

Analysis on the Development Status of Shandong Negative Carbon Technology System based on Patent Analysis

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Abstract. Shandong's energy structure is dominated by coal, and its industrial structure is relatively high. Its carbon emission ranks first in China, accounting for about 10% of China's. At the 12th provincial Party Congress, it was proposed that "the proportion of non fossil energy consumption will increase by more than 1 percentage point per year in the next five years", which is still far from the requirements of the Party Central Committee and the State Council for provincial carbon reduction indicators [1-2]. Therefore, the task of "carbon reduction" is heavy and difficult. The realization of carbon neutrality depends on the "three points" of energy structure, energy consumption and artificial carbon fixation. At present, the per capita GDP of Shandong is at the level of 10,000 US dollars. According to the development experience of advanced countries and regions such as Europe and the United States, the carbon emissions are still in a rapid rising period with economic development. There is a great pressure to reduce carbon by adjusting the energy structure and energy consumption [3]. It is urgent to start from the point of "artificial carbon fixation", lay out technologies such as carbon capture, utilization and storage (CCUS), and do a good job in negative carbon technology reserves. This study is based on the patent analysis method to find out the current situation of the development of Shandong's negative carbon technology, sort out the existing problems, and put forward countermeasures and suggestions to provide decision support for the government.

Keywords: Negative carbon technology; Patent analysis; present situation; Shandong.

1 Introduction

Due to the high proportion of non fossil energy and the emphasis on the secondary industry in the industrial structure, Shandong is still far from the national requirement that the proportion of non fossil energy consumption should reach about 25% by 2030[4]. Therefore, the task of "carbon reduction" is very arduous. At present, there are few researches in the field of negative carbon technology in Shandong Province, and the development of the field of negative carbon technology is not clear. This paper studies the current situation of the development of negative carbon technology in Shandong Province, in order to find out the existing problems, compare and analyze the gaps with advanced provinces and cities, and put forward countermeasures and suggestions. This study uses the patent database incoPat to analyze the published domestic negative carbon technology patent data [5]. Find out the

research results, research and development institutions and market subjects in the field of negative carbon technology in Shandong. Through horizontal comparison, Shandong's technological innovation in the field of artificial carbon fixation is compared with Beijing, Jiangsu, Zhejiang and other advanced provinces and cities, and the gap and existing problems in Shandong are analyzed in depth.

2 Analysis on the research status of Shandong negative carbon technology based on patent analysis

2.1 Authorized amount of negative carbon technology patents

As shown in Fig. 1, the number of domestic negative carbon technology patents authorized is 1128, of which Shandong ranks 9th, and 35 patents were authorized, accounting for 3.1%. Beijing ranked first, with 290 authorized patents, accounting for 25.7%; Jiangsu Province ranked second, with 105 authorized patents, accounting for 9.3%; Zhejiang Province ranked third, with 72 authorized patents, accounting for 6.4%; Shanghai ranked fourth, with 66 authorized patents, accounting for 5.9%; Guangdong Province ranked fifth, with 63 authorized patents, accounting for 5.6%.

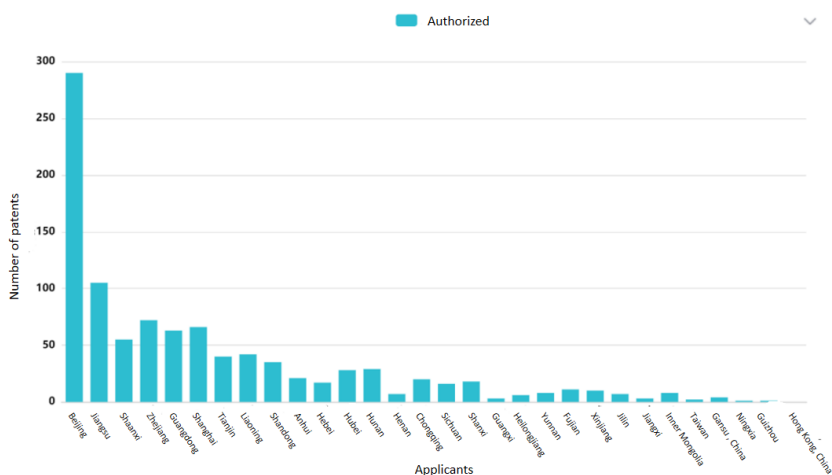


Fig. 1 Authorized number of negative carbon technology patents in various provinces and cities

It can be seen from the above results that more than 50% of the authorized patents of negative carbon technology are concentrated in Beijing, Jiangsu, Zhejiang, Shanghai and Guangdong. Although there is a clear gap between Shandong and advanced provinces and cities, and the number of patents is difficult to meet the huge artificial carbon fixation market in the province, as shown in Fig. 2, since 2018, the number of authorized patents has doubled year by year.

