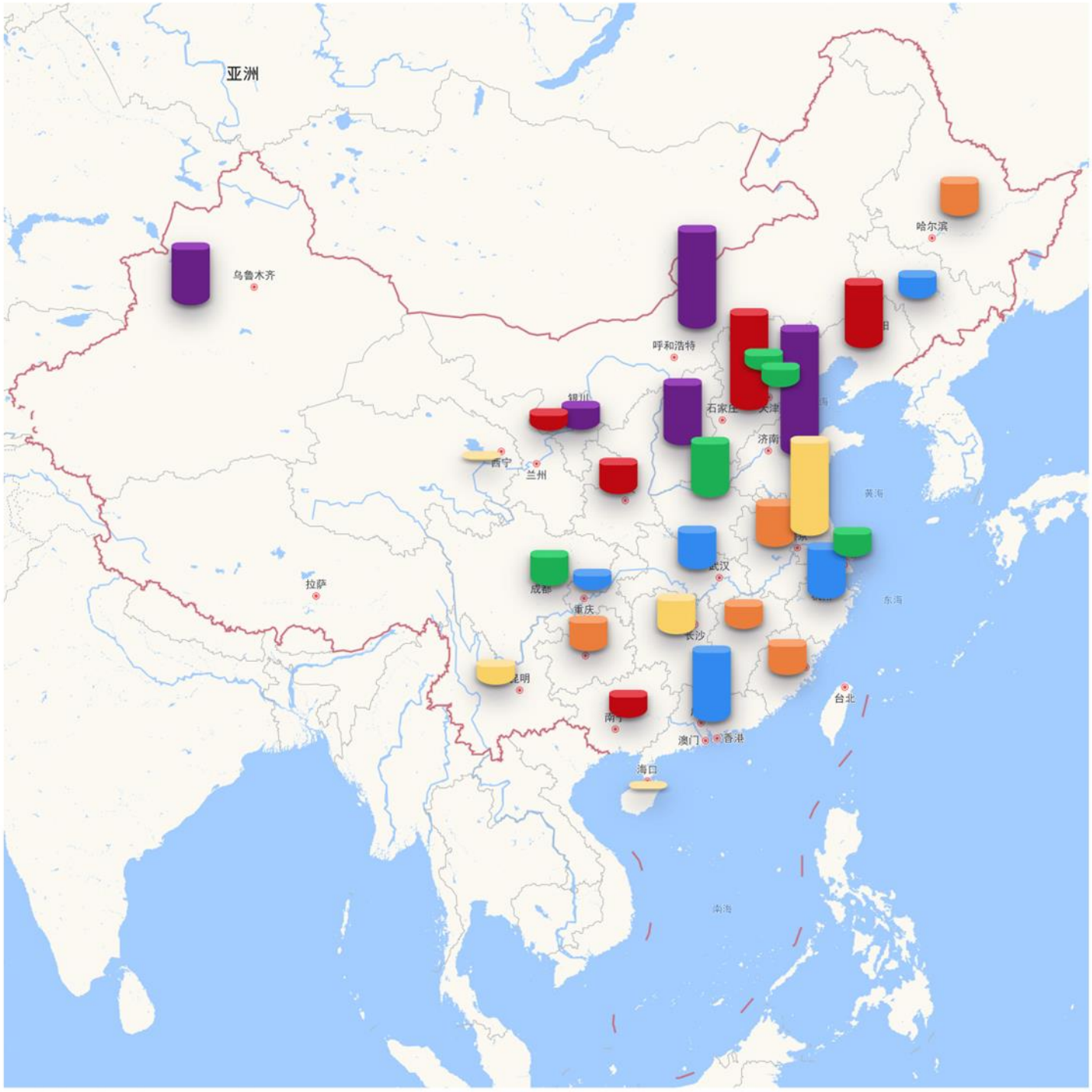
Chinese Province Carbon Peak & Carbon Neutrality Index

（2020-2021） Summary Report



Research Group on Chinese Province Carbon Peak & Carbon Neutrality Index

2021/06

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Background and Significance

China has solemnly committed to peak carbon emissions by 2030 and achieve carbon neutrality by 2060. These aims are collectively referred to as the “dual carbon” goal, which was a major strategic decision taken after careful consideration by the Party Central Committee led by President Xi Jinping. Achieving this “dual carbon” goal as scheduled will require high-quality socioeconomic development throughout China. In addition, China must achieve this goal to support its image as a responsible major country and to promote the construction of a community with a shared vision for the future for mankind.

The Central Economic Working Conference, which was held from December 16 to 18, 2020, prioritized the development of plans to reach carbon peak and achieve carbon neutrality as one of the eight key tasks for the country in 2021. In particular, the conference stated the need to accelerate the formulation of action plans to reach carbon peak before 2030 and to support provinces with ideal conditions to take the lead to peak carbon emissions.

On March 15, 2021, the ninth meeting of the Central Finance and Economics Committee announced that extensive and profound systematic socioeconomic changes would be required to peak carbon emissions and achieve carbon neutrality. Consequently, to achieve the “dual carbon” goal as scheduled, it must be incorporated into the overall scheme for the construction of ecological civilization.

The plenary meeting of the leading group on reaching peak carbon emissions and achieving carbon neutrality convened on May 26, 2021. The group stressed that to realize the “dual carbon” goal as scheduled, it will be essential to (i) break down objectives and tasks into achievable goals, (ii) strengthen the top-level design, and (iii) guide and urge local governments, key institutes, industries, and enterprises to set rational objectives and formulate appropriate action plans.

It will be highly challenging to meet all of the requirements set by the Party Central Committee and the State Council, as China has less than 10 years to peak its carbon emissions, and only 30 years to transition to carbon neutrality. In contrast, other developed countries have already reached peak emissions and have allowed themselves 50–70 years to transition to carbon neutrality. Nevertheless, China is making every effort to move towards its Long-Range Objectives Through the Year 2035 and the second Centenary Goal in 2050. Economic development must continue to increase at a high rate, and thus total energy consumption will continue to increase. In the short term, it will be difficult to fundamentally alter the industrial structure, which comprises a highly developed chemical industry, a coal-based energy network, and a transportation network that relies heavily on road freight. Moreover, some regions, industries, and enterprises do not properly understand the strategies for reaching peak carbon emissions and achieving carbon neutrality, and have insufficient ambition and ineffectual plans to contribute to these goals.

