

Independent Statistics & Analysis U.S. Energy Information Administration

Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2020

The tables presented below will be incorporated into the Electricity Market Module chapter of the U.S. Energy Information Administration's (EIA) *Annual Energy Outlook 2020* (AEO2020) Assumptions document. Table 1 represents EIA's assessment of the cost to develop and install various generating technologies used in the electric power sector. Generating technologies typically found in end-use applications, such as combined heat and power or roof-top photovoltaics (PV), will be described elsewhere in the Assumptions document. The costs shown in Table 1, except as noted below, are the costs for a typical facility for each generating technology before adjusting for regional cost factors. Overnight costs exclude interest accrued during plant construction and development. Technologies with limited commercial experience may include a technological optimism factor to account for the tendency to underestimate the full engineering and development costs for new technologies during technology research and development.

All technologies demonstrate some degree of variability in cost, based on project size, location, and access to key infrastructure (such as grid interconnections, fuel supply, and transportation). For wind and solar PV, in particular, the cost favorability of the lowest-cost regions compound the underlying variability in regional cost and create a significant differential between the unadjusted costs and the capacity-weighted average national costs as observed from recent market experience. To account for this difference, Table 1 shows a weighted average cost for both wind and solar PV, based on the regional cost factors assumed for these technologies in AEO2020 and the actual regional distribution of the builds that occurred in 2018.

Table 2 shows a full listing of the overnight costs for each technology and <u>electricity region</u>, if the resource or technology is available to be built in the given region. The regional costs reflect the impact of locality adjustments, including one to address ambient air conditions for technologies that include a combustion turbine and one to adjust for additional costs associated with accessing remote wind resources. Temperature, humidity, and air pressure can affect the available capacity of a combustion turbine, and EIA's modeling addresses these possible effects through an additional cost multiplier by region. Unlike most other generation technologies where fuel can be transported to the plant, wind generators must be located in areas with the best wind resources. Sites that are located near existing transmission with access to a road network or are located on lower development cost lands are generally built up first, after which additional costs may be incurred to access sites with less favorable characteristics. EIA represents this possibility through a multiplier applied to the wind plant capital costs that increases as the best sites in a region are developed.

Table 1. Cost and performance characteristics of new central station electricity generating technologies

				Base	Techno-	Total			
	First	Sizo	Lead	overnight	logical	overnight	Variable	Fixed O&M	Heat rate7
Technology	year ¹	(MW)	(years)	(2019 \$/kW)	factor ³	(2019 \$/kW)	\$/MWh)	(20193) kW-yr)	(Btu/kWh)
Ultra-supercritical coal (USC)	2023	650	4	3,661	1.00	3,661	4.48	40.41	8,638
USC with 30% carbon capture and									
sequestration (CCS)	2023	650	4	4,539	1.03	4,652	7.05	54.07	9,751
USC with 90% CCS	2023	650	4	5,851	1.03	5,997	10.93	59.29	12,507
Combined-cycle—single shaft	2022	418	3	1,079	1.00	1,079	2.54	14.04	6,431
Combined-cycle—multi shaft	2022	1,083	3	954	1.00	954	1.86	12.15	6,370
Combined-cycle with 90% CCS	2022	377	3	2,470	1.04	2,569	5.82	27.48	7,124
Internal combustion engine	2021	21	2	1,802	1.00	1,802	5.67	35.01	8,295
Combustion turbine—									
aeroderivative ⁸	2021	105	2	1,170	1.00	1,170	4.68	16.23	9,124
Combustion turbine—industrial									
frame	2021	237	2	710	1.00	710	4.48	6.97	9 <i>,</i> 905
Fuel cells	2022	10	3	6,671	1.10	7,339	0.59	30.65	6,469
Advanced nuclear	2025	2,156	6	6,016	1.05	6,317	2.36	121.13	10,461
Distributed generation—base	2022	2	3	1,555	1.00	1,555	8.57	19.28	8,946
Distributed generation—peak	2021	1	2	1,868	1.00	1,868	8.57	19.28	9,934
Battery storage	2020	50	1	1,383	1.00	1,383	0.00	24.70	NA
Biomass	2023	50	4	4,080	1.01	4,104	4.81	125.19	13,500
Geothermal ^{9,10}	2023	50	4	2,680	1.00	2,680	1.16	113.29	9,156
Municipal solid waste—landfill									
gas	2022	36	3	1,557	1.00	1,557	6.17	20.02	8,513
Conventional hydropower ¹⁰	2023	100	4	2,752	1.00	2,752	1.39	41.63	NA
Wind⁵	2022	200	3	1,319	1.00	1,319	0.00	26.22	NA
Wind offshore ⁹	2023	400	4	4,356	1.25	5,446	0.00	109.54	NA
Solar thermal ⁹	2022	115	3	7,191	1.00	7,191	0.00	85.03	NA
Solar photovoltaic —tracking ^{5,9,11}	2021	150	2	1,331	1.00	1,331	0.00	15.19	NA