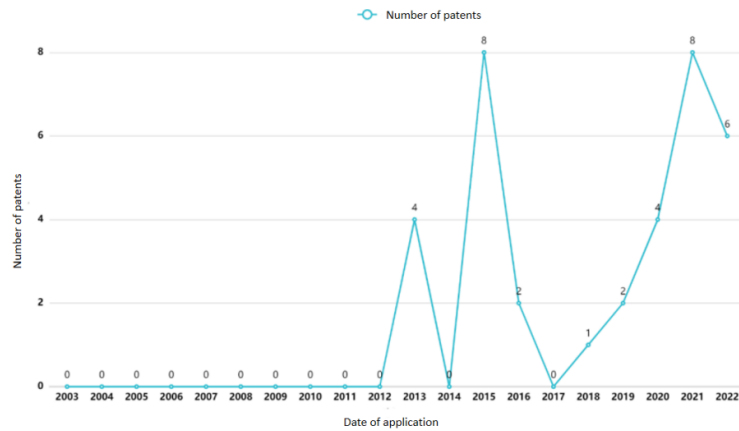


Fig. 2 Number of patents granted for Shandong negative carbon technology

2.2 Number of negative carbon technology research and development(R&D) institutions

After filtering and denoising the data of domestic negative carbon technology research and development institutions, Figure 3 can be obtained. There are 117 R & D institutions in Beijing, the No.2 is Jiangsu Province (78), the No.3 is Zhejiang Province (44), the No.4 is Shanghai (42), the No.5 is Shandong Province (37), and the No.6 is Guangdong Province (36).

Although 35 patents in Shandong Province rank 9th in the country in terms of the number of patents authorized, and there is a large gap from 63 patents in Guangdong Province, Shandong has surpassed Guangdong in terms of the number of R & D institutions, which reflects that Shandong Province has a relatively strong R & D foundation and should focus on cultivation.

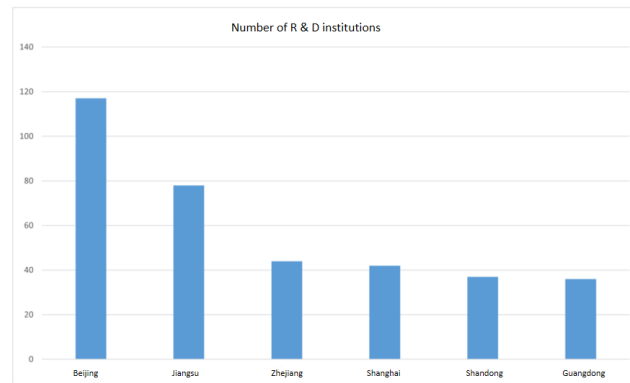


Fig. 3 Number of negative carbon technology research and development institutions in advanced provinces and cities

2.3 Distribution of negative carbon technology industry

As shown in Fig. 4, domestic negative carbon technologies are mainly concentrated in seven national economic sectors (accounting for more than 10%), of which 76.41% are in the field of

special equipment manufacturing, 72.22% in the field of general equipment manufacturing, 72.12% in the field of metal products, machinery and equipment repair, 65.44% in the field of instrument manufacturing, 41.30% in the field of chemical raw materials and chemical products manufacturing, 18.10% in the field of electrical machinery and equipment manufacturing, 11.87% in the field of motor vehicles, Electronic products and daily products repair industry.

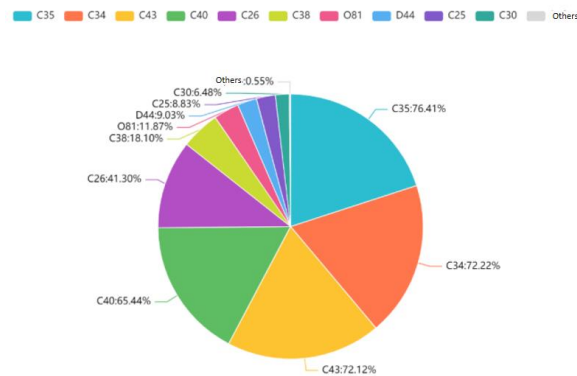


Fig. 4 Industry classification of domestic negative carbon technology in national economy

