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The Study on Prospect and Early Opportunities for Carbon Capture and Storage in Guangdong Province, China

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Abstract

CCS is regarded as an important and strategic technology option to reduce CO₂ emission, and has received tremendous attention around the world. Guangdong, as the largest economic and energy-consuming province in China, is necessary to take CCS as an important option to reduce its future CO₂ emission. This paper presents the partial outcome of the first CCS-related research in Guangdong, which is aiming for preliminary assessment on the feasibility of CCS development in Guangdong. The main objective of the study is to characterize the industrial CO₂ emissions and understand its CCS prospects. Coal-fired power plants in Guangdong are the major point sources, contributing to more than 90% of CO₂ emissions from the electric power generation. The power plants are mainly located in the Pearl River Delta, while the newly built and projected large plants are mainly located in eastern coastal zone, which provides a great potential for CO₂ capture. For the storage potential, there are six sedimentary basins in or around Guangdong with effective storage capacity of 568 Gt_{CO₂}. Since the onshore storage capacity in Guangdong is limited, the northern portion of the Pear River Mouth Basin (PRMB) was considered the most promising choice for Guangdong to storage CO₂. By considering the distance between source and sink, technology maturity, land resources and other factors, it can be concluded that in the short term the power plants under construction and projected located in the eastern coastal areas will be the most promising resources for CO₂ capture and the corresponding storage sites are the existing oil/gas fields which located in the northeast of PRMB. But in the long term, as technologies and the international carbon market mature, the extensively retrofitting of existing coal-fired power plants in the Pearl River Delta region with CO₂ capture will become possible. In order to promote the development of CCS in Guangdong, more basic investigation and policy research are necessary in the coming years.

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Keywords: Carbon capture and storage; Electric power industry; Buffer analysis method; Guangdong, China

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1. Introduction

Compared with energy efficiency improvement and renewable energy development, carbon capture and storage (CCS) is one of the most efficient technological options for greenhouse gas mitigation that allows continued use of fossil fuels. According to the forecast of IEA, in the foreseeable future (up to 2050), most countries around the world will still use fossil energy as their primary energy supply source [1]. In order to achieve the goal of keeping the increase of global average temperature below 2 °C [2], while at the same time to satisfy the fast growing energy demand, great attentions have been paid to CCS all around the world.

As one of the biggest CO₂ emitters in world and a representative country of coal-dominated energy consumption, China is deemed as a key player in the global CO₂ reduction effort, and inevitably experienced more pressure on global warming issues from other countries. In the long term, CCS can be one of the promising technologies that can decarbonize the energy sector while satisfying its fast-growing demand at the same time [3]. Nowadays, China is undertaking a range of technical research and development projects on CCS, including the national fundamental research and key high-tech programs, as well as a large number of international cooperative programs [4]. However, as shown in figure 1, there is a geographical gap in the existing body of research on CCS in China. To date, all of the demonstration and R&D projects of CCS in China have been focused on the north of the Yangtze River, without substantial research on China’s wealthy manufacturing provinces in the south [5]. Considering the differences in geographical and climatic conditions, as well as energy structure and economic level, it is unreasonable to simply apply the results to the south. Therefore, it is urgent for carrying out the CCS-related research in this area.

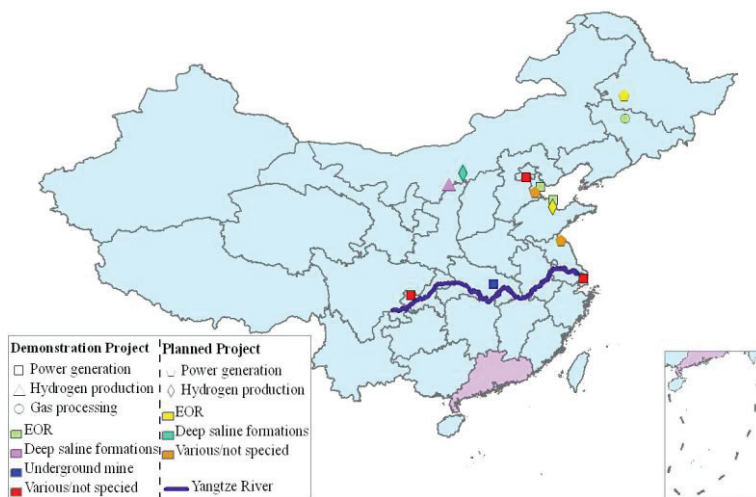


Figure 1. Map showing CCS demonstration projects in Mainland China and the location of Guangdong Province

