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Regional Energy Strategy Based on Engineering Thermodynamics

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Abstract: The formulation of scientific strategies must be aware of the advantages and disadvantages of regional structure. Sustainability is the only safe way. This will inevitably require the energy structure to change in the direction of diversification and environmental friendliness, and the energy use to change in the direction of saving and cleaning. The purpose of this paper is to study regional energy strategies based on engineering thermodynamics. Using electrical engineering, thermodynamics, fluid mechanics and other multidisciplinary knowledge, this paper systematically discusses the strategic significance of building a coordinated green development of regional ecology and energy industry, and deeply studies the potential impact of large-scale photovoltaic development in the Gobi region on the local ecological environment. The effect of large-scale laying of photovoltaic panels on the local evaporation in the Gobi was analyzed by thermodynamic modeling. Taking the M area, which is the most representative of photovoltaic development, as an example, and using NASA's measured data to conduct a detailed analysis, it is concluded that the large-scale laying of photovoltaic panels reduces the local surface temperature, weakens the evaporation capacity, and helps the soil to retain water.

1. Introduction

Region is a relative concept, which is artificially formulated by people according to the administrative planning, economic characteristics, natural conditions and social development of the region, and constitutes a part of the country [1-2]. Economic development and energy utilization are inseparable. Energy provides power for the train of the times, and the progress of economy, science and technology, and human knowledge level constantly promotes people to improve energy utilization efficiency and develop and utilize new energy [3]. Clean energy can not only effectively improve the level of regional energy use and promote the transformation of regional energy use from extensive to intensive, but also effectively control and optimize the regional energy structure, which greatly eases the pressure on the ecological environment [4].

At present, my country's energy application situation is very serious, energy problems have become a major factor affecting the harmonious development of my country's economy and society, and one of the reasons for my country's energy problems is the lack of energy application planning [5]. Afrakhte H proposes a coordinated energy management strategy to optimize the operation of MMG systems using variable weighted multi-objective functions. Based on this approach, in the event of an emergency, multiple operators are able to change the weight of functions according to the emergency and take responsibility for the correct use of energy storage systems and other distributed energy sources. Furthermore, an efficient optimization algorithm called target search shuffle complex evolution is proposed to rapidly optimize decision parameters in both fault and normal operating modes [6]. Azizivahed A investigates the expected unsupplied energy (EENS) and voltage stability index (VSI) of distribution networks in dynamically balanced and unbalanced distribution network reconfigurations, including RES and EES systems. Furthermore, due to the high investment cost of EES systems, the number of charge and discharges is limited, and state-of-health constraints are included as potential issues to extend the life of these facilities. The optimal charging/discharging scheme and optimal distribution network topology for EES system are proposed to simultaneously optimize operating cost, reliability and safety metrics. The proposed strategy is applied to a large-scale 119-bus power distribution test network to show the economic rationality of the proposed method [7]. In addition, the renewable energy is included in the scope of energy planning, and the planning scope is more detailed and extensive [8].

Based on the analysis of regional energy planning methods at home and abroad, this paper takes the regional energy strategy as the core, establishes the basic framework of the coordinated development strategy of regional ecology and energy industry green, and puts forward the calculation model of the regional energy strategy. The research object uses the green coordinated development strategy and calculation model of regional ecology and energy industry established in this paper for preliminary application and analysis. The important role of new energy is not only reflected in the transformation of traditional energy, but also in environmental governance, land reform, and promotion of related industries. development, etc.

2. Research on Regional Energy Strategy Based on Engineering Thermodynamics

2.1. Basic Characteristics of Regional Sustainable Development System

The regional sustainable development system is a dynamic, open and complex giant system. The regional sustainable development system exchanges material and energy with other systems outside the region; the subsystems and the elements within the subsystems are still in a state of flux. In the midst of constant movement and change [9-10]. Therefore, even if the level of economic and social development between regions is similar, the interaction between population, resources, environment and development also has its own characteristics. For the regional sustainable development system, the process of regional development is always the unity of certainty and randomness [11].