 $^{\rm 1}$ Represents the first year that a new unit could become operational.

² Base cost includes project contingency costs.

³ The technological optimism factor is applied to the first four units of a new, unproven design; it reflects the demonstrated tendency to underestimate actual costs for a first-of-a-kind unit.

⁴ Overnight capital cost includes contingency factors and excludes regional multipliers (except as noted for wind and solar PV) and learning effects. Interest charges are also excluded. The capital costs represent current costs for plants that would come online in 2020.

⁵ Wind and solar PV technologies' total overnight cost in the table shows the average input value across all 25 electricity market regions, as weighted by the respective capacity of that type installed during 2018 in each region to account for the substantial regional variation in wind and solar costs (as shown in Table 4). The input value used for onshore wind in AEO2020 was \$1,260 per kilowatt (kW) and for solar PV with tracking it was \$1,307/kW, which represents the cost of building a plant excluding regional factors. Region-specific factors contributing to the substantial regional variation in cost include differences in typical project size across regions, accessibility of resources, and variation in labor and other construction costs through the country.

⁶ O&M = Operations and maintenance.

⁷ The nuclear average heat rate is the weighted average tested heat rate for nuclear units as reported on the Form EIA-860, *Annual Electric Generator Report*. No heat rate is reported for battery storage because it is not a primary conversion technology; conversion losses are accounted for when the electricity is first generated; electricity-to-storage losses are accounted for through the additional demand for electricity required to meet load. For hydropower, wind, solar, and geothermal technologies, no heat rate is reported because the power is generated without fuel combustion and no set British thermal unit conversion factors exist. The model calculates the <u>average heat rate</u> for fossil generation in each year to report primary energy consumption displaced for these resources.

⁸ Combustion turbine aeroderivative units can be built by the model before 2021, if necessary, to meet a region's reserve margin.

⁹ Capital costs are shown before investment tax credits are applied.

¹⁰ Because geothermal and hydropower cost and performance characteristics are specific for each site, the table entries show the cost of the least expensive plant that could be built in the Northwest region for hydro and Great Basin region for geothermal, where most of the proposed sites are located.

¹¹ Costs and capacities are expressed in terms of net AC (alternating current) power available to the grid for the installed capacity.

Sources: Input costs are primarily based on a report provided by external consultants: Sargent & Lundy, December 2019. Hydropower site costs for non-powered dams were most recently updated for AEO2018 using data from Oak Ridge National Lab

Table 2. Total overnight capital costs of new electricity generating technologies by region

