

Table E1.gen. Electricity generation: World, Low Zero-carbon Technology Cost case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	733	737	379	195	106	69	55	-8.8%
Natural gas	6,700	6,634	6,481	6,453	6,811	6,880	6,772	0.0%
Coal	9,696	9,324	9,066	9,036	8,664	8,152	7,404	-1.0%
Nuclear	2,666	3,017	3,091	3,179	3,203	3,359	4,110	1.6%
Renewables	8,447	10,034	12,734	15,424	18,254	21,483	24,666	3.9%
Hydro	4,320	4,707	4,959	5,251	5,317	5,354	5,405	0.8%
Wind	1,967	2,335	3,337	4,233	5,450	6,420	6,970	4.6%
Geothermal	67	110	190	212	221	225	254	4.9%
Solar	1,421	2,247	3,577	5,052	6,595	8,696	11,153	7.6%
Other	672	635	671	676	670	788	884	1.0%
Net generation to grid	28,243	29,747	31,750	34,288	37,038	39,942	43,006	1.5%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531 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, Low Zero-carbon Technology Cost case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	158	159	74	33	15	5	4	-11.9%
Natural gas	2,260	2,007	1,702	1,508	1,569	1,488	1,300	-2.0%
Coal	934	838	371	318	305	235	169	-5.9%
Nuclear	889	924	915	840	714	599	800	-0.4%
Renewables	2,491	2,903	4,126	4,896	5,402	6,129	6,714	3.6%
Hydro	1,472	1,540	1,616	1,704	1,712	1,692	1,691	0.5%
Wind	611	710	1,314	1,637	1,866	2,137	2,218	4.7%
Geothermal	25	21	36	40	44	48	54	2.7%
Solar	260	526	1,066	1,436	1,716	2,172	2,662	8.7%
Other	122	104	94	80	65	81	89	-1.1%
Net generation to grid	6,732	6,831	7,189	7,595	8,005	8,456	8,986	1.0%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531 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, Low Zero-carbon Technology Cost case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	11	10	7	7	6	4	4	-3.8%
Natural gas	1,686	1,409	1,059	847	900	825	633	-3.4%
Coal	849	774	302	217	181	115	49	-9.7%
Nuclear	772	782	758	674	549	457	686	-0.4%
Renewables	1,003	1,365	2,439	3,040	3,364	3,843	4,177	5.2%
Hydro	276	299	290	283	279	259	257	-0.3%
Wind	440	513	1,071	1,334	1,419	1,525	1,475	4.4%
Geothermal	16	17	19	22	27	31	37	3.1%
Solar	205	468	992	1,338	1,579	1,954	2,326	9.1%
Other	67	68	66	62	61	75	82	0.7%
Net generation to grid	4,321	4,340	4,565	4,785	4,999	5,244	5,548	0.9%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531 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, Low Zero-carbon Technology Cost 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	115	130	128	123	127	1.6%
Coal	39	18	0	0	0	0	0	-100.0%
Nuclear	79	97	97	97	97	79	56	-1.2%
Renewables	452	470	503	544	623	719	812	2.1%
Hydro	399	417	430	430	430	430	430	0.3%
Wind	41	45	64	106	185	282	375	8.3%
Geothermal	0	0	0	0	0	0	0	0.0%
Solar	6	6	6	6	6	5	5	-0.5%
Other	5	3	4	2	2	2	2	-2.8%
Net generation to grid	656	674	715	770	847	921	995	1.5%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost 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	209	237	244	247	0.9%
Coal	9	9	18	19	19	19	19	2.8%
Nuclear	11	17	20	28	23	19	17	1.5%
Renewables	86	75	105	118	133	168	204	3.1%
Hydro	32	33	39	39	39	39	40	0.8%
Wind	35	26	36	36	36	36	36	0.1%
Geothermal	5	0	8	8	8	8	8	1.5%
Solar	12	14	22	35	50	85	121	8.7%
Other	2	1	1	1	0	0	0	-100.0%
Net generation to grid	342	344	361	386	417	449	487	1.3%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost 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	-15.7%
Natural gas	97	110	110	89	73	64	61	-1.7%
Coal	13	13	9	9	13	9	9	-1.3%
Nuclear	14	14	23	23	23	23	18	0.9%
Renewables	531	561	589	661	695	733	770	1.3%
Hydro	410	430	463	535	539	539	539	1.0%
Wind	62	83	85	93	133	171	207	4.4%
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	1	2	2	-9.4%
Net generation to grid	678	721	740	784	804	829	858	0.8%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost 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	233	233	233	233	0.4%
Coal	25	25	42	73	92	92	92	4.8%
Nuclear	12	13	18	18	21	22	23	2.3%
Renewables	419	432	490	533	588	666	750	2.1%
Hydro	354	361	395	417	425	425	425	0.7%
Wind	34	43	58	69	94	124	125	4.8%
Geothermal	5	4	9	9	9	9	9	2.5%
Solar	16	17	24	35	58	106	188	9.2%
Other	10	6	4	3	1	2	2	-5.3%
Net generation to grid	734	752	808	870	938	1,013	1,098	1.4%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	117	116	76	55	41	40	39	-3.8%
Natural gas	1,473	1,491	1,587	1,632	1,725	1,822	1,906	0.9%
Coal	802	741	550	533	519	571	617	-0.9%
Nuclear	995	1,153	1,069	1,062	1,055	1,036	1,001	0.0%
Renewables	1,963	2,179	2,463	2,829	3,187	3,404	3,705	2.3%
Hydro	915	982	986	1,056	1,057	1,060	1,060	0.5%
Wind	483	552	632	710	952	989	1,026	2.7%
Geothermal	23	39	52	52	52	52	59	3.4%
Solar	218	197	330	508	590	728	942	5.4%
Other	324	409	463	502	535	575	619	2.3%
Net generation to grid	5,350	5,681	5,745	6,110	6,527	6,874	7,268	1.1%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost 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	298	343	-1.3%
Nuclear	734	849	741	727	720	702	664	-0.4%
Renewables	1,649	1,863	2,137	2,464	2,825	3,018	3,278	2.5%
Hydro	621	697	706	753	754	754	754	0.7%
Wind	474	544	623	691	933	963	990	2.7%
Geothermal	22	38	52	51	51	51	57	3.4%
Solar	209	184	307	481	558	679	862	5.2%
Other	323	399	449	488	529	570	614	2.3%