Guangdong, which is located in the south of China (Figure 1), is the largest economic and energy-consuming province in China. In 2010, the GDP of Guangdong has reached 720 billion dollars, with an energy consumption of 260 million tons of standard coal equivalent (tce) [6]. As the vanguard of China’s reform and opening up, Guangdong Province was designated as one of the 13 pilot low-carbon zones in China by the National Development and Reform Commission(NDRC) in 2010 [7]. At present, the emphasis of Guangdong’s low carbon economy development has focused on the transformation toward

higher-value manufacturing and Strategic emerging industries, the promotion of energy conservation and efficiency, and the utilization of renewable energy [8]. In the last five years, the energy intensity per GDP of Guangdong has decreased from 0.794 in 2005 to 0.664 tce per ten thousand Yuan in 2010, which is in the national leading position. It will be more difficult and costly to further improve energy efficiency. Furthermore, although Guangdong is trying to develop new and renewable energy, such as nuclear power, wind power, solar and biomass, but in the long term the fossil energy will remain the mainstay energy for the economic growth due to the consideration of rich resources, low cost and energy safety. Therefore, it is necessary to study the feasibility of the development of CCS in Guangdong Province, by taking it as an important option to reduce CO₂ emission of Guangdong.

In this study, we chose electric power industry of Guangdong as the object to analysis the prospects and the early opportunities of CCS in province level. We first analyzed the main characters of CO₂ emissions in Guangdong's electric power industry, the storage capacity and potential storage sites by using geographic information system (GIS) data and method. The buffer analysis method is then used to assess the possibility of source to sink matching; meanwhile, the early opportunities of CCS in Guangdong are discussed by considering the technology maturity, land source, and other crosscut issues. At last, based on the analysis results we put forward a series of recommendations to promote the development of CCS in Guangdong Province of China.

2. Methodology

2.1. Emissions of fossil-fueled power plant

The CO₂ emissions of power plant are highly correlated with operation conditions, technology parameters, and fuel types. Since the deviations between the designed parameters and the actual energy conversion efficiencies are different for all plants, the efficiency of power units is measured by the designed energy conversion rate. The greenhouse gas emissions of each plant were defined as CO₂ emissions caused by complete combustion of fossil fuels, while methane and N₂O were not included. The CO₂ emissions of each power plant in 2010 are given by:

$$E_m = F_c \times E_f \quad (1)$$

$$F_c = I_c \times R_t \times D_p \times e \quad (2)$$

Where E_m is the CO₂ emissions of each power plant in million ton, F_c is the amount of fuel consumed in trillion joule, E_f is the default emission factor of CO₂ according to fuel type, and assumed carbon oxidation factor to be 1[9]. I_c is the installed capacity of power plant in Megawatt, R_t is the running time of power unit in 2010, D_p is the designed parameter of energy conversion efficiency in kg standard coal equivalent (sce) per kWh, e is the coefficient, 29307 KJ per kg sce.

2.2. Location of fossil-fueled power plant

The information from business directory and State Electricity Regulatory Commission (SERC) was employed to define the address of each power plant, and then find the power plant in Google EarthTM and get the exact position. Finally, the locations of power plants, the categories of units, and the CO₂ emissions were analyzed by GIS software.

2.3. The buffer analysis method

The buffer analysis is one of the several important analysis functions of geographical information system (GIS). It is based on the point, line and polygon in the GIS database to create the buffer area polygon around a certain width. The proximity problem can be solved by conjoint analyzing the buffer layer with the target layer. In order to assess the possibility of source to sink matching in Guangdong, this paper takes the potential CO₂ storage sites as the center to establish buffers with distance of 50km. The CO₂ emission point sources are then counted in each buffer area. Based on the statistical results, the prospect and early opportunities of CCS development in Guangdong are analyzed by considering the technology maturity, land source, and other crosscut issues.

