APPENDIX M:

AIR QUALITY AND CLIMATE CHANGE TECHNICAL INFORMATION AND ANALYSIS

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AIR QUALITY AND CLIMATE CHANGE TECHNICAL INFORMATION AND ANALYSIS

This appendix provides a description of the analysis used to evaluate the impacts of the alternatives considered in the Glen Canyon Dam Long-Term Experimental and Management Plan (LTEMP) Draft Environmental Impact Statement (DEIS). Glen Canyon Dam hydropower generation does not generate air emissions. However, dam operations can affect air emissions and ambient air quality over the 11-state Western Interconnection, comprising Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, because hydropower generation offsets generation from other non-hydropower generating facilities in the SLCA/IP and in the Western Interconnection via the spot market. Differences among alternatives in the amount of Glen Canyon Dam generation at peak demand hours could affect regional air emissions, through differences in the technology mix of compensating generating facilities within SLCA/IP and, if SLCA/IP generation is insufficient to meet Western's long-term firm contract obligations, through generation from combustion sources in the greater Western Interconnection accessed via the spot market..

Air quality issues within the study area include visibility degradation in Federal Class I areas. Coal, natural gas, and oil units emit SO_2 and NO_x, which are precursors to sulfate and nitrate aerosols, respectively. These aerosols play an important role in visibility degradation by contributing to haze. Among anthropogenic sources, sulfate is a primary contributor to regional haze in the Grand Canyon, and nitrate is a minor contributor. Effects on visibility are analyzed through a comparison of regional SO_2 and NO_x emissions under the various alternatives.

Differences among alternatives in the amount and timing of Glen Canyon Dam generation directly affect the generation needed from coal, natural gas, or oil units within the 11-state Western Interconnection region of which the SLCA/IP system is a part, from the wholesale power market. As described in Section M.2, changes in generation from facilities within this interconnected system under various LTEMP alternatives result in small changes in total emissions due to similarly small differences in emissions from the contributing facilities.

Effects on visibility were analyzed through a comparison of SO_2 and NO_x emissions under the various alternatives. SO_2 and NO_x are also criteria air pollutants with limits on ambient concentrations under the National Ambient Air Quality Standards (NAAQS). Alternatives were compared on the basis of total emissions of these two pollutants from the contributing generation facilities in the interconnected system.

Electricity generation of combustion facilities in the system produces CO_2 and other greenhouse gases (GHGs). LTEMP alternatives can affect GHG emissions through changes in Glen Canyon Dam operations and related changes in GHG emissions of interconnected combustion facilities, as for SO_2 and NO_x. For the purpose of this analysis, the principal GHG of concern is CO_2, which accounts for over 99% of GHG emissions related to power generation.

However, facility- or technology-specific GHG emission factors also consider other GHGs, such as methane (CH_4) and nitrous oxide (N_2O), which may be emitted during facility operations.

M.1 ANALYSIS METHODS

To compute total air emissions under the LTEMP alternatives, emissions were summed from all generating facilities in the SLCA/IP system. This analysis was tiered off the power systems analysis (Section 4.13 of the DEIS and Appendix K), which estimated electrical power generation for the same facilities under each of the alternatives, including base operations and experimental flows such as high-flow experiments (HFEs), trout management flows, and low summer flows. Emissions were estimated using emission factor and corresponding generation level along with emission control efficiency for facilities equipped with a control system. Emission factors (either lb/MWh for power output or lb/MMBtu for heat input) were taken from standard references (EIA 2013; EPA 2014). Generation levels (either MWh/yr or MMBtu/yr) were the estimated electricity generation of each facility and the electricity traded on the spot market under each alternative by calendar year, which were obtained from the AURORA model outputs described in Appendix K. Emissions were then estimated by multiplying emission factors by electrical power generation. Emission controls were reflected in the emission factors used. Table M-1 presents emission factors used for SO_2, NO_x, and GHGs by plant for individual plants in the SLCA/IP system and the spot market. Table M-2 presents annual-average power generation for the same plants and for the spot market.

M.1.1 System Power Generation

Table M-1 presents emission factors by power generation type for (1) specific existing powerplants, (2) specific generating stations with multiple generating units under long-term contract, (3) power generation under long-term contract where no generating units are specified, and (4) future plants needed to provide additional capacity employing advanced gas technologies. For specific powerplants in the SLCA/IP system, pollutant emission factors (in lb/MWh) available in the *Emissions and Generation Resource Integrated Database* (eGRID)[1] with year 2010 data (EPA 2014) were used to estimate air emissions (Table M-1).

For advanced natural gas-fired simple cycle and combined cycle generating units to be built in the future, emission factors for advanced combustion turbine (ACT) and advanced generation natural gas combined cycle (AG-NGCC) in EIA (2013) were used with the following values: 0.001 lb/MMBtu for SO_2 for both simple cycle (0.0098 lb/MWh) and combined cycle (0.0064 lb/MWh); 0.03 lb/MMBtu (0.29 lb/MWh) for simple cycle and 0.0075 lb/MMBtu

[1] eGRID is a comprehensive inventory of environmental attributes of electric power systems. The preeminent source of air emissions data for the electric power sector, eGRID is based on available plant-specific data for all U.S. electricity generating plants that provide power to the electric grid and report data to the U.S. Government. eGRID plant-level emissions reflect monitored data, estimated data, or a combination of both.

(0.048 lb/MWh) for NO_x for combined cycle; and 117 lb/MMBtu for CO_2 for both simple cycle (1,141 lb/MWh) and combined cycle (752 lb/MWh).

Since emission factors for future plants and plants under long-term contract (Coolidge and Fort Lupton generating stations) are based on emissions per heat energy input (lb/MMBtu), conversion to lb/MWh is needed to produce the values shown in Table M-1 for these entities. Conversion factors were taken from the AURORA model outputs described in Appendix K and had the following values (in units of MWh/MMBtu): 6.43 for advanced combined cycle; 9.75 for advanced simple cycle; 9 for Coolidge; and 9.19 for Fort Lupton. For Brush 2 under long-term contract, emission factors in the eGrid database were used.

The Coolidge Generating Station under long-term contract has 12 simple-cycle natural gas-fired peaking units with a total capacity of 575 MW, which began service in 2011. For this station, emission factors in lb/MMBtu for a conventional combustion turbine (CT) are assumed, which are the same as those for ACT (EIA 2013). The Fort Lupton Cogeneration Powerplant is a 272-MW combined-cycle natural gas-fired station. For this station, emission factors in lb/MMBtu for conventional natural gas combined cycle (NGCC) are assumed, which are the same as those for AG-NGCC (EIA 2013).

