Analysis of Compliance Path of Enterprises with CAFC and NEV Credit Deficits under the Influence of the Policy

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Abstract. CAFC and NEV Credit Management, as an important tool to promote the implementation of carbon peak and carbon neutrality goals in the auto industry, has made remarkable achievements in promoting the development of energy-saving and NEV (new energy vehicle) industry since its official implementation in 2017. The paper enumerates and analyzes the compliance path of enterprises suffering the CAFC and NEV credit deficits from the perspective of enterprises themselves, and constructs a compliance economy cost model for enterprises under various paths, thus providing valuable methodological references and guidance for enterprises to select the appropriate compliance paths.

Keywords: CAFC and NEV Credit Management, Enterprises Suffering CAFC and NEV Credit Deficits, Compliance Path, Economic Cost Model

1 Introduction

In order to promote the improvement of the energy-saving level of vehicles and electrification, and to propel the auto industry to achieve the goal of carbon reduction, in 2017, Ministry of Industry and Information Technology, along with four other departments, officially released the Measures for the Parallel Management of Corporate Average Fuel Consumption and New Energy Vehicle Credits for Passenger Car Enterprises (hereinafter referred to as the CAFC and NEV Credit Management), which targets the two overall goals as reducing the fuel consumption of conventional energy vehicles and developing NEVs. And against such a background, the CAFC and NEV credit are formed as a result. CAFC credit deficits will be generated if passenger car enterprises produce the conventional energy vehicles, while NEV credit surpluses will be generated if they produce NEVs. In addition, CAFC and NEV Credit Management sets different standards for different passenger car enterprises according to their production structure. The credit surpluses will be generated if they meet the standard while credit deficits generated if they fail to meet the standard. Passenger car enterprises that fail to meet the standards can achieve credit compliance via three ways: credit carry-over, credit transfer and credit trading[1]. Among them, credit trading refers to the paid transfer of credit surpluses from enterprises with credit surpluses to enter-

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prises suffering credit deficits, which is one of the most important ways for enterprises to achieve credit compliance.

The calculation and offset methods of CAFC and NEV credit are shown in Figure 1.

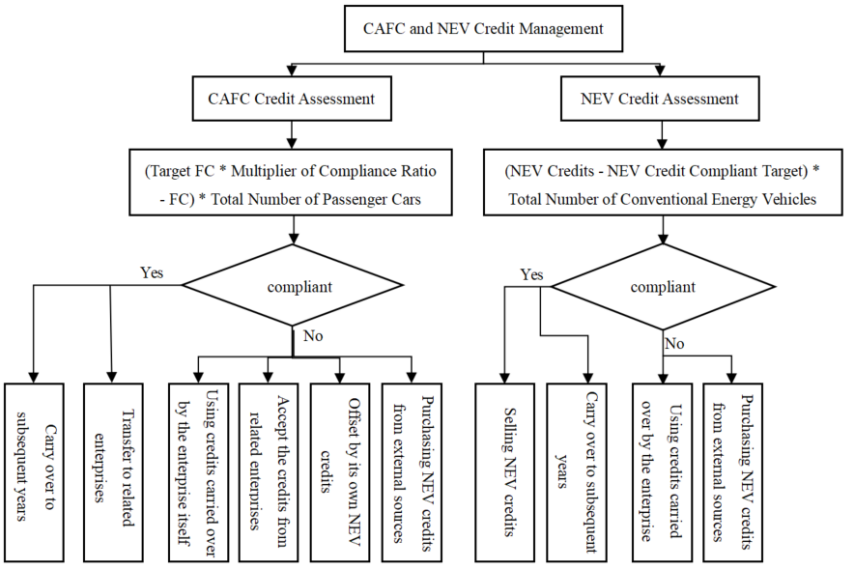

Fig. 1. Calculation of CAFC and NEV Credits and Offsetting Methods

2 Analysis on the Compliance Path of Enterprises under the CAFC and NEV Credit Management

Enterprises suffering credit deficits can follow 3 paths to achieve credit compliance: reducing the fuel consumption of conventional energy vehicles, increase the launch of NEVs, and purchase NEV credits from external sources[2]. Among them, reducing the fuel consumption of conventional energy vehicles can reduce the CAFC credit deficits, thus helping enterprises meet the standard of CAFC credits; increasing the launch of NEVs can both reduce the CAFC and NEV credit deficits, thus achieving the CAFC and NEV credit compliance.

