarbons (HC) pollutants, reaching 49% and 40%, respectively.

Figure 3: 2006-2016 production and import volume of China Passenger Cars



[1] http://data.stats.gov.cn/easyquery.htm?cn=C01&zb=A0G0J&sj=2016

2. CHINA'S PASSENGER CARS FUEL CONSUMPTION STANDARD

2.1 Passenger cars fuel consumption standard system

At the core of China's vehicle FC standard is the concept of limitations and targets, energy consumption labeling, and technical guidelines, as detailed in Table 1. It is a weight-bin standard (unlike the US), measured in L/100km (not by CO_2, as enacted in the EU and US), and it is based on the NEDC test cycle (yet the development of a new China cycle is underway). Since China started the implementation of a passenger vehicle FC standard in 2005, it underwent four phases, the last one entered into effect in 2016. The development of the standard regime is outlined in Table 2.

Table 1: China's Passenger Car Fuel Economy Standards

Type	Title and Year issued	Enforcement level
Testing standards	Measurement methods of fuel consumption for light duty vehicles (GB/T 19233-2008)	Voluntary
	Test methods for energy consumption of light-duty hybrid electric vehicles (GB/T 19753-2013)	Voluntary
Label standard	Energy consumption label for light vehicle – Part one: gasoline and diesel vehicles (GB 22757.1-2017)	Mandatory
	Energy consumption label for light vehicle – Part 2: electricity powered vehicles (GB 22757.2-2017)	Mandatory
Mandatory standards	Fuel consumption limits for passenger cars (GB19578-2014)	Mandatory
	Fuel consumption evaluation methods and targets for passenger cars (GB 27999-2014)	Mandatory
	EVs energy consumption limit*	Voluntary
Other voluntary standards	Conversion methods for energy consumption of hybrid electric vehicles*	Voluntary
	Off-cycle technology/device energy saving effects evaluation methods for passenger cars*	Voluntary

* Standards under development.

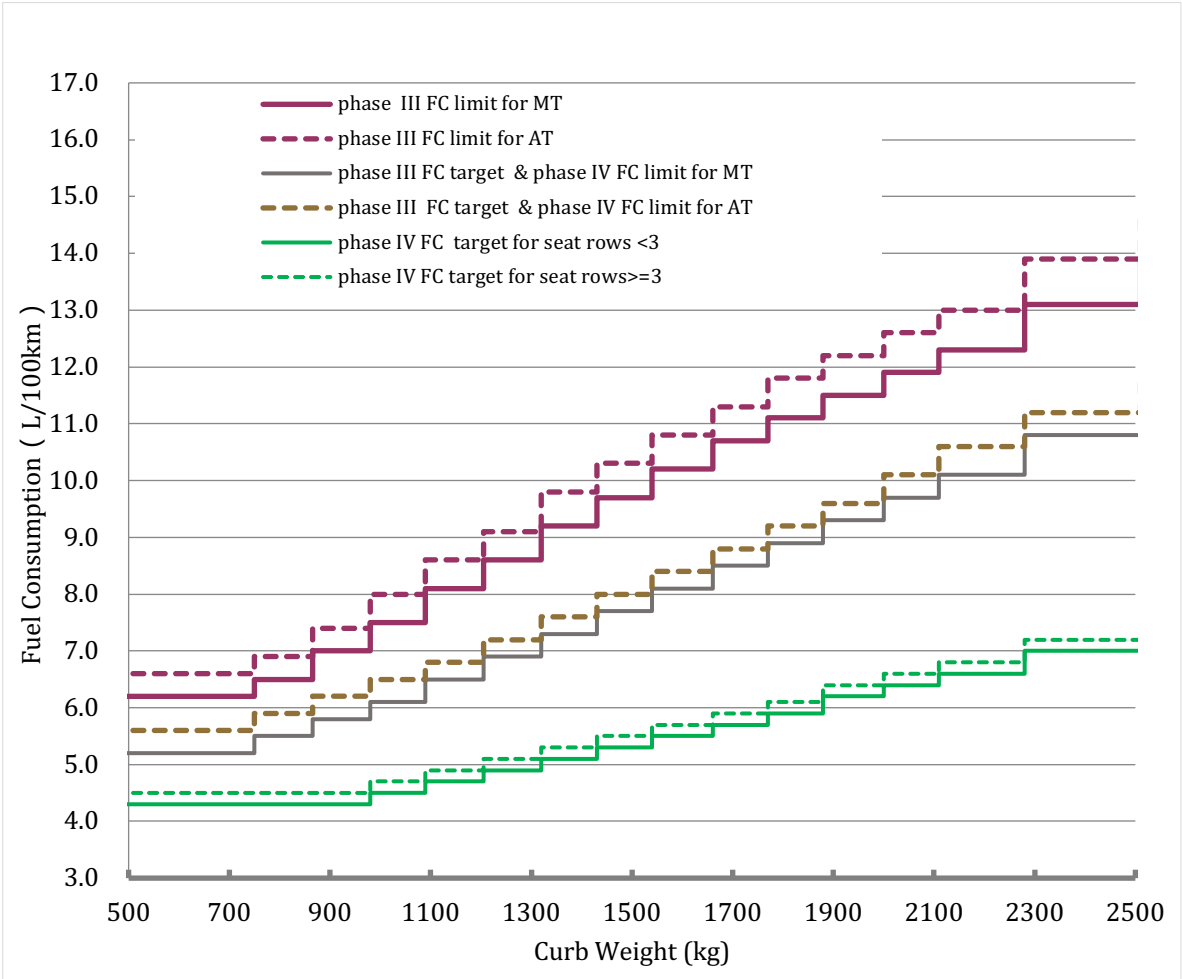
Table 2: China's By-Phase Fuel Consumption Standards

Phase	Timeframe	Title	Comments
Phase I	2005.07-2008.01 new models limit 2006.07-2009.01 in production models limit	GB19578-2004	Single vehicle FC limit (Imported vehicles not included)
Phase II	2008.01-2012.07 new models limit 2009.01-2012.07 in production models limit	GB19578-2004	

Phase III	2012.07-2015.12 limit similar to Phase II 2012.07-2015.12 new CAFC introduced	GB19578-2004 GB27999-2011	Single vehicle FC limit and corporate average FC target; (Imported vehicles included); Including imported vehicles.
Phase IV	2016.01-2020.12 new models limit 2018.01-2020.12 in production models limit 2016.01-2020.12 CAFC target and limit	GB19578-2014 GB27999-2014	Single vehicle FC limit and corporate average FC target; (Imported vehicles included); Including imported vehicles.

The standard requirement intensified with each phase. For example, the third standard requirement was 20% more stringent than those of the second phase, and the fourth phase requirements are 30%-40% more stringent than those of the third phase.

Figure 4: China's by-phase CAFC standard development



2.2 The fourth phase of China's FC standard

The fourth phase is aimed at achieving a national average FC target of 5L/100km by 2020. The standard is heavily invested in the actual value (versus the target value gap) of the corporate average fuel consumption (CAFC) rate, Its aim is to achieve a zero gap by 2020, as shown in Table 3.

Table 3: CAFC/TCAFC-IV Requirement for Car Producers and Importers During Phase IV

Year	Required ratio ($CAFC/T_{CAFC-IV}$)	National FC target (L/100km)
2016	134%	6.7
2017	128%	6.4
2018	120%	6.0
2019	110%	5.5
2020	100%	5.0

New Energy Vehicles (NEVs) were incorporated into China's CAFC accounting process as part of the "flexibility mechanism" designed to support an increased rate of target realization. According to the flexibility mechanism, NEVs are counted as several vehicles of with 0L/100km as detailed in Table 4. Off-cycle technologies (e.g. idle start-stop devices, shift reminders, efficient air conditioning, brake energy recovery, etc.) are also eligible for FC discounts typically counted as 0.5L/100km.

Table: New Energy and Energy Saving Vehicle Production Privilege in CAFC Calculation (production volume multiplier)

	PEV	FCV	PHEV*	ESV**
~2015	5	5	5	**3**
2016-2017	5	5	5	**3.5**
2018-2019	3	3	3	**2.5**
2020	2	2	2	**1.5**

** Plug-in electric vehicles (PHEVs) are defined as cars with electric range of at least 50km.*

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

China's passenger car energy efficiency standard has evolved and matured over the past decade. Phase V of the standard is currently underway, as well as the development of a China driving cycle, by the lead auto standard drafter - China Automotive Technology and Research Center (CATARC).

3. CHINA'S FUEL CONSUMPTION AND NEW ENERGY VEHICLE DOUBLE INTEGRAL MANAGEMENT

China's CAFC regime management relies on reporting and government verification, by-company performance release, production suspension, and set increasingly stringent CAFC/Tcafc performance target (see table 3) . The ambitious targets -- 5.0L/100km by 2020 and 4.0L/100km by 2025 – illustrates the seriousness with which the government intends to pursue implementation and enforcement. This chapter reviews the CAFC system, including the newly announced NEV credits, as well as an analysis of the pros and cons of the policy.

3.1 Requirements

Each manufacturer exceeding 2,000 vehicles per year is required to meet the by-vehicle standard limit (weight-bin based) as well as a corporate average FC limit and a certain percentage of the CAFC target. For the latter, credits can be accumulated if successful, or, if percentage target isn't met, the manufacturer can purchase excess credits within the compliance year.

In order to achieve these targets, China's Ministry of Industry and Information Technology (MIIT) enables more benefits from the shift to NEVs– not only the above explained NEV flexibility mechanism (see Table 3 and Table 4), but also a new NEV-credits system has been integrated in the CAFC management last September.[2]

Manufacturers of over 30,000 vehicles per year are required to produce 10% and 12% new energy vehicles in 2019 and 2020, respectively. Manufacturers that fail to meet the annual compliance requirement are required to purchase credits from manufacturers with excess credits to compensate.

3.2 Fuel consumption and new energy vehicle integrated accounting

(1) CAFC actual value and target value accounting

China's CAFC uses vehicle model, year, and annual sales data to calculate a weighted average for FC based on the New European Driving Cycle (NEDC). The CAFC target is based on individual vehicle FC targets, which use the quantity of annual production for each model to calculate a weighted average. Both CAFC limits and targets are calculated as shown in the formulas below:

$$CAFC = \frac{\sum_{i=1}^{N} FC_i \times V_i}{\sum_{i=1}^{N} V_i \times W_i} \qquad T_{CAFC} = \frac{\sum_{i=1}^{N} T_i \times V_i}{\sum_{i=1}^{N} V_i}$$

[2] Corporate Average Fuel Consumption and New Energy Vehicles Credits Joint Management Method report released. http://www.icet.org.cn/english/admin/upload/2017102642532337.pdf

Whereas:

***N**: the vehicle model number*

***FC$_i$**: fuel consumption of the "i"th model*

***V$_i$**: annual production of the "i"th model|*

***W$_i$**: production times of the "i"th model, if "i"th model is qualified NEV or ESV*

***T$_i$**: fuel consumption target of the "i"th model*

(2) Calculation of the integrated CAFC and NEV credits

China's CAFC Phase IV introduced an integrated dual management that enables the exchange of CAFC NEV super credits (difference between the target and actual CAFC).

$$C_{CAFC} = (\alpha \times T_{CAFC} - CAFC) \times TP$$

Where: C_{CAFC} - passenger car corporate average fuel consumption credits;

T_{CAFC} - passenger car corporate average fuel consumption target value;

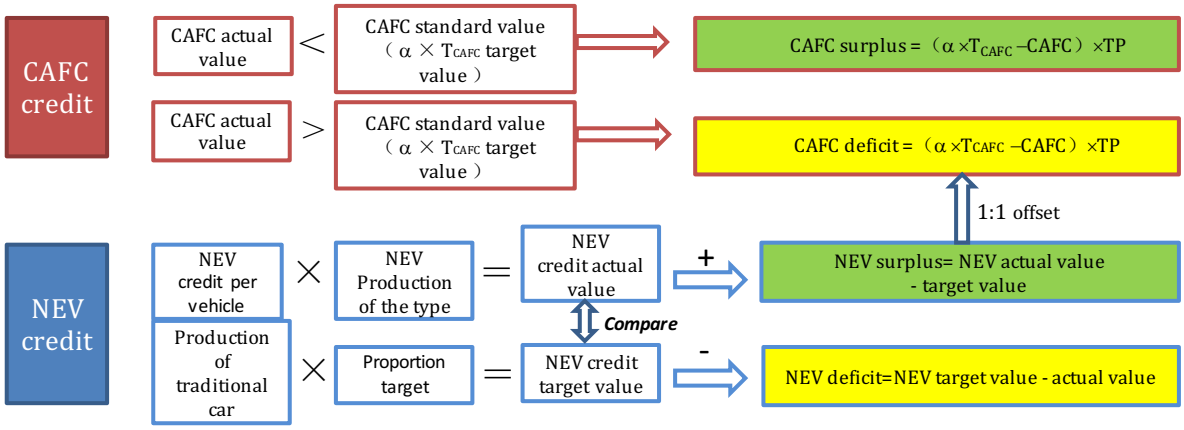
CAFC - Passenger car company average fuel consumption actual value;

α — annual average corporate fuel consumption requirement (%);

TP-passenger car production (excluding exports) or imports.

CAFC and NEV credits will be calculated independently. Corporate CAFC and NEV credits performance will also be evaluated separately. Yet CAFC can be offset by NEV credits, as illustrated in Figure 5. The ratio of trading is 1:1.

Figure 5: Dual-scheme – NEV super credits (CAFC credits) and NEV credits calculation method



Companies producing or importing over 30,000 passenger cars per year are obliged to comply with the NEV credits requirement, an annual NEV versus ICE production/importation ratio of 10% and 12% in 2019 and 2020, respectively. The 2021 ratio target will be determined in the future. Credit calculations per different vehicle technologies is specified in Table 5 and presented Figure 5, with a maximum of five credits per vehicle. The credit calculations are based on range and power consumption, as exemplified for BEVs in Figure 6, and for FCVs in Figure 7. Pure electric vehicles

models, for example, receive credits according to electric energy consumption (kW-h) and vehicle curb weight (reference base), using a factor of 0.5, 1, or 1.2. FCVs receive credits based on their rated power using a factor of 0.5.

