

# Supplementary Materials: Assessing the Environmental Sustainability of Electricity Generation in Turkey on a Life Cycle Basis

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Table S1. Lignite plants.

	Plant	Location	Type	Installed Capacity (MW)	Annual Generation in 2010 (GWh)	Contribution to Total Generation (%)	Efficiency (%)	Secondary Fuel Oil (t)
1	Afsin Elbistan A	K. Maras	PC <sup>b</sup>	1355	2042	5.8	29	5500
2	Afsin Elbistan B	K. Maras	PC + FDG <sup>c</sup>	1440	7694	21.7	35	8286
3	Mart Can	Canakkale	CFB <sup>d</sup>	320	2141	6.0	40	1450
4	Kangal	Sivas	PC + FDG <sup>e</sup>	457	2313	6.5	34	950
5	Orhaneli	Bursa	PC + FDG	210	1174	3.3	35	28
6	Seyitomer	Kutahya	PC	600	3623	10.2	33	2174
7	Tuncbilek	Kutahya	PC	365	1659	4.7	33	320
8	Kemerkoç	Mugla	PC + FDG	630	2720	7.7	34	0
9	Soma A	Manisa	PC	44	29	0.1	31	34
10	Soma B	Manisa	PC	990	3868	10.9	31	19
11	Yatagan	Mugla	PC + FDG	630	2599	7.3	31	
12	Yeniköy	Mugla	PC + FDG	420	1308	3.7	34	
13	Cayirhan Park	Beypazarı	PC + FDG	620	4324	12.2	38	
	<b>Total</b>			<b>8081 (8140) <sup>f</sup></b>	<b>35,494 (35,942) <sup>f</sup></b>			

<sup>a</sup> The 13 plants listed in the table are connected to the grid. The remaining three plants are auto-producers which are not connected to the grid. <sup>b</sup> PC: pulverised coal. <sup>c</sup> FGD: flue gas desulphurisation. <sup>d</sup> CFB: circulating fluidised bed. <sup>e</sup> FGD installed on one unit of 157 MW. <sup>f</sup> The total lignite installed capacity in 2010 was 8140 MW and the generation was 35,942 GWh. The difference from the installed capacity and the generation shown in the table is due to a lack of data for the three auto-producer plants not included in the table. However, total actual electricity generation has been used to estimate the impacts from lignite plants.

Table S2. Hard coal plants.

	Plant	Location	Type	Installed Capacity (MW)	Annual Generation in 2010 (GWh)	Contribution to Total Generation (%)	Efficiency (%)
1	Catalagzi	Zonguldak	Hard coal, PC	300	1883	11.7	31
2	Karabiga	Canakkale	Imported coal, CFB	405	3132	19.5	40
3	Isken Sugozy	Adana	Imported coal, PC + FGD	1320	9302	57.8	38
4	Silopi/Sirnak	Silopi	Asphaltite, CFB	135	984	6.1	40
5	Eren Catalagzi	Zonguldak	Imported coal, SC <sup>b</sup> + CFB	1360 <sup>c</sup>	798	5.0	40
<b>Total</b>				<b>3520 (3751)<sup>d</sup></b>	<b>16,099 (19,104)<sup>d</sup></b>		

<sup>a</sup> The five plants listed in the table are connected to the grid. The remaining three plants are auto-producers which are not connected to the grid. <sup>b</sup> SC: supercritical coal.

<sup>c</sup> 1230 MW of supercritical coal and 160 MW of circulating fluidised bed. <sup>d</sup> The total installed capacity in 2010 was 3751 MW and the generation was 19,104 GWh. The difference from the installed capacity and generation shown in the table is due to a lack of specific data for some of the three auto-producer plants not included in the table. However, total actual electricity generation has been used to estimate the impacts from hard coal plants.

Table S3. Natural gas plants.

	Plant	Location	Installed Capacity (MW)	Annual Generation in 2010 (GWh)	Contribution to Total Generation (%)	Efficiency (%)
1	Ambarli	Istanbul	1350.9	7941	8.09	51
2	Bursa	Bursa	1432	7098	7.23	55
3	Hamitabat	Luleburgaz	1120	5750	5.86	47
4	Aliaga	Izmir	180	251	0.26	42
5	Adapazari-1	Adapazari	1595.4	12,147	12.38	
6	Adapazari-2	Adapazari	797.7	6097	6.21	
7	Baymina	Ankara	798	5579	5.68	
8	Izmir	Izmir	1590.7	12,093	12.32	
9	Enron Trakya	Tekirdag	498.7	3387	3.45	
10	Esenyurt	Istanbul	188.5	1353	1.38	55
11	Colakoglu Dilovasi	Kocaeli	258.4	1882	1.92	48
12	Uni Mar IPR	Tekirdag	504	3429	3.49	
13	Aksa Antalya	Antalya	850	2226	2.27	59
14	Aksa Manisa	Manisa	115.3	663	0.68	
15	Alarko Altek	Kirklareli	164	481	0.49	