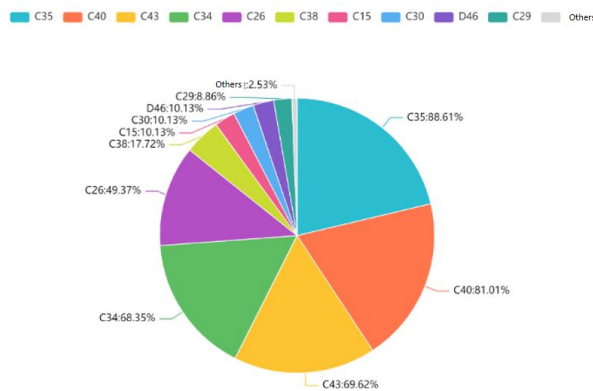


Fig. 5 Industry classification of Shandong negative carbon technology national economy

As shown in Fig. 5, Shandong's negative carbon technology is mainly concentrated in 9 national economic sectors (accounting for more than 10%), of which 88.61% is in the field of special equipment manufacturing, 81.01% in the field of instrument manufacturing, 69.62% in the field of metal products, machinery and equipment repair, 68.35% in the field of general equipment manufacturing, 49.37% in the field of chemical raw materials and chemical products manufacturing, 17.72% in the field of electrical machinery and equipment manufacturing, and 10.13% in the field of wine In the beverage and refined tea manufacturing industry, 10.13% is in the non-metallic mineral products industry, and 10.13% is in the water production and supply industry. Shandong is higher than the national average in 5 fields and lower than the national average in 4 fields.

2.4 Degree of marketization

To realize the widespread application of negative carbon technology, we must rely on market-oriented means, and enterprises should be the main body to carry out research and promotion of negative carbon technology. As shown in Fig. 6, among the advanced provinces and cities with many negative carbon patent technologies, we can see the proportion of patent applications by enterprises, colleges and universities, scientific research units and individuals in each province. The proportion of patent applications by enterprises represents the degree of marketization.

The patent application of Beijing's enterprise accounted for 67.70%, ranking the first in the country, Shanghai ranked the second, accounting for 60.29%, Shandong Province ranked the third, accounting for 55.29%, Jiangsu Province ranked the fourth, accounting for 51.23%, and Zhejiang Province ranked the fifth, accounting for 45.10%. Shandong's degree of marketization is higher than that of Zhejiang and Jiangsu, but lower than that of Beijing and Shanghai.

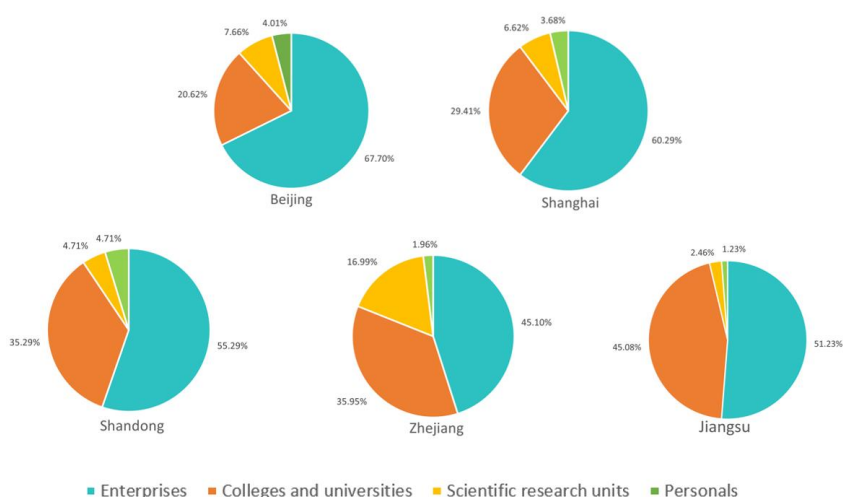


Fig. 6 Type of R&D institutions in five provinces

3 Problems in the innovation and development of Shandong negative carbon technology

3.1 Less achievements

The number of negative carbon patents authorized in Shandong Province accounts for about 3.1% of the total number of negative carbon technology patents authorized in China, and the overall proportion is relatively low, ranking 9th in the country. Beijing, Jiangsu, Zhejiang, Shanghai and Guangdong, the top five, hold more than 50% of the national total of negative carbon patents. The gap between Shandong and advanced provinces and cities is obvious, and

the negative carbon technology achievements can hardly meet the huge carbon reduction market in Shandong Province.

3.2 The number of R & D institutions is not high

In terms of the number of negative carbon technology research and development institutions, there are 37 in Shandong, ranking 5th in China. The top four are Beijing, Jiangsu, Zhejiang and Shanghai, with 117, 78, 44 and 42 enterprises respectively.

