CHAPTER 11. LIFE-CYCLE COST SUBGROUP ANALYSIS

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CHAPTER 11. LIFE-CYCLE COST SUBGROUP ANALYSIS

11.1 INTRODUCTION

Chapter 8 describes the life-cycle cost (LCC) and payback period (PBP) analyses that examine impacts of energy conservation standards on the U.S. population. In analyzing the potential impact of new or amended standards on residential consumers, DOE further evaluates the impact on identifiable groups of consumers (i.e., subgroups) that may be disproportionately affected by a national standard level. The LCC subgroup analysis evaluates impacts by analyzing the LCC and PBPs for subgroups of residential consumers.

For gas-fired and electric storage water heaters, DOE identified four consumer subgroups that warranted further study: (a) households composed of people 65 years of age or older (senior-only); (b) households at or below the poverty line (low-income); (c) households located in buildings with 2 or more units (multi-family); and (d) households living in manufactured homes. For gas wall fan and gas wall gravity DHE, DOE analyzed the impacts for the senior-only and low-income subgroups, and for gas hearth DHE, DOE analyzed the impacts for the senior-only subgroup.

DOE determined the impact on consumer subgroups for heating products using the LCC Spreadsheet Model, which allows for the examination of particular consumer subgroups. DOE has the ability to use the LCC Spreadsheet Model to analyze the LCC for any subgroup by sampling only the data that apply to that subgroup (Chapter 8 explains in detail the inputs to the model used in determining LCC and PBPs). As described in section 11.3, the energy use and energy price characteristics of the four subgroups (senior-only, low-income, multi-family, and manufactured homes) are different than that for the general population.

This chapter describes the subgroup identification in further detail and gives the results of the LCC and PBP analyses for the considered subgroups.

11.2 SUBGROUPS DEFINITION

11.2.1 Senior-Only Households

Senior-only households have occupants who are all at least 65 years of age. Based on the DOE Energy Information Administration (EIA)'s Residential Energy Consumption Survey of 2005 (RECS), senior-only households comprise 17 percent of the country's households.[1]

11.2.2 Low-Income Households

As defined in the RECS survey, low-income households are considered to be those at or below the "poverty line." The "poverty line" varies with household size, head of household age, and family income. Table 11.2.1 summarizes the income level baselines for selecting low-income households from the RECS sample. The RECS survey classifies 15 percent of the country's households as low-income.

Table 11.2.1 RECS 2005 Definitions of Low-Income Households by Yearly Income

	Average Income in $		
Household Size	**48 Contiguous States and D.C.**	**Alaska**	**Hawaii**
1	9,570	11,950	11,010
2	12,830	16,030	14,760
3	16,090	20,100	18,510
4	19,350	24,190	22,260
5	22,610	28,270	26,010
6	25,870	32,350	29,760
7	29,130	36,430	33,510
8	32,390	40,510	37,260
9	35,650	44,590	41,010
10	38,910	48,670	44,760
11	42,170	52,750	48,510
12	45,430	56,830	52,260
13	48,690	60,910	56,010
14	51,950	64,990	59,760
15	55,210	69,070	63,510

11.2.3 Multi-Family Households

Multi-family households are located in buildings with 2 or more units. According to the RECS survey, multi-family households comprise 22 percent of the country's households. This subgroup was only analyzed for water heaters. It comprises 11.1 percent of the sample used for gas-fire storage water heaters, and 17.2 percent of the sample used for electric storage water heaters.

11.2.4 Manufactured Home Households

According to the RECS survey, households living in manufactured homes comprise 6 percent of the country's households. This subgroup was only analyzed for water heaters. It comprises 3.5 percent of the sample used for gas-fired storage water heaters, and 11.9 percent of the sample used for electric storage water heaters.

11.3 INPUTS TO THE LIFE-CYCLE COST AND PAYBACK PERIOD SUBGROUP ANALYSIS

DOE performed the consumer subgroup analysis by analyzing the LCC and PBP of senior-only, low-income, multi-family, and manufactured households with the spreadsheet models used for the LCC and PBP analysis.

Tables 11.3.1 and 11.3.2 summarize the household populations for water heaters and direct heating equipment, while Tables 11.3.3 and 11.3.4 summarize the weighted-average annual energy

use for the households analyzed in the consumer subgroup analyses. These values are compared against the weighted-average values for the national sample.

For water heaters, DOE performed subgroup analyses for gas-fired storage water heaters and electric storage water heaters. Oil-fired storage water heaters were excluded due to low product shipments. Gas-fired instantaneous water heaters were excluded due to insufficient data.

