Formulation of Interstate Energy Contract Target Based on Optimal Energy Structure

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Abstract. The production and usage of energy are crucial to the economic development and environmental protection. Along the U.S. border with Mexico, there are four states – California, Arizona, New Mexico, and Texas. We take the data of 605 variables in 50 variables of four states as samples and combine demographic and economic information to analyze. Firstly, we use decision tree algorithm to describe the evolution characteristics of each energy distribution and establish energy decision analysis model. Secondly, we establish an energy profile evaluation model based on the analytic hierarchy process. Then, the states were given a certain amount of importance and put in the judgment submatrix. According to results, California scores the highest, which means it has the best energy structure. Thirdly, we use the grey prediction method to deduce the amount of energy consumption and economic status from 2010 to 2050. It's worth noting that how to determine interstate energy contracts in four states should take into account the best energy structure and four state energy standards. We choose the best energy structure as the reference target to formulate the energy agreement. Finally, we made some constructive recommendations toward the development blueprint of the interstate energy contract.

Keywords. Energy; Decision tree; Analytic hierarchy process; Grey prediction.

1. Introduction

The energy is the source of power, whose production and use are an important component of economic development [1]. In the United States, countries diversify various aspects of energy policy at the state level. Besides, different regions and industries in different states affect energy use and production. Thus, some states sign energy contracts. The border between the United States and Mexico is home to four states- California(CA), Arizona(AZ), New Mexico(NM), and Texas(TX). In order to achieve economic and environmental protection, it is essential to develop a realistic green energy contract that focuses on the use of cleaner, renewable energy sources.

To decide which state has the best energy structure, there are many factors we need to consider, not only geography and climate, but also social and economic impact. In order to make our judgment on the optimal energy structure and the prediction of future data reasonable and convincing, we have carried out a comprehensive analysis. The data which we collect has 605 variables of 50 years in 4 states. Therefore, from the measurement of the optimal energy structure, we start from the two categories of new energy and traditional energy, and combine some other factors, such as society, economy and so

on. We use decision tree and level analysis in the process of finding the optimal energy structure. Then we use DEXI software to generate the scores of all the factors in the four states to find the state with the best energy structure. Here we use gray prediction mode1 to predict the next few years based on known data. Finally, we can conclude that California has the best energy structure and made some suggestions of the other three states through analysis of the available data and forecast data.

2. Energy Profile for Each State

We take typical representative consumption (Unit: Btu) of coal(CLTXB), oil(PATXB) and natural gas(NGTXB) as traditional energy sources and locate the clean energy consumption (Unit: Btu) of wind energy(RETCB), hydropower(HYTCB) and solar(SOEGB) energy, and then filter out the relevant data. In particular, we selected the 1968 and 2008 data to map out their energy profiles.

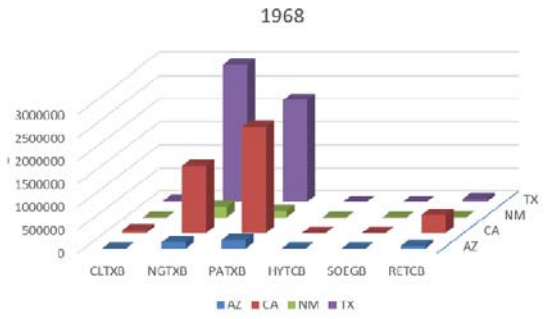

Figure 1. Energy profiles in four states in 1968

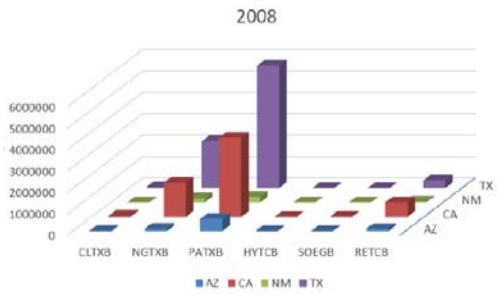

Figure 2. Energy profiles in four states in 2008

We can find that traditional fuel occupies a dominant position in energy consumption, especially the use of oil. In addition, the use of clean is on the rise in 40 years, however, the proportion of the total energy is still at a low level.

2.1. Model I: Energy Profile Analysis Decision System

To better study the energy profiles of the four states and to promote the improvement of present situation and the formulation of decisions, we propose a new model for the energy profile based on the relevant data from 1960 to 2009.

2.2. Model Preparation

Decision tree [2] is a flow chart like tree structure, where each internal node (non leaf nodes) represents a test on an attribute, each branch represents an output of the test, and each leaf node (or nodes) for a class label. The top node of the tree is the root node.

2.3. Value Scales

All attributes in the model are described by discrete and symbolic value scales, they can take discrete descriptive values, which are represented by words. In our model, we use a five-grade value scale (‘unacceptable’, ‘bad’, ‘middle’, ‘good’, ‘very good’) for the root attribute, which represents the main evaluation results.

3. Model Establishment

We use C4.5 algorithm [3] to solve the problem. The C4.5 algorithm uses the information gain ratio which introduces split information as a non-leaf node characteristic attribute selection criterion.