2.1 Reducing the Fuel Consumption of Conventional Energy Vehicles

The current technologies for reducing the fuel consumption of conventional energy vehicles mainly include the conventional energy-saving technologies such as TCI and GDI, three-cylinder turbocharged engines, idling stop-start, advanced transmissions, as well as advanced energy-saving technologies represented by 48V light hybrid and HEV strong hybrid. The application rate of various energy-saving technologies is shown in Figure 2.

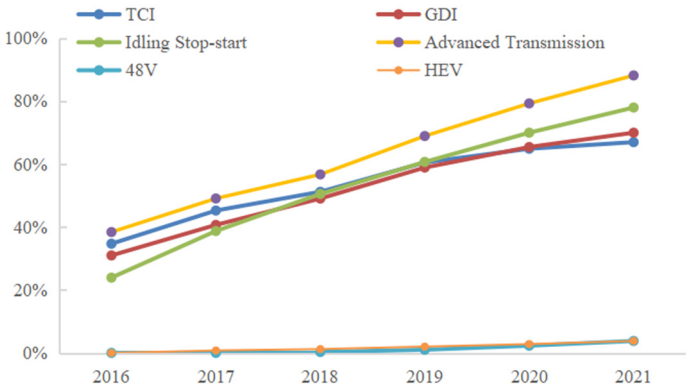

Fig. 2. Application of Energy-saving Technologies

In 2021, the penetration rate of conventional energy-saving technologies such as TCI, GDI, idling stop-start and advanced transmission are close to or higher than 70%, with a tendency to becoming saturated, and their contribution rate to the reduction of fuel consumption of conventional energy vehicles is significantly reduced. Meanwhile, 48V and HEV technologies are still in the initial stage of implementation, so the penetration rate is low currently, and effect of consumption reduction is obvious[3].

When corporate average fuel consumption (CAFC) is reduced to compliant fuel consumption, enterprises can achieve CAFC credit compliance. The percentage of 48V and HEV technologies that need to be applied under the guidance of compliance policy is shown in equation (1).

$$\frac{consu\_H \cdot pre\_H \cdot Q + consu\_V \cdot pre\_V \cdot Q + consu\_G \cdot (1 - pre\_H - pre\_V) \cdot Q}{Q + w \cdot q} = CAFC \tag{1}$$

Where, Q represents the total production of conventional energy vehicles produced, q represents the production of NEVs; *consu_H*, *consu_V*, and *consu_G* represent the average fuel consumption of HEV models, 48V models and gasoline models respectively, and *pre_H*, *pre_V* and *1 - pre_H - pre_V* represent the percentage of HEV models, 48V models, and gasoline models to conventional energy vehicles. w means the incentive calculation for NEVs, and its value is stipulated by CAFC and NEV Credit Management, and *CAFC* means the compliant corporate average fuel consumption of an enterprise stipulated by CAFC and NEV Credit Management.

The above equation is used to obtain the percentage of applying the 48V and HEV that meet the compliance requirements so as that the enterprise suffering credit deficits can achieve the CAFC credit compliance.

2.2 Launching NEVs

Reducing the fuel consumption of conventional energy vehicles can effectively reduce the CAFC credit deficits and achieve CAFC compliance. However, if enterprises

want to achieve NEV credit compliance, the only way is to expand the production of NEVs. Producing NEVs has a double effect, which on the one hand can reduce the NEV credit deficits while on the other hand reduce the CAFC credit deficit. The number of NEVs that enterprises suffering credit deficits need to produce in order to achieve credit compliance can be derived from the credit balance equation, as shown in equation (2).

$$\begin{cases} min(cafc, 0) + nev = 0, \\ cafc = [T \cdot avg\_Con(G) - avg\_Con(R)] \cdot \sum(q + Q), \\ nev = \sum avg\_Cre \cdot q - P \cdot \sum Q, \\ avg\_Con(x) = \frac{\sum F_{tx} \cdot Q + \sum f_{tx} \cdot q}{\sum (Q + H_x \cdot q)}, x = G \ or \ R \end{cases} \tag{2}$$

Among them, *cafc* represents CAFC credits of enterprises, while *nev* represents NEV credits of enterprises. The first equation in equation (2) reflects the compliance requirements for enterprises under the credit offset rule.

