



# A Study on Public Perceptions of Carbon Neutrality in China: has the Idea of ESG Been Encompassed?

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China has pledged to become carbon neutral by 2060 and has employed a variety of strategies to minimize carbon emissions. As people's support to achieve the carbon neutrality goal affects its success, this study reviewed the public's perception of carbon neutrality via cluster analysis on microposts. The co-occurrence matrix showed 258 nodes and 3,212 ties in the carbon neutrality social network. The top five most prominent nodes were neutralized, energy, China, blue-green, and economy. The keyword like blue-green (means water and plant) illustrated the popular terminology used by mainland Weibo users and its essential role in carbon neutrality. The multidimensional scaling analysis found that there were 11 clusters in carbon neutrality. The results revealed that people's concerns about carbon neutrality were mainly related to the environment (e.g. low carbon, sustainable, and wind power), social (e.g. country and poverty), and governance (responsibility, government report). Weibo users believed that achieving carbon-neutrality allows us to pursue a better life. Among the data collected, positive sentiment microposts (83.9%) were approximately eight times more than the negative ones (9.9%), and only 6.3% were neutral. The results indicated that most Weibo users were optimistic on carbon neutrality.

**Keywords:** carbon neutrality, China, cluster analysis, Weibo, sentiment analysis, ESG

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## 1 INTRODUCTION

One of the most serious environmental problems and difficulties people confront in the 21st century is global climate change (Wei et al., Forthcoming 2022). Thus, the idea of environmental, social, and governance (ESG) is suggested. Listed companies have to submit ESG reports as required by some stock markets. Similarly, carbon neutrality has become an essential agenda in global climate governance. As of 22 April 2022, 83 countries worldwide have set their goals to reduce global carbon emissions by 74% (Climate Watch 2022).

Parties are urged by the Paris Agreement to submit their most recent nationally determined contributions and long-term low-temperature greenhouse gas emission development policies by 2100. The proposal was made during the Paris Climate Peace Conference in 2020 to attain carbon neutrality targets between 2050 and 2060. China, a growing nation, has pledged to the international community that it will become carbon neutral by 2060. (Zhao, 2022). In September 2020, the Chinese government set a goal to achieve carbon neutrality by 2060 (Huang et al., 2022).

**TABLE 1** | Carbon neutrality strategic plans in China from 2003 to 2021.

Time	Plan
14 January 2003	Circular of the State Council on Printing and Distributing China's Action Plan for Sustainable Development in the Early 21st Century
28 March 2008	Several Opinions of the State Council on Promoting the Sustainable Development of Resource-Based Cities
20 August 2013	Notice of the Ministry of Transport on Printing and Distributing the Guiding Opinions on Accelerating the Development of Green Circular and Low-Carbon Transportation
2 December 2013	Notice of the State Council on Printing and Distributing the National Sustainable Development Plan for Resource-Based Cities (2013–2020)
30 April 2014	Notice of the National Development and Reform Commission on printing and distributing the Interim Measures for the Promotion and Administration of Energy-Saving and Low-Carbon Technologies
20 February 2015	Interim Measures for the Administration of Carbon Emissions Trading
20 December 2015	Measures for the Administration of Certification of Energy-Saving and Low-Carbon Products
13 December 2016	Notice on the Construction Plan of China's Innovation Demonstration Zone for the Implementation of the 2030 Agenda for Sustainable Development
20 September 2019	Guidelines for the Implementation of Carbon Neutrality in Large-Scale Activities (Trial Implementation)
26 October 2020	The 14th Five-Year Plan for National Economic and Social Development and the Long-Term Goals for the Year 2035
22 February 2021	Guiding Opinions on Accelerating the Establishment and Improvement of a Green and Low-Carbon Circular Development Economic System
10 March 2021	Administrative Measures for Carbon Emissions Trading (Trial Implementation)
11 March 2021	Outline of the 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and The Long-term Goals for 2035.
26 April 2021	Opinions on Establishing and Improving the Value Realisation Mechanism for Ecological Products
12 September 2021	Opinions on Deepening the Reform of the Compensation System for Ecological Protection
22 September 2021	Opinions on the Complete, Accurate, and Comprehensive Implementation of the New Development Concept to do an Excellent Job in Carbon Peak Carbon Neutrality
10 October 2021	National Standardization Development Program.
21 October 2021	Opinions on Promoting the Green Development of Urban and Rural Construction
24 October 2021	Opinions of the CPC Central Committee and the State Council on The Complete, Accurate, and Comprehensive Implementation of the New Development Concept to Do a Good Job in Carbon Peaking and Carbon Neutrality
26 October 2021	Notice of the State Council on Printing and Distributing the Action Plan for Carbon Peaking by 2030
27 October 2021	China's Policies and Actions to Address Climate Change

<https://www.ndrc.gov.cn/?code=&state=123>

The idea of sustainable development, green mountains, and clear water existed long ago on China's agenda. Similar to this is the notion of "carbon neutrality". China explores the means to reduce carbon emissions under the premise of industrial transformation and maintain rapid economic development simultaneously. However, cooperation between businesses and individuals to realise national policies is crucial for reaching carbon neutrality. As a result, its success depends on how much a nation's citizens care about, are aware of, and support achieving carbon neutrality (Shi 2006).

This article reviews people's concerns on Weibo because of the abovementioned lines of thoughts. Weibo is one of the most well-known social media platforms in mainland China (Zeng and Li, 2022) that enables people to publish their opinions online. Analyzing the published posts reflects people's sentiments and perceptions on social issues. It can overcome traditional questionnaire problems, such as inadequate response (Li et al., 2022). Moreover, collecting people's perception allows us to obtain the real-time data (Lee et al., 2022, forthcoming). All these drive us to use a relatively new approach to collect data from Weibo, rather than collecting data *via* survey.

In the following sections, **Section 2** examines China's strategic approach to reducing carbon emissions. The literature review in **Section 3** introduces Weibo and the databases we explored for information on carbon neutrality in China. It also exemplifies

earlier studies on emotion analysis and carbon neutrality. **Section 4** provides examples of the research approach and findings. **Section 5** wraps up the article.

## 2 CHINA'S STRATEGIC PLAN FOR CARBON NEUTRALITY

China has set a target of reaching a peak in carbon dioxide emissions by 2030 and working toward carbon neutrality by 2060. China's achievements have suggested that economic growth does not necessarily have to slow down to attain the goal (State Council of the PRC, 2021a). Since the Communist Party's 18th National Congress, China has completed 960 million mu (about 64 million hectares) afforestation. The forest cover increases by 2.68%–23.04%.

China's strategic plan at the national level regarding carbon reduction can be summarized as commitments, systematic planning, and implementation. **Table 1** shows China's important national documents on carbon reduction since 2003.

The State Council of the PRC's circular on Printing and Distributing China's Action Plan for Sustainable Development in the early 21st century (State Council of the PRC, 2003) highlighted the philosophy behind China's sustainable development strategy focuses on people-oriented, harmony between human and nature as the primary concern, economic development as the core target,

improving people's quality of lives as the starting point. Scientific, technological, and institutional innovation, constantly promotes the coordination between resources, and improves China's national strength and competitiveness, and lays a solid foundation to realizing the third-stage strategic goal.

Notice of the State Council on Printing and Distributing China's Implementation of the 2030 Agenda for Sustainable Development Innovation Demonstration Zone Construction Plan (State Council of the PRC 2016) centered on the implementation of the 2030 Agenda for Sustainable Development and aimed at reaching future development goals in poverty reduction, health, education, and environmental protection. While innovation is the driving force, China will promote economic and social development. The target year of the agenda for reaching the goal of sustainable development is the same as reaching a carbon peak in 2030.

