

Table E1.gen. Electricity generation: World, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	733	737	378	203	107	69	56	-8.8%
Natural gas	6,699	6,664	6,638	6,726	7,187	7,750	8,266	0.8%
Coal	9,696	9,339	9,165	9,412	9,378	9,475	9,612	0.0%
Nuclear	2,666	2,786	3,020	3,160	3,181	3,216	3,297	0.8%
Renewables	8,444	10,059	12,538	14,690	16,891	19,075	21,067	3.3%
Hydro	4,320	4,715	4,966	5,247	5,331	5,457	5,583	0.9%
Wind	1,967	2,357	3,249	4,012	4,995	5,569	5,805	3.9%
Geothermal	67	110	191	213	238	248	254	4.9%
Solar	1,421	2,241	3,457	4,531	5,639	6,984	8,521	6.6%
Other	669	636	674	687	688	817	903	1.1%
Net generation to grid	28,239	29,584	31,739	34,191	36,744	39,587	42,298	1.5%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459 and Annual Energy Outlook 2023 (March 2023), www.eia.gov/aeo

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E2.gen. Electricity generation: Americas, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	158	159	74	34	16	5	5	-11.4%
Natural gas	2,260	2,029	1,828	1,726	1,828	1,877	1,936	-0.6%
Coal	934	834	427	464	481	484	448	-2.6%
Nuclear	889	891	896	839	738	716	703	-0.8%
Renewables	2,491	2,910	3,949	4,504	4,897	5,330	5,857	3.1%
Hydro	1,472	1,544	1,625	1,717	1,726	1,732	1,736	0.6%
Wind	611	714	1,207	1,421	1,563	1,730	1,891	4.1%
Geothermal	25	21	38	41	45	49	54	2.8%
Solar	260	526	982	1,240	1,494	1,755	2,112	7.8%
Other	122	105	96	86	68	65	64	-2.3%
Net generation to grid	6,732	6,823	7,174	7,566	7,959	8,413	8,949	1.0%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459 and Annual Energy Outlook 2023 (March 2023), www.eia.gov/aeo

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E3.gen. Electricity generation: United States, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	11	10	7	7	6	5	5	-3.1%
Natural gas	1,685	1,431	1,169	1,036	1,115	1,169	1,209	-1.2%
Coal	849	770	359	354	314	292	256	-4.2%
Nuclear	772	782	758	700	625	626	625	-0.8%
Renewables	1,004	1,365	2,264	2,662	2,908	3,134	3,425	4.5%
Hydro	276	300	296	292	289	288	285	0.1%
Wind	440	513	967	1,127	1,150	1,182	1,218	3.7%
Geothermal	16	17	21	24	28	31	37	3.2%
Solar	205	468	911	1,151	1,378	1,573	1,828	8.1%
Other	67	68	68	68	63	59	57	-0.6%
Net generation to grid	4,321	4,357	4,557	4,760	4,969	5,226	5,520	0.9%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459 and Annual Energy Outlook 2023 (March 2023), www.eia.gov/aeo

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E4.gen. Electricity generation: Canada, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	5	5	0	0	0	0	0	-13.5%
Natural gas	81	85	131	153	161	148	166	2.6%
Coal	39	18	0	0	0	0	0	-100.0%
Nuclear	79	71	77	72	51	39	28	-3.7%
Renewables	452	470	503	544	624	720	813	2.1%
Hydro	399	417	430	430	430	430	430	0.3%
Wind	41	45	64	106	185	282	376	8.3%
Geothermal	0	0	0	0	0	0	0	0.0%
Solar	6	6	6	6	6	6	5	-0.5%
Other	5	3	4	2	3	2	2	-2.8%
Net generation to grid	656	649	711	770	836	908	1,006	1.5%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E5.gen. Electricity generation: Mexico, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	46	48	23	12	5	0	0	-19.1%
Natural gas	191	195	195	213	245	257	260	1.1%
Coal	9	9	17	19	19	19	19	2.8%
Nuclear	11	11	20	28	23	17	17	1.4%
Renewables	86	80	103	113	123	154	186	2.8%
Hydro	32	34	39	39	39	39	40	0.8%
Wind	35	31	36	36	36	36	36	0.1%
Geothermal	5	0	8	8	8	8	8	1.5%
