Establishment of Clean Energy Demand Forecasting Model in China Based on Genetic Algorithms

Jiying Chen 1, Gaoyuan Cheng 2,* and Shuanghe Chi 1

1 College of Pipeline and Civil Engineering, China University of Petroleum, Qingdao, 266580, China
2 School of Information Science and Engineering, Lanzhou University, Lanzhou 730000, China

*Corresponding author e-mail: Lanuc_0001@163.com

Abstract. In the future, energy development will face a series of severe challenges, such as insufficient domestic conventional energy resources, huge oil supply gap, large amount of clean energy needed by cities, and huge international pressure on global climate change. This paper uses historical data and genetic algorithm to improve it, and uses function expansion model to reveal the internal proportional connection between energy consumption and economic development. By comparing the forecasting methods of clean energy demand, it is found that the energy consumption elasticity coefficient method is used to measure and predict the growth ratio of energy consumption, and the figure in the next few years is measured. The software has self-built optimization model, reflects energy supply and demand fluctuations, and generates reports. It can make decision support for regional clean energy system planning, miscalculation and clean energy demand forecasting.

Keywords. Genetic Algorithms, Clean Energy, Demand Forecasting.

1. Introduction
China's social and economic advancement has reached the level of moderately developed countries, so it is necessary to ensure an adequate supply of clean and efficient energy. As the energy sector is highly capital-intensive and has a long construction cycle, it is necessary to formulate and implement medium-term and long-term energy development [1]. Energy is an indispensable material resource for the survival and the development of human society and an significant strategic material related to the lifeline of a country's economy. However, the insufficient total energy and structural deviation have become a bottleneck of China's sustainable development. China is facing the dual pressure of energy shortage and environmental constraints [2]. The total energy consumption and energy structure are closely related to the energy consumption of the sub-categories. The coal, oil, natural gas and electric power are forecasted. Simultaneously, the consumption of the sub-sectors is predicted, which can more objectively reflect the energy consumption demand and structural changes [3]. As a result of the large population, the possession of energy resources per capita is insufficient, and in recent years, China's energy resources have also declined to a certain extent, and China's energy resources are limited. The Chinese government
has made a commitment to diminish carbon emissions, accurately forecasting the demand for clean energy, and providing a scientific basis for China to rationally formulate its energy development strategy.

In order to protect China's economy and energy security and actively respond to climate change, it is imperative to vigorously develop clean energy. Accurately predicting the demand for clean energy can provide a scientific foundation for China to rationally formulate its energy development strategy. To achieve this goal, China must adjust its energy structure and develop clean energy vigorously [4-5]. Therefore, accurate and effective medium-term and even long-term forecasting of clean energy demand can not only conduct the rational development of clean energy in China, but also give scientific decision-making basis for the formulation of energy security strategies and economic development strategies. However, in order to implement the specific energy strategic development plan, it is necessary to understand the future energy consumption demand of our country. This paper compares the forecasting methods of energy consumption and forecasts the growth trend of energy consumption demand in our country, which has practical significance for solving the contradiction between energy demand and supply in our country in the future. Because of the features of China's energy resources and the actual situation at home and abroad, the goal and implementation route of future energy restructuring will have a significant impact on energy strategy. It is necessary to conduct comprehensive and targeted research and discussion.

2. Mathematical Modeling and Evaluation

The sustained growth of energy has added substantial pressure on the energy supply sector. The relative shortage of domestic energy resources, especially high-quality energy, and the backwardness of energy conversion technology restrict the improvement of China's energy supply capacity. Solar energy refers to the thermal radiation energy of the sun, which is principally reflected in the sunlight. In modern times, it is usually used to generate electricity or provide energy for water heaters, that is, photovoltaic power generation and photovoltaic heat [6]. Facing the major challenges of China's energy development in the future, including the insufficient supply of domestic conventional primary energy and the safety guarantee of large imports of oil and natural gas. By comparing various methods for predicting clean energy demand, it is found that various methods have their advantages and applicability, but the energy consumption elastic coefficient method is used to measure and predict the growth rate of energy consumption more in line with the principle of practicality, simplicity and accuracy [7]. This kind of energy structure leads to the seriousness of China's energy environmental problems not only in existing pollution, but more importantly, the potential clean energy demand in the future will exert tremendous pressure on the domestic environment. In the past, China's annual greenhouse gas emissions accounted for nearly half of all developing countries, close to 20% of the world's total emissions.

Models are based on China's energy consumption and data is used for model testing. The trend of energy consumption sequence X can be expressed as:

$$X^{ad} = \left[ d_1, d_2, \ldots, d_k, \ldots, d_K \right]^T$$  \hspace{1cm} (1)

On this basis, the optimization interval of each parameter is determined, and the accelerated genetic algorithm is used to solve the following formula(2). The flow chart of the genetic algorithm is showed in Figure 1. The part of Initial Value represent an “Energy Population”.

$$X^{ad} = \left[ d_1, d_2, \ldots, d_n, \ldots, d_N \right]^T$$  \hspace{1cm} (2)
Figure 1. Flow chart of genetic algorithm solution.