2.2. Regional Ecology and Green Coordinated Development Strategy of Energy Industry

(1) Change the mode of economic development and establish the concept of green development

Ecological construction has received more attention than before, and the extensive economic growth mode in the past is facing the danger of being eliminated. The government advocates green development, even at the expense of economic growth rate to achieve green economic development [12-13]. To achieve green development, we must optimize the energy consumption structure and industrial structure, increase investment in new energy research, and pay enough attention to new energy. The optimization of industrial structure involves the adjustment of the tertiary industry structure and the adjustment of light and heavy industries [14].

(2) Strengthen scientific and technological innovation and promote ecological optimization construction

Science and technology are the primary productive forces. Nowadays, a large part of the deterioration of the ecological environment is caused by the backwardness of science and technology. To strengthen scientific and technological innovation, all localities must attach great importance to the development of education, introduce innovative talents in professional fields with high salaries, increase investment in scientific and technological research and development, and introduce new technologies and new equipment required for research and development. Enterprises attaching importance to scientific and technological research and development can increase the competitiveness of enterprises. In order to survive the survival of the fittest, the innovation of science and technology can reduce the emission of pollutants and add luster to the corporate image [15-16]. Strengthening scientific and technological innovation can not only bring many benefits to the enterprise itself, but also make great contributions to the society.

(3) Solar power plant project

A solar power station is a power station that converts solar energy into electricity. Its basic form of operation is the use of a large number of solar collectors. Because it does not pollute the environment and emit no harmful gases, solar energy is currently the cleanest sun, radiating light all the time, and is also a renewable energy source [17].

Microinverters can be used in small to medium rooftop solar power plants such as homes, schools and factories. The micro-inverter has the characteristics of flexible and convenient installation, high power generation efficiency, high safety factor, high intelligent management, and low maintenance cost.

2.3. Engineering Thermodynamics

(1) Thermal convection model

The ground surface is in direct contact with the air, and if there is a temperature difference between them, heat exchange in the form of convection will occur between the ground surface and the air [18]. The convective heat transfer formula adopts the classical Newtonian cooling formula:

$$Q_{GA} = h_c(T_a - T_g) \tag{1}$$

In the formula: Tg/(℃) is the surface temperature; Ta/(℃) is the air temperature; when the total amount of convective heat transfer is constant, the factors affecting the ground temperature include air temperature and wind speed [19].

(2) Thermal radiation model

The radiation received by the surface is expressed as formula (2):

$$R_n = Q\alpha_G + \varepsilon_a\sigma T_a^4 - \varepsilon_g\sigma T_g^4 \tag{2}$$

In the formula, Q/(J/m2.h) is the total solar radiation; aG is the surface radiation absorption ratio. According to the properties of the Gobi Desert, aG=0.9; σ is the Stefan-Boltzmann constant; εg is the specific emissivity of the ground.

(3) Heat conduction model

The heat conduction existing on the surface is the heat exchange of the solid medium below the surface. According to the law of heat conduction, the heat conduction equation is shown in formula (3):

$$\frac{\partial T_g(z,t)}{\partial t} = a\frac{\partial^2 T_g(z,t)}{\partial z^2}, 0 \le z \le \infty \quad (3)$$

In the formula, a is the thermal conductivity; Z is the distance between a certain point underground and the surface.

3. Investigation and Research on Regional Energy Strategy Based on Engineering Thermodynamics

3.1. Program Design and Example Simulation

(1) Programming

The program used in this paper mainly includes three parts. The first part is based on the daily maximum and minimum air humidity and the average direct solar intensity. The second part is based on the radiation intensity to obtain the ground temperature at different depths. Solve the results to calculate the evaporative force. The related programs are written in the Matlab environment, and the program flow chart is shown in Figure 1.