Based on this, the Chinese Research Academy of Environmental Sciences and IPE established a joint research group in early 2021 that has launched a series of research projects on indices related to the “dual carbon” goal for China’s provincial administrative regions, key cities, and key state-owned enterprises. These projects aim to

guide local and key enterprises to better implement the national strategy for achieving the “dual carbon” goal. In response to this national strategy, the *Research Report 2021 on Chinese Province Carbon Peak and Neutrality Index* collected and analyzed public data to objectively evaluate the climate ambition, low-carbon status, and emission trends of various provinces. The results of this research report reflect the willingness of various provinces to build capacity and formulate plans to reach the “dual carbon” goal. The results also reveal the statuses of provinces in terms of their industrial structures, energy consumption, transportation system, and carbon sink capacity. These aspects will affect the realization of the “dual carbon” goal and the changes in carbon emission trends following policy implementation. The results of the research report thus serve as a reference for formulating national policies concerning the “dual carbon” goal, and will assist provinces to implement these policies.

The research group expects that the research results will act as a “compass” that guides various provincial administrative regions to improve their outlook, and will encourage them to overcome difficulties by acting creatively and expediently to take steps to achieve the “dual carbon” goal as scheduled. These steps could include driving the transformation of industry and the energy structure, making key technology breakthroughs and reducing carbon emissions, encouraging regions with ideal conditions to reach peak emissions first, shortening the platform period of peak emissions, and accelerating the decoupling of economic development and carbon emissions. The above steps will prevent the occurrence of no-win situations, encourage technological advancements, and encourage others to reach the same levels of achievement.

Overall, the research group aims to create a fair and competitive environment throughout China that will facilitate achievement of the “dual carbon” goal while enabling high-quality socioeconomic development.

Research Method

This study considers the logic of promoting the work of local governments and is based on the basic theories of sustainable development, a low-carbon economy, and carbon emission decoupling. Thus, we use econometric and statistical methods, follow the principles of science, hierarchy, representativeness, and data availability, cooperate with research institutions and social organizations, and comprehensively consider the impacts of economic development, energy use, carbon emissions, and other factors. We aim to construct an evaluation system for carbon peak and carbon neutrality indices, and to conduct an evaluation of 30 provincial administrative regions, excluding Hong Kong, Macao, Taiwan, and Tibet. The evaluation system is based on the international sustainable development index system, climate change performance indices, global environmental performance indices, low-carbon competitiveness evaluation and domestic climate change statistical index system, demonstration city construction evaluation index for the national circular economy, and green development index systems.

The technical roadmap of the study is shown in Fig. 1.

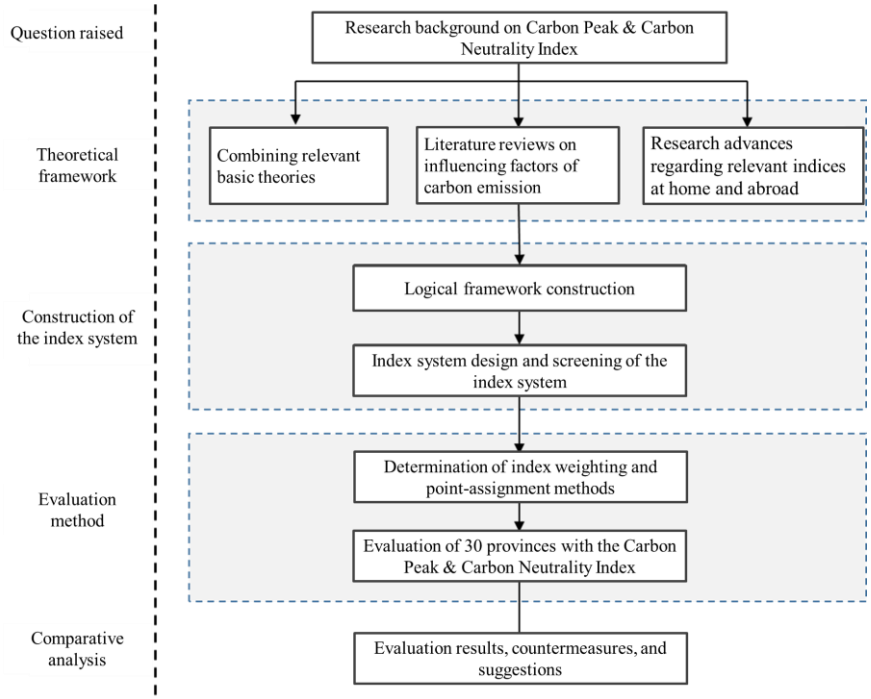


Fig. 1 Technical Roadmap

The evaluation index system is divided into three levels. The primary indices are composed of climate ambition, low-carbon status, and the carbon emission trend. The secondary indices are a detailed breakdown of the primary indices, which are composed of seven elements; these are subdivided into a total of 18 specific tertiary indices, and the decision-maker weighting method is adopted to provide the corresponding weights, as shown in Table 1.

Table 1 Evaluation System and Weighting of the Chinese Province Carbon Peak & Carbon Neutrality Index

	Primary indices	Secondary indices	Tertiary indices	
			Index name	Weight
Chinese Province Carbon Peak & Carbon Neutrality Index evaluation system (1)	Climate ambition (0.4)	Macro goals (0.6)	Goal of reaching peak carbon emissions	0.192
			Related goals of carbon neutrality	0.048
		Capacity building (0.4)	Pilot demonstration construction	0.064
			Disclosure of statistical accounting	0.048
			Proportion of energy conservation and environmental-protection investment	0.048
	Low-carbon status (0.4)	Carbon-emission status (0.3)	Carbon emissions per capita	0.048
			Carbon emissions per unit of GDP	0.072
		Economic and social structure (0.3)	Proportion of high-energy-consuming industries	0.060
			Proportion of highway freight turnover	0.036
			Per-capita public-transport vehicle ownership	0.024
			Energy consumption intensity per unit of GDP	0.072

		Energy consumption (0.3)	Proportion of non-fossil-energy consumption	0.048
		Low carbon endowment (0.1)	Annual average wind-power density	0.016
			Annual total solar radiation on a horizontal surface	0.016
			Total standing stock volume	0.008
	Emission trends (0.2)		Carbon-emission trend test	0.100
			Carbon-emission decoupling index	0.080
			Rate of change of carbon emissions	0.020

The data quoted in the report were mainly obtained from the *China Statistical Yearbook*, *China Energy Statistical Yearbook*, and *China Statistical Yearbook on the Environment*. Data were also obtained from national and provincial statistical bulletins on national socioeconomic development, publicly released achievements of research institutes, and public information and coverage on the official websites of various provincial governments and relevant departments. The data collection date was June 30, 2021. The carbon dioxide emission data used in this study were provided by the China City Greenhouse Gas Working Group. The scope of carbon emission accounting includes the direct carbon emissions of major fossil energy combustion activities (e.g., coal, oil products, and natural gas) and the indirect carbon emissions of power transmission.

