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Landscape Design and Dual-Carbon Technology: Integration and Symbiosis, Creating a Green Future

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Abstract: Under the background of global climate change and low-carbon development, landscape design, as an important part of urban construction, has an increasingly significant trend of low-carbon and ecological development. This paper deeply discusses the feasibility and practice path of combining landscape design and dual-carbon technology, aiming to promote the development of landscape design in the direction of low-carbon, efficient, and sustainable through technological innovation and concept renewal. Firstly, this paper reviews the basic principles and application fields of dual-carbon technology and the current market environment of landscape design and analyzes the potential value of dual-carbon technology in landscape design. Then, based on several concrete cases, the practical application of dual-carbon technology in landscape design is elaborated, including solar energy utilization, green building materials, etc. In addition, this paper also discusses the challenges and solutions in combining landscape design with dual-carbon technology, which provides a useful reference for future research and practice. The research shows that the combination of landscape design and dual-carbon technology can not only enhance the ecological benefits and aesthetic value of the landscape but also effectively reduce carbon emissions and promote the city's sustainable development.

Keywords: Low-carbon, ecological development, technological innovation, Landscape design.

1. Introduction

Focusing on the background of global climate change and the declining trend of the landscape design industry, this study explores how landscape design to gradually realize the transformation of intelligence, low carbon, and high efficiency. The integration and symbiosis of landscape design and dual carbon technology are of profound significance in promoting the modernization and transformation of landscape design. Therefore, this study mainly starts from the concept and significance of landscape design and dual carbon technology to explain the operation mechanism of carbon emission technology and its effect on improving the environment. The necessity and importance of the integration of the two disciplines are deeply analyzed through concrete practical application [1]. The risks and challenges faced by this technology and their countermeasures are discussed. Finally, the development of this technology is prospected.

In the process of research, the literature analysis method is mainly used, which requires searching and in-depth reading of relevant materials and literature. Through this method, the relevant

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knowledge of landscape design and dual carbon technology can be comprehensively understood and mastered. In addition, this paper also adopts the interdisciplinary research method, which integrates the theories, methods, and achievements of multiple disciplines to deeply study the development direction of landscape design. The advantage of this research method is that it can comprehensively analyze the integration path of landscape design and dual carbon technology, as well as their development prospects and future trends. By realizing the intersection and integration between disciplines, the progress of research can be better promoted.

The ultimate goal of this study is to explore the integration of landscape design and dual carbon technology, to realize the sustainable development of urban green space with low energy consumption. Only through in-depth research and practice, can find a path that is truly suitable for the integration of landscape design and dual carbon technology, promote the modernization and transformation of landscape design, and achieve sustainable development. It is hoped that through this study, can provide a new idea and method for the integration of landscape design and dual carbon technology and contribute to green development.

2. Background and Concept

2.1. Background

Under the background of increasingly severe global climate change, the integration and symbiosis of dual carbon technology and landscape design is particularly necessary and important. This integration is not only a positive response to environmental sustainability but also a profound exploration of future urban lifestyles. According to the International Energy Agency, global carbon emissions need to be cut by more than half by 2050 to meet the goals of the Paris Agreement. As an important part of urban space, the carbon emission reduction potential of landscape design cannot be ignored. For example, the High Line Park in New York can absorb about 2,100 tons of carbon dioxide per year through vegetation cover and a rainwater harvesting system, which fully demonstrates the great potential of landscape design in carbon reduction.

The significance of integrated symbiosis is that it can realize the harmonious coexistence of technology and nature and create an urban space that is both beautiful and environmentally friendly. On the one hand, the application of dual carbon technology provides more innovative possibilities for landscape design, such as solar landscape lighting systems and wind energy landscape sculpture, which not only adds a unique landscape line to the city but also achieves energy self-sufficiency. On the other hand, landscape design also provides a broad application scenario for dual carbon technology, which enhances the carbon sink capacity of the city and promotes the healthy development of the urban ecosystem through vegetation selection, wetland construction, and other means. As the famous architect Yang Jingwen said, "Architecture and the environment should coexist in harmony, not oppose each other." This concept also applies to the integration and symbiosis of dual carbon technology and landscape design.