3. Results and discussion

3.1 Characteristics of emission in electric power industry of Guangdong

3.1.1 Status and trends of emission in electric power industry

Guangdong has the largest total installed capacity of electricity in China, and the CO₂ emissions from the power sector accounts for more than half of the province's total emissions. In 2010, the total installed capacity of Guangdong has reached 71 GW [10], while the CO₂ emission was about 200 million tons. The installed capacity of fossil-fueled power is dominant, which accounted for over 74% of the total, while that of renewable energy is still very small. There are three main types of fossil-fueled power plant in Guangdong, coal-fired, gas-fired, and oil-fired. The emission composition and load of these power plants are showing in Figure 2. Although the policy of 'eliminating backward power generation capacity' had been implement for the coal-fired power plants since 2000, the installed capacity of coal-fired power plants is still dominant, which accounts for 76% of the total fossil-fueled power plants. The gas-fired power plant has a rapid development since 2006, and the installed capacity of these plants has reached 19% of the total fossil-fueled power plants in 2010. The reason is partly the exploitation of natural gas in the west of China and the importation of large quantities of natural gas from Australia. The oil-fired power plant has the smallest installed capacity, which mainly caused by the high cost of oil. By comparing the average load of different type fossil-fueled power plants (right figure, Figure 2), the average unit operational hours of coal-fired power plants is much longer than those of gas and oil power plants. So, the power generation of coal-fired power plant reached 85% of total power generation. And at the same time, the default emission factor of coal is much bigger than those of natural gas and oil. Consequently, the coal-fired power plants are the major sources of CO₂ emissions in the electric power industry of Guangdong.

Since Guangdong is in the rapid growth period of industrialization and urbanization, more power stations will be built to suit the demand of development in the future. By considering the development of renewable energy and nuclear energy cannot meet the demand of electricity, the new power plants will still dominate by fossil-fueled ones. The fossil-fueled based power generation structure will be continuing. According to the "12th five-year plan for economic and social development of Guangdong", the total installed capacity in Guangdong will increase to 100 GW by 2015, and fossil-fueled power will account for 70% of the total installed capacity [11]. The increase amount of fossil-fueled power plants' installed capacity is expected to more than 17 GW. In which, coal-fired power will increase about 12 GW and gas-fired power will increase about 5 GW.

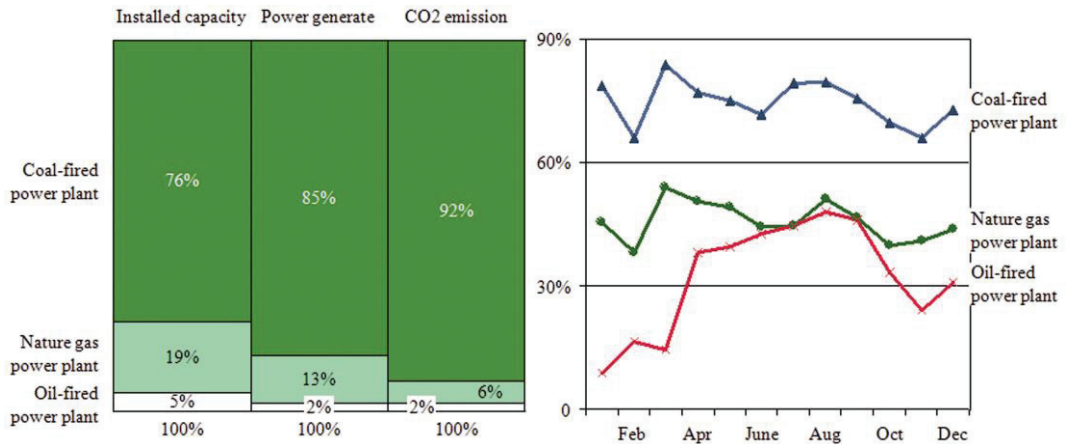


Figure 2. The compose (left) and load (right) of fossil-fueled power plant in Guangdong in 2010