For unspecified powerplants under long term-contract, composite emission factors were employed that are representative of all types of powerplants (such as fossil fuel-fired, hydroelectric, nuclear, and renewable resources) currently in operation over the 11-state Western Interconnection region. Composite emission factors were estimated to be 0.74, 1.07, and 963 lb/MWh for SO_2, NO_x, and GHGs in units of CO_2 equivalents (CO_2e),[2] respectively. Note that three plants (Kyrene, Rawhide, and Ray D. Nixon) have more than one generation type, but only one plant-wide composite emission factor for each pollutant is given in the EPA's eGRID database (EPA 2014). The available emission factors were applied to all generation at these three plants.

M.1.2 Spot Market

For spot market purchases and sales, composite emission factors in Table M-1 were used that are representative of power generation from gas powerplants currently in operation over the Western Interconnection, based on the assumption that spot market generation is primarily to serve peak loads. Composite emission factors were estimated to be 0.0083, 0.266, and 888 lb/MWh for SO_2, NO_x, and GHGs, respectively (EIA 2013).

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[2] Emission factors for GHGs are expressed in CO_2 equivalent (CO_2e) for the long-term contract (unspecified generation type) and power stations available in the EPA's eGrid database. CO_2e is a measure used to compare the emissions from various GHGs on the basis of their global warming potential, defined as the ratio of heat trapped by one unit mass of the GHG to that of one unit mass of CO_2 over a specific time period (usually 100 years).

M.1.3 Generation Type

Tables M-1and M-2 group plants and other generation entities according to the type of generation technology used. Such grouping is for the purpose of understanding the differences in emissions under various LTEMP alternatives due to differences in generation from contributing generation technologies. Different operating regimes of Glen Canyon Dam under the various LTEMP alternatives supply different proportions of baseload or peaking power. Peaking power produced at the dam is assumed to displace power that would otherwise be produced by plants using gas turbine technologies, while baseload power produced at the dam is assumed to displace power produced by plants employing steam turbine technologies, most typically coal-fired plants. Gas- and coal-fired technologies have distinctly different emission profiles and levels. Gas plants emit far less SO_2 and NO_x than do coal-fired plants per unit of energy produced. Different mixes of these two types of technologies under various alternatives is related to the total levels of emissions. The technology groupings shown in Tables M-1 and M-2 are used below in the reporting and interpretation of results.

M.2 RESULTS

M.2.1 SO_2 and NO_x

The potential effects on visibility from emissions of SO_2 and NO_x, which are precursors of sulfate and nitrate aerosols, respectively, and which contribute to haze, are shown in Table M-3 for LTEMP alternatives. The geographic area of potential visibility impacts corresponds to the location of contributing powerplants in the SLCA/IP system and, to a small degree, the 11-state Western Interconnection and includes Grand Canyon National Park. Because the sources are geographically dispersed, effects would be similarly dispersed and low at any particular location. Further, due to very small differences in SO_2 and NO_x precursor emissions, negligible differences are expected among the alternatives with regard to visibility and haze in the region.

Emissions of SO_2 and NO_x under various LTEMP alternatives are compared with respect to air quality effects under NAAQS. Tables M-4 and M-5 show emissions of SO_2 and NO_x, respectively, under each LTEMP alternative, from contributing plants (35 primary facilities) and other contributing entities in the SLC/IP system, and presents subtotals of emissions by generation technology type. These tables also show contributions from the spot market computed according to the level of electrical power generated at each plant and entity, using the emission factors in Table M-1.

Table M-6 presents a summary of total system emissions by generation technology type drawn from Tables M-4 and M-5 for the generation facilities within the SCLA/IP system and from contributions from the spot market. The 35 generating facilities within the SLCA/IP system are categorized according to generation technology type, such as gas turbine or steam turbine (usually coal-fired), so that contributing emissions can be summed by technology type across the system to evaluate emissions from different technology mixes under alternatives. With respect to the spot market entries in these tables, “sales” refers to sales of power by system utilities to non-system utilities within the Western Interconnection. Sales result in a net credit to total Western Interconnection emissions, because the sales result in a reduction in emissions from those non-system utilities that are purchasing the power. “Purchases” refers to purchases by system utilities from non-system utilities within the Western Interconnection. Emissions related to these purchases are added to the total emissions in the Western Interconnection.

Total SO_2 and NO_x emissions in the system averaged over the 20-year LTEMP period under Alternative A are estimated to be about 42,465 tons/yr and 78,496 tons/yr, respectively, while emissions under other LTEMP alternatives are similar to those under Alternative A. Differences in emissions of SO_2 and NO_x under LTEMP alternatives relative to those under Alternative A are very small, at most -0.04% and correspond to average annual emission differences that range from –18 to 5 tons/yr for SO_2 and -10 to 6 tons/yr for NO_x, compared to those under Alternative A.

With respect to generation technology type, SO_2 and NO_x emissions within the SLCA/IP system are dominated by steam turbine technologies, mainly coal-fired powerplants. Estimated differences among alternatives reflect slight differences in the contributions from various powerplant technologies; these are attributed to small differences in baseload and peaking energy generated by Glen Canyon Dam. As noted above, gas turbine peaking plant technologies produce lower SO_2 and lower NO_x emissions than baseload coal-fired plants. Thus, offsetting gas turbine peaking power with hydropower from Glen Canyon Dam has a potentially lower effect on total system emissions than does offsetting coal-fired baseload with baseload energy from Glen Canyon Dam.

Table M-6 shows levels of electricity generation at Glen Canyon Dam in MWh/day that would be produced under each LTEMP alternative. Differences in generation at the dam affect the amount of power needed by other contributing generators in the system. Little difference exists in generation at the dam among alternatives, which ranges from 11,438 MWh/day to 11,650 MWh/day. Alternative A produces the most energy, while Alternatives F and G produce roughly 2% less hydropower energy than Alternative A (98.3% and 98.2%, respectively). This reduction in generation is a consequence of the more frequent HFEs under these alternatives in which a portion of flows bypass the powerplant turbines.

Despite the fact that the steady-flow Alternatives F and G generate less power at Glen Canyon Dam than do the fluctuating-flow Alternatives A–E, and this lost generation must be made up by additional generation at other facilities in the system, Alternatives F and G have the lowest total emissions of all alternatives. This result may be explained by the operational regime of the dam under these alternatives with respect to baseload or peaking power. Under steady-flow Alternatives F and G, the dam produces baseload power which would displace baseload power from other facilities in the system, mainly coal-fired (steam turbine) facilities with relatively high emissions, while under fluctuating-flow Alternatives A–E, the dam produces a portion of peaking power, which offsets gas-fired peaking plants in the system, with relatively low emissions. See a more detailed discussion of this interpretation of results in Section 4.14.2 of the DEIS.