In addition, integration and coexistence can also bring about dual improvement of economic and social benefits. By using low-carbon materials and intelligent technology, the cost of landscape construction and maintenance can be reduced, and the economic benefits of the project can be improved. At the same time, the integration of dual carbon technology and landscape design can also improve the image of the city, enhance the awareness of environmental protection of citizens, and promote the sustainable development of society. Therefore, the integration and symbiosis of dual carbon technology and landscape design should be actively promoted to contribute to the construction of a beautiful and livable urban environment.

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2.2. Concept

In general, the carbon amount to peak means in a particular year peak emissions of carbon dioxide, after entering decline in orbit. Carbon neutrality refers to the balance and mitigation of carbon dioxide generated by specific entities or overall social activities through natural processes (such as afforestation, and ocean sequestration) and engineering storage technologies, and ultimately achieve a state of net "zero emissions" from human activities. Carbon emissions are closely related to the type of energy used and their respective treatment and utilization methods. At present, the world is towards a low carbon energy and industrial development, countries have formulated carbon-neutral timetables. China, in particular, has made significant progress in terms of emissions, the carbon intensity in 2019 was down 48.4% from 2005.

Internationally, it is commonly agreed that excessive carbon dioxide emissions are the primary driver of climate change. Carbon dioxide and other greenhouse gases emitted by human activities are causing global warming and enhancing the instability of the climate system, resulting in more frequent and intense extreme weather events like droughts, typhoons, heat waves, cold waves, and storms in certain regions. The "dual carbon" goal is not aimed at eliminating carbon dioxide emissions, but to encourage carbon dioxide absorption while reducing emissions, and balancing emissions with absorption. This will gradually shift the energy structure from high to low, or even zero, carbon. Implementing the "dual carbon" strategy will bring about widespread and significant system changes, balancing all elements between the two crucial points of maximizing development and minimizing emissions. One must strike a balance between development and emission reduction, the overall and the partial, long-term and short-term goals, and the government and the market. Clarifying the intricate network of relationships between the climate ecosystem, energy structure, industrial structure, scientific and technological development, and the social economy is essential. One needs to optimize the strategic layout of "dual carbon", reshape the mutual relationship between the natural, social, and economic systems, and enhance the coordination and optimization capabilities between the "dual carbon" goals and economic and social development goals.

The implementation of the "dual carbon" strategy urgently needs the comprehensive support of natural science, technology, humanities, and social sciences. Among them, the current basic scientific challenges and key technological bottlenecks mainly reflect the ecological environment optimization to adapt to the transformation of energy structure and industrial structure adjustment. To achieve ecological environment optimization, it is necessary to achieve the integration of dual carbon technology and landscape design. Focusing on key scientific issues such as the "dual carbon" target and the mutual feed mechanism between the ecological environment and human health, this paper studies the scientific principles of the consolidation and improvement of ecosystem carbon sink and the ecological environment optimization measures to adapt to the changes of energy and industrial structure and evaluates the effect of ecological environment pollution control, biosecurity, biodiversity, and human health benefits under the "dual carbon" target. Among them, the direction of landscape design should focus on the "dual carbon" goal and human health: carbon neutrality and human health benefits and potential risks; The health hazards of new pollutants from carbon neutrality initiatives; Surveillance of human pathogenic organism epidemic and health risk early warning assessment; Extreme climate change and human health risks, etc. [1].

Landscape architecture is an applied discipline based on a wide range of natural sciences humanities and arts. The core is to coordinate the relationship between humans and nature, and most of the elements contained in it serve people. People-oriented has become the goal and design principle of modern landscape design. Landscape design classifies and makes scientific and rational analysis of the problems encountered in the land and all human outdoor space, to seek solutions and approaches to planning and design problems, monitor the implementation of planning and design,

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and maintain and manage the earth's landscape [2]. According to the nature, content, and scale of the above problems, landscape design is divided into two professional directions, namely landscape planning and landscape design. Landscape design in China is a modern development based on landscape design, with public and open requirements, focusing on the ecology and design of land and human outdoor activity space.