16	Cakmaktepe	Izmir	104.7	178	0.18
17	Antalya	Antalya	94.2	386	0.39
18	Arenko	Denizli	12	54	0.06
19	Ayen OSTIM	Ankara	41	197	0.2
20	Berk	Istanbul	14.8	75	0.08
21	Binatom	Emet	2	4	0
22	BIS	Bursa	410	1712	1.74
23	BOSEN	Bursa	142.8	698	0.71
24	Burgaz	Luleburgaz	6.9	0	0
25	Can Enerji	Tekirdag	56.3	291	0.3
26	Can	Tekirdag	29.1	48	0.05
27	Camis	Mersin	252.2	1887	1.92
28	Cengiz	Samsun	203.9	460	0.47
29	Cebi		64.4	302	0.31
30	Celik Uzunciftlik		2.4	11	0.01
31	Cerkezko	Tekirdag	49.2	213	0.22
32	Delta		60	227	0.23
33	Enerji SA	Bandirma	930.8	743	0.76
34	Entek Koc	Istanbul	2.3	18	0.02
35	Entek	Koseko	157.2	987	1.01
36	Falez		11.7	57	0.06
37	Global Pelitlik		23.8	93	0.09
38	Hacisrahmet		7.8	36	0.04
39	HABAS	Izmir	224.5	1451	1.48
40	Hayat Kagit		7.5	24	0.02
41	Karege Arges	Kemalpasa	43.7	171	0.17
42	Modern		96.8	402	0.41
43	Noren		8.7	33	0.03
44	RASA	Van	114.9	593	0.6
45	Sayenerji	Kayseri	5.9	0	0
46	Sonmez	Usak	70.7	161	0.16
47	Sahinler Corlu	Tekirdag	26	65	0.07
48	T Enerji		1.6	0	0

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49	Ugur	Tekirdag	60.2	136	0.14
50	Zorlu (B.Karistiran)	Luleburgaz	115.3	513	0.52
51	Zorlu (Bursa)	Bursa	90	514	0.52
52	Zorlu (Sincan)	Ankara	50.3	228	0.23
53	Zorlu (Kayseri)	Kayseri	188.5	754	0.77
54	Zorlu (Yalova)	Yalova	15.9	104	0.11
55	AK (K.Pasa)	Kemalpasa	127.2	564	0.57
56	AK (Bozuyuk)	Bozuyuk	126.6	513	0.52
57	AK (C.Koy)	Cerkezkoy	98	427	0.44
58	AKSA	Yalova	70	427	0.43
59	ATAER		119.2	520	0.53
60	Baticim		45	277	0.28
61	Bil Balgat	Ankara	36.6	123	0.13
62	Camis	Trakya	32.9	194	0.2
63	DESA		9.8	70	0.07
64	Gul		24.3	1	0
65	Ege Birlesik	Izmir	12.8	80	0.08
66	Enerji-SA	Kosekoy	120	581	0.59
67	Enerji-SA	Canakkale	64.1	378	0.39
68	Enerji-SA	Adana	130.2	703	0.72
69	Enerji-SA	Mersin	64.5	385	0.39
70	Entek	Demirtas	145.9	805	0.82
71	Eskisehir 2	Eskisehir	59	276	0.28
72	KEN Kipas Karen	K.Maras	41.8	73	0.07
73	MOSB	Manisa	84.8	541	0.55
74	Maksi		7.7	49	0.05
75	Nuh		38	125	0.13
76	Yurtbay	Eskisehir	6.9	53	0.05
<b>Total</b>			<b>16,709</b>	<b>91,369</b>	
			<b>(18,213)<sup>b</sup></b>	<b>(98,144)<sup>b</sup></b>	

Blank spaces in the table indicate no data availability. <sup>a</sup> The plants listed in the table are connected to the grid. The remaining 111 plants are auto-producers which are not connected to the grid. <sup>b</sup> The total installed capacity in 2010 was 18,213 MW and the generation was 98,144 GWh. The difference from the installed capacity and generation shown in the table is due to a lack of data for the auto-producer plants not included in the table. However, total actual electricity generation has been used to estimate the impacts from gas plants.

**Table S4.** Reservoir hydropower plants.

	<b>Plant</b>	<b>Location</b>	<b>Installed Capacity (MW)</b>	<b>Generation in 2010 (GWh)</b>
1	Ataturk	Sanliurfa	2405.0	6162.7
2	Karkamis	Gaziantep	189.0	460.9
3	Karakaya	Diyarbakir	1800.0	8023.5
4	Dicle	Diyarbakir	110.0	270.0
5	Kralkizi	Diyarbakir	94.5	139.4
6	Batman	Diyarbakir	198.0	474.3
7	Keban	Elazig	1330.0	7958.6
8	Ozluce	Elazig	170.0	650.0
9	Altinkaya	Samsun	702.6	1372.1
10	Derbent	Samsun	56.4	299.7
11	Obruk	Corum	212.4	430.5
12	Hasan Ugurlu	Samsun	500.0	1721.9
13	Suat Ugurlu	Samsun	69.0	433.8
14	Gokcekaya	Eskisehir	278.4	504.6
15	Yenice	Ankara	37.9	128.4
16	Sariyar H.P.	Ankara	160.0	365.6
17	Gezende	Icel	159.4	53.2
18	Aslantas	Osmaniye	138.0	762.5
19	Hirfanli	Kirsehir	128.0	274.3
20	Kesikkopru	Ankara	76.0	171.5
21	Kapulukaya	Kirikkale	54.0	149.7
22	Menzelet	K.Maras	124.0	657.5
23	Kilickaya	Sivas	120.0	488.1
24	Camligoze	Sivas	32.0	139.4
25	Demirkopru	Manisa	69.0	138.4
26	Adiguzel	Denizli	62.0	128.6
27	Kemer	Aydin	48.0	122.2
28	Almus	Tokat	27.0	116.9
29	Kokluce	Tokat	90.0	479.8
30	Kurtun	Gumushane	85.0	189.3