M.2.2 Greenhouse Gas Emissions

Table M-7 presents emissions in CO_2e for contributing plants (approximately 35 primary facilities) and other contributing entities in the SLC/IP system described above under each LTEMP alternative and presents subtotals of emissions by generation technology type and for contributions from the spot market. The spot market reflects the effects of Glen Canyon Dam operations on the larger Western Interconnection region and represents an offset of about 1% of system emissions. Emissions are computed from the level of electrical power generated at each plant and entity under each alternative using the emission factors in Table M-1.

Table M-8 summarizes emissions in Table M-7 by technology type and presents total emissions under the LTEMP alternatives. Total CO_2e emissions in the system averaged over the 20-year LTEMP period under Alternative A are estimated to be 55,177,668 MT/yr (60,822,967 tons/yr), while emissions under other LTEMP alternatives are similar to those under Alternative A. Differences in emissions of CO_2e from Alternative A are very small, and would range from an increase of 0.011% (Alternative B) to 0.081% (Alternative F) and corresponds to average emission increases that would range from 5,900 MT/yr (6,503 tons/yr) (Alternative B) to 44,522 MT/yr (49,077 tons/yr) (Alternative F), considering total emissions (system generation plus spot market sales and purchases) compared to that under Alternative A. Alternatives C, D, E, and G would have intermediate increases in CO_2e emissions of 18,161; 22,908; 16,503; and 40,960 MT/yr (0.033%, 0.042%, 0.030%, and 0.074%), respectively, compared to Alternative A.

With respect to generation technology type, CO_2e emissions are dominated (about 87%) by steam turbine technologies within the system, mainly coal-fired powerplants, as is the case for SO_2 and NO_x (about 98%). Estimated differences among alternatives reflect slight differences in the contributions from various powerplant technologies providing baseload and peaking energy in conjunction with Glen Canyon Dam, as discussed above for SO_2 and NO_x. Since gas turbine peaking plant technologies produce about half the CO_2e emissions as baseload coal-fired plants per unit of energy produced (Table M-1), offsetting gas turbine peaking power with hydropower from Glen Canyon Dam has a potentially lower effect on total system emissions than does offsetting coal-fired baseload with baseload energy from Glen Canyon Dam.

As shown in Table M-8, total CO_2e emissions are expected to be slightly higher for steady-flow Alternatives F and G than for the fluctuating-flow alternatives A–E. These increases in total emissions result mainly from relatively higher gas turbine emissions under Alternatives F and G. Higher gas turbine emissions are, in turn, attributable to the lack of peaking power from Glen Canyon Dam under the steady-flow alternatives, which require compensating peaking power from gas turbine peaking plants within the system. As for SO_2 and NO_x, Alternatives F and G have lower CO_2e emissions from steam turbine technologies than Alternative A and other fluctuating-flow alternatives, reflecting relatively greater offsets of baseload coal-fired plants from the steady-flow alternatives. However, total CO_2e emissions are greatest overall for Alternatives F and G due to a more than compensating increase in the gas turbine contribution under these alternatives. Alternatives F and G rank highest for CO_2e, but lowest for SO_2 and low for NO_x. This reversal in rank is due to smaller differences in emission factors between gas turbine and stream turbine technologies for CO_2e than for SO_2 and NO_x. CO_2e emission factors are lower for gas turbine technologies by roughly a factor of 2, while SO_2 is lower by almost two orders of magnitude, and NO_X is lower by roughly a factor of 5 for gas turbines than for (coal-fired) steam turbines, as reflected in emission factors shown in Table M-1.

As shown in Table M-8, total system CO_2e emissions are a small fraction of total United States GHG emissions, totaling about 0.81% for all LTEMP alternatives.

M.3 REFERENCES

EIA (U.S. Energy Information Administration), 2013, *Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants*, April. Available at http://www.eia.gov/forecasts/capitalcost/pdf/updated_capcost.pdf. Accessed Jan. 21, 2015.

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EPA, 2014, “eGRID,” ninth edition with year 2010 data (Version 1.0). Available at http://www.epa.gov/cleanenergy/energy-resources/egrid. Accessed May 23, 2014.

TABLE M-1 Emission Factors by Plant for System Power Generation and Spot Market

Generation Type	Plant Name	EIA Plant No.	Emission Factor (lb/MWh) SO_2	NO_x	CO_2e[a]
System Power Generation					
Combined cycle	Advanced Combined Cycle Gas Turbine[b]	-[c]	0.006	0.048	752
	Desert Basin	55,129	0.005	0.094	1,001
	Front Range	55,283	0.005	0.264	975
	Kyrene #KY7 & #KY7Ae	147	0.005	0.141	932
	Long-Term Contract (Fort Lupton)[b]	-[c]	0.009	0.069	1,075
	Mesquite	55,481	0.004	0.064	879
	Nebo	56,177	0.005	0.135	890
	Rifle	10,755	0.021	1.026	716
	Santan	8,068	0.004	0.112	843
Composite	Long-Term Contract (Unspecified)[d]	-[c]	0.744	1.068	963
Gas turbine	Advanced Simple Cycle Gas Turbine[b]	-[c]	0.010	0.293	1,141
	Frank Knutson	55,505	0.033	0.394	1,500
	Kyrene KY4-KY6[e]	147	0.005	0.141	932
	Limon	55,504	0.111	0.794	1,714
	Long-Term Contract (Brush 2)	10,683	0.040	1.950	1,429
	Long-Term Contract (Coolidge)[b]	-[c]	0.009	0.270	1,053
	Pyramid	7,975	0.042	1.045	1,308
	Rawhide #A-#F[e]	6,761	0.775	1.616	2,049
Internal combustion	Payson	7,408	1.313	19.637	1,473
	Provo	3,686	0.257	17.719	1,493
Steam turbine	Bonanza	1	0.803	3.769	2,099
	Coronado	6,177	3.755	4.044	2,353
	Craig	6,021	0.694	3.035	2,216
	Escalante	87	1.449	3.721	2,449
	Four Corners	2,442	1.588	5.586	2,083
	George Birdsall	493	0.058	3.138	1,948
	Hayden	525	1.495	4.259	2,357
	Hunter	6,165	1.038	3.689	2,248
	Intermountain	6,481	0.765	3.999	2,011
	Kyrene 1 & 2[e]	147	0.005	0.141	932
	Laramie River 1	6,204.1	1.258	2.164	2,461
	Laramie River 2 & 3	6,204.2	1.627	2.890	2,332
	Martin Drake	492	7.428	4.205	2,435
	Navajo	4,941	0.621	2.974	2,179
	Nucla	527	3.859	4.874	2,625
	Rawhide #1[e]	6,761	0.775	1.616	2,049
	Ray D Nixon 1[e]	8,219	4.878	2.391	2,282
	San Juan	2,451	0.847	3.113	2,330
	Springerville	8,223	1.211	1.174	2,026

TABLE M-1 (Cont.)