Table 4: Credits calculation

Passenger vehicle type	Credits calculation requirement	Comments
BEV	0.012×R+0.8	(1) R is calculated according to the joint (urban and suburban) driving cycle (measured by km). (2) P is the rated power of the fuel cell system, in kW (3) The upper credits limit is 5 points. (4) Credit calculation results are rounded to two decimal points.
PHEV (REEV included)	**2**	
FCV	0.16×P	
Technological specifications available in references.[3]		

Figure 6: PEVs and PHEVs credits accumulation graph

[3] **Technological benchmark:**

(1) BEVs: The requirement is for a 30-minutes maximum drive speed of not less than 100km/h, and pure electric mode driving range of not less than 100 km.

(2) The credits enabled depend on the relationships between energy consumption and the vehicle curb weight (m) in the following manner: For Y1, if m≤1000kg, Y1≤0.014×m+0.5；if 1000<m≤1600kg, Y1≤0.012×m+2.5；if m>1600kg, Y≤0.005×m+13.7. For Y2, if m≤1000kg, Y2≤0.0098×m+0.35；if 1000<m≤1600kg, Y2≤0.0084×m+1.75；if m>1600kg, Y2≤0.0035×m+9.59. Of which, Y stands for energy consumption and M stands for the curb weight of BEVs.

(3) PHEVs: the minimal driving range for credit eligibility is 50 km;

PHEVs: when minimal range is 80 km or less, the energy consumption (GB 19578) should be less than 70% of the standard limit. Otherwise credits will be reduced to 50% of the formula.

Credits from PHEVs of more than 80 e-range but with lower energy consumption than the standard limit cannot be exchanged.

(4) FCVs: The requirement targets fuel cell system rated power to have not less than 30% of the rated power of the drive motor, and not less than 30kW. Failure to meet this requirement enables only 50% of the credits and disables credit exchange (own use only).

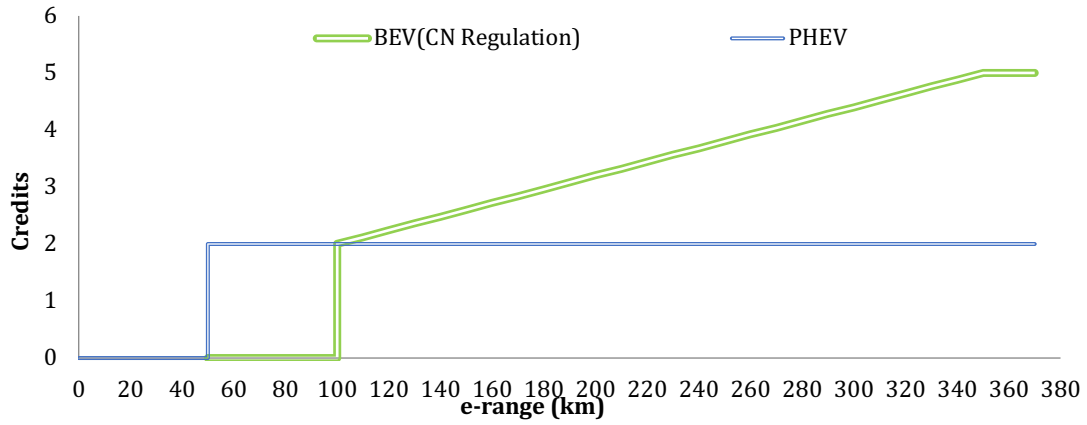


Figure 7: NEV credits obtained for BEV model by energy consumption (kWh; in policy notes: 'y')

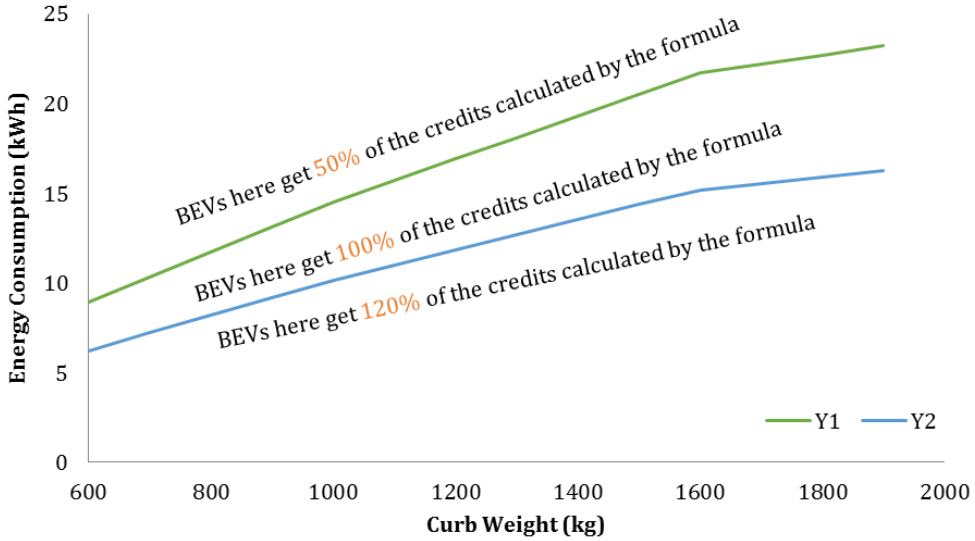
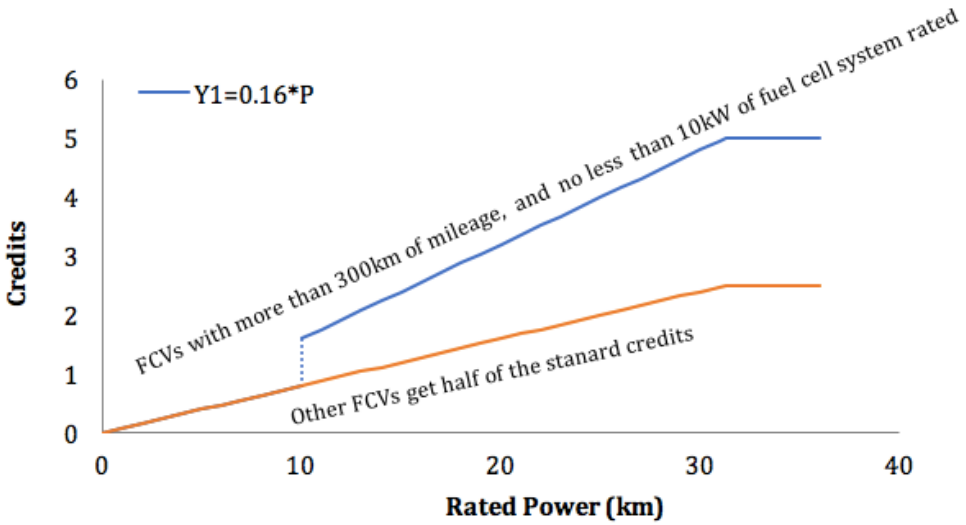


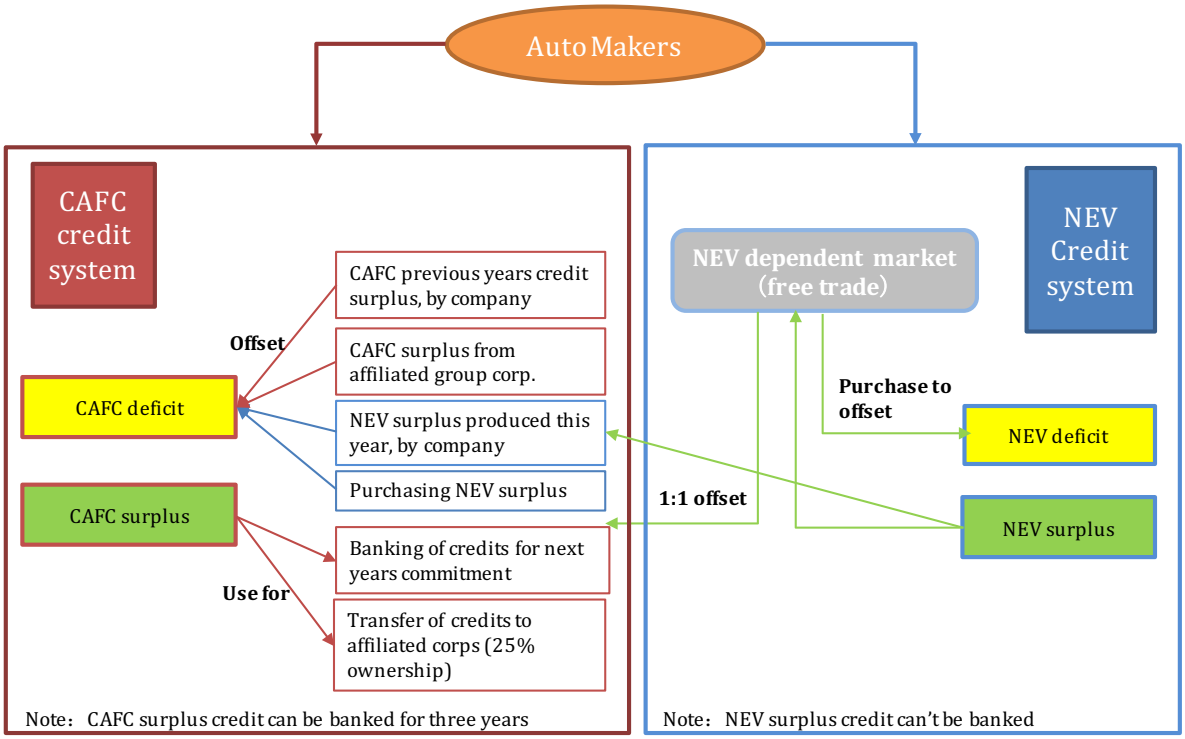
Figure 8: NEV credits obtained for FCV models by energy consumption (kWh; in policy notes: 'y')



3.3 Credits trading mechanism

CAFC and NEV negative points must be compensated for annually. An excess of CAFC credits can be carried forward three years, while NEV excess credits cannot (they can be carried forward one year from 2019, as a grace period). This is illustrated in Figure 9.

Figure 9: Credits exchange mechanism, including NEVS super credits (CAFC credits) and NEV credits



*i*CET believes this mechanism is threatening FC rate improvements for ICE vehicles. Given the already large flexibility of CAFC implementation through super credits (25%), a combination of the system is not useful. *i*CET has been an advocator for NEV credits system since 2013, yet believes such a system should be directly linked to carbon emission reductions and maintain independence from other systems. Given the difficulties of monitoring and enforcing the CAFC system it is unwise to further complication the system by integrating NEV credits.

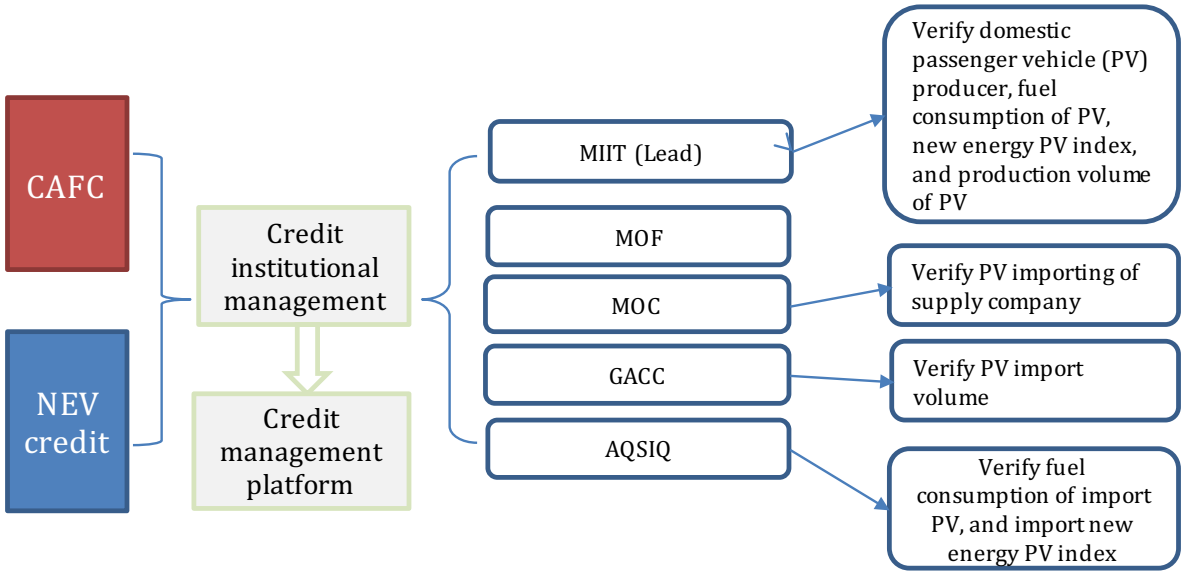
3.4 Credits management

MIIT, Ministry of Finance (MOF), Ministry of Commerce (MOFCOM), and General Administration of Customs, the State Administration of Quality Supervision, Inspection, and Quarantine (AQSIQ) will jointly enforce the "average fuel consumption of passenger cars and new energy vehicle integral management." The first two will oversee the enforcement of domestic manufacturers, while the latter two will support documentation submission of importers to the former two. The governing entities and their responsibilities are listed in Figure 10.

MIIT will establish a vehicle FC and NEV integrated information management platform, including the summary and publication of FC and NEV related information. Automakers and importers will promptly report their vehicle production and importation volumes as well as vehicle FC to MIIT –

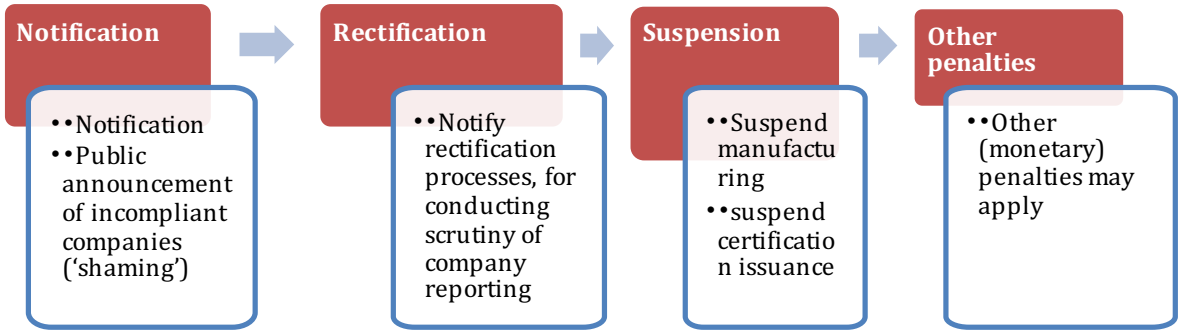
as listed in Appendix I of Regulation.[4] The reporting will include by-vehicle calculations performed by the automakers themselves.