CAFC and NEV Credit Management has provided for the detailed regulations on the calculation of CAFC and NEV credits. The CAFC credit is defined as the product of the difference between compliant FC and FC, and total passenger car production of the enterprise. The compliant FC is the product of target FC, *avg_Con(G)* and compliant ratio factor, *T*, and *avg_Con(R)* represents FC of the enterprise. The target FC, *avg_Con(G)* and FC, *avg_Con(R)* are calculated by the weighted average of the target FC F_{tG} and f_{tG} and FC F_{tR} and f_{tR} of conventional energy and new energy models, respectively. q and Q represent the NEV production and the conventional energy vehicle production respectively under the compliance requirement, and their sum is the total passenger car production of an enterprise.

The NEV credit is calculated as the difference between NEV credits and NEV credit compliant target. Among them, the NEV credit is the product of the NEV credit per vehicle, *avg_Cre,* of a NEV model and the production of a NEV model, q. The NEV credit compliant target is the product of the production of conventional energy vehicle, Q and compliant ratio requirement of NEV, which represented by P.

With the above equations, it is possible to obtain the NEV production that should be met in order to achieve credit compliance.

2.3 Purchasing Credits to Achieve Compliance

CAFC and NEV Credit Management provides detailed regulations on the methods to offset credit deficits. Passenger car enterprises suffering credit deficits can offset their credit deficits by purchasing credit surpluses with enterprises that have extra credit surpluses. Purchasing credits neither requires to adjust production schedules nor affects the strategic planning of enterprises, which is the most convenient way to achieve compliance[4].

3 Economic Analysis of Compliance Paths for Enterprises

Enterprises suffering credit deficits need to weigh the feasibility and economics of each compliance path and make their choice after comprehensive consideration. In this chapter, the economics of each of the 3 compliance paths are carefully evaluated, and the effect of selecting each compliance path for enterprises is shown.

3.1 Economic Analysis of Consumption Reduction of Conventional Energy Vehicles

The cost of reducing the fuel consumption of conventional energy models by equipping 48V and HEV is the cost of the devices that need to be equipped on the 48V and HEV hybrid system, as shown in equation (3).

$$C_1 = pre\_V \cdot Q \cdot c_{48V} + pre\_H \cdot Q \cdot c_{HEV} \tag{3}$$

Where, *pre_V* and *pre_H* represent the percentage of 48V and HEV that need to be equipped under the credit compliance requirement, respectively, while Q represents the total production of conventional energy vehicles, and c_{48V} and c_{HEV} represent the cost per conventional energy vehicle equipped with 48V and HEV.

3.2 Economic Analysis of Developing NEVs

For enterprises whose production capacity is relatively saturated, increasing the production of NEV means reducing the production of conventional energy vehicles, and under such a path, the compliance cost of enterprise comes from the relative loss of producing NEV models compared to producing conventional energy models[5], as shown in Equation (4).

$$c = battery + machine + control - engine - trans \tag{4}$$

In terms of relative loss, two aspects are mainly taken into account. The first is the increased manufacturing cost of NEV compared to that of the corresponding conventional energy vehicles, mainly including the cost of NEV's, motor, electronic etc., which represented by *battery*, *machine*, and *control* respectively; the second is the reduced manufacturing cost of NEVs compared to that of the conventional energy vehicles, such as engine and transmission, expressed by *engin* and *trans* respectively.

The production of NEV, which is q that the enterprise needs to produce can be obtained via equation (2). In addition, q_1 is used to indicate the number of NEVs that should be produced according to the enterprise's strategic planning, and q_2 indicates the number of additional NEVs that need to be produced in order to achieve credit compliance. Various production relationships can be expressed by equation (5).

$$q = q_1 + q_2 \tag{5}$$

It will certainly happen that enterprises produce NEVs in accordance with their strategic planning, which won't be affected by the credit compliance status. It is be-

lieved that the relative loss of producing q_2 number of NEVs is the compliance cost of enterprise suffering credit deficits under such a path, which is expressed by equation (6).

$$C_2 = c \cdot q_2 \tag{6}$$

Where, c represents the relative loss of producing NEVs, while q_2 represents the additional number of NEVs produced in order to achieve compliance.

3.3 Economic Analysis of Purchasing Credits

It is the fastest way to achieve compliance by purchasing NEV credits without the need to adjust the current production schedule.

The total cost of purchasing NEV credits to achieve compliance is shown in Equation (7).

$$C_3 = p \cdot [min(cafc, 0) + nev] \tag{7}$$

Where, p represents the credit trading price, and min*(cafc,0)+nev* represents the credit deficits that need to be offset.

