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Abstract. Recent research indicates that electric vehicles can greatly ease the problem of environmental pollution caused by fossil fuels. Therefore, based on the development of electric vehicle market in the United States, this paper aims at finding an optimal approach for the conversion of fossil fuels to electricity, in elements of environment, economy, etc. Firstly, a station-building model about the amount of charging stations for the future requirements is established. According to the site-selecting principles, we set the station-building cost optimization model to forecast the number of electric vehicle developments in the next decade. Secondly, we build an optimization model and a logistic model to draw a conclusion that after the emergence of the new technology, there are more charging stations than before. Moreover, the proportion of electric vehicles has reached 100% in advance of five years ahead of the original forecast, which speeds up the construction of charging stations. Lastly, we suggest a series of new energy development plans on account of the serious pollution under the domestic environment.

Keywords: optimization model logistics model classification system model.

1. The establishment and solution of the model

1.1. Establishment and solution of full coverage allocation model for charging stations

1.1.1. Site-selecting principle of charging station. Based on the factors such as the demand of electric vehicles in the United States, the principle of site selection is based on the central theory of kristler.

(1) Charging demand for electric vehicles

The greater the charge demand, the easier to meet the service limit of the charging station, which is conducive to the maintenance of the station's operation. As the increase of charging demand, the number of charging stations also increases.

(2) Electric vehicle charging mode

Different charging modes have different requirements for charging time, charging equipment, power grid pressure and charging safety. The current in the conventional charging mode is low, so it is a suitable way for charging during light load.

(3) Service radius of the charging station

The service radius of the charging station directly affects the construction density and quantity of the charging station. Generally, the greater the service radius, the less charging stations, the lower the density, the lower the convenience of users.

1.1.2. Establishment of station-building model. Based on the charging stations for charging vehicle data, through analyzing the power consumption situation in the process of the car, determine how many kilometres electric cars are driven in charge to need a charging station, based on the problems, intercepting allocation model is set up as follows:

$$Max(m) = \sum_{d \in D} f_D y_d \tag{1}$$

$$S.T. \begin{cases} \sum_{j \in J} y_j = q \\ \sum_{j \in J} y_j \geq y_d \\ y_j, y_p \in (0,1) \\ q < q_0 \end{cases} \tag{2}$$

q : Quantity of charging station construction.

q_0 : The maximum number of charging stations acceptable.

$\sum_{j \in J} y_j \geq y_p$: When a facility is built on a route, it is 1, otherwise 0. The maximum number of charging stations acceptable.

A hexagonal station model is established through the existing data of car ownership H ,the capacity of the charging station, the proportion of the working population. Take New York and Massachusetts as two examples, we set the urban economic center as the center point, and extend outward in the form of regular hexagon, the distance from the center point to the hexagonal vertex is r_i and the distance to the border of the continent is R_i.

$$\text{there into: } R_i = \sqrt{\frac{S_i}{\pi}} (i = 1, 2 \cdots 50) \tag{3}$$

Based on the site design scheme, the establishment model is as follows:

$$n_i = \frac{H \times q_i}{m_i} - 1 \tag{4}$$

$$N = \lambda_i \sum_{i=1}^{50} n_i - \alpha_i \tag{5}$$

Thereinto $q_i = a\% + \varepsilon_i$, $i = 1, 2, 3 \cdots 50$, the ratio of the living population to the working population, ε_i : The increment of the proportion of living population and working population for each additional cyclic hexagon in the state; α_i : The number of charging stations for intersecting two continents.

Confirm the division of urban, suburban, rural access rules: when the distance away from the downtown $h_i < \partial_{i1}$ for the city, when the $\partial_{i1} < h_i < \partial_{i2}$ is for the suburb, when the $\partial_{i2} < h_i < \partial_{i3}$ for the countryside, based on the distribution model of urban, suburban and rural are as follows:

$$\begin{cases} \alpha_1 = \dfrac{R(h_{i+1} - h_i)}{h_i h_{i+1}} \times n_1 \\ \alpha_2 = \dfrac{R(h_{i+1} - h_i)}{h_i h_{i+1}} \times n_2 \end{cases} \tag{6}$$

$$S.T. \begin{cases} n_1 + n_2 = N \\ h_1, h_2, h_3 < R \end{cases} \tag{7}$$

1.2. Analysis of electric vehicle development which based on national development strategy
The development of electric vehicles is not a single dimensional space but an open innovation. The structural changes of automobile energy involve different aspects like energy resources production, environmental protection, economic development, infrastructure and so on, it is a wide range, high integrated, multi-field crossing project.