		EIA	Emission Factor (lb/MWh)		
Generation Type	Plant Name	Plant No.	SO_2	NO_x	CO_2e[a]
Spot Market					
	Sales and purchases[f,g]	-[c]	0.0083	0.266	888

[a] Greenhouse gas (GHG) emissions are expressed in carbon dioxide equivalent (CO_2e), except for advanced combined cycle, advanced simple cycle, and long-term contract emissions (Coolidge and Fort Lupton), which are expressed as CO_2 and shaded for clarity.

[b] Emission factors were originally given in lb/MMBtu but were converted into lb/MWh using conversion factors (MMBtu/MWh) from the AURORA model outputs described in Appendix K: 6.43 for advanced combined cycle; 9.75 for advanced simple cycle; 9 for Coolidge; and 9.19 for Fort Lupton.

[c] A hyphen denotes “not applicable.”

[d] Generation type was not specified, so composite emission factors representative of all types of powerplants currently in operation over the 11 Western Interconnect states were used.

[e] These plants have more than one generation type and only one plant-wide emission factor for each pollutant were given in the EPA’s 2010 eGrid database.

[f] Composite emission factors representative of gas powerplants currently in operation over the 11 Western Interconnection states were used.

[g] “Sales” refers to sales of power by system utilities to non-system utilities within the Western Interconnection. Sales result in a net credit to total Western Interconnection emissions, because the sales result in a reduction in emissions from those non-system utilities that are purchasing the power. “Purchases” refers to purchases by system utilities from non-system utilities within the Western Interconnection. Emissions related to these purchases are added to the total emissions in the Western Interconnection.

Source: EIA (2013); EPA (2014).

TABLE M-2 Power Generation (in MWh per Year) Averaged over the 20-Year LTEMP Period by Alternative

Generation Type	Plant Name	EIA Plant No.	A (No Action Alternative)	B	C	D (Preferred Alternative)	E	F	G
			Alternative						
System Power Generation									
Combined cycle	Advanced combined cycle gas turbine	-[a]	7,620,301	7,623,594	7,617,489	7,620,763	7,622,969	7,605,136	7,609,471
	Desert Basin	55,129	585,800	586,934	590,663	589,933	589,238	588,298	594,677
	Front Range	55,283	919,790	914,735	921,585	924,406	919,148	930,841	925,349
	Kyrene #KY7 & #KY7A	147	46,112	45,923	46,315	47,042	46,657	47,749	46,933
	Long-term contract (Fort Lupton)	-[a]	123,898	121,375	121,530	122,814	120,978	121,286	127,739
	Mesquite	55,481	4,637,436	4,639,304	4,637,048	4,637,704	4,637,659	4,639,378	4,636,160
	Nebo	56,177	205,798	204,042	206,783	206,287	206,392	210,230	209,969
	Rifle	10,755	145,808	145,812	145,755	145,838	145,754	146,621	146,144
	Santan	8,068	1,409,562	1,404,660	1,416,449	1,417,293	1,418,136	1,423,356	1,430,155
	Combined Cycle Subtotal		**15,694,506**	**15,686,380**	**15,703,618**	**15,712,080**	**15,706,930**	**15,712,895**	**15,726,598**
Composite	**Long-term contract (unspecified)**	-[a]	**1,628,526**	**1,629,588**	**1,628,457**	**1,630,110**	**1,629,858**	**1,632,176**	**1,627,328**
Gas turbine	Advanced simple cycle gas turbine	-[a]	597,114	587,362	672,023	639,175	647,159	774,061	702,516
	Frank Knutson	55,505	62,101	60,909	62,752	63,133	62,638	70,930	67,843
	Kyrene KY4-KY6	147	938	940	932	936	938	950	962
	Limon	55,504	37,077	36,889	36,664	36,912	36,575	41,589	38,986
	Long-term contract (Brush 2)	10,683	35,169	33,873	34,940	35,592	34,641	36,379	38,201
	Long-term contract (Coolidge)	-[a]	249,994	248,005	247,539	249,364	248,463	248,981	252,243
	Pyramid	7,975	162,140	156,957	163,256	164,392	162,204	172,688	178,097
	Rawhide #A-#F	6,761	4,280	4,267	4,306	4,354	4,278	4,796	4,548
	Gas Turbine Subtotal		**1,148,814**	**1,129,201**	**1,222,411**	**1,193,859**	**1,196,895**	**1,350,374**	**1,283,395**
Internal combustion	Payson	7,408	1,717	1,713	1,678	1,691	1,679	1,670	1,714
	Provo	3,686	854	850	825	882	869	844	828
	Internal Combustion Subtotal		**2,571**	**2,563**	**2,503**	**2,573**	**2,548**	**2,514**	**2,542**

TABLE M-2 (Cont.)

Generation Type	Plant Name	EIA Plant No.	Alternative: A (No Action Alternative)	B	C	D (Preferred Alternative)	E	F	G
System Power Generation (Cont.)									
Steam turbine	Bonanza	7,790	3,589,525	3,589,527	3,589,525	3,589,524	3,589,525	3,589,364	3,589,525
	Coronado	6,177	5,764,907	5,767,009	5,764,236	5,764,829	5,764,453	5,762,531	5,761,006
	Craig	6,021	8,061,885	8,061,806	8,061,979	8,061,745	8,061,885	8,061,388	8,061,713
	Escalante	87	1,783,864	1,783,312	1,782,293	1,783,100	1,783,539	1,775,851	1,781,911
	Four Corners	2,442	1,145,170	1,145,639	1,145,109	1,145,343	1,145,548	1,143,803	1,144,356
	George Birdsall	493	116	115	116	116	114	141	121
	Hayden	525	989,044	989,196	989,115	989,115	989,327	989,267	989,196
	Hunter	6,165	1,514,296	1,514,296	1,514,296	1,514,296	1,514,296	1,514,296	1,514,296
	Intermountain	6,481	5,491,131	5,491,122	5,491,139	5,491,139	5,491,139	5,491,139	5,491,137
	Kyrene 1 & 2	147	1,028	1,034	1,023	1,034	1,027	1,053	1,053
	Laramie River 1	6,204.1	1,039,808	1,039,810	1,039,806	1,039,789	1,039,805	1,039,800	1,039,774
	Laramie River 2 & 3	6,204.2	2,079,620	2,079,620	2,079,620	2,079,620	2,079,620	2,079,620	2,079,620
	Martin Drake	492	1,920,235	1,920,236	1,920,225	1,920,234	1,920,236	1,920,231	1,920,225
	Navajo	4,941	3,741,478	3,741,640	3,741,240	3,741,369	3,741,359	3,740,851	3,740,803
	Nucla	527	753,249	753,276	753,462	753,462	753,504	752,312	752,981
	Rawhide #1	6,761	2,108,554	2,108,554	2,108,554	2,108,554	2,108,554	2,108,554	2,108,554
	Ray D Nixon 1	8,219	1,663,200	1,663,200	1,663,200	1,663,200	1,663,200	1,663,200	1,663,200
	San Juan	2,451	571,214	571,347	571,264	571,231	571,344	570,592	570,934
	Springerville	8,223	6,131,532	6,133,174	6,130,698	6,130,759	6,131,637	6,121,038	6,126,970
	Steam Turbine Subtotal		**48,349,855**	**48,353,913**	**48,346,900**	**48,348,459**	**48,350,114**	**48,325,031**	**48,337,375**
System Subtotal			**66,824,271**	**66,801,645**	**66,903,888**	**66,887,081**	**66,886,345**	**67,022,991**	**66,977,238**
Spot Market									
	Sales (emissions subtracted)[b]	-[a]	−3,753,513	−3,707,051	−3,830,282	−3,784,783	−3,812,913	−3,915,541	−3,872,321
	Purchases (emissions added)[b]	-[a]	2,823,573	2,816,937	2,848,706	2,836,661	2,848,870	2,865,526	2,861,183
Spot Market Subtotal			**−929,940**	**−890,114**	**−981,576**	**−948,122**	**−964,043**	**−1,050,015**	**−1,011,139**
Total (System + Spot Market)			**65,894,331**	**65,911,531**	**65,922,312**	**65,938,959**	**65,922,302**	**65,972,976**	**65,966,099**