2019 dollars per kilowatt

	1	2	3	4	5	6	7	8	9	10	11	12	13
Technology	TRE	FRCC	MISW	MISC	MISE	MISS	ISNE	NYCW	NYUP	PJME	PJMW	PJMC	PJMD
Ultra-supercritical coal (USC)	3,402	3,523	3,892	3,923	3,973	3,521	4,242	NA	4,146	4,280	3,651	4,601	3,940
USC with 30% CCS	4,362	4,499	4,906	4,959	5,004	4,506	5,338	NA	5,231	5,372	4,651	5,710	5,000
USC with 90% CCS	5,660	5,826	6,273	6,395	6,407	5,860	6,785	NA	6,611	6,796	5,975	7,236	6,350
CC—single shaft	974	1,011	1,125	1,119	1,147	1,003	1,294	1,717	1,298	1,296	1,075	1,299	1,237
CC—multi shaft	848	886	1,003	1,004	1,030	880	1,131	1,549	1,112	1,137	931	1,192	1,051
CC with 90% CCS	2,409	2,466	2,614	2,604	2,644	2,454	2,728	3,090	2,666	2,706	2,488	2,820	2,592
Internal combustion engine	1,695	1,744	1,871	1,924	1,903	1,756	1,972	2,472	1,898	1,973	1,768	2,150	1,836
CT—aeroderivative	1,035	1,087	1,242	1,227	1,264	1,078	1,316	1,685	1,270	1,309	1,122	1,438	1,191
CT—industrial frame	626	658	754	746	769	653	801	1,034	772	797	680	878	723
Fuel cells	7,042	7,191	7,531	7,793	7,653	7,272	7,939	9,346	7,617	7,871	7,251	8,392	7,474
Advanced nuclear	5,963	6,120	6,494	7,008	6,766	6,290	7,156	NA	6,676	6,992	6,180	7,688	6,432
Dist. generation—base	1,384	1,425	1,536	1,597	1,581	1,390	1,778	2,540	1,799	1,862	1,596	1,597	1,358
Dist. Generation—peak	1,795	1,864	1,847	1,905	1,852	1,818	1,940	2,631	1,915	2,055	1,894	1,899	1,767
Battery storage	1,383	1,385	1,363	1,431	1,386	1,415	1,425	1,420	1,388	1,392	1,379	1,397	1,392
Biomass	3,808	3,944	4,292	4,371	4,385	3,944	4,873	6,614	4,888	4,974	4,182	4,982	4,766
Geothermal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MSW—landfill gas	1,467	1,509	1,613	1,662	1,642	1,520	1,702	2,120	1,637	1,701	1,528	1,850	1,587
Conventional hydropower	NA	4,905	1,609	NA	NA	NA	1,808	NA	3,699	3,843	3,530	3,349	3,399
Wind	1,231	NA	1,260	1,259	1,509	1,260	1,670	NA	2,037	1,670	1,260	1,668	1,739
Wind offshore	5,319	5,446	5,446	NA	6,521	NA	5,446	5,478	6,643	5,446	5,446	7,210	5,672
Solar thermal	6,937	7,049	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Solar PV— tracking	1,289	1,265	1,318	1,355	1,341	1,275	1,354	1,593	1,341	1,381	1,304	1,423	1,301
		45		47	40	40	20	24				25	
Technology	14 SRCA	15 SRSE	16 SRCE	17 SPPS	18 SPPC	19 SPPN	20 SRSG	21 CANO	22 CASO	23 NW/PP	24 RMRG	25 BASN	
Technology	14 SRCA	15 SRSE	16 SRCE	17 SPPS	18 SPPC	19 SPPN	20 SRSG	21 CANO	22 CASO	23 NWPP	24 RMRG	25 BASN	
Technology Ultra-supercritical coal (USC)	14 SRCA 3,522	15 SRSE 3,615	16 SRCE 3,593	17 SPPS 3,546	18 SPPC 3,768	19 SPPN 3,586	20 SRSG 3,737	21 CANO NA	22 CASO NA	23 NWPP 3,959	24 RMRG 3,701	25 BASN 3,861	
Technology Ultra-supercritical coal (USC) USC with 30% CCS	14 SRCA 3,522 4,509	15 SRSE 3,615 4,610	16 SRCE 3,593 4,578	17 SPPS 3,546 4,522	18 SPPC 3,768 4,772	19 SPPN 3,586 4,564	20 SRSG 3,737 4,761	21 CANO NA NA	22 CASO NA NA	23 NWPP 3,959 5,004	24 RMRG 3,701 4,711	25 BASN 3,861 4,888	
Technology Ultra-supercritical coal (USC) USC with 30% CCS USC with 90% CCS	14 SRCA 3,522 4,509 5,871	15 SRSE 3,615 4,610 5,976 1,002	16 SRCE 3,593 4,578 5,951	17 SPPS 3,546 4,522 5,839 1,001	18 SPPC 3,768 4,772 6,136 1,063	19 SPPN 3,586 4,564 5,881	20 SRSG 3,737 4,761 6,117	21 CANO NA NA NA	22 CASO NA NA NA	23 NWPP 3,959 5,004 6,418	24 RMRG 3,701 4,711 6,027	25 BASN 3,861 4,888 6,306	
Technology Ultra-supercritical coal (USC) USC with 30% CCS USC with 90% CCS CC—single shaft	14 SRCA 3,522 4,509 5,871 991	15 SRSE 3,615 4,610 5,976 1,003	16 SRCE 3,593 4,578 5,951 1,023	17 SPPS 3,546 4,522 5,839 1,001	18 SPPC 3,768 4,772 6,136 1,063	19 SPPN 3,586 4,564 5,881 992	20 SRSG 3,737 4,761 6,117 975	21 CANO NA NA NA 1,451	22 CASO NA NA NA 1,374	23 NWPP 3,959 5,004 6,418 1,135	24 RMRG 3,701 4,711 6,027 919	25 BASN 3,861 4,888 6,306 994	
Technology Ultra-supercritical coal (USC) USC with 30% CCS USC with 90% CCS CC—single shaft CC—multi shaft	14 SRCA 3,522 4,509 5,871 991 869	15 SRSE 3,615 4,610 5,976 1,003 883 2,425	16 SRCE 3,593 4,578 5,951 1,023 901	17 SPPS 3,546 4,522 5,839 1,001 879	18 SPPC 3,768 4,772 6,136 1,063 944	19 SPPN 3,586 4,564 5,881 992 872 872	20 SRSG 3,737 4,761 6,117 975 839	21 CANO NA NA 1,451 1,278	22 CASO NA NA 1,374 1,202	23 NWPP 3,959 5,004 6,418 1,135 985	24 RMRG 3,701 4,711 6,027 919 790 2,070	25 BASN 3,861 4,888 6,306 994 887	