3.1.2 Spatial distribution of emission resources

In 2010, the fossil-fueled power installed capacity in Guangdong was more than 53 GW, and total CO₂ emission was 206 million tons (Mt). In order to facilitate spatial analysis, we divided the objective area into three regions according to the power consumption of each city in 2010 [6]. The criteria for classification are shown in Table 1 and the corresponding results are shown in Figure 3. It can be seen that fossil-fueled power plants are mainly located in class I and II regions, which covered the entire Pearl River Delta Region. The installed capacity and CO₂ emissions of these two regions are 34.7 GW and 131.4 Mt, accounted for 65.1% and 63.6% of the total installed capacity and CO₂ emissions respectively. Class I region, which covers Guangzhou, Shenzhen, Dongguan, and Foshan, contributes to more than 40% of both total installed capacity and CO₂ emissions within 8.6% of the area. It is the load center of Guangdong, and also will be the key area for CO₂ capture.

Table 1. Electricity consumption, installed capacity, and CO₂ emissions in three types of regions

Region	City	Electricity consumption of each city (10 ³ GWh)	Installed capacity (GW)	CO ₂ emissions (Mt)
I	Gz, Sz, Dg, Fs ¹	40 to 60	21.8	84.9
II	Hu, Qy, Jm, Zs, St ²	10 to 20	12.9	46.5
III	Other 12 cities	0 to 10	18.6	75.2
Total	21 cities	406	53.3	206.6

1. Guangzhou, Shenzhen, Dongguan, Foshan
 2. Huizhou, Qingyuan, Jiangmen, Zhongshan, Shantou

Figure 3 shows the distribution of main CO₂ emission point resources by size within Guangdong. It can be seen that the coal-fired power plants are the major point sources of CO₂ emissions in Guangdong Province, which covers all over the region. By the end of 2010, there are 65 fossil-fueled power plants in Guangdong. The Pearl River Delta region has the highest amount of existing emission point resources within Guangdong. 45 of the fossil-fueled power plants are located in this region. Most large fossil-fueled power plants, with annual emissions of more than 5 million tons, are mainly located in coastal zones. Besides, Meizhou, Shaoguan and Yunfu are also having comparatively large emission point resources.

According to the "12th Five-Year Plan", there are about 24 fossil-fueled power plants on planning and under construction. The large, new power units being planned and constructed are mainly located in eastern and western coastal cities, such as Shanwei, Jieyang, Shantou, and Yangjiang. Meanwhile, the small units are mainly found in undeveloped inland areas, such as Shaoguan and Meizhou. The new capacity installed in these regions will reach 30 GW in the next five years [12]. However, almost no new power project is being deployed in economically developed regions because of the consideration for environmental protection. The emphasis of power projects in those regions are to rebuild and extend based on existing power plants to improve their efficiency in the future. Generally, the harbors of the eastern cities are the key areas for future fossil-fueled power industry.

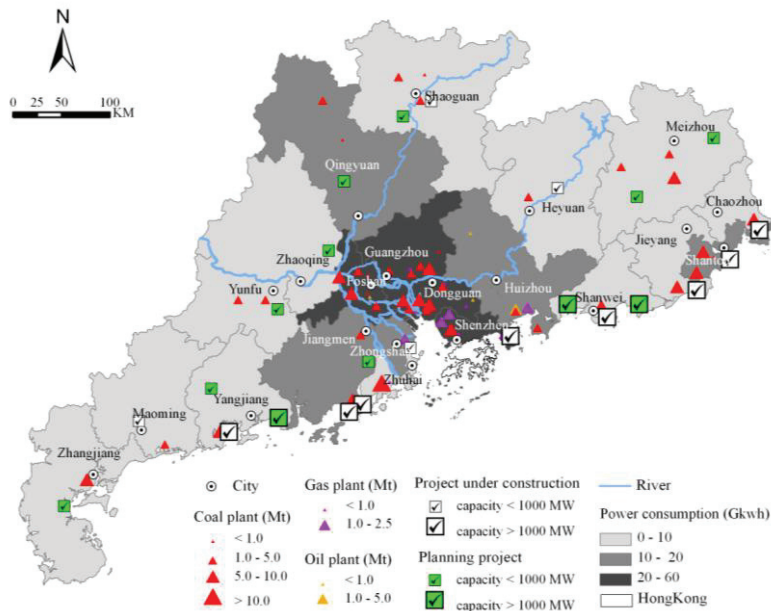


Figure 3. The existing, planning & under construction emission point sources in Guangdong