Solar	12	14	20	30	40	71	103	8.1%
Other	2	1	1	1	0	0	0	-100.0%
Net generation to grid	342	343	359	385	415	446	482	1.2%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E6.gen. Electricity generation: Brazil, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	23	23	9	1	0	0	0	-15.5%
Natural gas	97	110	110	89	73	69	66	-1.4%
Coal	13	13	9	9	13	9	9	-1.3%
Nuclear	14	14	23	23	23	18	18	0.9%
Renewables	531	561	589	660	692	728	758	1.3%
Hydro	410	430	463	536	539	539	539	1.0%
Wind	62	83	85	91	131	165	195	4.2%
Geothermal	0	0	0	0	0	0	0	0.0%
Solar	21	21	22	22	22	22	22	0.1%
Other	38	26	19	12	0	1	2	-9.5%
Net generation to grid	678	721	740	783	802	824	852	0.8%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E7.gen. Electricity generation: Other Americas, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	73	74	34	13	4	0	0	-18.4%
Natural gas	205	208	223	234	234	234	234	0.5%
Coal	25	25	42	82	134	164	164	7.0%
Nuclear	12	12	18	15	15	15	15	0.8%
Renewables	419	434	490	525	550	595	675	1.7%
Hydro	354	364	398	421	428	436	442	0.8%
Wind	34	43	55	61	62	65	67	2.5%
Geothermal	5	4	9	9	9	9	9	2.5%
Solar	16	17	23	31	48	83	154	8.4%
Other	10	6	4	3	1	2	2	-5.2%
Net generation to grid	734	753	807	869	937	1,009	1,089	1.4%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E8.gen. Electricity generation: Europe and Eurasia, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	117	116	75	54	41	40	39	-3.9%
Natural gas	1,473	1,499	1,587	1,631	1,731	1,841	1,962	1.0%
Coal	802	752	557	532	519	586	616	-0.9%
Nuclear	995	1,003	1,044	1,062	1,055	1,036	1,039	0.2%
Renewables	1,963	2,186	2,472	2,826	3,172	3,362	3,602	2.2%
Hydro	915	989	987	1,056	1,057	1,060	1,060	0.5%
Wind	483	552	633	714	949	967	983	2.6%
Geothermal	23	39	53	52	52	59	59	3.4%
Solar	218	197	336	502	578	701	882	5.1%
Other	324	409	464	502	535	575	618	2.3%
Net generation to grid	5,350	5,556	5,735	6,106	6,518	6,865	7,258	1.1%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E9.gen. Electricity generation: Western Europe, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	97	97	67	50	37	36	36	-3.5%
Natural gas	777	792	792	750	718	690	668	-0.5%
Coal	501	447	270	259	246	313	343	-1.3%
Nuclear	734	723	733	727	720	702	702	-0.2%
Renewables	1,649	1,863	2,143	2,464	2,817	3,002	3,236	2.4%
Hydro	621	697	706	753	754	754	754	0.7%
Wind	474	544	623	695	930	947	962	2.6%
Geothermal	22	38	52	51	51	57	57	3.4%
Solar	209	184	313	478	554	673	849	5.1%
Other	323	399	449	488	529	570	614	2.3%
Net generation to grid	3,758	3,922	4,005	4,250	4,539	4,744	4,985	1.0%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E10.gen. Electricity generation: Russia, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	17	16	6	2	2	1	1	-10.6%
Natural gas	499	502	589	661	716	771	823	1.8%
Coal	184	187	148	122	121	121	121	-1.5%
Nuclear	217	229	234	234	234	234	227	0.2%
Renewables	220	216	210	237	230	228	228	0.1%
Hydro	211	204	192	211	211	211	211	0.0%
Wind	5	1	3	10	10	10	10	2.4%
Geothermal	0	0	0	1	1	1	1	1.0%
Solar	3	3	3	3	3	3	3	0.0%
Other	0	8	13	13	6	4	4	16.6%
Net generation to grid	1,137	1,150	1,187	1,256	1,303	1,355	1,400	0.7%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E11.gen. Electricity generation: Eastern Europe and Eurasia, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	3	3	2	2	2	2	2	-1.0%
Natural gas	197	205	205	220	297	380	471	3.2%
