

# Research on Carbon Unlocking Pathway in Sichuan Province under the Background of “Dual Carbon”

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## ABSTRACT

In the progress of realizing green development and transformation, many difficulties exist in Sichuan Province, such as low level of ‘carbon unlocking’, unbalanced development of ‘carbon unlocking’ among regions, and insufficient systematic coordination and governance capacity. So, this paper from technology, system and industry and other aspects, based on the ‘double carbon’ goal of Sichuan Province, to construct the ‘carbon unlocking’ mechanism with the characteristics of Sichuan Province, to create a ‘multi-body-multi-path’ synergistic mechanism. This will help to promote green technology innovation and help to achieve the ‘dual-carbon’ goal on schedule.

## KEYWORDS

Sichuan Province; Carbon locking; Carbon unlocking; Green development.

## 1. INTRODUCTION

In facing climate change and the pressure of the international community, especially under the constraints of the ‘dual carbon’ target, China's pressure to reduce carbon emissions is increasing. How to break the path of dependence on the traditional low-carbon economic development model and balance the contradiction between economic growth and the containment of carbon sources is an important issue in achieving the ‘dual-carbon’ goal on schedule.

Report to the 20th CPC National Congress of the Party emphasized that ‘based on China's energy resource endowment, adhere to the first to establish and then to break, and implement the carbon peak action in a planned and step-by-step manner’[1]. Sichuan is an important economic hinterland and ecological barrier in the western part of China, whose dual-wheel drive model of economic development and ecological protection has laid a solid foundation for the road to carbon unlocking. However, entering a new stage of development in which the dual challenges of ‘a major shift in the mode of economic and environmental protection’ and ‘pressing ahead with the task of achieving carbon peaks’ are intertwined, it is urgent for Sichuan to continue to explore the innovative path of green development, and to be brave enough to break out of the established framework, unlock the carbon shackles, and break through carbon locks, to meet the new challenges posed by climate change. Coping with the new challenges brought by climate change.

## 2. CURRENT SITUATION OF GREEN DEVELOPMENT LEVEL IN SICHUAN PROVINCE

Recently, Sichuan has adapted to the new situation and requirements of ecological civilization construction, led by the construction of beautiful Sichuan and the creation of ecological civilization

demonstration, actively explored effective and diversified ways to transform green mountains into golden mountains, and solidly promoted the reform of ecological civilization system and mechanism to stimulate the vitality of the construction of beautiful Sichuan[2-3]. By optimizing the treatment process and exploring new ways to reduce the “carbon footprint”, remarkable results have been achieved in green development. Its abundant clean energy resources, strong technological innovation capability and solid industrial foundation provide solid support for its green development path.

## **2.1. Economic resource base**

### **2.1.1. Strong province of clean energy, leading the new future of green industry**

As an important hinterland of China's western region that is firmly committed to sustainable development strategies, Sichuan Province is rich in clean energy resources. Meanwhile, as the core ecological barrier and water conservation center of the upper reaches of the Yangtze River, Sichuan Province contributes one-third of the total runoff of the Yangtze River system, and is extremely rich in hydropower resources. Sichuan Province makes full use of the abundant hydro energy resources and actively develops the hydropower industry, with the installed hydropower capacity ranking the first in China, which is not only the leader of China's hydropower development, but also a strategic base for the implementation of the ‘West-to-East Electricity Transmission’.

Sichuan has also vigorously developed photovoltaic and wind power and other clean energy, deepen the construction work as a national clean energy demonstration province, and continue to optimize and adjust the energy structure, and achieved remarkable results: the energy efficiency of key industries has been significantly improved, coal consumption continues to decline[4][3], the electric photovoltaic planning more than 200 million kilowatts, the hydropower installed capacity of more than 100 million kilowatts. Not only effectively reduce the dependence on traditional fossil energy, significantly reduce carbon emissions, but also for the development of the province's green industry provides a huge potential for economic and social green development has laid a solid foundation.