In 2021, the State Council initially released their opinions on carbon neutrality and carbon peak (State Council of the PRC, 2021b). The proposal highlights the attainment of carbon peak and carbon neutrality as a the direction. Building a community with a common destiny for all of humanity is a solemn obligation.

The Action Plan for Carbon Peak before 2030 (State Council of the PRC, 2021c), published by the State Council on October 26, 2021, outlined China's development strategy and ideology for reaching a carbon peak.

### 3 LITERATURE REVIEW

#### 3.1 Carbon Peak and Neutrality

According to the Intergovernmental Panel on Climate Change (IPCC, 2022), "carbon neutrality" refers to the anthropogenic emissions of carbon dioxide that are balanced by anthropogenic removals over a particular period. A "carbon peak" has been proposed in line with the carbon neutrality concept. It is defined as where carbon dioxide emissions reach the peak, stop increasing, and then fall. Prior to achieving carbon neutrality, the carbon peak must be reached.

Using industrial data from China, Zhang et al. (2021) evaluated how the carbon trading industry will affect economic production and carbon emissions. China may be able to meet the 2060 carbon neutrality goal, according to research by Yang et al. (2021). Due to the widespread use of coal-fired power, Wyrwa et al. (2022) investigated how to achieve carbon neutrality and suggested solutions. From the construction industry standpoint, Sun et al. (2022) carried out the research and review on achieving carbon neutrality in the construction industry. Some studies have investigated the relationship between renewable energy and carbon emission reductions (Gullberg et al., 2014).

#### 3.2 Weibo

In China, the general public's favorite social media is Weibo. It allows users to share information in words, images, and videos (Zeng and Li, 2022). In the 2017 Research Report on the Development of Internet Governance in China (Zhang and Lu, 2018), websites and social media were the main news sources,

followed by WeChat and Weibo. WeChat (27%) and Weibo (38%) were the top three media information dissemination channels. Despite WeChat is also a social media platform, it serves a fundamentally different purpose than Weibo. Weibo is frequently referred to be Chinese Twitter, although WeChat is comparable to "WhatsApp." Weibo had 249 million average daily active users and 573 million monthly active users by the end of 2021, according to the company's 2021 fourth quarter and full-year financial report (Weibo 2022). In 2020, people who learned about COVID-19 through Weibo made up 57.74% throughout the pandemic preventive and control phases (Zhu and Pan, 2021).

Weibo users can look for microposts that contain specific themes by keyword search on Weibo users can create tags that resemble Twitter's tags. However, the syntax is #tag#. A tag is typically used for a more specific event, making it easy for others to search for and discuss. Instead of focusing on tags, this study examines the entire contents of Weibo micro posts. This is because the search results encompass all those with tags. A micropost would not appear in search results if it was published without a "#tag#."

For instance, Tommy wrote on a micropost that carbon neutral is incredible! "#Carbon neutral is impossible#" said Janet in a blog post. As there is no "#tag#" in Tommy's micropost, nobody could see his by searching for the tag. Yet, Janet's posts could be seen.

#### 3.3 Sentiment Analysis

Sentiment is an essential part of human beings. People express their sentiments and opinions about a topic through their posts on social media. Sentiment analysis uses computer algorithms and a word dictionary to automatically extract users' emotional states. Public opinion analysis, information prediction, information screening, personalized recommendations, and many other industries have benefited greatly from this kind of analysis (Poria et al., 2017). Song et al. (2022) studied linguacultural differences by analyzing Twitter sentiment *via* machine learning. It found that more positive English tweets were more likely to be retweeted. Nevertheless, more negative French tweets were more likely the tweets to be retweeted. Yao et al. (2021) found that there was a positive correlation between retweets and favorites in construction safety knowledge sharing.

On the Internet, bad news has constantly been circulated. In the Chinese proverb "seven emotions and six desires," four express negative emotions. Weibo's share of the first adverse event reports is as high as 75.6%, according to studies by Yin et al. (2011) and Tang et al. (2021). People are inherently more sensitive to unpleasant feelings.

### 4 RESEARCH METHOD AND RESULTS

This study obtained the real-time Weibo data, it involved three main processes: data crawling, clustering and sentiment analyses (Figure 1). It investigated 11 sets of keywords in Chinese: 1. carbon peak, carbon-neutral, industry, and adjustments; 2. Carbon neutral and achieve target; 3. Carbon neutral and regulations; 4. Carbon-neutral, economy, and industry; 5.

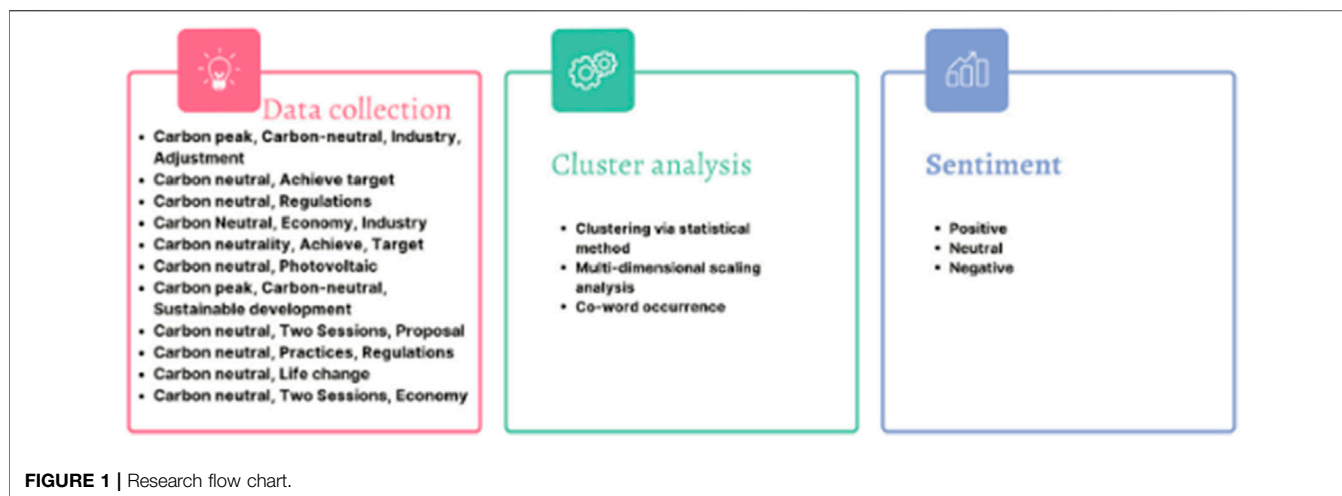


FIGURE 1 | Research flow chart.

TABLE 2 | Total amount of the Weibo data.

Keywords	Number of messages	Keywords in Chinese
Carbon peak, carbon-neutral, Industry, and Adjustment	1,416	碳达峰 碳中和 产业 调整
Carbon-neutral; Achieve target	1,180	碳中和 达到目标
Carbon-neutral; Regulations	394	碳中和 规定
Carbon-neutral, Economy, and Industry	951	碳中和 经济 产业
Carbon neutrality, Achieve, and Target	66	碳中和 目标 达标
Carbon-neutral; Photovoltaic	978	碳中和 光伏
Carbon peak, carbon-neutral, and Sustainable development	991	碳达峰 碳中和 可持续发展
Carbon-neutral, Two Sessions, and Proposal	60	碳中和 两会 提案
Carbon-neutral, Practices, and Regulations	12	碳中和 实践 规定
Carbon-neutral; Life change	719	碳中和 生活 改变
Carbon-neutral, Two Sessions, and Economy	271	碳中和 两会 经济
Total	7,038	

Carbon neutrality, achieve, and target; 6. Carbon-neutral and photovoltaic; 7. Carbon peak, carbon-neutral, and sustainable development; 8. Carbon-neutral, two sessions and proposal; 9. Carbon-neutral, practice, and regulations; 10. Carbon-neutral and life change; and 11. Carbon-neutral, two sessions (Table 2).

