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LETTER TO THE EDITOR

Evaluation Model for Energy Saving and Emission Reduction Effect of New Energy Vehicle Based on Secondary Relative Benefit

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It is of great practical significance to analyze the energy saving and emission reduction of new energy vehicles. An evaluation method for energy saving and emission reduction effect of new energy vehicles based on secondary relative benefit is proposed. The life cycle analysis method of new energy vehicle fuel, carbon emission calculation method and energy consumption calculation analysis method are described. Based on this, the evaluation of energy saving and emission reduction effect of new energy vehicles is completed based on the secondary relative benefit method. The experimental results show that the proposed method has good performance and can provide a feasible reference for energy saving and emission reduction of new energy vehicles.
Secondary relative benefit; New energy vehicle; Energy saving and emission reduction; Evaluation

1 INTRODUCTION

With the progress of science and technology, people focus on environmental protection. In view of the environmental and energy problems brought about by the development of automobile industry, countries around the world are taking active measures to promote the strategic transformation of traditional automobiles and develop new energy electric vehicles in order to realize the electrification of automobile power system. At present, the main new energy electric vehicles promoted at home and abroad mainly include pure electric vehicle (BEV), hybrid electric vehicle (HEV), plug-in hybrid electric vehicle (PHEV) and fuel cell vehicle. These vehicles can effectively reduce the consumption of petroleum resources in the field of transportation, improve the efficiency of energy use, and also reduce the exhaust emissions from traditional vehicles. In order to better achieve emission reduction targets in the field of transportation, combining with the current power generation energy structure in China, it is necessary to quantify the energy consumption and carbon emissions of new energy vehicles and traditional fuel vehicles with secondary relative benefits, and find out the relevant factors affecting their energy consumption and carbon emissions. This paper makes a comprehensive analysis of the energy saving and emission reduction effects of developing new energy electric vehicles with secondary relative benefits in China, explores whether the development of new energy electric vehicles can achieve energy saving effects, finds out the influencing factors of energy saving and emission reduction. On this basis, the relevant scenarios are set to find a suitable technical path for the development of new energy electric vehicles in China.

Yuanying Chi, Lina Yuan, Hongying Li, Yu Zhang and Guoqing Bai published an article in the journal of Ekoloji

(Issue 107,2019, entitled "Using LEAP Model to Predict Energy Consumption of Beijing under the Constraint of Low-Carbon Economy" (Chi et al. 2019). This article points out that the quantity of energy directly determines the speed and sustainability of economic development, but the consumption of energy will pollute the environment. Based on the five main scenarios of benchmarks and e, the paper constructs the transition-Beijing model. The development trend of energy consumption and energy structure, economic growth rate, different industrial structure, energy saving and integration are analyzed in 2017-2035. The study points out that the energy consumption of the tertiary industry continues to increase and the growth rate is obvious.

By analyzing the current situation of the new energy automobile market, Wang (2017) established a trend prediction model of new energy automobile market based on Bass model, analyzed the future development trend, and formulated countermeasures to improve the development of the new energy automobile industry. Based on the existing research, our paper proposes a new energy-saving and emission reduction evaluation model for new energy vehicles based on secondary relative benefits.

2 IDEA DESCRIPTIO

2.1 Life Cycle Analysis of New Energy Vehicle Fuels

Life cycle analysis (LCA) is a method of evaluating the impact of products from cradle to grave on resources and environment in the whole process of use. Many scholars at home and abroad use this method to study (Wei et al. 2018). The life cycle analysis method is applied in the field of transportation, that is, the life cycle analysis method of vehicle fuel. This analysis method mainly focuses on the cycle of fuel consumed by vehicles, and does not consider the manufacturing process of vehicles, vehicle scrap and recycling. Strictly speaking, this analysis method can not fully take into account the energy consumption and scrap of automobiles in the life cycle. However, since the fuel consumption and greenhouse gas emissions of automobiles can account for more than 70% of the whole life cycle, this calculation has certain significance and simplifies the complexity of the study (Mana et al. 2017).