### **2.1.2. Relying on rich mineral resources, accelerate the construction of a new highland of green new energy industry new heights**

During the ‘14th Five-Year Plan’ period, significant progress has been made in Sichuan's industrial restructuring: a clean, low-carbon, safe and efficient energy system has been initially established, a low-carbon development model in key areas has basically taken shape, and the energy utilization efficiency of key energy-consuming industries has reached the advanced level in China[4]. Due to its rich mineral resources and deep reserves, Sichuan is also a key province for mineral raw material manufacturing in the western region and even in the whole country. Even the country's key province of mineral raw materials manufacturing, sitting on the world's top vanadium and titanium, lithium, rare earths and other mineral resources, for the development of related industries to provide a unique resource advantage, and at the same time, according to local conditions and actively open up photovoltaic, lithium, new energy vehicles and other new areas of the new track, monocrystalline silicon and polycrystalline silicon production has increased significantly in the field of power batteries, crystalline silicon photovoltaic industry has formed a certain advantage of the industrial clusters. This has played a key role in optimizing the province's energy structure and developing energy efficiency. A green new energy industry belt with multi-point layout, diversified complementarity, multi-chain integration and multi-city progress is accelerating.

## **2.2. Technological innovation and industrial base**

### **2.2.1. Clean energy technology innovation leads**

With technological innovation in the fields of clean energy such as hydropower, wind power and photovoltaics, Sichuan Province has promoted the research, development and application of clean

energy technologies by introducing and nurturing a group of clean energy enterprises with core competitiveness. In its early layout in the hydrogen industry, the formation of a number of green hydrogen preparation technology results, such as: to reach the international leading level of offshore wind power without desalination of seawater in situ direct electrolysis hydrogen technology sea pilot successfully achieved; as a national key research and development plan 'hydrogen technology' special project to promote China's first 10,000-tonne scale new energy hydrogen production project successfully put into use, for China's first hydrogen production project. As a key project of the National Key Research and Development Program 'Hydrogen Energy Technology', the first 10,000-tonne scale new energy hydrogen production project in China has been successfully put into operation, which has injected a strong impetus for the rapid development of China's hydrogen industry.

### **2.2.2. Green & Low Carbon Technology Leads and Empowers Green Development**

Sichuan Province supports enterprises to carry out technological innovation and transformation of achievements and promotes the industrial application of a number of green and low-carbon technologies, covering a wide range of fields such as energy conservation and environmental protection and resource recycling. For example, building green data centers, promoting green and efficient cooling and heating technologies, grid-connecting the world's largest water-optical complementary project, the Kola PV power station, and speeding up the implementation of multi-energy complementary power supply projects and interconnected and mutually beneficial power grid projects, which have significantly enhanced the ability to supply clean energy. At the same time, it actively adopts intelligent and information technology to drive the in-depth implementation of green development, builds an intelligent environmental protection platform, promotes intelligent monitoring equipment, and leads environmental protection and sustainable development to new heights.

## **2.3. Existing problems and challenges**

### **2.3.1. Regional disparities in green development highlighted, balanced development becomes a new issue**

Owing to the uneven economic foundation, development level, industrial structure, ecological and environmental conditions and policy implementation, there is a large gap in the green development index among the regions in Sichuan province. For example, Panzhihua, Mianyang and Guangyuan have high green development index, while Zigong, Neijiang and Ziyang are relatively low ones. In terms of categorical indices such as environmental quality and ecological protection, different regions also show obvious differences, which are not only reflected in numerical values, but also in the actual environmental protection and carbon governance effects. The unbalanced development state affects the overall promotion of green development in the province.

### **2.3.2. Continued progress in environmental governance and a new chapter in the construction of a dual-carbon ambition**

The realization of the goal of double carbon is a comprehensive and far-reaching social transformation and innovation[5], which is distinctly systematic and requires the integrated promotion of all fields and the synergy of all forces. In recent years, the ranking of Sichuan's comprehensive air quality index has improved, but the prevention and control of air pollution still faces many challenges; although the water environment quality has achieved a historic breakthrough, the water quality of small watersheds has not yet reached stable compliance; while soil pollution prevention and control is highlighted, it is still necessary to further strengthen the prevention and control of the source[6]. The province's energy consumption structure favors fossil energy, and the clean energy substitution process needs to be accelerated; the energy efficiency level of some industries is relatively low, with huge potential for energy saving and emission reduction; the

supporting role of scientific and technological innovation for green development needs to be strengthened; and the policy mechanism needs to be further improved. The green development of Sichuan Province has entered a period of multiple challenges, such as the uneven level of carbon emission management, the challenges of carbon data management, the increasing pressure of clearing compliance costs, the weak regulatory capacity at the grassroots level, and the prying effect of carbon pricing to be played.