## 4.1 Keyword Search Results

There are 7,038 relevant microposts from Weibo. After deleting the same microposts from the same users and irrelevant content, there are 3,851 carbon neutrality microposts. The co-occurrence matrix is analyzed from UCINET 6. Degree Centrality is the most direct measure of node centrality in network analysis. The larger the node the higher is the degree of centrality, and the more influential the node is in the network. From Figure 2, 58 nodes and 3,212 ties are observed. The top five most prominent nodes are neutralized, energy, China, blue-green (in mainland China, blue green refers to the water and plant), and economy, which are vital keywords in carbon neutrality. Keyword like blue-green reflects Chinese slang used by Weibo users.

The cluster analysis method uses the statistical method of clustering, takes the frequency of co-word occurrence as the research object, simplifies the co-occurrence network into the relationship between several groups, and visually illustrates the

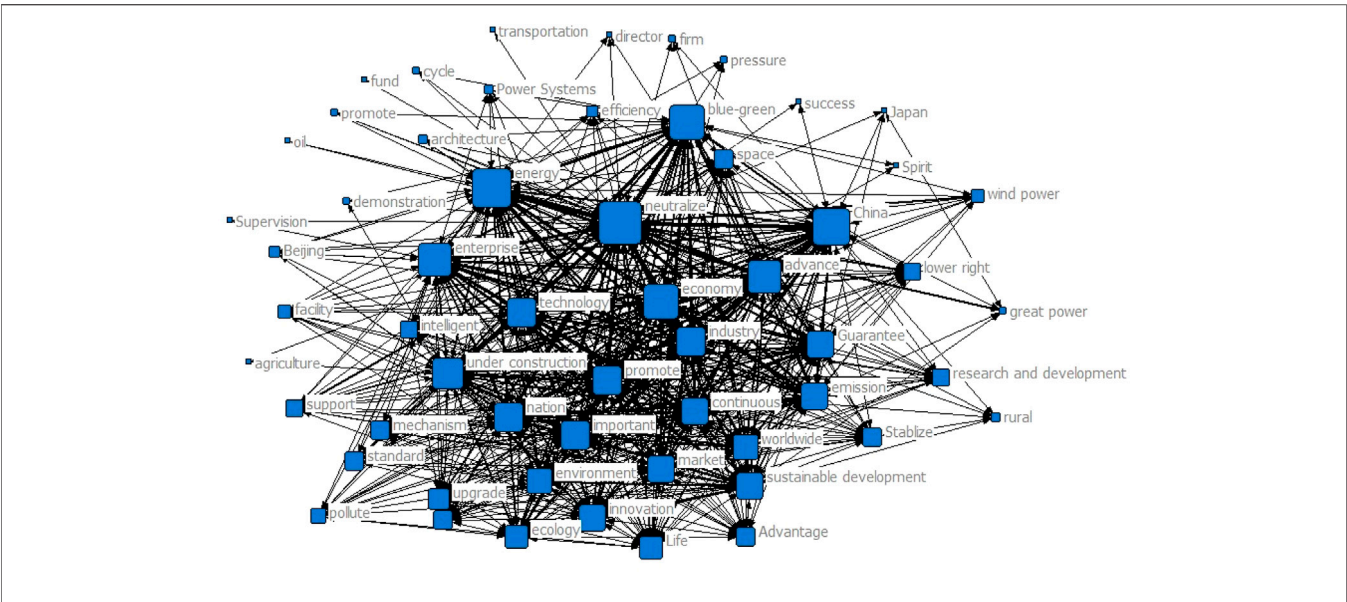
results by clustering. Multidimensional scaling analysis finds the topic structure by measuring the distance between topic words and can intuitively judge the position of a research field within the discipline. The KHCoder is used to perform the clustering of research samples from Weibo. In Figure 3, there are 11 clusters. The most crucial cluster includes carbon, neutrality, goal, industry, development, new, green, adjustment, structure, consumption, low-carbon, transformation, sustainable, economic, and social. The second-largest cluster includes country, emission, reduction, major, and responsibility. The third-largest cluster includes capacity, power, and generation. It also reveals various people's concerns on carbon neutrality link to the environment (e.g. low carbon, sustainable, and wind power), social (e.g. country and poverty), and governance (responsibility and government report).

## 4.2 Keyword Search Results

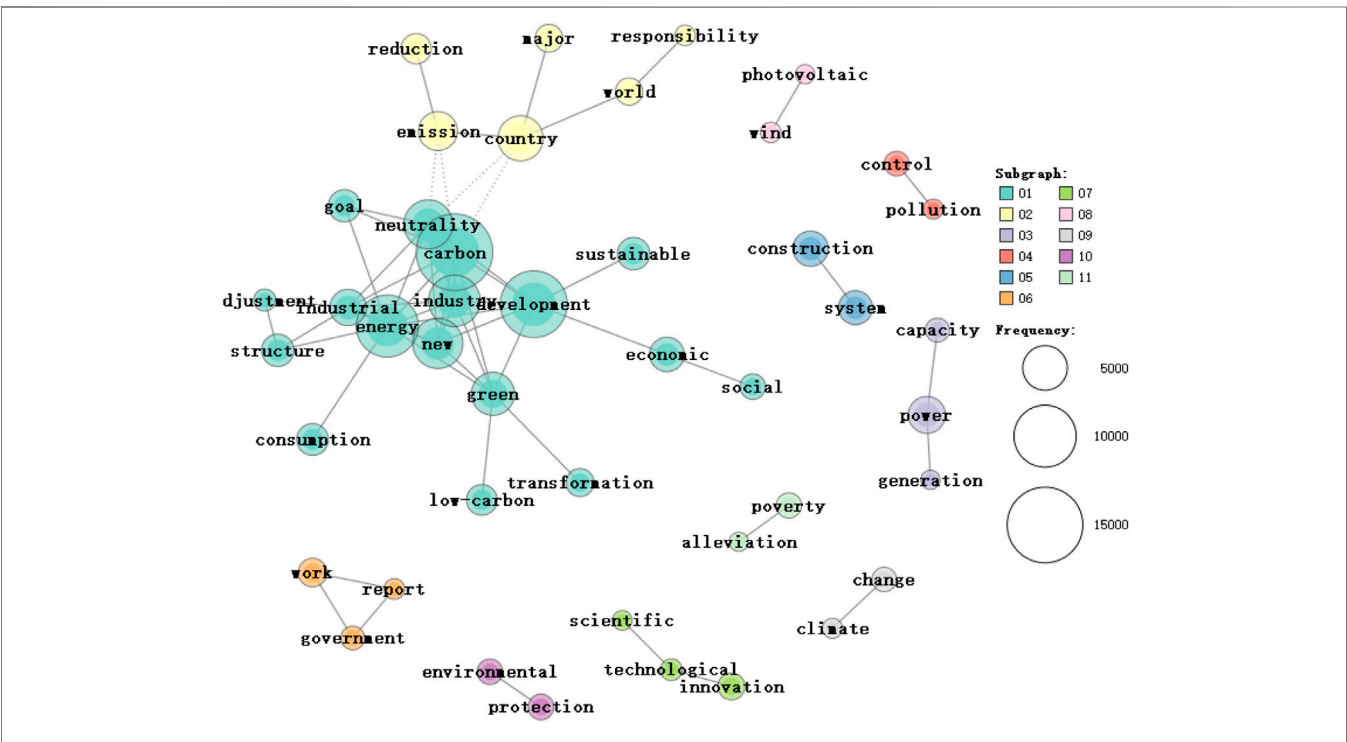
### 4.2.1 Carbon Neutral, Economy, and Industry