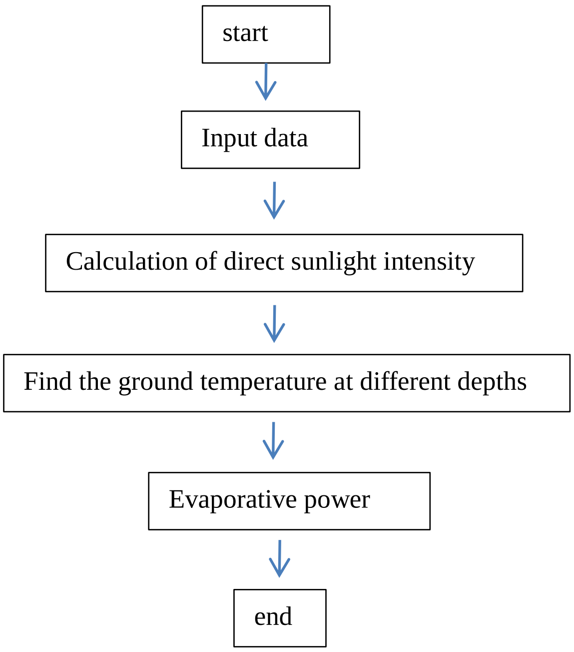

Figure 1. Flowchart of the calculation program for the influence of solar power plants on soil moisture evaporation

3.2. Introduction to Calculation Examples

Province M is one of the most important areas in the country to develop photovoltaic projects in a centralized manner. Here, we take the M area with a large number of completed and under construction photovoltaic projects as an example for calculation and analysis. Province M is vast and sparsely populated with few rainfall. The average annual rainfall is 40mm, but the average annual evaporation is more than 2000mm. The sunshine duration is long, the annual average is as high as 3600 hours, which has typical desert characteristics and has sufficient light resources, which is suitable for large-scale development of solar energy resources. China is building a solar photovoltaic power station group, which is a typical large-scale concentrated solar power station project in desert. The data used in the calculation of the example in this paper is the measured data of NASA, and the RETScreen software is used to obtain the meteorological data in 2020 from the database officially provided by NASA, and the simulation is carried out in combination with the above model.

4. Analysis and Research of Regional Energy Strategy Based on Engineering Thermodynamics

4.1. Primitive Ground Temperature

The RETScreen software data acquisition platform is shown in Table 1:

Table 1. Statistics

Month	Air temperature(℃)	Land temperature(℃)	Relative humidity	Wind speed (m/sec)
1	-5.6	-6.5	35%	1.5
2	-3.8	-4.6	28%	2.1
3	1.5	-1.1	33%	2.2
4	5.7	3.2	26%	3.5
5	9.6	7.6	28%	3.4
6	16.4	15.3	30%	2.8
7	17.8	15.8	31%	2.5
8	20.4	17.4	25%	2.4
9	11.5	10.6	30%	1.7
10	8.2	3.8	36%	1.6
11	4.4	2.7	33%	1.4
12	-1.8	1.9	27%	1.8

