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Green building policies in China: A policy review and analysis[1]

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Abstract

Green building policies (GBPs) are considered the most fundamental and effective pathway towards green building (GB) promotion. However, few studies have focused on policies from the multi-level governance perspective. To fill this gap, this study empirically analyses the historical development of GB governance in China and

Abbreviations: GB, Green Building; GBP, Green Building Policy; GHG, Greenhouse Gas; FYP, Five-Year Plan; DBP, Direction-Based Policy; TSP, Technical Support Policy; FSP, Financial Support Policy; SBP, Service-Based Policy; RBP, Regulation-Based Policy.

unearths solutions for future policy development. A total of 254 central and 1175 local GBPs during 2004–2021 are systematically reviewed and analysed from the dimensions of policy correlation, content, quantity, type and intensity. Key findings demonstrate that the central government stresses its guiding role by issuing a large number of direction-based policies. Meanwhile, local governments increasingly respond to the central initiatives by improving their GBPs framework, forming a 'top-down' GB governance system. Over time, China has set more ambitious targets, achieved improved progression and established a 'carrot-and-stick' system in GB governance. Accordingly, China's GBP development is suggested to focus on 1) alleviating economic inequality and facilitating regional cooperation, 2) improving legal and regulatory systems, 3) conducting policy innovation based on regional heterogeneity, 4) establishing information disclosure mechanism and 5) developing market-oriented green finance system. This study provides a valuable reference for improving policy system to promote GB in other countries and regions.

Keywords: Green building policy; policy review; policy evolution; China

1. Introduction

Over the last few decades, the building and construction sector has been criticised consistently for contributing to massive energy consumption and greenhouse gas (GHG) emissions [1]. In detail, in 2020, it consumed nearly 36% of the global end-use energy and was responsible for 37% of total carbon emissions [2]. Such a situation is more

38 severe in China, with the building and construction sector contributing the most to
39 energy consumption (46%) and carbon emissions (50%) in 2019 [3]. Substantial
40 reductions in energy usage and carbon emissions help to protect the environment and
41 improve human life quality [4]. Therefore, to achieve sustainability, the Chinese
42 government has encountered a key policy challenge in saving energy and cutting
43 emissions associated with buildings, especially with the goal of reaching carbon peaks
44 at around 2030 and carbon neutrality at around 2060 [5,6].

45 Recognising the challenge of reducing energy consumption and GHG emissions
46 in the building sector, green buildings (GBs) have been introduced as a possible
47 measure to address the issue [7]. GBs, as defined by the World Green Building Council
48 [8], refer to '*the buildings in its design, construction or operation, reduces or eliminates*
49 *negative impacts, and can create positive impacts on our climate and natural*
50 *environment*', and they have been regarded as a sustainable alternative to traditional
51 buildings (non-GBs) [9,10]. Driven mainly by sustainability goals, GBs can mitigate
52 the adverse effects of building stock on the economy, society and natural environment
53 [1,11,12]. For instance, compared with non-GBs, GBs produced 50%, 48% and 5% less
54 GHGs associated with water consumption, solid waste management and transportation,
55 respectively [13]. In China, some GBs consume 26% less energy than non-GBs [14].
56 In this sense, GB development is a key component of the construction industry's shift
57 to sustainability [15].

Motivated by GBs' advantages, the Chinese government has released dozens of green building policies (GBPs) to support and promote the implementation of GB widely. Due to the policy support for GB promotion, the number of new GBs in China has increased over the past decade [16]. GBPs refer to policies that affect the entire life of the building, from design and construction to operation and demolition [17]. Attention to these GBPs from researchers has also increased gradually regarding the government and its GBPs playing a vital and irreplaceable role in promoting GB [18–20]. Existing research on GBPs focuses mainly on evaluating the policy effectiveness [21–23], assessing policy effects on GB development [6,24–26] and comparing different policy scenarios [27–30]. All these efforts have provided the scientific basis for formulating GBPs to promote GB. However, limited studies have examined the existing policies for GB promotion, and these are limited to 1) static pattern [16,31], ignoring the dynamic evolution of GBPs; 2) partial object scope, focusing only on a sub-topic (e.g., green retrofit [31,32]) and 3) national level [33], lacking the GBPs issued by local governments. Put simply, studies that have adopted this focus fail to provide a comprehensive review of the entire GBPs across multiple levels of governance. A systematic understanding of the policies' patterns, characteristics and evolution is a prerequisite for optimising the entire process of policy initiation, formulation, design, implementation, management and evaluation [34]. Furthermore, comparisons between the central and local GBPs can help policymakers and researchers further unearth how the Chinese governments govern GB development and determine

how to advance GB governance through upcoming policies under a multi-level governance system. Consequently, optimising the GB policy system and promoting GB in China.

In the interests of further promoting GB in China, this study addresses these gaps by systematically reviewing and analysing the structure and trends of China's central and local GBPs based on the mixed content analysis method. The study begins with a comparative and correlation analysis of central and local policies and divides the development of GBPs into three stages in the timeline. Then, to present the governments' dynamic actions and solutions, the characteristics of each stage are determined through a chronological review of policy content with the help of extracted high-frequency keywords. Meanwhile, to fully understand multi-level governments' preferences and attitudes towards GBP implementation, the central and local governments' historical evolutions of policy structure are analysed, and their corresponding enforcement intensities are evaluated. Based on that, this study draws a clear picture of GBP development in China's multi-level governance context, summarises the past achievements and associated shortcomings and presents implications for the future development of GBPs.

To the best of our knowledge, this study represents the first attempt to review China's GBPs systematically from the perspective of central and local government levels. The study provides new insights into current policy actions in China for researchers and policymakers to better understand the GB governance process. This

enables the Chinese government to optimise the existing policies to promote GB under the multi-level governance system; in the meantime, it provides a valuable reference for GBPs implementation, assessments and improvement in other countries and regions to promote GB.

The rest of this study is structured as follows. The methodology is introduced in Section 2. Section 3 presents an overview and analyses the evolution, structure and intensity of GBPs from the central and local government levels. Section 4 presents the achievements, challenges and implications. Lastly, Section 5 draws the conclusions.

2. Methodology

Fig. 1 illustrates the research framework and the process comprising the following steps. First, data collection and processing aim at collecting GBPs comprehensively. After screening the initial policy documents retrieved from the PKULAW database and official websites, a total of 1429 GBPs are obtained. Then, the mixed content analysis method that combines text-mining, qualitative, content and quantitative analysis is performed to review and analyse the GBPs quantitatively and qualitatively. Specifically, the content review and analysis enable the coding and categorisation of GBPs and the determination of their policy content, including objectives, implemented time, innovation points and issuing bodies. Text-mining and quantitative analyses are performed to support the comprehensive understanding of GBPs from the perspective of policy hotspots, correlation, structure and intensity. Accordingly, a full picture of the

current GBPs in China can be obtained. Finally, the results of the policy documents are explored further in terms of achievements, challenges and implications.

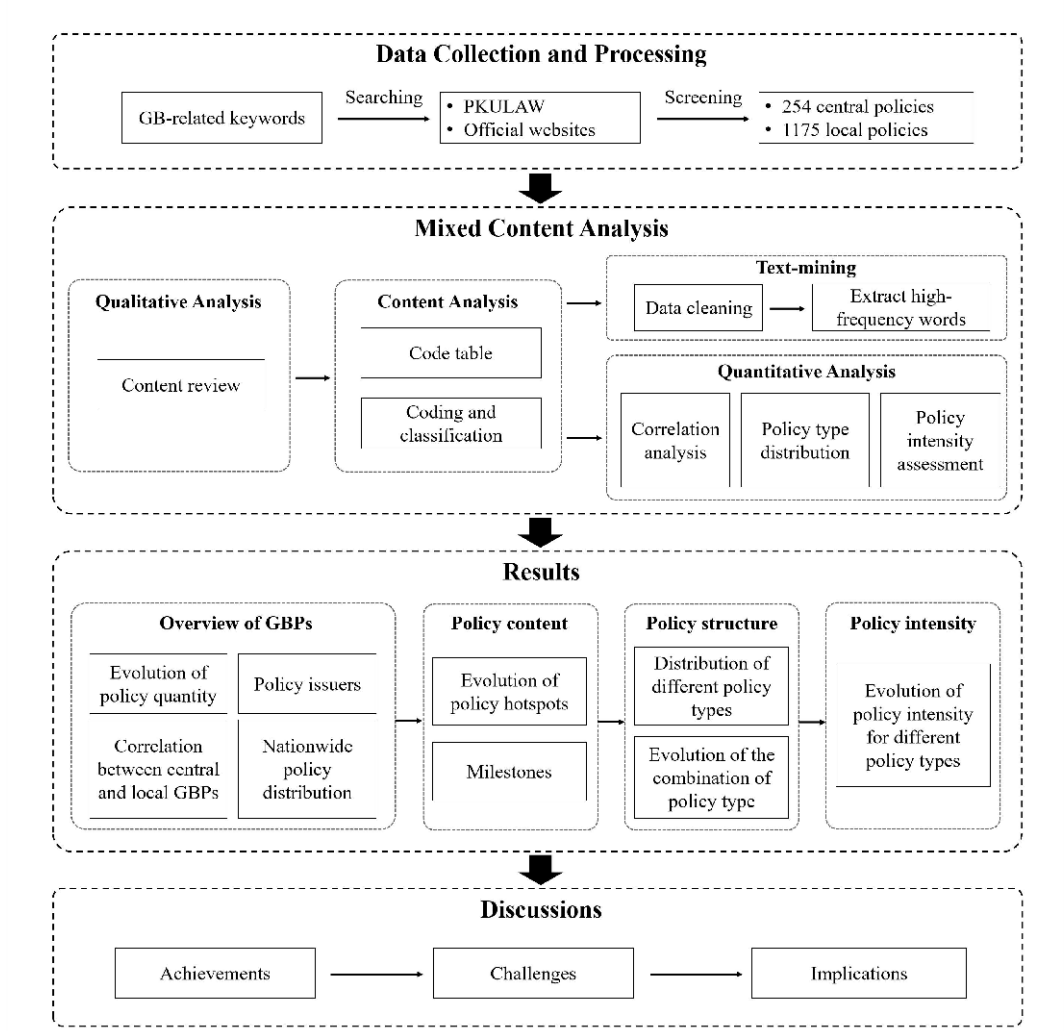


Fig. 1. Research framework of this study.

2.1. Data collection and processing

The data in this study are based on China's green building policies implemented at all governmental levels. Specifically, policies related to green building refer to those with the policy objectives of promoting the implementation of GB via diverse policy

modes and styles, such as laws and regulations, issued by the central and local governments and related departments of China. Two types of data sources are used to ensure the integrity of the dataset: 1) all levels of governmental websites and 2) PKULAW Database (https://www.pkulaw.com/), which is the largest and most up-to-date database of Chinese policy in full text and has successfully served as a reliable data source for a policy review in various domains in China, such as disaster [35], artificial intelligence [36], resource recycling [37], joint prevention and control of atmospheric pollution [38], urban residential heating [34] and green building [33]. The Chinese-character keywords for the search included 'Lv Se Jian Zhu (green building)', 'Ke Chi Xu Jian Zhu (sustainable building)' and 'Sheng Tai Jian Zhu (ecological building)'. Considering that the first GBP was released in 2004, this study collects GBPs dated from 2004 to 2021. After retrieving the policies, the policy texts that directly reflect government attitudes, such as laws, regulations, provisions, decisions, plans, suggestions, opinions, measures, notices and announcements, are chosen. In contrast, official endorsements of proposed policies are excluded. Then, the collected texts are examined, and texts with less frequent keyword combinations are removed. Repeated policy content in search results is also excluded. Finally, 1429 GBPs texts from 2004 to 2021 are obtained through search and screening: 254 central government policy documents and 1175 local government policy documents.

To investigate the regional distribution of GBPs at the local level, the 31 provinces/municipalities of mainland China are divided into the eastern, central and

149 western regions following their geographical locations, which have been widely used
150 in China's regional studies [39]. The eastern region consists of the following 11
151 provinces/municipalities: Beijing, Fujian, Guangdong, Hainan, Hebei, Jiangsu,
152 Liaoning, Shandong, Shanghai, Tianjin and Zhejiang. There are 8 provinces in the
153 central region: Anhui, Henan, Heilongjiang, Hubei, Hunan, Jilin, Jiangxi and Shanxi.
154 Twelve provinces, municipalities, and autonomous areas make up the western region:
155 Gansu, Guangxi, Guizhou, Inner Mongolia, Ningxia, Qinghai, Shaanxi, Sichuan,
156 Xinjiang, Yunnan, Chongqing and Tibet.