High-frequency words included the following among the 951 microposts found using the keyword search "carbon neutral, economy, and industry", high-frequency words included the following: Development and Reform Commission, slip,





**FIGURE 2 |** Co-occurrence matrix analysis.



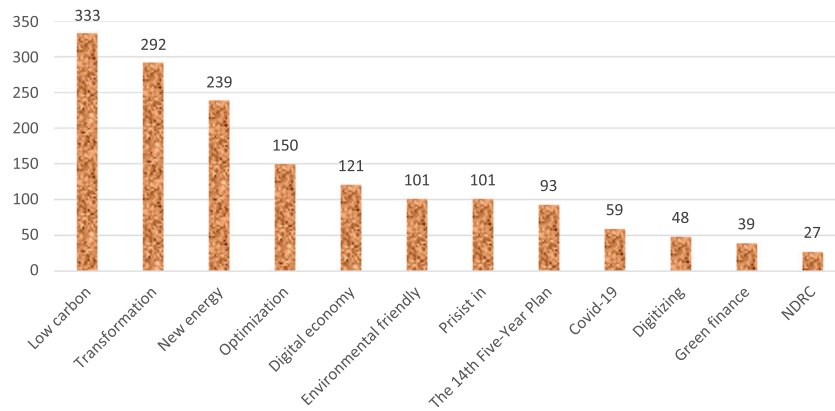
**FIGURE 3 |** Co-occurrence network analysis.

COVID-19, unfavorable, new energy, digitizing, optimization, low carbon, transformation, the 14th Five-Year Plan, green finance, strive, environmentally friendly, digital economy, and persist in **Figure 4**.

Low-carbon (333), new energy (239), and transformation (292), appeared to be the most often stated keywords (one to

five words) connected with “carbon neutral, economy, industry” in the findings of tokenisation. It is consistent with the national goal of industrial transformation to drive low-carbon economic development and new energy development.

Positive high-frequency keywords are associated with new policies (National Development and Reform Commission,



**FIGURE 4 |** Most mentioned keywords for “Carbon-neutral, Economy, and Industry” in Weibo microposts.

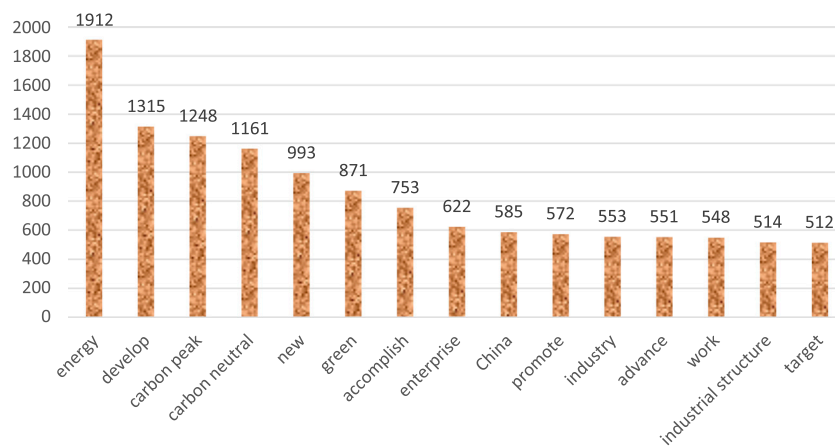
Transformation, and 14th Five-Year Plan), digitization (digital economy and green finance), and new energy (low carbon and environmentally friendly). The words “persist in” and “strive” convey the nation’s and its citizens’ confidence in driving economic growth through industrial transformation.

#### 4.2.2 Carbon Peak, Carbon-Neutral, Industry, and Adjustment

There were numerous duplicates among the 1,416 microposts for the keywords “Carbon peak, Carbon-neutral, Industry, and Adjustment.” Forty media sites, for instance, published the same micropost regarding the “China Carbon Peak Carbon Neutrality Progress Report in 2021” 623 unique microposts left after removing duplicates. The following words frequently appeared in the high-frequency keywords list: energy, develop, carbon peak, carbon-neutral, new, green, accomplish, enterprise, China, promote, industry, advance, work, industrial structure, and target (Figure 5).

The keywords “carbon peak, carbon-neutral, industry, and adjustment“ were mentioned in 177 microposts, which made up

28.41% of all posts. This demonstrates that Weibo users consider industrial change is important to reach carbon neutrality. Among them, 52 microposts has unique authors who commented on “Guiding Opinions on Promoting the High-quality Development of Central Enterprises and Doing a Good Job of Carbon Peak carbon neutrality.” These comments centre on the government’s declarations: “by 2025, the adjustment and optimisation of the industrial and energy structures of central enterprises will make significant progress; the energy utilisation efficiency of key industries will be greatly improved; the construction of new power systems will be accelerated; the research, development, and promotion and application of green and low-carbon technologies will make positive progress; total energy consumption of the output value of central enterprises will be reduced by 15% as compared with 2020; the output value of 10,000 yuan will be reduced by 18% compared with 2020; and the proportion of renewable energy power generation capacity will reach more than 50%. The proportion of revenue of strategic emerging industries is not less than 30%, laying a solid foundation for achieving the carbon peak.”



**FIGURE 5 |** Most mentioned keywords for “Carbon peak, Carbon-neutral, Industry, and Adjustment” in Weibo microposts.

### 4.2.3 Carbon Neutrality in the Photovoltaic Sector

The microposts on carbon neutrality have frequently brought up the photovoltaic business. This article gathered data using the keywords “photovoltaic and carbon neutral.” As the growth of the new energy sector inextricably links to the achievement of carbon neutrality (Liu and Lu, 2022), China places much significance on the photovoltaic industry as one of the new energy sectors. The photovoltaic industry in China is currently heavily dependent on government subsidies despite being a crucial new energy source and component of the optimisation of energy transformation. The power generation cost is high, continued technology advancement and extensive grid connections are required.

The user’s investment history in the photovoltaic business and the private investment proposal for the sector made up around half of the data. Many Weibo users expressed their worries about the situation in Europe, they asked, “Will Western European countries leave carbon neutrality, abandon the photovoltaic industry, and turn to cheaper thermal electricity in the context of the Russian-Ukrainian conflict?” Is it necessary to halt investments? Because the consumers lost money when they invested in the photovoltaic sector, some micropost entries denigrated the photovoltaic industry and carbon neutrality.

Users’ perspectives on the growth of the photovoltaic industry in China were more favorable. Microposts from various regional and solar enterprises make up about one-third of the data. After all the photovoltaic power is used, diesel will be reduced by over 1,000 tons annually, and carbon dioxide emissions will be lowered by more than 3,000 tons. The shelter forest covers 3,128 hectares, can absorb approximately 20,000 tons of carbon dioxide annually, neutralises cars’ carbon emissions. Users’ support for carbon-neutral legislation and satisfaction with national accomplishments can be seen in microposts. Thirteen distinct microposts evidenced photovoltaic energy’s role in Beijing’s commitment to the Winter Olympics’ carbon neutrality, reaffirming the viability of photovoltaic energy generation.

