

APPENDIX 5-A. DETAILED LIFE CYCLE COST OUTPUT

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5-A.1 Introduction

Appendix 5-A shows the detailed lifecycle results obtained from running each class of commercial boiler through the LCC analysis for the AEO 2008 Reference Case fuel price scenario. The results are shown as distributions of Life Cycle Cost Savings from the Baseline (ASHRAE 90.1-2007 equivalent) efficiency level for each equipment class. Up to four efficiency levels above the baseline were analyzed. The results are presented as deciles of increasing LCC savings in 2008\$. Average LCC savings for the distribution as well as the percent of units experiencing positive LCC savings are shown.

In addition, the distribution of payback periods (PBPs) experienced is also shown. Note that all paybacks calculated with greater than 100 year PBP were assigned a 100 year PBP. This is done to avoid as much as possible skewing of the average PBP data to far from the median point, as in some cases, PBP can be calculated to be essentially infinitely long and averaging these infinite values is nonsensical in terms of describing the overall results for the population.

5-A.2 LCC Results

Tables 5-A.1 through 5-A.20 shows the distribution of LCC savings and PBP for each of the 10 classes of commercial boilers analyzed.

Table 5-A.1 Distribution of Life-Cycle Cost Savings from Baseline Level for Small Gas-Fired Hot Water Commercial Packaged Boilers

Efficiency Level	Decrease in LCC from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (2008\$)											Average LCC Savings	Percent of Units with LCC Savings
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%		
Level 1	(5,981)	(2,242)	(1,200)	(518)	(19)	593	1,581	2,187	3,918	6,321	21,688	1,700	59%
Level 2	(10,357)	(4,471)	(2,430)	(1,437)	(172)	1,512	3,177	4,256	7,160	11,502	42,448	3,239	60%
Level 3	(17,561)	(9,946)	(7,314)	(5,629)	(2,967)	(653)	1,704	2,926	6,951	12,689	58,553	1,329	44%
Level 4	(28,369)	(18,986)	(15,763)	(13,963)	(9,799)	(7,417)	(4,814)	(2,152)	2,411	10,056	69,254	(4,760)	22%

Table 5-A.2 Distribution of Payback Period Results for Small Gas-Fired Hot Water Commercial Packaged Boilers

Efficiency Level	Payback Period from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (yrs)											Average Payback Period
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
Level 1	4.5	7.7	10.1	10.7	12.6	13.8	16.7	19.7	26.2	34.1	100.0	25.4
Level 2	3.7	7.5	8.8	9.5	11.5	13.0	14.5	17.4	22.4	30.7	100.0	30.6
Level 3	4.0	9.0	9.9	10.8	14.0	14.9	17.5	20.3	27.1	36.8	100.0	42.7
Level 4	4.9	11.1	12.1	13.1	17.3	18.3	20.2	25.3	34.3	46.1	100.0	56.7

Table 5-A.3 Distribution of Life-Cycle Cost Savings from Baseline Level for Small Gas-Fired Steam All Except Natural Draft Commercial Packaged Boilers

Efficiency Level	Decrease in LCC from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (2008\$)											Average LCC Savings	Percent of Units with LCC Savings
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%		
Level 1	(5,423)	(2,804)	(2,474)	(1,879)	(1,601)	(1,343)	(1,016)	(527)	576	1,797	7,307	(870)	24%
Level 2	(8,402)	(4,669)	(3,537)	(2,936)	(2,471)	(1,891)	(846)	(178)	1,447	3,992	19,724	(674)	29%
Level 3	(13,104)	(8,180)	(6,945)	(5,989)	(4,957)	(4,002)	(2,343)	(1,697)	581	3,940	27,838	(2,423)	22%
Level 4	(16,804)	(10,746)	(8,994)	(7,679)	(6,473)	(5,029)	(2,884)	(2,240)	836	5,158	36,875	(3,064)	21%

Table 5-A.4 Distribution of Payback Period Results for Small Gas-Fired Steam All Except Natural Draft Commercial Packaged Boilers