3.3 Uneven distribution of industry development

Shandong's negative carbon technology is mainly concentrated in nine national economic sectors. Compared with the national average level, in the fields of "repair of motor vehicles, electronic products and daily-use products", "repair of metal products, machinery and equipment", "general equipment manufacturing" and "electrical machinery and equipment manufacturing", it is 4.28, 2.5, 3.87 and 0.38 percentage points lower than the national average level respectively.

3.4 The degree of marketization needs to be improved

The degree of marketization of Shandong's negative carbon technology is generally high, with enterprises accounting for 59.49%. The degree of marketization is 11.86 and 4.08 percentage points lower than that of Beijing and Shanghai, and 13.18 and 13.66 percentage points higher than that of Zhejiang and Jiangsu.

3.5 The technical reserve is difficult to meet the demand

Shandong is a traditional industrial province and a large energy consumption province, with coal consumption accounting for 66.84%, which is much higher than Beijing (1.50%) and Guangdong (31.3%) which are close to the carbon peak. The CO₂ emission ranks first in the country, accounting for about 1 / 10 of the country. The time for carbon reduction is tight and the task is heavy. For every 10000 yuan of GDP added, about 1.5 tons of CO₂ will be produced. Shandong's per capita GDP is currently at the level of 10000 US dollars. With the rapid development of economy, carbon emissions are still in a rapid rising period. Shandong's existing negative carbon technology reserves can hardly meet the huge demand for carbon reduction.

4 Countermeasures and suggestions for the development of Shandong negative carbon technology innovation

4.1 Strive to cultivate leading R & D institutions

The number of R & D institutions in Shandong is higher than that in Guangdong Province, which has a good R & D foundation. At the same time, it is necessary to give full play to the demonstration role of leading enterprises and institutions to form a head effect and lead the benign development of Shandong's negative carbon industry.

4.2 Deepen inter-provincial cooperation in technological innovation

It is necessary to actively expand inter-provincial cooperation, strengthen cooperation in negative carbon technology innovation through investment attraction and building an exchange platform, and explore the establishment of a joint research and knowledge sharing mechanism for negative carbon technology innovation. Focus on and docking with units with high national negative carbon patent technology, such as China Huaneng Group Clean Energy Technology Research Institute Co., Ltd., Tianjin University, China Petroleum and Chemical Corporation, Southeast University, Xi'an Jiaotong University, Xi'an thermal Research Institute Co., Ltd.

4.3 Strengthen top-level design

Closely follow the actual situation of Shandong, conduct research as soon as possible, sort out the advantageous industries and weak industries of Shandong's negative carbon technology. It should formulate and issue the action plan and technology roadmap for the innovation and development of Shandong's negative carbon technology, and integrate the development of negative carbon technology into relevant plans for overall deployment. Unblock the inter departmental coordination mechanism, focus on the negative carbon technology needs in Shandong Province, and lay out the research and development of negative carbon technology in key fields in advance.

4.4 Prepare to build a negative carbon technology innovation platform

Focus on the key and core technologies of negative carbon technology, and actively prepare to build a number of provincial laboratories, provincial key laboratories, provincial technology innovation centers, new research and development institutions and other technology R&D platforms. At the same time, support leading enterprises and institutions to take the lead in establishing a negative carbon technology innovation alliance, accelerate the transformation of achievements, and promote collaborative innovation of industry, University and research.

4.5 Strengthen key technology research

On the basis of investigating and sorting out the "bottleneck" technologies in the field of negative carbon technology, we should focus on the "blocking points" restricting the development of negative carbon technology, support basic research by classification, apply basic research and development of leading-edge disruptive technologies, carry out scientific and technological research, build a market-oriented negative carbon technology innovation system, and promote industrial development.

5 Conclusion

This study is based on the patent analysis method to find out the current situation of the development of Shandong's negative carbon technology, sort out the existing problems, and put forward countermeasures and suggestions to provide decision support for the government.

Shandong Province as a large carbon emission province, has few achievements in negative carbon patent technology, the number of R&D institutions and the marketization need to be

improved, the distribution of industry development is uneven, and the technical reserves are difficult to meet the needs of five aspects. In the future, Shandong Province should strengthen top-level design, focus on cultivating leading R&D institutions, deepen inter-provincial cooperation in technological innovation, prepare to build negative carbon technology innovation platform, and strengthen key technology research. In order to achieve the goal of "carbon reduction", we should prepare negative carbon technology reserves.

Future research should strengthen the dynamic monitoring of relevant patent indicators in the field of negative carbon technology in Shandong, so as to provide a basis for the government's policy adjustment.

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