Regarding the set of keywords energy, develop, power generation, industry, electricity, construction, market, and

green. Micropost users most commonly used “energy” in this keyword group. It appeared 1,515 times, more than twice as frequently as the runner-up “development” (710). Industry only appeared 415 times, or approximately 25% as often as energy (Figure 6).

All in all, the development of the photovoltaic industry is viewed as being crucial throughout the nation, and Weibo users are optimistic about the industry’s future in China.

### 4.2.4 Carbon Neutrality and Change in Life

The keyword “carbon-neutrality, change in life” was chosen to determine users’ views about how carbon neutrality affected life. With this particular collection of keywords, 719 results were obtained. 388 remained after deleting duplicates. 237 of the 388 were deleted as all these related to “CBN carbon-neutral communities.” These posts began with “#CBN Carbon Neutral Community#”. Although all the words seem to be different, they shared the same contents: “Come and buy the concept of CBN.” Moreover, all the writers’ ID format was “CBN” and “Chinese character” and “number” or “Chinese character and number.” These micropost were marketing and advertising.

After deleting the micropost related to “CBN,” 151 remained. Table 3 shows some CBN microposts. These data differ from others as the microposts about foreign countries are collected. People frequently brought up energy (561) and the economy (432) when discussing how their lives have changed, and 15 (10%) microposts mentioned “Japan.” A phrase that featured four times was “the Japanese government called the people to adjust their eating habits, eat more vegetarian cuisine, and contribute to reaching carbon neutrality.” “Develop” was the word that appeared the most frequently (773) (Figure 7).

### 4.2.5 Carbon Neutrality, Targets, and Achieve

Five of the 66 microposts on “carbon neutrality, targets, and standards” cited electricity limits as a way to reach carbon neutrality objectives in some locations. The standard power-using activity should not jeopardize carbon neutrality, according to all five microposts. A micropost read, “China has stated it will accomplish

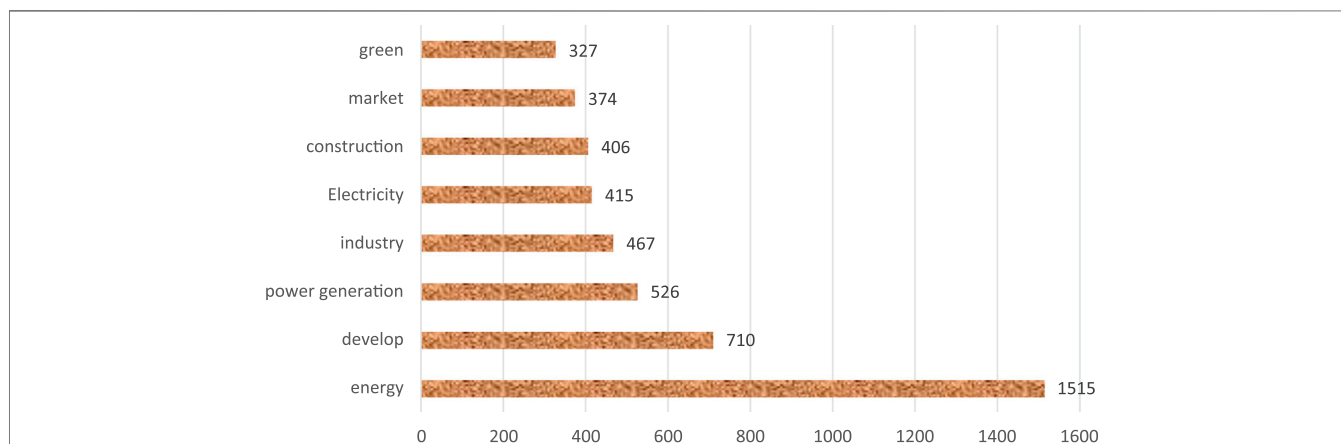
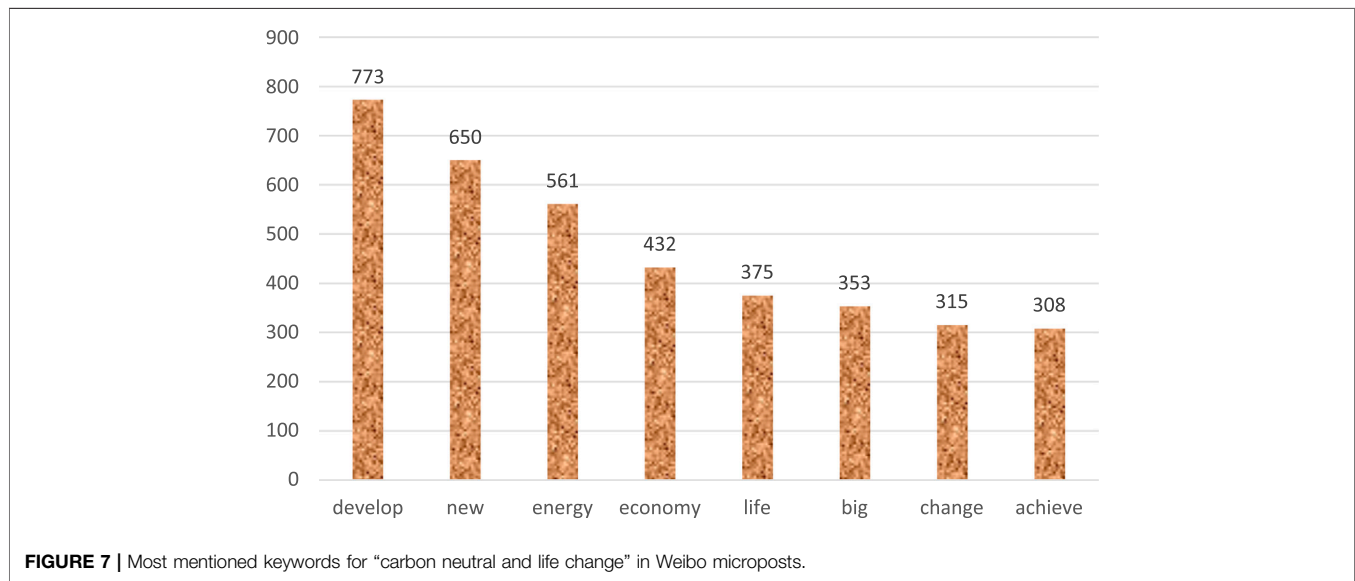


FIGURE 6 | Most mentioned keywords for “photovoltaic and carbon-neutral” in Weibo microposts.