For direct heating equipment, DOE performed subgroup analyses for gas wall gravity DHE and gas fan wall DHE. Gas floor DHE were excluded due to the low and decreasing levels of product shipments. Gas room DHE were excluded for this same reason. For gas hearth DHE, DOE performed the senior-only analysis but did not perform the low-income analysis due to the extremely small sample size, and relatively high product cost.

Table 11.3.1 Household Population Data for Water Heaters

	Gas		Electric	
	Count	Weight	Count	Weight
National	2,166	55,180,081	1,523	39,506,510
Senior Only	317	9,082,147	256	6,900,727
Senior Only %	14.6%	16.5%	16.8%	17.5%
Low Income	311	6,336,149	291	6,294,691
Low Income %	14.4%	11.5%	19.1%	15.9%
Multi-Family	241	6,140,241	267	6,799,555
Multi-Family %	11.1%	11.1%	17.5%	17.2%
Manufactured Home	90	1,948,744	181	4,719,689
Manufactured Home %	4.2%	3.5%	11.9%	11.9%

Table 11.3.2 Household Population Data for Direct Heating Equipment

	Gas Wall Fan / Gas Wall Gravity		Gas Floor		Gas Room		Gas Hearth	
	Count	Weight (million)	Count	Weight (million)	Count	Weight	Count	Weight
National	101	2.45	95	2.30	153	3.83	121	3.10
Seniors	14	0.46	13	0.40	38	0.94	15	0.40
Low Income	30	0.69	29	0.67	36	0.85	4	0.08

Table 11.3.3 Weighted-Average Annual Energy Use for Baseline for Water Heaters

	All Households	Senior -Only	Low-Income	Multi-Family	Mfr Homes
Gas-Fired Water Heaters					
Water-Heating Natural Gas Use (MMBtu)	16.5	13.4	16.4	11.9	15.9
Water-Heating Electricity Use (kWh)	0.0	0.0	0.0	0.0	0.0
Electric Water Heaters					
Water-Heating Electricity Use (kWh)	2604	2193	2576	1391	2579

Table 11.3.4 Weighted-Average Annual Energy Use for Baseline for Direct Heating Equipment

	All Households	Senior-Only	Low-Income
Gas Wall Fan DHE			
Space-Heating Natural Gas Use (MMBtu)	29.9	33.7	42.0
Space-Heating Electricity Use (kWh)	38.6	43.4	54.0
Gas Wall Gravity DHE			
Space-Heating Natural Gas Use (MMBtu)	29.9	33.7	42.0
Space-Heating Electricity Use (kWh)	0.0	0.0	0.0
Gas Hearth DHE			
Space-Heating Natural Gas Use (MMBtu)	16.6	18.2	NA
Space-Heating Electricity Use (kWh)	0.0	0.0	NA

11.4 RESULTS

11.4.1 Water Heaters

Tables 11.4.1 through 11.4.8 below summarize the LCC results for gas-fired storage water heaters and electric storage water heaters. The LCC results provide the average installed price, average lifetime operating cost (discounted), average life-cycle cost, average life-cycle cost savings, the percentage of consumers that are burdened with net costs, realize net savings, or are not impacted, and the median and average payback period.

Table 11.4.1 Gas-Fired Storage Water Heaters: LCC and PBP Results for Senior-Only Households

EF	Life-Cycle Cost *(2009$)*			Life-Cycle Cost Savings				Payback Period *(years)***	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings *(2009$)*	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
0.59	$1,054	$2,039	$3,092						
0.62	$1,143	$1,929	$3,072	$14	27%	32%	41%	1.9	19.4
0.63	$1,213	$1,868	$3,081	$7	34%	19%	47%	4.1	19.5
0.64	$1,539	$1,862	$3,401	-$278	73%	11%	16%	36.4	57.8
0.65	$1,571	$1,800	$3,371	-$250	71%	6%	22%	27.4	39.9
0.67	$1,631	$1,724	$3,355	-$235	71%	6%	22%	22.5	27.8
0.80	$1,869	$1,508	$3,377	-$257	75%	1%	24%	17.4	18.2

* "No impact" means that the base case product assigned to the household has greater efficiency than the level indicated, so the household is not affected.

** Based on the payback calculation, a very small change in operating cost can result in a few extremely large paybacks, which will skew the average payback period. In these cases, median is probably a better indicator.