3.2 CO₂ storage potential in Guangdong

According to the research of South China Sea Institute of Oceanology (SCSIO) [13], there are six sedimentary basins in or around Guangdong Province, including Sanshui Basin inland, Maoming Basin inland, Pearl River Mouth Basin offshore, Beibuwan Basin offshore, Qiongdongnan Basin offshore and Yinggehai Basin offshore (Figure 4). The effective CO₂ storage capacities of saline formation and of oil/gas fields are estimated based on published data. Since the Maoming Basin which contains oil shale is still of economic interests, it is not included in estimate catalog. Table 2 shows the result of CO₂ storage capacity estimate. The total effective CO₂ storage capacity in saline formation is about 568 Gt_{CO2}, including 4 Gt_{CO2} in oil and gas fields. This storage capacity is more than 960 times of the 2010 emissions (587 Mt_{CO2}) in Guangdong Province.

The onshore storage opportunity is 1260 Mt_{CO2} at Sanshui Basin, which is just enough for all the CO₂ emissions in Guangdong for 2 years. Compared with the limited storage capacity onshore, offshore storage shows a promising future for carbon capture and storage in Guangdong. Although offshore storage makes the operation and construction cost more expensive than the onshore option, it also have

some advantages, such as no interference with population, agriculture, and industry, no damage to groundwater, and in technical issues such as the potential to manage pressure within the geological formation [14]. So the offshore storage becomes the most potential storage mode in Guangdong Province.

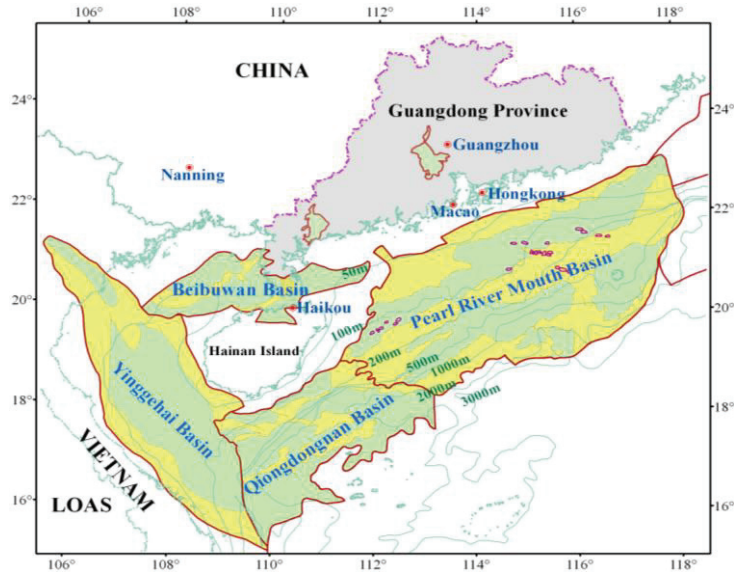


Figure 4. The sedimentary basins in and around Guangdong Province

Table 2. CO₂ storage potential of Guangdong Province

Basin name	Size (km ²)	Saline aquifer	Oil field	Gas field
		Effective CO ₂ storage capacity (Gt)	Effective CO ₂ storage capacity (Gt)	Effective CO ₂ storage capacity (Gt)
Sanshui Basin	490	1.26	-	-
Pearl River Mouth Basin	2×10 ⁵	308	0.115	1.395
Beibuwan Basin	4×10 ⁴	57	0.022	-
Qiongdongnan Basin	8.9×10 ⁴	41	0.015	0.790
Yinggehai Basin	1.2×10 ⁵	161.4	-	1.660
Grant Total (Gt)	4.49×10 ⁵	568.66	0.152	3.845