**TABLE 3** | Some of the “CBN” blogs.

A	Blogs
FENG***	#CBN Carbon Neutral Community# 🎁🎁🎁🎁 Do not leave life with regrets and regret. We should seize every opportunity to change our lives as much as possible. Now, the carbon-neutral CBN green financial chain is coming. Do you want to grab it to change your life?
QI***	#CBN Carbon Neutral Community# 🌸🌸🌸 Do not leave life with regrets and regret. We should seize every opportunity to change our lives as much as possible. Now, the carbon-neutral CBN green financial chain is coming. Do you want to seize it to change your life? 🌸🌸🌸
QING***	#CBN Carbon Neutral Community# In order not to leave life with regrets and regrets, we should seize every opportunity to change our lives as much as possible. CBN 15% handling fee is strongly destroyed + automatic dividends for holding coins + underpinning makes the price of the currency fall and does not rise. The only contract address for pancake trading on Binance Chain: 0x3008ebba0131a6085fcc230ef947ed8f8f12346f
C***	#CBN Carbon Neutral Community# CBN Carbon Neutral Community Do not leave life with regrets and regret. We should seize every opportunity to change our lives as much as possible. Now, the carbon neutral CBN green financial chain is coming, do you want to seize it to change your life?
ZHI***	#CBN Carbon Neutral Community# Some people complain that life is unfair, but they do not want to change themselves. Some people work hard for a long time but always stop halfway at the critical moment. No one is born a king. On the way to growth, do not always think about where there is light, just run forward. Dreams are not empty words but the fruit of hard work in the lonely struggle! CBN family, happy Laba Festival!!
T***	#CBN Carbon Neutral Community# 🌳🌳🌳🌳🌳🌳 Some people complain that life is unfair, but they do not want to change themselves. Some people work hard for a long time but always stop halfway at the critical moment. No one is born a king. On the way to growth, do not always think about where there is light; just run forward. Dreams are not empty words but the fruit of hard work in the lonely struggle!
Q***	#CBN Carbon Neutral Community# CBN Carbon Neutral Community CBN 🙏 If you did not get on, hurry up and get on! Do not miss this opportunity. Conditions Online and offline community. The strongest Weibo, super talk, finance, and economics section of the entire network is the first hot search...What you missed is the opportunity of turning 100 yuan to 2 million yuan!!



the carbon neutrality goal between 2030 and 2060. The global ecology demands a great deal of sacrifice and work. Naturally, the nation will restrict the production of coal-fired power! The central government has already proposed environmental protection indicators. There will be many “sudden shutdowns” if the local government continues to operate the same way as before.

Another lengthy micropost detailed locals’ worries about power outages in Liaoning Province. Residents in Liaoning

experienced “failure” of road traffic signals and had to purchase candles for unexpected power outages. They were concerned about how the power outages would affect the winter heating. Rising thermal power costs severely negatively impact Liaoning Province’s economy (Liaoning Province Development and Reform Commission 2021). The Liaoning provincial government stated that it would not falsify the data to achieve carbon neutrality and pay close



attention to people's livelihood (Liaoning Province Development and Reform Commission 2022). The micropost mentioned: "Can the power grid handle harsh temperatures with the new energy it relies on so heavily? This must be taken into consideration as renewable energy is developed."

"The Corolla icon that has been with me for 16 years will finally be changed," a user wrote in a post. "I have used this car for more than ten years without any issues. Only the emission standard symbol or national III needs to be replaced to reach the carbon neutrality goal. Although there is little data, users are aware of the aim of carbon neutrality and are prepared to put effort into achieving it. However, when achieving carbon neutrality conflicts with daily lives, everyday life needs should come before achieving carbon neutrality. Under this set of keywords, the word that appears the most frequently is "develop" (154), followed by "construction" (132). The

additional two words that are more frequent are "project" (116) and "new" (106) (Figure 8).

#### 4.2.6 Carbon Neutrality and Two Sessions

The Chinese People's Political Consultative Conference and the National People's Congress of the People's Republic of China are referred to as the "two sessions" collectively. This is mainly because of their timing and importance. The People's Republic of China's National People's Congress is the highest-ranking body in state power. The Standing Committee of the National People's Congress is its permanent organization. The state's legislative authority is exercised by the National People's Congress and its Standing Committee. Representatives chosen by provinces, autonomous regions, municipalities directly under the Central Government, special administrative regions, and the military make up the National People's Congress (National People's Congress. 1982). The Chinese People's Political Consultative Conference is a crucial

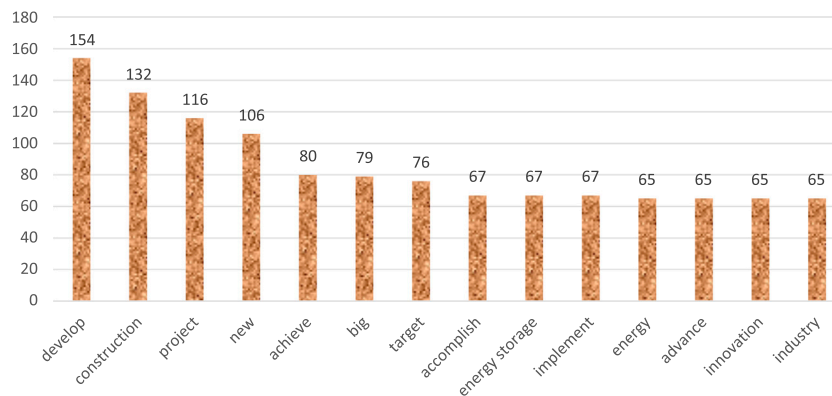


FIGURE 8 | Most mentioned words for "Carbon neutrality, Targets, and Achieve" in Weibo microposts.

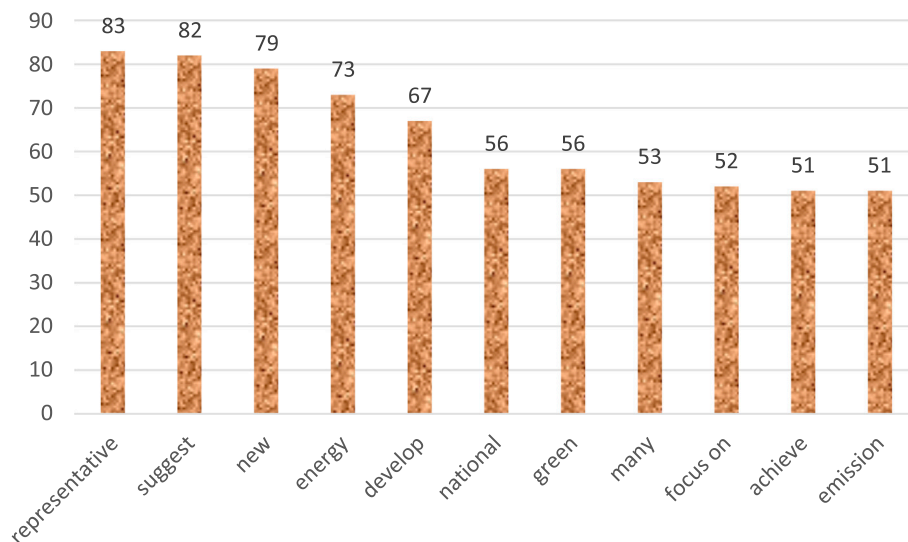


FIGURE 9 | Most mentioned words for "carbon neutrality, two sessions and proposals" in Weibo microposts.

**TABLE 4 |** Source data analysis.

	Positive score	Negative score	Neutral	No sent	No data	Overall
Total items processed	2996	353	224	278	0	3851
Total items processed	78%	9%	6%	7%	0	100%
Average number of words per item	294	260	218	70	0	270
No. containing a URL or email address	50	2	4	2	0	58
Percentage	2%	1%	2%	1%	0	2%

component of the national government system and a Chinese-specific institutional system (General Office of the Central Committee of the Communist Party of China, 2015). The “two sessions” per Chinese Constitution, are responsible for gathering and organizing public information, requesting its representatives, and relaying it to the Party Central Committee (National People’s Representative Meeting, 1982). To some extent, the ideas made by the delegates of the two sessions can reflect public opinion. The people’s attitudes about carbon-neutrality might reflect in the microposts with “carbon neutrality” and “two sessions.”