Carrying out research on carbon unlocking paths, tapping into and exploring carbon emission reduction paths and strategies in line with Sichuan's characteristics is important and significantly beneficial in terms of responding to global climate change, promoting green and low-carbon development, fostering technological innovation and industrial upgrading as well as exerting a demonstration effect.

### **3. RESEARCH ON CARBON UNLOCKING PATHWAY IN SICHUAN PROVINCE**

#### **3.1. Intensify green and low-carbon scientific and technological research, and accelerate the promotion and application of results**

##### **3.1.1. Consolidate basic research, forward-looking layout of carbon technology**

Technological innovation is the key to unlock the carbon shackles. Our province's industrial economy has long relied on carbon-based technologies, forming a technology lock-in effect that hinders the development of alternative technologies (such as zero-carbon or low-carbon technologies). It is necessary to strengthen the cornerstone of basic research, forward-looking layout of cutting-edge technology fields, and lead the technological revolution and industrial upgrading with innovation drive; carry out carbon unlocking innovation research in an orderly layout, promote the in-depth integration of industry, academia, research and use, and accelerate the transformation and application of scientific and technological achievements; integrate and optimize innovation inputs, and support the conduct of research on basic theories, major issues, key technologies, etc.; and build the Sichuan characteristics of the carbon peak, carbon-neutral human resources system[7]. Encourage colleges and universities to set up more energy saving, energy storage, carbon neutral and other fields of related disciplines.

##### **3.1.2. Research and develop carbon unlocking assessment methodology and build a synergistic emission reduction roadmap**

Utilize clean energy in western provinces and regions to shift energy consumption from single to multiple sources and reduce the proportion of fossil energy consumption; research and develop a synergistic assessment method for carbon unlocking and establish a synergistic indicator system and indexes to dynamically and quantitatively characterize the effectiveness of carbon unlocking; and at the same time establish a fusion list of atmospheric pollutants and carbon emissions and build a deeply integrated analysis system to accurately identify the sources of such pollutants and explore emission reduction paths and technological solutions to synergize the control of the two. At the same time, we will establish a fusion inventory of air pollutants and carbon emissions, build a deeply integrated analysis system, accurately identify their sources and explore the emission reduction paths and technical solutions for synergistic control of the two, so as to construct a synergistic roadmap for pollution reduction and carbon reduction in the fields of atmosphere, water environment and solid waste, and accelerate the promotion of green low-carbon development. Consolidate the role of ecosystem carbon sequestration, enhance the capacity of ecosystem carbon sinks, and strengthen the basic support of ecosystem carbon sinks[8]. Green economic, trade, technological and financial co-operation will be carried out to open a new chapter in the construction of the green 'Belt and Road'.

### **3.2. Improve the construction of policy mechanism and optimize the policy implementation and supervision mechanism.**

#### **3.2.1. Strengthen the support of laws and regulations.**

Carbon lock-in caused by the system is the key to unlocking carbon in our province. In addition, green technological innovation has a ‘double externality’ characteristic, only the system lock to disintegrate, in order to better achieve low-carbon development. Therefore, the province should improve the top-down unified rules and regulations, docking implementation of the system standards, and comprehensively enhance the statistical monitoring capacity; secondly, we should optimize the implementation of financial and tax and pricing policies, comprehensively integrate all types of existing financial resources, and enhance the financial support for the key actions of the dual-carbon goals, demonstration projects and key projects; thirdly, we should place carbon asset management in a more important position, improve the investment policies, actively and steadily control carbon emissions and carbon footprint, and incorporate the concept and requirements of carbon unlocking synergistic governance into the policy system of ecological civilization construction, beautiful Sichuan construction, ecological environmental protection, energy and resource conservation as well as the development of the circular economy; Fourthly, it is necessary to follow the intrinsic mechanism of carbon unlocking, formulate and promote the carbon unlocking synergistic technical guidelines for various industries, and build a synergistic emission reduction technology system[9-10].

#### **3.2.2. Deepening the Carbon Market and Collaborative Governance Mechanism**

The carbon market is the core policy instrument for China to promote the achievement of the dual-carbon target, and it is also the main framework of China's carbon pricing mechanism. China's carbon market has an important influence on the global carbon price level and the effectiveness of the carbon trading mechanism and has received a high degree of attention from the international community. The quota allocation method based on the carbon emission intensity control target demonstrates the flexibility and applicability of the carbon market mechanism, which is of great significance in breaking the carbon lock-in effect in our province. The province should be more proactive and give full play to the advantages of Chengdu National Carbon Market Capacity Building Centre to further participate in the construction of the national carbon emissions trading market, participate in carbon trading and revitalize carbon assets.