157 2.2. Content analysis

158 Content analysis is a commonly used research method that can convert qualitative
159 text into quantitative data. This method enables researchers to analyse policy content
160 quantitatively, clarify the essence of the current policy and its evolutionary process and
161 improve their cognition of the texts according to these data [40–42]. In practice,
162 categorising and coding are crucial for applying content analysis [43]. In this regard, a
163 coding table of 'Green Building Policies' is built, including direction-based policies
164 (DBPs), technical support policies (TSPs), financial support policies (FSPs), service-
165 based policies (SBPs) and regulation-based policies (RBPs) [33,44,45]. Notably,
166 multiple codes may be assigned to one policy text. The coding table is strictly based on
167 prior research and clearly defined concepts to ensure validity [46]. Besides, two experts
168 who are familiar with the GBP in China are invited to cross-validate the coding table.

Through an independent review by each expert, both agreed with the validity of the coding table. Two trained researchers are assigned to code independently. Regarding any discrepancies, they referred to the first author. The Kappa coefficient of the two coders is calculated, and the coefficient is over 0.8, suggesting good reliability of content analysis [47].

Regarding the large amount of data that required review in this study, the text-mining method is adopted as a supplement to support the content analysis and reduce subjective problems caused by the qualitative research method. Specifically, high-frequency words are counted to determine the hotspots and grasp the evolution of policy focus.

2.3. Correlation analysis

Following Xie et al. [48], to understand the relationship between the number of policies issued in two different regions, the Pearson correlation coefficient is used to measure the degree of linear correlation between two regions [49,50]. The formula is shown as follows:

$$r = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i-\bar{y})^2}} \quad , \tag{1}$$

where r is the Pearson correlation coefficient and represents the correlation degree, n is the sample size while x_i and y_i are the individual sample points, r has a value between −1 and 1. $r = 1$ implies a perfect positive relationship while $r = -1$

188 implies a perfect negative relationship between the variables. $r = 0$ indicates that no
189 linear dependency exists between the two variables.

190 2.4. Policy intensity assessment

191 Policy intensity is a powerful tool for quantitative policy research [51]. A policy
192 intensity index is established through text analysis to assess policy intensity. Policy
193 intensity reflects the government's attitude and enforcement intensity towards policy
194 implementation, which is highly correlated with the scope and nature of the policy itself
195 [52]. Table 1 lists the indicators' criteria and scores [34,53,54].

196 The authority level consists of three criteria. Document types are assigned a value
197 from 1 to 5, depending on the policy level. 'Notice, Announcement or Letter' has the
198 lowest value of 1. 'Suggestion, Measure, Interim planning, Opinion or Rule' takes a
199 lower value of 2. 'Planning or Deployment' has a medium rank of 3. 'Decision or
200 Provision' scores 4. 'Law or Local regulation' has the most significant enforcement
201 effectiveness, with the highest rank of 5. The leading body is assigned a value from 1
202 to 5 according to the agency's administrative level. The national people's congress and
203 state council represent the highest administrative and legislative organisations,
204 respectively. Therefore, their published policy has a score of 5. Policy issued by the
205 central ministry/commission or province-level/municipality-level people's congress
206 /government has a value of 4, followed by province-level/municipality-level
207 department or prefecture-level government policy with a value of 3. Meanwhile,

policies issued by a prefecture-level bureau or district-level/county-level government are scored 2, while the policy is assigned the lowest value of 1 if the leading body is a district-level/ county-level bureau. Regarding the number of involved agencies, 1, 2, and 3 scores are respectively assigned, based on the number of involved agencies. The target type supports the target strength, and the score depends on whether the proposed goal is qualitative or quantitative. Vague qualitative goals have the lowest value of 1, while 'Measurable, verifiable and detailed' goals score the highest value of 3.

Policy intensity is calculated by multiplying the indicators' scores listed in Table 1. A higher policy intensity implies more vigorous policy enforcement.

Table 1

Hierarchical structure of policy intensity index [34,53,54].

Index	Indicator definition		Value
Policy enforcement intensity	Authority level	Document type	1= Notice/ Announce/ Letter
			2= Suggestion / Measure / Interim planning / Opinion / Rules
			3= Planning / Deployment
			4= Decision / Provision
			5= Central law / Local regulation
		Leading body	1= District-level or county-level bureau
			2= Prefecture-level bureau / District-level or county-level government
			3*= Province-level or municipality-level department/ Prefecture-level government

			4*= Central ministry or commission/ Province-level or municipality-level people's congress or government
			5= National people's congress / State council
		Number of involved agencies	1= One agency
			3= Some agencies (2-4)
			5= More agencies (≥5)
	Target strength	Target type	1= Qualitative target
			2= Some quantitative targets
			3= Detailed quantitative targets

* Note: sub-provincial city adds a half-point.

3. Results

3.1. Overview of Green Building Policies (GBPs)

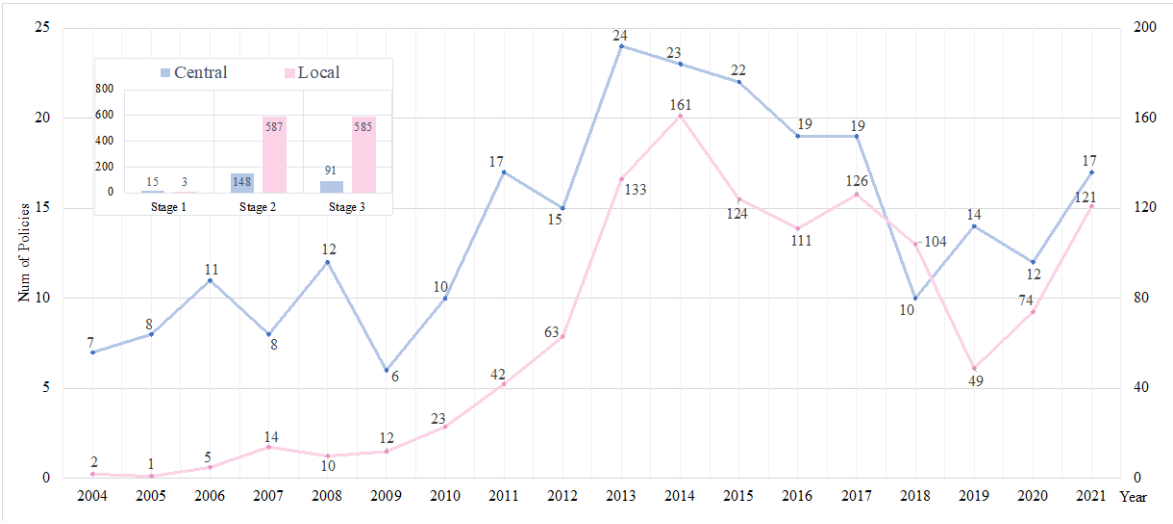


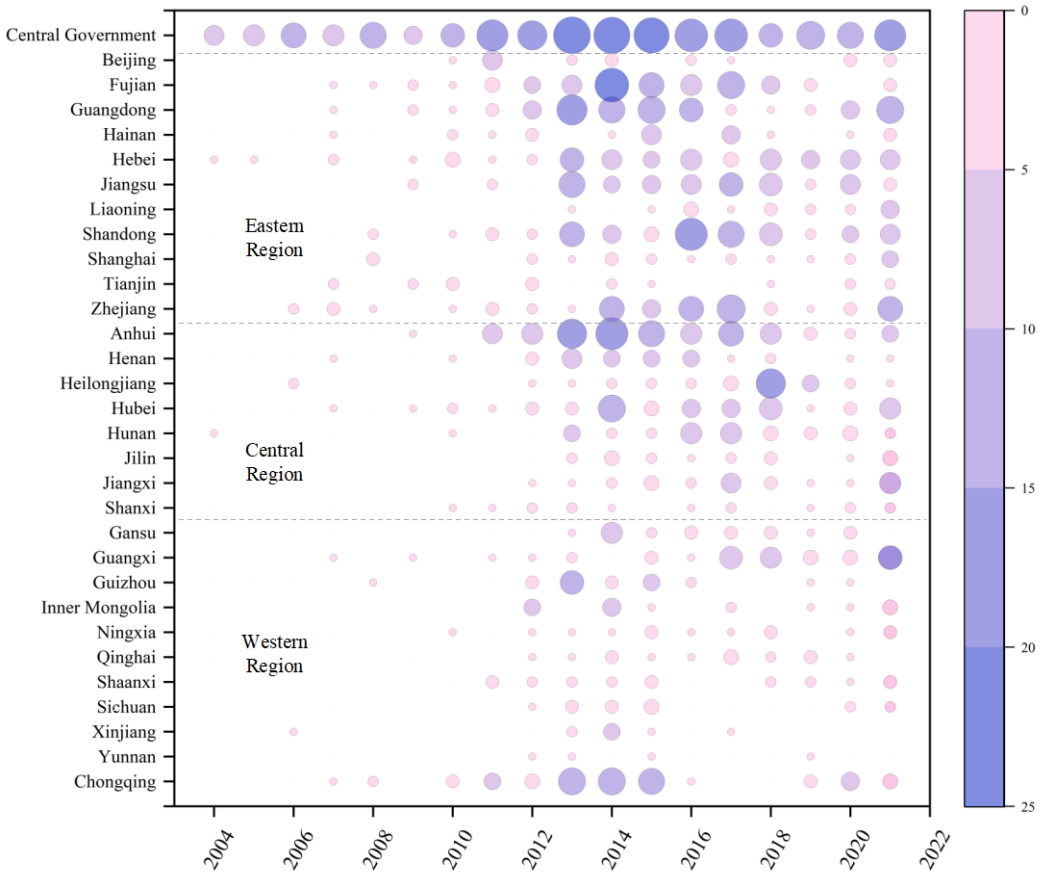
Fig. 2. Temporal distribution of GBPs released in China (2004–2021).

This subsection presents an overview of GBPs from the perspective of policy issuance time, quantity, region and unit based on the content review, correlation and quantitative analyses.

Given the tremendous changes to national strategies and issuing significant policies, the GBPs are divided into three stages: Stage 1: infancy and exploration (2004–2005), Stage 2: rapid development (2006–2015) and Stage 3: further enhancement (2016–2021). Fig. 2 illustrates the annual number of released GBPs and the total number for each stage. In Fig. 2, the number of central and local policies reached a peak in Stage 2, which also has the largest policy quantities. The annual number of central and local policies fluctuates, with central policies peaking in 2013 (24 policies) and local policies peaking in 2014 (161 policies). With a lag of around a year, the overall trend in the number of local policies is overwhelmingly compatible with that of the central policy, which may be influenced by the significant events and essential policies of the central government in the preceding year. Local governments should implement the policies willingly or obligatorily after the central government introduces them. Therefore, local governments may implement particular policies in the same year or the year after.

Fig. 3 shows the GBPs by issued time and regions. A larger node implies a larger number of issuances. Since 2004, GBPs began to spread to the local level in relatively developed eastern and central regions, forming a top-down vertical diffusion dimension. Only two provinces started exploring the concept of GB management during the initial

stage. The horizontal diffusion of local GBPs in the eastern region exploded in 2007–2008, followed by the central region in 2009–2010 and finally in the western region in 2011–2012. From 2013 to 2017, massive local policies were released. The issued GBPs show temporal continuity in the eastern and central regions compared to the western regions. Notably, 2013 and 2020 are the turning points that witnessed significant changes in the number of local GBPs. By 2021, 30 provinces/municipalities responded to central GBPs by enacting applicable policies. Tibet has not issued any GBPs to date. Furthermore, GBPs vary widely across regions. The eastern region promulgates the most policies (578), followed by the central region (332) and the western region (265). As far as specific provinces/municipalities are concerned, Anhui issues the most policies (98), followed by Guangdong (88) and Fujian (85). Two of the three provinces with the most policies are in the eastern region.



257

258 **Fig. 3.** Spatial-temporal distribution of GBPs released in China.

