# Evolution, Stage Characteristics, and Governance Model Transformation of China' s Low-Carbon Policies (Post-Print)

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## Abstract

To construct the "dual carbon" policy system and achieve the "dual carbon" goals, it is imperative to systematically review the development trajectory of China' s low-carbon policies and the evolution of its governance models. Based on policy transition theory, this study constructs an analytical framework of "policy objectives—policy themes—policy fluctuations," employs text mining techniques and policy econometric methods to analyze 1,743 low-carbon policies issued in China from 2000 to 2021, summarizes the stage-specific characteristics and evolutionary pathways of low-carbon policy development, quantitatively evaluates the contribution levels of various policy themes across different stages, and systematically depicts the transformation of China' s low-carbon governance model. The findings indicate that low-carbon policy themes have undergone a strategic evolution from "pollution prevention and ecological protection as equal priorities" to "energy conservation and emission reduction," and subsequently to "coordinated energy conservation, emission reduction, pollution reduction, and carbon reduction." Low-carbon governance has experienced a transformation through exploratory governance, campaign-style governance, pluralistic governance, and adaptive governance, with significant stage-specific variations in the combination characteristics of regulatory and incentive intensities across different models.

## Full Text

## Abstract

A systematic review of China' s low-carbon policy evolution and governance paradigm transformation is imperative for establishing a well-designed policy system to achieve the "dual carbon" goals. Based on policy change theory, this study constructs an analytical framework of "policy objectives—policy themes

–policy fluctuations." Using text mining techniques and policy measurement methods, we analyze 1,743 low-carbon policies promulgated in China between 2000 and 2021. The study summarizes the stage-specific characteristics and evolutionary trajectory of low-carbon policy development, quantitatively evaluates the contribution of each policy theme at different stages, and systematically portrays the transformation of China' s low-carbon governance paradigm. The findings reveal that low-carbon policy themes have evolved from "equal emphasis on pollution prevention and ecological protection" to "energy conservation and emission reduction," and finally to the strategic layout of "synergistic governance of energy conservation, emission reduction, pollution reduction, and carbon mitigation." China' s low-carbon governance has undergone a transformation through exploratory governance, campaign-style governance, pluralistic governance, and adaptive governance, with distinct stage-specific differences in the combination of constraint intensity and incentive intensity under different paradigms.

**Keywords:** low-carbon policy, policy themes, evolutionary analysis, governance model transformation

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As a responsible major country, China attaches great importance to the serious environmental problems caused by excessive carbon dioxide emissions and has adopted a series of measures to resolve the contradiction between environmental protection and economic growth, controlling carbon emissions and promoting green economic growth. In September 2020, President Xi Jinping proposed the carbon peaking and carbon neutrality (hereinafter referred to as "dual carbon" ) goals at the general debate of the 75th session of the United Nations General Assembly. The report of the 20th National Congress of the Communist Party of China proposed "actively and steadily promoting carbon peaking and carbon neutrality." General Secretary Xi Jinping has repeatedly emphasized in important speeches: "We have established and improved a green, low-carbon, and circular economic development system, continuously promoted industrial structure and energy structure adjustment," and "accelerated the construction of a 'dual carbon' policy system." Building a "dual carbon" policy system is an institutional guarantee for implementing new development concepts and promoting comprehensive green and low-carbon transformation of the economy and society. The realization of the "dual carbon" goals depends on the implementation intensity and effectiveness of China' s low-carbon policies. Therefore, how to formulate a rational and effective low-carbon policy system and adjust and improve national institutional arrangements related to low-carbon development is an urgent question. Based on policy text content analysis and text measurement methods, this paper conducts in-depth mining of China's low-carbon policy texts, 梳理 the evolution of China' s low-carbon policy themes from a temporal correlation dimension, and systematically portrays the "past," "present," and "future" of China' s low-carbon governance paradigm by combining the dynamic

evolution characteristics of "low-carbon strategic objectives, policy themes, and policy theme fluctuations," providing reference and inspiration for the future evolution path of China's low-carbon governance model.

## 2 Research Methods and Data Processing

### 2.1 Data Sources

Based on the "Peking University Law Database," this study takes all low-carbon policies promulgated by the central government and various ministries between January 1, 2000, and December 31, 2021, as the analysis text. Following the retrieval method of Luo Min et al. [**?**], the keywords include "climate change," "greenhouse gas," "energy conservation and emission reduction," "carbon sink," "carbon trading," "low-carbon," "energy conservation and environmental protection," "carbon dioxide," "energy saving," "climate governance," "green," "environmental protection," "clean," "carbon emission," and "carbon tax," yielding 13,045 policies. After eliminating policies irrelevant to the research theme and duplicates, 1,743 highly relevant texts were finally selected.