Firstly, it is necessary to strengthen the province's carbon emission statistics and accounting system, optimize and refine the statistical accounting methods for carbon emissions by region and industry, achieve the regular compilation and updating of greenhouse gas emission inventories, and actively explore and build a cross-sectoral carbon emission data-sharing mechanism, so as to promote the effective use of data resources and synergistic management. Promoting the construction of market-based mechanisms, improving investment policies, and continuously consolidating and enhancing the capacity of carbon sinks.

Secondly, we should narrow the carbon emission quota gap or expand the surplus of carbon emission quotas through technology, engineering, management and trading initiatives, flexibly apply market trading rules, mechanisms and systems, and proactively avoid trading risks; adhere to the problem-orientation and development-orientation; enhance the level of carbon measurement, carbon accounting, carbon assets, carbon disclosure, and carbon financial development; reduce the cost of clearing compliance by key emission units; promote the transformation of ecological and emission reduction advantages into sustainable development advantages; and strengthen the foundation of the province's carbon peak carbon neutrality.

Thirdly, we should promote the differentiation and refinement of cities, districts, counties and parks to formulate pollution reduction and carbon synergistic programs, enhance the positioning recognition, targeted measures and engineering support, and achieve multi-objective synergism;

establish and improve the system of pollution prevention and control and carbon peak effectiveness inspection and assessment; strengthen the carbon unlocking of the collection of typical cases and the publicity and promotion of the deepening of the green and low-carbon lifestyles, and promote the green and low-carbon development in accordance with local conditions[10-12].

### **3.3. Promote the optimization and upgrading of industrial structure and promote green and low-carbon transformation**

#### **3.3.1. Building an efficient industrial ecosystem**

Industries in Sichuan Province have carbon locking characteristics such as evolutionary inertia and super-stable structure, building a green and efficient industrial system is a key move for low-carbon development in the province. At the same time, it is necessary to further promote low-carbon energy consumption, industrial green low-carbon transformation and formulate the implementation plan of carbon peaking in various industry sectors. Implement key projects for energy saving and carbon reduction, and build a green manufacturing system; promote energy saving and efficiency of key energy-using equipment, and accelerate the process of low-carbon and zero-carbon technological innovation and digital transformation in various fields; cultivate and grow green and low-carbon advantageous industries, with a focus on optimizing and enhancing the competitiveness of the province's clean energy industry, especially strengthening the development of key clean energy support industries such as crystalline silicon photovoltaics; accelerate the vigorous development of the digital economy and facilitate the accelerate the vigorous development of the digital economy, promote the transformation of traditional industries towards digitalization to jointly build a green, intelligent and efficient industrial ecosystem.

#### **3.3.2. Accelerate industrial upgrading and energy efficiency monitoring**

Continue to promote the consumption of renewable energy, strengthen the “Electric Sichuan” action plan, and further expand the scope of substitution of electric energy. Resolutely curb the disorderly expansion of projects with high energy consumption and high emissions, and implement accurate classification management strategies[13-14]. For the stock of projects with energy-saving and emission reduction potential, accelerate the pace of technological transformation and upgrading to improve energy efficiency and reduce emissions; at the same time, orderly promote the elimination of backward production capacity, and promote the optimization and upgrading of industrial structure; strengthen the energy-saving supervision of high-energy-consuming and high-emission projects, and set up and improve the online monitoring system of energy consumption, so as to achieve real-time monitoring of the use of energy and efficient management. It will also improve the resource recycling system, strengthen the comprehensive utilization of bulk solid wastes, and promote the reduction and resourcing of domestic wastes.

## **4. CONCLUSION**

Enhancing the efficiency of carbon emissions and transforming the economic development model have always been hot issues in research. Based on the background of ‘dual-carbon’ development, this paper analyses the current situation of green development level, combines the current situation of green development level in Sichuan Province, identifies the key features of energy consumption and carbon emissions, and locates the advantages and shortcomings in green development. On this basis, the paper draws a carbon unlocking path with Sichuan characteristics from the dimensions of energy structure adjustment, green industry transformation, science and technology innovation drive, and policy mechanism guarantee.

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