Efficiency Level	Payback Period from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (yrs)											Average Payback Period
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
Level 1	8.3	13.8	15.9	19.3	21.9	24.0	27.7	33.1	48.5	61.9	100.0	41.6
Level 2	6.3	11.6	15.1	16.3	18.3	20.7	23.7	29.2	37.2	51.7	100.0	41.8
Level 3	6.5	14.0	15.7	17.1	20.5	23.3	26.3	31.4	41.9	57.3	100.0	50.7
Level 4	6.3	14.0	15.5	17.1	20.8	22.8	27.1	30.5	41.6	57.2	100.0	50.8

Table 5-A.5 Distribution of Life-Cycle Cost Savings from Baseline Level for Small Gas-Fired Steam Natural Draft Commercial Packaged Boilers

Efficiency Level	Decrease in LCC from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (2008\$)											Average LCC Savings	Percent of Units with LCC Savings
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%		
Level 1	(4,835)	(2,126)	(1,818)	(1,169)	(833)	(540)	(195)	376	1,419	2,762	8,609	(50)	36%
Level 2	(6,582)	(2,683)	(1,509)	(747)	(152)	403	1,572	2,142	4,037	6,645	23,292	1,657	56%
Level 3	(9,341)	(4,166)	(2,435)	(1,292)	(557)	554	2,233	3,084	5,437	9,233	34,348	2,184	55%
Level 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5-A.6 Distribution of Payback Period Results for Small Gas-Fired Steam Natural Draft Commercial Packaged Boilers

Efficiency Level	Payback Period from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (yrs)											Average Payback Period
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
Level 1	6.3	11.7	13.3	16.3	18.8	20.5	24.1	29.0	40.4	51.5	100.0	30.9
Level 2	4.8	8.6	11.2	11.9	14.2	15.4	18.5	21.9	28.0	37.3	100.0	25.4
Level 3	4.5	9.1	11.0	12.3	14.0	15.8	18.9	21.7	27.6	37.8	100.0	28.7
Level 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5-A.7 Distribution of Life-Cycle Cost Savings from Baseline Level for Small Oil-Fired Hot-Water Commercial Packaged Boilers

Efficiency Level	Decrease in LCC from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (2008\$)											Average LCC Savings	Percent of Units with LCC Savings
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%		
Level 1	(5,795)	(1,041)	417	1,484	2,355	3,287	4,631	6,719	8,645	11,930	25,812	4,902	83%
Level 2	(9,822)	(2,521)	848	2,090	4,498	7,060	9,268	13,189	16,222	23,581	50,570	9,770	86%
Level 3	(16,374)	(6,340)	(1,850)	(140)	4,329	8,179	10,886	16,589	20,640	31,984	71,077	11,482	70%
Level 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5-A.8 Distribution of Payback Period Results for Small Oil-Fired Hot-Water Commercial Packaged Boilers

Efficiency Level	Payback Period from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (yrs)											Average Payback Period
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
Level 1	3.0	5.9	6.9	8.7	9.6	10.6	12.0	15.6	21.7	32.8	100.0	16.5
Level 2	3.4	5.4	6.5	7.5	9.0	9.7	11.0	13.8	20.9	30.7	100.0	17.5
Level 3	4.0	6.3	7.3	8.6	10.3	11.4	12.8	16.5	25.1	34.7	100.0	24.0
Level 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5-A.9 Distribution of Life-Cycle Cost Savings from Baseline Level for Small Oil-Fired Steam Commercial Packaged Boilers

Efficiency Level	Decrease in LCC from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (2008\$)											Average LCC Savings	Percent of Units with LCC Savings
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%		
Level 1	(5,300)	(2,161)	(1,542)	(963)	(443)	(30)	612	1,739	2,939	4,831	11,522	771	49%
Level 2	(8,093)	(3,416)	(1,819)	(993)	87	1,100	2,289	4,397	6,222	9,981	23,873	2,626	61%
Level 3	(14,217)	(6,849)	(3,877)	(2,449)	352	3,004	4,650	8,739	11,651	19,944	46,848	5,406	62%
Level 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5-A.10 Distribution of Payback Period Results for Small Oil-Fired Steam Commercial Packaged Boilers