Figure 10: NEV super credits (CAFC credits) and NEV dual network management



Penalties include the seizure of vehicle production or importation and the issuing of a public notice ("shaming" approach), summarized in Figure 11. Enforcement will be pursued in accordance with "Automobile Industry Development Policy" [5] and the "Mandatory Product Certification Management Regulations."[6]

Figure 11: CAC management enforcement instruments



3.5 Difficulties and Challenges on energy efficiency management

At present, there are nearly 100 passenger car manufacturers in China and nearly 30 importers. Over 2,900 new models were added to MIIT's Fuel Economy website in 2016[7]. The high volume of

[4] http://zqyj.chinalaw.gov.cn/draftDetail?listType=2&DraftID=1894&1497592757400

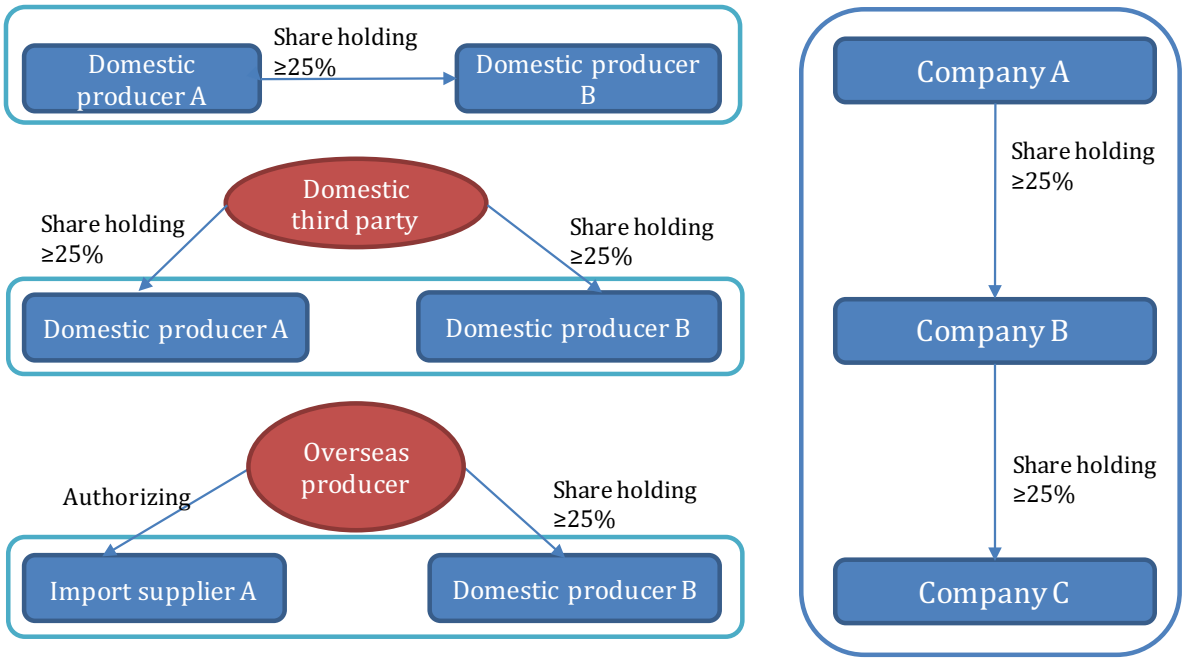
[5] http://www.miit.gov.cn/n1146295/n1146557/n1146624/c3554600/content.html

[6] http://www.cnca.gov.cn/cnca/rdht/qzxcprz/flfg/193003.shtml

[7] China Auto fuel Consumption official website（中国汽车燃料消耗量网站）. http://chinaafc.miit.gov.cn/

vehicles and new models creates enormous enforcement challenges. The dual management scheme governing both CAFC and the new NEV credits system is increasing the pressures on governing entities, as illustrated in Figure 12.

Figure 12: Complex structure to China's auto regime



The governing institutional structure of CAFC and NEV credits is complex. It includes several MIIT departments, the National Development and Reform Commission, the Ministry of Finance, the Ministry of Commerce, the General Administration of Customs, the General Administration of Quality Supervision, Inspection and Quarantine, and other government agencies. This complexity increases coordination challenges and hinders prospects for adequate enforcement.

China made great efforts to develop energy-saving and new energy vehicles, and is in a period of industrial restructuring. Based on *i*CET's decade of analysis and research on fuel consumption standards and their development and implementation in China, it is advised that:

(1) Companies be given a clear long-term compliance plan, that would support the development of competitive products.

(2) All economic mechanisms (penalties in particular) be clear, significant, and enforced.

4. COMPARISON BETWEEN CHINA'S NEV CREDITS AND CALIFORNIA'S ZEV CREDITS

Inspired by the California's 1990 ZEV regulation, which has been modified multiple times and adopted in nine other US states, China released its own adjusted version in September 2017, which

entered into effect in 2018.[8] There are significant differences between the ZEV credit systems, as shown in Figure 13 and Figure 14.

Figure 13: Comparison between the China and California NEC credits management mechanisms

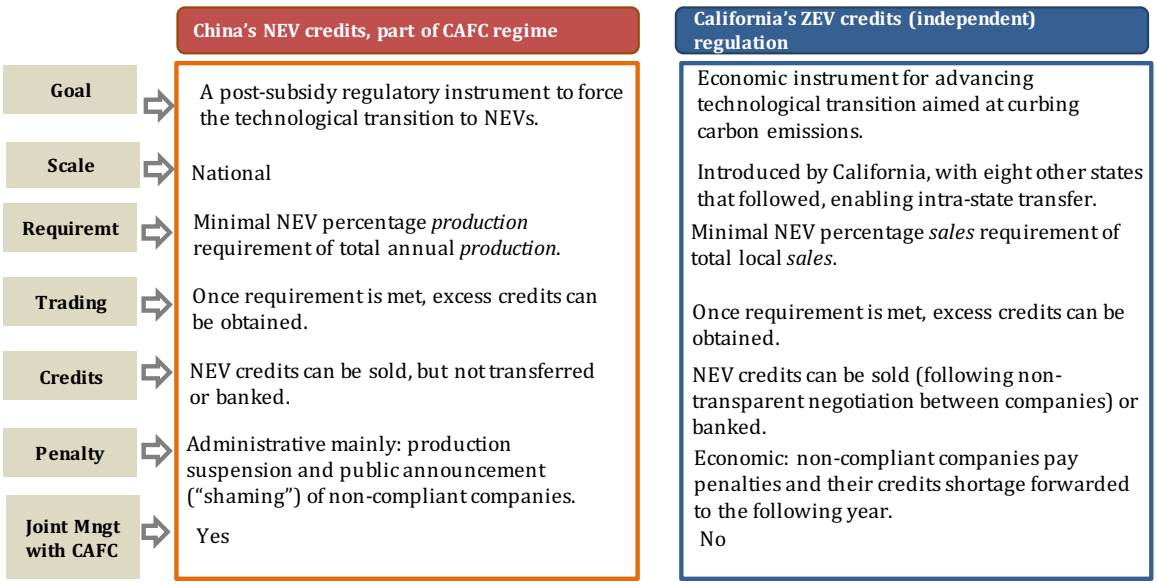


Figure 14: Comparison between the China and California NEV credit policy design

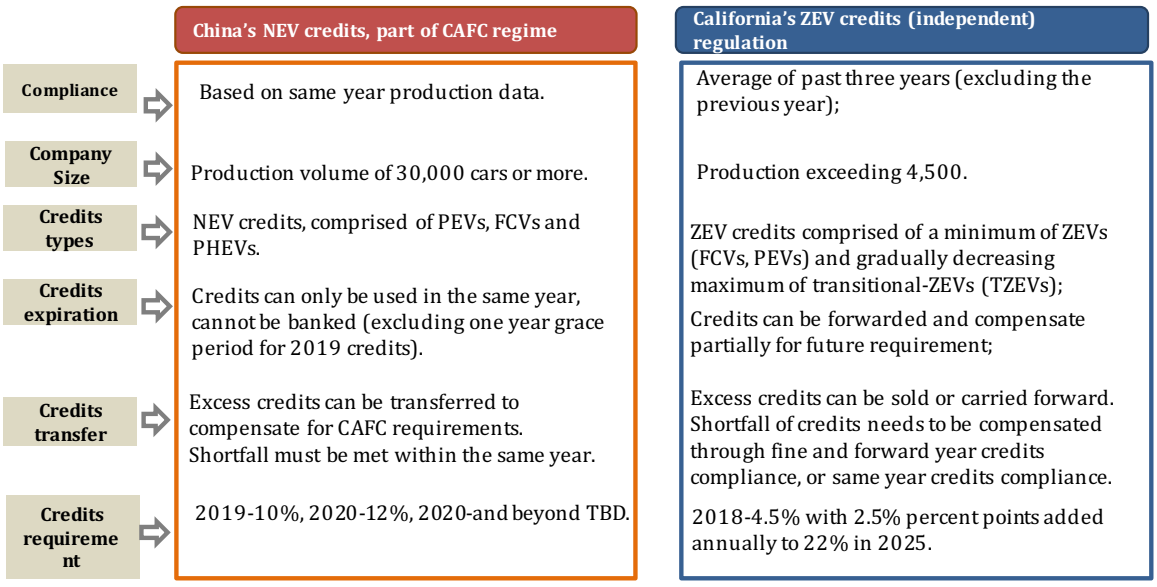


Figure 15: BEV credit comparisons between the new NEV-credits draft and ZEV credit regulation in California

[8] Corporate Average Fuel Consumption and New Energy Vehicles Credits Joint Management Method Regulation http://www.icet.org.cn/english/admin/upload/2017101337455653.pdf

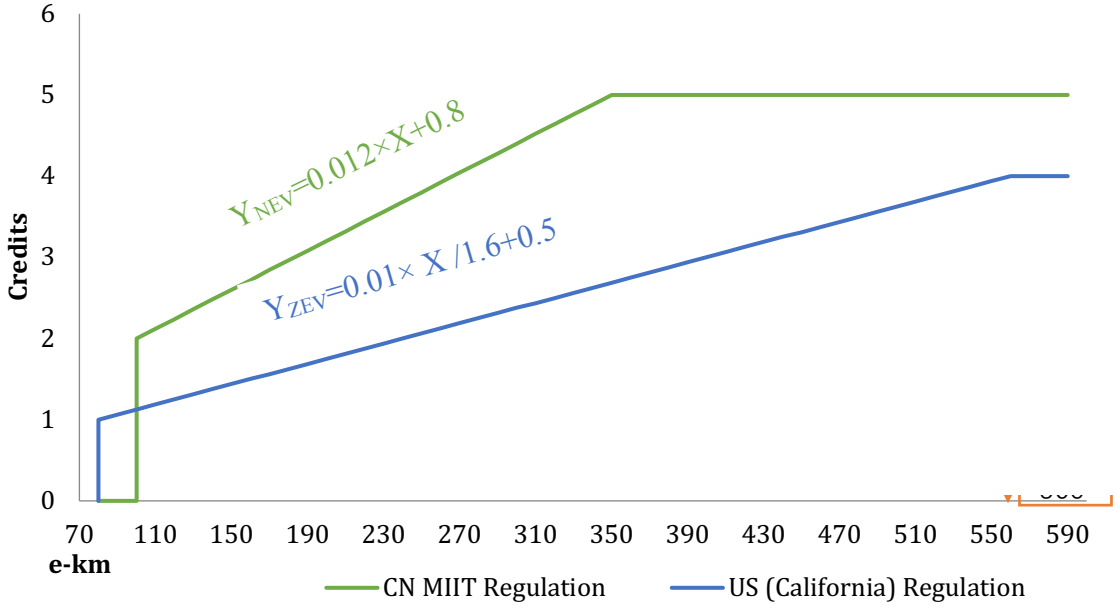


Figure 16: Combined cycle credit results for seven BEVs models under NEV-credits draft and ZEV-credits system compared

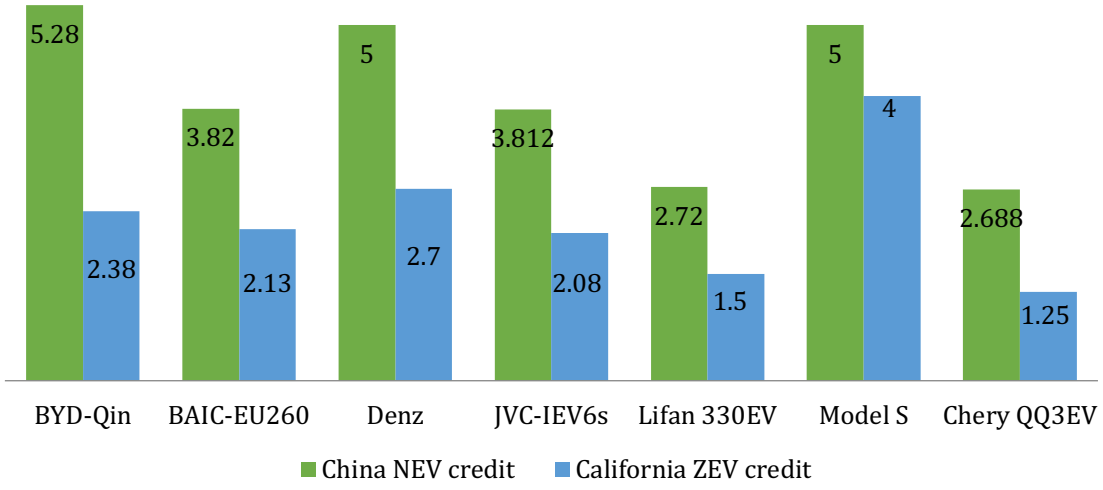


Figure 17: PHEV credit comparisons between the new NEV-credits draft and ZEV credit regulation in California