Net generation to grid	3,758	4,048	4,007	4,250	4,546	4,744	4,989	1.0%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost 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	662	717	773	824	1.8%
Coal	184	187	148	122	121	121	121	-1.5%
Nuclear	217	229	234	234	234	234	227	0.2%
Renewables	220	210	208	237	230	228	228	0.1%
Hydro	211	197	191	211	211	211	211	0.0%
Wind	5	1	1	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	1,143	1,185	1,257	1,303	1,357	1,401	0.7%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	3	3	3	3	3	3	3	-0.3%
Natural gas	197	197	205	220	290	359	414	2.7%
Coal	117	107	133	152	152	152	152	0.9%
Nuclear	44	75	94	101	101	101	111	3.4%
Renewables	94	107	118	127	132	158	199	2.7%
Hydro	82	88	89	92	92	95	95	0.5%
Wind	4	7	7	9	9	15	26	7.3%
Geothermal	0	0	0	1	1	1	1	--
Solar	6	10	20	24	29	46	77	9.4%
Other	2	2	1	2	1	1	1	-1.5%
Net generation to grid	455	490	553	603	678	773	879	2.4%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	110	108	49	27	15	11	8	-8.8%
Natural gas	1,617	1,738	1,776	1,691	1,745	1,724	1,746	0.3%
Coal	7,746	7,560	7,944	7,959	7,571	7,099	6,395	-0.7%
Nuclear	746	859	1,011	1,160	1,300	1,588	2,174	3.9%
Renewables	3,725	4,550	5,571	6,999	8,881	10,886	12,781	4.5%
Hydro	1,745	1,949	2,101	2,196	2,253	2,299	2,338	1.0%
Wind	842	1,007	1,278	1,760	2,503	3,132	3,536	5.3%
Geothermal	13	44	67	74	78	78	78	6.7%
Solar	902	1,431	2,015	2,878	3,977	5,245	6,657	7.4%
Other	224	119	110	91	69	132	173	-0.9%
Net generation to grid	13,944	14,815	16,351	17,837	19,511	21,307	23,104	1.8%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost 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	-5.8%
Natural gas	363	383	383	339	301	279	279	-0.9%
Coal	291	283	167	178	178	178	178	-1.7%
Nuclear	78	115	139	139	139	139	139	2.1%
Renewables	210	203	238	265	315	349	370	2.0%
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	137	154	164	173	182	2.0%
Other	23	8	8	7	24	30	23	0.1%
Net generation to grid	971	1,014	942	930	938	951	972	0.0%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost 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	-5.0%
Natural gas	177	174	176	156	143	129	129	-1.1%
Coal	149	143	145	152	157	160	160	0.3%
Nuclear	201	228	228	228	228	218	214	0.2%
Renewables	50	53	79	111	140	178	203	5.1%
Hydro	3	4	4	5	5	5	5	1.1%
Wind	5	18	33	64	94	142	167	13.5%
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	15	6	6	-3.5%
Net generation to grid	586	606	631	650	669	687	709	0.7%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost 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	-12.4%
Natural gas	56	52	52	41	32	25	25	-2.8%
Coal	111	104	123	129	135	126	129	0.5%
Nuclear	0	0	0	0	0	0	0	0.0%
Renewables	127	149	167	198	231	279	306	3.2%
Hydro	36	41	45	45	45	45	45	0.8%
Wind	42	57	67	89	100	103	104	3.3%
Geothermal	9	9	9	9	9	9	9	0.0%
Solar	38	41	45	55	77	122	148	5.0%
Other	2	1	1	0	0	0	0	-10.0%
Net generation to grid	298	308	341	369	398	429	461	1.6%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost 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	-17.1%
Natural gas	302	357	389	456	626	648	671	2.9%
Coal	5,248	5,139	5,229	5,220	4,849	4,444	3,819	-1.1%
Nuclear	383	416	538	674	810	1,108	1,698	5.5%
Renewables	2,573	3,061	3,544	3,953	4,686	5,390	5,993	3.1%
Hydro	1,221	1,300	1,379	1,428	1,474	1,515	1,551	0.9%
Wind	653	724	872	1,083	1,499	1,948	2,101	4.3%
Geothermal	0	0	0	0	0	0	0	0.1%
Solar	575	983	1,251	1,410	1,685	1,831	2,197	4.9%
Other	123	54	42	31	28	96	143	0.5%
Net generation to grid	8,519	8,985	9,701	10,303	10,971	11,590	12,180	1.3%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost 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	73	72	72	72	72	-0.3%
Coal	1,240	1,252	1,470	1,361	1,326	1,165	1,084	-0.5%
Nuclear	41	47	52	67	70	70	70	1.9%
Renewables	395	591	898	1,604	2,286	3,242	4,113	8.7%
Hydro	154	195	197	199	201	203	205	1.0%
Wind	119	181	259	417	575	577	580	5.8%
Geothermal	0	0	0	0	0	0	0	0.0%
Solar	99	196	425	975	1,510	2,461	3,328	13.4%
Other	23	18	16	14	0	0	0	-100.0%
Net generation to grid	1,757	1,966	2,494	3,103	3,754	4,549	5,338	4.0%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost 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	571	571	571	-0.4%
Coal	706	638	811	920	927	1,025	1,025	1.3%
Nuclear	43	53	53	53	53	53	53	0.8%
Renewables	369	493	646	867	1,223	1,448	1,795	5.8%
Hydro	258	326	393	434	443	446	446	2.0%
Wind	15	19	38	94	197	304	507	13.5%
Geothermal	1	32	55	61	65	65	65	17.9%
Solar	58	84	131	258	515	632	775	9.7%
Other	37	32	28	22	2	1	1	-13.6%
Net generation to grid	1,812	1,937	2,241	2,482	2,782	3,101	3,445	2.3%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	348	354	179	80	35	13	3	-15.3%
Natural gas	1,349	1,398	1,416	1,622	1,772	1,846	1,820	1.1%
Coal	214	184	200	227	269	247	223	0.1%
Nuclear	37	81	96	116	135	135	135	4.8%
Renewables	269	403	574	701	784	1,064	1,466	6.2%
Hydro	188	235	256	295	295	303	317	1.9%
Wind	30	65	113	126	130	163	190	6.8%
Geothermal	6	6	34	47	47	47	63	8.6%
Solar	42	92	166	231	312	551	892	11.5%
Other	2	4	4	3	0	0	4	1.5%
Net generation to grid	2,217	2,420	2,466	2,746	2,994	3,305	3,648	1.8%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost case