Efficiency Level	Payback Period from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (yrs)											Average Payback Period
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
Level 1	4.7	9.7	11.4	14.0	15.4	17.1	20.3	24.4	36.2	55.5	100.0	30.2
Level 2	4.7	7.9	9.7	11.6	13.2	14.5	16.3	21.1	29.9	45.1	100.0	29.9
Level 3	4.8	7.5	8.9	10.2	12.4	13.4	15.4	19.3	27.3	42.5	100.0	31.9
Level 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5-A.11 Distribution of Life-Cycle Cost Savings from Baseline Level for Large Gas-Fired Hot Water Commercial Packaged Boilers

Efficiency Level	Decrease in LCC from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (2008\$)											Average LCC Savings	Percent of Units with LCC Savings
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%		
Level 1	(7,088)	(1,151)	968	2,204	3,082	4,664	6,380	7,391	10,379	14,792	44,397	6,411	84%
Level 2	(13,853)	(4,196)	151	2,482	5,022	8,001	11,816	13,603	18,587	26,998	86,473	11,303	80%
Level 3	(24,783)	(11,660)	(4,581)	(2,297)	2,516	6,958	12,160	14,503	21,563	33,693	122,402	11,324	63%
Level 4	(69,300)	(41,579)	(24,835)	(19,529)	(6,341)	3,359	16,004	21,247	38,185	64,809	275,971	13,271	53%

Table 5-A.12 Distribution of Payback Period Results for Large Gas-Fired Hot Water Commercial Packaged Boilers

Efficiency Level	Payback Period from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (yrs)											Average Payback Period
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
Level 1	2.9	5.7	6.7	7.5	8.7	9.6	11.4	13.7	17.0	22.4	100.0	15.3
Level 2	2.7	5.8	6.6	7.4	9.1	9.8	12.2	14.0	17.6	24.0	100.0	19.3
Level 3	3.1	7.1	8.0	8.9	11.0	11.9	14.5	16.4	22.1	30.0	100.0	28.7
Level 4	3.6	8.3	9.3	10.5	13.0	14.4	16.8	19.1	26.8	35.1	100.0	38.3

Table 5-A.13 Distribution of Life-Cycle Cost Savings from Baseline Level for Large Gas-Fired Steam All Except Natural Draft Commercial Packaged Boilers

Efficiency Level	Decrease in LCC from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (2008\$)											Average LCC Savings	Percent of Units with LCC Savings
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%		
Level 1	(6,287)	(123)	2,231	3,416	4,485	5,925	8,001	9,011	11,857	16,409	47,502	7,876	89%
Level 2	(8,685)	1,367	6,226	9,082	11,110	14,183	18,680	20,925	25,892	34,972	96,861	18,144	95%
Level 3	(11,233)	2,809	10,468	14,028	17,717	22,061	28,951	32,322	38,851	52,876	144,785	27,941	96%
Level 4	(14,226)	3,738	14,540	18,477	23,878	29,354	38,490	42,963	51,133	69,927	191,073	37,065	96%

Table 5-A.14 Distribution of Payback Period Results for Large Gas-Fired Steam All Except Natural Draft Commercial Packaged Boilers

Efficiency Level	Payback Period from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (yrs)											Average Payback Period
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
Level 1	2.7	5.3	6.3	7.0	8.1	9.0	10.9	12.9	15.8	20.8	100.0	11.8
Level 2	1.9	3.9	4.6	5.3	6.2	6.8	8.7	9.7	12.0	15.9	100.0	8.8
Level 3	1.7	3.6	4.1	4.7	5.6	6.1	7.8	8.9	11.2	14.6	100.0	8.0
Level 4	1.6	3.6	4.1	4.5	5.5	6.0	7.7	8.6	10.8	14.5	100.0	7.8

Table 5-A.15 Distribution of Life-Cycle Cost Savings from Baseline Level for Large Gas-Fired Steam Natural Draft Commercial Packaged Boilers

