

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	(6,640)	(2,669)	(1,822)	(1,286)	(718)	34	484	1,385	2,938	6,102	19,009	860	51%
Level 2	(11,243)	(5,286)	(3,481)	(1,996)	(891)	238	1,770	2,952	5,905	11,547	37,702	2,007	51%
Level 3	(18,847)	(10,218)	(8,317)	(6,605)	(4,715)	(2,410)	(707)	1,466	5,364	13,071	51,800	(319)	37%
Level 4	(29,969)	(19,410)	(17,703)	(15,017)	(11,880)	(9,102)	(7,262)	(3,712)	181	10,798	60,781	(6,649)	20%

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	4.8	8.6	10.4	11.5	13.3	14.7	16.4	20.6	29.2	36.5	100.0	26.8
Level 2	3.9	7.3	8.9	10.2	11.4	12.8	14.8	18.0	23.7	32.3	100.0	30.7
Level 3	4.2	8.8	9.9	11.0	12.8	14.4	16.1	20.1	26.9	36.9	100.0	42.5
Level 4	4.9	10.8	11.4	12.7	15.2	17.5	19.5	24.4	33.0	45.2	100.0	56.5

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	(6,081)	(3,761)	(3,081)	(2,540)	(2,142)	(1,820)	(1,611)	(886)	(275)	1,181	7,637	(1,530)	17%
Level 2	(9,248)	(5,083)	(4,251)	(3,773)	(3,126)	(2,356)	(1,836)	(1,040)	579	3,704	16,977	(1,545)	26%
Level 3	(14,260)	(8,969)	(7,590)	(6,734)	(6,034)	(4,876)	(3,682)	(2,478)	(470)	4,056	24,004	(3,521)	19%
Level 4	(17,891)	(11,580)	(9,858)	(8,371)	(7,406)	(5,874)	(4,283)	(2,705)	(158)	5,634	32,229	(4,163)	20%

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	8.5	13.8	17.0	19.8	23.7	26.2	29.7	37.6	49.1	66.0	100.0	44.1
Level 2	6.8	12.4	15.1	16.4	18.8	21.8	23.3	28.3	40.6	52.8	100.0	42.8
Level 3	6.8	12.9	15.7	17.8	19.7	22.6	25.3	31.6	42.8	58.6	100.0	51.2
Level 4	6.4	12.7	14.7	16.9	18.7	21.9	24.6	30.3	41.8	56.4	100.0	50.7

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	(5,480)	(2,975)	(2,364)	(1,763)	(1,402)	(1,070)	(774)	(82)	534	2,142	9,010	(712)	28%
Level 2	(7,301)	(3,092)	(2,135)	(1,491)	(970)	(21)	351	1,313	3,007	6,347	20,449	789	50%
Level 3	(10,235)	(4,947)	(3,275)	(2,415)	(1,493)	(647)	836	1,866	4,119	8,715	30,382	1,103	47%
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	6.6	12.0	14.2	17.4	20.2	22.4	26.2	31.9	41.3	56.5	100.0	33.5
Level 2	5.3	9.5	11.6	12.7	14.4	16.6	18.1	22.3	32.1	39.7	100.0	26.6
Level 3	4.9	9.0	11.2	12.3	13.9	15.5	18.0	22.2	28.3	39.8	100.0	28.9
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	(6,558)	(2,233)	(1,331)	(207)	374	1,061	2,039	3,955	5,660	8,592	20,515	2,441	67%
Level 2	(10,921)	(4,207)	(1,679)	(459)	1,777	3,133	5,036	7,924	11,156	16,624	40,634	5,376	65%
Level 3	(17,981)	(8,989)	(5,264)	(4,032)	(236)	2,037	4,365	8,828	12,848	22,033	56,661	5,212	60%
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	3.3	6.4	7.6	9.6	10.3	11.8	13.5	17.5	24.7	36.9	100.0	19.2
Level 2	3.6	5.7	7.0	8.1	9.9	10.3	12.0	15.1	23.4	33.5	100.0	19.6
Level 3	4.1	6.5	7.6	8.9	11.2	11.8	13.5	16.4	26.7	37.7	100.0	26.6
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	(5,997)	(3,223)	(2,630)	(1,949)	(1,717)	(1,312)	(883)	79	1,076	2,158	8,535	(732)	30%
Level 2	(9,010)	(4,632)	(3,648)	(2,811)	(1,940)	(1,433)	(111)	1,614	3,342	6,214	18,410	88	40%
Level 3	(15,606)	(8,563)	(6,371)	(5,369)	(2,901)	(1,794)	657	3,370	6,426	12,730	36,593	864	43%
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	5.3	10.4	12.1	16.2	17.2	18.7	21.8	27.6	40.8	57.0	100.0	35.1
Level 2	5.1	8.5	10.2	12.1	14.0	14.8	17.6	22.5	33.6	50.0	100.0	33.7
Level 3	5.0	7.9	9.3	10.6	13.1	14.1	16.3	20.4	30.8	45.8	100.0	35.0
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	(7,793)	(2,057)	113	1,265	2,229	3,165	5,183	6,483	8,812	14,010	39,858	5,254	81%
Level 2	(14,925)	(4,412)	(1,541)	1,516	3,252	6,408	9,505	12,070	16,565	27,058	77,989	9,421	74%
Level 3	(26,492)	(11,895)	(7,122)	(3,793)	(209)	4,603	8,521	12,271	19,407	33,980	110,024	8,678	60%
Level 4	(73,288)	(41,216)	(27,814)	(23,363)	(11,361)	(715)	8,371	16,008	32,442	64,130	247,420	7,637	48%

