

Evaluation of Straw Resources in Beijing-Tianjin-Hebei Area

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Abstract. Beijing-Tianjin-Hebei area is one of the economic centers of China. With the development of economy, its demand to electricity has become larger and larger, which results in large consumption of fossil fuel and causes serious air pollution. At the same time, many villages in this area burn countless tons of straw every year, which causes environment problems such as haze. The living environment is getting worse and worse. One way to solve the problem is to use straw as raw material to generate electricity. But before building green power plants, people need to consider whether it is economical efficient. So, evaluating straw resource of one area is important. This paper will calculate the straw reserve of three areas: Beijing, Tianjin, Hebei separately, evaluates their own straw resources' richness then try to find an appropriate place to build straw power plants.

Introduction

Beijing-Tianjin-Hebei area locates in Hubei Plain. This region is one of the economic centers of China. It is densely populated and industrial developed. With the development of economy, demand to energy resources (especially to electricity) has become larger and larger. A great number of fossil fuel represented by coal is used in power generating industry, so it leads to a heavy discharge of SO_2 and CO_2 . The concentration of $\text{PM}_{2.5}$ also has a significant rise. Environmental problems such as acid rain, haze come thereupon. Except the combustion of fossil fuel, the burning of straw has also caused serious environmental pollution. Since year 2013, areas around Beijing-Tianjin-Hebei have countless particle emission to atmosphere per year because the burning of straw. Daily concentration of $\text{PM}_{2.5}$ has increased to $60\mu\text{g}/\text{m}^3$. Our task to transform and optimize the construction of energy utilization is extremely urgent. As mentioned in << Beijing Tianjin Hebei collaborative development plan >>, which was issued in 2015.4.30: China must organize and carry out the construction for usage of reproducible and clean energy in Beijing-Tianjin-hebei region. Experts suggest that using agricultural residues such as straw to generate electricity is a good way to solve the problem for power supply tension and environment pollution at the same time. But at the same time, usage of biomass energy needs to adjust measures to local conditions. Environmental protection and economical efficiency should also be considered. When people encourage use straw to generate electricity in one region, whether this area has a rich straw resource must be considered. This paper will calculate the straw reserve of three areas: Beijing, Tianjin, Hebei separately, and evaluate their own straw resources' richness.

Analysis

According to data already collected, Beijing and Hebei have more straw types than Tianjin. Straw resources mainly come from rice, wheat, corn, beans, tubers, cotton, oil-bearing crops, fiber crops. Compared with them, Tianjin has less straw types. Main sources are only wheat, corn, cotton and oil-bearing crops.

Estimation Method used for Straw Resource. In China, straw yield is not listed in national statistical investigation range so its production should be calculated according to the formula on the basis of crop yield. Computation formula is as follows:

$$CR = \sum_i^n QC_i R_i$$

In this formula, CR represents total reserves of straw resources. QC_i represents the yield for species i crop, R_i is the grain-straw ratio for species i crop (RPR), n means the number of crop species. The key to estimate crop straw resources mainly depends on the established grain-straw ratio (RPR), and then calculate the total yield of straw resources. RPR is a empirical constant comes from observation and experiment. According to existing select method and consider the natural condition in Beijing-Tianjin-Hebei area, the paper define RPR as shown in Table 1.

Table 1 RPR of Beijing-Tianjin-Hebei area

Farm Crops	Rice	Wheat	Corn	Beans	Tubers	Cottons	Sesame	Peanut	Fiber Crops
RPR	1	1.4	2	1.5	0.5	3	2	0.4	1

Evaluation Results of Straw Reserves in Each Area

Table 2 Regional main crop yields in Hebei province in Year 2013

Unit: Ten thousand ton

City	Rice	Wheat	Corn	Beans	Tubers	Cotton	Sesame	Peanut	Fiber Crops
Shijiazhuang	0.13	255.74	256.14	2.48	8.96	1.09	0.07	19.79	
Chengde	14.06		99.62	2.7	23.97		0.014	0.1	0.0034
Zhangjiakou	1.04		88.11	3.83	40.89			0.2	
Qinhuangdao	7.13	2.12	55.29	3	13.62	0.26	0.014	7.05	0.074
Tangshan	48.92	62.1	179.82	5.04	11	2.66	0.025	29.5	
Langfang	0.011	43	126.12	2.88	3.28	4.03	0.064	3.95	
Baoding	0.87	250.14	314.67	4.04	22.44	2.7	0.1	27.01	
Cangzhou	0.32	199.56	263.41	5.49	5.7	11.69	0.19	8.95	
Hengshui			183.22	2.13	2.57	14.34	0.12	9.58	
Xingtai			208.45	3.24	4.73	18.89	0.19	10.97	
Handan	1.08	259.43	273.14	2.89	5.13	12.69	0.085	12.98	
Total	73.561	1072.09	2047.99	37.72	142.29	68.35	0.872	130.08	0.0774