31	Torul	Gumushane	103.2	388.6
32	Catalan	Adana	168.9	496.8
33	Borcka	Artvin	300.0	1128.8
34	Muratli	Artvin	115.0	495.2
35	Karacaoren	Burdur	32.0	148.6
36	Kockopru	Van	8.8	18.8
37	Hosap	Van	3.5	5.2
38	Seyhan	Adana	67.5	10.6
39	Kadincik 1	Mersin	70.0	297.5
40	Kadincik 2	Mersin	56.0	235.2
41	Sir	K.Maras	283.1	989.2
42	Berke	Osmaniye	510.0	2150.4
43	Manavgat	Antalya	48.0	163.6
44	Karacaoren 2	Burdur	46.4	217.3
45	Birecik	S.Urfa	672.0	1985.4
46	Yamula	Kayseri	100.0	618.6
47	Uzuncayir	Tunceli	82	281.7
48	Oymapinar	Antalya	540.0	1207.5
<b>Total</b>			<b>12,732</b>	<b>44,106</b>
			<b>(13,067) <sup>a</sup></b>	<b>(44,468) <sup>b</sup></b>

<sup>a</sup> The total installed capacity in 2010 was 13,067 MW. The difference from the capacity shown in the table is due to a lack of specific data for some of the plants. <sup>b</sup> The total generation in 2010 was 44,468 GWh. The difference from the generation shown in the table is due to a lack of specific data for some of the plants. However, total actual electricity generation has been used to estimate the impacts from reservoir hydropower plants.

Table S5. Run-of-river hydropower plants.

	Plant	Installed Capacity (MW)	Generation in 2010 (GWh)		Plant	Installed Capacity (MW)	Generation in 2010 (GWh)
1	Cag-Cag	14.4	22.7	56	Firtina Sumer	21.6	25.5
2	Dogankent	74.5	274.7	57	Filyos Yalnizca	14.4	49.0
3	Goksu	10.8	59.1	58	Erenkoy Turkerler	21.5	5.7
4	Kadincik 1	70.0	297.5	59	Hamzali Turkon	16.7	88.2
5	Kadincik 2	56.0	235.2	60	HGM Keklicek	8.7	15.1
6	Kepez 1-2	32.4	125.8	61	Selimoglu	8.8	14.1
7	Kovada 1-2	59.5	37.8	62	Yukari Mahnahoz	22.4	73.7
8	Sanliurfa	51.8	175.7	63	IC-EN Calkisla	7.7	19.5
9	Sizir	6.8	51.5	64	Ictas Yukari Mercan	14.2	59.1
10	Girlevik	3.0	20.8	65	Kabaca	8.5	25.8
11	Kisik	9.6	32.5	66	Molu	3.4	14.2
12	Tortum	26.2	133.4	67	Kale	34.1	13.7
13	Yuregidir	6.0	13.4	68	Kalen I-II	31.3	89.2
14	Aksu Caykoy	16.0	42.7	69	Kaletepe Kayen	10.2	31.0
15	AYEN Camlica	84.0	420.0	70	Karadeniz Uzundere	62.2	34.4
16	Berdan	10.0	55.6	71	Karasu	2.4	16.7
17	Fethiye	16.5	61.7	72	Karel Pamukova	9.3	52.9
18	Gaziler	11.2	38.2	73	KAR-EN Aralik	12.4	12.3
19	Girlevi Mercan	11.0	35.4	74	Kulp IV	12.3	36.6
20	Gonen	10.6	57.9	75	Lamas III	35.7	63.8
21	Hasanlar	9.6	32.7	76	Maras Firnis	7.2	33.9
22	Sucati	7.0	29.8	77	Murgul	24.2	11.3
23	Tohma Medik	12.5	48.7	78	Ozgur Tahta	12.5	54.1
24	Akcay	28.8	8.4	79	Oztay Gunayse	8.3	28.9
25	Akim	91.4	169.3	80	Pamuk Toroslar	23.3	86.6
26	Akkoy	101.9	303.2	81	PETA Mursal II	4.5	16.0
27	Akua	5.8	23.7	82	Resadiye 1	15.7	2.1
28	Alp Tinaztepe	7.7	21.0	83	Resadiye 2	26.1	24.2
29	Anadolu Cakirlar	16.2	57.6	84	Resadiye 3	22.3	141.0