4 Analysis of Compliance Path of Enterprises Suffering Credit Deficits in 2021

Taking the credit trading situation in 2021 as an example, various possible compliance paths of Enterprise A suffering credit deficits are analyzed.

The total production of passenger cars of Enterprise A is about 802k units, among which, the number of battery electric passenger cars is 2k units, the number of conventional gasoline models is 680k units, and the number of HEV models is 120k units. The average fuel consumption of gasoline models and HEV models were 5.94L/100km and 4.58L/100km respectively. Under the current production scheduling situation, Enterprise A generated 500k CAFC credit deficits and 80k NEV credit deficits.

4.1 Analysis on the Cost of Conventional Energy Vehicles to Reduce Fuel Consumption

Since Enterprise A does not have 48V hybrid system technology at present, it reduces fuel consumption of conventional energy vehicles by increasing the percentage of equipped HEV. In the trading year of 2021, CAFC and NEV Credit Management clearly stipulated that the incentive calculation multiplier was 1, i.e. w=1. According to Equation (1), when the CAFC credit compliance is achieved, the percentage of HEV applied by Enterprise A is 40.3%, that is, 200k additional HEV vehicles need to be produced under the circumstance that the total number of conventional energy vehicles remains unchanged.

The cost of gasoline models of Enterprise A increases by about RMB15,000 after they apply the HEV system, so the cost of achieving CAFC credit compliance under such a path is about RMB3 billion.

In addition, while achieving CAFC credit compliance under this path, it is also necessary for Enterprise A to achieve NEV credit compliance through purchasing credits from external sources. After the HEV production is enhanced, the shortage of NEV credits is still 80k credits, and based on the average trading price of credits in 2021, i.e., RMB2,100 per credit[6], Enterprise A has to spend about RMB200 million to achieve NEV credit compliance. As a result, the total cost of CAFC and NEV credit compliance for Enterprise A under this path is RMB3.2 billion.

4.2 Analysis on the Cost of Developing NEVs

Currently, Enterprise A produces 2k NEVs, and the average credit per vehicle is 6 credits/vehicle. If increasing production according to the current ratio, and referring to equation (2), it can be noticed that Enterprise A needs to produce additional 60k NEVs before it can achieve credit compliance.

Through researches, compared with the cost of conventional energy vehicles, the increased battery cost of BEV (battery electric vehicle) of Enterprise A is about RMB54,000/unit, increased motor cost is about RMB5,000/unit, increased electronic control cost is about RMB4,000/unit, reduced engine cost is RMB9,000/unit, and transmission cost is RMB7,000/unit. Therefore, the cost of battery electric vehicle is increased by RMB47,000/vehicle compared with that of conventional energy models.

According to this path, it can be noticed that the compliance cost for Enterprise A is about RMB2.8 billion.

4.3 Analysis on the Compliance Cost of Purchasing Credits from External Sources

The total demand of Enterprise A for credit deficits is 580k credits, and the average price of credit in 2021 was about RMB2,100/credit[6]. The CAFC and NEV compliance cost of Enterprise A in this path is about RMB1.2 billion.

It can be seen that, from the economic point of view alone, it is more appropriate for Enterprise A to purchase NEV credits from external sources in the 2021 trading year. However, it is worth noting that there are risks for enterprises to rely on NEV credit surpluses in the credit market to achieve credit compliance. As the credit compliance is a rigid constraint, when the supply of NEV credit surpluses in the external credit market is insufficient, enterprises will not be able to achieve credit compliance. As a result, from the perspective of compliance risk and long-term development of enterprises, it is strongly necessary to develop models with low fuel consumption and NEVs.

5 Conclusions

The CAFC and NEV Credit Management has made significant achievements in promoting the development of the energy-saving and NEV industry. Subject to the rigid constraint of credit compliance, enterprises suffering credit deficits will have to pay a lot to achieve credit compliance every year. This paper has carefully analyzed the 3 paths of achieving credit compliance, and provided a methodology for calculating the production of passenger cars that enterprises have to complete under each credit compliance path. In addition, this paper also analyzes the compliance costs of the passenger car enterprise A under each of the 3 compliance paths from the economic point of view, taking the 2021 credit trading year as an example.

The research achievements of this paper can provide strong support for enterprises when they make decisions on how to achieve credit compliance, and have certain practical application significance.

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