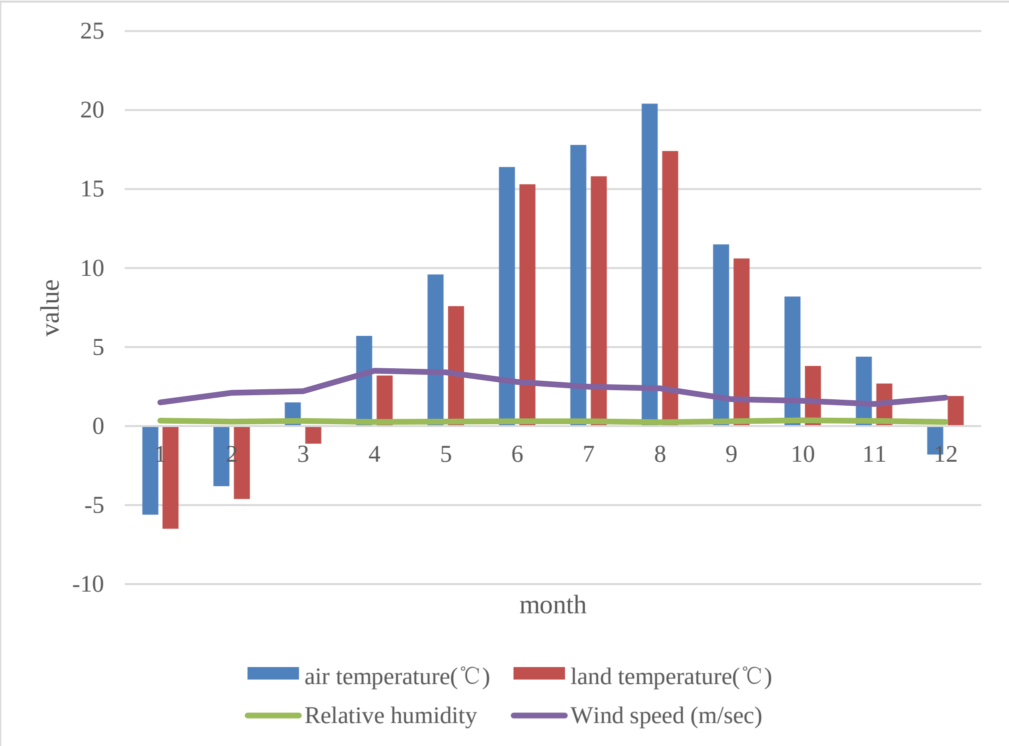

Figure 2. Meteorological data of M in 2020

In the four seasons, one day is taken as a typical day for analysis and simulation in the order of winter, spring, summer and autumn. At the same depth level, the fluctuation range of ground temperature in summer is significantly higher than that in winter, as shown in Figure 2, taking 1cm ground temperature as an example, the highest ground temperature Usually around two in the afternoon.

In the same season, as the depth increases, the temperature fluctuation range decreases, and the temperature change lags. Taking summer as an example, for every 10cm depth increase, the temperature change lags about 2 to 3 hours. As the depth increases, the ground temperature decreases degrade. The ground temperature at a depth of 50 cm remained basically stable over time.

4.2. Ground Temperature after Lying

A large number of simulation calculations have been carried out for laying photovoltaic panels in different proportions on the ground. Here, the effects of laying 0%, 10%, 20%, 30%, 40%, and 50% photovoltaic panels on the ground surface on soil temperature are given.

After laying photovoltaic panels, the maximum value of surface temperature decreased significantly with the increase of laying density, and the decrease was approximately proportional to the change of laying ratio. For every 10% increase in the laying ratio, the maximum surface humidity decreases by about 4.2 degrees Celsius. When the laying ratio is 40%, the daily maximum temperature drops by about 6.4 degrees Celsius. The ground temperature at a depth of 50 cm remained basically unchanged with time, and the ground temperature at a depth of 40 cm decreased by about 1.2 degrees Celsius for every 10% increase in the proportion of photovoltaic panels.

According to the annual meteorological data of M ground given by NASA, the annual average surface temperature changes before and after the laying of 50% PV panels were obtained. As shown in Figure 3, the construction of solar power plants makes the surface temperature decline throughout the year, and the decline in summer is greater than that in winter.

Table 2. Comparison of ground temperature before and after laying

Month	Unlaid panels	Lay 50% panels
1	-6.5	-9.2
2	-4.6	-6.6
3	-1.1	-4.5
4	3.2	-1.1
5	7.6	-4.2
6	15.3	10.4
7	15.8	9.2
8	17.4	11.4
9	10.6	6.5
10	3.8	1.2
11	2.7	-1.2
12	1.9	-2.8