30	Asa Kale	9.6	23.6	85	Saritepe	4.9	13.5
31	Bayburt	14.6	58.6	86	Sarmasik 1	21.0	65.0
32	Bereket Dalaman	37.5	135.6	87	Sarmasik 2	21.6	74.8
33	Bereket Feslek	9.5	18.8	88	Selen Kepezkaya	28.0	15.0
34	Bereket Gokyar	11.6	40.9	89	Su Cayoren	4.6	20.5
35	Bereket Koyulhisar	42.0	220.2	90	ISKUR Suleymanli	4.6	20.2
36	Bereket Mentas	39.9	11.0	91	Tektug Erkenek	12.5	50.0
37	Beytek	9.5	14.7	92	Tektug Andirin	40.5	12.7
38	EnerjiSA Birkapili	48.8	74.6	93	Tektug Kalealti	15.0	59.9
39	Bahcelik Molu	4.2	30.2	94	Tektug Kargilik	23.9	88.3
40	Cansu	9.2	42.2	95	Tektug Keban Deresi	5.0	40.5
41	Berkman Enova	25.2	23.3	96	Tum Pinar	30.1	94.2
42	Oskan Enova	23.9	56.2	97	YPM Susehri	3.6	133.4
43	Ceykar	29.6	90.7	98	YAPISAN Hacilar	13.3	86.2
44	Cakit	20.2	28.7	99	YAPISAN Karica	97	408
45	Caldere	8.7	29.9	100	Yavuz Masat	22.5	18.4
46	Cenay	16.4	12.5	101	Yesilbas	14	40.3
47	Degirmenustu	38.6	106.0	102	Zorlu Cildir	15.4	44.1
48	Dim	38.3	50.1	103	Zorlu Ikizdere	18.6	117.4
49	Elestas Yaylabel	5.1	19.3	104	Zorlu Mercan	20.4	105.7
50	Dodurga Elta	4.1	11.7	105	Tasova Yeniderekoy	2	12.0
51	EnerjiSA Sahmallar	14.0	30.0	106	TEMSA Gozede	2.4	12.9
52	EnerjiSA Kizilduz	15.4	33.2	107	Tocak I Yurt	4.8	12.1
53	Erenler BME	45.0	25.6	108	Egemen Enersis I-II	19.9	5.3
54	Erikli Akocak	82.5	20.3		Others	308.5	402.3
55	Esen 2 Goltas	43.4	141.8		<b>Total</b>	<b>2764</b>	<b>7327</b>



Table S6. Onshore wind plants.

	Plant	Location	Installed Capacity (MW)	Turbine Power (MW)	Number of Turbines	Generation in 2010 (GWh)
1	Mersin Mut	Mersin	33	3	11	65.2
2	Ayyildiz	Balikesir	15	3	5	45.1
3	Sarikaya	Tekirdag	28.8	2/0.8	15	79.1
4	Cataltepe	Balikesir	16	2	8	-
5	Kuyucak	Manisa	25.6	2/0.9	14	5.1
6	Camseki	Canakkale	20.8	2/0.8	11	63.9
7	Cesme	Izmir	1.5	0.5	3	4.2
8	Keltepe	Balikesir	20.7	0.9	23	68.3
9	Intepe	Canakkale	30.4	0.8	38	80.2
10	ARES	Izmir	7.2	0.6	12	13.0
11	Bandirma 3	Balikesir	24	2.5	10	49.3
12	Akbuk	Aydin	31.5	2.1	15	99.6
13	Samli	Balikesir	113.1	3	30	204.2
14	Senbuk	Hatay	15	3	5	30.3
15	Belen	Hatay	36	3	12	77.1
16	Aliaga	Izmir	90	2.5	36	170.6
17	Soma	Manisa	90	2.5	36	144.9
18	Bandirma 3	Balikesir	60	3	20	161.2
19	Boreas	Edirne	15	2.5	6	35.1
20	Bozcaada	Canakkale	10.2	0.6	17	33.3
21	Dares Datca	Mugla	29.6	0.8/0.9	36	79.5
22	Sebenoba	Hatay	30	2	15	83.7
23	Karakurt	Manisa	10.8	1.8	6	27.9
24	Sayalar	Manisa	34.2	0.9	38	82.2
25	Burgaz	Canakkale	14.9	0.8/0.9	18	37.3
26	Sares	Canakkale	22.5	2.5	9	1.7
27	Yuntdag	Izmir	57.5	2.5	17	131.3
28	Kores 2	Izmir	15	2.5	6	47.4
29	Kemberburgaz	Istanbul	24	2	12	50.0
30	Mazi 1	Izmir	39.2	0.8/0.9	49	116.0

31	Mazi 3	Izmir	30	2.5	12	89.2
32	Gokcedag	Osmaniye	135	2.5	54	283.5
33	Turguttepe	Aydin	24	2	11	0.2
34	Catalca	Istanbul	60	3	20	161.6
35	Sunjut	Istanbul	1.2	0.6	2	2.3
36	Tepe	Istanbul	0.85	0.85	1	2.3
37	Duzova	Izmir	30	2.5	12	56.3
38	Bandirma 3	Balikesir	35	1.5/2.5	20	
39	Ziyaret	Hatay	42.5	2.5	17	43.2
<b>Total</b>			<b>1320</b>		<b>682</b>	<b>2765 (2916) <sup>a</sup></b>

<sup>a</sup> The total generation in 2010 was 2916.4 GWh. The difference from the generation shown in the table is due to a lack of specific data for some of the plants. However, total actual electricity generation has been used to estimate the impacts from wind plants.