The life cycle of vehicle fuel mainly includes the upstream and downstream stages of vehicle fuel, in which the upstream stage is the exploitation, transportation and conversion of fuel, and the downstream stage is mainly the use of fuel (Priyam et al. 2016). Life cycle analysis is divided into two parts: oil well to oil tank and oil tank to wheel. Life cycle analysis (LCA) is the energy conversion efficiency of vehicle fuel exploitation, transportation, conversion and other links, mainly the energy conversion efficiency of vehicle fuel use links.

2.2 Energy Consumption Measurement and Analysis

In view of the fact that traditional fuel-fired vehicles only use one kind of energy in the use process, its energy conversion efficiency is relatively easy to calculate; while the main energy consumption of new energy electric vehicles in the use process is electricity, we need to consider the power generation energy structure of China. Through the analysis and calculation of various energy conversion efficiency (including mining, transportation and the corresponding power generation efficiency), on this basis, the comprehensive efficiency of power generation in China (Shao et al. 2017) is obtained. At the same time, the power consumption of new energy electric vehicles is obtained on the basis of considering the transmission efficiency of power grid. In order to facilitate the comparative analysis of the energy consumption of new energy electric vehicles and traditional fuel vehicles, this paper uses the calorific value of gasoline as the intermediate value to convert its fuel consumption into calorific value in order to achieve the unity of units and facilitate the comparative analysis.

2.3 Carbon Emission Measurement Method

In view of the different power used by pure electric vehicle, hybrid electric vehicle and traditional fuel vehicle, different carbon emission calculation models are adopted. For pure electric vehicles, because its main driving force is electricity, it is necessary to consider the power generation energy structure of China and analyze the carbon dioxide emissions generated by different energy sources in the process of power generation when using vehicle fuel life cycle method to analyze carbon dioxide emissions. For hybrid electric vehicles, the same calculation method is used as for fuel vehicles (Gao et al. 2017).

2.4 Design of Evaluation Model for Energy saving and Emission Reduction Effect of New Energy Vehicle

This paper evaluates the effect of energy saving and emission reduction of new energy vehicles by using the method of secondary relative benefit. Based on the characteristics analysis of dynamic evaluation of energy saving and emission reduction effects in coal industry and the solution of the difficulties in the application of existing evaluation models, this paper puts forward a new idea for constructing the evaluation model for energy saving and emission reduction effects of new energy vehicles: under the guidance of system theory, the second relative benefit evaluation method is applied to aim at meeting the dynamic characteristics of energy saving and emission reduction effects of new energy vehicles, improving its evaluation scientificity and having dynamic effectiveness evaluation .

The dynamic evaluation model for energy saving and emission reduction effect of new energy vehicles is mainly embodied in the following two aspects:

The first is the selection of evaluation methods. Compared with other evaluation methods, the evaluation method based on secondary relative benefit uses mathematical programming to project evaluation units onto the frontier of the exponential state possible set, and dynamically evaluates their relative performance according to the relative distance between evaluation units and the frontier of the exponential state possible set.

The second is the calculation of the evaluation index score. When using the dynamic evaluation model for energy saving and emission reduction effect of new energy vehicles to calculate the energy saving and emission reduction effect of the unit to be measured in an evaluation period, it mainly reflects the actual energy saving and emission reduction effect based on the dynamic changes of the initial reference value and the final current value of the evaluation period, and the determination method of the initial reference value is to select the unit to be measured in front of the actual energy saving and emission reduction effect. The arithmetic average value of evaluation results in several evaluation cycles (which can objectively reflect the basic conditions of each evaluation unit) is taken as the initial reference value, which is also a dynamic reflection of the evaluation results. Of course, this paper does not blindly pursue absolute dynamics when constructing the dynamic evaluation model for energy saving and emission reduction effect of new energy vehicles, which is also unrealistic. The evaluation of energy saving and emission reduction of new energy vehicles must also contain static factors, such as the selection of the current value of the evaluation index, that is, the actual achievement of the evaluation index at the end of the evaluation period, it must be a static index value. Therefore, this paper also fully considers the organic combination of dynamic and static (Zhu 2017).