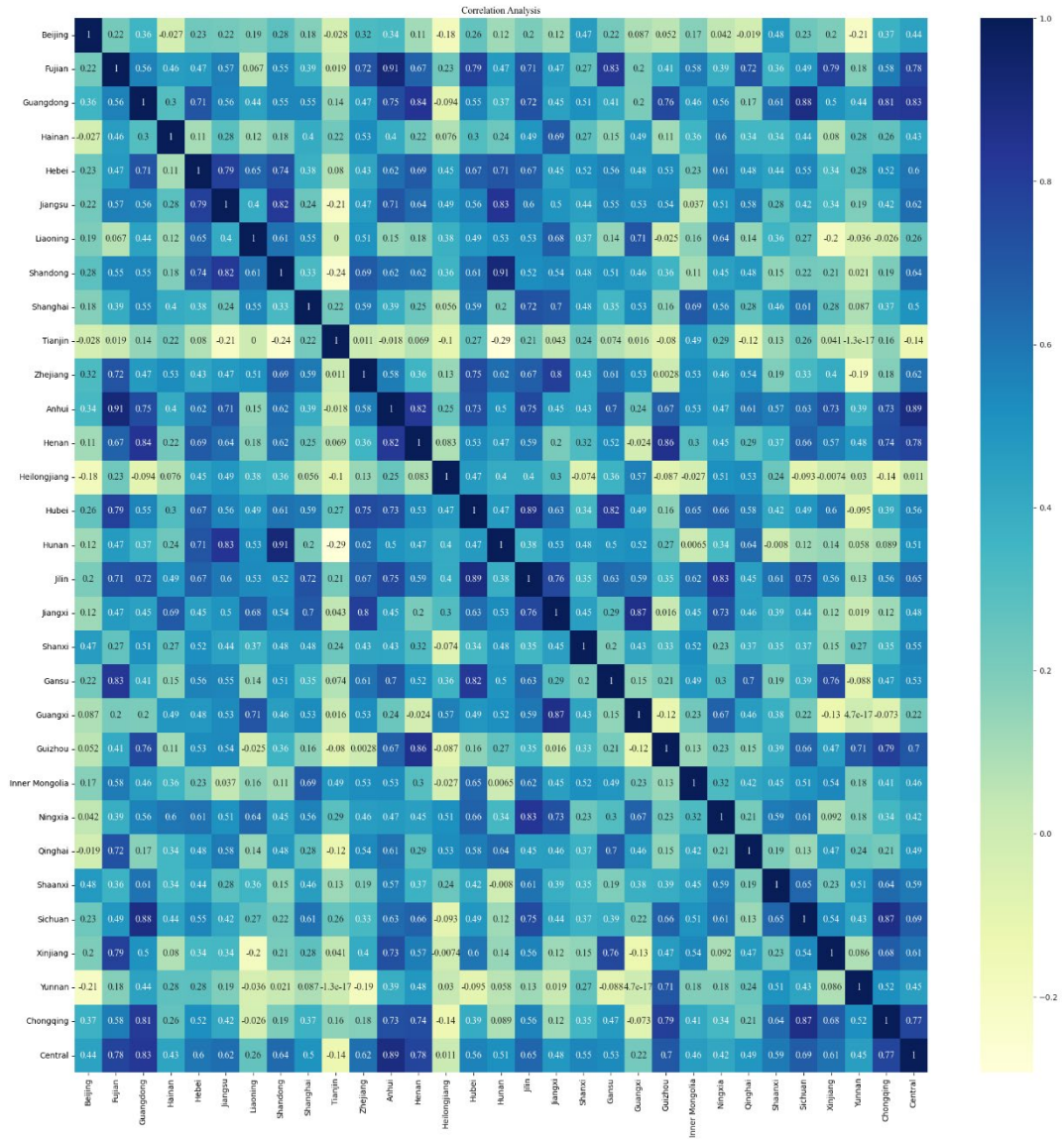


Fig. 4. Relationship between the number of GBPs released in different regions.

Through correlation analysis, Fig. 4 shows the relationship between the number of GBPs released in different regions from 2004 to 2021. Concerning the relationship between the number of central and local policies issued, most provinces located in the eastern and central regions with a short distance from the central government have a strong positive correlation with the central government, e.g., Anhui (0.89), Henan (0.78), Shangdong (0.64) and Hebei (0.6), indicating that the central policies have a significant impact on these regions. However, Beijing (0.44) and Shanghai (0.5) show

weaker positive correlations with the central government. This may be because these two municipalities enjoy more administrative and economic privileges and are flexible and able to make self-governance regulations. Meanwhile, the number of central policies released and the number of policies issued in Tianjin (-0.14) barely correlate with one another, which may be related to the frequent transfer of Tianjin leaders. By contrast, Chongqing (0.77), as the only municipality in the western region, is greatly affected by the central government. Concerning the relationship between the number of policies issued between different regions, geographically adjacent regions, such as Fujian and Zhejiang (0.72), Sichuan and Chongqing (0.87), Anhui and Henan (0.82), and Jiangxi and Zhejiang (0.8), have stronger correlations. Neighbour regions can learn or imitate each other and have tight correlations.

In terms of issue units, for central policies, the Ministry of Housing and Urban-Rural Development and State Council dominates, launching the most policies. Among 254 national-level policies, 211 policies were released independently by individual departments, accounting for 83.1%, 18 were released jointly by two issuers, while the other 43 were issued by three or more departments, accounting for 16.9%. For local policies, the provincial/municipal governments and Department/Bureau of Housing and Urban-Rural Development dominate. Among 1175 local-level policies, 1086 were independently released by individual departments, accounting for 92.43% of the total. 89 were released jointly by multiple departments, accounting for 7.57% of the total. Concerning different regions, joint policy issuances accounted for 7.79%, 10.54%, and

289 3.40% of the total policies issued in the eastern, central, and western regions,
290 respectively. Joint policy issuances generally reflect the degree of communication,
291 cooperation, and coordination among multiple departments [55]. Thus, the central
292 government forms deeper cooperation and pays more attention to coordination among
293 departments when formulating GBPs, followed by the central, eastern and western
294 regions.

295 3.2. Policy content: a review of the evolution of GBP

296 Combining the high-frequency keywords extracted by the text-mining method at
297 different stages, this subsection captured the historical development of GBPs in China
298 through content analysis. Table 2 summarises the emerging high-frequency keywords
299 related to GBPs.

300 **Table 2**

301 Emerging high-frequency keywords related to GBPs.

Stage	Word and Frequency
Infancy and exploration stage (2004-2005)	Technology (1047), Development (693), Build (513), Research (470), Environment (279), Resource (272), Energy-saving (209), Innovation (163), Declaration (109).
Rapid development stage (2006–2015)	Standard (7757), Unit (5701), Design (5084), Management (4792), Retrofit (4769), Implementation (4523), Pilot (4217), Label (4168), System (3671), Construction (3543), Evaluation (2814), Public buildings (2663), Local (2215), Fund (1056), Encouragement (722).

Further enhancement stage (2016-2021)	Review (2195), Provision (1993), Inspection (1941), Acceptance (1749), Supervision (1672), Reformation (1680), Full implementation (1343), Examination (766), Compulsory (423), High-quality (404), Penalty (218).

3.2.1. Infancy and exploration stage (2004–2005)

Before 2006, green building governance was in its infancy, and few policies were issued. Generally, the central administration dominated the green building governance at this stage. Fig. 2 shows that only 15 documents from the central government and 3 from local governments were issued. This suggests that local governments did not prioritise green building because the central government's objectives were too general and non-mandatory. The first two responding provinces were Henan and Hunan, which promulgated policies in 2004. In this phase, the concept of green building emerged, and the central government's attention shifted from the original energy-saving building to green building, which is more eco-friendly and stresses energy-saving, land-saving, water-saving and material-saving, thereby minimising adverse effects on the environment throughout the life cycle. This concept is known as 'Four-saving and One-benign' [56]. Therefore, the keywords 'development', 'environment', 'resource' and 'energy-saving' were highly used at this stage.

'Green building' first occurred in the national policy in 2004, encouraging enterprises to participate in GB-related innovations (mainly technological innovation). Words such as 'technology', 'research', 'innovation' and 'declaration' appeared at a high frequency. Particularly, the central government launched the Green Building

Innovation Award [57] and Technology Project [58] to stimulate GB development. In 2005, the Ministry of Housing and Urban-Rural Development and the Ministry of Science and Technology jointly issued the '*Green Building Technical Guidelines*' to guide and standardise the development of GBs by local governments and enterprises and explore economic and sustainable alternatives for promoting GBs [59]. The guideline clarifies the definition of GB and provides theoretical support for the index system and technical points in the stages of planning and design, construction and operation management.

3.2.2. Rapid development stage (2006–2015)

The year 2006 featured a milestone: the central government issued the first assessment standard for GBs (GB/T50378-2006). This standard has played an essential role in regulating and guiding GBs in China, laying a solid foundation for forming the GB industry. Overall, the GBPs stepped into the diffusion stage. The emergence of keywords 'management', 'system', 'evaluation', 'standard', 'pilot', 'label', 'encouragement' and 'fund' shows that the GB management system gradually took shape with technical and financial support.

Initially off, this stage was large-scale and first introduced quantifiable targets. The national '*Five-Year-Plan*' (FYP) for 2011–2015 formally proposed that the construction industry should promote green building and construction, and GB was first written into China's national plan. Passive ultra-low energy buildings, prefabricated

buildings, nearly zero-energy buildings, and green ecological urban areas were introduced in GBPs to enrich the GB scope. Meanwhile, the quantitative targets of GB adoption rate evolved from 15% to 50% in new urban buildings, and it became mandatory for large-scale public buildings to follow GB standards and be green. Thus, 'public building' appeared at a high frequency. Some local governments set more ambitious targets, such as Guangzhou, Foshan, and Dongying in Guangdong Province, requiring all new construction or renovation projects to meet the one-star standard. Moreover, the target for GB pilot numbers grew from 30 to 100.

In 2013, the '*Green Building Action Plan*' marked the official launch of the national GB action [60], after which local policies exploded. In stark contrast to previous provincial-level government-led governance, more and more municipal governments became involved in issuing relevant policies. The frequent occurrence of 'local' and 'unit' suggests that local governments and departments were more actively engaged in GB governance.

Regarding technical support, this stage established and improved the GB standard system because several standards were developed and issued in the succeeding years. In particular, assessment standards cover almost all lifecycle stages of all building types in most regions [61]. Regarding the lifecycle stage, GB standards cover stages of design, operation, construction and refurbishment or retrofit factories, offices, stores, hospitals, hotels, and school campuses regarding building types, respectively. Regarding regions, 21 provinces/municipalities localised and launched their standards.

3.2.3. Further enhancement stage (2016–2021)

The emergency keyword 'high-quality' shows the government's ambitious target and improving requirements at this stage. In 2019, China redefined green building in response to changes in the major social contradiction proposed by the 19th National Congress of the Communist Party of China. In '*Assessment Standard for Green Buildings*' (GB/T50378-2019), 'high-quality' is added before 'building'. Meanwhile, to be consistent with the people's needs for a better life in the new era, the word 'people' is added before 'harmonious coexistence with nature', and the word 'maximum' is moved to the front of 'people' rather than 'resource-saving', demonstrating the focus of GB has shifted from resource conservation to reaching the harmony between human and nature. This fully embodies the principle of 'people-oriented' and enhances the attention of GBs to users themselves [62]. In the following 2020, the '*Green Building Creation Action Plan*' [63] was enacted jointly by 7 national departments to meet the inevitable requirements of GB development, stressing the people's role in GB action as well as the regulation of demand-sided users. On the other hand, achieving the goal of carbon peaking and neutrality has put forward higher requirements for developing GB in China. For instance, healthy buildings, zero-carbon buildings, and green ecological communities are proposed, and 70% of new urban buildings will be green by 2022 [63].

Unlike the previous stages, after 2015, the legal system of GB began to take shape. Keywords 'provision', 'inspection', 'review', 'supervision', and 'compulsory' emerged at this stage. 11 local governments launched GB Regulations, of which 6 are from the

eastern region, 3 from the central region, and 2 from the western region. The regulations clarify mandatory requirements and responsibilities and promulgate quantifiable punishment measures. However, there is no GB law for the central government so far. In this context, the '*Green Building Creation Action Plan*' [63] emphasises the importance of GB legislation, requiring local governments to enact GB regulations to strengthen GB governance, which is conducive to promoting GB legislation at the national level. Apart from enacting regulations, the inspection of the GB implementation of the lower government by the upper government also played an important role at this stage. The primary purpose of the inspection is to grasp the completion of GB tasks in various regions; thereby, deficiencies could be corrected promptly, and successful experiences and practices could be summarised and shared nationwide. Put simply, the government started establishing a comprehensive monitoring system to acquire timely GB information to ensure meeting the GB goals.

3.3. Policy structure: evolution of the combination of policy types

GBPs are grouped into five categories, namely, direction-based policies (DBPs), technical support policies (TSPs), financial support policies (FSPs), service-based policies (SBPs), and regulation-based policies (RBPs). Direction-based policies (e.g., plans and framework) offer a roadmap and future directions for promoting GB. Regulation-based policies (e.g., laws and regulations) set the requirements for

implementing green building. Technical support policies support governments' objectives through standards, codes, and guidelines, while financial support policies are through subsidies, funds, tax exemptions or deductions, loans, etc. Service-based policies provide service and information to promote GB through pilot, organisation, professional training, information sharing, propaganda, declaration, etc. The following quantification analysis is conducted from the perspective of central and local governments to gain the evolution of policy type. Moreover, statistical results of different regions in three periods are integrated into Table 3 for comparison and illustration.