Where V is the optimization objective function; K is the model calculation value; F is the sequence measurement value. Thus available:

\[ F = K \times \frac{(V - V_t)^2}{V} \]  \hspace{1cm} (3)

V can be re-sampled based on self-help method. Firstly, the error sequence K is centralized to get the new sequence Vt, from which we can get:

\[ V = \sqrt{\frac{F \times V_t}{K} + \frac{F^2}{4 \times K^2} + V_t + \frac{F}{2 \times K}} \]  \hspace{1cm} (4)

The assumption that the relationship between the observed statistics I and the true value x is equivalent to the predicted value of the energy consumption of x years in China:

\[ \beta_{xy} = \frac{I_{xy}}{\sum_{a=1}^{g-1} I_{xa}} \]  \hspace{1cm} (5)

Clean energy refers to energy that does not emit contaminants and can be directly used in production and people’s life. It contains nuclear energy and “renewable energy”. Renewable energy refers to the energy that raw materials can regenerate. It takes a lot of labor to collect and it is difficult to form a scale. As the economy develops, if the labor cost for collection is higher than the opportunity cost of labor. The objective proportional relationship between economic growth and energy consumption is an empirical law after confirming the causal relationship. When we recognize this law and understand the energy consumption demand of China in the next few years, we can measure energy more accurately. The connection between consumption and energy supply, energy consumption and economic growth. The proportion of clean energy like solar or wind energy and natural gas in the energy structure will be further increased [8-10]. By comparing the fitted value with the actual value of clean energy demand
over the years, it can be seen that the model has a high degree of fitness and stable results, and can accurately describe the changing law of clean energy demand. Windmills can be used to convert the kinetic energy of wind into rotating motion to drive generators to generate electricity. The merits of wind energy are that it is copious, even nearly endless, and widely distributed as well as very clean. China has adopted this policy [10], and has begun to work in many ways in order to import large quantities of clean energy such as oil and gas from the international market and develop overseas resources. Increase the proportion of renewable energy development and increase the supply of electricity to ensure the safety of China's energy supply. In particular, it is necessary to focus on the development of hydropower, wind power, nuclear power, solar energy, and other forms of supplementary power generation to achieve diversification of energy use. The combined forecasting model makes full use of the information of a single model to improve the rationality of the forecasting results. It indicates that the forecast results of clean energy demand in this paper have certain rationality and can provide decision support for the formulation of national policies for energy conservation and emission reduction.

3. Result Analysis and Relevant Discussion

China is promoting the use of solar energy, mainly for domestic hot water supply and solar houses. However, the efficiency of solar photovoltaic power generation is relatively low and the cost is high. It is necessary to speed up the construction of pumped storage power stations, so as to achieve “simultaneous planning, simultaneous construction, and simultaneous production”, effectively ensuring the safety of the “nuclear storage integration” development and operation mode, and safely and efficiently alleviating the nuclear power plants under variable load conditions[9-10]. The impact caused. It can be seen that energy consumption plays a very important role in economic development, so in order to sustain, stable and rapid economic development of our country, it is necessary to understand the energy consumption demand of our country for a period of time in the future. To solve the energy and environmental problems in the regional system, the purpose of optimizing the energy structure is mainly achieved through regional energy planning. Reasonable energy planning can not only adjust the energy structure to ensure safe and efficient energy supply, but also make great contributions to national energy conservation and emission reduction.

By 2020, the proportion of clean energy consumption to total energy consumption in China is also close to the planning target of 20% and the current situation of 15%. Therefore, the prediction of clean energy demand in this paper has certain reliability. Table 1 and Figure 1 below show the demand for clean energy in China in 2020(tce:ton of standard coal equivalent ).

| Clean energy    | Demand / billion tce | Proportion (%) |
|-----------------|----------------------|----------------|
| Solar energy    | 4.87                 | 20.36          |
| Wind energy     | 5.01                 | 22.17          |
Figure 2. China's clean energy demand in 2020.

For a long time, coal has dominated China's energy consumption by two-thirds, and coal consumption is the main source of carbon emissions. Therefore, to ensure that carbon emissions are reduced to the planned targets, it is necessary to reduce coal consumption and increase clean energy. Scientific and rational development planning is a prerequisite for the success of clean energy development. At present, there are problems in the development of power grid development planning and clean energy development planning. Therefore, it is necessary to further clarify the functional orientation of the nuclear power industry park and further clarify the development direction of the near and long term. In order to meet the huge demand for primary energy, China's primary energy supply will continue to be dominated by coal, and should make full use of water, natural gas, oil, nuclear and renewable energy and other available resources to form a coal-based diversified energy structure system. In order to meet the needs of rapid economic growth, it will inevitably lead to the rapid growth of energy consumption. According to the current structure of energy consumption, coal and oil consumption accounts for nearly 80%, which shows that the energy to promote economic growth is mainly non-renewable fossil energy [11-12].