Among the four offshore basins around Guangdong, the Pearl River Mouth Basin (PRMB) is the largest sedimentary basin in the margin of the northern South China Sea. The total area of PRMB is nearly 2×10⁵ km² and the maximum sediment thickness is over 14 km. The estimated effective storage capacity is 308 Gt in deep saline formations, including 1.51 Gt in oil and gas fields. This capacity is sufficiently large for depositing CO₂ emissions from the electric power industry in Guangdong for more than 150 years, if 10% of the effective storage capacity can be utilized and the total emission is maintained at the present level [5]. For the distance to Guangdong, the PRMB and Beibuwan Basin are much closer than other two basins. Compared with the Beibuwan Basin, the northern part of the Pearl River Mouth Basin is most proximal to the industrialized Pearl River Delta and the coastal zones of

Guangdong, which has the highest amount of existing and planning emission point resources. For the depth of water, about 60% area of Qiongdongnan Basin and the southern part of the PRMB have water depth > 300m, which is not viable for cost-effective CO₂ injection. Take into account the storage capacity, the distance to Guangdong and the depth of water, the northern portion of the PRMB was considered the most promising choice for Guangdong Province to storage CO₂.

3.3 Prospect and early opportunities for CCS in Guangdong

According to the preceding analysis, we can see that the electric power industry of Guangdong has the characteristics such as large amount of emission, high rate of increase, and concentrated emission. Moreover, Guangdong also has a huge offshore storage potential, especially the northern portion of the PRMB. In order to further analyze the prospect and early opportunities of CCS development in Guangdong, a buffer analysis was used to matching the CO₂ sources and sinks.

Since the cost of offshore CO₂ storage may be greatly reduced by using the existing production platform and related facilities after the depletion of the oil/gas fields, and also it is much convenient to be connected with the adjacent structures, the oil/gas field is important especially in the early stage of CCS development. The oil/gas fields in the PRMB are mainly located in the northeast and northwest portion, and can easily be divided into three regions. By considering the geological conditions, three promising storage sites are defined, and named P1, P2, and P3 respectively (Figure 5). Then we take these sites as centers to do the buffer analysis, and measure the numbers and emissions of existing and planning power plants in every 50 km distance.

Table 3. The emission point resources in different buffer distance

Point	Distance (km)	Existing plants		Planning & under construction plants	
		No. of plants	Emission (Mt)	No. of plants	Installed capacity(MW)
P1	150	3	16.96	3	3000
	200	7	21.68	2	2000
	250	6	26.09	2	1600
	300	22	49.94	3	1800
	350	13	47.89	2	1600
	400	3	17.67	1	600
P2	150	6	12.44	0	0
	200	21	61.73	5	4200
	250	16	54.10	2	2000
	300	7	32.82	5	3800
	350	8	30.62	5	3800
	400	3	6.60	3	1800
P3	150	0	0.00	0	0
	200	1	5.98	1	1000
	250	3	24.94	5	3800
	300	2	13.11	1	600
	350	17	44.52	2	1200
	400	24	58.68	1	600

Table 3 shows the results of the buffer analysis. It can be seen that the distance between the CO₂ emission sources and storage sites are more than 100 km. Within 400 km distance, these three point sites

are covering 54 (P1), 61 (P2) and 47 (P3) existing fossil-fueled power plans, with CO₂ emissions of 180 Mt, 198 Mt, and 147 Mt, respectively. And for the Planning & under construction fossil-fueled plants, there are 13 (P1), 20 (P2) and 10 (P3) plants with installed capacity of 10.6 GW, 15.6 GW and 7.2 GW in the range of 400 km. Since the cost of transportation is closely depended on the distance, we take 200 km as the economical transportation distance. Within this economical distance, 10 existing power plans with CO₂ emissions of 38.6 Mt and 5 planning & under construction plants with installed capacity of 5 GW are belong to P1. And 27 existing power plans with CO₂ emissions of 74.2 Mt and 5 planning & under construction plants with installed capacity of 4.2 GW belong to P2. Moreover, P3 only have 1 existing power plan with CO₂ emissions of 6 Mt and 1 under construction plant with installed capacity of 1 GW. Consequently, P1 and P2 are more viable for cost-effective CO₂ injection by comparing with P3, and the northeastern portion of the PRMB is the most promising area for CO₂ storage of Guangdong.