Table S7. Geothermal power plants.

	Name	Place	Installed Capacity (MW)	Generation in 2010 (GWh)	Temperature (°C)
1	Kizildere	Denizli	15.0	103.9	200–242
2	Tuzla	Canakkale	7.5	35.4	174
3	Dora 2	Aydin	9.5	70.0	171
4	Germencik (Gurmat)	Aydin	47.4	401.7	200–232
5	Kizildere Bereketli	Denizli	6.85		200–242
6	Dora 1 (Salavatli)	Aydin	7.95	57.2	171
<b>Total</b>			<b>94.2</b>	<b>668.2</b>	

Table S8. Annual abiotic depletion potential (ADP elements) over the period 1990–2014.

kg Sb-eq.	Lignite	Hard Coal	Gas	Reservoir	Run-of-River	Wind	Geothermal	TOTAL
1990	$4.0 \times 10^2$	$5.0 \times 10^1$	$3.4 \times 10^2$	$1.5 \times 10^2$	0.0	0.0	$3.8 \times 10^{-1}$	$9.4 \times 10^2$
1995	$5.2 \times 10^2$	$1.8 \times 10^2$	$5.4 \times 10^2$	$2.3 \times 10^2$	0.0	0.0	$4.1 \times 10^{-1}$	$1.5 \times 10^3$
2000	$7.0 \times 10^2$	$3.1 \times 10^2$	$1.3 \times 10^3$	$2.0 \times 10^2$	0.0	2.2	$3.6 \times 10^{-1}$	$2.5 \times 10^3$
2005	$6.1 \times 10^2$	$1.1 \times 10^3$	$1.9 \times 10^3$	$2.4 \times 10^2$	$5.8 \times 10^1$	3.8	$4.6 \times 10^{-1}$	$3.9 \times 10^3$
2010	$7.3 \times 10^2$	$1.5 \times 10^3$	$2.4 \times 10^3$	$2.8 \times 10^2$	$1.5 \times 10^2$	$1.9 \times 10^2$	3.2	$5.3 \times 10^3$
2014	$7.4 \times 10^2$	$3.0 \times 10^3$	$3.0 \times 10^3$	$1.9 \times 10^2$	$2.5 \times 10^2$	$5.6 \times 10^2$	$1.1 \times 10^1$	$7.7 \times 10^3$

**Table S9.** Annual abiotic depletion potential (ADP fossil) over the period 1990–2014 (ADP elements).

<b>MJ</b>	<b>Lignite</b>	<b>Hard Coal</b>	<b>Gas</b>	<b>Reservoir</b>	<b>Run-of-River</b>	<b>Wind</b>	<b>Geothermal</b>	<b>TOTAL</b>
1990	$2.9 \times 10^{11}$	$8.4 \times 10^9$	$1.2 \times 10^{11}$	$3.0 \times 10^8$	0.0	0.0	$1.4 \times 10^6$	$4.3 \times 10^{11}$
1995	$3.9 \times 10^{11}$	$3.0 \times 10^{10}$	$2.0 \times 10^{11}$	$4.6 \times 10^8$	0.0	0.0	$1.5 \times 10^6$	$6.2 \times 10^{11}$
2000	$5.2 \times 10^{11}$	$5.2 \times 10^{10}$	$4.9 \times 10^{11}$	$4.0 \times 10^8$	0.0	$3.6 \times 10^6$	$1.3 \times 10^6$	$1.1 \times 10^{12}$
2005	$4.5 \times 10^{11}$	$1.8 \times 10^{11}$	$6.9 \times 10^{11}$	$4.8 \times 10^8$	$1.1 \times 10^8$	$6.2 \times 10^6$	$1.7 \times 10^6$	$1.3 \times 10^{12}$
2010	$5.4 \times 10^{11}$	$2.6 \times 10^{11}$	$8.8 \times 10^{11}$	$5.8 \times 10^8$	$2.9 \times 10^8$	$3.2 \times 10^8$	$1.2 \times 10^7$	$1.7 \times 10^{12}$
2014	$5.5 \times 10^{11}$	$5.0 \times 10^{11}$	$1.1 \times 10^{12}$	$3.9 \times 10^8$	$4.7 \times 10^8$	$9.1 \times 10^8$	$3.9 \times 10^4$	$2.1 \times 10^{12}$