Footnotes on next page.

TABLE M-2 (Cont.)

[a] A hyphen denotes "not applicable."

[b] "Sales" refers to sales of power by system utilities to non-system utilities within the Western Interconnection. Sales result in a net credit to total Western Interconnection emissions, because the sales result in a reduction in emissions from those non-system utilities that are purchasing the power. "Purchases" refers to purchases by system utilities from non-system utilities within the Western Interconnection. Emissions related to these purchases are added to the total emissions in the Western Interconnection.

Data source: AURORA model outputs described in Appendix K.

TABLE M-3 Summary of Potential Impacts of LTEMP Alternatives on Visibility and Regional Air Quality

Air Quality	A (No Action Alternative)	B	C	D (Preferred Alternative)	E	F	G
	Alternative						
Overall summary of impacts	No change from current conditions	Negligible increase in SO_2 and NO_x emissions compared to Alternative A	Negligible decrease in SO_2 emissions and no change in NO_x emissions compared to Alternative A	No change in SO_2 emissions and negligible increase in and NO_x emissions compared to Alternative A	Negligible increase in SO_2 and NO_x emissions compared to Alternative A	Negligible decrease in SO_2 and NO_x emissions compared to Alternative A	Negligible decrease in SO_2 emissions and negligible increase in NO_x emissions compared to Alternative A
Visibility[a]	No change from current conditions	No change from Alternative A	No change from Alternative A	No change from Alternative A	No change from Alternative A	No change from Alternative A	No change from Alternative A
Air Quality in 11-State Western Interconnection Region							
SO_2 emissions (tons/yr)	42,465[b]	42,471[b]	42,463[b]	42,465[b]	42,466[b]	42,448[b]	42,453[b]
	No change from current conditions	Negligible increase (0.01%)[c]	Negligible reduction (−0.01%)[c]	No change from current conditions	Negligible increase (<0.005%)[c]	Negligible reduction (−0.04%)[c]	Negligible reduction (−0.03%)[c]
NO_x emissions (tons/yr)	78,496[b]	78,501[b]	78,496[b]	78,503[b]	78,500[b]	78,487[b]	78,498[b]
	No change from current conditions	Negligible increase (0.01%)[c]	No change from current conditions	Negligible increase (0.01%)[c]	Negligible increase (<0.005%)[c]	Negligible reduction (−0.01%)[c]	Negligible increase (<0.005%)[c]

[a] Visibility effects are estimated from expected changes in the emissions of sulfate and nitrate precursors, SO_2 and NO_x.

[b] Total air emissions from combustion-related powerplants in the Western Interconnection averaged over the 20-year LTEMP period.

[c] Changes in air emissions compared to Alternative A.

Source: EPA (2014).

TABLE M-4 Annual SO_2 Emissions (in tons per Year) Averaged over the 20-Year LTEMP Period by Alternative

Generation Type	Plant Name	EIA Plant No.	Alternative: A (No Action Alternative)	B	C	D (Preferred Alternative)	E	F	G
System Power Generation									
Combined cycle	Advanced combined cycle gas turbine	-[a]	24	25	24	25	25	24	24
	Desert Basin	55,129	1	1	1	1	1	1	1
	Front Range	55,283	2	2	2	2	2	2	2
	Kyrene #KY7 & #KY7A	147	0	0	0	0	0	0	0
	Long-term contract (Fort Lupton)	-[a]	1	1	1	1	1	1	1
	Mesquite	55,481	10	10	10	10	10	10	10
	Nebo	56,177	0	0	0	0	0	0	0
	Rifle	10,755	2	2	2	2	2	2	2
	Santan	8,068	3	3	3	3	3	3	3
	Combined Cycle Subtotal		**44**	**44**	**44**	**44**	**44**	**44**	**44**
Composite	**Long-term contract (unspecified)**	-[a]	**606**	**607**	**606**	**607**	**607**	**608**	**606**
Gas turbine	Advanced simple cycle gas turbine	-[a]	3	3	3	3	3	4	3
	Frank Knutson	55,505	1	1	1	1	1	1	1
	Kyrene KY4-KY6	147	0	0	0	0	0	0	0
	Limon	55,504	2	2	2	2	2	2	2
	Long-term contract (Brush 2)	10,683	1	1	1	1	1	1	1
	Long-term contract (Coolidge)	-[a]	1	1	1	1	1	1	1
	Pyramid	7,975	3	3	3	3	3	4	4
	Rawhide #A-#F	6,761	2	2	2	2	2	2	2
	Gas Turbine Subtotal		**13**	**13**	**13**	**13**	**13**	**15**	**14**
Internal combustion	Payson	7,408	1	1	1	1	1	1	1
	Provo	3,686	0	0	0	0	0	0	0
	Internal Combustion Subtotal		**1**	**1**	**1**	**1**	**1**	**1**	**1**

TABLE M-4 (Cont.)