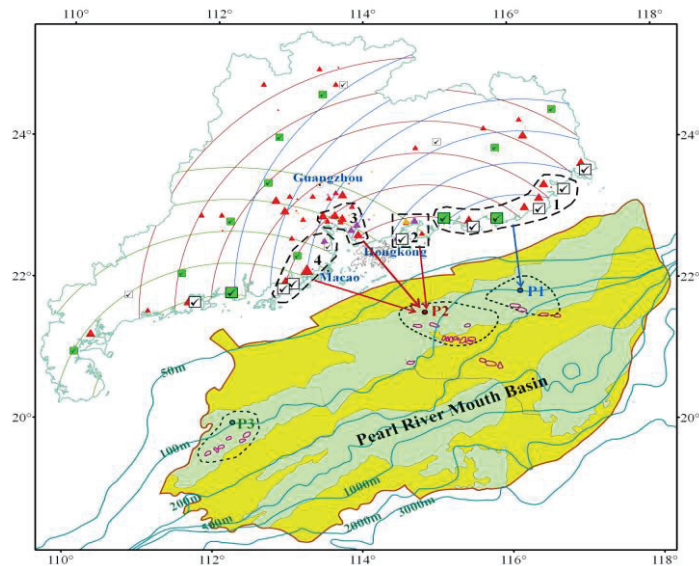


Figure 5. Map of matching between promising source clusters and storage regions

In order to analyze the promising CO₂ capture plants, we overlay the emission sources and three buffers of P1, P2 and P3. Figure 5 shows the distribution of emission sources in different buffers. It can be seen that the larger existing power plants located in Pearl River Delta region and the planning & under construction plants located in the eastern coastal areas are much closer to the promising storage sites, and more likely to be the most promising CO₂ capture objects. According to the overlay analysis, we can easily identify four clusters for Guangdong to capture CO₂ (Figure 5). The distance from the power plants in the clusters to their corresponding storage sites are all within 200 km. Among these four clusters, cluster 1 is located in the eastern coastal areas of Guangdong, and mainly hosts planning & under construction plants. Cluster 3 is located in the Pearl River Delta region, and the plants are all existing ones. Cluster 2 and cluster 4 have both existing, planning and under construction plants.

Since the Pearl River Delta region is the economically developed region of Guangdong, the land resource is much less than the eastern coastal areas. And correspondingly, the difficulty and cost of plant retrofitting in the Pearl River Delta region will be much higher than the eastern coastal areas. Consequently, in the short term the emphasis of implementing CO₂ capture technology should be focused on new power plants being planned or constructed. But in the long term, as technologies and the

international carbon market becoming mature, the extensively retrofitting old coal-fired power plants with CO₂ capture capability will become possible [15]. By considering the distance between source and sink, technology maturity, land resources and other factors, cluster 1 will be the early opportunity for Guangdong to develop CO₂ capture, and the corresponding storage sites are the exhausted oil and gas fields around P1. Since cluster 2 and 4 also have planning & under construction plants, they are another promising area for CO₂ capture in the early stage. Besides, these two clusters are proximity to the existing power plants (cluster 3), thus the overall research and planning of CCS in this region will be necessary.

3.4 Recommendations to promote the development of CCS in Guangdong

The urgent need to reduce CO₂ emissions around the world is the largest impetus in the development of CCS technologies in many countries. The development of CCS technology in Guangdong Province of China should be encouraged because of the following advantages. First, the power industry is the foundation of economic and social developments, and coal-fired power generation accounts for 85% of the total in Guangdong. If no remarkable changes are made in the energy structure, coal-fired power generation will inevitably increase along with economic growth. Thus, CCS can provide a choice to guarantee the security of the energy supply under the pressure of global climate change. Second, most of large and new fossil-fueled power plants in Guangdong are located in the Pearl River Delta region and eastern coastal zones, near the promising storage site of the PRMB. The location of point sources and sink sites makes it possible to reduce CO₂ transportation costs. At last, coal-fired power plants will be the major emission sources in China for a long time because of the coal-based energy supply structure. Thus, CCS demonstration projects and R&D will be more pertinent and maneuverable, making it much easier for Guangdong to spread engineering experiences.