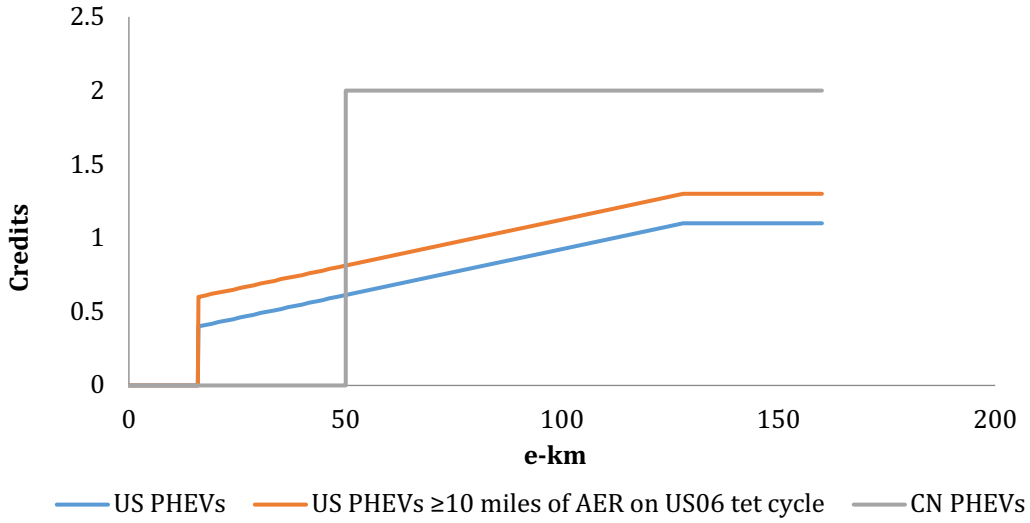
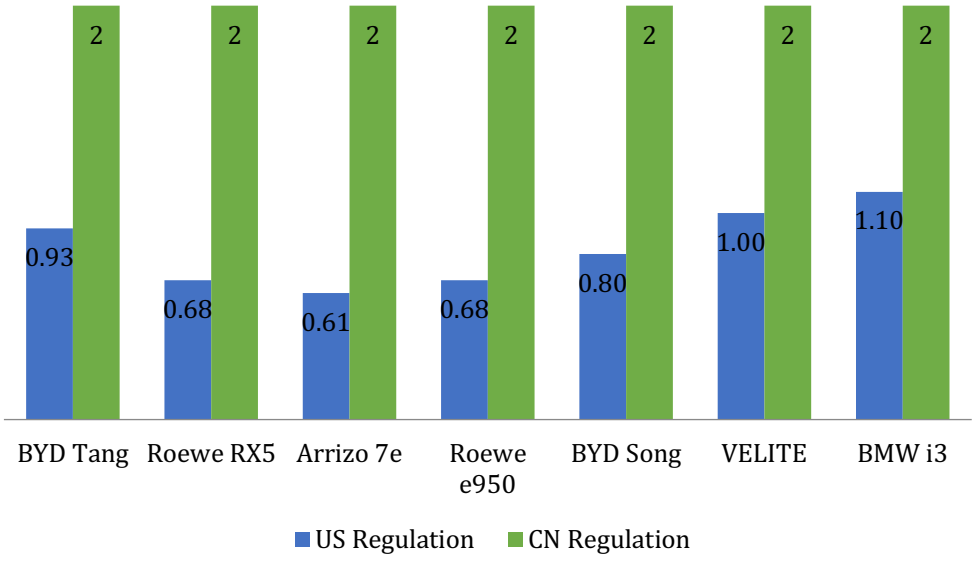


Figure 18: Comparison between credits from seven PHEVs models under NEV-credit draft and ZEV-credit system

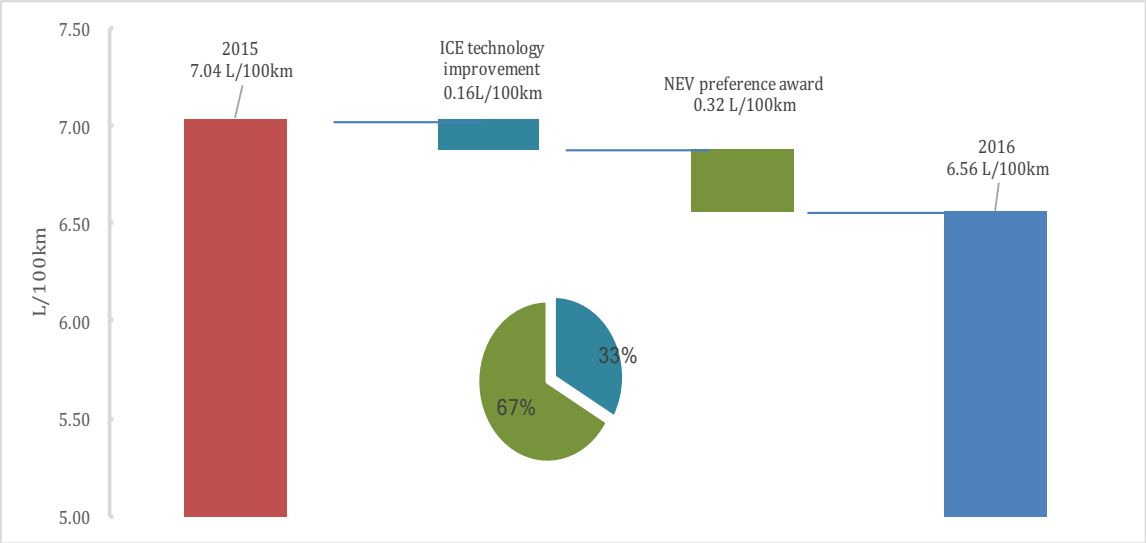


5. CURRENT STATUS AND TRENDS FOR PASSENGER CAR FC IN CHINA

5.1 Reported FC value largely unchanged

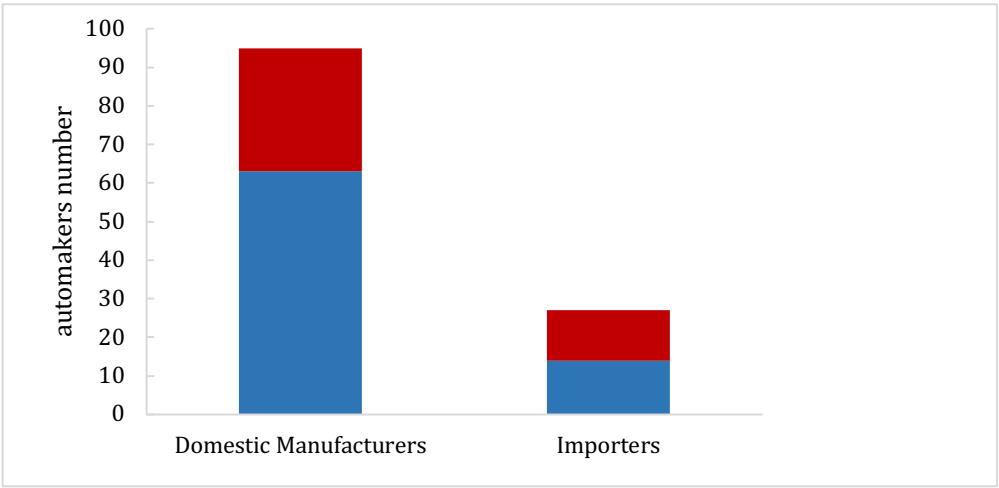
According to the MIIT in 2016, the average FC rate of domestic and imported cars was 6.51L/100km and 7.89L/100km, respectively. Compared with the 2015 average FC rate of 7.04L/100km, the reported annual average of 6.56L/100km in 2016 shows a decrease of 0.16L/100km (33%) that can be attributed to vehicle energy efficiency improvement and 0.32L/100km (67%) that can be attributed to NEV super credits (the flexibility mechanism).

Figure 19: China's average FC - MIIT reported, NEV and energy saving technologies contribution



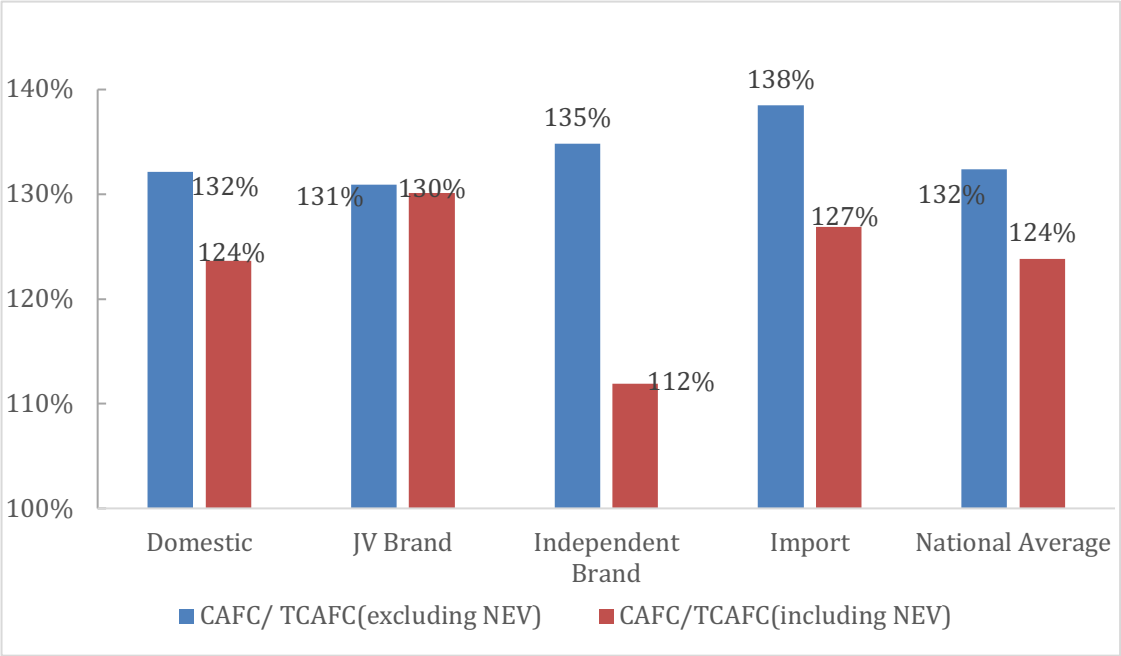
After entering the FC standard implementation phase IV in 2016, the rate of non-compliance among domestic and importing car companies reached about 30% and 50% respectively. In 2015, the non-compliance rate for importers was a mere 4%, indicating the fuel saving application in many auto companies did not catch up with the stringent standard requirements.

Figure 20: By corporate type - Phase IV compliance



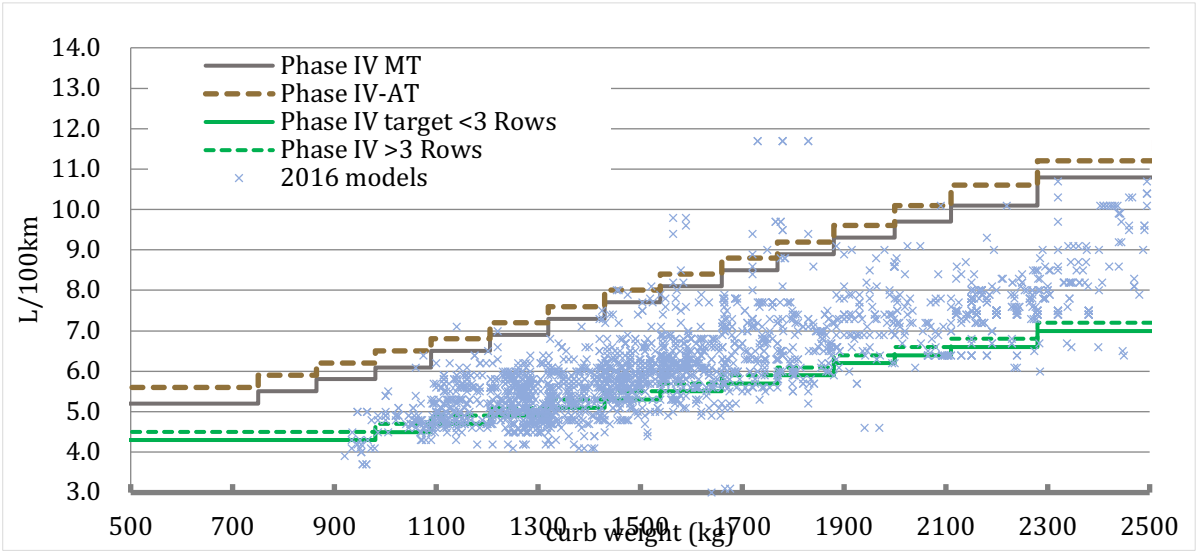
Although many enterprises did not meet the standard, the actual FC rate of the passenger vehicle industry in 2016 had a value-to-target ratio of 132%, lower than the required ratio of 134%, highlighted in Figure 21. After incorporating NEV reductions to CAFC, the ratio goes even lower to 126% - beating the 2017 value-to-target ratio of 128% ratio one year earlier. This indicates the standard is currently not stringent enough.

Figure 21: 2016 companies reported versus target value



In 2016, as many as 2,906 new (M1 class) domestic models were added to the MIIT's fuel economy website, indicating there was huge opportunity for improvements in corporate fuel savings. However, only 400 models in 2016 reached the target, accounting for 15% of the total models, demonstrated in Figure 22. Going forward, the policy regime will clearly need to play a bigger role in the adoption of fuel saving initiatives.

Figure 22: Reported FC of 2016 M1 passenger vehicles

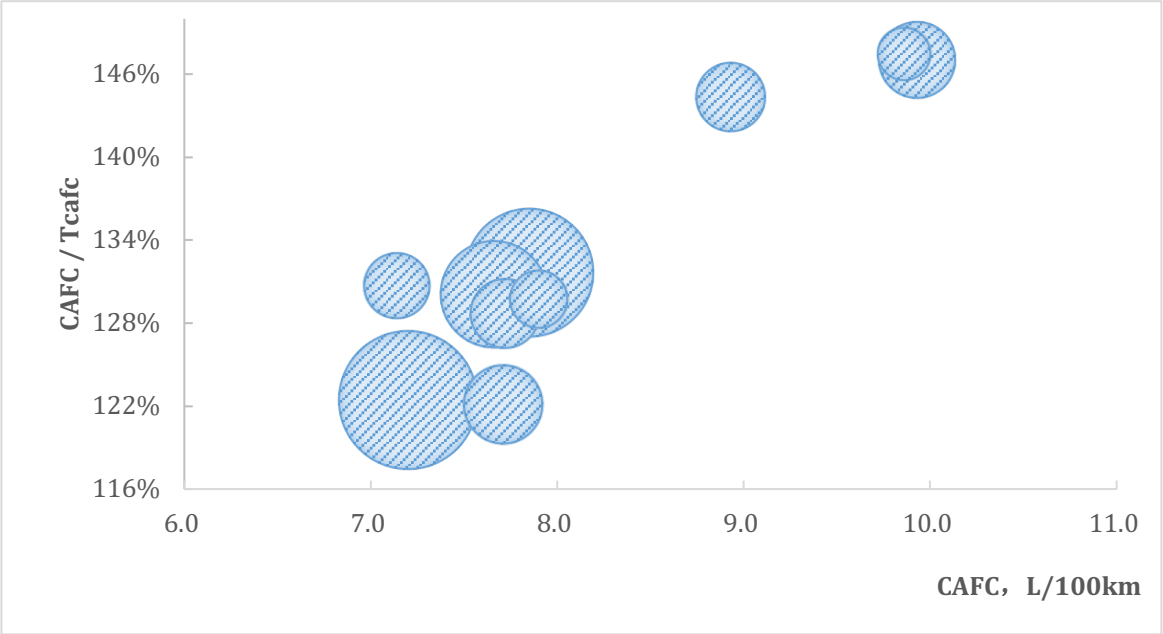


Note: Phase IV of CAFC officially entered implementation in 2016.