Technology Ultra-supercritical coal (USC) USC with 30% CCS USC with 90% CCS CC—single shaft CC—multi shaft CC with 90% CCS	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,795	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,797	21 CANO NA NA 1,451 1,278 2,802 2,157	22 CASO NA NA 1,374 1,202 2,708	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,004	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764	25 BASN 3,861 4,888 6,306 994 887 2,335	
Technology Ultra-supercritical coal (USC) USC with 30% CCS USC with 90% CCS CC—single shaft CC—multi shaft CC with 90% CCS Internal combustion engine	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787	21 CANO NA NA 1,451 1,278 2,802 2,157	22 CASO NA NA 1,374 1,202 2,708 2,098	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,002	
Technology Ultra-supercritical coal (USC) USC with 30% CCS USC with 90% CCS CC—single shaft CC—multi shaft CC with 90% CCS Internal combustion engine CT—aeroderivative	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,785	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 700	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981	21 CANO NA NA 1,451 1,278 2,802 2,157 1,406	22 CASO NA NA 1,374 1,202 2,708 2,098 1,324	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082	
Technology Ultra-supercritical coal (USC) USC with 30% CCS USC with 90% CCS CC—single shaft CC—multi shaft CC with 90% CCS Internal combustion engine CT—aeroderivative CT— industrial frame	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072 649 2,325	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,081 656	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109 673	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080 654	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 702	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087 659	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981 594	21 CANO NA NA 1,451 1,278 2,802 2,157 1,406 860 2,152	22 CASO NA NA 1,374 1,202 2,708 2,098 1,324 808	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212 737	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950 575	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082 658	
Technology Ultra-supercritical coal (USC) USC with 30% CCS USC with 90% CCS CC—single shaft CC—multi shaft CC with 90% CCS Internal combustion engine CT—aeroderivative CT— industrial frame Fuel cells	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072 649 7,325 C 374	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,081 656 7,372	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109 673 7,368	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080 654 7,191	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 702 7,492	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087 659 7,256	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981 594 7,357	21 CANO NA NA 1,451 1,278 2,802 2,157 1,406 860 8,60 8,480	22 CASO NA NA 1,374 1,202 2,708 2,098 1,324 808 8,305	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212 7,37 7,705	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950 575 7,216	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082 658 7,686	
Technology Ultra-supercritical coal (USC) USC with 30% CCS USC with 90% CCS CC—single shaft CC—multi shaft CC with 90% CCS Internal combustion engine CT—aeroderivative CT— industrial frame Fuel cells Advanced nuclear	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072 649 7,325 6,371 1,352	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,081 656 7,372 6,382	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109 673 7,368 6,438	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080 654 7,191 6,116 1,460	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 702 7,492 6,468	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087 659 7,256 6,114	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981 594 7,357 6,342	21 CANO NA NA 1,451 1,278 2,802 2,157 1,406 860 8,480 NA	22 CASO NA NA 1,374 1,202 2,708 2,098 1,324 808 8,305 NA	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212 737 7,705 6,865	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950 575 7,216 6,143	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082 658 7,686 6,872	