Coal	117	117	140	151	151	151	151	0.9%
Nuclear	44	52	77	101	101	101	111	3.4%
Renewables	94	107	119	125	124	132	137	1.4%
Hydro	82	88	89	92	92	95	95	0.5%
Wind	4	7	7	9	9	10	10	3.8%
Geothermal	0	0	1	1	1	1	1	--
Solar	6	10	20	21	21	25	30	5.8%
Other	2	2	2	2	1	1	1	-1.2%
Net generation to grid	455	484	543	599	676	766	873	2.4%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E12.gen. Electricity generation: Asia Pacific, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	110	108	49	27	16	11	9	-8.7%
Natural gas	1,617	1,738	1,798	1,746	1,845	2,089	2,292	1.3%
Coal	7,746	7,563	7,965	8,146	8,135	8,130	8,272	0.2%
Nuclear	746	837	993	1,143	1,253	1,329	1,420	2.3%
Renewables	3,721	4,560	5,547	6,710	8,094	9,487	10,534	3.8%
Hydro	1,745	1,949	2,101	2,206	2,257	2,307	2,353	1.1%
Wind	842	1,026	1,295	1,757	2,361	2,745	2,805	4.4%
Geothermal	13	44	67	74	78	78	78	6.7%
Solar	902	1,423	1,974	2,582	3,317	4,182	5,082	6.4%
Other	220	119	110	91	82	174	216	-0.1%
Net generation to grid	13,940	14,807	16,352	17,772	19,343	21,045	22,526	1.7%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E13.gen. Electricity generation: Japan, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	29	29	15	9	6	6	6	-5.6%
Natural gas	363	383	383	339	306	310	300	-0.7%
Coal	291	283	167	182	182	182	182	-1.7%
Nuclear	78	115	139	139	121	102	102	0.9%
Renewables	210	203	241	265	320	349	377	2.1%
Hydro	72	83	83	86	86	86	86	0.6%
Wind	8	8	8	14	37	57	76	8.5%
Geothermal	3	3	3	4	4	4	4	0.8%
Solar	105	101	139	154	164	173	182	2.0%
Other	23	8	8	7	30	30	30	0.9%
Net generation to grid	972	1,014	945	934	935	949	966	0.0%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E14.gen. Electricity generation: South Korea, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	8	7	3	3	2	2	2	-4.6%
Natural gas	177	174	176	161	148	139	139	-0.9%
Coal	149	145	145	152	157	159	159	0.2%
Nuclear	201	228	228	228	228	218	214	0.2%
Renewables	50	53	79	107	132	162	183	4.7%
Hydro	3	4	4	5	5	5	5	1.1%
Wind	5	18	33	60	85	114	135	12.6%
Geothermal	0	0	0	0	0	0	0	0.0%
Solar	26	26	26	26	26	26	26	0.0%
Other	16	6	15	17	17	17	17	0.2%
Net generation to grid	586	607	631	650	666	681	697	0.6%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E15.gen. Electricity generation: Australia and New Zealand, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	4	4	0	0	0	0	0	-12.0%
Natural gas	56	52	52	41	33	38	38	-1.3%
Coal	111	104	125	138	139	139	139	0.8%
Nuclear	0	0	0	0	0	0	0	0.0%
Renewables	127	149	164	189	225	247	277	2.8%
Hydro	36	41	45	45	45	45	45	0.8%
Wind	42	57	64	77	89	89	90	2.8%
Geothermal	9	9	9	9	9	9	9	0.0%
Solar	38	41	46	58	83	103	133	4.6%
Other	2	1	1	0	0	0	0	-10.0%
Net generation to grid	298	308	341	369	397	424	455	1.5%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E16.gen. Electricity generation: China, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	13	12	1	0	0	0	0	-16.8%
Natural gas	302	357	401	495	713	956	1,169	5.0%
Coal	5,248	5,121	5,211	5,282	5,053	4,826	4,797	-0.3%
Nuclear	383	416	538	674	799	903	998	3.5%
Renewables	2,573	3,066	3,559	3,829	4,325	4,788	4,896	2.3%
Hydro	1,221	1,300	1,379	1,428	1,474	1,515	1,551	0.9%
Wind	653	724	862	1,043	1,395	1,726	1,746	3.6%
Geothermal	0	0	0	0	0	0	0	0.1%
Solar	575	988	1,275	1,326	1,420	1,420	1,430	3.3%
Other	123	54	42	31	35	127	169	1.1%