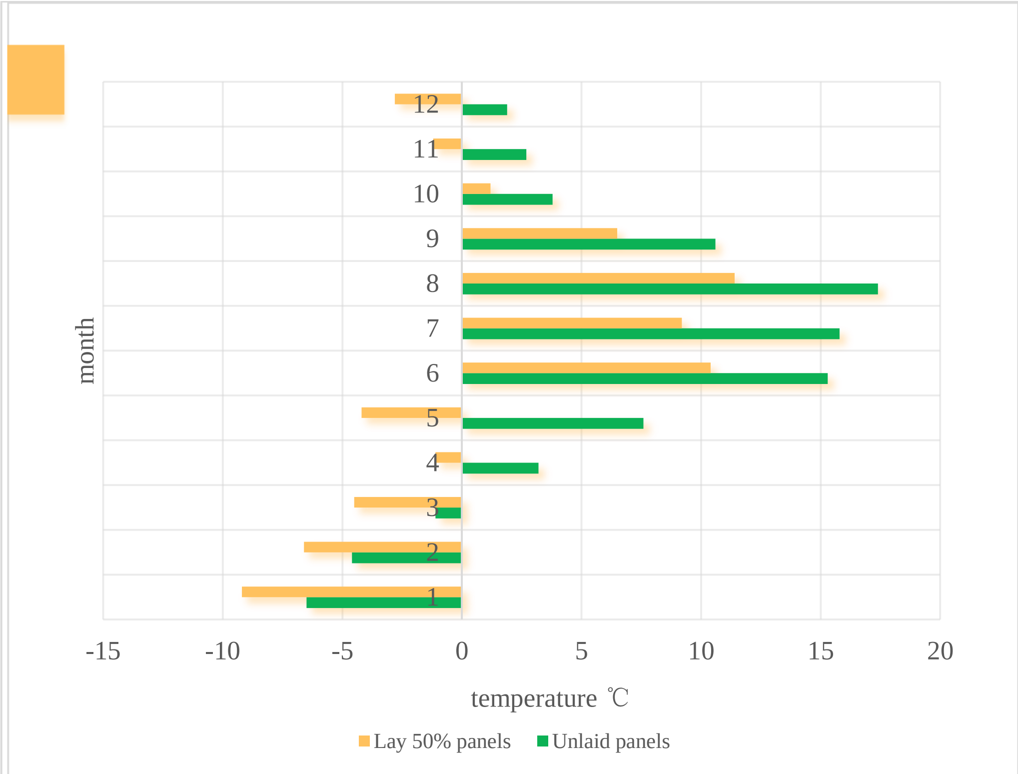

Figure 3. Annual ground temperature before and after laying solar panels

The research results show that the large-scale construction of solar power plants makes the surface temperature of the Gobi Desert in the M region change in a direction conducive to the growth of vegetation during the vegetation growth period, and the soil evaporation decreases.

5.Conclusion

Energy and environmental issues are two of the most challenging major issues in this century. Improving energy efficiency and developing a low-carbon economy are the inevitable choices to achieve sustainable development in today's world. The coordinated development of economy, energy and environment is also an important prerequisite for realizing my country's modernization and sustainable development goals. In this paper, the land temperature, air temperature and relative humidity in the M area are studied by using the engineering thermodynamic model. The coordinated development of ecological and energy system in M area is studied by using the coordinated development of solar power plant project. Through empirical research, this paper summarizes the annual ground temperature before and after the installation of solar panels in M area, and puts forward the path of coordinated development of energy and ecology in M area.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Davatgaran V , Saniei M , Mortazavi S S . Optimal bidding strategy for an energy hub in energy market. Energy, 2018, 148(APR.1):482-493.
[2] Das N K , Chakrabartty J , Dey M , et al. Energy Strategy Reviews xxx (xxxx) xxx Present energy scenario and future energy mix of Bangladesh. Energy Strategy Reviews, 2020, 32(100576):1-11.
[3] Hong J H , Kim J , Son W , et al. Long-term energy strategy scenarios for South Korea: Transition to a sustainable energy system. Energy Policy, 2019, 127(APR.):425-437.
[4] Schmid R , Buerger J , Bajcinca N . Energy Management Strategy for Plug-in-Hybrid Electric Vehicles Based on Predictive PMP. IEEE Transactions on Control Systems Technology, 2020, PP(99):1-13.
[5] Saluja D , Singh R , Saluja N , et al. Energy-Efficient Strategy for Improving Coverage and Rate Using Hybrid Vehicular Networks. IEEE Transactions on Intelligent Transportation Systems, 2020, PP(99):1-14.
[6] Afrakhte H , Bayat P . A contingency based energy management strategy for multi-microgrids considering battery energy storage systems and electric vehicles. Journal of Energy Storage, 2020, 27(Feb.):101087.1-101087.22.
[7] Azizivahed A , Arefi A , Ghavidel S , et al. Energy management strategy in dynamic distribution network reconfiguration considering renewable energy resources and storage. IEEE Transactions on Sustainable Energy, 2020, 11(2):662-673.

