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Application Potential of Asset Appraisal Clean Energy (Pace) Financing Mechanism Based on Particle Swarm Optimization Algorithm in Clean Energy Grid Industry

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ABSTRACT. With the increasing demand for energy and the strengthening of environmental protection all over the world, the popularization and application of clean energy has become an inevitable trend. Asset Appraisal Clean Energy (PACE) financing provides an effective financing mechanism for the government to attract private capital to invest in new energy-efficient green buildings. In this paper, the application path of asset appraisal clean energy (PACE) financing mechanism based on particle swarm optimization algorithm in clean energy power grid industry is put forward. Combined with price transmission, explanatory structure model and comprehensive evaluation theory, the structural model of electricity price factors is formed, and the validity test model of electricity price formation mechanism is constructed. The effectiveness of renewable energy electricity price subsidy policy is analyzed by using this model. The purpose is to actively explore the application of PACE financing in China and promote green building investment in clean energy grid industry.

KEYWORDS: Particle swarm optimization algorithm: pace, Clean energy

1. Introduction

Since the 21st century, human beings have to face the following three important issues: energy shortage, climate change and environmental pollution. As far as the current situation is concerned, more than 80% of the global energy consumption still depends on traditional fossil energy such as coal and oil, and the consumption of fossil energy will inevitably produce a large amount of greenhouse gases[1]. The exploitation and utilization of fossil energy is almost crazy, which makes the environment worse and worse, and the fossil energy is in short supply. Therefore, human beings have to find a way to gradually replace fossil energy with clean energy. As far as the economic externality of clean energy is concerned, due to the economic correlation between the main bodies, the first task to solve the economic externality is to clarify whether the economic externality is distributable [2]. In this case, clean energy must be used for development, so as to save losses and realize the optimal allocation of resources. In this process, we can rely on many new energy sources such as solar energy, wind energy, biomass energy, geothermal energy and ocean energy to improve it. At the same time, we can rely on advanced technology to improve the energy utilization rate and maintain the ecological environment.

Based on the practical application of clean energy, as well as the current technical status and development trend of clean energy at home and abroad, this paper puts forward the feasibility of applying PACE financing mechanism based on particle swarm optimization algorithm in clean energy grid industry and the problems to be solved, thus providing a basis for the development of clean energy.

2. Comparative Analysis of the Impact of Clean Energy Development Policies

2.1 Performance Evaluation of Energy Policy

The environmental effect of renewable energy is recognized. This makes it have strong positive externalities. The expansion of secondary and tertiary industries with high energy consumption has led to the rapid increase of energy consumption and the increase of environmental load; Since the “Twelfth Five-Year Plan”, the binding indicators of environmental protection and investment in environmental protection have increased accordingly, which reflects that “externality” has always been the biggest problem facing environmental regulation. With the increase of renewable

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energy output and the decrease of production cost, it is bound to improve the profit level of renewable energy manufacturers [3]. The high output of renewable energy will also lead to the reduction of the use of non-renewable energy, thus reducing the environmental burden. However, blindly promoting urbanization policy with restraint will lead to the continuous increase of energy consumption and total carbon emissions, seriously affecting the ecological environment, and urbanization should be consistent with the speed of environmental development and economic development; Renewable energy is not only common energy, but also has additional contributions to society, such as protecting the environment and ensuring energy security. The additional contribution of renewable energy is the positive externality called by economics. Government subsidies and other policies are often adopted to solve the positive externality.