5.2 2016 CAFC compliance status

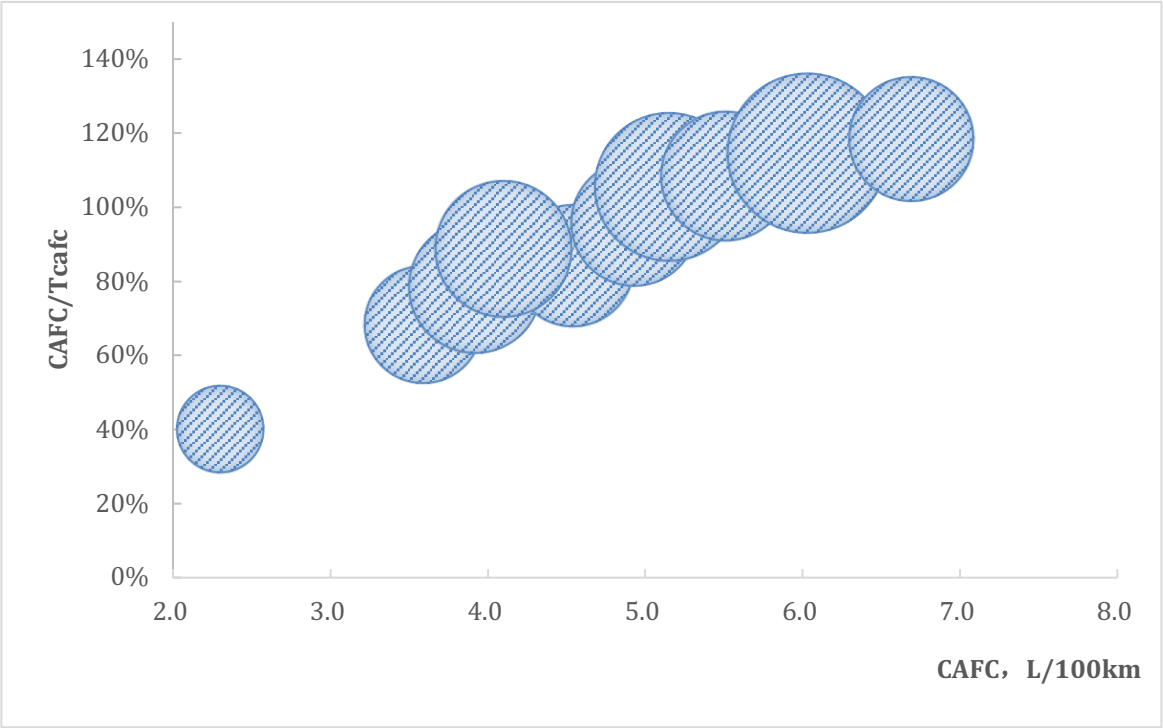
Among the top 10 selling domestic automakers, Great Wall Motor, Chang'an Changan and Changan Ford did not meet the value-to-target requirement ratio of 134%. FAW-Volkswagen, on the other hand, reached 125% value-to-target ratio, well ahead the 2017 requirements (see Figure 22). NEV producers, however, achieved a substantially lower ratio: as many as six such manufacturers were able to reach the 2020 target in 2016. That said, most of these manufacturers would perform poorly if it wasn't for the use of the NEV flexibility mechanism, e.g. Jiangnan Automobile, JAC (see Figure 24). Both independent and importers would have failed to meet the target if it wasn't for the NEV super credit option (see Figure 25).

Figure 23: Top 2016 average CAFC performing domestic manufacturers



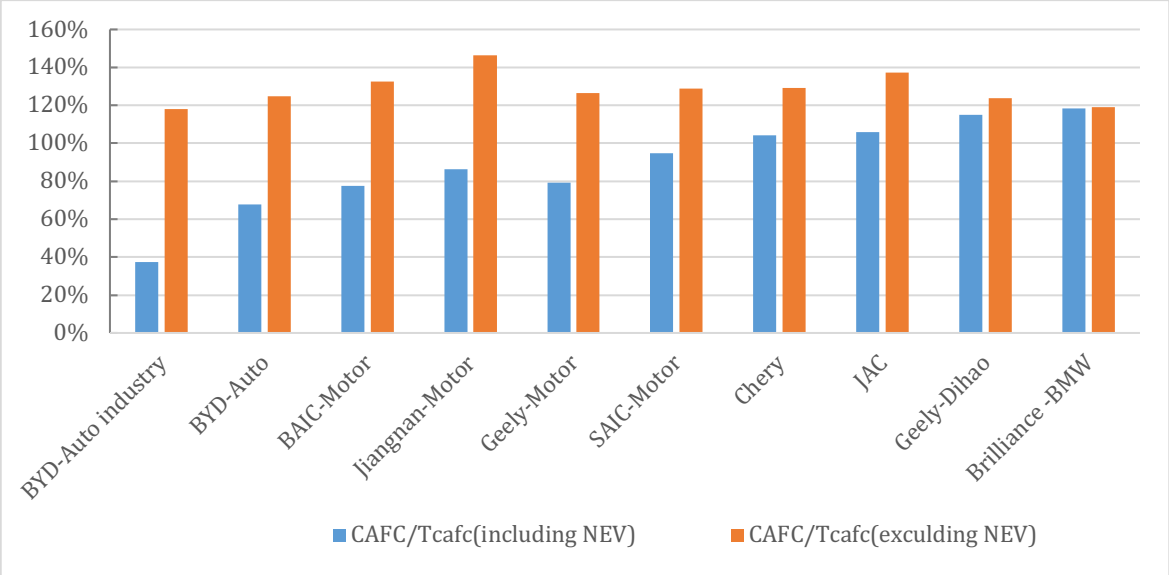
Note: The size of the bubble represents comparative annual production volume.

Figure 24: Domestic 2016 CAFC in comparison to China's 2020 target



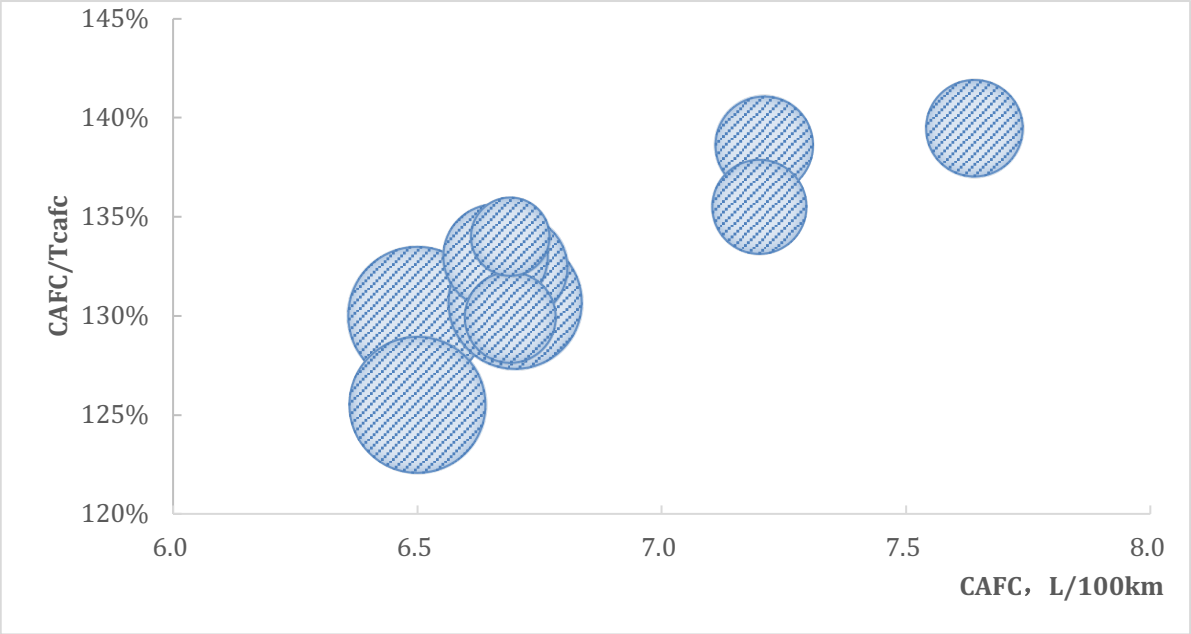
Note: Only auto companies with annual production exceeding 100,000 cars are included; The size of the bubble represents comparative annual production volume.

Figure 25: By-corporate type CAFC comparison with/without NEV credits



The top 10 importing car companies' CAFC actual-to-target ratio was relatively scattered; three companies had a ratio higher than 140%, while some achieved the 2017 ratio ahead of time (e.g. BMW, Porsche), as shown in Figure 26.

Figure 26: Importers' 2016 CAFC in relation to 2016 and 2017 target

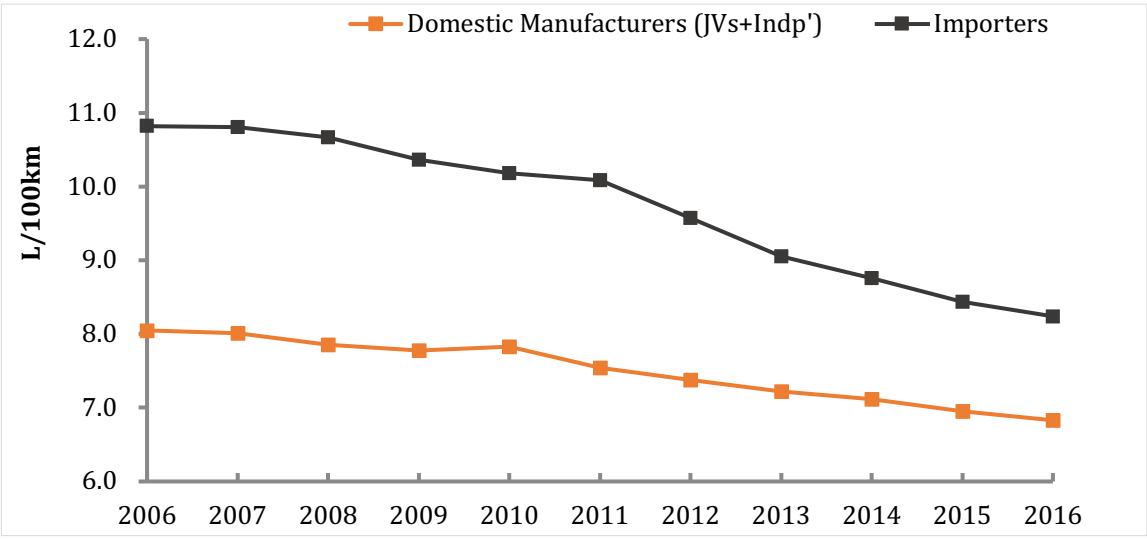


Note: The size of the bubble represents comparative annual production volume.

5.3 Fuel consumption trends

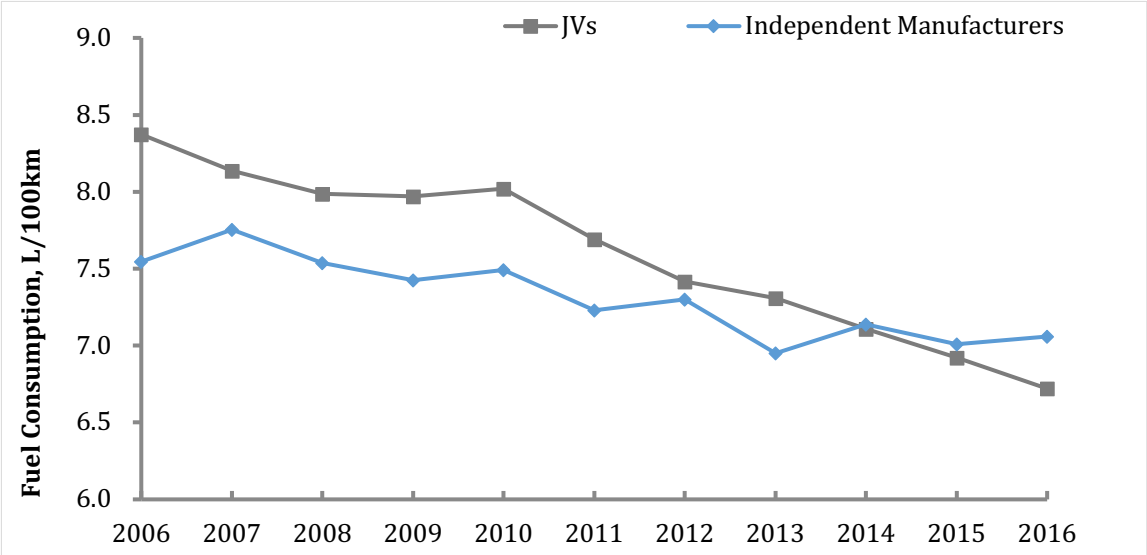
China's fuel consumption standards saw an average annual drop of 1.7% and 2.7% from 2006 to 2016 throughout the implementation period of its three first phases, respectively. From 2012 to 2016, the average annual decline in the FC rate for imported cars was 3.7%, significantly lower than that of domestic vehicles, which saw an average decline of 2.2%. The annual average decline over the same period was 2% (see figure 27). JVs and independent manufacturers CAFC decreased by 2.2% and 1% from 2006 to 2016, respectively (see figure 28).

Figure 27: Importers and domestic CAFC development



Note: NEV flexibility mechanism excluded, only ICE FC calculation included.