billion kilowatthours

Fuel	2022	2025	2030	2035	2040	2045	2050	Average annual percentage change, 2022–2050
Liquid fuels	48	47	16	3	0	0	0	-16.5%
Natural gas	358	367	385	459	533	572	607	1.9%
Coal	214	184	200	227	269	247	223	0.2%
Nuclear	13	16	30	43	52	52	52	5.1%
Renewables	227	310	420	526	583	793	1,047	5.6%
Hydro	165	210	231	266	266	274	288	2.0%
Wind	28	47	76	85	89	120	147	6.1%
Geothermal	6	6	34	47	47	47	63	8.6%
Solar	26	44	76	125	181	352	545	11.5%
Other	2	3	3	2	0	0	3	0.9%
Net generation to grid	861	923	1,051	1,257	1,438	1,665	1,929	2.9%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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, Low Zero-carbon Technology Cost 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	1,031	1,163	1,239	1,274	1,213	0.7%
Coal	0	0	0	0	0	0	0	-6.2%
Nuclear	24	66	66	73	83	83	83	4.6%
Renewables	42	93	154	175	200	271	420	8.6%
Hydro	23	25	25	29	29	29	29	0.8%
Wind	3	19	37	40	40	42	42	10.4%
Geothermal	0	0	0	0	0	0	0	0.0%
Solar	16	48	91	105	131	199	347	11.5%
Other	0	0	0	0	0	0	1	--
Net generation to grid	1,357	1,497	1,415	1,489	1,556	1,640	1,718	0.8%

Data source: U.S. Energy Information Administration, World Energy Projection System (2023), run lz_230821.151531

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.