Taking into account the factors that may influence the similarities and differences between the four states, such as total energy(EN), per capita economy(EC), traditional energy(TE), new energy(NE), nature(NA) and society(SO), we use DEXi software to make an energy profile analysis and decision system. It is a human-computer system that helps decision makers use data and models to make decisions.

Through the calculation process, we can get the results shown in the following Figure3.

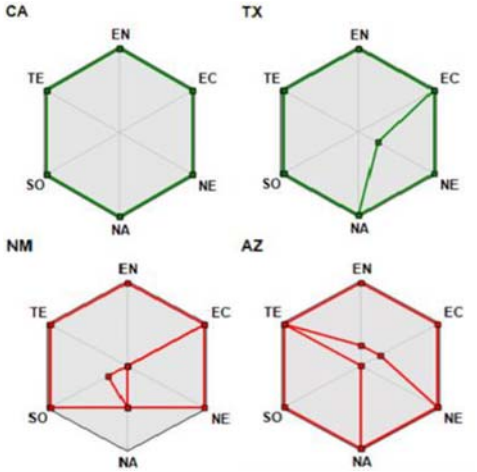

Figure 3. Energy profiles for four states six-dimensional radar map

According to the evaluation in the Figure3 above, we can get the climate and social factors have less impact on energy profiles in all four states. What's more, the proportion of traditional energy use is still large in each state. At the same time, we can see, the clean energy use of CA and AZ is better than that of TX and NM.

4. Model II: Energy Profile Evaluation

4.1. Model Preparation

Analytic hierarchy process (AHP) [4] is the decomposition of elements that are always related to decision making into goals, criteria, schemes, and so on. Using AHP, we decompose the best evaluation problem of new energy into four levels, compare and calculate the factors in the four levels. and get the weight of different factors, the state highest score is the one that has the best energy structure.

4.2. Model Establishment

(1) Establish a Hierarchical Structure [5].

(2) Constructs pairwise comparison judgment matrix to calculate the relative weight of the compared elements.

(3) Judgment matrix consistency test.

By using MATLAB software, the eigenvector is normalized, and the combination weight of each level element is solved. We get the weight of several factors by algorithm and the get score. The final ranking of the four states using clean energy profiles is shown in Table 1.

Table 1. The final ranking of energy structures in four states

STATE	MODE	SCORE
CA	1	0.5345
TX	2	0.2453
AZ	3	0.1432
NM	4	0.0770

Table 3 shows that the best profile for energy structure in four states is CA.

5. Model Ⅲ: Grey Prediction Model

5.1. Model Preparation

It is based on the gray system theory, through a small amount of incomplete information, the establishment of gray differential prediction model, the law of things to make a vague description of the long-term.

5.2. Model Establishment

We can obtain the sequence of prediction results as Table 2.

Table 2. Energy forecasts of four states in 2025 and 2050(Unit: Btu)

STATE	ENERGY	2025	2050
CA	Clean energy	3771057.58	5079692.389
	Total energy	4352487	883456370.8
AZ	Clean energy	549611.7307	662647.6154
	Total energy	49012886.77	87755916.75
NM	Clean energy	32428.51273	113591.1912
	Total energy	23081498.44	28960111.86
TX	Clean energy	1347468.869	3337306.413
	Total energy	307127178	437580480.5

As we can see in the Table 2, the clean energy use in each state is increased, and the proportion of clean energy in total energy consumption is higher and higher.

5.3. New four- state Contract Target

5.4. Renewable energy use targets

Based on the data, we selected wind energy, solar energy, and hydraulic energy as the predicted samples. Assuming that there is no significant change in the policy situation of each state, combined with the difference between the four states and the "best" standard set before, we have determined the targets for renewable energy use in 2025 and 2050.The use of clean energy should be on the rise, and factors of the states is different. So, it's roughly expressed in terms of the proportion of energy used in total energy. After comparison, the goal of 2025 is that clean energy accounts for 0.8% of the total energy use while the goal in 2050 is 1%.

5.5. Actions to achieve a compact energy goal

The use of fossil fuels should be further reduced and low carbon development ought to be implemented.

The energy structure should be optimized to improve the use of clean energy and the development of new energy such as flammable ice, tidal energy, etc. [6]

Build a smart energy system to improve the efficiency of all kinds of energy.

5.6. Future Improvements

The core of the theory of large data analysis is the data mining algorithm. One of the most important application areas of data analysis is predictive analysis, mining features from big data, then we can bring new data into the model and predict future data. Meanwhile, considering more factors that may affect the outcome such as policy changes is also vital.

6. Conclusions

According to the decision tree algorithm and analytic hierarchy process, California has best energy structure in the energy structure of the state, and the energy development of the other three states. It is

of guiding significance. After that, we use the grey prediction algorithm to analyze and predict the trend of energy development in these four states, and the results are still more rationalized in the development of California. Therefore, when the energy can meet the needs of urban development, the rest of the States should learn from California, optimize the capacity structure, and gradually move towards clean and green cities.

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