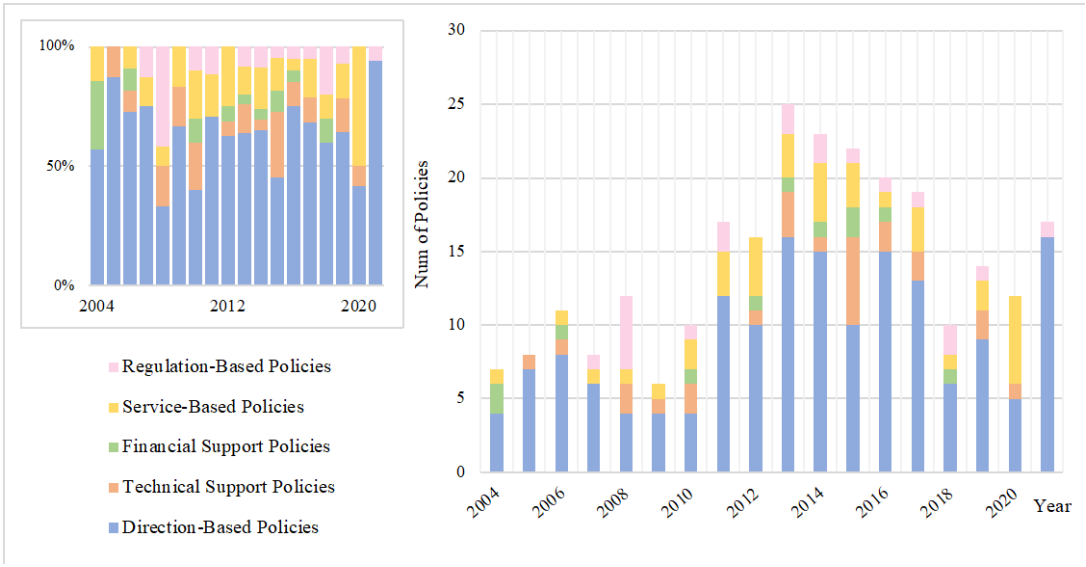


Fig. 5. Distribution of policy types for China's central government.

Fig. 5 depicts the distribution of various policies issued by the central government. The total number of DBPs is 164, contributing the largest proportion at 63.81%, followed by SBPs at 14.40%, TSPs at 9.73%, RBPs at 7.78%, and FSPs at 4.28%. The most employed GBP is DBP. Except for 2008, 2010, 2015 and 2020, such policy accounts for more than half of the annual GBPs. Second to DBP, SBP receives volatile

but generally rising attention from the central government. From 2004 to 2019, SBP ranged from 0 to 4 (averagely 13.23%). That number then jumped to 6 (50%) in 2020. Furthermore, TSP receives less attention than the above two policies. Such a type of policy is concentrated in Stage 2, which is aimed at establishing the GB technical system. Compared with the other types of GBPs, the central government largely ignores policies related to RBPs and FSPs. In 2008, there was a peak for RBP. At that time, the central government was devoted to regulating GB labels. FSPs occupied a large proportion in 2004, indicating that the central government offered financial incentives to stimulate GB promotion in its infancy period; however, this type of policy is largely ignored in Stage 3. Overall, the central government prefers DBP, and this type is overused, underscoring the planned and methodical approach the central government has taken to the development of GB.

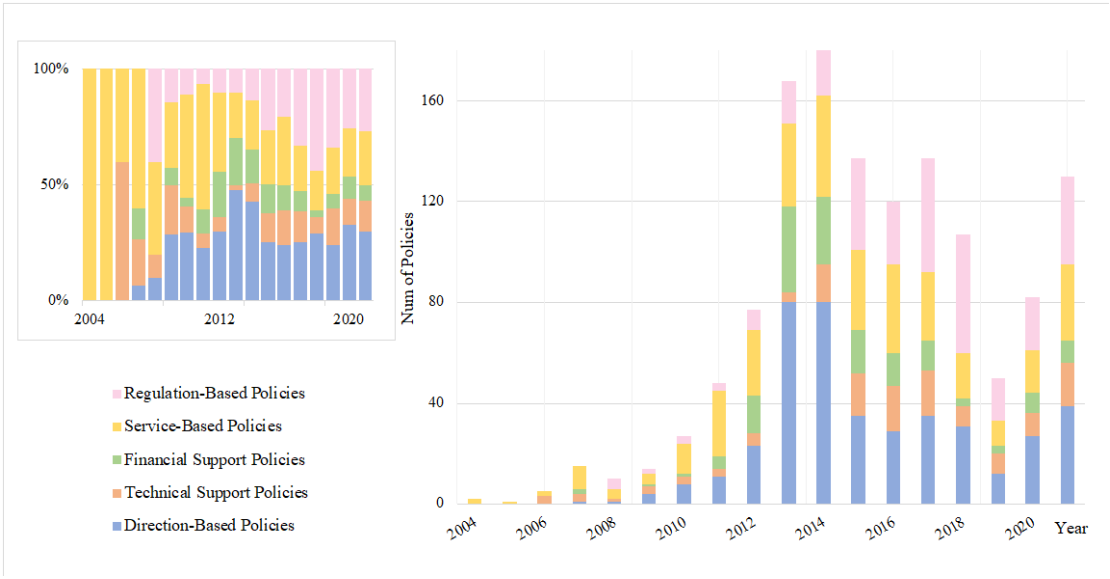


Fig. 6. Distribution of policy types for China's local governments.

Fig. 6 depicts the distribution of local governments' policy types. See Appendix A for the distribution of each province/municipality. Unlike the structure where DBPs significantly dominate central GBPs, local governments have a more balanced distribution of policy types. The total number of DBPs is 416, accounting for the largest proportion at 31.61%, which decreases compared with the central government but remains the greatest, followed by SBPs at 24.85%, RBPs at 21.88%, FSPs at 11.40%, TSPs at 10.26%.

Regarding the temporal dimension, different from the central government's GBPs, SBP was the only type introduced by local governments in Stage 1. Such type of policy becomes less regarded over time. DBPs published by local governments increased in Stage 2 and stabilised in Stage 3. Similarly, the proportion of RBPs at the local level peaked in 2008. Starting from 2008, RBPs received fluctuating attention in Stage 2 and became dominant in Stage 3. TSPs occupied a large part at the beginning of Stage 2, indicating that some more developed cities were responding to build the technical system of GB. In 2012, the central government introduced an incentive scheme [64], and since then, a wide range of FSPs has begun to be released. This policy became less popular in Stage 3 as local governments stressed their roles in regulation.

From the spatial dimension, DBPs are the most applied policies across all regions. Beyond that, each region has its preferred policy components. The eastern region launched more FSPs (12.12%) than the central (10.60%) and western regions (10.77%). Among them, Shandong is in a leading position in the formulation of financial support

policies in the eastern region. A series of provincial and municipal FSPs have been introduced to incentivise GB promotion, with detailed objectives and support conditions. The central region prefers RBPs (26.90%) compared with the eastern (20.09%) and western regions (19.53%). In detail, Hubei and Anhui actively participate in regulating GB by issuing policies, especially carrying out special inspections. The western region issues more TSPs (12.79%) to promote GB compared with the central (6.79%) and eastern (11.04%) regions. Chongqing and Guangxi in the western region take the lead in formulating TSPs, enacting a series of standards and targeting various stages (e.g., design, inspection, and quality acceptance).

Table 3

Spatial-temporal distribution of policy types.

Region	Stage	Direction-Based Policies	Financial Support Policies	Service-based Policies	Regulation-Based Policies	Technical Support Policies
Central government	Stage 1	73.33%	13.33%	6.67%	0	6.67%
	Stage 2	59.33%	4.67%	15.33%	9.33%	11.33%
	Stage 3	69.57%	2.17%	14.13%	6.52%	7.61%
	All stages	63.81%	4.28%	14.40%	7.78%	9.73%
Local governments	Stage 1	0	0	100.00%	0	0
	Stage 2	35.32%	14.83%	27.33%	14.24%	8.28%
	Stage 3	27.64%	7.67%	21.88%	30.35%	12.46%
	All stages	31.59%	11.39%	24.91%	21.87%	10.25%
Eastern region	Stage 1	0	0	100.00%	0	0
	Stage 2	35.67%	14.02%	26.83%	15.55%	7.93%
	Stage 3	26.09%	10.25%	24.53%	24.84%	14.29%
	All stages	30.83%	12.12%	25.92%	20.09%	11.04%
Central region	Stage 1	0	0	100.00%	0	0
	Stage 2	34.44%	16.11%	29.44%	15.00%	5.00%
	Stage 3	31.02%	5.35%	16.58%	38.50%	8.56%
	All stages	32.61%	10.60%	23.10%	26.90%	6.79%

	Stage 1	0	0	0	0	0
Western region	Stage 2	35.56%	15.00%	26.11%	11.11%	12.22%
	Stage 3	26.50%	4.27%	23.08%	32.48%	13.68%
	All stages	31.99%	10.77%	24.92%	19.53%	12.79%

Table 3 shows the spatial-temporal distribution of policy types. Comparative analyses of the central and local policy types reveal that the central government takes its guiding role in China's GB development, launching a large number of DBPs at each stage. DBPs shared the largest portion in Stage 1, providing an initial development roadmap for GB at the beginning. The portion of DBP decreased in Stage 2 but rebounded in Stage 3, mainly because the central government exerted efforts to establish the GB technology system through TSPs and SBPs in Stage 2, laying a solid base for GB promotion. The portion of DBP increased in Stage 3 because new requirements for high-quality GB emerged during this period. Thus, the central government applied more DBPs to guide the large-scale development of high-quality GB. Moreover, at the central and local levels, FSPs took a relatively larger share in the initial stage with the aim of motivating stakeholders. However, FSPs have obtained less attention over time. Unlike the central government, the local governments' RBPs became predominant in Stage 3, indicating that government supervision has aroused significant concerns. However, central government oversight is insufficient.

Overall, a streamlined policy framework initially guided GB development in China and gradually became more diverse as theory and practice developed. Specifically, in the beginning, the central government adopted a more comprehensive policy framework, including DBP, SBP, FSP and TSP, while local governments only

issued SBPs to provide information to GB stakeholders, indicating that local governments are conservative and unwilling to take risks, taking a wait-and-see attitude towards the development of GB. Local governments only began to introduce diverse policies as the central government introduced more policies, indicating the central government's determination to promote GB.

3.4. Policy intensity: evolution of enforcement for different policy types

Government policy initiatives are one way to promote GB, but greater enforcement of these policies is also essential and will affect GB adoption [65]. Policy intensity is quantified in this sub-section to illustrate the dynamic implementation of GBPs over the years. The distribution of policy intensity for each province/municipality can be found in Appendix B.

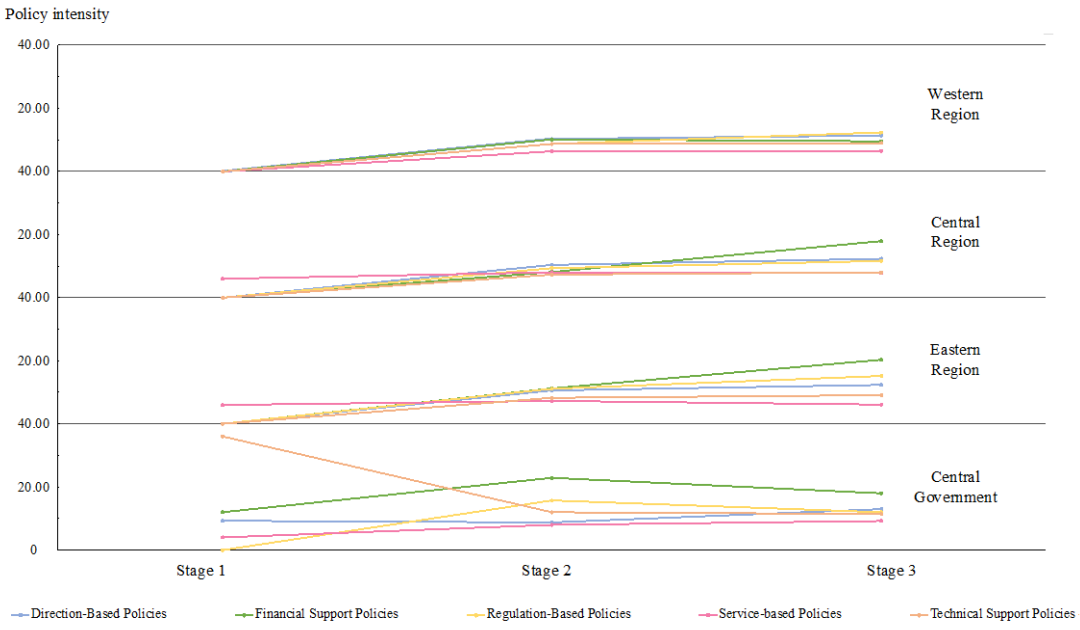


Fig. 7. Policy intensity of GBPs in China.