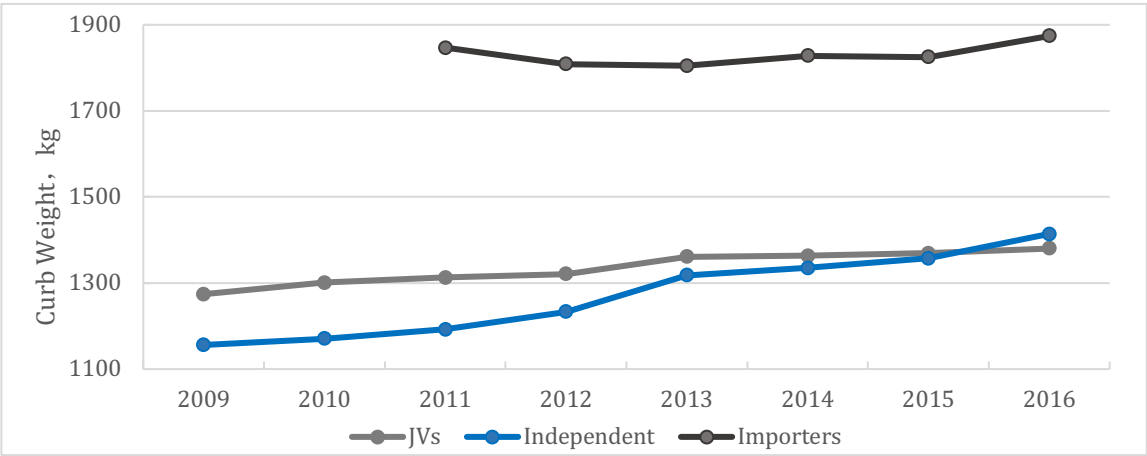
Figure 28: Importer 2016 CAFC in relation to 2016 and 2017 target



Note: NEV flexibility mechanism excluded, only ICE FC calculation included.

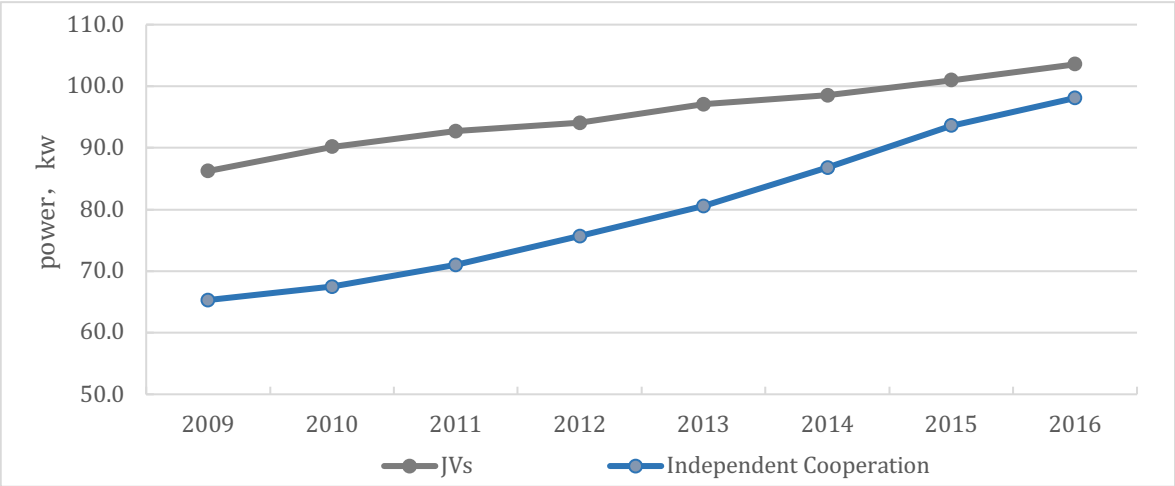
There is ample evidence that it is the increase in vehicle weight that slows FC reductions. Between 2006 and 2016, domestic vehicle car curb weight increased by 160kg (13%), of which independent cars weight increased by as much as 258kg (22%), as shown in Figure 29. Because each 100 kg increase in curb weight is equivalent to a FC increase of about 0.3-0.6L, China's vehicle curb weight increase led to 0.5-1 L/100km FC increase. Domestic vehicle average weight increase led to FC increase of 0.7-1.5 L. Luckily, domestic car power and displacement also continued to increase (while that of imported cars stabilized), absorbing some of the weight-based FC increase.

Figure 29: By-corporate type curb-weight (kg) development trend



In addition, the rated power of domestic passenger cars continues to increase. The rated power of joint-venture and independent brands between 2009 and 2016 increased from 17kW to 33kW, respectively, as shown in Figure 33.

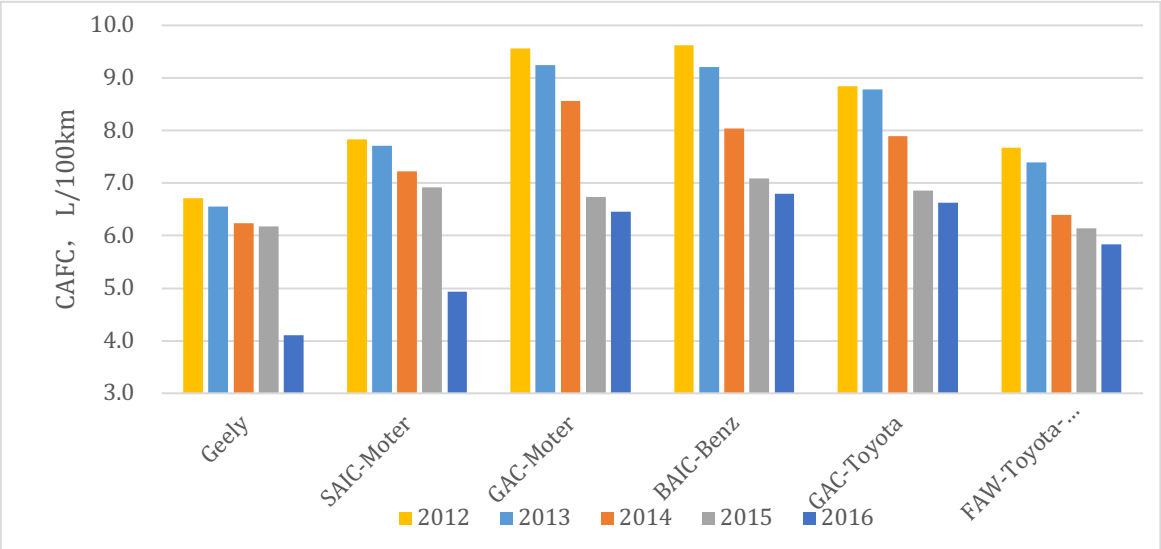
Figure 30: By-corporate type power (kw) development trend



5.4 Brand FC performance

Six automakers that achieved the steepest CAFC decline, reaching 24% to 39%, are listed in figure 26. Among these, NEVs were an instrumental CAFC reduction pathway for Geely Automobile and SAIC (Geely Zhidou and Dihao EV production reached 40,000, SAIC Roewe plug-in hybrid production was 22,000). GAC, on the other hand, focused on fuel saving flagship model production (Chuan Qi GS4 with 6.3-6.7L/100km, which reached 336,000 sales). Beijing Benz, Guangzhou Automobile and Tianjin FAW Toyota also focused on fuel saving technology integration (e.g. lightweight technology, idle stop-start, supercharged direct injection, advanced transmission).

Figure 31: Top performing companies in CAFC reduction between 2012 and 2016



Among importing brands, Porsche and Volvo saw the largest FC decrease of over 30% between 2012 and 2016, as illustrated in Figure 32. Porsche's corporate FC rate dropped from 9.12L/100km in 2015 to 7.71L/100km in 2015, down 15.4%. In part, this is a result of high importation of Porsche Cayenne, the flagship of the company's small and low FC capacities. Great Wall Motor and Changan Automobile, are the leaders of CAFC increase as illustrated in Figure 33, likely due to their strategic focus on large engine and SUV markets.

Figure 32: Top performing importers in CAFC reduction between 2012 and 2016

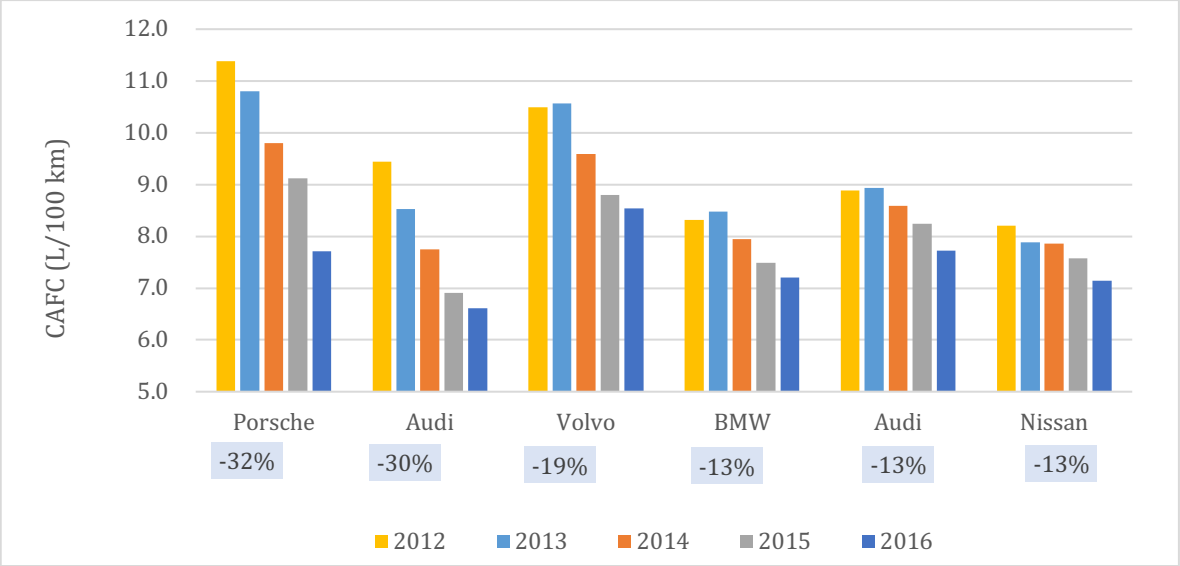
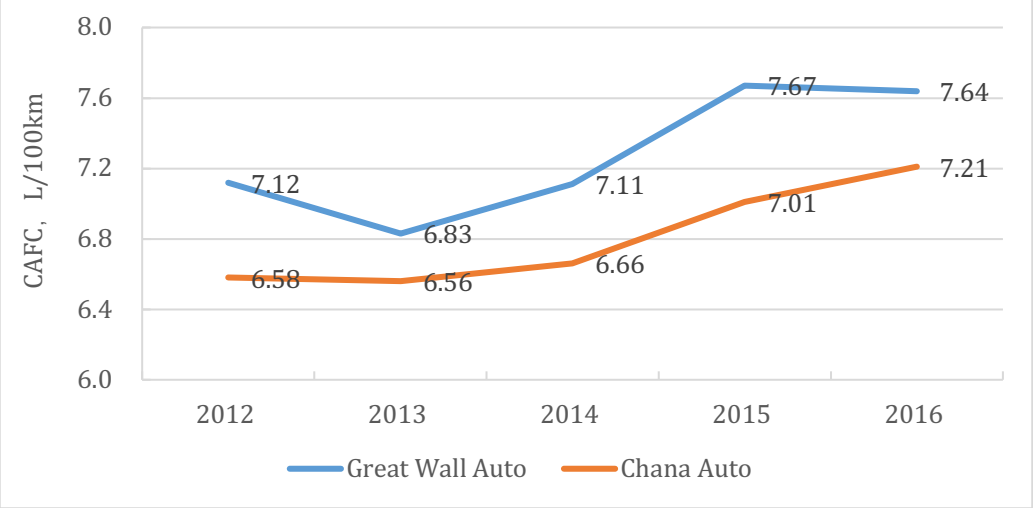


Figure 33: Great Wall Motors and Chana Auto CAFC trends



5.5 Impact of SUV and MPV market expansion on China's national FC performance

While compact cars saw less than 4% growth in 2016, SUV and MPV sales increased by over 40% and 20% (respectively) for four consecutive years, eroding the market share of small and compact car. In 2016, SUVs and MPVs accounted for nearly one-half of the entire passenger car market, as illustrated in Figure 34.

SUV market share increased from 15% in 2012 to over 40% in 2016. Market share of independent SUVs in particular, increased from 16% to 64%, while JV's SUVs market share increased from 13% to 27%, during this period – as shown in Figure 35.