With the proposal of the national "dual carbon" strategic goal, green low-carbon environmental protection has gradually become a hot spot in the field of production and consumption. If enterprises want to obtain competitive advantages, they must comply with the concept of green consumption, take the concept of circular economy as the guidance, take the efficient use of resources as the core, empower their development with green and low-carbon technology, vigorously promote equipment upgrading, process optimization, structural adjustment, and industrial upgrading, accelerate the layout of green products, accelerate the extension of the industrial chain, and take the strategic road of green brand development. In short, the proposal of the "dual carbon" goal will give enterprises a broader development space for green transformation and provide new development opportunities for green brand building [3].

3. Theory

In 2011, Chinese scientists put forward the concept of green carbon science, aiming to optimize the process of carbon resource processing, energy utilization, carbon fixation, and carbon cycling, minimize the carbon imbalance caused by fossil resource utilization, and provide carbon peak and carbon-neutral solutions.

The goal of green carbon science is to achieve the neutral balance of carbon, which is the scientific cornerstone to achieve the neutral balance of carbon in the contradiction between carbon energy utilization and CO2 emission. The issues related to carbon should be viewed dialectically, the elements of which are first balance and second circulation. Carbon is indispensable. Without carbon and the greenhouse effect, there would be no life and modern civilization. Fossil energy is the basis of energy and economy in the world today. However, the excessive use of fossil energy leads to increasing CO2 emissions, which also brings the risk of global climate deterioration. Green carbon science is based on the unity of opposite redox chemistry. This constitutes the research frontier of energy chemistry, including the carbon energy system with oxidation and reduction complementary to each other, the material system based on carbon, hydrogen, oxygen three elements and derived organic matter, hydrogen, carbon dioxide, water, and other molecules, and the chemical bond evolution between them and the reaction to generate a large number of molecules [4].

The official announcement of the "dual carbon" target signals China's comprehensive entry into a new era of "carbon neutrality" construction. This not only serves as a crucial driving force for China's ongoing ecological civilization development but also represents a significant step in addressing global climate challenges and demonstrating its responsibility as a major power. With the increasing frequency of extreme weather events worldwide, China's traditional economic growth model is gradually losing its effectiveness. Consequently, promoting high-quality development has become a top priority. This means fostering new-quality productive forces, which in turn necessitates the development of green productive forces. Given the scientific essence and cutting-edge features of new-quality productivity, its correlation with achieving the "dual carbon" target in the context of high-quality development can be summarized as follows: Firstly, the disruptive technological advancements highlighted by new-quality productivity provide the innovative impetus for attaining the "dual carbon" goal. Secondly, the innovation and optimization of production factor allocation demanded by new-quality productivity inject fresh momentum into achieving the "dual carbon" target. Lastly, the profound industrial transformation and upgrading necessitated by new-quality productivity offers robust industrial backing for realizing the "dual carbon" goal [3].

According to authoritative research, under the condition of the same building volume and heating and cooling demand, the energy consumption per unit building area of public buildings is more than 20 times that of civil residential buildings. This data intuitively reflects the current problem of excessive energy consumption in the field of urban public buildings, which is contrary to the advocated concept of green, energy conservation and emission reduction. Therefore, the deep integration of landscape design and the dual carbon goal has become the only way to achieve the dual carbon goal, but also the inevitable choice for the development of the landscape design field. This is not only a practice of the concept of green and low-carbon development, but also a positive contribution to the sustainable development goals of human society [5].

The theory of sustainable development advocates balanced development among the three fields of economy, society, and environment. Its basic feature is the 'three pillars', that is, considering the ecological environment, economic development, and social development at the same time. Sustainable development of the ecological environment refers to economic and social development, protection of the environment, and sustainable use of resources within the carrying capacity of resources and the environment. Economic growth is the standard to test development. The economic level and people's living standards have improved, and the hard power of the country has increased. To achieve sustainable economic development, need to shift from "weight change" to "quality change". Sustainable social life includes improving the living environment, increasing living comfort, and meeting material spiritual, and cultural needs.