**Table S10.** Annual acidification potential (AP) over the period 1990–2014.

<b>kg SO<sub>2</sub>-eq.</b>	<b>Lignite</b>	<b>Hard Coal</b>	<b>Gas</b>	<b>Reservoir</b>	<b>Run-of-river</b>	<b>Wind</b>	<b>Geothermal</b>	<b>TOTAL</b>
1990	$2.1 \times 10^8$	$3.8 \times 10^6$	$1.2 \times 10^7$	$1.0 \times 10^5$	0.0	0.0	$7.0 \times 10^5$	$2.3 \times 10^8$
1995	$2.8 \times 10^8$	$1.3 \times 10^7$	$1.8 \times 10^7$	$1.6 \times 10^5$	0.0	0.0	$7.5 \times 10^5$	$3.1 \times 10^8$
2000	$3.7 \times 10^8$	$2.3 \times 10^7$	$4.5 \times 10^7$	$1.4 \times 10^5$	0.0	$1.0 \times 10^3$	$6.6 \times 10^5$	$4.4 \times 10^8$
2005	$3.2 \times 10^8$	$8.0 \times 10^7$	$6.5 \times 10^7$	$1.7 \times 10^5$	$4.1 \times 10^4$	$1.8 \times 10^3$	$8.5 \times 10^5$	$4.7 \times 10^8$
2010	$3.9 \times 10^8$	$1.2 \times 10^8$	$8.2 \times 10^7$	$2.0 \times 10^5$	$1.1 \times 10^5$	$9.1 \times 10^4$	$5.9 \times 10^6$	$6.0 \times 10^8$
2014	$3.9 \times 10^8$	$2.2 \times 10^8$	$1.0 \times 10^8$	$1.3 \times 10^5$	$1.8 \times 10^5$	$2.6 \times 10^5$	$2.0 \times 10^7$	$7.4 \times 10^8$

**Table S11.** Annual eutrophication potential (EP) over the period 1990–2014.

<b>kg PO<sub>4</sub>-eq.</b>	<b>Lignite</b>	<b>Hard Coal</b>	<b>Gas</b>	<b>Reservoir</b>	<b>Run-of-River</b>	<b>Wind</b>	<b>Geothermal</b>	<b>TOTAL</b>
1990	$2.3 \times 10^8$	$1.4 \times 10^6$	$1.4 \times 10^6$	$4.1 \times 10^4$	0.0	0.0	$7.8 \times 10^1$	$2.3 \times 10^8$
1995	$3.1 \times 10^8$	$5.1 \times 10^6$	$2.2 \times 10^6$	$6.3 \times 10^4$	0.0	0.0	$8.4 \times 10^1$	$3.1 \times 10^8$
2000	$4.1 \times 10^8$	$8.8 \times 10^6$	$5.5 \times 10^6$	$5.5 \times 10^4$	0.0	$5.1 \times 10^2$	$7.4 \times 10^1$	$4.2 \times 10^8$
2005	$3.5 \times 10^8$	$3.1 \times 10^7$	$7.9 \times 10^6$	$6.5 \times 10^4$	$1.7 \times 10^4$	$8.6 \times 10^2$	$9.5 \times 10^1$	$3.9 \times 10^8$
2010	$4.3 \times 10^8$	$4.4 \times 10^7$	$1.0 \times 10^7$	$7.9 \times 10^4$	$4.6 \times 10^4$	$4.4 \times 10^4$	$6.5 \times 10^2$	$4.8 \times 10^8$
2014	$4.3 \times 10^8$	$8.4 \times 10^7$	$1.2 \times 10^7$	$5.3 \times 10^4$	$7.5 \times 10^4$	$1.3 \times 10^5$	$2.2 \times 10^3$	$5.3 \times 10^8$

**Table S12.** Annual freshwater aquatic ecotoxicity potential (FAETP) over the period 1990–2014.

kg DCB-eq.	Lignite	Hard Coal	Gas	Reservoir	Run-of-River	Wind	Geothermal	TOTAL
1990	$4.1 \times 10^{10}$	$2.3 \times 10^8$	$5.0 \times 10^7$	$1.5 \times 10^7$	0.0	0.0	$1.3 \times 10^2$	$4.1 \times 10^{10}$
1995	$5.4 \times 10^{10}$	$8.1 \times 10^8$	$7.9 \times 10^7$	$2.4 \times 10^7$	0.0	0.0	$1.4 \times 10^2$	$5.5 \times 10^{10}$
2000	$7.2 \times 10^{10}$	$1.4 \times 10^9$	$2.0 \times 10^8$	$2.1 \times 10^7$	0.0	$3.9 \times 10^5$	$1.2 \times 10^2$	$7.3 \times 10^{10}$
2005	$6.3 \times 10^{10}$	$4.8 \times 10^9$	$2.8 \times 10^8$	$2.4 \times 10^7$	$5.9 \times 10^6$	$6.6 \times 10^5$	$1.5 \times 10^2$	$6.8 \times 10^{10}$
2010	$7.5 \times 10^{10}$	$6.9 \times 10^9$	$3.5 \times 10^8$	$3.0 \times 10^7$	$1.6 \times 10^7$	$3.4 \times 10^7$	$1.1 \times 10^3$	$8.2 \times 10^{10}$
2014	$7.6 \times 10^{10}$	$1.3 \times 10^{10}$	$4.4 \times 10^8$	$2.0 \times 10^7$	$2.5 \times 10^7$	$9.7 \times 10^7$	$3.6 \times 10^3$	$9.0 \times 10^{10}$

