

Path to Green High-Quality Development of Industrial Parks towards the "Dual Carbon" Goals

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Abstract: Industrial parks are critical pillars of China's industrialization and urbanization. Nevertheless, they frequently exhibit inefficient production processes and a pronounced dependence on coal, which make them substantial contributors to national carbon emissions. Exploring their green high-quality development path is of great significance for achieving the "dual carbon" goals. Based on the "1+N" policy system framework for carbon peaking and carbon neutrality, this paper systematically analyzes the internal logic and practical pathways for implementing the "dual carbon" goals in industrial parks from three dimensions: policy guidance, industrial upgrading, and enterprise support. The findings indicate that industrial parks should take "increasing carbon sinks and reducing carbon sources" as the core guideline, clarify the relationships among policy priorities and grasp the patterns of policy effectiveness. At the industrial level, they should balance carbon reduction with economic development and strictly control the blind expansion of "two-high" projects. At the enterprise level, they need to provide service guarantees and set up exemplary models. To achieve the "dual carbon" goals, industrial parks should follow a "policy-industry-enterprise" linked logic, integrate green and low-carbon concepts into all aspects of park operations, and thus truly forge a path of green high-quality development.

Keywords: Dual Carbon Goals; Industrial Parks; Green Development; High-Quality Development

1. Introduction

Industrial parks are critical pillars of China's industrialization and urbanization. Nevertheless, they frequently exhibit inefficient production processes and a pronounced dependence on coal, which make them substantial contributors to

national carbon emissions. A study from Tsinghua University shows that carbon dioxide emissions from China's industrial parks account for more than 30% of the national total, positioning them as a primary front for the current "dual carbon" efforts [1]. Industrial parks are not only gathering places for various pioneering policies but also testing grounds for corporate innovation and practice. Therefore, achieving the "dual carbon" goals in industrial parks requires the development of a systematic pathway that connects policy requirements with grassroots implementation.

2. Policy Guidance: Key Relationships and Mechanisms of Policy Effectiveness

To implement the "dual carbon" goals, the Chinese central government has proposed the top-level design of a "1+N" policy system for carbon peaking and carbon neutrality [1,2]. Industrial parks need to clarify the internal relationships among key policy points and grasp the mechanisms of policy effectiveness in order to fully leverage the guiding role of policies.

2.1 Clarifying the Internal Relationships among Key Policy Points

The core "1" of the "1+N" system – the Opinions on Fully, Accurately, and Comprehensively Implementing the New Development Philosophy and Doing a Good Job in Carbon Peaking and Carbon Neutrality (hereinafter referred to as the Opinions), along with the primary "N" document – the Action Plan for Carbon Peaking before 2030 (hereinafter referred to as the Action Plan), are the guiding documents for implementing the "dual carbon" agenda. These documents not only define the phased objectives but also systematically propose ten action plans for achieving the "dual carbon" goals, covering aspects such as industrial optimization, transportation, and scientific and technological innovation [2]. Industrial parks need to assign different positioning to these action plans based on their actual circumstances: industrial

optimization and energy substitution are the core action plans and should be regarded as the primary means of achieving the "dual carbon" goals in industrial parks; action plans related to transportation and urban-rural development, while not centered on industrial parks, still call for parks to strive to become exemplars; action plans involving scientific and technological innovation, circular economy development, and carbon sink enhancement fall within the supporting system, and industrial parks should actively provide testing grounds for these initiatives.

To facilitate the implementation of the Opinions and the Action Plan, various national ministries and commissions have also issued a series of supporting policies. The most relevant policies for industrial parks mainly involve three modules: industrial structure adjustment, energy structure adjustment, and eco-park development. Policies on industrial structure adjustment primarily originate from the ministries of industry and information technology and development and reform, detailing energy conservation and carbon reduction action plans for key industries such as metallurgy, building materials, and petrochemicals. Policies on energy structure adjustment mainly focus on promoting the development and utilization of clean energy and the construction of new-generation power grid systems. Policies on eco-park development are primarily led by environmental authorities, which have formed a relatively systematic institutional framework regarding park development, management, and standards; additionally, industry authorities have issued a pilot work plan for low-carbon industrial parks [2].

Overall, although each module of policies has its primary issuing authority, there is also a phenomenon of multiple authorities issuing overlapping regulations. Therefore, industrial parks need to conduct policy comparison and analysis of the provisions across modules, guided by the core logic of "increasing carbon sinks and reducing carbon sources" as outlined in the guiding documents, and implement them accordingly.

2.2 Grasping the Mechanisms of Policy Effectiveness

The effectiveness of public policies typically follows the dual pattern of "positive effects gradually emerging" and "negative effects

gradually diminishing." [3] The former depends on the introduction of supporting policies, while the latter relies on the efficient implementation of policies.