Energy planning is considered as the only way for energy system to achieve sustainable economic and environmental development, taking into account technology, economy and environment. Its change is a high-dimensional non-linear dynamic process with great uncertainty, so it will be more scientific and accurate to express the predicted value of energy consumption in the form of confidence interval. China will continue to focus on coal consumption in the future. To ensure that carbon emissions fall within the target range, it is necessary to reduce coal consumption and increase the consumption of clean energy. In the process of infrastructure construction, attention should be paid to the integration of existing resources, the technical transformation of supporting facilities in the start-up zone, the rational arrangement of operating procedures, and the improvement of equipment utilization rate. This not only improves the conversion efficiency of coal synthesis gas fuel, but also avoids the complicated process flow that is currently repeatedly synthesized, and reduces the investment of a large number of process equipment, so that the cost of synthetic fuel can be significantly reduced. It is also possible to adjust the industrial structure with the help of some enterprises in the state of suspension or semi-discontinuation, thereby promoting the adjustment of the energy consumption structure. Third, increase the research and development of alternative energy sources for non-renewable energy, such as straw instead of coal. Energy-saving energy structure, orderly development of clean energy such as hydro-power and wind power.
4. Summary
From the perspective of the development of the clean energy industry, most of them show the trend of industrial agglomeration. Using this model to predict the demand for clean energy, and to construct a future socio-economic development scenario, combined with carbon emission reduction targets to promote clean energy demand, and thus establish a medium- and long-term predictive model of clean energy based on genetic algorithm. There are many influencing factors in the selection and design of wind turbine foundation structure in offshore wind farms. There are many non-structural influencing factors that are difficult to quantify. In order to reduce the influence of subjective factors, the fuzzy optimization theory is applied to optimize the design of structure selection. In this system, comprehensive consideration is given to the production of synthetic transport fuel and the development and application of advanced coal-fired power generation technology. Fuels in cities must use clean energy. Natural gas and urban gas should be given priority to the economic energy consumption of residents and service industries. The regional clean energy planning work in this study lays a foundation for the development of better and more practical regional energy system optimization software in the future, and has reference value.

References
[1] Suganthi L, Samuel A A . Energy models for demand forecasting—A review. Renewable and Sustainable Energy Reviews, Vol. 16 (2012) No. 2, p. 1223-1240.
[2] E. González-Romera, M.A. Jaramillo-Morán, D. Carmona-Fernández. Monthly electric energy demand forecasting with neural networks and Fourier series. Energy Conversion and Management, Vol. 49 (2008) No. 11, p. 3135-3142.
[3] Gonzalez-Romera E, Jaramillo-Moran M A, Carmona-Fernandez D . Monthly Electric Energy Demand Forecasting Based on Trend Extraction. IEEE Transactions on Power Systems, Vol. 21 (2006) No. 4, p. 1946-1953.
[4] Energy management strategy for a renewable-based residential microgrid with generation and demand forecasting. Applied Energy, Vol. 158 (2015), p. 12-25.
[5] Iman G, Ehsan A, Gary R W, et al. An overview of energy demand forecasting methods published in 2005–2015. Energy Systems, Vol. 8 (2016) No. 2, 1-37.
[6] Wang, Zheng-Xin. A Predictive Analysis of Clean Energy Consumption, Economic Growth and Environmental Regulation in China Using an Optimized Grey Dynamic Model. Computational Economics, Vol. 46 (2015) No. 3, p. 437-453.
[7] Verdejo H, Awerkin A, Becker C, et al. Statistic linear parametric techniques for residential electric energy demand forecasting. A review and an implementation to Chile. Renewable and Sustainable Energy Reviews, Vol. 74 (2017), p. 512-521.
[8] Stambouli A B, Khiat Z, Flazi S, et al. A review on the renewable energy development in Algeria: Current perspective, energy scenario and sustainability issues. Renewable & Sustainable Energy Reviews, Vol. 16 (2012) No. 7, p. 4445-4460.
[9] Lihong Peng,Yi Zhang,Feng Li,Qian Wang,Xiaochou Chen,Ang Yu. Policy implication of nuclear energy’s potential for energy optimization and CO 2 mitigation: A case study of Fujian, China. Nuclear Engineering and Technology,Vol.51(2019),No.4.p.1154-1162.
[10] Jingjing Zeng,Ting Liu,Richard Feiock,Fei Li. The impacts of China's provincial energy policies on major air pollutants: A spatial econometric analysis. Energy Policy,Vol. 132 (2019) , p. 392-403.
[11] Baños, R., et al. Optimization methods applied to renewable and sustainable energy: a review. Renewable and Sustainable Energy Reviews, Vol. 15(2011) No. 7,p. 1753–1766.
[12] Liu, P., et al., Finding multiple optimal solutions to optimal load distribution problem in hydropower plant. Energies,Vol.5 (2012), No.5,p. 1413–1432.