Establishment of evaluation index model:

$$\omega = \frac{\sum V_i}{\vartheta} (i = 1, 2, 3, 4) \tag{8}$$

1.2.1. Analysis on the construction of charging station. Based on the charging vehicle data that saved in the charging station, we analyze the power consumption during the driving process, and then estimate the distance that a fully-charged car could maintain. That is, the maximum distance between two charging stations. According to this, the model is set up as follows:

$$Max(m) = \sum_{d \in D} f_D y_d \tag{9}$$

$$S.T. \begin{cases} \sum_{j \in J} y_j = q \\ \sum_{j \in J} y_j \geq y_d \\ y_j, y_p \in (0,1) \\ q < q_0 \end{cases} \tag{10}$$

A hexagonal station model is established through the existing data of car ownership H , the capacity of the charging station, the proportion of the working population.

Based on the site design scheme, the establishment of the cloth station model is as follows:

$$n_i = \frac{H \times q_i}{m} - 1 \tag{11}$$

$$N = \lambda_i \sum_{i=1}^{i=k} n_i - \alpha_i \tag{12}$$

1.2.2. Analysis of the development of the charging station based on multi-objective optimization model. Considering that the charging network in the country starts from scratch, and the difference of land price, electricity cost and operation cost, combined with the hexagon theory we put in task 1, the construction cost of charging station is different.

Based on the calculation model and distribution model of the number of charging stations , the multi-objective optimization model is set up as follows:

$$\begin{cases} Max(m) = \sum_{d \in D} f_D y_d \\ Min(F) = F_1 + F_2 + F_3 \end{cases} \\ S.T.: r < l \tag{13}$$

The F_1, F_2, F_3, respectively represents the construction cost, operation cost and power exchange cost of constructing a charging station or a destination charging station.

$$F_1 = \kappa_l A^l C^l + \kappa_e G^t C^t + \kappa_d G^q C^q \tag{14}$$

Which Includes land costs, the cost of distribution transformer and charger cost, we use κ_l for land cost coefficient for years.

$$F_2 = (\alpha + \beta) spH \tag{15}$$

$$F_3 = \chi \sum_i \sum_i D_{ij} \tag{16}$$

Where χ is the coefficient of reduction, D_{ij} is the linear distance from the point i to the changing station j .According to the above data, the total cost of urban construction is lower than the total cost of construction in the rural area.

1.2.3. Development analysis of electric vehicle based on Logistic model. The development of electric vehicles is not accomplished overnight. It should be carried out in stages under certain economic basis. A Logistic model for time and electric car sales is set up as follows:

$$x(t) = \frac{x_m}{1 + (\frac{x_m}{x_0} - 1) e^{-rt}} \tag{17}$$

1.3. Establishment of classification evaluation system

We integrate the previous analysis of the construction site plan into the classification evaluation system as shown in the figure:

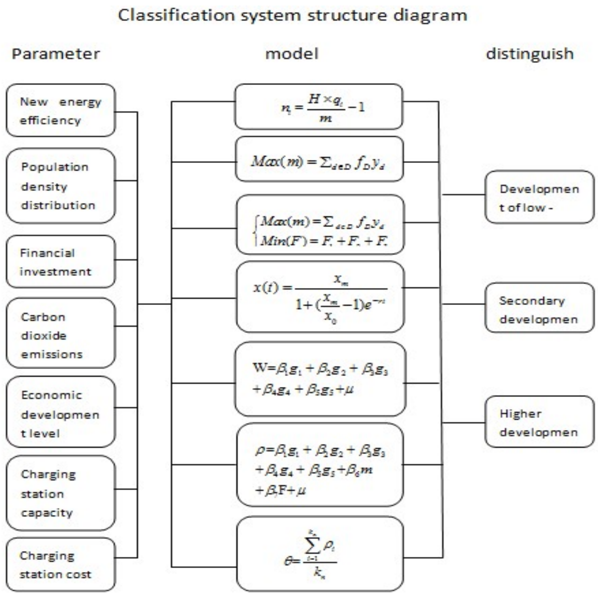

Figure 1. Classification evaluation system structure diagram

The comprehensive evaluation model is established according to the factors that influence the development of electric vehicles in different countries.