### 2.2 Policy Text Analysis

First, this paper divides the policy development stages according to temporal analysis and time-interval methods, segmenting the time series in chronological and logical order. Second, referencing Li Xiangdong et al. [**?**], we utilize the Latent Dirichlet Allocation (LDA) topic model and Jensen-Shannon (JS) divergence method from natural language processing to construct two indicators: theme intensity and policy theme-oriented fluctuation index. Specifically, we use LDA topic modeling technology to mine low-carbon policy themes, forming a policy theme set for central low-carbon policy texts, and further visualize theme intensity to reveal policymakers' focus and evolutionary logic. Using JS divergence, we construct a policy theme-oriented fluctuation index to explore the stability of low-carbon policies, inflection years, and policy events. Based on low-carbon strategic objectives, changes in policy themes within time intervals, and their fluctuations, combined with in-depth expert interviews, we clarify the "past," "present," and "future" of China's low-carbon governance model.

### 2.3 Division of Policy Development Stages

To more accurately 梳理 the evolutionary path of low-carbon policy themes along the temporal correlation dimension, this paper adopts the literature growth theory [**?**] and time-interval method [**?**], combining policy quantity distribution to divide the development of China's low-carbon policies into three stages (Figure 1 [Figure 1: see original paper]). (1) **Initial/Incubation Stage (2000–2005):** The number of low-carbon policy texts was small and showed irregular fluctuations, indicating that the country had not yet clearly incorporated carbon reduction into pollution control tasks and environmental policy objectives. Low-carbon policies were few in number and remained in the initial/incubation

stage. (2) **Development/Germination Stage (2006–2010):** The number of low-carbon policy texts showed a rapid growth trend, indicating that policy formulation and issuance were in the development/germination stage. (3) **Deepening/Intensification Stage (2011–2021):** Except for a brief decline in policy numbers in 2018–2019, the number of low-carbon policy texts remained stable at a high level from 2011–2021, indicating that low-carbon policy research and formulation were in the deepening/intensification stage during this period.

## 3 Low-Carbon Policy Evolution Analysis

### 3.1 Evolution Analysis of Low-Carbon Strategic Objectives

The root cause of China' s huge carbon dioxide emissions lies in the massive combustion of fossil fuels such as coal and oil [**?**]. Since the "11th Five-Year Plan" period, the Chinese government has successively established three binding indicators: unit Gross Domestic Product (GDP) energy consumption level, unit GDP carbon dioxide emissions, and the proportion of non-fossil energy in primary energy consumption, to promote industrial structure adjustment and reduce carbon dioxide emissions.

**(1) Unit GDP Energy Consumption Level.** In March 2006, China proposed the first energy constraint indicator in the "11th Five-Year Plan" —unit GDP energy consumption level, specifying that the 2010 unit GDP energy consumption level should be reduced by 20% compared to 2005. The "12th Five-Year Plan" proposed reducing the 2015 unit GDP energy consumption level by 16% compared to 2010. The "13th Five-Year Plan" proposed reducing the 2020 unit GDP energy consumption level by 13.5% compared to 2015. By continuously achieving the goal of reducing unit GDP energy consumption, energy utilization efficiency has been improved and clean and low-carbon energy transformation has been promoted.

**(2) Unit GDP Carbon Dioxide Emissions.** In December 2009, at the UN Climate Change Conference in Copenhagen, China made its first quantitative carbon reduction commitment to the international community: to reduce unit GDP carbon dioxide emissions by 40%–45% by 2020 compared to 2005. In June 2015, "China' s Nationally Determined Contributions" extended this target to 2030, raising the reduction ratio to 60%–65%. At the Climate Ambition Summit in December 2020 and in the "Action Plan for Carbon Peaking Before 2030" in October 2021, the 2030 carbon reduction target was set at above 65%. The "12th Five-Year Plan" set a target of reducing carbon dioxide emissions by 17% in 2015 compared to 2010, the "13th Five-Year Plan" set a reduction of 18% in 2020 compared to 2015, and the "14th Five-Year Plan" stabilized the reduction ratio at 18% again. In November 2014, China committed in the "U.S.-China Joint Announcement on Climate Change" to "peak carbon emissions by 2030," and made the solemn commitment to "achieve carbon neutrality by 2060" at the UN General Assembly in September 2020.

**(3) Proportion of Non-Fossil Energy in Primary Energy Consump-**

**tion.** In March 2011, the binding indicator of the proportion of non-fossil energy in primary energy consumption was proposed and gradually improved. The "12th Five-Year Plan" proposed that the proportion of non-fossil energy in primary energy consumption should reach 11.4% in 2015. In the "National Climate Change Adaptation Plan (2014–2020)" issued in September 2014, the target was set at 15% for 2020. In the "U.S.-China Joint Announcement on Climate Change" issued in November 2014, the target was raised to 20% for 2030. In the "Action Plan for Carbon Peaking Before 2030" issued in October 2021, the target was further raised to around 25% for 2030. This strategic objective has continuously promoted the development of new and renewable energy.