The specific evaluation steps are as follows:

2.4.1 Geometric Explanation of Effective Effort Degree of Energy saving and Emission Reduction in Units to be Measured

Some existing evaluation methods, such as analytic hierarchy process (AHP) and efficiency coefficient method, are used to evaluate the energy saving and emission reduction effect of the unit under test. The evaluation results reflect the strength of the unit under test in achieving performance. It can be used as a measure of the objective basic conditions of the unit under test, called reference index. Using the same method to evaluate the current achievement performance of the unit under test, the evaluation results reflect the current performance of the unit under test, which is called the current index.

Assuming that there are n units to be measured, X_i is the reference index of the first unit to be measured, and Y_i is the current index of the unit to be measured, the array (X_i, Y_i) is the exponential state of the second unit to be measured, and the exponential state is convex. With the concepts of reference index, current index, exponential state and possible set of exponential state, the effective effort of the unit to be measured can be described by Figure 1.

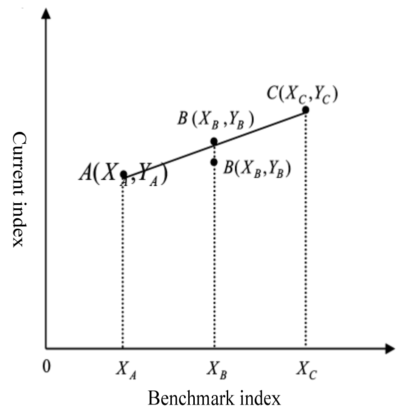

Fig. 1 Effective effort of the unit to be tested

According to Figure 1, the effective effort of the unit to be tested and the contribution of its supporting facilities and service capabilities to performance can be reflected by the dynamic changes between the reference index and the current index.

2.4.1 Secondary Relative Performance Evaluation of the Unit to be Measured

On the basis of describing the exponential state possibility set of the unit to be measured and the effective effort degree of the unit to be measured, the evaluation subject can use DEA method to obtain the boundary of the exponential state possibility set, that is, the frontier corresponding to the unit to be measured. By using DEA model to measure the relative effectiveness, the result is the secondary relative performance of the unit to be measured, which can also be called its dynamic performance. It reflects the efficiency of the unit to be measured and the benefits of infrastructure and related inputs, while eliminating the impact of objective basic conditions.

3 RESULTS

To verify the effectiveness of this method, the evaluation results of the proposed method are analyzed by statistical analysis, and the accuracy of the test results of this method is analyzed by computer software. The results are shown in Table 1.

Table 1 Evaluation accuracy

Number of experiments/times	Accuracy /%
5	89-.2
10	86.5
15	90.1
20	92.1
25	91.3

According to the analysis results in Table 1, the proposed method has a high evaluation accuracy and can accurately complete the evaluation of energy saving and emission reduction effect of new energy vehicles, indicating that this method has a certain feasibility.

4 DISCUSSION

At present, the mainstream market of automotive fuel in various countries is still dominated by traditional fuel gasoline. However, with the continuous development of new energy vehicles and the increasing awareness of energy saving and environmental protection, the situation that new energy vehicles will keep pace with traditional fuel vehicles will emerge for quite a long time in the future. Now the state and local governments have issued a series of preferential policies to support and encourage the development of new energy vehicles, and try their best to improve the relevant supporting facilities, publicize the benefits of new energy vehicles through various channels, create a social overall atmosphere that advocates energy saving, environmental protection and low carbon awareness, so that every public can start from themselves and become an environmentally friendly person.

5 CONCLUSION

With the increasing prominence of global environmental problems and energy crisis, countries around the world are actively taking measures to achieve sound development of domestic economy and society. As a major consumer of oil consumption and carbon dioxide emissions, automobiles need revolutionary changes. Therefore, the development of new energy electric vehicles has become the consensus of all countries in the world. This paper evaluates the effect of energy saving and emission reduction of new energy vehicles based on the secondary relative benefit, and verifies the performance of this method through experiments. The results show that the evaluation method in this paper has higher accuracy and better practical application value.

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