Evaluation Results

The comprehensive evaluation results of the weighted indices were obtained by integrating the results from the three primary indices (i.e., climate ambition, low-carbon status, and carbon emission trend). The top 10 provinces are shown in Table 2; Beijing and Shanghai were ranked first, followed by Guangdong, Sichuan, Tianjin, Henan, Jiangsu, Chongqing, Zhejiang, and other provinces. The comprehensive ranking results of all 30 provinces, cities, and autonomous regions participating in the evaluation are listed in Table 1. A schematic diagram is shown in Fig. 1 of the Appendix.

Table 2. Comprehensive evaluation results of the Chinese Province Carbon Peak & Carbon Neutrality Index

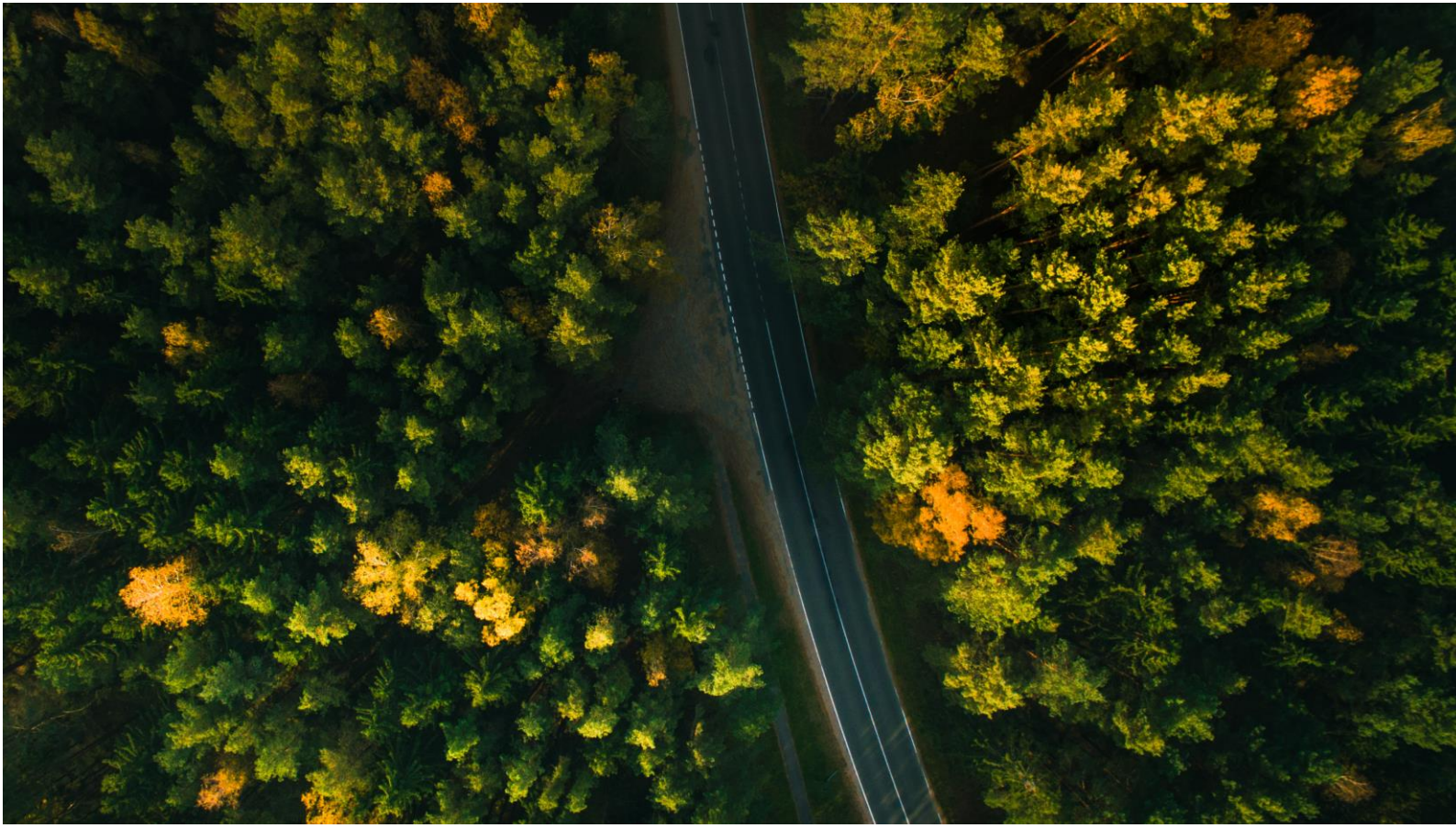
Rank	Province	Composite index on carbon peak and carbon neutrality	Climate ambition index	Low carbon status index	Emission trend index
1	**Beijing***	**78.7**	90.4	81.2	50.4
2	**Shanghai***	**61.7**	50.7	76.0	55.3
3	**Guangdong***	**61.6**	53.8	78.3	43.9
4	**Sichuan**	**57.3**	30.0	71.0	84.7
5	**Tianjin***	**57.2**	36.4	67.4	78.7
6	**Henan**	**55.2**	28.5	62.6	94.0
7	**Jiangsu**	**54.4**	53.1	68.0	30.0
8	**Chongqing***	**53.8**	35.7	70.5	56.8
9	**Zhejiang**	**53.0**	36.6	73.5	45.2
10	**Jilin**	**52.7**	21.4	67.4	85.8

Note: Those marked with * are low-carbon pilot provinces and cities.

Specific evaluation results of the three primary indices are as follows:

1. The climate ambition index consists of two secondary indices: macro objectives and capacity building. The evaluation score is weighted by five tertiary indices, such as related goals of carbon peak and carbon neutrality, and pilot demonstration construction.

   Beijing obtained the highest score (90.4) for taking the lead to confirm their peak



carbon emissions. Guangdong, Jiangsu, Shanghai, and other eastern provinces and cities also scored above 50, while Jiangxi and Qinghai scored highest among the central and western provinces and regions. Hebei and Ningxia, which had yet to clarify the year in which they will reach their peak carbon emissions, scored low.

The scores of all 30 provinces, cities, and autonomous regions participating in the evaluation are shown in Fig. 2 of the Appendix.