Technology Ultra-supercritical coal (USC) USC with 30% CCS USC with 90% CCS CC—single shaft CC—multi shaft CC with 90% CCS Internal combustion engine CT—aeroderivative CT— industrial frame Fuel cells Advanced nuclear Dist. Generation—base	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072 649 7,325 6,371 1,358 1,267	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,081 656 7,372 6,382 1,418	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109 673 7,368 6,438 1,409	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080 654 7,191 6,116 1,460 1,052	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 702 7,492 6,468 1,515	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087 659 7,256 6,114 1,521	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981 594 7,357 6,342 1,555	21 CANO NA NA 1,451 1,278 2,802 2,157 1,406 860 8,480 NA 1,933 2,445	22 CASO NA NA 1,374 1,202 2,708 2,098 1,324 808 8,305 NA 1,933 2,445	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212 737 7,705 6,865 1,569	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950 575 7,216 6,143 1,638	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082 658 7,686 6,872 1,569	
Technology Ultra-supercritical coal (USC) USC with 30% CCS USC with 90% CCS CC—single shaft CC—multi shaft CC with 90% CCS Internal combustion engine CT—aeroderivative CT— industrial frame Fuel cells Advanced nuclear Dist. Generation—base Dist. Generation—peak	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072 649 7,325 6,371 1,358 1,767	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,081 656 7,372 6,382 1,418 1,868	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109 673 7,368 6,438 1,409 1,786	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080 654 7,191 6,116 1,460 1,850	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 702 7,492 6,468 1,515 1,888 1,205	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087 659 7,256 6,114 1,521 1,848	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981 594 7,357 6,342 1,555 2,157	21 CANO NA NA 1,451 1,278 2,802 2,157 1,406 860 8,480 NA 1,933 2,145	22 CASO NA NA 1,374 1,202 2,708 2,098 1,324 808 8,305 NA 1,933 2,145	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212 737 7,705 6,865 1,569 1,569 1,956	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950 575 7,216 6,143 1,638 2,246	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082 658 7,686 6,872 1,569 1,569 1,956	
Technology Ultra-supercritical coal (USC) USC with 30% CCS USC with 90% CCS CC—single shaft CC—multi shaft CC with 90% CCS Internal combustion engine CT—aeroderivative CT—industrial frame Fuel cells Advanced nuclear Dist. Generation—base Dist. Generation—peak Battery storage	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072 649 7,325 6,371 1,358 1,767 1,428 2,952	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,081 656 7,372 6,382 1,418 1,868 1,408	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109 673 7,368 6,438 1,409 1,786 1,419	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080 654 7,191 6,116 1,460 1,850 1,376	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 702 7,492 6,468 1,515 1,888 1,385	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087 659 7,256 6,114 1,521 1,848 1,368	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981 594 7,357 6,342 1,555 2,157 1,400	21 CANO NA NA NA 1,451 1,278 2,802 2,157 1,406 860 8,480 NA 1,933 2,145 1,440	22 CASO NA NA 1,374 1,202 2,708 2,098 1,324 808 8,305 NA 1,933 2,145 1,441	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212 737 7,705 6,865 1,569 1,956 1,956 1,416	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950 575 7,216 6,143 1,638 2,246 1,371	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082 658 7,686 6,872 1,569 1,956 1,956 1,426	