### 3.2 Evolution Analysis of Low-Carbon Policy Themes

Based on the changing trends of policy theme intensity, low-carbon policy themes can be divided into three categories: (1) **Stabilizing policy themes**, including waste recycling technology, energy conservation and emission reduction, and building energy efficiency; (2) **Growing policy themes**, including green technology research and development, pollution prevention, ecological carbon sinks, and administrative supervision; (3) **Fluctuating policy themes**, including fiscal incentives, new and renewable energy, and energy efficiency constraints.

From the perspective of policy theme intensity changes (Figure 2 [Figure 2: see original paper]), waste recycling technology, energy conservation and emission reduction, and building energy efficiency policy themes have developed over a long period, with relatively complete policy systems overall and policy development tending to stabilize. Green technology research and development, pollution prevention, ecological carbon sinks, and administrative supervision policy themes have occupied important positions in China' s low-carbon policy system in recent years, showing an upward trend. The theme intensity of fiscal incentives, new and renewable energy, and energy efficiency constraints shows a fluctuating trend.

From the roadmap of the evolution of key policy themes in China' s low-carbon policy (Figure 3 [Figure 3: see original paper]), we can observe that China' s low-carbon policy has long been committed to energy conservation and pollutant emission reduction, specifically manifested in the evolution from "equal emphasis on pollution prevention and ecological protection" in the initial/incubation stage, to a focus on "energy conservation and emission reduction" in the development/germination stage, and finally gradually evolving to "synergistic governance of energy conservation, emission reduction, pollution reduction, and carbon mitigation" in the deepening/intensification stage.

### 3.3 Evolution Analysis of Low-Carbon Policy Theme Fluctuations

From the perspective of policy theme fluctuation-oriented paths and the main policy themes causing fluctuation inflection points (Figure 4 [Figure 4: see orig-

inal paper]), during the initial/incubation stage, the policy theme fluctuation index remained volatile at a high level. On the one hand, because China focused more on economic development during this stage, relatively weakening attention to environmental issues, with fewer environmental policies; on the other hand, to address increasingly severe environmental problems, policies tended to favor end-of-pipe treatment, with waste recycling technology and pollution prevention policy themes being more prominent during this stage. During the development/germination and deepening/intensification stages, policy theme fluctuation index fluctuations slowed down.

The most obvious inflection point in policy theme-oriented fluctuations during the initial/incubation stage occurred in 2004 (PT1). The sharp decrease in waste recycling technology and ecological carbon sink policy theme intensity, combined with the increase in energy conservation and emission reduction policy theme intensity, constituted this policy fluctuation. In 2003, the Party Central Committee proposed the Scientific Development Concept, and in 2005, established a resource-saving and environmentally friendly society as a strategic task in national economic and social development. Key policies such as the "Notice of the General Office of the State Council on Carrying Out Resource Conservation Activities" and the "Notice on Organizing Resource Conservation Special Inspections" were issued during this period.

The most obvious inflection points in policy theme-oriented fluctuations during the development/germination stage occurred in 2007 (PT2) and 2009 (PT3). (1) In PT2, building energy efficiency policy theme intensity relatively weakened, while energy conservation and emission reduction and pollution prevention policy theme intensity increased. Since 2006, when energy conservation and emission reduction were incorporated into the "11th Five-Year Plan," this policy theme intensity has continued to increase. In 2007, the State Council established the National Leading Group on Climate Change and Energy Conservation and Emission Reduction. Representative policies of this stage include the "Notice of the State Council on Issuing the Comprehensive Work Plan for Energy Conservation and Emission Reduction"and the "Implementation Plan for the National Energy Conservation and Emission Reduction Action." (2) In PT3, building energy efficiency policy theme intensity reached a new high compared to PT2, which may be related to the simultaneous price and volume increase in China' s real estate market in 2009, making real estate a new investment demand. Representative policies include the "Implementation Plan for Renewable Energy Building Application City Demonstration" and the "Supplementary Explanation of the Green Building Evaluation Technical Rules (Operational Use Part)."

The most obvious inflection point in policy theme-oriented fluctuations during the deepening/intensification stage occurred in 2021 (PT4). Administrative supervision policy theme intensity decreased slightly at a high level, while energy efficiency constraints and ecological carbon sink policy theme intensity increased. Representative policies include the "Administrative Measures for Carbon Emis-

sion Rights Trading (Trial)," the "Key Points of Energy Supervision Work in 2021," and the "Opinions on Deepening the Reform of the Ecological Protection Compensation System."