2. Under the low-carbon status index, there are four secondary indices: carbon emission status, socio-economic structure, energy consumption, and low-carbon endowment. The overall score is weighted by 10 tertiary indices, such as per-capita carbon emissions, carbon emissions per unit of GDP, and the proportion of high energy-consuming industries.

   In addition to the good performance of Beijing and some eastern provinces and cities (e.g., Guangdong, Fujian, Shanghai, and Zhejiang), central and western provinces such as Sichuan, Chongqing, and Hubei also took advantage of their natural endowments and ranked relatively high. Ningxia, Xinjiang, and Inner Mongolia, which also have good natural endowments, ranked lower owing to their major industrial structure and coal-based energy structure.

   The scores of all 30 provinces, cities, and autonomous regions participating in

the evaluation are shown in Fig. 3 of the Appendix.

3. The evaluation results of the emission trend were obtained by weighting three tertiary indices: the carbon-emission trend test, carbon emission decoupling index, and the rate of change in carbon emissions. Henan and Jilin ranked first, followed by Sichuan and Tianjin. The economic development of Ningxia and Inner Mongolia ranked lower, as these areas remain reliant on industries with intensive carbon emissions.

   The scores of all 30 participating provinces, cities, and autonomous regions are shown in Fig. 4 of the Appendix.

Implications of Results

In the first year of the strategy to achieve the "dual carbon" goal, the provincial action plans were still being planned, and thus the full results of climate ambition and policy have yet to be obtained. Thus, the index evaluation results of most provinces are only based on their socioeconomic development and natural resource endowment over the years. With the clarified "dual carbon" goals and the implementation of the supporting policy documents for reducing carbon emissions and trends, increasing carbon sinks, climate ambition, and low-carbon status, there is considerable room for the improvement in these scores. In later stages, our research group will continue to track and evaluate these research objectives and present the dynamic changes in various indices.

1. **Some provinces, cities, and autonomous regions must exhibit greater ambition in their strategies to achieve the "dual carbon" goal.**

   None of the 30 provinces, cities, or autonomous regions included in the evaluation have persisted in their efforts, except for Beijing, which indirectly announced its peak carbon emissions and set its carbon neutrality goal for 2050. Tianjin, Jiangsu, Shanghai, Guangdong, and other provinces and cities announced that they would reach their peak carbon emissions in the "14th Five-Year Plan". The target peak carbon emissions of most other provinces are consistent with each other, although a few provinces have not yet clarified the year in which they will reach their peak carbon emissions.

   In the *Work Plan for Low-carbon Development of Shandong Province (2017–2020*), it was stated that the province aimed to reach their peak carbon emissions by approximately 2027 and would strive to do so as soon as possible before this year. In the *Work Plan for Controlling Greenhouse Gas Emissions during the 13th Five-Year Plan of Xinjiang Autonomous Region*, the region stated that they aimed to reach their peak carbon emissions by 2030. However, since the launch of the strategy of the "dual carbon" goal, these two regions have not further clarified the actual year in which they intend to peak carbon emissions.

   Zhejiang has carried out a series of low-carbon and near-zero carbon pilot demonstration constructions, and has proposed requirements such as "taking the

lead in fighting a tough battle to achieve high standards" and "advancing efforts to rank first with respect to peak carbon emissions and carbon neutrality, and to set a good example for the nation." However, Zhejiang has not yet stated the year in which it will reach its peak carbon emissions.

In their "14th Five-Year Plan," Hebei and Ningxia only stated that they aim "... to reach their peak carbon emissions by 2035," after which their carbon emissions would be stable and gradually decline. However, these regions have not clarified if they aim to reach their peak emissions before 2030.

2. **Beijing and Shanghai take the lead in the national campaign to achieve the "dual carbon" goal, but there remains scope for improvement**

   As international metropolises, Beijing and Shanghai have played an exemplary role in climate ambition. The overall quality of socioeconomic development in the two cities is high, and thus they are ranked first in the evaluation.

   Beijing, which performed the best and gained wide acclaim, has confirmed that it has reached carbon peak and will reach carbon neutrality by 2050, highlighting the capital's responsibilities and obligations. However, Beijing mainly depends on coal-fired power, which has accounted for more than 90% of the total power demand in recent years. In the future, Beijing will need to focus on how it can improve the proportion of green power and strengthen its coordination with regions that are rich in renewable energy (e.g., Inner Mongolia).

   Shanghai's secondary industry accounts for 27% of all industry, with large energy-consuming enterprises such as Shanghai Gaoqiao Petrochemical Co., Ltd., Jinshan Petrochemical Co., Ltd., and Baoshan Iron & Steel Co., Ltd. Due to the limited development of local clean energy, coal consumption in Shanghai continues to account for more than 30% of its total energy consumption. In the future, it will be necessary to make a sustained effort to improve energy efficiency, improve the energy structure, and reduce emissions through disruptive technologies.

3. **Low-carbon pilot provinces have achieved remarkable results, indicating the value and significance of pilot demonstrations.**

   Since 2010, China has carried out three sets of low-carbon pilot projects in some provinces, regions, and municipalities. Guangdong, Liaoning, Hubei, Shaanxi,

Yunnan, Tianjin, and Chongqing were in the first set, while Beijing, Shanghai, and Hainan were in the second set. The evaluation results show that these low-carbon pilot projects have played a positive role and achieved impressive results; 4 of the 10 low-carbon pilot provinces and municipalities were in the top 5 in the evaluation, and 5 were in the top 10. Of these, Beijing, Shanghai, and Guangdong were the top three; Tianjin and Chongqing were fifth and eighth, respectively; and Hubei, Hainan, and Yunnan were 11th, 12th, and 13th, respectively. Thus, the pilot provinces and municipalities have exhibited excellent performance, highlighting the value and significance of the pilot demonstration work.

4. **The "dual carbon" strategy of energy-exporting provinces needs to be planned holistically to ensure the security of national energy**

Inner Mongolia, Xinjiang, Shanxi, Shaanxi, Ningxia, Gansu, and other provinces are China's main energy bases, and important coal- or power-generating provinces, and have therefore greatly contributed to energy security and socioeconomic development in China. However, as their energy structures are based on a high proportion of coal use and related industrial structure, the abovementioned provinces are all ranked low in the evaluation. At present, carbon emission accounting only considers the direct carbon emissions from energy combustion and the indirect carbon emissions from power input. This means that the carbon emissions related to power output or product output in the above provinces are not subtracted, and thus their scores do not fairly reflect their endeavors.

Energy security is an important component of national security and a national strategic goal that should be guaranteed. Therefore, China's "dual carbon" strategy must be mapped out, systematically planned, supported with strong policies, and based on suitable pathways. This will effectively support the transformation of the energy structure and the achievement of high levels of socioeconomic development in major energy-exporting provinces.