To promote the development of new-quality productive forces is to practice the concept of sustainable development, integrate public buildings with social and cultural conditions and new energy technologies, make the ecology in cities and villages operate at a high speed and effectively, stimulate the internal power, and achieve the sustainable development goals of steady improvement of economic level, happy living and working of residents, and energy-saving and efficient application of resources.

4. Apply Practice

The actual green building operation projects in China are selected for investigation, and the green and energy-saving technologies and products applied in the projects are statistically analyzed to clarify the actual operation of the existing green and low-energy public buildings. China is divided into five climate zones according to climate type, namely: severe cold region, cold region, hot summer and cold winter region, hot summer and warm winter region, and mild region. Among them, the ecological energy-saving experimental building of Liaoning Vocational and Technical College of Urban Construction was selected for analysis in the cold area. The construction area of the ecological experimental building was 5100 square meters, and cutting-edge technology and new energy-saving materials were adopted in energy, building materials, and technology. It includes solar lighting, solar heating, ground source heat pump, energy-saving enclosure process, building landscape design, waste treatment, wastewater utilization, and other processes, and the application of energy-saving materials, solar power generation, intelligent control, natural ventilation, natural lighting, and other new technologies and products in the construction field. Among them, the technologies with regional characteristics are ground source heat pump technology, breathing curtain wall technology, and wind power generation technology, which solve the energy consumption problem and ventilation problem of cold area heating [6].

Beijing Daxing International Airport has been chosen for an analysis of buildings in cold climates. From the outset, it embraced a fresh development philosophy, with green construction as a cornerstone to achieve its ambition of pioneering global airport construction and setting a worldwide benchmark. By integrating 'green planning, green design, and green construction' with 'conceptual, technological, and management innovation', it ensures the green approach permeates every phase of the airport's lifecycle, from site selection to planning, design, bidding, procurement, construction management, and operations [2]. Prioritizing functionality, the terminal's green implementation path follows a three-pronged strategy of 'reduction, replacement, and improvement'. This focuses on comprehensively optimizing and enhancing aspects such as the building envelope, HVAC system, equipment, lighting, renewable energy utilization, natural lighting, ventilation, non-traditional water sources, and indoor environments. Sixty percent of the terminal boasts natural lighting, achieved through eight colossal C-shaped columns that double as structural supports and windows for interior illumination. Additionally, a ribbon skylight runs along the top of each finger corridor, spanning 600 meters across the five-finger design, not only flooding the interior with ample light but also guiding passengers. Moreover, the roof, exterior walls, curtain walls, windows, and other exterior envelope structures have undergone integrated optimization, resulting in a 20% increase in the heat transfer coefficient compared to the Public Building Energy Efficiency Design Standards, and a 12.5% improvement in the curtain wall's shading coefficient [7].

According to estimations, the Beijing Daxing International Airport terminal boasts a 20% reduction in energy consumption compared to similarly sized airport terminals, achieving an annual reduction of carbon dioxide emissions by 22,000 tons. This reduction is equivalent to planting approximately 1.19 million trees [8]. Furthermore, the entire airport venue has implemented a comprehensive planning strategy for water resource collection, treatment, and reuse, resulting in an efficient and well-designed composite ecological water system. By employing techniques such as "infiltration, retention, storage, net use, and discharge," the airport aims to achieve the Sponge Airport concept, with an annual runoff control rate of 85% and a discharge flow not exceeding 30 cubic meters per second. Moreover, the airport boasts a 100% rainwater collection rate, establishing a reservoir with a total capacity of 2.8 million cubic meters. It also ensures 100% rainwater and sewage diversion, a 100% sewage treatment rate, and full reuse of reclaimed water as a substitute for municipal water. This results in a 30% utilization rate of non-traditional water sources. Notably, in November 2017, the Beijing Daxing International Airport terminal achieved the dual certification of three-star green building and energy-saving 3A, marking it as the first energy-saving building 3A project in China, thus holding significant benchmarking value [6].