Generation Type	Plant Name	EIA Plant No.	Alternative: A (No Action Alternative)	B	C	D (Preferred Alternative)	E	F	G
System Power Generation (Cont.)									
Steam turbine	Bonanza	7,790	1,441	1,441	1,441	1,441	1,441	1,441	1,441
	Coronado	6,177	10,822	10,826	10,821	10,822	10,821	10,818	10,815
	Craig	6,021	2,795	2,795	2,795	2,795	2,795	2,795	2,795
	Escalante	87	1,293	1,292	1,291	1,292	1,292	1,287	1,291
	Four Corners	2,442	909	910	909	910	910	908	909
	George Birdsall	493	0	0	0	0	0	0	0
	Hayden	525	739	739	739	739	740	739	739
	Hunter	6,165	786	786	786	786	786	786	786
	Intermountain	6,481	2,099	2,099	2,099	2,099	2,099	2,099	2,099
	Kyrene 1 & 2	147	0	0	0	0	0	0	0
	Laramie River 1	6,204	654	654	654	654	654	654	654
	Laramie River 2 & 3	6,204	1,692	1,692	1,692	1,692	1,692	1,692	1,692
	Martin Drake	492	7,132	7,132	7,132	7,132	7,132	7,132	7,132
	Navajo	4,941	1,161	1,161	1,161	1,161	1,161	1,161	1,161
	Nucla	527	1,453	1,453	1,454	1,454	1,454	1,451	1,453
	Rawhide #1	6,761	817	817	817	817	817	817	817
	Ray D Nixon 1	8,219	4,056	4,056	4,056	4,056	4,056	4,056	4,056
	San Juan	2,451	242	242	242	242	242	242	242
	Springerville	8,223	3,712	3,713	3,712	3,712	3,712	3,706	3,710
	Steam Turbine Subtotal		**41,805**	**41,810**	**41,802**	**41,804**	**41,805**	**41,785**	**41,792**
System Power Generation Total			**42,469**	**42,474**	**42,467**	**42,469**	**42,470**	**42,452**	**42,457**
Spot Market									
	Sales (emissions subtracted)[b]	-[a]	−16	−15	−16	−16	−16	−16	−16
	Purchases (emissions added)[b]	-[a]	12	12	12	12	12	12	12
Spot Market Subtotal			**−4**	**−4**	**−4**	**−4**	**−4**	**−4**	**−4**
Total (System + Spot Market)			**42,465**	**42,471**	**42,463**	**42,465**	**42,466**	**42,448**	**42,453**

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TABLE M-4 (Cont.)

[a] A hyphen denotes “not applicable.”

[b] “Sales” refers to sales of power by system utilities to non-system utilities within the Western Interconnection. Sales result in a net credit to total Western Interconnection emissions, because the sales result in a reduction in emissions from those non-system utilities that are purchasing the power. “Purchases” refers to purchases by system utilities from non-system utilities within the Western Interconnection. Emissions related to these purchases are added to the total emissions in the Western Interconnection.

TABLE M-5 Annual NO_x Emissions (in tons per Year) Averaged over the 20-Year LTEMP Period by Alternative

Generation Type	Plant Name	EIA Plant No.	Alternative A (No Action Alternative)	B	C	D (Preferred Alternative)	E	F	G
System Power Generation									
Combined cycle	Advanced combined cycle gas turbine	-[a]	184	184	184	184	184	183	183
	Desert Basin	55,129	28	28	28	28	28	28	28
	Front Range	55,283	122	121	122	122	121	123	122
	Kyrene #KY7 & #KY7A	147	3	3	3	3	3	3	3
	Long-term contract (Fort Lupton)	-[a]	4	4	4	4	4	4	4
	Mesquite	55,481	147	147	147	147	147	147	147
	Nebo	56,177	14	14	14	14	14	14	14
	Rifle	10,755	75	75	75	75	75	75	75
	Santan	8,068	79	79	80	80	80	80	80
	Combined Cycle Subtotal		**655**	**654**	**656**	**657**	**656**	**658**	**658**
Composite	**Long-term contract (unspecified)**	-[a]	**869**	**870**	**869**	**870**	**870**	**871**	**869**
Gas turbine	Advanced simple cycle gas turbine	-[a]	87	86	98	93	95	113	103
	Frank Knutson	55,505	12	12	12	12	12	14	13
	Kyrene KY4-KY6	147	0	0	0	0	0	0	0
	Limon	55,504	15	15	15	15	15	17	15
	Long-term contract (Brush 2)	10,683	34	33	34	35	34	35	37
	Long-term contract (Coolidge)	-[a]	34	33	33	34	34	34	34
	Pyramid	7,975	85	82	85	86	85	90	93
	Rawhide #A-#F	6,761	3	3	3	4	3	4	4
	Gas Turbine Subtotal		**271**	**265**	**282**	**278**	**277**	**307**	**300**
Internal combustion	Payson	7,408	17	17	16	17	16	16	17
	Provo	3,686	8	8	7	8	8	7	7
	Internal Combustion Subtotal		**24**	**24**	**24**	**24**	**24**	**24**	**24**

TABLE M-5 (Cont.)

Generation Type	Plant Name	EIA Plant No.	Alternative: A (No Action Alternative)	B	C	D (Preferred Alternative)	E	F	G
System Power Generation (Cont.)									
Steam turbine	Bonanza	7,790	6,764	6,764	6,764	6,764	6,764	6,764	6,764
	Coronado	6,177	11,656	11,661	11,655	11,656	11,655	11,652	11,648
	Craig	6,021	12,236	12,235	12,236	12,235	12,236	12,235	12,235
	Escalante	87	3,319	3,318	3,316	3,318	3,318	3,304	3,315
	Four Corners	2,442	3,199	3,200	3,198	3,199	3,200	3,195	3,196
	George Birdsall	493	0	0	0	0	0	0	0
	Hayden	525	2,106	2,107	2,106	2,106	2,107	2,107	2,107
	Hunter	6,165	2,793	2,793	2,793	2,793	2,793	2,793	2,793
	Intermountain	6,481	10,979	10,979	10,979	10,979	10,979	10,979	10,979
	Kyrene 1 & 2	147	0	0	0	0	0	0	0
	Laramie River 1	6,204.1	1,125	1,125	1,125	1,125	1,125	1,125	1,125
	Laramie River 2 & 3	6,204.2	3,005	3,005	3,005	3,005	3,005	3,005	3,005
	Martin Drake	492	4,037	4,037	4,037	4,037	4,037	4,037	4,037
	Navajo	4,941	5,563	5,563	5,562	5,562	5,562	5,562	5,562
	Nucla	527	1,836	1,836	1,836	1,836	1,836	1,833	1,835
	Rawhide #1	6,761	1,704	1,704	1,704	1,704	1,704	1,704	1,704
	Ray D Nixon 1	8,219	1,989	1,989	1,989	1,989	1,989	1,989	1,989
	San Juan	2,451	889	889	889	889	889	888	889
	Springerville	8,223	3,600	3,601	3,600	3,600	3,600	3,594	3,598
	Steam Turbine Subtotal		**76,800**	**76,806**	**76,796**	**76,799**	**76,801**	**76,766**	**76,781**
System Power Generation Total			**78,620**	**78,620**	**78,626**	**78,629**	**78,628**	**78,626**	**78,632**
Spot Market									
	Sales (emissions subtracted)[b]	-[a]	−499	−492	−509	−503	−506	−520	−514
	Purchases (emissions added)[b]	-[a]	375	374	378	377	378	381	380
Spot Market Subtotal			**−124**	**−118**	**−130**	**−126**	**−128**	**−139**	**−134**
Total (System + Spot Market)			**78,496**	**78,501**	**78,496**	**78,503**	**78,500**	**78,487**	**78,498**

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TABLE M-5 (Cont.)