Fig. **7** displays the average changes in policy intensity for different policy types at the central and local levels during each stage. Significant differences in governments' enforcement of different policies can be observed. In general, SBP gains relatively low attention compared with other types. Besides, except for DBP, the central government generally presents stronger enforcement. The enforcement of FSP is a priority for both the central and local governments to promote GB.

The policy intensity varies for the central government. The policy intensity of SBP demonstrates a continuous upward trend while TSP shows a continuous downward trend. The central government has exerted considerable efforts in enforcing TBP at the very beginning to guarantee the foundation of GB development. The DBP shows a V-shaped trend, while FSP and RBP illustrate an inverse V-shaped trend in the timeline. The central government shifted from TSP in Stage 1 to RBP and FSP in Stage 2 and then to DBP and FSP in Stage 3.

For local governments, most types of policies show increasing policy intensity. All regions show rising policy intensity of RBP, DBP and TSP, reflecting that more attention and improvements are devoted to these policies. However, the results depict obvious regional heterogeneity. On average, the eastern region conducts stronger enforcement, followed by the central and western regions. The eastern region places a high priority on FSP in Stages 2 and 3. In contrast, western and central regions are more proactive in offering financial incentives in Stages 2 and 3, respectively. Specifically, both eastern and western regions exert increasing efforts on financial support policy

518 while the western region decreases the intensity in Stage 3, shifting its focus to RBP.
519 Furthermore, even though RBP ranks second in the eastern region, its policy intensity
520 is still higher than other regions in both stages. The western region stresses RBP in
521 Stage 3, while the central region favours higher DBP policy intensity over RBP in both
522 stages. In addition, the intensity of SBP in eastern and central regions shows a
523 moderately declining trend, while the western region shows a slight increase.

3.5. Summary

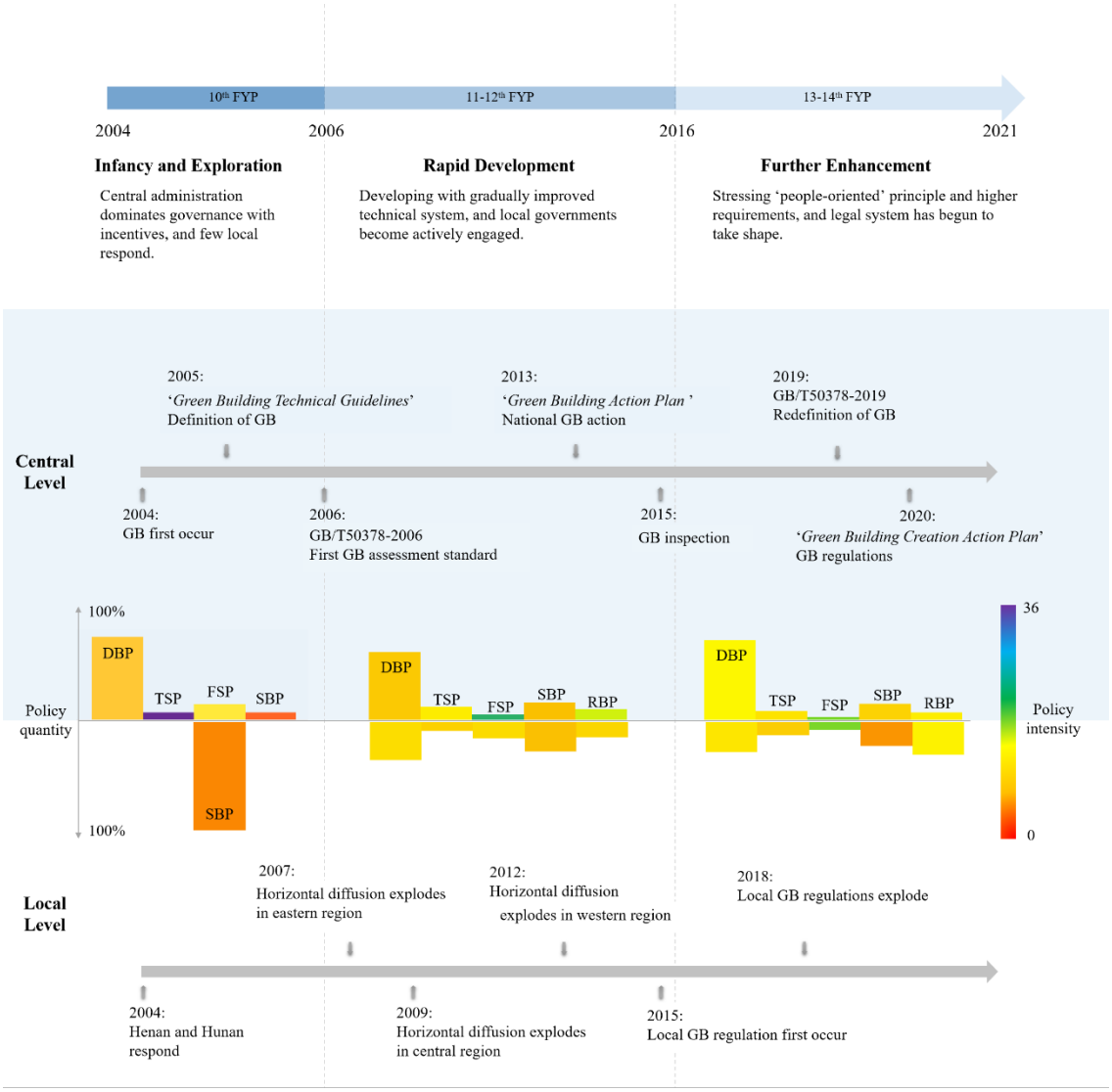


Fig. 8. Chronology of GBP development and milestones in China.

Based on the chronological review of GBP content and the analysis of policy structure and intensity from the above subsections, a comprehensive picture of GBP evolution in China can be presented in Fig. 8. It summarises the GBP milestones from Section 3.2, showing the remarkable transition at different stages. The historical development of GBP evolved from the 'Infancy and Exploration' stage (2004–2005),

532 when there were few local responses, to the ‘Rapid Development’ stage (2006–2015),
533 when a comprehensive technical system developed, and finally entered the ‘Further
534 Enhancement’ stage (2016–2021) towards a legal system.

535 Central and local governments have different policy structures and intensities at
536 each stage. In Stage 1, the central government adopted a more comprehensive and
537 powerful policy structure, while local governments preferred a simple policy
538 framework and were reluctant to implement policies vigorously. In Stage 2, RBPs are
539 introduced into the policy structure at the central and local levels. From the policy
540 quantity and intensity perspective, the central government pays uneven attention to
541 different types. Specifically, it releases many DBPs with low policy intensity, while
542 FSPs and RBPs with minor releases have high policy intensity. In contrast, GBPs issued
543 by local governments are more balanced, with smaller differences in enforcement
544 intensity. The central government emphasises DBPs in Stage 3 and strengthens their
545 implementation. The rest of the GBPs are less of a concern than Stage 2. By contrast,
546 local governments prefer RBP in Stage 3. Except for SBP, the policy intensity of other
547 types increases.

548 To sum up, the GBPs of local governments have generally been improved and
549 strengthened over time; however, the central government has prioritised different
550 policies at different stages and typically focused on policy implementation in Stage 2.
551 Second, FSP, despite its small proportion in terms of quantity, is high in intensity at
552 both central and local levels. Third, local governments have been focusing increasing

attention to RBP and TSP in terms of intensity and quantity. Furthermore, while DBP quantitatively dominates central government policy, its intensity is moderate.

4. Qualitative discussions

Supported by the comprehensive reviews and quantitate analysis of the GBPs, this section conducts an in-depth discussion to summarise the policy achievements, identify policy challenges and propose the corresponding implications. The findings are reported as follows.

4.1. Policy achievements

4.1.1. Establishment of a 'top-down' GB governance system

From the evolution of policy content and spatial-temporal distribution of GBPs (e.g., Figs 3 and 4), a systemic governance system dedicated to promoting GB in China has emerged. Because of the negative environmental impact of the construction industry, the central government has introduced a large portion of DBPs, highlighting its leading role in GB development. Most local governments have responded by correlating with the central government in formulating policies to carry out central mandates. Every accelerated diffusion of GBPs at the local level is related closely to the top-level design at the central level. For example, the '*Green Building Action Pla*n' launched in 2013 and the '*Green Building Creation Action Plan*' launched in 2020.

571 Such a governance system is characterised as a ‘top-down’ mode and has evolved
572 dynamically in various contexts.

573 Specifically, the central government was the main policymaker, and the GB
574 governance remained at the central level in Stage 1. In Stage 2, because of the central
575 government’s lead and strong enforcement, the GB governance extended to the local
576 level, province/municipality- and prefecture-level governments actively complied with
577 the central government’s guidance. In Stage 3, the central and local governments
578 proceeded to overhaul the GB governance system in concert, thereby strengthening
579 supervision by better clarifying responsibilities and conducting inspections of lower-
580 level actors.

581 ### 4.1.2. Perseverance of the centre and increasing response of the local

582 A comparison of the evolution of policy structure and intensity (e.g., Fig. 7 and
583 Table 3) shows that the central government has insisted on its guiding and leading role
584 by successively enacting many DBPs since 2004. Driven by the central government’s
585 initiative and determination to promote GB, the more developed eastern and central
586 regions took the lead in responding to the central policies in Stage 1 but only issued
587 several SBPs with weaker execution. During this initial stage, the policy structure is
588 quite simple at the local level. The western region followed in Stage 2, stepping into
589 GB governance. Since then, increasing attention has been placed on local governments’
590 GB governance, resulting in 30 province/municipality- and 155 prefecture-level

591 governments adopting diverse GBPs for promoting GB by 2021, as well as greater
592 policy enforcement intensity, which has led to the rapid progression of GB in China.

593 4.1.3. Expanded scope and more ambitious target

594 Based on policy content and structure evolution (e.g., Figs 5 and 6), the GBPs have
595 expanded in scope and set a more ambitious target. After decades of development, the
596 scope of GBs has been broadened from a single GB to passive ultra-low energy
597 buildings, prefabricated buildings, nearly zero energy buildings, green ecological urban
598 areas, healthy buildings, zero-carbon buildings and green ecological communities. The
599 scope of GBP guidance has also been extended from the design or operation stage to
600 all life cycle stages. The scope of the GBP framework evolved from single SBPs to
601 comprehensive utilisation of DBPs, SBPs, FSPs, TSPs and RBPs. The scope of GB
602 supervision has been expanded from the supply to the demand side, stressing the
603 regulation of GB users to ensure the GB's efficiency at the operation stage [63].
604 Likewise, the priorities of GB have shifted from resource-saving to reaching harmony
605 between humans and nature, highlighting the 'people-oriented' principle. Moreover,
606 increasing environmental concerns have resulted in the ever-increasing demands for
607 GB promotion. The latest plan sets the target for all new town buildings to be
608 constructed entirely as green buildings by 2025 [66].

4.1.4. Improved and more diverse progression

According to the policy content and its evolution, the GBPs have been gradually improved through diversified and detailed revisions to meet the more ambitious targets. For instance, emerging high-tech, such as 5G, IoT, and artificial intelligence [63], are continuously updated with each revision. Faced with there being very few top-rated and operation-certified GBs in China [26], the GBP has been revised, removing the design-certified label and emphasising high-quality standards. Moreover, to ensure the implementation of GB, the third-party green building evaluation system has been introduced gradually [67,68].

4.1.5. Establishment of a "carrot-and-stick" system

The evolution of policy structure and intensity (e.g., Figs 5, 6 and 7) shows that the FSP made up a relatively large proportion in the initial stage and then gradually decreased, but its intensity increased. RBP is introduced in Stage 2, and its intensity gradually increases. Thus, it is evident that 'carrots', that is, the financial support (FSP), were popular at the beginning stage of GB development, providing incentives to overcome economic barriers. At that time, there were no RBPs at the central and local levels. Realising the 'carrots' were neither sufficient nor efficient to achieve promising progress, the government combined 'sticks', the stricter mandates to promote GB [15,69]. The 'carrot-and-stick' system with strong incentives and supervision began to take shape in Stage 2, replacing the previous single 'carrot' system. Specifically, the

FSP issue has decreased, but its intensity is strong, and RBP has become popular with increasing intensity, especially at the local level. Meanwhile, to supervise the implementation of GB, the upper-level government assigned specific top-down distribution targets that consider regional heterogeneity [70,71]. Fulfilments of such assigned targets would be linked to the performance and promotion of local officials. This help to achieve expanded goals and improve GB promotion.