The results of the “carbon neutrality, two sessions were relatively few (60) as compared to “two sessions, sustainable development” (1549). This is foreseeable since sustainable development is more comprehensive than carbon neutrality. While carbon neutrality is only one facet of the environmental problem, sustainable development addresses the economic, social, and environmental issues. Most frequent mentioned keywords are shown in **Figure 9**.

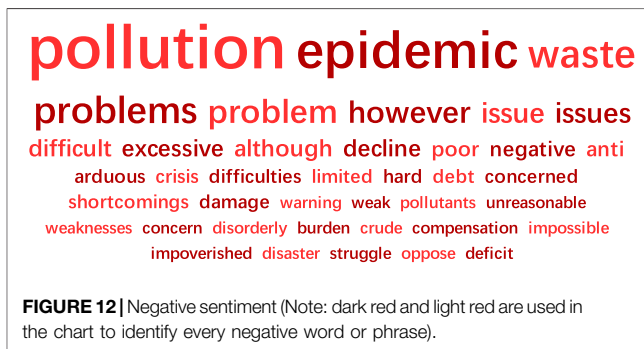
### 4.3 Sentiment Analysis

The research samples are also analyzed *via* AI Sentiment. The source data analysis is shown in **Table 4**. The most popular words (or tags) like ‘Achieve,’ ‘high quality,’ ‘improve,’ ‘support,’ and ‘good’ express a positive sentiment (**Figure 10**). From **Figure 11**, the words (or tags) with positive sentiment included ‘achieve,’ ‘high quality,’ ‘improve,’ ‘support,’ ‘good,’ ‘comprehensive,’ ‘relevant,’ and ‘cooperation.’ The negative sentiment include ‘pollution,’ ‘epidemic,’ ‘waste,’ ‘problems,’ ‘however,’ and ‘issue’ (**Figure 12**). From **Figure 13**, the proportion of positive sentiment accounts for 83.9%, while the negative sentiment only accounts for 9.9%. **Figure 13** shows the distribution of positive, negative and neutral microposts percentage and **Figure 14** illustrates the results of another algorithm that identified text emotions ranging from –18 to 40. The highest score (288) described Nanyang City’s economic activities and provided detailed guidance on achieving the goals while

controlling pollution. The lowest one scored –18. It criticized extravagant moon cake packaging that caused a lot of waste and excessive emissions, detrimental to the carbon-neutral goal.



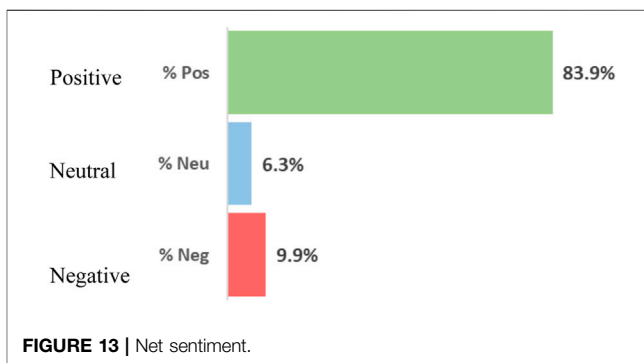
**FIGURE 11 |** Word cloud for positive words in carbon neutrality microposts (Note: dark and light green are used to see all positive words or phrases in a clearer way).



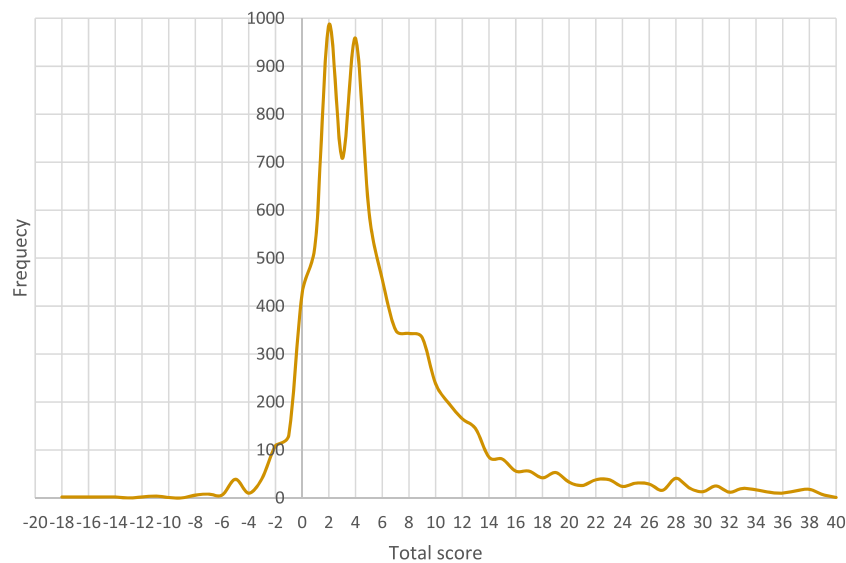
**FIGURE 12 |** Negative sentiment (Note: dark red and light red are used in the chart to identify every negative word or phrase).



**FIGURE 10 |** Word clouds of most frequent mentioned words’ sentiment in carbon neutrality



**FIGURE 13 |** Net sentiment.



**FIGURE 14** | Sentiment score distribution of all words in carbon neutrality microposts.

#### 4.4 Parts of Speech

Figures 15 and 16 show the most frequent verbs and adjectives. Verbs such as “develop,” “contribute,” “promote,” and “continue” are related to goals and development and the future.

Regarding the adjectives of more than 1,000 times, all except “low” was positive. However, “low” was usually combined with words like “low carbon,” “low emission,” and collocations “New” were usually mentioned. Common collocations included “new energy,” “new chapter,” “new opportunity”. Although sustainable development is an old terminology, carbon-neutral is a “new concept”, and carbon-neutral policies are also new. Figure 15 shows the results of visualization.

#### 4.5 Mega-Events and Carbon Neutrality

This study reflects carbon neutral events in China. As the first carbon neutral winter Olympics, “the Beijing Winter Olympics” appeared many times in Weibo. The Hangzhou Asian Games also appeared in the March microposts. These expressed user’s appreciation for the Beijing Winter Olympics and expectations for the Asian Games, the first Asian Games which achieve carbon neutrality.

#### 4.6 Is Carbon Neutrality a Friend of Economic Development?

By examining the microposts, it was discovered that the Weibo users supported carbon neutrality and believed it would enable them to live better. Similar ideas like “sustainable development” and “green mountains and clear water are mountains of gold and silver” were popular in China before the Western world developed the concept of “carbon neutrality.” The idea of “carbon neutrality” is in line with Chinese policy, cultural norms, and ideals.

Beyond the bright side, several Weibo users questioned whether carbon neutrality was a trap set by the West to slow global development. We are all aware that industrial development must go through a process that results in substantial carbon emissions. Developing industries is essential for a developing nation. How can emerging nations conform to the industrial chain promise of carbon neutrality while assuring their development?

Many comments under this post advocated that the carbon neutrality commitments are all national aims. Nevertheless, the high carbon emissions in other countries frequently come at the expense of one country’s attempt to become carbon neutral. For instance, as low-end sectors shifted to Southeast Asia, local carbon emissions in China decreased but increased in Southeast Asian nations.

Another post mentioned that, “carbon emission rights were an idea that the West utilized to stifle the development of later developing countries, according to another piece. China agreed to it because it represents the pinnacle of morality on the global stage.” This statement highlights the importance of governance to meet the social and environmental needs when we wish to realise the goal of carbon neutrality.