In terms of crop species, wheat and corn had a huge yield, which accounted for 87.35% of total yield. Corn's planting areas were so wide that all over the province could see its figure. From yield divided by region, Shijiazhuang, Baoding, Cangzhou and Handan had the biggest yield, which accounted for 62.37% of total yield.

Table 3 Regional straw reserves in Hebei province in Year 2013

Unit: Ten thousand ton

City	Rice	Wheat	Corn	Bean	Tuber	Cotton	Oil-bearing Crops	Fiber Crops	Total
Shijiazhuang	0.13	358.036	512.28	3.72	4.48	3.27	8.056		889
Chengde	14.06		199.24	4.05	11.99		0.068	0.0034	229.4064
Zhangjiakou	1.04		176.22	5.745	20.45		0.08		203.53
Qinhuangdao	7.13	2.968	110.58	4.5	6.81	0.78	2.848	0.074	135.69
Tangshan	48.92	86.94	359.64	7.56	5.5	7.98	11.85		528.39
Langfang	0.011	60.2	252.24	4.32	1.64	12.09	1.708		332.209
Baoding	0.87	350.196	629.34	6.06	11.22	8.1	11.004		1016.79
Cangzhou	0.32	279.384	526.82	8.235	2.85	35.07	3.96		856.639
Hengshui			366.44	3.195	1.285	43.02	4.072		418.012
Xingtai			416.9	4.86	2.365	56.67	4.768		485.563
Handan	1.08	363.202	546.28	4.335	2.565	38.07	5.362		960.894
Total	73.561	1500.93	4096	56.58	71.15	205.05	53.776	0.0774	6057.095

As for total yield, straw resources are concentrated in Baoding, Handan, Shijiazhuang and Cangzhou whose yield accounted for 47.34% of total yield of Hebei province. Wheat straw mainly came from Shijiazhuang, Baoding and Handan, whose yield accounted for 71.38% of total wheat yield. Corn straw mainly came from Baoding, Handan, Cangzhou and Shijiazhuang, whose average yield was above 500 tons and the yield proportion accounted for 54.07% of the total province. In summary, Baoding, Handan, Shijiazhuang and Cangzhou have an advantage in building straw power plants. As for straw resources, choosing one of them as the site of power plant is wise.

Table 4 Main crop yields in Beijing in Year 2013 and 2014

Unit: Ton

	2013	2014	variation	Rate of change
Rice	1305.9	1269.2	-36.7	-2.81%
Wheat	187213.2	121937.9	-65275.3	-34.87%
Corn	751832.2	500382.8	-251449.4	-33.44%
Tubers	7776.5	6819.5	-957	-12.31%
Soybeans	8056.1	6039.0	-2017.1	-25.04%
Cotton	150.9	107.1	-43.8	-29.03%
Peanut	9084.7	6084.7	-3000	-33.02%

From the view of crop varieties, wheat and corn had the largest yield in year 2013 and 2014. They also had the highest proportion of the total grain yield, respectively accounted for 97.28% and 96.84% in these two years. From the point of view of total grain output, Beijing didn't have a high grain yield compared with other areas. Yield in 2014 was even lower than that in year 2013, total yield dropped 322779.3 tons, and the decline proportion was 33.43%. Wheat and corn had the biggest

decline proportion, respectively fell 34.87% and 33.43%. They were higher than the average decline. Beijing's agricultural total yield decline is caused by the shrinking planting area. According to Beijing municipal bureau of agriculture website, since year 2008 the cultivated area has been in a decline trend. The reason may be that Beijing's surrounding areas have sped up the urbanization recently and the speed of industrial structure adjustment has also quickened. As expected, in the future as Beijing capital function get strengthen, the yield of grain will have a further decline.