Efficiency Level	Decrease in LCC from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (2008\$)											Average LCC Savings	Percent of Units with LCC Savings
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%		
Level 1	(5,375)	1,142	3,626	4,843	6,001	7,431	9,641	10,785	13,637	18,441	51,309	9,531	95%
Level 2	(8,369)	2,116	7,248	10,292	12,435	15,633	20,386	22,811	27,965	37,491	102,705	19,836	96%
Level 3	(13,058)	1,559	9,790	13,278	17,283	21,874	29,138	32,623	39,375	54,301	150,861	28,016	94%
Level 4	(19,771)	(1,131)	10,463	14,435	19,834	25,884	35,259	39,942	48,336	68,129	195,543	33,835	89%

Table 5-A.16 Distribution of Payback Period Results for Large Gas-Fired Steam Natural Draft Commercial Packaged Boilers

Efficiency Level	Payback Period from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (yrs)											Average Payback Period
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
Level 1	2.2	4.2	5.0	5.8	6.4	7.2	8.8	10.3	13.2	16.8	100.0	9.1
Level 2	1.8	3.6	4.2	4.8	5.7	6.2	8.0	9.2	11.0	14.6	100.0	8.0
Level 3	1.8	4.1	4.6	5.2	6.3	6.8	8.8	9.9	12.4	16.6	100.0	9.0
Level 4	2.1	4.7	5.5	6.0	7.3	8.0	10.3	11.5	14.8	19.7	100.0	11.0

Table 5-A.17 Distribution of Life-Cycle Cost Savings from Baseline Level for Large Oil-Fired Hot-Water Commercial Packaged Boilers

Efficiency Level	Decrease in LCC from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (2008\$)											Average LCC Savings	Percent of Units with LCC Savings
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%		
Level 1	(10,218)	3,003	9,906	11,809	16,517	22,101	26,776	34,279	39,667	52,901	105,679	26,820	97%
Level 2	(18,830)	365	9,208	12,329	20,346	28,890	35,123	46,125	53,249	73,859	151,735	35,114	90%
Level 3	(27,863)	(3,398)	7,820	12,348	23,286	34,915	42,582	57,556	65,808	93,918	196,018	42,551	87%
Level 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5-A.18 Distribution of Payback Period Results for Large Oil-Fired Hot-Water Commercial Packaged Boilers

Efficiency Level	Payback Period from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (yrs)											Average Payback Period
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
Level 1	2.0	3.2	4.0	4.7	5.3	6.0	6.5	8.9	12.8	18.0	100.0	8.4
Level 2	2.5	4.1	4.7	5.8	6.7	7.7	8.3	11.4	16.4	22.5	100.0	11.8
Level 3	2.8	4.6	5.2	6.5	7.6	8.6	9.4	12.9	18.7	26.2	100.0	14.3
Level 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5-A.19 Distribution of Life-Cycle Cost Savings from Baseline Level for Large Oil-Fired Steam Commercial Packaged Boilers

Efficiency Level	Decrease in LCC from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (2008\$)											Average LCC Savings	Percent of Units with LCC Savings
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%		
Level 1	(5,942)	1,393	5,391	6,226	8,489	11,500	13,671	17,591	20,883	27,472	54,869	13,940	97%
Level 2	(10,395)	3,130	10,313	12,186	16,978	22,705	27,615	35,311	40,804	54,353	108,458	27,598	97%
Level 3	(17,526)	2,256	11,666	14,495	22,770	31,394	38,172	49,484	56,790	77,382	157,677	37,978	91%
Level 4	(30,292)	1,050	15,578	20,857	34,668	49,200	59,709	78,021	88,959	123,551	253,899	59,175	90%

Table 5-A.20 Distribution of Payback Period Results for Large Oil-Fired Steam Commercial Packaged Boilers

Efficiency Level	Payback Period from Baseline (Level 0) Shown by Percentiles of the Distribution of Results (yrs)											Average Payback Period
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
Level 1	1.8	3.4	4.1	4.9	5.6	6.4	7.0	9.3	12.7	19.1	100.0	8.5
Level 2	2.1	3.3	4.1	4.8	5.5	6.1	6.7	9.2	13.2	18.5	100.0	8.4
Level 3	2.4	3.8	4.5	5.5	6.4	7.2	7.9	10.8	15.5	21.3	100.0	10.3
Level 4	2.5	4.2	4.8	6.0	6.9	7.8	8.6	11.4	17.0	23.7	100.0	11.5