Other users have expressed criticisms and dialectical analyses of the microposts: “China’s carbon-neutral emission aim is not merely a moral dilemma in the highlands or a climate change problem. The most crucial aspect is that we employ it to improve our economic growth. As a result, the foundation for the sustainable development of the Chinese country was solidly constructed. Thus, the public favors low-carbon emission reduction, but they do not permit sacrificing national development and the quality of life for the people to reach the goal.

The promotion of high-quality development is vital for achieving carbon peak and neutrality, which must be done unwaveringly, according to the 2021 Central Economic Work Conference. It is

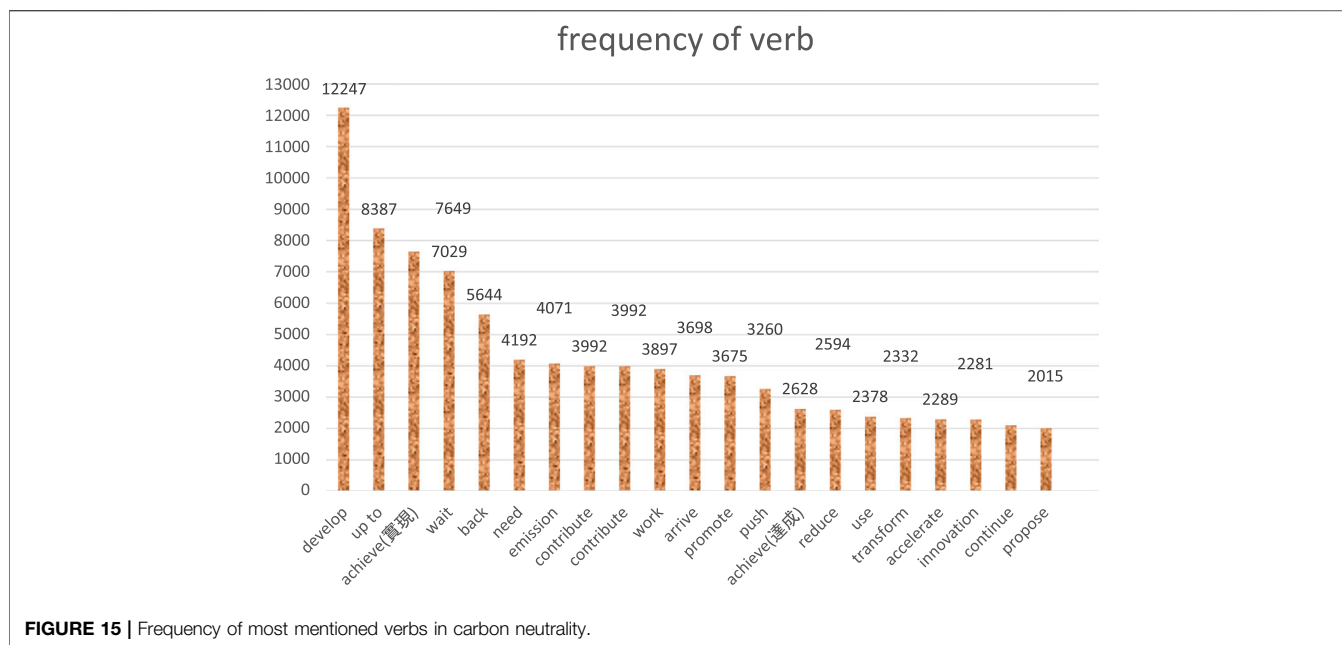


FIGURE 15 | Frequency of most mentioned verbs in carbon neutrality.

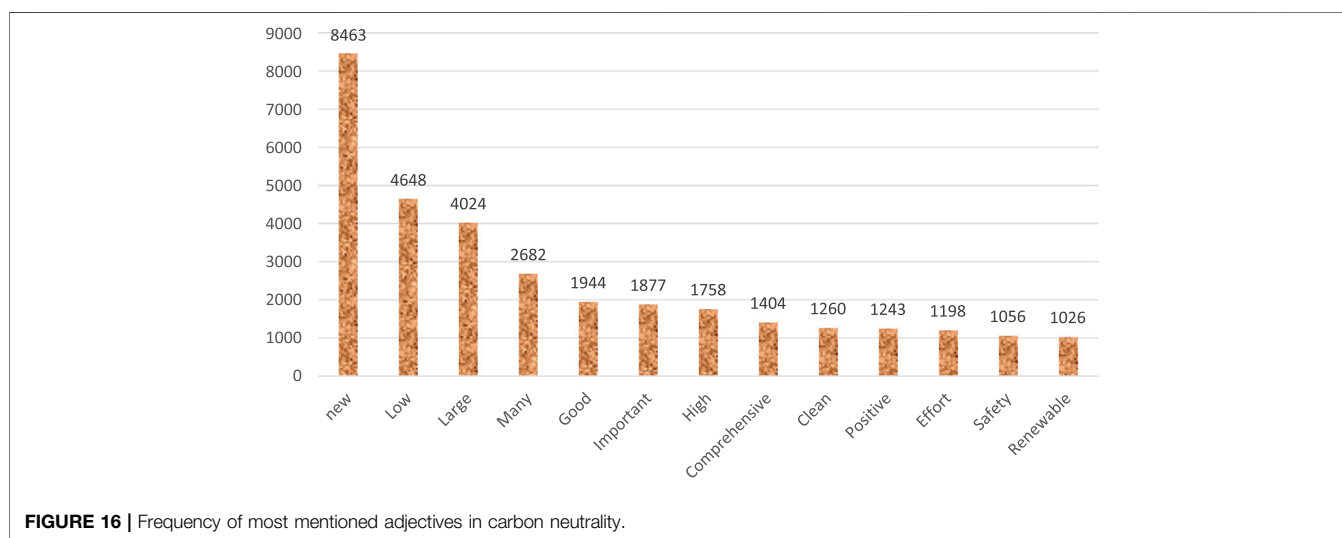


FIGURE 16 | Frequency of most mentioned adjectives in carbon neutrality.

nonetheless impossible to achieve all the goals at once. Since reaching the carbon peak and being carbon neutral would need significant economic and social transformation, it will not be simple. We must be steadfast for a long time if we want to promote carbon neutrality in an organized and methodical way. To solidly and successfully promote various works, we have to be patience.

## 5 CONCLUSION

One of China’s primary objectives is carbon neutrality; writers on Weibo indicated an interest in it. Through data collection and sentiment analysis on Weibo, this study made a novel contribution by demonstrating how different people’s concerns

about carbon neutrality are related to the environment, social and governance (ESG). Weibo users expressed concern about new energy’s role in achieving carbon neutrality and commented on environmental issues, such as low carbon and sustainability. Their posts highlighted that new energy-related businesses in China worked hard to develop cutting-edge technologies.

The notion that achieving carbon neutrality will enable us to live better lives was widely held in the social aspect. People mentioned governance (responsibility and government reports) in their posts. Therefore, the ESG idea existed even though this word was seldom mentioned in microposts. Besides, Weibo users are optimistic that China will accomplish its carbon neutrality targets and support national policies, despite their concerns about the potential adverse impacts.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## AUTHOR CONTRIBUTIONS

RL: Conceptualization, Validation, Writing—original and revised, Data analysis, Writing—review and editing, and Project administration, QW: Writing—original draft preparation, Investigation, Methodology, and Formal analysis LZ: Writing—original draft preparation, Software, Methodology, and Visualization HC: Resources and Conceptualization All authors have read and agreed to the submitted version of the manuscript.

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