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	3.2	5.8	7.1	7.9	8.9	9.8	12.1	14.7	19.0	23.9	100.0	16.0
Level 2	2.8	5.8	6.6	7.8	8.6	9.7	11.8	14.2	18.8	24.2	100.0	19.3
Level 3	3.2	7.1	7.8	8.9	10.4	11.4	13.6	16.4	22.1	29.3	100.0	27.8
Level 4	3.6	7.9	9.1	9.8	12.2	13.4	15.8	18.7	25.5	35.2	100.0	37.1

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	(6,966)	(920)	1,314	2,550	3,544	4,537	6,705	7,921	10,536	15,596	42,829	6,711	86%
Level 2	(9,475)	1,002	5,310	7,817	9,650	13,381	15,838	18,799	23,791	33,810	88,152	16,291	94%
Level 3	(12,147)	2,526	8,710	13,078	15,408	21,093	24,692	29,178	36,490	51,369	132,137	25,415	95%
Level 4	(14,990)	3,557	11,842	17,516	21,263	28,227	33,144	39,167	48,637	68,284	174,820	34,087	95%

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	3.0	5.4	6.6	7.4	8.3	9.3	11.5	13.8	17.9	22.2	100.0	12.5
Level 2	2.0	4.0	4.7	5.4	6.2	7.1	8.3	10.0	13.2	16.7	100.0	9.1
Level 3	1.8	3.5	4.2	5.0	5.4	6.4	7.6	8.9	11.6	15.0	100.0	8.1
Level 4	1.6	3.4	4.0	4.7	5.3	6.1	7.3	8.6	11.3	14.4	100.0	7.7

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	(6,002)	410	2,675	3,933	4,998	6,184	8,201	9,685	12,423	17,625	46,427	8,339	92%
Level 2	(9,131)	1,745	6,278	9,088	10,868	14,826	17,441	20,606	25,845	36,301	93,576	17,917	95%
Level 3	(14,106)	1,384	7,812	12,501	14,889	20,860	24,667	29,265	36,953	52,720	137,580	25,371	93%
Level 4	(20,951)	(1,289)	7,430	13,772	17,221	24,835	29,919	35,629	45,714	66,862	178,439	30,669	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	2.4	4.5	5.4	6.2	6.7	7.5	9.5	11.2	14.9	18.0	100.0	9.8
Level 2	1.9	3.7	4.4	5.0	5.7	6.5	7.7	9.3	12.1	15.4	100.0	8.2
Level 3	1.9	4.0	4.6	5.5	6.1	7.2	8.6	10.0	12.7	16.8	100.0	9.1
Level 4	2.1	4.7	5.2	6.2	7.1	8.1	9.6	11.2	14.6	19.3	100.0	10.8

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	(11,478)	(548)	5,488	6,684	11,521	15,004	17,915	23,807	29,198	40,207	87,157	18,874	89%
Level 2	(20,827)	(4,721)	3,112	4,990	12,987	18,265	21,874	30,699	37,902	55,504	124,408	23,498	86%
Level 3	(30,624)	(9,071)	79	2,518	13,755	20,800	25,006	37,060	45,700	69,805	160,078	27,342	80%
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	2.1	3.4	4.2	4.7	5.8	6.2	7.0	9.1	13.7	19.7	100.0	9.3
Level 2	2.6	4.3	4.9	5.8	7.3	7.8	8.7	10.7	17.7	23.7	100.0	12.9
Level 3	2.9	4.7	5.5	6.6	8.2	8.7	9.6	12.0	19.2	26.7	100.0	15.4
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	(6,788)	(136)	2,450	4,019	5,554	7,062	9,316	12,302	15,668	20,601	45,059	9,613	88%
Level 2	(11,695)	(499)	5,811	7,019	11,855	15,468	18,562	24,591	30,090	41,261	89,501	19,472	89%
Level 3	(19,479)	(2,996)	5,416	7,029	15,030	20,598	24,756	33,736	41,075	58,668	129,742	26,117	86%
Level 4	(33,119)	(6,163)	6,050	9,065	22,806	31,733	38,210	53,063	63,709	93,590	208,870	40,322	86%

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	2.0	3.8	4.5	5.7	6.3	6.9	7.8	10.2	14.6	21.4	100.0	9.7
Level 2	2.2	3.4	4.4	4.9	6.0	6.4	7.2	9.3	14.1	20.1	100.0	9.3
Level 3	2.5	4.0	4.7	5.6	6.9	7.4	8.2	10.9	16.9	22.4	100.0	11.2
Level 4	2.6	4.2	4.9	6.0	7.2	7.8	8.6	11.3	17.2	24.0	100.0	12.3