[a] Ahyphen denotes "not applicable."

[b] "Sales" refers to sales of power by system utilities to non-system utilities within the Western Interconnection. Sales result in a net credit to total Western Interconnection emissions, because the sales result in a reduction in emissions from those non-system utilities that are purchasing the power. "Purchases" refers to purchases by system utilities from non-system utilities within the Western Interconnection. Emissions related to these purchases are added to the total emissions in the Western Interconnection.

TABLE M-6 Summary of Impacts of LTEMP Alternatives on SO_2 and NO_x Emissions

Generation Type	A (No Action Alternative)	B	C	D (Preferred Alternative)	E	F	G
Total Glen Canyon Dam power generation relative to Alternative A (MWh/day) (% of Alternative A)	11,650 (100%)	11,616 (99.7%)	11,566 (99.3%)	11,525 (98.9%)	11,571 (99.3%)	11,449 (98.3%)	11,438 (98.2%)
SO_2 Emissions (tons per year)							
System Power Generation							
Combined cycle	44	44	44	44	44	44	44
Composite[a]	606	607	606	607	607	608	606
Gas turbine	13	13	13	13	13	15	14
Internal combustion	1	1	1	1	1	1	1
Steam turbine	41,805	41,810	41,802	41,804	41,805	41,785	41,792
System Subtotal	**42,469**	**42,474**	**42,467**	**42,469**	**42,470**	**42,452**	**42,457**
Spot Market[b]							
Sales (emissions subtracted)	−16	−15	−16	−16	−16	−16	−16
Purchases (emissions added)	12	12	12	12	12	12	12
Spot Market Subtotal	**−4**	**−4**	**−4**	**−4**	**−4**	**−4**	**−4**
Total (System + Spot Market)	**42,465**	**42,471**	**42,463**	**42,465**	**42,466**	**42,448**	**42,453**
NO_x Emissions (tons per year)							
System Power Generation							
Combined cycle	655	654	656	657	656	658	658
Composite[a]	869	870	869	870	870	871	869
Gas turbine	271	265	282	278	277	307	300
Internal combustion	24	24	24	24	24	24	24
Steam turbine	76,800	76,806	76,796	76,799	76,801	76,766	76,781
System Subtotal	**78,620**	**78,620**	**78,626**	**78,629**	**78,628**	**78,626**	**78,632**
Spot Market Sales[b]							
Sales (emissions subtracted)	−499	−492	−509	−503	−506	−520	−514
Purchases (emissions added)	375	374	378	377	378	381	380
Spot Market Subtotal	**−124**	**−118**	**−130**	**−126**	**−128**	**−139**	**−134**
Total (System + Spot Market)	**78,496**	**78,501**	**78,496**	**78,503**	**78,500**	**78,487**	**78,498**

[a] Unspecified generation type.

[b] "Sales" refers to sales of power by system utilities to non-system utilities within the Western Interconnection. Sales result in a net credit to total Western Interconnection emissions, because the sales result in a reduction in emissions from those non-system utilities that are purchasing the power. "Purchases" refers to purchases by system utilities from non-system utilities within the Western Interconnection. Emissions related to these purchases are added to the total emissions in the Western Interconnection.

TABLE M-7 Annual Greenhouse Gas Emissions (in metric tons per year CO_2e)[a] under LTEMP Alternatives

Generation Type	Plant Name	EIA Plant No.	Alternative: A (No Action Alternative)	B	C	D (Preferred Alternative)	E	F	G
System Power Generation									
Combined cycle	Advanced combined cycle gas turbine	-[b]	2,600,367	2,601,491	2,599,408	2,600,525	2,601,278	2,595,192	2,596,672
	Desert Basin	55,129	265,937	266,452	268,144	267,813	267,498	267,071	269,967
	Front Range	55,283	406,591	404,356	407,384	408,631	406,307	411,476	409,048
	Kyrene #KY7 & #KY7A	147	19,494	19,414	19,580	19,887	19,724	20,186	19,841
	Long-term contract (Fort Lupton)	-[b]	60,427	59,216	59,291	59,907	59,026	59,174	62,270
	Mesquite	55,481	1,849,137	1,849,882	1,848,983	1,849,244	1,849,226	1,849,912	1,848,629
	Nebo	56,177	83,114	82,405	83,512	83,312	83,354	84,904	84,799
	Rifle	10,755	47,363	47,364	47,345	47,372	47,345	47,627	47,472
	Santan	8,068	539,188	537,313	541,823	542,146	542,468	544,465	547,066
	Combined Cycle Subtotal		**5,871,619**	**5,867,894**	**5,875,470**	**5,878,837**	**5,876,226**	**5,880,006**	**5,885,763**
Composite	**Long-term contract (unspecified)**	-[b]	**711,604**	**712,068**	**711,574**	**712,296**	**712,186**	**713,199**	**711,081**
Gas turbine	Advanced simple cycle gas turbine	-[b]	308,968	303,922	347,729	330,732	334,863	400,526	363,507
	Frank Knutson	55,505	42,240	41,430	42,683	42,942	42,605	48,246	46,146
	Kyrene KY4-KY6	147	396	397	394	396	396	402	407
	Limon	55,504	28,833	28,686	28,511	28,704	28,442	32,341	30,317
	Long-term contract (Brush 2)	10,683	22,800	21,960	22,651	23,074	22,458	23,585	24,766
	Long-term contract (Coolidge)	-[b]	119,405	118,455	118,233	119,105	118,674	118,921	120,479
	Pyramid	7,975	96,184	93,109	96,845	97,520	96,222	102,441	105,650
	Rawhide #A-#F	6,761	3,979	3,966	4,003	4,047	3,977	4,458	4,227
	Gas Turbine Subtotal		**622,805**	**611,925**	**661,049**	**646,520**	**647,637**	**730,920**	**695,498**
Internal combustion	Payson	7,408	1,147	1,145	1,121	1,130	1,122	1,116	1,145
	Provo	3,686	579	576	559	597	588	572	561
	Internal Combustion Subtotal		**1,726**	**1,721**	**1,680**	**1,728**	**1,711**	**1,688**	**1,706**

TABLE M-7 (Cont.)