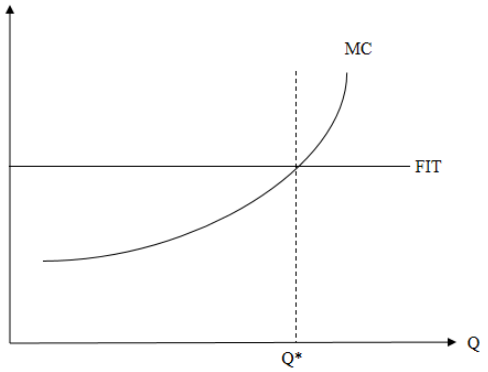

Fig.1 Fixed Electricity Price Mechanism of Renewable Energy

At present, China's environmental regulation policy consists of two parts, namely, environmental regulation intensity and environmental regulation tools. The government sets benchmark electricity prices for various renewable energies (i.e., FIT prices), and enterprises, as price recipients, look for the points to maximize their profits at this price to develop until the marginal cost of production = FIT (see Figure 1)[4]. Taking energy conservation and emission reduction advocated by our country recently as an example, production enterprises will tend to use clean energy to replace the energy which has high pollution to the environment before. In addition, the use of new technologies will reduce the demand of enterprises for high pollution energy. Its development stems from the inefficiency in the implementation of command and control policies and the limitations in the implementation of market-based environmental regulation policies. The means adopted by this policy is to provide mutual incentives to stakeholders by using non-traditional environmental regulation methods. The gap between the cost of renewable energy generation and the cost of traditional conventional energy sources will continue to narrow, and the losses incurred by power grid enterprises due to the acceptance of renewable energy will also continue to decrease.

2.2 Policy Influence without Goal Constraint

Energy is the main component of resources, which is closely related to economic and environmental factors. Environmental labeling is a voluntary application for product certification by enterprises; Information disclosure mainly requires the government and polluting enterprises to let relevant stakeholders know about the environment by means of public opinion, such as media and internet; In recent years, China has carried out price control in the field of renewable energy power generation including hydropower, wind power and solar energy to promote its development. The development level of renewable energy should be coordinated with the peak-shaving capacity of the system, otherwise, the power grid cannot accept all renewable energy power, resulting in low utilization rate of renewable energy. China's investment in energy efficiency improvement of new and existing buildings can bring about 1.2 billion tons of emission reduction (equivalent to 3.8% of global carbon emissions in 2015), and help the construction industry reach the peak of carbon emissions in 2030. At present, after large-scale Internet access, it is bound to increase the operation cost of power grid [5-6]. When clean energy is delivered to users, because of its high initial development cost, the electricity price will rise through the cost transmission system. The main development trend of solar photovoltaic utilization will be gradually transformed into grid-connected solar photovoltaic power generation, and the trend of solar power generation is spreading step by step from non-electricity areas to electricity.

3. Influencing Factors of Power Grid Infrastructure Investment

There are many influencing factors in power grid investment forecasting, and causality method and artificial intelligence method are usually used to solve the relatively complex forecasting problems. Literature [7] constructs index sets from macro-strategy and micro-process, and realizes the correlation between them in the form of index chain, forming an index system. However, most of these index systems focus on the overall evaluation of power grid development, and there is no effective evaluation system for individual infrastructure projects. Moreover, there are many qualitative indicators in the index system of literature [8], which are difficult to quantify. The budget mainly presents the investment plan in the form of financial statements. However, in the actual investment budget process, the specific arrangement and investment quota of infrastructure projects are not clear, which leads to the inaccurate investment budget, which leads to the disconnection between the budget and the specific situation of infrastructure projects. Therefore, before the start of the power infrastructure project, it is necessary to hire a team with professional design theory ability and rich design experience to design and plan the drawings, and at the same time, it is necessary to review them in strict accordance with the national legal procedures. Therefore, it is necessary to study the relationship among energy, environment and economy, so as to provide suggestions and decision support for future sustainable development.

The annual investment in power grid construction is closely related to the state of economic development, and the main influencing factors include GDP, electricity consumption of the whole society, electricity sales and load. Although different individual indicators can reflect their attributes from different angles, in order to reflect them comprehensively and profoundly, it is necessary to screen closely related indicators according to the evaluation purpose and analyze the correlation between these indicators, thus forming an indicator system. In the process of implementing the investment budget of power grid infrastructure projects, it is necessary to constantly summarize and analyze the implementation process and results, compare with the previous power grid infrastructure projects, and analyze the reasons for the differences in budget implementation in bidding and purchasing, material requisition, project settlement and other aspects. For electric power infrastructure construction projects, the basic personal safety of construction personnel should be guaranteed first. If the personal safety of construction personnel can not be guaranteed, then all construction operations in the later period can not be carried out smoothly; In order to ensure the safe and stable operation of power and maintain the balance between power supply and demand, it is necessary to increase the investment in power grid construction, expand the scale of power grid construction and improve the level of power grid structure to adapt to the new changes and requirements.