Figure 34: By-segment market share development

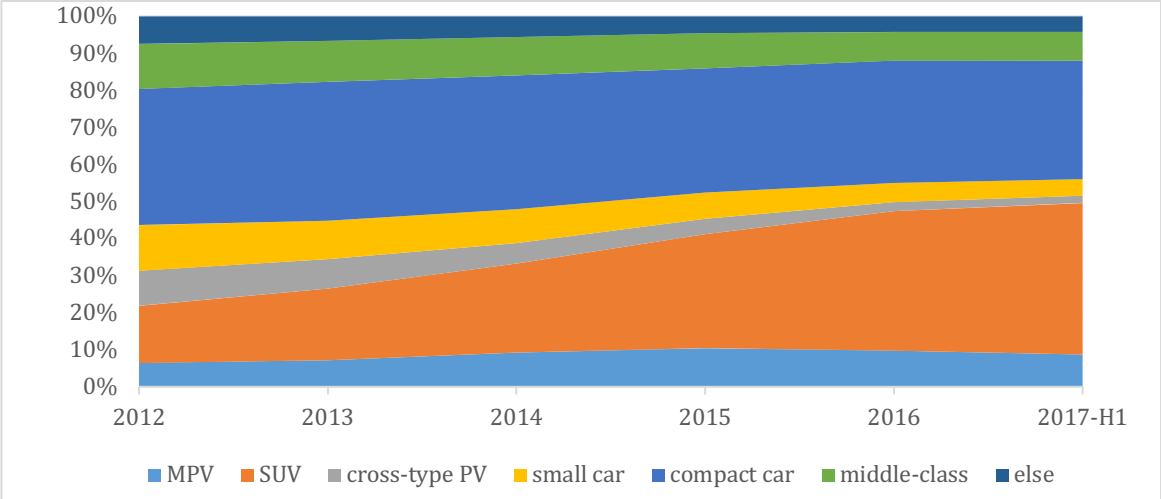
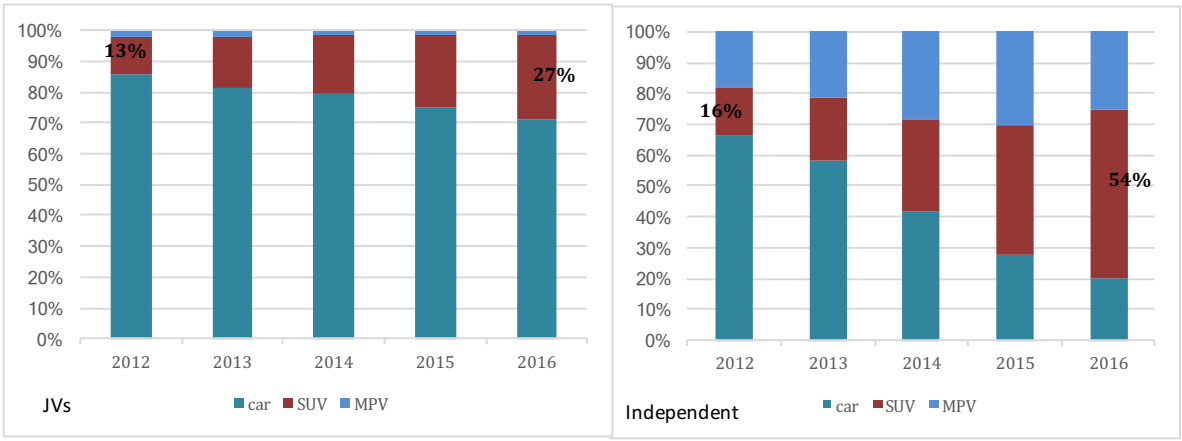
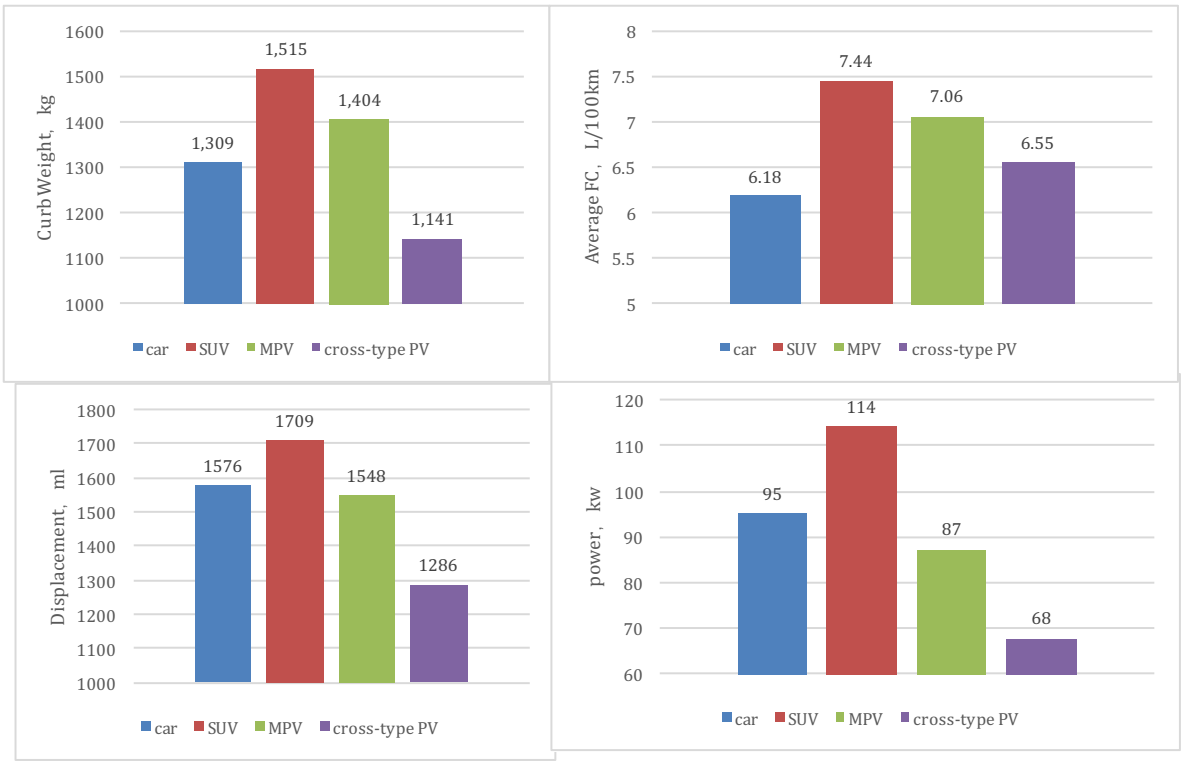


Figure 35: By-corporate type vehicle segment development



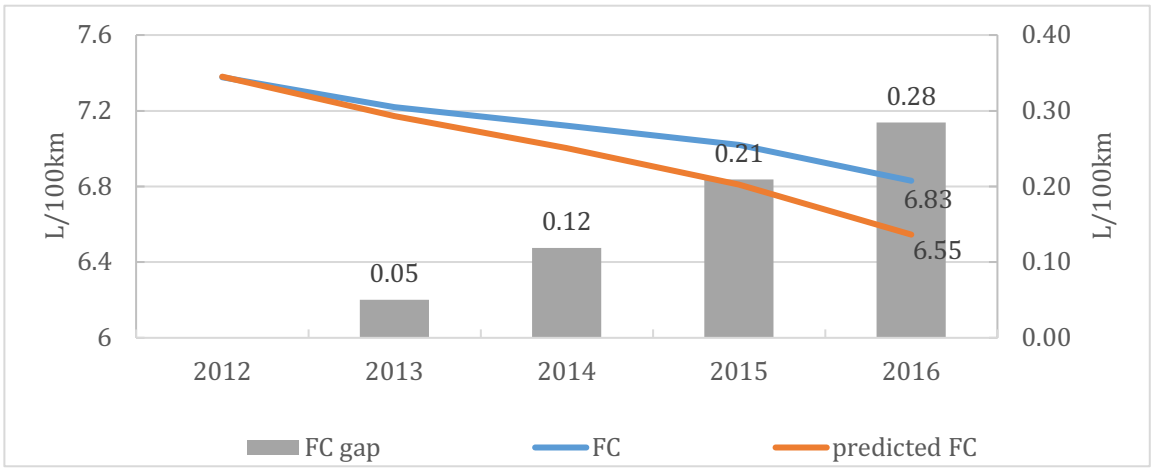
The average FC rate for SUV in 2016 was 7.44L/100km, 1.2L/100km higher than that of compact cars.The average FC rate for MPVs was also higher than that of compact cars by 1L/100km. This is in large part due to the average curb weight of the SUVs and MPVs, 200kg and 100kg higher than that of average passenger cars, respectively. In addition, the average displacement and power is also higher than that of the passenger car, as demonstrated in Figure 36.

Figure 36: By- segment development vehicle 2016 average features: FC, weight, power, displacement



Given higher FC rate as well as the increase in market share for SUVs and MPVs, FC targets have become harder to achieve than they were before. If the structure of China's car market in 2016 was similar to that of 2012, average total FC would have been about 20% lower, as shown in Figure 37.

Figure 37: SUV/MPV market share increase pushes average FC upward



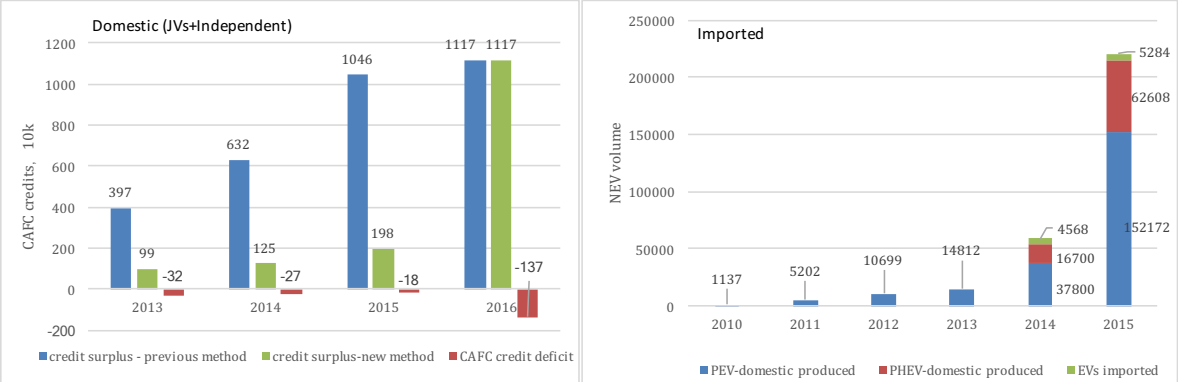
Note: Predicted FC is based on 2012 auto structure; because SUV and MPV share is likely to continue to increase, FC is likely to increase.

6. CHINA CAFC NEV (SUPER-) CREDITS AND NEV CREDITS

6.1 Corporate CAFC NEV super-credits

After entering Phase IV, given the market dominance of domestically produced cars and their increased production of NEVs, overall CAFC credits maintained high volume and manufacturers compliance pressures remained low – as demonstrated in Figure 38. Great Wall had the largest shortage of CAFC credits in 2016, and may therefore purchase credits from Yogoma, an EV company that GreatWall bought 25% of its shares. Changan Automobile, the second largest manufacturer with CAFC shortage, is likely to be reliant on Changan Group's affiliated enterprises for credits compensation.

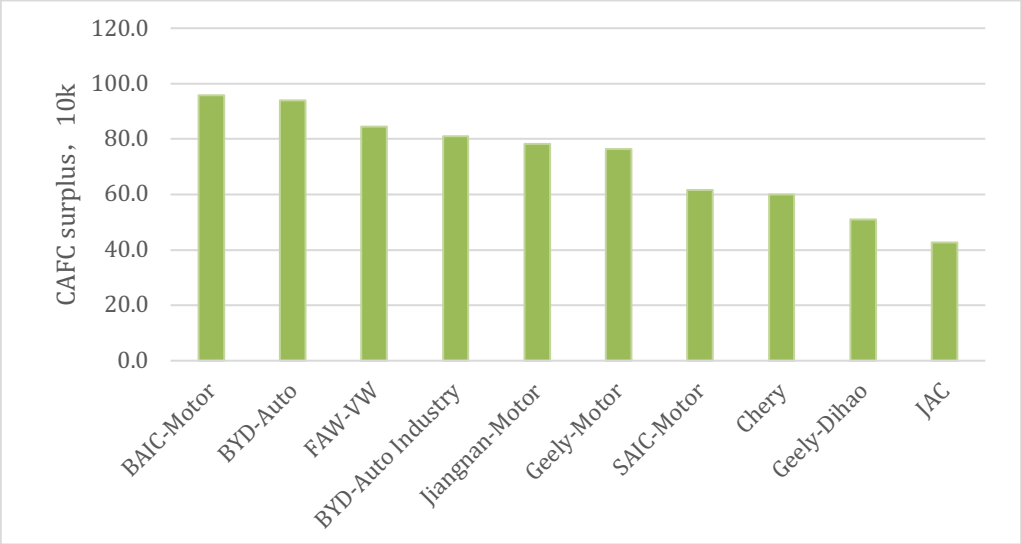
Figure 38: By- segment development vehicle 2016 averages: FC, weight, power, displacement



Note: The 2013-15 credits are calculated according to the "Accounting Method for Average Fuel Consumption of Passenger Vehicle Enterprises", while 2016 credits are calculated including flexibility mechanism.[9] *If 2016 calculations were performed using 2013-15 credits, credits for these years would have been significantly reduced.*

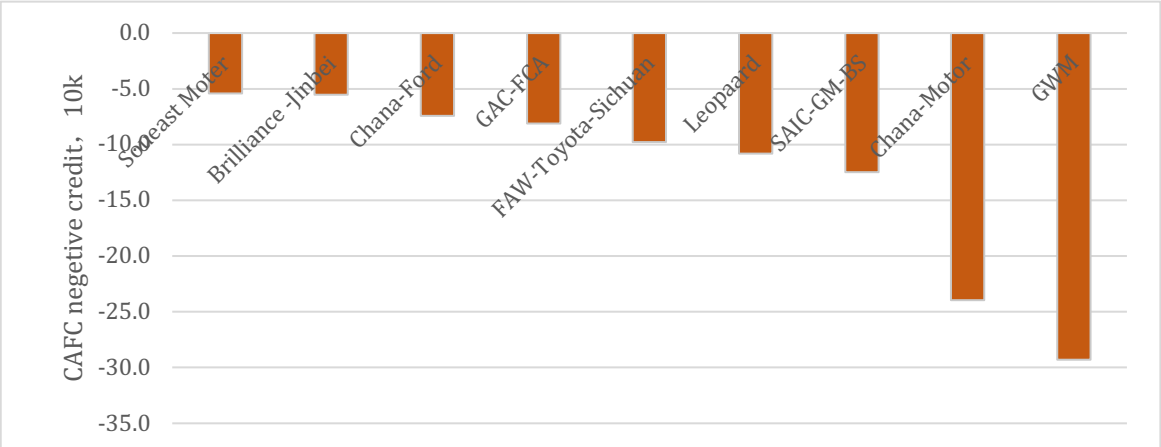
Figure 39: Top 10 surplus CAFC super credits holders

[9] Passenger car CAFC calculation method (乘用车企业平均燃料消耗量核算办法) http://chinaafc.miit.gov.cn/n2257/n2783/c86525/content.html



In 2016, as indicated in Figure 38, the top 10 CAFC credit producers were NEV manufacturers (besides FAW-Volkswagen), the majority of which were JVs e.g. FAW-Volkswagen, Shanghai Volkswagen, Changan Ford, BMW Brilliance, and Dongfeng Nissan. The greatest CAFC credit shortages were from SUV leaders Great Wall and Changan, with a total of 290,000 and 230,000 negative points respectively, as shown in Figure 40. The bulk of the 2016 CAFC credit deficit was produced by two major independent brand manufacturers, Great Wall and Changan, with a total of 290,000 and 230,000 negative credits, respectively. Cheetah and SAIC also had an excess of over 100,000 deficit of credits.

Figure 40: Top 10 deficit CAFC super credits holders



Great Wall, the largest negative credit auto manufacturer, has transferred as many as 40,000 positive credits forward since 2013 (only 80% of the credits can be transferred to the following year)) yet still holds 270,000 negative credits. In order to comply, Great Wall is projected to inject 25% of the shares of electric car maker Yogomo into its affiliated company in order to achieve FC compliance[10].