## 4 Governance Model Transformation of Low-Carbon Policy

Based on the dynamic evolution of low-carbon strategic objectives, policy themes, and policy theme fluctuations, and according to changes in the combination of constraint intensity and incentive intensity, we clarify the "past," "present," and "future" of China' s low-carbon governance model (Figure 5 [Figure 5: see original paper]).

### 4.1 Exploratory Governance

During the initial/incubation stage, the environmental pressure from rapid economic growth and international pressure from joining the World Trade Organization multiplied, triggering changes in China' s environmental governance. Low-carbon policy themes showed high-level fluctuations. On the one hand, local governments at all levels still prioritized economic development, without proposing clear and explicit low-carbon strategic objectives, with insufficient investment in and constraints on carbon reduction, remaining in an exploratory process. On the other hand, China experienced rapid development in environmental law construction and management systems, beginning to adopt economic policies such as pollution discharge fees to internalize the negative externalities of polluting enterprises, emphasizing green technology, pollution prevention, and ecological protection-related policy themes to reduce carbon dioxide emissions. Overall, due to the lack of advanced theories, technologies, and experience in environmental governance, low-carbon governance remained in exploratory governance with weak constraint intensity and weak incentive intensity.

### 4.2 Campaign-Style Governance

During the development/germination stage, as China' s environmental regulation policy system underwent strategic transformation, the government' s governance philosophy shifted from the past emphasis on economy over environment to balancing economy and environment, ushering in a new round of changes in low-carbon governance with rapid policy growth and declining policy theme fluctuation ranges. China first explicitly proposed reducing carbon dioxide emission intensity, continuously promoting green and low-carbon transformation by setting dual control constraint indicators for energy consumption and carbon emission intensity. Low-carbon governance means became more diversified, building upon pollution discharge fees to implement emission rights trading systems, increasing fiscal investment in energy conservation, emission reduction, and non-fossil energy, improving fiscal incentive mechanisms for carbon reduction positive externalities, and implementing green procurement systems. Low-clow-carbon governance exhibited campaign-style and task-oriented charac-

teristics. The former State Environmental Protection Administration launched four “environmental assessment storms”between 2005 and 2007, and local governments subsequently made energy conservation indicators an important criterion for cadre evaluation. Therefore, this stage mainly adopted a “top-down” governance model, clarifying low-carbon strategic objectives, mobilizing resources from various administrative departments, embedding low-carbon tasks into the administrative system, and promoting them forcefully. Thus, during the development/germination stage, China’ s low-carbon governance was dominated by campaign-style governance.

### 4.3 Pluralistic Governance

During the deepening/intensification stage, China paid greater attention to balancing economic and environmental values, gradually establishing a long-term mechanism for “government, market, and public” collaborative governance. The 18th National Congress of the Communist Party of China proposed the “five-in-one” overall layout, placing ecological civilization in a prominent position. The 19th National Congress further made “harmonious coexistence between humans and nature” an important component of the basic strategy for upholding and developing socialism with Chinese characteristics in the new era, triggering a new round of changes in China’ s low-carbon governance. By implementing stricter low-carbon strategic objectives, the campaign-style governance model exhibited “campaign-like” characteristics. For example, during the “13th Five-Year Plan” period, the battle against pollution was mobilized and deployed at the national level, achieving synergistic efficiency in pollution and carbon reduction by concentrating social forces. The public’ s role in low-carbon governance and supervision became increasingly prominent, with the environmental information disclosure system gradually improving, effectively reducing information asymmetry in public opinion and media supervision of corporate carbon and pollution emissions, and enhancing external supervision effectiveness on polluting enterprises. Therefore, during the deepening/intensification stage, both constraint intensity and incentive intensity of low-carbon governance were significantly strengthened, gradually establishing a model of multi-entity collaboration and multi-dimensional governance means combining “government, market, and public,” with pluralistic governance dominating this stage.

### 4.4 Adaptive Governance

Looking toward future “dual carbon” development, the low-carbon governance system requires greater adaptability and resilience in constraints, incentives, and coordination mechanisms to form the institutional foundation and logic for long-term governance. The low-carbon policy system should continuously incentivize the research, development, and promotion of green and low-carbon technologies, promote the development of new and renewable energy and green industries, optimize social resource allocation, improve ecosystem service capabilities, and form an internally driven environment-friendly model that spontaneously ad-

justs the contradiction between economy and environment through adaptive activities. The low-carbon policy system should be based on a learning process, guided by low-carbon strategic objectives, systematically understand the complex low-carbon governance system through learning, determine the reasonable sequence of policy theme application, continuously and systematically solve complex problems in low-carbon development, and continuously enhance the government' s low-carbon governance capabilities. Therefore, future low-carbon governance in China should be dominated by adaptive governance, reasonably applying incentive and constraint mechanisms, and innovating incentive and constraint mechanisms by balancing economic development and environmental protection.

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*Note: Figure translations are in progress. See original paper for figures.*