In terms of introducing supporting policies, the Action Plan has proposed key supporting tasks from both international cooperation and policy guarantee perspectives. Four of these points – green trade and economy, statistical accounting, green finance, and carbon emissions trading – are most closely related to the actual "dual carbon" work in industrial parks. Therefore, industrial parks should proactively explore and make arrangements in these areas in accordance with the Action Plan and other policy guidelines, in order to seize policy opportunities and take the initiative in development. For example, industrial parks may formulate incentive policies encouraging enterprises to independently entrust qualified third-party institutions to conduct carbon emission audits, identify their baseline emissions, and prepare for participation in the national carbon market.

In terms of policy implementation, the focus of industrial parks should be on changing the mindsets and resistance among enterprises within the park, so as to mitigate the negative effects of the "dual carbon" policies. To this end, industrial parks can pave the way for policy implementation from two dimensions: infrastructure and services. For example, in infrastructure, industrial parks may actively explore integrated new energy utilization models, promoting the construction of distributed energy stations, hydrogen facilities, and multi-energy complementary integrated energy supply systems, ensuring that enterprises in the park have access to efficient and affordable clean energy. In services, industrial parks may assist enterprises in accessing carbon emissions rights financial products from financial institutions, using surplus carbon emission allowances as collateral for low-interest financing.

Furthermore, the effectiveness of public policies also requires consideration of the laws of interest regulation, with emphasis on prioritizing the interests of dominant groups through measures such as compensation for losses, and ensuring the satisfaction of the majority. For park enterprises, carbon can be either a cost or a source of revenue. To this end, industrial parks may explore establishing an integrated "energy conservation and carbon reduction – carbon

offsetting and compensation" model for "dual carbon" work. This model would both support "two-high" enterprises in improving their conventional energy utilization efficiency and encourage factories, individual buildings, and public facilities to install distributed energy systems for self-generation and self-consumption, thereby obtaining carbon credits or even trading them externally, thus meeting the differentiated core demands of various stakeholders.

3. Industrial Upgrading: Balancing Multiple Objectives and Strictly Controlling "Two-High" Projects

Manufacturing is a major carbon emitter, with steel, coal chemical, building materials, and other "two-high" industries being the most prominent. These are the "bull's nose" that industrial parks must grasp to achieve the "dual carbon" goals. At the same time, industrial parks are also primary fronts for economic development. Therefore, it is imperative to adhere to a dual-wheel drive approach of energy conservation, carbon reduction, and economic development, advancing industrial transformation and upgrading in a scientific and orderly manner.

3.1 Balancing the "Dual Carbon" and Economic Objectives

The Action Plan explicitly emphasizes that all regions should promote carbon peaking in a phased and orderly manner, taking into account their actual economic and social development conditions and resource-environment endowments. Therefore, the "dual carbon" work in industrial parks must also consider economic development objectives, avoiding a "one-size-fits-all" approach to carbon reduction that could cause long-term harm to the economy and the environment [4].

3.1.1 Promoting digital transformation of manufacturing models in park enterprises

In the context of the "dual carbon" goals, enterprises aiming for sustainable production and profitability must explore new manufacturing models under strong carbon constraints. Leveraging digital technologies to intelligently regulate the entire manufacturing process is a highly effective approach [5]. To this end, industrial parks should introduce incentive programs with the objectives of green and low-carbon development, high value-added

and high-end orientation, and digital intelligence. These programs should focus on supporting the deep integration of manufacturing processes, resources, and energy systems of "two-high" enterprises with modern information technologies such as the Industrial Internet and artificial intelligence, improving manufacturing processes and enhancing equipment operational efficiency. This approach promotes energy conservation and emission reduction through increased productivity and work efficiency, while ensuring normal production operations.

3.1.2 Developing a digital zero-carbon smart energy system in parks

Industrial parks can drive low-carbon and efficient economic development through demonstration effects in energy supply, monitoring, management, and services, which is key to industrial transformation and upgrading under the "dual carbon" goals. To this end, industrial parks should explore the use of digital technologies to establish a zero-carbon smart energy system [6]. This involves systematically identifying and closely monitoring the key carbon emission elements within the park, and equipping the system with enhanced capabilities for carbon accounting and scenario-based carbon reduction. This system would provide methodological and data support for industrial chain optimization, corporate energy-saving and carbon-reduction technological transformation activities, distributed power source coordination, and product carbon footprint tracing, thereby promoting energy conservation and emission reduction through efficient energy management and smart decision-making while ensuring normal energy supply for production.

Jointly carrying out circular transformation of parks with enterprises.