4.2. Policy challenges and implications

Although the GBPs have been continuously revised and updated to enhance their feasibility at the central and local levels, they still encounter substantial challenges, particularly in the context of a multi-level governance system and an uncertain economic environment. This subsection summarises the key challenges and provides policy implications correspondingly.

4.2.1. Regional inequalities

The spatial distribution of local GBPs varies among regions; the policy quantity, type and intensity have regional imbalances (e.g., Figs 3 and 7 and Table 3). In general, the eastern region enacted the most GBPs and put the highest policy intensity on average to promote GB, followed by the central and western regions. Regarding specific policy types, the eastern region launched more FSPs (12.12%), while the other two opted for different types of policies. The results are rational because of the prolonged regional inequalities in China. Great regional differences and imbalanced

development are China's basic national conditions [72]. The economic capacity of the eastern region is stronger than that of the central and western regions [39]. The central region is geographically close to the eastern region, with middle-level economic capacity among the three regions [73], which may explain why the eastern region is more active in launching GBPs to promote GB, especially by offering financial support policies and imposing stronger policy enforcement. Comparatively, the central region has opted for regulatory-based policies to safeguard GB implementation. However, most are non-GB regulations with insufficient enforcement intensity, which has narrowed the gap with GB development in the eastern region to a certain extent, but remains inefficient.

Combined with Chen et al. [4], regional inequalities lead to uneven distribution of local GBPs, different policy preferences and enforcement intensity and unbalanced GB promotion, which suggests the need to alleviating economic inequality and strengthening regional cooperation. For instance, the central government could apply solely or preferentially specific transfer payments to the poorer provinces for GB development. Furthermore, given that local governments in the eastern region shared more than half of the GB regulations, local governments in the central and western regions should increase their policy intensity and launch more GB regulations in response to the central government's call for GB legislation.

4.2.2. Conflicts of interest under multi-level governance

The Chinese governance system is characterised by largely fiscal decentralised across multi-level governments, but at the same time has a centralised governance structure with strong top-down mandates [74] that leads to inconsistency in the interests of central and local governments, thereby hindering the implementation of GBPs [6,75]. Particularly, the central government is only responsible for setting GBPs and targets [76] and the launched policies often leave space for flexible implementation [77], with local governments responsible for implementing them. Unsurprisingly, some local governments only choose to meet the minimum requirements of GBP due to enforcement costs, economic pressures and 'blame politics' [78,79], resulting in incomplete enforcement, implementation lag, weak efficiency and insufficient incentives for GBPs. For instance, the central government promulgated financial incentives to GB stakeholders in 2012, including 45 Yuan/m^2 for two-star GB and 80 Yuan/m^2 for three-star GB [64]. However, this policy neither clarifies which level(s) the local government should pay nor specifies punishment for noncompliance. Accordingly, local governments flexibly choose to follow this policy based on the fiscal budget. A similar situation also happens with other types of policies, resulting in an unbalanced GB development among cities and, sometimes, collusion between local governments and firms [80–82]. In this sense, regulating and monitoring GBP implementation across local governments from the upper level is an imperative challenge.

689 Currently, the central government is actively playing its guiding role, issuing a
690 large number of DBPs; however, it ignores its regulatory role (with a small proportion
691 of RBPs launched and decreasing enforcement intensity). This ignorance leads to
692 inefficient GBP implementation and GB promotion. Legislation is fundamental to
693 promoting GB [56]. However, the GBP at the central level lacks laws and regulations.
694 Although the central government has introduced central inspections and self-reporting
695 to monitor GB implementation, both methods have limitations. On the one hand, central
696 inspections happen infrequently and are announced to local governments in advance
697 [83], which leaves room for preparation. Self-reporting, on the other hand, requires
698 provincial governments to submit annual self-evaluation reports to the Ministry of
699 Housing and Urban-Rural Development. Nevertheless, self-evaluation is quite
700 susceptible to data manipulation [77]. Hence, there is a need to strengthen the central
701 government's regulating responsibility and conduct top-level design of GBP involving
702 relevant laws and detailed law-enforcement implementation requirements at the central
703 level. Introducing random inspections and public release into regulation-based policies
704 is also suggested to further guarantee the GBP implementation.

705 ### 4.2.3. Convergence in policy content

706 Based on content review, although central and local governments have different
707 combinations of policy types, a convergence in their policy content can be observed.
708 From a vertical perspective, lower-level governments often simply follow the GBP

framework of upper-level governments, adjusting a few goals and policy tools, especially regarding DBPs. From a horizontal perspective, the content of regulations issued by local governments is almost the same; the main difference is the amount of fines. The attitudes of local governments toward policy innovation are compulsively risk-averse, making them overly conservative in formulating their policies. Thus, it is recommended that local governments conduct policy innovations according to the heterogeneity of cities rather than copy or imitate GBPs in other regions.

4.2.4. Information disclosure

Second to direction-based policy, the service-based policy has received fairly considerable attention from central and most local governments. Still, its policy intensity is relatively low, and over time, it has become less popular at the local level. This type of policy covers pilot, organisation, professional training, declaration and information dissemination. Governments at all levels focus mainly on organisation, professional training and declaration, which provides a solid foundation for cultivating experiences and qualified professionals, thereby facilitating the development of GB. However, SBPs appear to lack information disclosure measures, which make it hard for the public and governments to acquire nationwide GB information, such as GB labels and building energy consumption. Lack of transparency reduces the public's enthusiasm to participate in GB development and reduces the efficiency of the government's monitoring of GB. As a response, great efforts should be made by all

levels of government to develop and enforce information disclosure measures in SBPs, such as carrying out a national unified information disclosure platform.

4.2.5. Unsustainable financial support

Subsidies from the central and local governments are the most common financial supporting tool available in China's GBP to boost GB. Despite the subsidy compensating GB developers' costs, it is unsustainable in the long term and could not yield promising outcomes. First, fluctuations in local fiscal revenues create uncertainty in such incentive schemes and cannot ensure the long-term availability of subsidies. The COVID-19 pandemic has exacerbated this uncertainty. Consequently, risk-averse developers might decide against overcommitting to future GB development [84]. Second, as the subsidies vanish at the different levels of government, GB developers show less enthusiasm for subsidies because they could not obtain much money [85]. Finally, an immature market environment and incremental operating costs lead GB developers to intentionally give up subsidies [86].

Hence, it is suggested that a market-oriented green finance system be established to realise the self-sustainability of GB development, rather than relying solely on monetary rewards. Moreover, the financial support in the current GBP system is concentrated mainly on the supply side, with insufficient attention to the demand side. Zhang et al. [26] highlighted the obvious positive effect of financial incentives on the demand side of GBs. In this connection, demand-side incentives should be embodied

749 as an essential aspect of future policy development because they are not well
750 represented in the current policy content.

751 5. Conclusion

752 This study systematically reviews the development and characteristics of China's
753 GBPs of central and local governments from 2004 to 2021 using mixed content analysis.
754 Through mining and understanding of the 1429 GBPs texts, the evolution is divided
755 into three stages: 1) the infancy and exploration stage with few local responses (2004–
756 2005); 2) the rapid development stage accompanied by comprehensive technical system
757 development (2006–2015) and 3) the further enhancement stage towards a legal system
758 (2016–2021), each of which is characterised by a distinctive policy intensity and
759 structure at central and local levels.

760 The results reveal that the central government continuously stresses its guiding
761 role by launching a large number of DBPs (accounting for 63.81% out of total central
762 GBPs). Second, instead of only issuing SBPs in Stage 1 (accounting for 100% out of
763 total local GBPs), local governments place increasing attention on launching and
764 enforcing various GBPs, taking RBPs as the main tool in Stage 3 (accounting for 30.35%
765 out of total local GBPs). Third, the GB governance system is shown to have a 'top-
766 down' pattern, and China has set more ambitious targets, achieved improved and more
767 diverse progress and established a 'carrot-and-stick' system.

768 Although the GBPs have made remarkable achievements and improvements, it
769 still encounters several challenges, especially under the multi-level governance system
770 and uncertain economic contexts. 1) Regional inequalities, 2) conflicts of interest under
771 multi-level governance, 3) convergence in policy content, 4) information disclosure and
772 5) unsustainable financial support are highlighted to draw the policymakers' attention.
773 The corresponding policy implications are proposed as follows: 1) alleviating economic
774 inequality and promoting regional cooperation, 2) improving legal and regulatory
775 systems and strengthening the central government's regulating responsibility, 3)
776 conducting policy innovations according to the regional heterogeneity, 4) developing
777 and enforcing information disclosure measures and 5) establishing a market-oriented
778 green finance system.

779 The contributions of this study are as follows. In theory, this study provides a
780 holistic summary of the evolution of China's GBP under a multi-level governance
781 system, extending the knowledge of GBP development in the aspects of achievements,
782 challenges and implications. Moreover, the proposed mixed content analysis method
783 successfully reveals the characteristics and evolution of GBP from a huge dataset of
784 central and local policy documents. In practice, this study demonstrates a full picture
785 of China's GBPs at the central and local levels, which serve as a theoretical basis for
786 Chinese governments to optimise and design future GBPs and provide practitioners and
787 researchers with a comprehensive understanding of current GBPs. In addition, the

Chinese lesson may also potentially shed light on other countries with related political agendas.

Extensively, the proposed methodology can be applied to other countries and other fields to discover their policy historical development, achievements and barriers. Future work could be extended to compare the GBPs system between China and other countries. Moreover, although current data can reveal differences in GBPs among eastern, central and western regions, the policy analysis at the city level could be a meaningful research point as more prefectures within provinces release GBPs in the future.

CRediT authorship contribution statement

Qidan Hu: Conceptualisation, Writing – original draft, Visualisation, Writing – review & editing. Jin Xue: Writing – review & editing, Methodology. Rongsheng Liu: Writing – review & editing, Visualisation, Methodology. Geoffrey Qiping Shen: Writing – review & editing, Supervision. Feng Xiong: Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] A.E. Ikudayisi, A.P.C. Chan, A. Darko, O.B. Adegun, Integrated design process of green building projects: A review towards assessment metrics and conceptual framework, Journal of Building Engineering. 50 (2022) 104180. https://doi.org/10.1016/j.jobe.2022.104180.

[2] U.E.P. Global Alliance for Buildings and Construction, 2021 Global Status Report for Buildings and Construction, 2021. https://globalabc.org/resources/publications/2021-global-status-report-buildings-and-construction (accessed June 23, 2022).

[3] C.A. of B.E.E. CABEE, 2021 China Building Energy Consumption and Carbon Emission Research Report, 2021. https://www.cabee.org/site/content/24237.html (accessed June 23, 2022).

[4] L. Chen, A.P.C. Chan, A. Darko, X. Gao, Spatial-temporal investigation of green building promotion efficiency: The case of China, Journal of Cleaner Production. 362 (2022) 132299. https://doi.org/10.1016/j.jclepro.2022.132299.

[5] Z. Liu, Z. Deng, G. He, H. Wang, X. Zhang, J. Lin, Y. Qi, X. Liang, Challenges and opportunities for carbon neutrality in China, Nat Rev Earth Environ. 3 (2022) 141–155. https://doi.org/10.1038/s43017-021-00244-x.

[6] Y. Zou, W. Zhao, R. Zhong, The spatial distribution of green buildings in China: Regional imbalance, economic fundamentals, and policy incentives, Applied Geography. 88 (2017) 38–47. https://doi.org/10.1016/j.apgeog.2017.08.022.

[7] R. Friedman, G. Rosen, Policy entrepreneurs in green building transitions: The role of interurban coalitions, Environmental Innovation and Societal Transitions. 43 (2022) 160–172. https://doi.org/10.1016/j.eist.2022.03.009.

[8] W.G.B.C. WorldGBC, What is green building?, World Green Building Council. (2022). https://www.worldgbc.org/what-green-building (accessed July 31, 2022).

[9] B.-G. Hwang, L. Zhu, J.T.T. Ming, Factors Affecting Productivity in Green Building Construction Projects: The Case of Singapore, Journal of Management in Engineering. 33 (2017) 04016052. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000499.