Table 5 Regional straw reserves in Beijing in year 2013 and 2014

Unit: Ton

Farm Crop Straw	2013	2014	variation	Rate of change
Rice	1305.9	1269.2	-36.7	-2.81%
Wheat	262098.48	170713.06	-91385.42	-34.87%
Corn	1503664.4	1000765.6	-502898.8	-33.44%
Tubers	3888.25	3409.75	-478.5	-12.31%
Soybeans	12084.15	9058.5	-3025.65	-25.04%
Cotton	452.7	321.3	-131.4	-29.03%
Peanut	3633.88	2433.88	-1200	-33.02%
Total	1787127.76	1187971.29	-599156.47	-33.53%

As seen in Table 5, the main straw resources in Beijing come from wheat and corn. With the decreasing of wheat and corn planting area, straw yield had a sharp decline. In year 2014, the yield of wheat dropped 34.87% compared with year 2013, and corn yield dropped 33.44%, which had the largest decrease. Then the decline of peanut and cotton nearly reached 30%. Meanwhile, the total grain yield decreased 33.53% compared with last year. These signs show that Along with the corresponding urban planning policy, crop planting area in Beijing decrease rapidly, it makes a further decline for straw resources which has already been not abundant. In terms of the straw resource in Beijing, it's not appropriate to build straw power plants. If a power plant is needed to be built, people may have to get straw resources from Hebei province.

Table 6 Main crop yields in Beijing in Year 2013 and 2014

Unit: Ton

	2013	2014	variation	Rate of change
Rice	129000	121000	-8000	-6.20%
Wheat	573000	586000	13000	2.27%
Corn	1021000	1014000	-7000	-0.69%
Beans	9300	10700	1400	15.05%

The crop species in Tianjin is the most single among three areas. There are only four kinds of main crop and they are mainly planted in Jixi an, Baodi, Wuqing. Same with Hebei and Beijing yield

of wheat and corn took up the first place among all crops in year 2013 and 2014. Their proportion respectively accounted for 92.02% and 92.39% in these two years. The yield of wheat rose 2.27% compared with last year, corn yield decreased 0.69% at the same time. As for total grain yield, yield of this four kinds crop in Tianjin were all larger than those in Beijing. Total yield didn't have an obvious change in these two years. According to data's in Tianjin municipal bureau of agriculture, in recent years, planting area in Tianjin expanded continuously. Grain yield is expected to be further improved in the future. Therefore, straw yield has a big room to increase.

Table 7 Regional straw reserves in Beijing in year 2013 and 2014

Unit: Ton

Farm Crops	2013	2014	variation	Rate of change
Rice	129000	121000	-8000	-6.20%
Wheat	802200	820400	18200	2.27%
Corn	2042000	2028000	-14000	-0.69%
Beans	13950	16050	2100	15.05%
Total	2987150	2985450	-1700	-0.06%

Tianjin straw resources mainly come from wheat and corn which have the highest yield. In 2013 and 2014, corn straw accounted for nearly 70% of the total yield, wheat straw accounted for 27% of the total. Although wheat straw and bean straw's production rose, due to rice straw and corn straw whose yield took the first place decline, resulted in that the total straw yield had a slight decrease over the previous year, which fell by 0.06%. According to Tianjin Bureau of Agricultural Statistics report, since 2010, area of grain crop has risen steadily, from 467.67 acres to 518.7 acres in 2014. It can be expected in the future, crop planting areas will explain and grain yield may have a further increase, as a result, straw resources will also increase a lot. Therefore, Tianjin has material basis for the establishment of straw power plant, located in places whose food production is considered abundant, like Jixi an, Baodi, Wuqing.

Conclusion

According to the above analysis, straw yield in Beijing-Tianjin-Hebei area approximately reached 65 million tons in recent years. Most of straw resources come from Hebei province, the proportion of straw yield in Hebei respectively accounted for 92.69% of total grain yield. So, Hebei has the best material condition to build straw power plant. Hebei province has a large population and developed industry, its power consumption is so huge that straw power generation has a broad market. The location is also an advantage because it is adjacent to Beijing, whose advanced technology can give Hebei an effective support. As Beijing's capital function is strengthened, and local government improve the consciousness of environmental protection, many energy industry are transferred to Hebei province, so green power generation industry can get supportive policy in Hebei. In a word, Hebei province has advantages in resource, technology and policy. It is appropriate to choose Hebei as site for straw power plant base.

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