Technology Ultra-supercritical coal (USC) USC with 30% CCS USC with 90% CCS CC—single shaft CC—multi shaft CC with 90% CCS Internal combustion engine CT—aeroderivative CT—industrial frame Fuel cells Advanced nuclear Dist. Generation—base Dist. Generation—peak Battery storage Biomass	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072 649 7,325 6,371 1,358 1,767 1,428 3,959	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,081 656 7,372 6,382 1,418 1,868 1,408 4,033	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109 673 7,368 6,438 1,409 1,786 1,419 4,009	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080 654 7,191 6,116 1,460 1,850 1,376 3,962	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 702 7,492 6,468 1,515 1,888 1,385 4,209	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087 659 7,256 6,114 1,521 1,848 1,368 4,045	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981 594 7,357 6,342 1,555 2,157 1,400 4,333	21 CANO NA NA 1,451 1,278 2,802 2,157 1,406 860 8,480 NA 1,933 2,145 1,440 5,616	22 CASO NA NA 1,374 1,202 2,708 2,098 1,324 808 8,305 NA 1,933 2,145 1,441 5,389	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212 737 7,705 6,865 1,569 1,956 1,416 4,480	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950 575 7,216 6,143 1,638 2,246 1,371 4,292	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082 658 7,686 6,872 1,569 1,956 1,426 4,292	
TechnologyUltra-supercritical coal (USC)USC with 30% CCSUSC with 90% CCSCC—single shaftCC—multi shaftCC with 90% CCSInternal combustion engineCT—aeroderivativeCT—industrial frameFuel cellsAdvanced nuclearDist. Generation—baseDist. Generation—peakBattery storageBiomassGeothermal	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072 649 7,325 6,371 1,358 1,767 1,428 3,959 NA	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,081 656 7,372 6,382 1,418 1,868 1,408 4,033 NA	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109 673 7,368 6,438 1,409 1,786 1,419 4,009 NA	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080 654 7,191 6,116 1,460 1,850 1,376 3,962 NA	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 702 7,492 6,468 1,515 1,888 1,385 4,209 NA	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087 659 7,256 6,114 1,521 1,848 1,368 4,045 NA	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981 594 7,357 6,342 1,555 2,157 1,400 4,333 2,817	21 CANO NA NA 1,451 1,278 2,802 2,157 1,406 860 8,480 NA 1,933 2,145 1,440 5,616 2,794	22 CASO NA NA 1,374 1,202 2,708 2,098 1,324 808 8,305 NA 1,933 2,145 1,441 5,389 2,262	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212 737 7,705 6,865 1,569 1,956 1,416 4,480 2,734	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950 575 7,216 6,143 1,638 2,246 1,371 4,292 NA	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082 658 7,686 6,872 1,569 1,956 1,426 4,292 2,680	
TechnologyUltra-supercritical coal (USC)USC with 30% CCSUSC with 90% CCSCC—single shaftCC—multi shaftCC with 90% CCSInternal combustion engineCT—aeroderivativeCT—industrial frameFuel cellsAdvanced nuclearDist. Generation—peakBattery storageBiomassGeothermalMSW—landfill gas	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072 649 7,325 6,371 1,358 1,767 1,428 3,959 NA 1,529	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,081 656 7,372 6,382 1,418 1,868 1,408 4,033 NA 1,545	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109 673 7,368 6,438 1,409 1,786 1,419 4,009 NA 1,545	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080 654 7,191 6,116 1,460 1,850 1,376 3,962 NA 1,515	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 702 7,492 6,468 1,515 1,888 1,385 4,209 NA 1,595	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087 659 7,256 6,114 1,521 1,848 1,368 4,045 NA 1,529	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981 594 7,357 6,342 1,555 2,157 1,400 4,333 2,817 1,545	21 CANO NA NA NA 1,451 1,278 2,802 2,157 1,406 860 8,480 NA 1,933 2,145 1,440 5,616 2,794 1,859	22 CASO NA NA NA 1,374 1,202 2,708 2,098 1,324 808 8,305 NA 1,933 2,145 1,441 5,389 2,262 1,809	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212 737 7,705 6,865 1,569 1,956 1,416 4,480 2,734 1,645	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950 575 7,216 6,143 1,638 2,246 1,371 4,292 NA 1,525	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082 658 7,686 6,872 1,569 1,956 1,426 4,292 2,680 1,632	
