Supplementary Materials

Benefits of photovoltaic development on abandoned mines for carbon neutrality in China

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Table A1. Related parameters of photovoltaic power generation in abandoned open-pit mines in China.

Province	Optimum mounting angle （°）	Total annual radiation （kWh·m^{-2}）	Peak sunlight hours （h/day）	Static distance between front and rear rows of photovoltaic panels （mm）
Anhui	26	1215.52	3.33	6738.69
Beijing	35	1382.97	3.79	9980.54
Chongqing	18	869.75	2.38	4431.09
Fujian	18	1290.88	3.54	5459.72
Gansu	36	1630.32	4.47	9308.63
Guangdong	18	1187.14	3.25	5260.34
Guangxi	15	1526.25	4.18	4954.87
Guizhou	17	1334.30	3.66	5385.91
Hainan	13	1637.57	4.49	4598.84
Hebei	37	1416.97	3.88	10079.71
Henan	32	1273.18	3.49	7922.52
Heilongjiang	43	1302.56	3.57	18517.29
Hubei	21	1108.86	3.04	6149.48
Hunan	17	1079.15	4.04	5437.41
Jilin	40	1338.42	3.67	12489.17
Jiangsu	24	1315.75	3.60	6775.46
Jiangxi	37	1200.67	3.29	7354.42
Liaoning	36	1412.39	4.47	10698.15
Inner Mongolia	36	1566.76	4.29	10554.52

Ningxia	37	1584.93	4.34	9333.56
Qinghai	36	1732.07	4.75	8665.86
Shandong	34	1357.25	3.72	8755.15
Shanxi	32	1414.75	3.88	8818.71
Shaanxi	30	1338.51	3.67	8007.93
Sichuan	17	1207.09	3.31	5613.71
Tianjin	25	1376.33	3.77	8146.80
Tibet	32	1883.10	5.16	7417.15
Xinjiang	39	1558.39	4.27	11951.86
Yunnan	25	1564.35	4.29	6044.26
Zhejiang	20	1220.81	3.34	5991.20
Shanghai	24	1421.47	3.52	6735.26

Note: The optimum mounting angle, total annual radiation, peak sunlight hours, and static distance between front and rear photovoltaic panels were obtained through PVsyst software.

Table A2. The energy crops distribution and per-unit output on abandoned mine lands and bioenergy production related coefficients in China

Energy crop categories	Specific plants	Main distribution provinces	Per area of dry matter or seed yield (t/ha)	Average bioenergy conversion coefficients			Energy consumption when energy crops for bioenergy production (MJ/kWh, or MJ/ kg)
			Mining subsidence and restoration sites	Biopower (kWh/kg)	Ethanol (kg/kg)	Biodiesel (kg/kg)	
Cellulose energy crops	Panicum virgatum [1-5]	Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang	2.30-23.00	1.50			6.02[6]
	Miscanthus sinensis [7-8]	Jilin, Hebei, Shandong, Shaanxi, Anhui, Jiangsu, Zhejiang, Jiangxi, Hubei, Sichuan, Guizhou, Yunnan, Fujian, Guangdong, Guangxi, Hainan	2.30-15.00	1.59			7.74[6]
	Triarrhena	Beijing, Hebei, Shanxi, Inner	2.30-32.10	1.48			4.05[6]

	sacchariflora [9-10]	Mongolia, Liaoning, Jilin, Heilongjiang, Jiangsu, Jiangxi, Shandong, Henan, Anhui, Hubei, Hunan, Chongqing, Shaanxi, Gansu, Ningxia			
	Arundo donax [4-5,13-14]	Beijing, Jiangsu, Zhejiang, Hunan, Sichuan, Guizhou, Yunnan, Tibet, Fujian, Guangdong, Hainan	7.60-13.80	1.54	4.01[13-14]
	Hybrid Pennisetu [4, 9-10,15]	Beijing, Tianjin, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang	4.0-40.10	1.42	4.53[13]
	Hippophae rhamnoide[16]	Jiangsu, Zhejiang, Fujian, Jiangxi, Anhui, Guangdong, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Liaoning	0.50-8.00	1.76	7.27[17]

Carbohydrate energy crops	Sorghum dochna[18-20]	Beijing, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Zhejiang, Fujian, Jiangxi, Shandong, Henan, Hebei, Anhui, Hubei, Hunan, Guangdong, Guangxi, Hainan, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Xinjiang	15.00-32.00	0.23	19.28[21]
	Dioscorea esculenta [22]	Hebei, Zhejiang, Fujian, Jiangxi, Shandong, Henan, Anhui, Hubei, Hunan, Guangdong, Guangxi, Hainan, Sichuan, Guizhou, Yunnan, Tibet	15.00-20.00	0.14	18.76[23]
	Helianthus tuberosus [18,22]	Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Jiangsu, Fujian, Shandong, Henan, Anhui, Hubei, Hunan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang	22.00-40.00	0.17	18.76[23-24]

	Saccharum officinarum [18,25]	Jiangxi, Guangxi, Hainan, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi	12.00-22.50	0.30		26.14[21,23-24]
	Manihot esculenta [22]	Fujian, Jiangxi, Shandong, Guangdong, Guangxi, Hainan, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi	20.00-30.00	0.22		14.96[24]
Oil energy crops	Pistacia chinensis [26]	Hebei, Shanxi, Shandong, Henan, Anhui, Hubei, Hunan, Guangdong, Guangxi, Sichuan, Yunnan, Shaanxi, Gansu	2.30-4.00		0.40	15.94[27-28]
	Ricinus communis [29-30]	Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Jiangsu, Zhejiang, Fujian, Jiangxi, Shandong, Anhui, Hunan, Guangdong, Guangxi, Sichuan, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, Xinjiang	1.30-1.60		0.16	15.10[27-28]
	Jatropha curcas	Shandong, Hunan, Guangdong, Guangxi, Hainan, Sichuan,	4.00-7.50		0.23	19.88[32-33]

	[18,31]	Guizhou, Yunnan, Tibet		
	Xanthoceras sorbifolium [34-35]	Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jiangsu, Zhejiang, Fujian, Jiangxi, Shandong, Anhui, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang	2.30-9.00	0.27	18.64[32-33]

Note: The energy crop distribution region cited from the Subject Database of China Plant [36] and some literatures.

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