**Table S13.** Annual global warming potential (GWP) over the period 1990–2014.

kg CO <sub>2</sub> -eq.	Lignite	Hard Coal	Gas	Reservoir	Run-of-River	Wind	Geothermal	TOTAL
1990	$2.1 \times 10^{10}$	$7.0 \times 10^8$	$7.1 \times 10^9$	$1.6 \times 10^8$	0.0	0.0	$5.0 \times 10^6$	$2.9 \times 10^{10}$
1995	$2.7 \times 10^{10}$	$2.5 \times 10^9$	$1.1 \times 10^{10}$	$2.5 \times 10^8$	0.0	0.0	$5.4 \times 10^6$	$4.1 \times 10^{10}$
2000	$3.7 \times 10^{10}$	$4.3 \times 10^9$	$2.8 \times 10^{10}$	$2.1 \times 10^8$	0.0	$2.4 \times 10^5$	$4.8 \times 10^6$	$6.9 \times 10^{10}$
2005	$3.2 \times 10^{10}$	$1.5 \times 10^{10}$	$3.9 \times 10^{10}$	$2.5 \times 10^8$	$1.1 \times 10^7$	$4.1 \times 10^5$	$6.1 \times 10^6$	$8.6 \times 10^{10}$
2010	$3.8 \times 10^{10}$	$2.2 \times 10^{10}$	$5.0 \times 10^{10}$	$3.1 \times 10^8$	$3.0 \times 10^7$	$2.1 \times 10^7$	$4.2 \times 10^7$	$1.1 \times 10^{11}$
2014	$3.9 \times 10^{10}$	$4.1 \times 10^{10}$	$6.2 \times 10^{10}$	$2.1 \times 10^8$	$4.9 \times 10^7$	$6.1 \times 10^7$	$1.4 \times 10^8$	$1.4 \times 10^{11}$

**Table S14.** Annual human toxicity potential (HTP) over the period 1990–2014.

kg DCB-eq.	Lignite	Hard coal	Gas	Reservoir	Run-of-River	Wind	Geothermal	TOTAL
1990	$2.7 \times 10^{10}$	$1.9 \times 10^8$	$8.4 \times 10^7$	$6.2 \times 10^7$	0.0	0.0	$1.0 \times 10^5$	$2.8 \times 10^{10}$
1995	$3.6 \times 10^{10}$	$6.7 \times 10^8$	$1.3 \times 10^8$	$9.5 \times 10^7$	0.0	0.0	$1.1 \times 10^5$	$3.7 \times 10^{10}$
2000	$4.8 \times 10^{10}$	$1.1 \times 10^9$	$3.3 \times 10^8$	$8.3 \times 10^7$	0.0	$7.2 \times 10^5$	$9.8 \times 10^4$	$4.9 \times 10^{10}$
2005	$4.2 \times 10^{10}$	$4.0 \times 10^9$	$4.7 \times 10^8$	$9.8 \times 10^7$	$1.9 \times 10^7$	$1.2 \times 10^6$	$1.3 \times 10^5$	$4.6 \times 10^{10}$
2010	$5.0 \times 10^{10}$	$5.7 \times 10^9$	$6.0 \times 10^8$	$1.2 \times 10^8$	$5.0 \times 10^7$	$6.3 \times 10^7$	$8.6 \times 10^5$	$5.7 \times 10^{10}$
2014	$5.1 \times 10^{10}$	$1.1 \times 10^{10}$	$7.4 \times 10^8$	$8.0 \times 10^7$	$8.0 \times 10^7$	$1.8 \times 10^8$	$2.9 \times 10^6$	$6.3 \times 10^{10}$

**Table S15.** Annual marine aquatic ecotoxicity potential (MAETP) over the period 1990–2014.

kg DCB-eq.	Lignite	Hard Coal	Gas	Reservoir	Run-of-River	Wind	Geothermal	TOTAL
1990	$1.3 \times 10^{14}$	$8.6 \times 10^{11}$	$9.7 \times 10^{10}$	$2.5 \times 10^{10}$	0.0	0.0	$4.4 \times 10^7$	$1.3 \times 10^{14}$
1995	$1.6 \times 10^{14}$	$3.1 \times 10^{12}$	$1.5 \times 10^{11}$	$3.8 \times 10^{10}$	0.0	0.0	$4.7 \times 10^7$	$1.7 \times 10^{14}$
2000	$2.2 \times 10^{14}$	$5.3 \times 10^{12}$	$3.8 \times 10^{11}$	$3.3 \times 10^{10}$	0.0	$4.2 \times 10^8$	$4.1 \times 10^7$	$2.3 \times 10^{14}$
2005	$1.9 \times 10^{14}$	$1.8 \times 10^{13}$	$5.4 \times 10^{11}$	$3.9 \times 10^{10}$	$9.7 \times 10^9$	$7.1 \times 10^8$	$5.3 \times 10^7$	$2.1 \times 10^{14}$
2010	$2.3 \times 10^{14}$	$2.7 \times 10^{13}$	$6.9 \times 10^{11}$	$4.8 \times 10^{10}$	$2.6 \times 10^{10}$	$3.7 \times 10^{10}$	$3.6 \times 10^8$	$2.6 \times 10^{14}$
2014	$2.3 \times 10^{14}$	$5.1 \times 10^{13}$	$8.6 \times 10^{11}$	$3.2 \times 10^{10}$	$4.2 \times 10^{10}$	$1.0 \times 10^{11}$	$1.2 \times 10^9$	$2.8 \times 10^{14}$