TechnologyUltra-supercritical coal (USC)USC with 30% CCSUSC with 90% CCSCC—single shaftCC—multi shaftCC with 90% CCSInternal combustion engineCT—aeroderivativeCT— industrial frameFuel cellsAdvanced nuclearDist. Generation—baseDist. Generation—peakBattery storageBiomassGeothermalMSW—landfill gasConventional hydropower	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072 649 7,325 6,371 1,358 1,767 1,428 3,959 NA 1,529 1,892	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,081 656 7,372 6,382 1,418 1,868 1,408 4,033 NA 1,545 4,105	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109 673 7,368 6,438 1,409 1,786 1,419 4,009 NA 1,545 1,297	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080 654 7,191 6,116 1,460 1,850 1,376 3,962 NA 1,515 NA	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 702 7,492 6,468 1,515 1,888 1,385 4,209 NA 1,595 1,711	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087 659 7,256 6,114 1,521 1,848 1,368 4,045 NA 1,529 1,971	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981 594 7,357 6,342 1,555 2,157 1,400 4,333 2,817 1,545 3,262	21 CANO NA NA NA 1,451 1,278 2,802 2,157 1,406 860 8,480 NA 1,933 2,145 1,440 5,616 2,794 1,859 3,323	22 CASO NA NA NA 1,374 1,202 2,708 2,098 1,324 808 8,305 NA 1,933 2,145 1,441 5,389 2,262 1,809 4,478	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212 737 7,705 6,865 1,569 1,956 1,569 1,956 1,416 4,480 2,734 1,645 2,752	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950 575 7,216 6,143 1,638 2,246 1,371 4,292 NA 1,525 3,286	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082 658 7,686 6,872 1,569 1,956 1,426 4,292 2,680 1,632 3,591	
TechnologyUltra-supercritical coal (USC)USC with 30% CCSUSC with 90% CCSCC—single shaftCC—multi shaftCC with 90% CCSInternal combustion engineCT—aeroderivativeCT—industrial frameFuel cellsAdvanced nuclearDist. Generation—baseDist. Generation—peakBattery storageBiomassGeothermalMSW—landfill gasConventional hydropowerWind	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072 649 7,325 6,371 1,358 1,767 1,428 3,959 NA 1,529 1,892 1,503	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,081 656 7,372 6,382 1,418 1,868 1,408 4,033 NA 1,545 4,105 1,703	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109 673 7,368 6,438 1,409 1,786 1,419 4,009 NA 1,545 1,297 1,260	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080 654 7,191 6,116 1,460 1,850 1,376 3,962 NA 1,515 NA 1,260	18 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 702 7,492 6,468 1,515 1,888 1,385 4,209 NA 1,595 1,711 1,260	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087 659 7,256 6,114 1,521 1,848 1,368 4,045 NA 1,529 1,971 1,260	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981 594 7,357 6,342 1,555 2,157 1,400 4,333 2,817 1,545 3,262 1,260	21 CANO NA NA NA 1,451 1,278 2,802 2,157 1,406 860 8,480 NA 1,933 2,145 1,440 5,616 2,794 1,859 3,323 2,782	22 CASO NA NA NA 1,374 1,202 2,708 2,098 1,324 808 8,305 NA 1,933 2,145 1,441 5,389 2,262 1,809 4,478 2,185	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212 737 7,705 6,865 1,569 1,956 1,416 4,480 2,734 1,645 2,752 1,670	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950 575 7,216 6,143 1,638 2,246 1,371 4,292 NA 1,525 3,286 1,260	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082 658 7,686 6,872 1,569 1,956 1,426 4,292 2,680 1,632 3,591 1,260	