[10] B.-J. He, Towards the next generation of green building for urban heat island mitigation: Zero UHI impact building, Sustainable Cities and Society. 50 (2019) 101647. https://doi.org/10.1016/j.scs.2019.101647.

[11] A. Darko, C. Zhang, A.P.C. Chan, Drivers for green building: A review of empirical studies, Habitat International. 60 (2017) 34–49. https://doi.org/10.1016/j.habitatint.2016.12.007.

[12] J. Zuo, Z.-Y. Zhao, Green building research–current status and future agenda: A review, Renewable and Sustainable Energy Reviews. 30 (2014) 271–281. https://doi.org/10.1016/j.rser.2013.10.021.

[13] L. Mozingo, E. Arens, Quantifying the Comprehensive Greenhouse Gas Co-Benefits of Green Buildings, (2014). https://escholarship.org/uc/item/935461rm (accessed June 23, 2022).

852 [14] Q. Shi, Y. Yan, J. Zuo, T. Yu, Objective conflicts in green buildings projects: A
853 critical analysis, Building and Environment. 96 (2016) 107–117.
854 https://doi.org/10.1016/j.buildenv.2015.11.016.
855 [15] S.D. Sentman, S.T. Del Percio, P. Koerner, A Climate for Change: Green
856 Building Policies, Programs, and Incentives, Journal of Green Building. 3 (2008)
857 46–63. https://doi.org/10.3992/jgb.3.2.46.
858 [16] Y. Shen, M. Faure, Green building in China, Int Environ Agreements. 21 (2021)
859 183–199. https://doi.org/10.1007/s10784-020-09495-3.
860 [17] D.C. Matisoff, D.S. Noonan, M.E. Flowers, Policy Monitor—Green Buildings:
861 Economics and Policies, Review of
862 Environmental Economics and Policy. 10 (2016) 329–346.
863 https://doi.org/10.1093/reep/rew009.
864 [18] L. Chen, A.P.C. Chan, E.K. Owusu, A. Darko, X. Gao, Critical success factors
865 for green building promotion: A systematic review and meta-analysis, Building
866 and Environment. 207 (2022) 108452.
867 https://doi.org/10.1016/j.buildenv.2021.108452.
868 [19] H. Li, S.T. Ng, M. Skitmore, Stakeholder impact analysis during post-occupancy
869 evaluation of green buildings – A Chinese context, Building and Environment.
870 128 (2018) 89–95. https://doi.org/10.1016/j.buildenv.2017.11.014.

871 [20] M. Sharma, Development of a ‘Green building sustainability model’ for Green
872 buildings in India, Journal of Cleaner Production. 190 (2018) 538–551.
873 https://doi.org/10.1016/j.jclepro.2018.04.154.
874 [21] Y. Li, G. Wang, J. Zuo, Assessing Green-Building Policies with Structural
875 Consistency and Behavioral Coherence: A Framework of Effectiveness and
876 Efficiency, Journal of Construction Engineering and Management. 147 (2021)
877 04021149. https://doi.org/10.1061/(ASCE)CO.1943-7862.0002178.
878 [22] Q. Shi, X. Lai, X. Xie, J. Zuo, Assessment of green building policies – A fuzzy
879 impact matrix approach, Renewable and Sustainable Energy Reviews. 36 (2014)
880 203–211. https://doi.org/10.1016/j.rser.2014.04.076.
881 [23] C.-F.J. Kuo, C.-H. Lin, M.-W. Hsu, M.-H. Li, Evaluation of intelligent green
882 building policies in Taiwan – Using fuzzy analytic hierarchical process and
883 fuzzy transformation matrix, Energy and Buildings. 139 (2017) 146–159.
884 https://doi.org/10.1016/j.enbuild.2016.12.078.
885 [24] F. Kong, L. He, Impacts of supply-sided and demand-sided policies on
886 innovation in green building technologies: A case study of China, Journal of
887 Cleaner Production. 294 (2021) 126279.
888 https://doi.org/10.1016/j.jclepro.2021.126279.
889 [25] Y. Song, C. Li, L. Zhou, X. Huang, Y. Chen, H. Zhang, Factors affecting green
890 building development at the municipal level: A cross-sectional study in China,

Energy and Buildings. 231 (2021) 110560.
https://doi.org/10.1016/j.enbuild.2020.110560.
[26] L. Zhang, J. Wu, H. Liu, Policies to enhance the drivers of green housing development in China, Energy Policy. 121 (2018) 225–235.
https://doi.org/10.1016/j.enpol.2018.06.029.
[27] X. Cao, T. Zhao, Z. Xing, How Do Government Policies Promote Green Housing Diffusion in China? A Complex Network Game Context, International Journal of Environmental Research and Public Health. 19 (2022) 2238.
https://doi.org/10.3390/ijerph19042238.
[28] L. Chen, X. Gao, C. Hua, S. Gong, A. Yue, Evolutionary process of promoting green building technologies adoption in China: A perspective of government, Journal of Cleaner Production. 279 (2021) 123607.
https://doi.org/10.1016/j.jclepro.2020.123607.
[29] Q. Feng, H. Chen, X. Shi, J. Wei, Stakeholder games in the evolution and development of green buildings in China: Government-led perspective, Journal of Cleaner Production. 275 (2020) 122895.
https://doi.org/10.1016/j.jclepro.2020.122895.
[30] Q. Meng, Y. Liu, Z. Li, C. Wu, Dynamic reward and penalty strategies of green building construction incentive: an evolutionary game theory-based analysis, Environ Sci Pollut Res. 28 (2021) 44902–44915. https://doi.org/10.1007/s11356-021-13624-z.

912 [31] Y. Tan, T. Luo, X. Xue, G.Q. Shen, G. Zhang, L. Hou, An empirical study of
913 green retrofit technologies and policies for aged residential buildings in Hong
914 Kong, Journal of Building Engineering. 39 (2021) 102271.
915 https://doi.org/10.1016/j.jobe.2021.102271.
916 [32] G. Liu, Y. Tan, X. Li, China's policies of building green retrofit: A state-of-the-
917 art overview, Building and Environment. 169 (2020) 106554.
918 https://doi.org/10.1016/j.buildenv.2019.106554.
919 [33] Z. Wu, Q. He, K. Yang, J. Zhang, K. Xu, Investigating the Dynamics of China's
920 Green Building Policy Development from 1986 to 2019, International Journal of
921 Environmental Research and Public Health. 18 (2021) 196.
922 https://doi.org/10.3390/ijerph18010196.
923 [34] B. Zhu, C. Liu, C. Wei, Urban residential heating policy in China: A review,
924 Energy and Buildings. 253 (2021) 111547.
925 https://doi.org/10.1016/j.enbuild.2021.111547.
926 [35] Q. Zhang, Q. Lu, D. Zhong, X. Ye, The Pattern of Policy Change on Disaster
927 Management in China: A Bibliometric Analysis of Policy Documents, 1949–
928 2016, Int J Disaster Risk Sci. 9 (2018) 55–73. https://doi.org/10.1007/s13753-
929 018-0164-y.
930 [36] C. Yang, C. Huang, Quantitative mapping of the evolution of AI policy
931 distribution, targets and focuses over three decades in China, Technological

Forecasting and Social Change. 174 (2022) 121188. https://doi.org/10.1016/j.techfore.2021.121188.

[37] H. Yao, C. Zhang, A bibliometric study of China's resource recycling industry policies: 1978–2016, Resources, Conservation and Recycling. 134 (2018) 80–90. https://doi.org/10.1016/j.resconrec.2018.03.008.

[38] H. Du, Y. Guo, Z. Lin, Y. Qiu, X. Xiao, Effects of the joint prevention and control of atmospheric pollution policy on air pollutants-A quantitative analysis of Chinese policy texts, Journal of Environmental Management. 300 (2021) 113721. https://doi.org/10.1016/j.jenvman.2021.113721.

[39] C.C. Fan, M. Sun, Regional Inequality in China, 1978-2006, Eurasian Geography and Economics. 49 (2008) 1–18. https://doi.org/10.2747/1539-7216.49.1.1.

[40] H. Peng, Y. Liu, A comprehensive analysis of cleaner production policies in China, Journal of Cleaner Production. 135 (2016) 1138–1149. https://doi.org/10.1016/j.jclepro.2016.06.190.

[41] W.A. Scott, Reliability of Content Analysis: The Case of Nominal Scale Coding, The Public Opinion Quarterly. 19 (1955) 321–325. https://www.jstor.org/stable/2746450 (accessed June 19, 2022).

[42] R. Weber, Basic Content Analysis, SAGE Publications, Inc., 2455 Teller Road, Thousand Oaks California 91320 United States of America, 1990. https://doi.org/10.4135/9781412983488.

953 [43] S. Stemler, An overview of content analysis, Practical Assessment, Research,
954 and Evaluation. 7 (2019). https://doi.org/10.7275/z6fm-2e34.
955 [44] B. Sun, M. Baker, Towards an analytical governance framework within the
956 policy dimension in China: the evolution of national climate policies since 1978,
957 Journal of Environmental Planning and Management. 64 (2021) 202–223.
958 https://doi.org/10.1080/09640568.2020.1760800.
959 [45] Y. Tan, G. Liu, Y. Zhang, C. Shuai, G.Q. Shen, Green retrofit of aged residential
960 buildings in Hong Kong: A preliminary study, Building and Environment. 143
961 (2018) 89–98. https://doi.org/10.1016/j.buildenv.2018.06.058.
962 [46] Z. Liao, The evolution of wind energy policies in China (1995–2014): An
963 analysis based on policy instruments, Renewable and Sustainable Energy
964 Reviews. 56 (2016) 464–472. https://doi.org/10.1016/j.rser.2015.11.097.
965 [47] O.R. Holsti, Content analysis for the social sciences and humanities, Addison-
966 Wesley Pub. Co, Reading, Mass., 1969. https://bac-
967 lac.on.worldcat.org/oclc/489602701 (accessed October 18, 2022).
968 [48] M. Xie, Y. Qiu, Y. Liang, Y. Zhou, Z. Liu, G. Zhang, Policies, applications,
969 barriers and future trends of building information modeling technology for
970 building sustainability and informatization in China, Energy Reports. 8 (2022)
971 7107–7126. https://doi.org/10.1016/j.egyr.2022.05.008.

[49] J. Lee Rodgers, W.A. Nicewander, Thirteen Ways to Look at the Correlation Coefficient, The American Statistician. 42 (1988) 59–66. https://doi.org/10.1080/00031305.1988.10475524.

[50] K. Pearson, Notes on Regression and Inheritance in the Case of Two Parents Proceedings of the Royal Society of London, 58, 240-242, K Pearson. (1895).

[51] G. Zhang, Y. Gao, J. Li, B. Su, Z. Chen, W. Lin, China's environmental policy intensity for 1978–2019, Sci Data. 9 (2022) 75. https://doi.org/10.1038/s41597-022-01183-y.

[52] G. Zhang, P. Zhang, J. Xiu, J. Chai, Are energy conservation and emission reduction policy measures effective for industrial structure restructuring and upgrading?, Chinese Journal of Population Resources and Environment. 16 (2018) 12–27. https://doi.org/10.1080/10042857.2017.1418267.

[53] S. GU, M. XUE, X. GUO, Evaluation on the Administrative Ability of Sichuan, Shaanxi and Chongqing Governments to Promote Scientific and Technological Development——Based on the Perspective of Science and Technology Policy (in Chinese), Soft Science. 36 (2022) 8-14+22. https://doi.org/10.13956/j.ss.1001-8409.2022.02.02.

[54] C. Liu, B. Zhu, J. Ni, C. Wei, Residential coal-switch policy in China: Development, achievement, and challenge, Energy Policy. 151 (2021) 112165. https://doi.org/10.1016/j.enpol.2021.112165.