5. **Major eastern coastal provinces should set a good example in "dual carbon" strategy**

Guangdong, Jiangsu, Shandong, and Zhejiang are the top four coastal provinces in China in terms of aggregate economic performance, as their carbon emissions

and GDP collectively account for approximately 28% and 35% of the total national carbon emissions and GDP, respectively. Owing to rapid economic development, energy consumption and carbon emissions continue to rise in these four regions. Among them, Guangdong province has the highest comprehensive ranking, which is mainly because this region has clearly committed itself to reaching its peak carbon emissions by 2025, which is well ahead of schedule. In addition, its energy consumption structure is well optimized and incorporates a good adjustment effect, and the score of its low-carbon status was higher than that of Zhejiang and Jiangsu. Zhejiang province has not yet clarified the year in which it aims to reach its peak carbon emissions, and scored low in emission trends, due to high energy consumption of the petrochemical industry in recent years and other factors, resulting in its relatively low ranking. Shandong province is the third largest province in China in terms of aggregate economic activity, and a major center of thermal power generation and chemical industries. Its carbon emissions per unit of GDP was higher than that of the other three provinces (e.g., approximately twice that of Guangdong province). Therefore, Shandong province will face a great challenge to reduce carbon emissions in the future. These major economic provinces should lead in taking action and play an exemplary role in implementing the "dual carbon" strategy, with reference to carbon emissions per capita GDP in developed countries such as Europe and the United States when they peaked carbon emissions.

6. **Provinces with good resource endowments should actively plan to facilitate the realization of national carbon neutrality**

Sichuan, Chongqing, Hubei, Qinghai, Yunnan, Hainan, and other provinces have advantages in resource endowment. These provinces performed well in terms of their low-carbon status, and thus ranked high in this index. Sichuan, Chongqing, Hubei, and Yunnan have abundant hydropower resources, whereas Qinghai has abundant light energy, wind energy, and hydropower resources. The industrial structure of Hainan is characterized by low-emission tourism, and this region has a good low-carbon status as it has the potential to develop clean energy such as nuclear power, offshore wind power, and tidal energy. These provinces also have suitable climatic conditions, good conditions for vegetation growth, and mainly mountainous terrains with high forest coverage, and thus have distinct carbon sink resources. In Hainan and Yunnan, forest covers more than 50% of the total

area, while the total standing stock volume in Yunnan reaches 2×10^9 m^3.

Overall, Sichuan, Chongqing, Hubei, Qinghai, Yunnan, Hainan are provinces with a desirable endowment, and thus have advantages for realizing the "dual carbon" goals over more economically developed and energy/resource-based provinces. Therefore, provinces should guard against achieving the "dual carbon" goal with minimal effort; instead, they should make full use of their resource endowment, plan systematically, and take the initiative to act and achieve the "dual carbon" goal ahead of schedule.

7. **Provinces with rapid economic growth should strive to promote high-quality socioeconomic development that is consistent with the "dual carbon" goal.**

   Despite their generally low levels of GDP per capita and urbanization, Henan, Jiangxi, Anhui, Hunan, Guizhou, and other provinces have a strong willingness for development. In recent years, these provinces have undergone active economic development, with an acceptable growth momentum, a GDP growth rate of greater than 7%, and continuous improvements in their level of urbanization. However, the evaluation results revealed slight differences in their respective extents of growth. For example, in recent years Henan has accelerated the transformation and upgrading of its traditional industries and improved its quality and efficiency of economic growth, whilst significantly decreasing its per-capita GDP energy consumption and carbon emissions. The carbon emission trends of Henan exhibited a downward trend after reaching their peak, and the province's economic development and carbon emissions decoupled, ranking it sixth in China in this regard. In contrast, Anhui has a rapidly developing economy and energy structure that is highly dependent on coal, which means it is not yet on target to reach peak carbon emissions and therefore ranks relatively low in the evaluation. Hunan, Jiangxi, and Guizhou provinces in central China are all characterized by rapid economic growth. In the future, these regions need to further improve the quality of their economic development to be in keeping with the "dual carbon" goal. They should also strive to realize the decoupling of economic development and carbon emissions as soon as possible.

8. **During the period of economic adjustment, provinces should seek new driving forces for development to realize the "dual carbon" goal.**

Tianjin and Jilin ranked among the top 10 provinces and Heilongjiang ranked 21st, as these three provinces had good emission trends. According to the carbon emission trend test, Tianjin and Jilin reached their peak carbon emissions in 2014 and 2012, respectively, and then showed significant downward trends. The peak carbon emissions of Heilongjiang were observed in 2016.

The data showed that Jilin and Heilongjiang provinces exhibited an obvious lack of momentum in economic growth, and Tianjin was also in a critical adjustment period in terms of its economic structure. The GDP growth rates of the three provinces in 2019 were less than 5.0%, which was lower than the national average. Jilin and Heilongjiang belong to the old industrial bases in northeast China. Due to backward industries and resource depletion in this area, its population has greatly decline and the region's economy is showing signs of recession. As a result, the energy consumption and carbon emissions in northeast China have similarly declined. In contrast, the industrial structure of Tianjin is characterized by heavy industry and the chemical industry. After the explosion accident at Tianjin Binhai Port in 2015, Tianjin intensified its industrial transformation and upgrading effort, eliminated several inefficient and high-risk old production capacities, and raised the threshold for the introduction of new industries. These changes resulted in a slowdown in economic growth and a significant decline in carbon emissions.

The reduction in carbon emissions in the abovementioned regions is a natural manifestation of the economic adjustment period. Unlike the carbon peak goals driven by policies in more economically developed regions, there is a need to seek new drivers of economic development in these less economically developed regions, under the constraints of the goal of reaching peak carbon emissions. There is also a need to avoid a rapid rebound in carbon emissions following economic recovery.

Countermeasures and Suggestions

Based on the evaluation results of the Chinese Province Carbon Peak & Carbon Neutrality Index, the research group proposed some countermeasures and suggestions.

First, it was proposed to coordinate the goals of carbon peak and carbon neutrality, and to resolutely curb the misunderstanding in some localities that the peak carbon goal represents a period of artificially reaching peak emissions. Moreover, achieving carbon neutrality as scheduled by 2060 should be taken as a hard constraint. It is also necessary to propose national and provincial emission peak targets as soon as possible, make continual emission reductions after reaching peak carbon emissions, and create favorable conditions for achieving carbon neutrality.