Generation Type	Plant Name	EIA Plant No.	Alternative: A (No Action Alternative)	B	C	D (Preferred Alternative)	E	F	G
System Power Generation (Cont.)									
Steam turbine	Bonanza	7,790	3,418,218	3,418,220	3,418,218	3,418,217	3,418,218	3,418,064	3,418,218
	Coronado	6,177	6,153,123	6,155,366	6,152,407	6,153,039	6,152,639	6,150,587	6,148,959
	Craig	6,021	8,102,872	8,102,792	8,102,966	8,102,731	8,102,872	8,102,372	8,102,699
	Escalante	87	1,981,912	1,981,299	1,980,168	1,981,064	1,981,551	1,973,010	1,979,743
	Four Corners	2,442	1,081,762	1,082,205	1,081,704	1,081,925	1,082,120	1,080,471	1,080,993
	George Birdsall	493	103	101	103	103	101	124	107
	Hayden	525	1,057,553	1,057,715	1,057,628	1,057,628	1,057,855	1,057,791	1,057,715
	Hunter	6,165	1,544,335	1,544,336	1,544,335	1,544,335	1,544,336	1,544,335	1,544,335
	Intermountain	6,481	5,009,462	5,009,453	5,009,469	5,009,469	5,009,469	5,009,469	5,009,467
	Kyrene 1 & 2	147	435	437	432	437	434	445	445
	Laramie River 1	6,204.1	1,160,583	1,160,585	1,160,581	1,160,562	1,160,580	1,160,574	1,160,546
	Laramie River 2 & 3	6,204.2	2,199,501	2,199,501	2,199,501	2,199,501	2,199,501	2,199,501	2,199,501
	Martin Drake	492	2,120,585	2,120,587	2,120,574	2,120,585	2,120,587	2,120,581	2,120,575
	Navajo	4,941	3,697,248	3,697,409	3,697,013	3,697,141	3,697,131	3,696,629	3,696,581
	Nucla	527	896,805	896,837	897,059	897,059	897,108	895,690	896,486
	Rawhide #1	6,761	1,960,118	1,960,118	1,960,118	1,960,118	1,960,118	1,960,118	1,960,118
	Ray D Nixon 1	8,219	1,721,687	1,721,687	1,721,687	1,721,687	1,721,687	1,721,687	1,721,687
	San Juan	2,451	603,661	603,801	603,714	603,679	603,799	603,004	603,365
	Springerville	8,223	5,634,678	5,636,188	5,633,913	5,633,969	5,634,776	5,625,035	5,630,487
	Steam Turbine Subtotal		**48,344,640**	**48,348,638**	**48,341,590**	**48,343,248**	**48,344,880**	**48,319,488**	**48,332,026**
System Power Generation Total			**55,552,395**	**55,542,246**	**55,591,363**	**55,582,629**	**55,582,640**	**55,645,301**	**55,626,074**
Spot Market									
	Sales (emissions subtracted)[c]	–[b]	−1,512,509	−1,493,787	−1,543,444	−1,525,109	−1,536,444	−1,577,799	−1,560,383
	Purchases (emissions added)[c]	–[b]	1,137,782	1,135,108	1,147,910	1,143,056	1,147,975	1,154,687	1,152,937
Spot Market Subtotal			**−374,727**	**−358,679**	**−395,534**	**−382,053**	**−388,469**	**−423,112**	**−407,447**
Total (System + Spot Market)			**55,177,668**	**55,183,567**	**55,195,829**	**55,200,576**	**55,194,171**	**55,222,189**	**55,218,627**

Footnotes on next page.

TABLE M-7 (Cont.)

[a] To convert from metric tons to tons, multiply by 1.023.

[b] A hyphen denotes "not applicable."

[c] "Sales" refers to sales of power by system utilities to non-system utilities within the Western Interconnection. Sales result in a net credit to total Western Interconnection emissions, because the sales result in a reduction in emissions from those non-system utilities that are purchasing the power. "Purchases" refers to purchases by system utilities from non-system utilities within the Western Interconnection. Emissions related to these purchases are added to the total emissions in the Western Interconnection.

TABLE M-8 Summary of Impacts of LTEMP Alternatives on CO_2e Emissions

	CO_2e Emissions by Alternative (MT/yr)[a,b]						
CO_2e Emissions Source	A (No Action Alternative)	B	C	D (Preferred Alternative)	E	F	G
System Power Generation							
Combined cycle	5,871,619	5,867,894	5,875,470	5,878,837	5,876,226	5,880,006	5,885,763
Composite[c]	711,604	712,068	711,574	712,296	712,186	713,199	711,081
Gas turbine	622,805	611,925	661,049	646,520	647,637	730,920	695,498
Internal combustion	1,726	1,721	1,680	1,728	1,711	1,688	1,706
Steam turbine	48,344,640	48,348,638	48,341,590	48,343,248	48,344,880	48,319,488	48,332,026
System Subtotal	**55,552,395**	**55,542,246**	**55,591,363**	**55,582,629**	**55,582,640**	**55,645,301**	**55,626,074**
Spot Market[d]							
Sales (emissions subtracted)	−1,512,509	−1,493,787	−1,543,444	−1,525,109	−1,536,444	−1,577,799	−1,560,383
Purchases (emissions added)	1,137,782	1,135,108	1,147,910	1,143,056	1,147,975	1,154,687	1,152,937
Spot Market Subtotal	**−374,727**	**−358,679**	**−395,534**	**−382,053**	**−388,469**	**−423,112**	**−407,447**
Total Emissions (System + Spot Market)	**55,177,668**	**55,183,567**	**55,195,829**	**55,200,576**	**55,194,171**	**55,222,189**	**55,218,627**
	No change from current conditions	0.011% increase	0.033% increase	0.042% increase	0.030% increase	0.081% increase	0.074% increase
Difference from Alternative A (MT/yr)	0	5,900	18,161	22,908	16,503	44,522	40,960
Total Emissions as % of Total U.S. GHG Emissions[e]	No change from current conditions	0.011% increase	0.033% increase	0.042% increase	0.030% increase	0.081% increase	0.074% increase

[a] GHG emissions are expressed in carbon dioxide equivalent (CO_2e).

[b] GHG emissions (metric tons) from combustion-related powerplants in the Western Interconnect averaged over the 20-year LTEMP period.

[c] Unspecified generation type.

[d] "Sales" refers to sales of power by system utilities to non-system utilities within the Western Interconnection. Sales result in a net credit to total Western Interconnection emissions, because the sales result in a reduction in emissions from those non-system utilities that are purchasing the power. "Purchases" refers to purchases by system utilities from non-system utilities within the Western Interconnection. Emissions related to these purchases are added to the total emissions in the Western Interconnection.

[e] U.S. total GHG emissions at 6,810.3 million MT/yr CO_2e in 2010 (EPA 2013).