https://doi.org/10.1109/TSTE.2019.2901429

[8] Krishan O , Suhag S . Power management control strategy for hybrid energy storage system in a grid-independent hybrid renewable energy system: a hardware-in-loop real-time verification. IET Renewable Power Generation, 2020, 14(3):454-465. https://doi.org/10.1049/iet-rpg.2019.0578

[9] Buccoliero G , Anselma P G , Bonab S A , et al. A New Energy Management Strategy for Multimode Power-Split Hybrid Electric Vehicles. IEEE Transactions on Vehicular Technology, 2020, 69(1):172-181. https://doi.org/10.1109/TVT.2019.2950033

[10] Djerioui A , Houari A , Zeghlache S , et al. Energy management strategy of Supercapacitor/ Fuel Cell energy storage devices for vehicle applications. International journal of hydrogen energy, 2019, 44(41):23416-23428. https://doi.org/10.1016/j.ijhydene.2019.07.060

[11] Tavakoli A , Negnevitsky M , Saha S , et al. Self-Scheduling of a Generating Company With an EV Load Aggregator Under an Energy Exchange Strategy. Smart Grid, IEEE Transactions on, 2019, 10(4):4253-4264. https://doi.org/10.1109/TSG.2018.2854763

[12] Jabir M , Mokhlis H , Muhammad M A , et al. Optimal Battery and Fuel cell Operation for Energy Management Strategy in Microgrid. IET Generation Transmission & Distribution, 2019, 13(7):997-1004. https://doi.org/10.1049/iet-gtd.2018.6755

[13] Marzougui H , Kadri A , Martin J P , et al. Implementation of energy management strategy of hybrid power source for electrical vehicle. Energy Conversion & Management, 2019, 195(SEP.):830-843.

[14] Finnerty N , Sterling R , Contreras S , et al. Defining corporate energy policy and strategy to achieve carbon Emissions reduction Targets via energy MANAGEMENT in non-energy intensive multi-site manufacturing organisations. Energy, 2018, 151(MAY15):913-929.

[15] Rajaeifar M A , Hemayati S S , Tabatabaei M , et al. A review on beet sugar industry with a focus on implementation of waste-to-energy strategy for power supply. Renewable and Sustainable Energy Reviews, 2019, 103(APR.):423-442.

[16] Neves D , Baptista P , Simoes M , et al. Designing a municipal sustainable energy strategy using multi-criteria decision analysis. Journal of Cleaner Production, 2018, 176(MAR.1):251-260.

[17] Katinas V , Gaigalis V , Savickas J , et al. Analysis of sustainable liquid fuel production and usage in Lithuania in compliance with the National Energy Strategy and EU policy. Renewable & Sustainable Energy Reviews, 2018, 82(pt.1):271-280.

[18] Smith M M , Aber J D . Energy recovery from commercial-scale composting as a novel waste management strategy. Applied Energy, 2018, 211(FEB.1):194-199.

[19] Haar L , aa. A financial option perspective on energy security and strategic storage. Energy Strategy Reviews, 2019, 25(August):65-74.