Second, as there is unbalanced development across China, a system concept should be used to balance efficiency and fairness, and to coordinate the promotion of the "dual carbon" strategy throughout the country. On the one hand, localities should have a clear understanding of their responsibilities. On the other hand, policies should be implemented appropriately by considering the situation of each locality, and a concerted effort should be made to adjust measures to local conditions. The idea of reaching peak carbon emissions in an orderly manner should be promoted in various regions, without high economic and social costs being necessary. This will prevent adverse effects on people's livelihoods due to a lack of effort until that "last minute."

Third, the key to achieving the "dual carbon" goals as scheduled is to shift from a dependence on resources to a dependence on science and technology. This will require a focus on problems and goals, the innovation of research mechanisms and systems, an increase in scientific and technological investment, and a focus on making breakthroughs in the development of strategic support technologies for carbon neutrality (e.g., smart grids, new forms of energy, negative emissions technologies, novel transmission structures, energy storage, and hydrogen energy).

Fourth, a fairer assessment mechanism should be implemented for energy-exporting/importing provinces, and the carbon emissions associated with electricity outputs for energy-exporting provinces should be reduced. Regions with power inputs must increase their proportion of green power from year to year, thus creating market expectations, stimulating investment momentum, and allowing energy-exporting provinces to accelerate their adjustment process for their industrial and energy structures.

Fifth, considering the problems identified in the evaluation, such as difficult data acquisition, data incompleteness, and inconsistencies, improvements are needed in the methods of data measurement, reporting, and verification, and in disclosure, and a data-sharing mechanism must be established. Such improvements will provide a solid and reliable data foundation for scientific research and decision making by governments at all levels, and stimulate public participation and the application of a market mechanism.

Appendix

Table 1. Evaluation results of the Chinese Province Carbon Peak & Carbon Neutrality Index

Rank	Provinces	Composite index of carbon peak and carbon neutrality	Climate ambition index	Low-carbon status index	Emission trend index
1	**Beijing***	**78.7**	90.4	81.2	50.4
2	**Shanghai***	**61.7**	50.7	76.0	55.3
3	**Guangdong***	**61.6**	53.8	78.3	43.9
4	**Sichuan**	**57.31**	30.0	71.0	84.7
5	**Tianjin***	**57.27**	36.4	67.4	78.7
6	**Henan**	**55.2**	28.5	62.6	94.0
7	**Jiangsu**	**54.4**	53.1	68.0	30.0
8	**Chongqing***	**53.8**	35.7	70.5	56.8
9	**Zhejiang**	**53.0**	36.6	73.5	45.2
10	**Jilin**	**52.7**	21.4	67.4	85.8
11	**Hubei***	**52.0**	34.3	68.3	54.8
12	**Hainan***	**50.9**	49.5	65.1	25.4
13	**Yunnan***	**50.4**	32.1	67.4	53.2
14	**Qinghai**	**50.2**	41.4	55.9	56.3
15	**Fujian**	**47.6**	32.8	76.2	20.2
16	**Jiangxi**	**47.2**	44.2	59.9	27.5
17	**Hunan**	**47.0**	27.4	66.6	46.7
18	**Anhui**	**45.1**	28.1	63.6	42.0
19	**Shaanxi***	**44.0**	37.0	61.7	22.7
20	**Guizhou**	**43.75**	33.5	54.7	42.3
21	**Heilongjiang**	**43.74**	25.6	63.0	41.5
22	**Liaoning***	**41.7**	37.4	54.9	23.9
23	**Gansu**	**40.2**	27.0	53.7	39.7
24	**Guangxi**	**40.0**	24.8	64.8	20.9
25	**Shandong**	**39.8**	32.6	57.7	18.4

26	**Hebei**	**37.3**	26.9	47.2	38.2
27	**Shanxi**	**33.5**	32.0	39.5	24.4
28	**Xinjiang**	**26.4**	22.8	33.9	18.7
29	**Inner Mongolia**	**24.3**	25.5	34.3	1.7
30	**Ningxia**	**10.9**	15.1	11.9	0.5

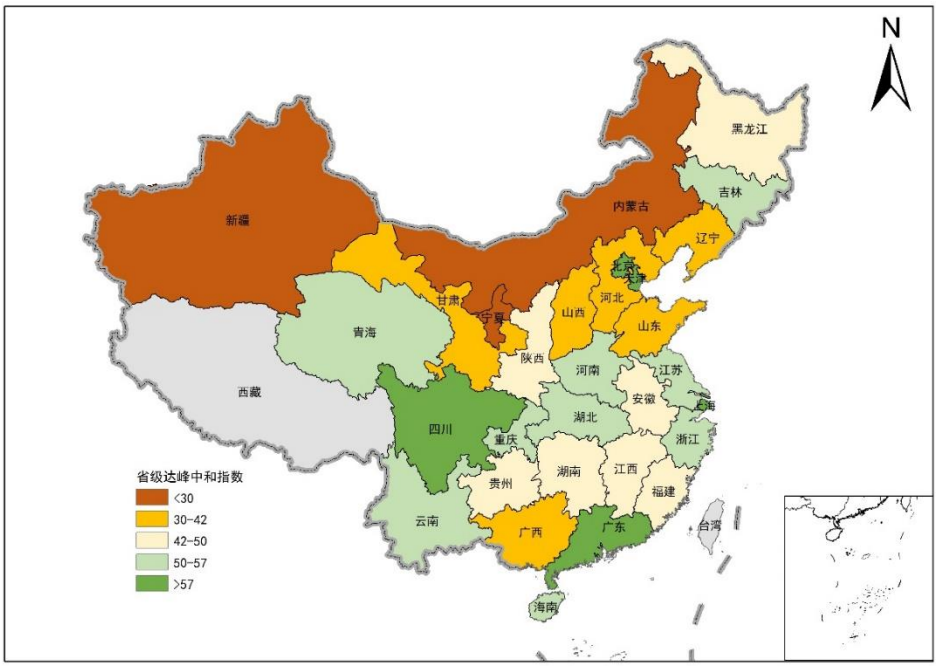


Fig. 1. Schematic diagram of the evaluation results for the Chinese Province Carbon Peak & Carbon Neutrality Index