TechnologyUltra-supercritical coal (USC)USC with 30% CCSUSC with 90% CCSCC—single shaftCC—multi shaftCC with 90% CCSInternal combustion engineCT—aeroderivativeCT—industrial frameFuel cellsAdvanced nuclearDist. Generation—baseDist. Generation—peakBattery storageBiomassGeothermalMSW—landfill gasConventional hydropowerWindWind offshore	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072 649 7,325 6,371 1,358 1,767 1,428 3,959 NA 1,529 1,892 1,503 4,901	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,081 656 7,372 6,382 1,418 1,868 1,408 4,033 NA 1,545 4,105 1,703 NA	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109 673 7,368 6,438 1,409 1,786 1,419 4,009 NA 1,545 1,297 1,260 NA	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080 654 7,191 6,116 1,460 1,850 1,376 3,962 NA 1,515 NA 1,260 NA	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 702 7,492 6,468 1,515 1,888 1,385 4,209 NA 1,595 1,711 1,260 NA	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087 659 7,256 6,114 1,521 1,848 1,368 4,045 NA 1,529 1,971 1,260 NA	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981 594 7,357 6,342 1,555 2,157 1,400 4,333 2,817 1,545 3,262 1,260 NA	21 CANO NA NA NA 1,451 1,278 2,802 2,157 1,406 860 8,480 NA 1,933 2,145 1,440 5,616 2,794 1,859 3,323 2,782 7,126	22 CASO NA NA NA 1,374 1,202 2,708 2,098 1,324 808 8,305 NA 1,933 2,145 1,441 5,389 2,262 1,809 4,478 2,185 5,446	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212 737 7,705 6,865 1,569 1,956 1,416 4,480 2,734 1,645 2,752 1,670 5,446	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950 575 7,216 6,143 1,638 2,246 1,371 4,292 NA 1,525 3,286 1,260 NA	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082 658 7,686 6,872 1,569 1,956 1,426 4,292 2,680 1,632 3,591 1,260 NA	
TechnologyUltra-supercritical coal (USC)USC with 30% CCSUSC with 90% CCSCC—single shaftCC—multi shaftCC with 90% CCSInternal combustion engineCT—aeroderivativeCT—industrial frameFuel cellsAdvanced nuclearDist. Generation—baseDist. Generation—peakBattery storageBiomassGeothermalMSW—landfill gasConventional hydropowerWindWind offshoreSolar thermal	14 SRCA 3,522 4,509 5,871 991 869 2,424 1,765 1,072 649 7,325 6,371 1,358 1,767 1,428 3,959 NA 1,529 1,892 1,503 4,901 NA	15 SRSE 3,615 4,610 5,976 1,003 883 2,425 1,785 1,081 656 7,372 6,382 1,418 1,868 1,408 4,033 NA 1,545 4,105 1,703 NA NA	16 SRCE 3,593 4,578 5,951 1,023 901 2,477 1,785 1,109 673 7,368 6,438 1,409 1,786 1,419 4,009 NA 1,545 1,297 1,260 NA NA	17 SPPS 3,546 4,522 5,839 1,001 879 2,427 1,752 1,080 654 7,191 6,116 1,460 1,850 1,376 3,962 NA 1,515 NA 1,260 NA 7,007	18 SPPC 3,768 4,772 6,136 1,063 944 2,508 1,847 1,156 702 7,492 6,468 1,515 1,888 1,385 4,209 NA 1,595 1,711 1,260 NA 7,279	19 SPPN 3,586 4,564 5,881 992 872 2,390 1,770 1,087 659 7,256 6,114 1,521 1,848 1,368 4,045 NA 1,529 1,971 1,260 NA 6,936	20 SRSG 3,737 4,761 6,117 975 839 2,211 1,787 981 594 7,357 6,342 1,555 2,157 1,400 4,333 2,817 1,545 3,262 1,260 NA 7,268	21 CANO NA NA NA 1,451 1,278 2,802 2,157 1,406 860 8,480 NA 1,933 2,145 1,440 5,616 2,794 1,859 3,323 2,782 7,126 8,614	22 CASO NA NA NA 1,374 1,202 2,708 2,098 1,324 808 8,305 NA 1,933 2,145 1,441 5,389 2,262 1,809 4,478 2,185 5,446 8,430	23 NWPP 3,959 5,004 6,418 1,135 985 2,558 1,904 1,212 737 7,705 6,865 1,569 1,956 1,416 4,480 2,734 1,645 2,752 1,670 5,446 7,736	24 RMRG 3,701 4,711 6,027 919 790 2,079 1,764 950 575 7,216 6,143 1,638 2,246 1,371 4,292 NA 1,525 3,286 1,260 NA 6,984	25 BASN 3,861 4,888 6,306 994 887 2,335 1,888 1,082 658 7,686 6,872 1,569 1,956 1,426 4,292 2,680 1,632 3,591 1,260 NA 7,751	

Notes: Costs include contingency factors and regional cost and ambient conditions multipliers. Interest charges are excluded. The costs are shown before investment tax credits are applied.

NA = not available; plant type cannot be built in the region because of a lack of resources, sites, or specific state legislation.

USC = ultra-supercritical, CCS = carbon capture and sequestration, CC = combined cycle, CT = combustion turbine, PV = photovoltaic, MSW = municipal solid waste Electricity Market Module region map

Source: U.S. Energy Information Administration, Office of Electricity, Coal, Nuclear and Renewables Analysis

Updated March 2020: EIA changed regional costs for solar thermal to NA in regions where resource quality may be insufficient to support significant development of solar thermal power.