Developing a circular economy enables the recycling of materials and products, effectively reducing carbon emissions and enhancing the carbon sequestration capacity of products [7]. Industrial parks should fully leverage the advantages of industrial agglomeration, tap into the symbiotic potential within and between parks, and recycle by-products and wastes from production processes. This approach reduces resource consumption and carbon emissions at the source while generating additional revenue for enterprises, thus achieving an organic unity of economic, social, and environmental benefits. To this end, industrial parks should, on the one hand, promote circular transformation by

optimizing spatial layout, promoting centralized heating and gas supply, and strengthening the comprehensive utilization of bulk solid waste. On the other hand, they should encourage "two-high" enterprises to explore new development paths such as carbon dioxide resource utilization and hazardous solid waste recycling, and strongly support enterprises in participating in the drafting of standards related to circular economy development.

3.2 Strictly Controlling the Blind Expansion of "Two-High" Projects

Strictly controlling "two-high" industries is a primary focus of energy conservation and carbon reduction efforts [8]. However, strict control does not mean preventing projects from being launched; rather, it aims to curb the blind expansion of such projects. In line with policy requirements at various levels, industrial parks can systematically control "two-high" projects from the perspectives of industrial planning, investment attraction, and park management.

3.2.1 Clarifying the development direction of "two-high" projects in industrial planning

Following the principle of "curbing blind new construction and allowing reasonable time for rectification of existing projects," industrial parks should, on the one hand, strictly implement the guidance from governments at all levels regarding new "two-high" projects. They should clearly identify the designed, freed-up, and additional energy consumption, coal consumption, and pollutant emissions of these projects, coordinate the park's overall energy and coal consumption indicators and environmental capacity, and ensure that the total energy and coal consumption of "two-high" projects only decreases, not increases, and that total pollutant emissions meet regulatory requirements. Projects not meeting these requirements cannot be included in industrial development plans [9]. On the other hand, they should formulate plans for the orderly phase-out of existing "two-high" projects, expedite the optimization of energy structures and improvement of production processes in "two-high" enterprises, and implement an elimination mechanism based on comprehensive evaluations of output efficiency per unit of energy consumption and per unit of land area, thereby forcing the transformation and upgrading of these enterprises.

3.2.2 Raising the entry standards for "two-high" projects in investment attraction

In accordance with national, provincial, and municipal policy requirements, industrial parks should strictly enforce the "dual-high" project access gate by focusing on "joint review of 'two-high' projects" and "strict assessment of project impacts." [10] Projects that do not comply with policy requirements, especially those involving blind development of "two-high" projects, should not be considered. Furthermore, industrial parks should strengthen energy efficiency assessments in project introduction, conducting comprehensive evaluations from multiple perspectives, including environmental access, planning and site selection, plant energy consumption, and pollution prevention, to screen out and eliminate "quasi-high-energy" projects that do not fall into traditional "two-high" categories but have high actual energy consumption [5]. This approach promotes structural carbon reduction at the industry source and accelerates industrial restructuring, transformation, and upgrading.

3.2.3 Strengthening the supervision and management of "two-high" projects in park operations

For existing "two-high" projects, industrial parks should adhere to the principle of "supervision as a means, innovation as the goal" to guide these projects towards green and low-carbon development. On the one hand, in accordance with policy guidance at all levels, they should implement full-process, round-the-clock, and all-round monitoring of existing "two-high" projects, closely tracking production capacity, output, energy consumption, coal consumption, water consumption, and highlighting key links such as logistics and transportation, measuring instruments, tax receipts, and pollutant emissions. Regular scheduling, inspections, and reporting should be conducted to ensure early detection, timely correction, and prompt resolution of problems. On the other hand, they should verify the energy and coal consumption data of existing "two-high" projects one by one. For enterprises with potential for energy conservation and emission reduction, efforts should focus on guiding them to implement energy-saving retrofits and upgrades through measures such as adopting new energy-efficient equipment and clean coal gasification technologies, as well as achieving breakthroughs in new energy applications through alternative energy measures such as distributed photovoltaic power generation, natural gas, and biomass.

4. Supporting Enterprises: Service Guarantees and Establishing Exemplary Models

Enterprises are both the executors and pioneers in achieving the "dual carbon" goals. To ensure the smooth progress of "dual carbon" work, industrial parks need not only to provide policy support but also to form collaborative relationships with enterprises to enhance their energy conservation and carbon reduction capabilities. To this end, industrial parks should both provide services and take the lead in setting exemplary models for "dual carbon" work.

4.1 Providing Service Guarantees for "Dual Carbon" Work

A key advantage of enterprises developing within parks is access to a comprehensive range of services. For "dual carbon" work, industrial parks can primarily provide service guarantees to enterprises from two aspects: "efficient approval" and "precise coordination."