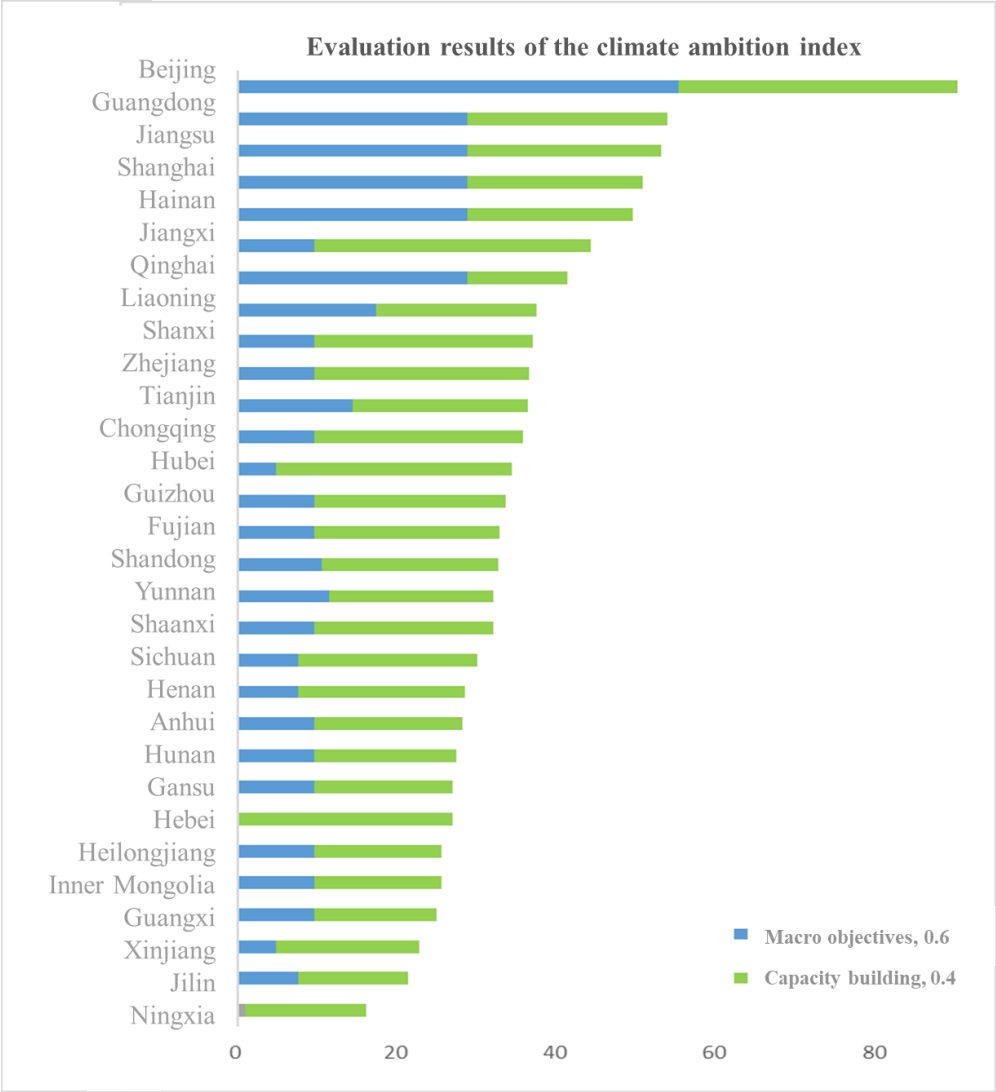


Fig. 2 Evaluation results of the climate ambition index

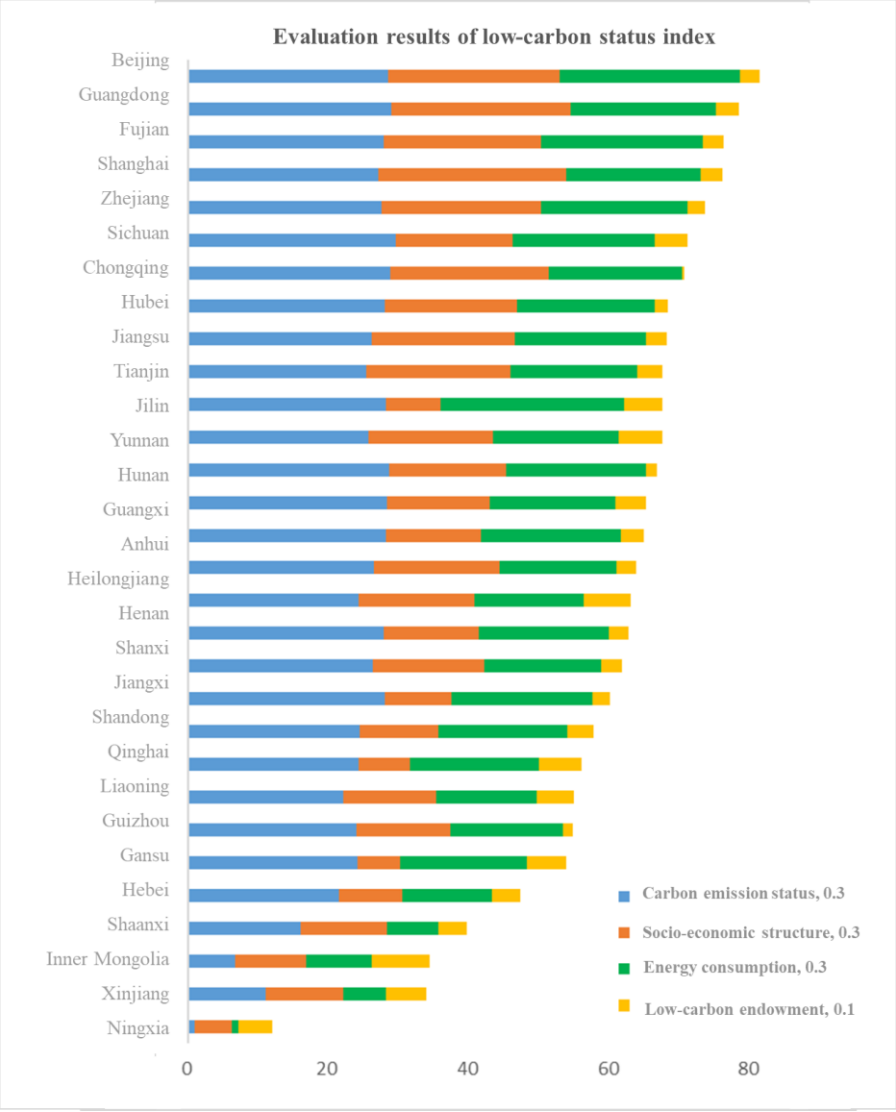


Fig. 3 Evaluation results of the low-carbon status index

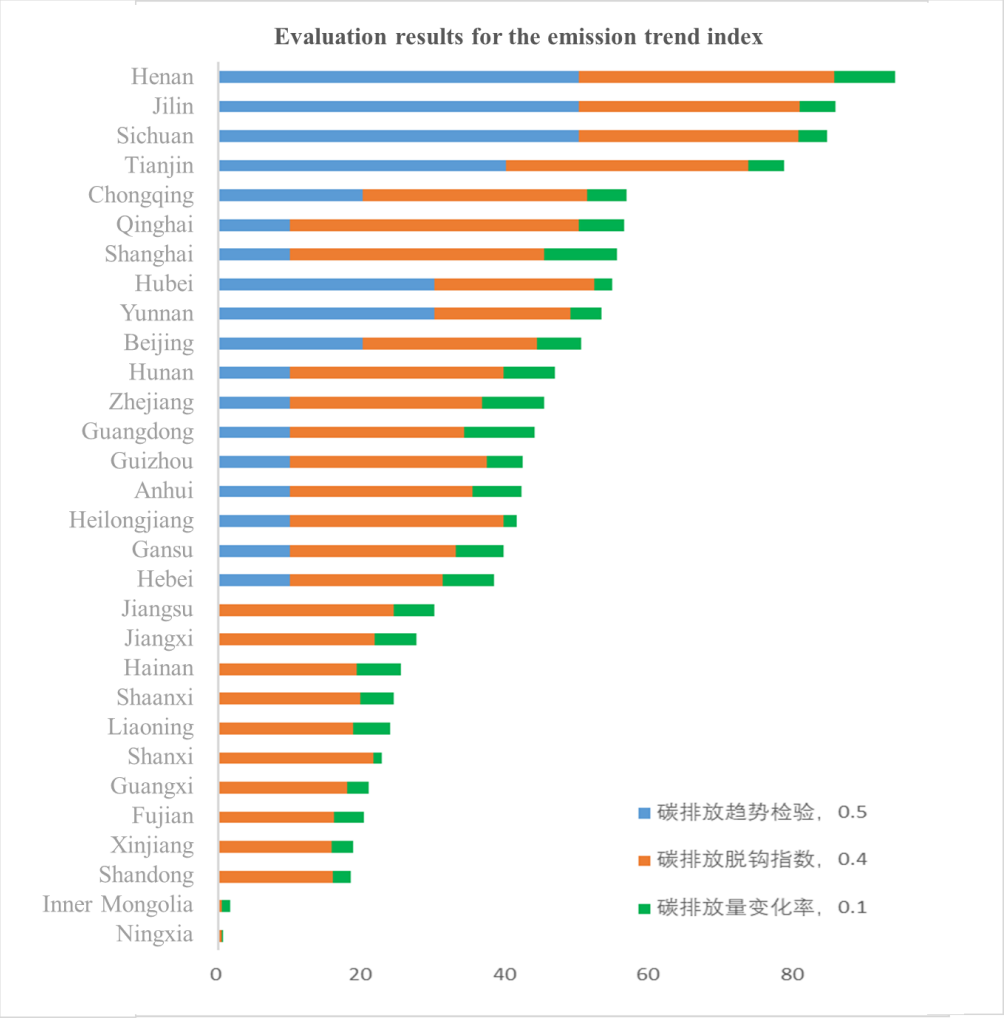


Fig. 4 Evaluation results for the emission trend index

Special Explanations

To help all parties better understand the intention and logic of the development and evaluation of the Chinese Province Carbon Peak & Carbon Neutrality Index, the research group makes the following special explanations.

I. The aim of the evaluation is to guide each provincial-level administrative region in determining their starting point with respect to achieving the "dual carbon" goal. The selection of each index is based only on the belief that it will have a certain impact on the realization of meeting the "dual carbon" goal. The extent of this impact can be reflected through index weighting. The screening of indices and the interaction between indices will require further scientific analysis in the follow-up stage, to continually optimize and improve the index system.

II. The data quoted in this report were mainly from the *China Statistical Yearbook*, *China Energy Statistical Yearbook*, and *China Statistical Yearbook on the Environment*. Data were also obtained from national and provincial statistical bulletins on national socioeconomic development, publicly released achievements of research institutes, and public information and coverage on the official websites of various departments. The data collection date was June 30, 2021. The carbon dioxide emission data for each provincial-level administrative region were provided by the China City Greenhouse Gas Working Group. The above data are for exclusive use in research and exchange, and cannot be equated with official data.

III. In this evaluation, based on the responses of provincial governments regarding their achievements related to the "dual carbon" strategy, socioeconomic development status, and key areas of carbon emissions (e.g., energy, industry, transportation, and daily life), a policy-driven index system of peak carbon emissions and carbon neutrality has been constructed after multiple rounds of discussions. In the future, the selection and point-assignment of some indices will be adjusted with the promotion and deepening of China's efforts to achieve the "dual carbon" goal.