At present, CCS technology is still in the R&D stage, and facing the immediate problem of efficiency loss and investment rise [16]. In order to promote the development of CCS in Guangdong, a series of measures should be undertaken by the local government or related organizations. First of all, CCS-related research requires detailed emission and geological data, but existing data are quite limited and not detailed enough to analyze the feasibility of CO₂ capture and to accurately determine potential sink sites for CO₂ storage. It is necessary to build up the database for CCS feasibility study by collecting the information of the existing and planning power plants and other potential emission utilities, and also the potential storage sites, which can make the analysis more accurate. Secondly, CCS technology is still in the R&D stage, so the related industries in Guangdong should carry out the R & D and demonstration projects as soon as possible, making it much easier to spread technologies and engineering experiences in the future. And then, the cost reduction of CCS projects will heavily depend on effective infrastructures. The overall cost of CCS will be reduced sharply if the CO₂ capture and pipeline project can be constructed on a large scale. Thus, the overall research and planning of CCS for Guangdong is necessary. Furthermore, CCS-Ready is a plant design concept enabling fossil fuel plants to be retrofitted in future more economically with carbon dioxide capture and storage technologies. With the development of CCS-Ready, CCS technology can be compatible with the current energy system without substantially modifying the material and the process of generation. So it will be better for the electricity plants in Guangdong to research and implement CCS-Ready projects in the coming years. Finally, the extensively use of CCS also need the support of the policy, it is necessary for the government to formulate relevant incentive polices to promote the development of CCS in Guangdong.

4. Conclusions

Guangdong Province has the largest total installed capacity of electricity in China, and the CO₂ emissions from the power sector accounts for more than half of the province's total emissions. In 2010, the installed capacity of Guangdong reached 71 GW, while the CO₂ emission is more than 200 Mt. The coal-fired power plants, which have the 76% of installed capacity and contribute 85% and 92% of total power generation and CO₂ emissions respectively is the most important CO₂ emissions source in Guangdong. According to the "12th Five-Year Plan", the total installed capacity in Guangdong will increase to 100 GW by 2015, while fossil-fueled power will still account for more than 60%. The existing fossil-fueled power plants are mainly located in the Pearl River Delta region, and the eastern coastal cities are the key area for future fossil-fueled power industry.

There are six sedimentary basins in or around Guangdong. The total effective CO₂ storage capacity in saline formation is about 568 Gt_{CO₂}, including 4 Gt_{CO₂} in oil and gas fields. Since the onshore storage capacity in Guangdong is limited, the offshore storage becomes the promising way to storage CO₂. The Pearl River Mouth Basin is the largest sedimentary basin in the margin of the northern South China Sea with the estimated effective storage capacity of 308 Gt. It is sufficiently large for depositing the CO₂ of the electric power industry in Guangdong for more than 150 years, if 10% of the effective storage capacity can be utilized and the total emission is maintained at the present level. Take into account the storage capacity, the distance to Guangdong and the depth of water, the northern portion of the PRMB was considered the most promising choice for Guangdong to storage CO₂.

By considering the source to sink distance, technology maturity, land resources and other factors, in the short term the power plants under construction and planning located in the eastern coastal areas will be the most promising CO₂ capture objects, and the corresponding storage sites are the existing oil/gas fields which located in the northeast of PRMB. But in the long term, as technologies and the international carbon finance market mature, the extensively retrofitting of old coal-fired power plants in the Pearl River Delta region with CO₂ capture will become possible, thus the overall research and planning of CCS in this region will be necessary. Besides, CCS-Ready can greatly facilitate subsequent retrofitting to capture CO₂ and can significantly reduce the probability of 'carbon lock-in' throughout their lifetime. If CCS-Ready concepts, such as equipment space and land reserve are introduced to the new plants of Guangdong, the means to prepare for a regional scale CCS will be great. In order to promote the development of CCS in Guangdong, it is necessary for the government and related organizations to build up the database for CCS and CCS-Ready feasibility study. Then the related industries in Guangdong should carry out the R & D research and demonstration projects to master the technologies and to accumulate experience. Moreover, the extensively use of CCS also need the support of the policy, it is necessary for the government to formulate relevant incentive polices to promote the development of CCS in Guangdong.

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