[10] 长城入股御捷，新一轮新能源领域的合资合作即将开启. http://auto.sina.com.cn/news/qw/2017-08-30/detail-ifykpuuh9592164.shtml

Changan Automobile, the second largest negative credits manufacturer, has relatively low compliance pressure. Some of its negative points can be carried forward using positive credits produced in previous years – more than 100,000 positive credits generated in 2013. In 2016, the company generated about 21,000 new energy credits through its various affiliates companies (Changan Mazda, Changan Suzuki, Hefei Changan, etc.). Recently, Changan Automobile also introduced "Shangri-La," a new energy brand that is projected to increase investment in new energy vehicles to comply[11].

Changan Ford performed well in corporate CAFC compliance in the past few years, but generated over 70,000 negative credits in 2016. The company mainly produces high-quality sedans and SUVs. After entering Phase IV, the standard increased in stringency, and is becoming harder to meet without new energy vehicles production.

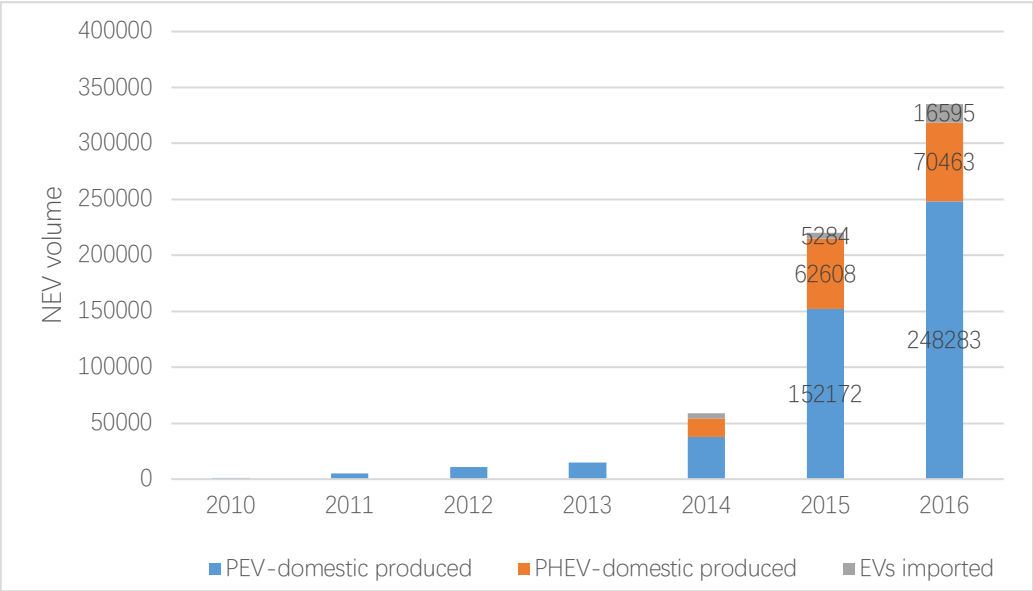
In recent years, Guangzhou Automobile Group produced negative integrals. From 2015 to 2016, energy-saving technologies were widely employed in the development of the GAIC GS series models , as GS4 with low FCgains a good sales. In this way, without the aid of new energy vehicles, the company managed to make the shift from a negative CAFC to a positive credits manufacturer.

6.2 NEV credits

In 2016, the number of domestic NEV cars reached 319,000, accounting for 1.35% of China's total passenger cars. This marked an increase of 48.5% from the previous year, as shown in Figure 41. Also in this time, pure electric vehicle (PEV) and plug-in hybrid vehicle (PHEV) production was 248,000 and 70,000, respectively. Imports of electric passenger cars reached 16,600, doubled from last year. NEVs gradually shifted from commercial and government procurement to the private passenger car domain.

Figure 41: NEVs production development

[11] 2025 年将全部停售燃油车？长安汽车发布“香格里拉”计划.
http://auto.sina.com.cn/j_kandian.d.html?docid=fymzzpv7049586&subch=bauto



According to the recently introduced integrated CAFC super credits and NEV credits management system, all manufacturers producing over 30,000 vehicles per year would be required to produce 10% NEVs in 2019 (about 60 domestic manufacturers and 10 importers). Companies required to comply make up over 90% of the market. In 2016, a total of 954,000 new energy passenger vehicles were generated, of which 813,000 were from PEVs and 141,000 were from PHEVs. According to the compliance requirements of 2019, 3 million NEV credits are required, equivalent to about 1 million NEVs. Based on NEV growth thus far – this target will be easily met.

In 2016, there were nine automobile enterprises with an NEV output exceeding 10,000, including BYD, Beiqi, Geely, Jiangnan Automobile, SAIC, Chery, and JAC. A total of 901,000 NEV credits were generated, accounting for 94.4% of the total credits, as shown in Table 6.

Most NEV credits are projected to be produced by BYD, Beiqi, Geely, Jiangnan, and JMC. In particular, BYD generated 250,000+ NEV credit surplus that could be used to offset negative CAFC credits (own or others).

Table 5: NEV points for major Chinese electric vehicle manufacturers in 2016

Vehicle manufacturer	Main models	NEV production volume	NEV credits	2019NEVcredits requirement (10%)*	Credits surplus**
BYD industry	Tang/Denz/e6	46458	154784	9652	145132

BAIC Motor	EU200/EV200	42260	113745	29764	83981
BYD Auto	Qin/e5	40186	130719	22927	107792
Geely Motor	DihaoEV/ZD	39449	133811	33003	100808
Jiangnan Motor	Zotye100/E200/ Jiangnan TT	35899	104301	25834	78467
SAIC Motor	Roewee550/e950	22151	45896	29121	16775
Chery	Arrizo 7/eQ	20118	50415	41219	9196
JAC	iEV5	18370	60632	30960	29672
JMC-Landwind	E100/E200	17362	45558	7879	37679
Geely Haoqing Motor	ZD	7533	19493	49307	-29814
Chana Motor	EadoEV	5701	21880	99294	-77414
Dongfeng	ER30	5298	19734	14583	5151

***Note**: * The 10% NEV credits requirement calculation here for 2019 is based on 2016 vehicle production instead of same year production.*

*** Surplus is calculated in comparison to the 2016-based generated 2019 NEV credits requirement versus 2016 NEV production.*

At present, the electric vehicle market is dominated by vehicles of Class A and below (about 75%). For the Class B (e.g. sedans or SUVs) vehicles available, NEVs are primarily plug-in hybrid vehicles. In 2016, the average curb weight of electric vehicles was 1480kg. PEVs averaged 1355kg while PHEVs averaged 1917kg, 66kg heavier than that of conventional vehicles. Although the average weight increase of electric vehicles was derived from added battery weight, increases in PHEVs weight was derived from larger vehicle models. Listed in Table 6, PEVs average reported mileage was 204km.

Table 6: Comparison between ICE and EV parameters in 2016

Vehicle parameters	**Pure Electric Vehicles（PEV）**	**Plug-in Hybrid Vehicles（PHEV）**	**Internal Combustion Engine（ICE）Cars**
Vehicle size group	A00/A0/A	A/B	All
Energy consumption*	N/A	N/A	6.86 L/100km
Weight，kg	1355	1917	1391
Power，kW	69	119	101
Displacement ，ml	0	1689	1617
Range，km	204	N/A	Unlimited

***Note**: The model parameters in the table are calculated based on the average features of domestic models (imported models are excluded).*

*** PEVs and PHEVs power consumption data is not easily accessible (among other reasons, because NEVs are tax exempt and therefore less reporting is available online).*

In 2016, as many as ten PEVs exceeded 10,000 vehicle sales, including the BYD e5/e6, BAIC200 EU200/EV200, Imperial EV, Zotyeun 100, and Chery eQ. Their features were as follows: energy consumption ranged 10-20kwh/100km, e-ranged 150- 400km, and NEV credits eligibility ranged 1.33-5.28 credits (averaging 3.28 credits), as detailed in Table 7. Details related to these features of major PHEV brands are available in Table 8.

Table 7: Features of China's 2016 major PEV brands

Model	Curb weight (kg)	e-range (km)	Energy consumption (kwh/100km）	2016 Annual sales	NEV credits eligibility
BYDe6	2420	400	19.5	18917	5.00
BAICEU200	1600	200	12	17892	3.84
Jeely DihaoEV	1570	300	N/A	16894	4.40
Zotye100	1040	150	10	15314	2.60
CheryeQ	1128	151	12	15136	2.61
ZotyeE200	1080	160	N/A	13497	2.72
BYD e5	1845	256	N/A	12333	3.87
BAICEV200	1295	200	15	10509	3.84
JMCE100	825	152	N/A	10005	2.62
ZDD2	690	155	N/A	9178	2.66

***Note**: Because PEVs power consumption data is not easily accessible, the credits calculation uses a factor of 1 for all models.*

Table 8: Features of China's 2016 major PHEV brands

Model	Curb weight (kg)	e-range (km)	Energy consumption (kwh/100km）	2016 Annual sales	NEV credits eligibility
BYD Tang	2280	80	2.0、N/A	24871	2
BYD Qin	1720	80	1.4、N/A	19493	2
Roewee550	1699	58	1.6、N/A	16253	2
Arrizo7	1590	50	2.7、N/A	3660	2
Roewee950	1590	60	1.7、N/A	3900	2

***Note**: Because PHEVs power consumption data is not easily accessible, the table states N/A (not applicable).*

6.3 NEV credits impact: concluding remarks

China's new NEV credits system is projected to drive NEV production while largely avoiding energy saving shifts among traditional and well selling ICE models. For example, JMCHoldings average FC rate is as high as 9.76L/100km. The company's FC challenge is led by its best selling SUV Landsat X7 with FC as high as 10.4 L/100km. However, the production of its A100 E100 electric car (shown in Figure 24) dropped the company's average FC to 4.71L/100km. The issue is the resulted carbon impact. Were the 10,000 E100 produced sold and used within highly populated areas and therefore brought actual local carbon and other emission reductions or is it the 60,000 highly polluting X7s which are now the dominant source of local air quality?

Figure 42: Selected ICE versus NEV model

VS

JMC-ICE
Flagship model –Landwind X7
Production 2016：approx. 60 thousand，75% of traditional models
Kerb mass：1775 kg
Average displacement：2.0 L
Average power：140 kW
Combined fuel consumption：10.4 L/100km
134% of target：7.9 L/100km

JMC-EV
Flagship model -E100
Production 2016：approx. 10 thousand，60% of electric models
Kerb mass：825 kg
Average displacement：152km
Average power：20 kW
Combined electricity consumption：N/A
NEV credit：2.62 per vehicle

As many as 12 major electric vehicle companies (including NEV and non-NEV), were able to reduce their ICE vehicle based corporate average FC by 3% to 68%, as shown in Figure 43. The accumulated NEV credit surplus can, in turn, be transferred to affiliated companies (defined as figure 13), or sold to other companies, but not to save for use in future years. One approach adopted by large manufacturers is the acquisition of NEV manufacturers and the creation of strategic JVs, adding to market non-competitiveness, impeding the goals of the standard regime and further complicating the management of the standard's implementation and enforcement.

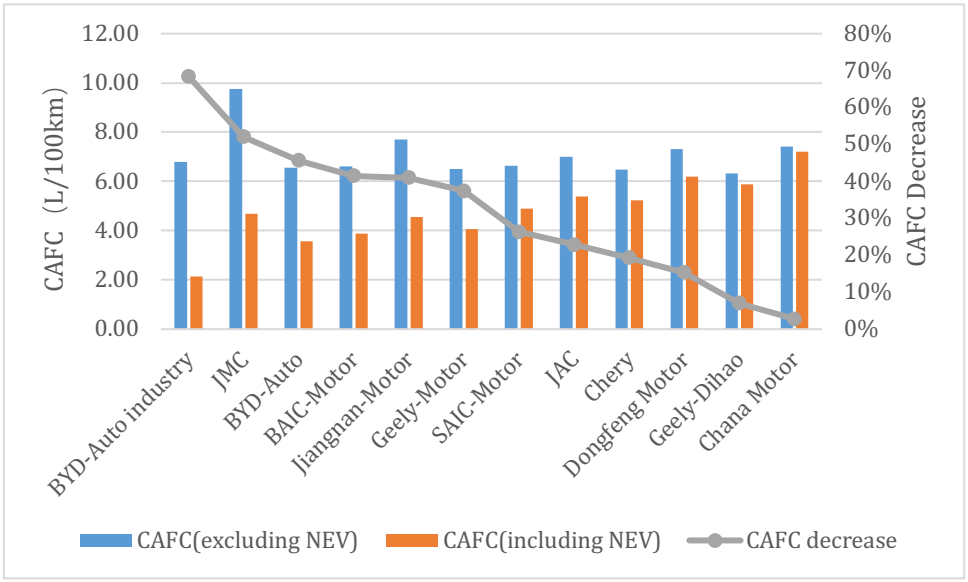


Figure 43 : NEV super credit impact on CAFC of EV producers

In the short term, NEV manufacturers will be benefited by the new NEV credit standard as it will create a revenue stream and enable further investments in product improvement, as was the case in the US in the early years of the ZEV-credits policy. For instance, the Great Wall investments in the Yogomo.

To sum up *i*CET's views on the influence of NEV credits:

(1) NEV credits will play a key role in the transition of China's auto sector into a global leader in zero tailpipe emission efforts, as it provides financial incentives to advance investments in NEVs.

(2) Given the NEV credit system, investments in energy saving policies and programs is even less desirable than before. Since companies have not been delivering the improvements needed for meeting the standard, the shift to NEVs may finally present an implementable approach to vehicle emissions reductions.

(3) Overall emission impacts of the NEV credits has yet to unfold. Yet policies governing energy production should move ahead quickly and effectively, and overall gains are projected in the longer run.

In order to ensure the NEV is making actual contribution to China's emission reduction goals, *i*CET's suggests the following:

(5) The NEV credit system should be a stand-alone mechanism in order to clarify corporate responsibilities and enable good implementation and enforcement. Given China's complex industrial and inter-ministerial structures, the CAFC regime has proven to be too complex to manage well, even before the NEV credit policy was introduced.

(6) Policy designers should introduce longer term requirements and predictable baseline of the NEV credits policy should be presented as soon as possible to enable strategic market planning, minimize market risks and promote steady investment streams, and sound gradual improvements of quality NEVs.

(7) Policy makers should introduce well-informed and effectively implementable penalty mechanism to ensure the strength and effectiveness of the NEV credits policy. This includes fee levels, supplementary penalties (for example, credit owed will still be owed regardless of penalties paid), and efficient and transparent policy scrutiny and panelizing process.

(8) Policy makers should consider simplification of the policy to ease its management; for example, eliminate the practice of forwarding credits among corporate actors.

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