4. Feasibility of Application of Assets Appraisal Clean Energy Financing in China

For a high proportion of access to clean energy power grid, the flexible adjustment capability of power grid refers to the pre-adjustment of hydropower, thermal power, tie line, time-shiftable load and frequency when the power grid is under normal adjustment. Biomass combustion power generation means that the energy obtained by direct combustion of biomass raw materials drives corresponding steam turbines and other equipment to generate electricity; The biomass gasification power generation technology is based on the combustible gas obtained from biomass raw materials, and then converted into electricity by internal combustion engines and other equipment. At present, the only profit margin of wind power generation lies in the final electricity price income. According to industry insiders, it depends on the state's pricing strategy and on-grid tariff subsidies-"If there is no subsidy, the wind power will be profitable in the foreseeable future".

PSO algorithm, as an iterative tool, has the ability of global optimization and is often used to solve optimization problems. Traditional PSO algorithm is easy to cause defects such as the individual quality of particles can not be guaranteed, the solving efficiency is not high, and it is easy to fall into local extremum. In this paper, chaos system and adaptive inertia weight coefficient are used to improve PSO algorithm, so as to improve the efficiency of the algorithm and avoid the premature problem of the algorithm.

Logistic chaotic system is adopted in this paper, and its iterative formula is:

$$v(k+1) = \mu v(k)(1-v(k)) \quad (1)$$

In the formula, $v(k)$ is the mapping sequence of chaotic system; μ is the control parameter $\mu \in (2,4]$. When $\mu = 4,\ 0 \le v(0) \le 1$, Logistic is completely chaotic.

Shrinkage factors β, BB and particle number $i = 1,2,\cdots,N$ are introduced in the optimization process of PSO algorithm. β decreases with the increase of iteration times, thus slowing down the late optimization speed of particle swarm optimization and reducing the probability of the whole population falling into local optimal solution. The speed and position updating formula of PSO algorithm after improvement is as follows:

$$z_{i,j}(k)=\beta[\omega z_{i,j}(k)+g_1 r(p_{best_{i,j}}(k)-x_{i,j}(k))+g_2 r(l_{best_{i,j}}(k)-x_{i,j}(k))] \quad (2)$$

$$x_{i,j}(k+1)=x_{i,j}(k)+z_{i,j}(k+1) \quad (3)$$

In which ω is inertia coefficient; g_1, g_2 is the acceleration constant; r is a random number varying within the range of [0,1]; $j=1,2,\cdots,H$; $X_i=(x_{i,1},x_{i,2},\cdots,x_{i,H})$ and $Z_i(z_{i,1},z_{i,2},\cdots,z_{i,H})$ are the position and velocity of particles in h-dimensional search space; $p_{best_i}=(p_{best_i,1},p_{best_{i,2}},\cdots p_{best_i,H})$ and l_{best} are the best positions for a single particle and all particles in the whole population.

If managers try to use project fees to recover most or even all of the management costs, the project costs will increase accordingly and may hinder developers from adopting PACE financing. To minimize management costs and recover these costs, managers can encourage project sponsors and financing companies to guide the higher-cost work in project management. The externality of clean energy power generation also reflects the characteristics of integration of time and space. Specifically, when clean energy and electricity are produced, the impact on various stakeholders is directly reflected. This makes banks still adopt cautious or restrictive credit policies for clean energy industry. Its loan scale is difficult to ensure the development of clean energy industry.

In this paper, the combined forecasting method of improved particle swarm optimization algorithm is used to test the annual total capital investment forecast of a provincial power grid. First of all, the historical data of GDP, electricity sales, maximum load and power grid infrastructure investment of 220 kV and below are selected from 2014to 2018, as shown in Table 1.