992 [55] H. Zhang, J. Huang, R. Hu, D. Zhou, H. ur R. Khan, C. Ma, Echelon utilization
993 of waste power batteries in new energy vehicles: Review of Chinese policies,
994 Energy. 206 (2020) 118178. https://doi.org/10.1016/j.energy.2020.118178.
995 [56] Y. Li, L. Yang, B. He, D. Zhao, Green building in China: Needs great
996 promotion, Sustainable Cities and Society. 11 (2014) 1–6.
997 https://doi.org/10.1016/j.scs.2013.10.002.
998 [57] M. of H.& U.-R.D. MOHURD, Notice of the Ministry of Construction on
999 Printing and Distributing the “Administrative Measures for the National Green
1000 Building Innovation Award,” (2004).
1001 http://182.150.59.104:8888/https/77726476706e69737468656265737421e7e056
1002 d2373b7d5c7f1fc7af9758/chl/f82af568e3a9dce5bdfb.html?keyword=%E7%BB
1003 %BF%E8%89%B2%E5%BB%BA%E7%AD%91%2B%E5%8F%AF%E6%8C
1004 %81%E7%BB%AD%E5%BB%BA%E7%AD%91%2B%E8%8A%82%E8%83
1005 %BD%E5%BB%BA%E7%AD%91%20 (accessed April 18, 2022).
1006 [58] M. of H. and U.-R.D. MOHURD, Notice of the Ministry of Construction on
1007 Organizing the Application for the 2005 Science and Technology Plan Projects
1008 (in Chinese), (2005).
1009 http://182.150.59.104:8888/https/77726476706e69737468656265737421e7e056
1010 d2373b7d5c7f1fc7af9758/chl/3a2c4b78e4092b72bdfb.html?keyword=%E7%BB
1011 %BF%E8%89%B2%E5%BB%BA%E7%AD%91%2B%E5%8F%AF%E6%8C

%81%E7%BB%AD%E5%BB%BA%E7%AD%91%2B%E8%8A%82%E8%83
%BD%E5%BB%BA%E7%AD%91%20 (accessed April 18, 2022).
[59] M. of H. and U.-R.D. MOHURD, M. of S. and T. MOST, Notice of the Ministry of Construction and the Ministry of Science and Technology on Printing and Distributing the “Technical Guidelines for Green Buildings” (in Chinese), (2005). http://182.150.59.104:8888/https/77726476706e69737468656265737421e7e056d2373b7d5c7f1fc7af9758/chl/5b2a7825edef7adabdfb.html?tiao=1&keyword=%E7%BB%BF%E8%89%B2%E5%BB%BA%E7%AD%91%2B%E5%8F%AF%E6%8C%81%E7%BB%AD%E5%BB%BA%E7%AD%91%2B%E8%8A%82%E8%83%BD%E5%BB%BA%E7%AD%91%20 (accessed April 18, 2022).
[60] China Academy of Building Research, Zhong guo lv se jian zhu biao zhun gui fan hui gu yu zhan wang [Review and Prospect of China’s Green Building Standards] (in Chinese), China Architecture & Building Press, Beijing, 2017.
[61] L. Ye, Z. Cheng, Q. Wang, H. Lin, C. Lin, B. Liu, Developments of Green Building Standards in China, Renewable Energy. 73 (2015) 115–122. https://doi.org/10.1016/j.renene.2014.05.014.
[62] X.-J. Li, C. Wang, W. Chen, S. Bora, J.B.H. Yap, B. Samuel, Green building performance assessment in China using a cloud model, Environ Dev Sustain. (2021). https://doi.org/10.1007/s10668-021-01926-8.

[63] M. of H. and U.-R.D. MOHURD, N.D. and R.C. NDRC, M. of E. MOE, M. of I. and I.T. MOIIT, the P.B. of C. PBOC, S.A. of the P.B. of C. SAOPBC, C.B. and I.R.C. CBIRC, Notice of the Ministry of Housing and Urban-Rural Development, the National Development and Reform Commission, the Ministry of Education, the Ministry of Industry and Information Technology, the People's Bank of China, the State Administration of the People's Bank of China, and the China Banking and Insurance Regulatory Commission on Issuing the Green Building Creation Action Plan (in Chinese), (2020). http://www.gov.cn/zhengce/zhengceku/2020-07/24/content_5529745.htm (accessed May 18, 2022).

[64] M. of F. MOF, M. of H.& U.-R.D. MOHURD, Implementation Opinions of the Ministry of Finance and the Ministry of Housing and Urban-Rural Development on Accelerating the Development of Green Building in China (in Chinese), (2012). http://www.gov.cn/zwgk/2012-05/07/content_2131502.htm.

[65] A. Darko, A.P.C. Chan, Review of Barriers to Green Building Adoption, Sustainable Development. 25 (2017) 167–179. https://doi.org/10.1002/sd.1651.

[66] S.C. SC, Notice by the State Council Regarding Issuing the Comprehensive Work Plan for Energy Conservation and Emission Reduction for the "14th Five-Year Plan" Period (in Chinese), (2021). http://www.gov.cn/zhengce/content/2022-01/24/content_5670202.htm.

[67] M. of H.& U.-R.D. MOHURD, Notice of the General Office of the Ministry of Housing and Urban-Rural Development on the management of green building evaluation labels (in Chinese), (2015). https://www.pkulaw.com/chl/feeac9e233c43d7cbdfb.html?keyword=%E4%BD%8F%E6%88%BF%E5%9F%8E%E4%B9%A1%E5%BB%BA%E8%AE%BE%E9%83%A8%E5%8A%9E%E5%85%AC%E5%8E%85%E5%85%B3%E4%BA%8E%E7%BB%BF%E8%89%B2%E5%BB%BA%E7%AD%91%E8%AF%84%E4%BB%B7%E6%A0%87%E8%AF%86%E7%AE%A1%E7%90%86%E6%9C%89%E5%85%B3%E5%B7%A5%E4%BD%9C%E7%9A%84%E9%80%9A%E7%9F%A5 (accessed June 13, 2022).

[68] M. of H.& U.-R.D. MOHURD, Notice of the Ministry of Housing and Urban-Rural Development on Further Standardizing the Evaluation and Management of Green Buildings (in Chinese), (2017). http://www.gov.cn/xinwen/2017-12/23/content_5249727.htm (accessed June 13, 2022).

[69] O.A. Olubunmi, P.B. Xia, M. Skitmore, Green building incentives: A review, Renewable and Sustainable Energy Reviews. 59 (2016) 1611–1621. https://doi.org/10.1016/j.rser.2016.01.028.

[70] M. of H.& U.-R.D. MOHURD, “Twelfth Five-Year” green building and green eco-city development plan (in Chinese), (2013). http://www.gov.cn/gongbao/content/2013/content_2441025.htm (accessed June 13, 2022).

[71] M. of H.& U.-R.D. MOHURD, Notice on Printing and Distributing the “Twelfth Five-Year” Building Energy Conservation Special Plan (in Chinese), (2012). http://www.gov.cn/zwgk/2012-05/31/content_2149889.htm (accessed June 13, 2022).

[72] Z. Xin-gang, L. Fan, Spatial distribution characteristics and convergence of China’s regional energy intensity: An industrial transfer perspective, Journal of Cleaner Production. 233 (2019) 903–917. https://doi.org/10.1016/j.jclepro.2019.06.073.

[73] S. Zhou, C. Zhou, Evaluation of China’s low-carbon city pilot policy: Evidence from 210 prefecture-level cities, PLOS ONE. 16 (2021) e0258405. https://doi.org/10.1371/journal.pone.0258405.

[74] X. ZHANG, Fiscal decentralization and political centralization in China: Implications for growth and inequality, in: Regional Inequality in China, Routledge, 2009.

[75] K. Lieberthal, M. Oksenberg, Policy Making in China: Leaders, Structures, and Processes, Princeton University Press, 1988.

[76] G. Kostka, Command without control: The case of China’s environmental target system, Regulation & Governance. 10 (2016) 58–74. https://doi.org/10.1111/rego.12082.

1092 [77] K. Lo, China's low-carbon city initiatives: The implementation gap and the
1093 limits of the target responsibility system, Habitat International. 42 (2014) 236–
1094 244. https://doi.org/10.1016/j.habitatint.2014.01.007.
1095 [78] Ran R., Understanding Blame Politics in China's Decentralized System of
1096 Environmental Governance: Actors, Strategies and Context, The China
1097 Quarterly. 231 (2017) 634–661. https://doi.org/10.1017/S0305741017000911.
1098 [79] Y. Zhou, Qujing (取经) as policy mobility with Chinese characteristics: A case
1099 study of ultralow-energy building policy in China, Environ Plan A. 53 (2021)
1100 410–427. https://doi.org/10.1177/0308518X20960736.
1101 [80] P.G. Fredriksson, D.L. Millimet, Strategic Interaction and the Determination of
1102 Environmental Policy across U.S. States, Journal of Urban Economics. 51 (2002)
1103 101–122. https://doi.org/10.1006/juec.2001.2239.
1104 [81] Y. Qian, G. Roland, Federalism and the Soft Budget Constraint, The American
1105 Economic Review. 88 (1998) 1143–1162. https://www.jstor.org/stable/116864
1106 (accessed June 20, 2022).
1107 [82] H. Wu, Y. Li, Y. Hao, S. Ren, P. Zhang, Environmental decentralization, local
1108 government competition, and regional green development: Evidence from China,
1109 Science of The Total Environment. 708 (2020) 135085.
1110 https://doi.org/10.1016/j.scitotenv.2019.135085.

[83] K. Lo, Governing energy consumption in China: a comprehensive assessment of the energy conservation target responsibility system, Energy Transit. 4 (2020) 57–67. https://doi.org/10.1007/s41825-020-00023-0.

[84] Y. Liu, Y. Lu, Z. Hong, V. Nian, T.S.A. Loi, The “START” framework to evaluate national progress in green buildings and its application in cases of Singapore and China, Environmental Impact Assessment Review. 75 (2019) 67–78. https://doi.org/10.1016/j.eiar.2018.12.007.

[85] Y. Zhou, State power and environmental initiatives in China: Analyzing China’s green building program through an ecological modernization perspective, Geoforum. 61 (2015) 1–12. https://doi.org/10.1016/j.geoforum.2015.02.002.

[86] H. Yang, Abandoning subsidy: confusion and reflection on the subsidy policy of green building in Shenzhen (in Chinese), Residential and Real Estate. (2019) 34–38. https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CJFD&dbname=CJFDLAST2019&filename=ZZFD201926008&uniplatform=NZKPT&v=APmCVgbxCRe5JG5CA8aNWydxm4Jmeo1eYo0cnxKXszcYbwBBCkhXVk3l6ZGBEdm4 (accessed June 17, 2022).

Appendix A

Table A

Distribution of policy types for each province/municipality.

Region	Direction-Based Policies	Financial Support Policies	Service-Based Policies	Regulation-Based Policies	Technical Support Policies
			Eastern Region		
Beijing	8	5	8	1	7
Fujian	20	8	31	21	13
Guangdong	36	9	16	28	9
Hainan	8	1	11	6	1
Hebei	28	10	12	16	15
Jiangsu	18	7	27	16	3
Liaoning	8	1	4	5	3
Shandong	27	18	34	16	1
Shanghai	8	3	6	5	2
Tianjin	8	2	2	4	6
Zhejiang	30	15	18	13	12
			Central Region		
Anhui	25	12	42	25	5
Henan	13	10	10	6	3
Heilongjiang	19	0	4	12	2
Hubei	25	5	10	23	2
Hunan	14	7	10	9	5
Jilin	8	0	5	6	2
Jiangxi	10	2	3	12	5
Shanxi	8	3	1	6	1
			Western Region		
Gansu	11	3	6	4	3
Guangxi	10	1	6	18	12
Guizhou	7	3	13	5	1
Inner Mongolia	11	7	6	2	0
Ningxia	7	2	5	3	1
Qinghai	5	2	5	4	2
Shaanxi	11	3	4	4	1
Sichuan	8	3	1	4	1
Xinjiang	7	6	2	1	0
Yunnan	3	0	0	1	0
Chongqing	15	2	26	12	17

Appendix B

Table B

Distribution of policy intensity for each province/municipality.

Region	Eastern Region									
	Beijing	Fujian	Guangdong	Hainan	Hebei	Jiangsu	Liaoning	Shandong	Shanghai	Tianjin
Stage 1	0	0	0	0	6	0	0	0	0	0
Stage 2	10.7	7.33	9.19	7.94	8.63	10.9	11.3	11.9	11.3	8.44
Stage 3	11.7	10.1	12.8	9.82	13.3	11.3	11.4	9.64	9.42	18.5
Region		Central Region								Western Region
	Zhejiang	Anhui	Henan	Heilongjiang	Hubei	Hunan	Jilin	Jiangxi	Shanxi	Gansu
Stage 1	0	0	0	0	0	6	0	0	0	0
Stage 2	12.2	9.15	7.13	7.31	9	9.71	11.7	9.9	11	7.36
Stage 3	14.7	14.38	12.9	8.78	10.7	11.7	12.8	8.55	7	8.08
Region	Western Region									
	Guangxi	Guizhou	Inner Mongolia	Ningxia	Qinghai	Shaanxi	Sichuan	Xinjiang	Yunnan	Chongqing
Stage 1	0	0	0	0	0	0	0	0	0	0
Stage 2	6.09	6.8	9.94	9.11	9	12.1	8.42	9.57	18	8.94
Stage 3	7.5	11.3	14.3	17.7	9.82	10.8	15.9	9	12	9.17