Net generation to grid	8,519	8,972	9,711	10,280	10,889	11,474	11,861	1.2%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E17.gen. Electricity generation: India, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	4	4	1	0	0	0	0	-14.7%
Natural gas	78	73	83	83	83	83	83	0.2%
Coal	1,240	1,251	1,473	1,420	1,436	1,454	1,411	0.5%
Nuclear	41	42	52	67	70	70	70	1.9%
Renewables	395	596	870	1,495	2,096	2,822	3,587	8.2%
Hydro	154	195	197	199	201	203	205	1.0%
Wind	119	198	289	471	653	653	653	6.3%
Geothermal	0	0	0	0	0	0	0	0.0%
Solar	99	184	368	811	1,241	1,966	2,728	12.6%
Other	23	18	16	14	0	0	0	-100.0%
Net generation to grid	1,757	1,965	2,479	3,064	3,685	4,429	5,150	3.9%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E18.gen. Electricity generation: Other Asia Pacific, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	52	53	28	15	8	3	1	-14.8%
Natural gas	641	699	703	627	562	562	562	-0.5%
Coal	706	661	844	972	1,169	1,369	1,583	2.9%
Nuclear	43	36	36	36	36	36	36	-0.6%
Renewables	365	493	633	825	996	1,119	1,215	4.4%
Hydro	258	326	393	444	446	454	461	2.1%
Wind	15	21	39	92	102	105	105	7.3%
Geothermal	1	32	55	61	65	65	65	17.9%
Solar	58	83	119	207	383	495	583	8.6%
Other	33	32	28	22	0	0	0	-14.7%
Net generation to grid	1,807	1,941	2,244	2,475	2,771	3,089	3,396	2.3%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E19.gen. Electricity generation: Africa and Middle East, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	348	354	179	87	35	13	3	-15.3%
Natural gas	1,349	1,398	1,426	1,623	1,783	1,944	2,076	1.6%
Coal	214	190	215	270	243	275	276	0.9%
Nuclear	37	54	87	116	135	135	135	4.8%
Renewables	269	402	570	650	729	896	1,074	5.1%
Hydro	188	232	253	268	291	358	435	3.0%
Wind	30	65	114	121	122	126	126	5.2%
Geothermal	6	6	33	46	63	63	63	8.6%
Solar	42	95	165	206	250	346	446	8.8%
Other	2	4	4	8	2	3	4	2.1%
Net generation to grid	2,217	2,398	2,478	2,746	2,924	3,264	3,565	1.7%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E20.gen. Electricity generation: Africa, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	48	47	16	10	0	0	0	-16.3%
Natural gas	358	367	391	456	523	590	654	2.2%
Coal	214	189	215	270	243	275	275	0.9%
Nuclear	13	13	30	43	52	52	52	5.1%
Renewables	227	307	412	480	552	707	878	4.9%
Hydro	165	207	224	239	262	329	406	3.3%
Wind	28	46	76	81	82	83	83	4.0%
Geothermal	6	6	33	46	63	63	63	8.6%
Solar	26	44	75	107	142	229	322	9.4%
Other	2	3	3	7	2	3	4	1.6%
Net generation to grid	861	923	1,063	1,259	1,371	1,626	1,860	2.8%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.

Table E21.gen. Electricity generation: Middle East, Reference case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	300	307	164	77	34	13	3	-15.2%
Natural gas	990	1,031	1,036	1,167	1,259	1,354	1,423	1.3%
Coal	0	0	0	0	0	0	0	-5.9%
Nuclear	24	41	58	73	83	83	83	4.6%
Renewables	42	96	158	169	177	189	197	5.7%
Hydro	23	25	29	29	29	29	29	0.8%
Wind	3	19	38	40	40	42	42	10.4%
Geothermal	0	0	0	0	0	0	0	0.0%
Solar	16	51	91	100	108	117	125	7.5%
Other	0	0	0	0	0	0	1	--
Net generation to grid	1,357	1,475	1,415	1,487	1,554	1,638	1,705	0.8%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run r_230822.081459

Note: Totals may not equal sum of components due to independent rounding. Net generation to grid represents gross generation minus losses from thermal efficiency and parasitic load.