Table 1 Historical Data Of Provincial Capital Construction from 2014 to 2018

Year	GDP/ 100 million yuan	Electricity sold/100 million kW·h	Unified adjustment of maximum power load/10,000 kW	Capital construction investment/10,000 yuan
2014	3484.07	3984.88	5986.71	2345013
2015	5863.12	4453.72	7822.33	2986730
2016	6987.22	6982.61	9673.62	3011244
2017	8997.08	9344.08	12860.89	5932327
2018	9963.78	13543.37	13074.92	7321228

Taking GDP, electricity sales and maximum load as the influencing factors, multiple linear regression, BP neural network and improved particle swarm optimization combined forecasting method are used to forecast. After calculation, the predicted annual growth rate of the province's infrastructure investment under three methods is obtained, as shown in Figure 2.

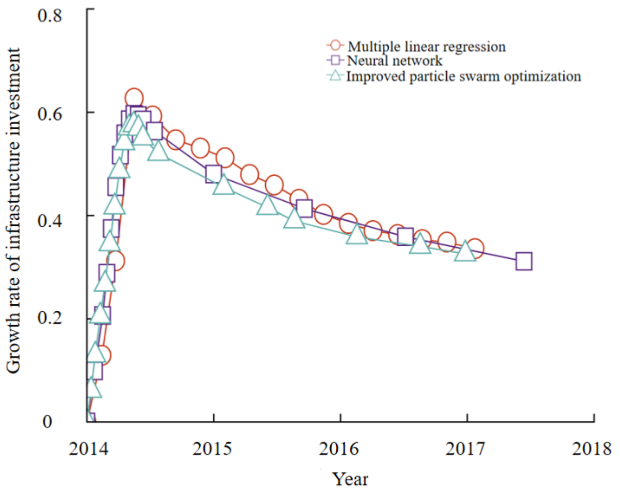

Fig.2 Forecast Value of Capital Construction Investment Growth Rate in the Whole Province

The calculation results show that the combined forecasting method based on the improved particle swarm optimization algorithm has a good performance in forecasting accuracy, and its forecasting accuracy is obviously better than the other two forecasting methods.

It is not difficult to find that solar energy and wind energy have a strong complementary role in time and region, and wind-solar hybrid power supply system has become one of the important forms of renewable energy independent power supply system. If the benchmark electricity price is low and the incentive effect is not strong enough, the development speed of renewable energy must be lower than the government's expectation; If the benchmark electricity price is on the high side, renewable energy manufacturers can get excess profits, which leads to the rapid growth of installed capacity. Technical externality mainly refers to the influence on the stability and reliability of power grid and the economic operation of other conventional power plants, while economic externality refers to the influence on the economic interests of various subjects related to clean energy and power. Under any operation mode, the reactive power of wind power plant should be guaranteed to have a certain regulation capacity; When the voltage deviation at the parallel points of the wind farm is between plus and MINUS 10%, the wind turbines in the wind farm should be able to operate normally; For developers, PACE can help break through the market barriers of developing green buildings such as high financing cost and uncertain holding period. For the government, PACE mechanism makes energy efficiency upgrading projects more attractive to investors and owners, which is conducive to the smooth achievement of its action goals of energy conservation, emission reduction and climate change.

5. Conclusion

If the clean energy power supply is used as the backup power supply of distribution system, the access of clean energy power supply can improve the power supply reliability of the system; Good policies will inevitably promote investors' confidence and bring prosperity to the capital market. As a clean energy industry, we should seize the opportunity to strengthen asset financing. Aiming at the feasibility of applying asset appraisal clean energy financing in China, this paper proposes a combinatorial analysis method based on improved particle swarm optimization. In the application of evaluative clean energy financing prediction, this method not only considers the actual influencing factors in the prediction, but also effectively improves the prediction accuracy, and can get more accurate and reasonable results in the prediction, which has good applicability to the application of asset evaluative clean energy financing in China. Next, we should conduct a detailed feasibility study on the application of PACE financing mechanism in China, and find the most suitable PACE financing model for large-scale application in China. Especially in view of the opportunity of China's huge new construction market, it effectively combines the unique management structure, laws, systems and market environment to help the building energy conservation and the healthy and rapid development of green buildings.

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