4.1.1 Efficient approval to provide institutional opportunities for "dual carbon" work

Industrial parks should focus on two aspects: "filing of enterprise investment projects" and "energy conservation review." They should actively coordinate to assume approval authority, provide efficient approval services for newly signed enterprises, and establish the first line of defense for enterprise energy consumption. In the approval of enterprise investment project filings, they should actively guide and support the development of the circular economy and green industries, while encouraging enterprises to consider incorporating energy-saving equipment and designing energy-efficient facilities during planning and feasibility study preparation. In energy conservation reviews, they should strictly conduct reviews in accordance with the Measures for Energy Conservation Review of Fixed Asset Investment Projects promulgated by the national development and reform commission, regulate the energy conservation and emission reduction of new enterprises, and ensure that enterprise energy consumption indicators remain within a reasonable range from the source. Additionally, industrial parks should further seek guidance from higher authorities, explore ways to substantively implement the "regional energy assessment" policy, and effectively reduce the burden on enterprises.

4.1.2 Precise coordination to provide market opportunities for "dual carbon" work

Energy conservation and carbon reduction is a systemic project involving knowledge and skills from multiple fields, including technology, markets, and capital. Enterprises focused on production often find it difficult to independently secure resource support in all these areas. To this end, industrial parks need to leverage their comprehensive service capabilities, precisely coordinate different stakeholders, and secure resources for enterprises' "dual carbon" work [8]. In the technology field, industrial parks should increase financial support to incentivize enterprises to accelerate technological transformation, adopt more advanced, environmentally friendly, and efficient technologies or equipment, and fundamentally improve carbon reduction, carbon efficiency, and carbon recovery. In the market field, industrial parks should be based on the concept of circular economy development, identify favorable entry points in the industrial chain for enterprise waste gases and waste heat based on the characteristics of production processes in different industries, and strategically introduce new energy enterprises and intelligent green projects to explore new paths for integrated green industrial development [9]. In the capital field, they should closely monitor the launch and operation of the national unified carbon trading market, guide enterprises in the park to actively participate, and assist enterprises in obtaining financial service support from financial institutions based on their carbon emission rights.

4.2 Establishing Exemplary Models for "Dual Carbon" Work

Currently, enterprises face difficulties in their "dual carbon" work, including high investment and high uncertainty. Therefore, industrial parks need to establish exemplary models, leverage their demonstration effects, and pave the way for followers to progress in the right direction [10]. To this end, industrial parks can establish exemplary models from two aspects: "strengthening themselves" and "selecting enterprises."

4.2.1 Industrial parks themselves should play an exemplary and leading role

Industrial parks can serve as models for park enterprises through the following four tasks: First, source reduction, specifically involving the

improvement of green and low-carbon transportation systems and the strengthening of low-carbon building design. Second, carbon sink enhancement, specifically involving expanding the park's green area through green roofs and prioritizing the installation of charging infrastructure. Third, energy substitution, such as exploring rooftop distributed photovoltaic pilot projects and promoting distributed photovoltaic applications in production facilities. Fourth, concept promotion, such as strengthening green and low-carbon awareness education for employees, promoting green and low-carbon lifestyles, and disseminating energy-saving and carbon-reduction tips through new media, promotional materials, and seminars.

4.2.2 Industrial parks should select outstanding enterprises to become exemplary models

Park enterprises typically adopt diverse approaches and have different strengths in their "dual carbon" work. Therefore, industrial parks can develop evaluation criteria from multiple dimensions, including technological transformation, energy substitution, digital innovation, circular economy, carbon trading, and carbon footprint tracing, to select outstanding enterprises as exemplary models for "dual carbon" work. They should also summarize lessons learned to guide followers. For example, many enterprises are exploring product carbon footprint tracing. Industrial parks can establish evaluation criteria for this area, select enterprises with comprehensive carbon emission management systems, clear organizational structures, proven experience in carbon footprint tracing, and even international certification as models [9]. These models should be provided with financial incentives and policy support, and encouraged to take the lead in organizing relevant enterprises within and outside the park to collectively conduct research on carbon footprint tracing, thereby advancing the maturation of this "dual carbon" practice.

5. Conclusion

Overall, to achieve the "dual carbon" goals, industrial parks need to adopt a long-term perspective and a broad vision, follow a "policy-industry-enterprise" integrated logic of thinking, fully absorb knowledge from different professional fields, integrate the concept of "increasing carbon sinks and reducing carbon sources" into all aspects of park operations, and demonstrate innovation and a sense of

responsibility. Only in this way can they truly forge a green high-quality development path.

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