$$\mathrm{W}=\beta_1 g_1+\beta_2 g_2+\beta_3 g_3+\beta_4 g_4+\beta_5 g_5+\mu \tag{18}$$

Which is suitable for composite scores, W , β_i for the coefficient of each affecting factor, g_i for all the factors, $i=1,2,3,4,5$ in a number of factors, in order to analysis the key factors, using analysis of variance, and each factor and coefficient of variance between countries are as follows:

Based on the factors influencing the development of electric vehicles in five countries, the classification system model is established as follows:

$$\rho=\beta_1 g_1+\beta_2 g_2+\beta_3 g_3+\beta_4 g_4+\beta_5 g_5+\beta_6 m+\beta_7 \mathrm{F}+\mu \tag{19}$$

$$\theta=\frac{\sum_{i=1}^{k_n}\rho_i}{k_n} \tag{20}$$

$$\begin{cases} Max(m)=\sum_{d\in D} f_D y_d \\ Min(F)=F_1+F_2+F_3 \end{cases} \tag{21}$$
$$S.T.: r<l$$

1.4. The great changes brought by the new technology to the development of electric vehicles

1.4.1. Changes in the number of charging stations. In recent years, the combination of artificial intelligence and electric vehicle has created intelligent driving electric vehicle, and the charging station has also been innovated, such as fast changing power station. Therefore, considering the appearance of the intelligent electric vehicle and the model of the task one, the calculation model of the charging station is set up as follows:

$$\chi_i = \frac{(H+\varphi)\times q_i}{m_i+\phi} - 1 \tag{22}$$

$$N=\lambda_i \sum_{i=1}^{50} n_i - \alpha_i \tag{23}$$

$$Max(m) = \sum_{d\in D} f_D y_d \tag{24}$$
$$S.T.: \phi < \varphi$$

Among them, the $i = 1, 2 \cdots 50$, χ_i for the intelligent electric cars and fast charging stations after the introduction of the charging station construction quantity, φ for the number of intelligent electric cars, the emergence of the ϕ for quick change plant from charging station capacity increment, the meaning of other symbols are the same as the task in a.

1.4.2. Changes in the influence factors. Because of the emergence of smart electric vehicles and fast changing power stations, the sales of electric vehicles have increased rapidly, and the speed of the replacement of fuel vehicles by electric vehicles is faster. Therefore, it brings real changes on the factors of South Korea's new energy utilization, through the arrangement of the Internet data, the changes of the index of the influence factors are as follows:

According to the above table, it can be seen clearly that after the emergence of new technologies, the production of energy resources in Korea has been reduced, the utilization rate of new energy has been improved, the government's investment in the electric vehicle market has increased, and the environmental protection index has been greatly improved.

1.4.3. Changes in the proportion of electric vehicles. According to the law of automobile market development, the growth rate of the car sales market will gradually slow down to a certain extent, and eventually tends to stabilize. Therefore, The block growth model was established as follows:

$$x(t) = \frac{x_m}{1+(\frac{x_m}{x_0}-1)e^{-rt}} \tag{25}$$

Assuming that the largest number of electric vehicles sold in South Korea is x_m, the sales of electric vehicles will not increase when $x = x_m$, and x_0 will be the initial sales of electric vehicles.

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References

[1] "Operations research" Huang-Hong Xuan Tsinghua University Press. June 1, 2005.
[2] "Operations research" guo peng Xi'an Jiaotong University Press, December 2013.
[3] "Optimization and optimal control", Xiao-Liang He Zhao-Qiang Ge Xi'an Jiaotong University Press February 1, 2009
[4] "Nonlinear regression analysis and SAS intelligence" Liang-Ping Hu Electronic Industry Press, July 1, 2013.
[5] "Regression analysis" yuxie Social Sciences Academic Press, March 1, 2013.