IV. The Chinese Province Carbon Peak & Carbon Neutrality Index give a high weight to the climate ambition of local governments, with the intention to create a positive incentive, promote regions with ideal conditions to make practical efforts to reach peak emissions first, and stimulate continual research and planning of reduction pathways after reaching peak emissions. The focus on climate ambition is also intended to curb the tendency of some localities to regard their "peak carbon emission" period as a window period of artificially reaching such a peak.

V. The evaluation results reflect the ambition of local governments to follow the "dual carbon" strategy, and the low-carbon status in 2019 and the trend change from

2016 to 2019. Some of the lower ranking provinces have cities with excellent performance, which will be highlighted in the follow-up *Research Report on Chinese City Carbon Peak and Carbon Neutrality Index 2021*. Some provinces either already have or are actively carrying out policies to work toward the "dual carbon" goals. However, the results of their actions have not been included in this evaluation; instead, this information will be included in the annual evaluation report to be released in the future.

VI. According to the existing national rules for carbon accounting, the carbon emission data used in this evaluation did not deduct the carbon emissions involved in power transmission, thus leading to a certain degree of unfairness in the scoring allocated to energy-producing provinces. However, as the carbon emissions of energy activities occur locally, their impact on environmental pollution is also local. From the perspective of reducing pollution and carbon emissions, the "dual carbon" goal aims to encourage major energy provinces to improve their energy utilization efficiency. The research group proposes that policies should be adopted to encourage power-importing provinces to decrease their usage of energy while increasing their proportion of imported green energy.

Achieving the "dual carbon" goal will require profound system-wide change, and thus calls for a joint effort by the whole of society. The research group welcome your valuable opinions and suggestions to help us improve the index system and evaluation methods, and jointly contribute to the as-scheduled realization of the "dual carbon" goal.

Research Group on Chinese Province Carbon Peak & Carbon Neutrality Index

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