5. Discussion and Suggestions

With the continuous growth of global energy demand, the development and utilization of new energy have gradually become an indispensable part of building energy conservation and design. New energy technology covers all aspects of life. While it is convenient, there are still some areas to be improved. This paper will give examples to illustrate the stability and efficiency of new energy.

Solar energy refers to the radiant energy from sunlight. Its main utilization forms are photothermal conversion, photoelectric conversion, and photochemical conversion. Solar cells are one of the key utilization methods, converting sunlight energy into electricity through photoelectric conversion. Solar water heaters utilize solar heat to heat water and generate electricity. However, solar energy has some disadvantages. It is intermittent and weather-dependent, affecting its reliability as a stable energy source. Cloudy days and nights can reduce its reliability, requiring energy storage devices or alternative energy sources as a backup. Large-scale solar projects also require significant land use, potentially encroaching on natural and agricultural areas. While solar technology has become more affordable, the initial investment cost may still be high for some individuals or businesses. Technical constraints, such as energy storage capacity and efficiency, also hinder the wider deployment of solar energy.

As a new energy source, nuclear energy has both significant advantages and some disadvantages that cannot be ignored. Nuclear power generation has the characteristics of high efficiency, and its energy density is very high, and does not produce greenhouse gases and other pollutants in the process

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of power generation, is a kind of clean energy; Nuclear power is a perfect complement to renewable energy sources such as solar and wind power because it is not affected by weather or season and can provide stable power supply around the clock. But at the same time, radioactive waste will be generated in the process of nuclear power generation, and the treatment and storage of these wastes have security risks, requiring high cost and high technology input. The construction period of nuclear power stations is long, the initial investment is large, and a lot of capital and technical support are needed. Although the safety record of nuclear power plants is good, once an accident occurs, the consequences will be very serious, posing a great threat to humans and the environment.

The research and development and application of low-carbon materials are the key links in the current sustainable development strategy. Low-carbon materials refer to new materials that reduce the amount of non-renewable natural raw materials under the premise of ensuring the performance of use, have low energy consumption, low pollution and low emissions in the manufacturing process, have a long service life, do not produce harmful substances in the use process, and can be recycled and reproduced. Bio-based materials: Algenesis has successfully developed bio-based and degradable TPU materials, which are derived from algae and non-edible plants and are biodegradable, effectively solving the microplastics crisis. Plant-based Foam Technology: FATES plant-based foam technology, developed by Evoco, is a plant-based innovation platform that replaces oil with plants to develop high-performance materials with up to 85% bio-based content and 70% less greenhouse gas emissions compared to traditional oil-based polyurethane foam. With the increasing global emphasis on sustainable development and environmental protection, the R&D and application of low-carbon materials will be further promoted. It is expected that low-carbon materials will be widely used in the field of landscape design in the future, fully integrating the two disciplines for collaborative innovation, making greater contributions to the realization of carbon emission reduction and environmental protection goals, and providing superior conditions for the innovative transformation and creative development of urban green space and humanistic construction [9].

6. Conclusion

The research result of this study is that in landscape design, the application of low-carbon technology has a significant effect. The further research conclusion is that the energy consumption and carbon emissions of landscape engineering can be greatly reduced by selecting green building materials, optimizing plant configuration, and adopting water-saving irrigation technology. At the same time, these technologies can also improve the ecological benefits of the landscape and provide a more comfortable and healthier living environment for citizens. This study provides a lot of valuable reference significance for future research in this direction, which mainly affects the comprehensive development direction of landscape design and the specific and efficient application of carbon emissions and carbon synthesis. Future research should focus more on the direction of green building materials and resource reuse for in-depth exploration.

With the increasingly severe problem of global climate change, the comprehensive application of landscape design and dual carbon technology will be paid more and more attention. In the future, one should further explore the integration path of landscape design and dual carbon technology, promote technological innovation and concept renewal, and provide more scientific and effective solutions for urban sustainable development. At the same time, one also needs to strengthen public education and awareness raising, so that more people can understand and support the comprehensive application of landscape design and dual carbon technology, and jointly promote the green and low-carbon development of the city.

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