**Table S16.** Annual ozone layer depletion potential (ODP) over the period 1990–2014.

kg R11-eq.	Lignite	Hard Coal	Gas	Reservoir	Run-of-River	Wind	Geothermal	TOTAL
1990	$3.8 \times 10^1$	4.7	$1.3 \times 10^3$	1.8	0.0	0.0	$-3.1 \times 10^{-7}$	$1.3 \times 10^3$
1995	$5.0 \times 10^1$	$1.7 \times 10^1$	$2.1 \times 10^3$	2.7	0.0	0.0	$-3.3 \times 10^7$	$2.1 \times 10^3$
2000	$6.6 \times 10^1$	$2.9 \times 10^1$	$5.1 \times 10^3$	2.4	0.0	$1.6 \times 10^{-2}$	$-2.9 \times 10^{-7}$	$5.2 \times 10^3$
2005	$5.8 \times 10^1$	$1.0 \times 10^2$	$7.3 \times 10^3$	2.8	$6.7 \times 10^{-1}$	$2.8 \times 10^{-2}$	$-3.8 \times 10^{-7}$	$7.4 \times 10^3$
2010	$6.9 \times 10^1$	$1.4 \times 10^2$	$9.2 \times 10^3$	3.4	1.8	1.4	$-2.6 \times 10^{-6}$	$9.5 \times 10^3$
2014	$7.0 \times 10^1$	$2.8 \times 10^2$	$1.2 \times 10^4$	2.3	2.9	4.1	$-8.8 \times 10^{-6}$	$1.2 \times 10^4$

**Table S17.** Annual photochemical oxidants creation potential (POCP) over the period 1990–2014.

kg C <sub>2</sub> H <sub>4</sub> -eq.	Lignite	Hard Coal	Gas	Reservoir	Run-of-River	Wind	Geothermal	TOTAL
1990	$9.4 \times 10^6$	$2.1 \times 10^5$	$2.5 \times 10^6$	$4.2 \times 10^4$	0.0	0.0	$9.4 \times 10^1$	$1.2 \times 10^7$
1995	$1.2 \times 10^7$	$7.4 \times 10^5$	$4.0 \times 10^6$	$6.4 \times 10^4$	0.0	0.0	$1.0 \times 10^2$	$1.7 \times 10^7$
2000	$1.6 \times 10^7$	$1.3 \times 10^6$	$9.9 \times 10^6$	$5.6 \times 10^4$	0.0	$1.4 \times 10^2$	$8.8 \times 10^1$	$2.8 \times 10^7$
2005	$1.4 \times 10^7$	$4.4 \times 10^6$	$1.4 \times 10^7$	$6.6 \times 10^4$	$5.7 \times 10^3$	$2.3 \times 10^2$	$1.1 \times 10^2$	$3.3 \times 10^7$
2010	$1.7 \times 10^7$	$6.4 \times 10^6$	$1.8 \times 10^7$	$8.1 \times 10^4$	$1.5 \times 10^4$	$1.2 \times 10^4$	$7.8 \times 10^2$	$4.2 \times 10^7$
2014	$1.7 \times 10^7$	$1.2 \times 10^7$	$2.2 \times 10^7$	$5.4 \times 10^4$	$2.5 \times 10^4$	$3.4 \times 10^4$	$2.6 \times 10^3$	$5.2 \times 10^7$

**Table S18.** Annual terrestrial ecotoxicity potential (TETP) over the period 1990–2014.

<b>kg DCB-eq.</b>	<b>Lignite</b>	<b>Hard Coal</b>	<b>Gas</b>	<b>Reservoir</b>	<b>Run-of-River</b>	<b>Wind</b>	<b>Geothermal</b>	<b>TOTAL</b>
1990	$7.6 \times 10^7$	$1.2 \times 10^6$	$3.6 \times 10^6$	$2.0 \times 10^6$	0.0	0.0	$1.1 \times 10^2$	$8.3 \times 10^7$
1995	$1.0 \times 10^8$	$4.3 \times 10^6$	$5.8 \times 10^6$	$3.1 \times 10^6$	0.0	0.0	$1.2 \times 10^2$	$1.1 \times 10^8$
2000	$1.3 \times 10^8$	$7.3 \times 10^6$	$1.4 \times 10^7$	$2.7 \times 10^6$	0.0	$2.3 \times 10^4$	$1.0 \times 10^2$	$1.6 \times 10^8$
2005	$1.2 \times 10^8$	$2.5 \times 10^7$	$2.0 \times 10^7$	$3.2 \times 10^6$	$6.0 \times 10^5$	$3.8 \times 10^4$	$1.3 \times 10^2$	$1.7 \times 10^8$
2010	$1.4 \times 10^8$	$3.7 \times 10^7$	$2. \times 10^7$	$3.9 \times 10^6$	$1.6 \times 10^6$	$2.0 \times 10^6$	$9.0 \times 10^2$	$2.1 \times 10^8$
2014	$1.4 \times 10^8$	$7.0 \times 10^7$	$3.2 \times 10^7$	$2.6 \times 10^6$	$2.6 \times 10^6$	$5.7 \times 10^6$	$3.0 \times 10^3$	$2.5 \times 10^8$