Table 11.4.2 Gas-Fired Storage Water Heaters: LCC and PBP Results for Low-Income Households

EF	Life-Cycle Cost *(2009$)*			Life-Cycle Cost Savings				Payback Period *(years)***	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings *(2009$)*	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
0.59	$1,043	$2,565	$3,608						
0.62	$1,142	$2,449	$3,591	$9	29%	31%	40%	2.1	18.7
0.63	$1,221	$2,389	$3,610	-$8	36%	19%	45%	6.1	21.2
0.64	$1,540	$2,382	$3,922	-$284	72%	11%	17%	37.9	57.4
0.65	$1,579	$2,321	$3,900	-$264	71%	6%	22%	28.9	41.7
0.67	$1,649	$2,229	$3,877	-$243	71%	6%	23%	22.9	28.5
0.80	$1,882	$1,965	$3,847	-$213	70%	2%	28%	16.4	17.6

* "No impact" means that the base case product assigned to the household has greater efficiency than the level indicated, so the household is not affected.
** Based on the payback calculation, a very small change in operating cost can result in a few extremely large paybacks, which will skew the average payback. In these cases, median is probably a better indicator.

Table 11.4.3 Gas-Fired Storage Water Heaters: LCC and PBP Results for Multi-Family Households

EF	Life-Cycle Cost *(2009$)*			Life-Cycle Cost Savings				Payback Period *(years)***	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings *(2009$)*	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
0.59	$1,098	$1,710	$2,808						
0.62	$1,207	$1,618	$2,825	-$11	31%	33%	36%	2.4	26.5
0.63	$1,306	$1,562	$2,868	-$45	41%	21%	38%	11.0	27.2
0.64	$1,623	$1,563	$3,186	-$327	73%	11%	16%	43.9	67.3
0.65	$1,667	$1,504	$3,172	-$314	73%	6%	21%	32.9	49.0
0.67	$1,751	$1,431	$3,182	-$324	74%	6%	19%	27.2	35.2
0.80	$1,977	$1,262	$3,239	-$380	79%	2%	19%	21.2	23.2

* "No impact" means that the base case product assigned to the household has greater efficiency than the level indicated, so the household is not affected.
** Based on the payback calculation, a very small change in operating cost can result in a few extremely large paybacks, which will skew the average payback. In these cases, median is probably a better indicator.

Table 11.4.4 Gas-Fired Storage Water Heaters: LCC and PBP Results for Manufactured Home Households

EF	Life-Cycle Cost *(2009$)*			Life-Cycle Cost Savings				Payback Period *(years)***	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings *(2009$)*	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
0.59	$1,021	$2,994	$4,015						
0.62	$1,177	$2,857	$4,035	-$17	36%	29%	35%	9.9	25.1
0.63	$1,293	$2,789	$4,082	-$59	48%	17%	34%	13.1	26.7
0.64	$1,502	$2,765	$4,266	-$222	69%	11%	20%	28.7	48.0
0.65	$1,588	$2,695	$4,283	-$238	70%	6%	24%	25.0	36.9
0.67	$1,709	$2,566	$4,275	-$232	69%	6%	25%	21.1	27.3
0.80	$1,932	$2,275	$4,207	-$164	64%	2%	34%	14.7	17.0

* "No impact" means that the base case product assigned to the household has greater efficiency than the level indicated, so the household is not affected.
** Based on the payback calculation, a very small change in operating cost can result in a few extremely large paybacks, which will skew the average payback. In these cases, median is probably a better indicator.

Table 11.4.5 Electric Storage Water Heaters: LCC and PBP Results for Senior-Only Households

EF	Life-Cycle Cost *(2009$)*			Life-Cycle Cost Savings				Payback Period *(years)***	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings *(2009$)*	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
0.90	$569	$2,307	$2,876						
0.91	$601	$2,271	$2,872	$0	7%	65%	28%	3.7	11.2
0.92	$622	$2,236	$2,859	$6	11%	42%	47%	3.8	10.1
0.93	$631	$2,218	$2,849	$11	12%	38%	50%	3.8	9.9
0.94	$671	$2,167	$2,839	$19	21%	16%	63%	5.0	9.2
0.95	$705	$2,132	$2,837	$20	30%	10%	60%	6.3	9.6
2.00	$1,576	$1,361	$2,937	-$76	59%	5%	36%	11.0	21.6
2.35	$1,702	$1,193	$2,895	-$34	58%	1%	41%	10.5	17.5

* "No impact" means that the base case product assigned to the household has greater efficiency than the level indicated, so the household is not affected.
** Based on the payback calculation, a very small change in operating cost can result in a few extremely large paybacks, which will skew the average payback. In these cases, median is probably a better indicator.

Table 11.4.6 Electric Storage Water Heaters: LCC and PBP Results for Low-Income Households

EF	Life-Cycle Cost *(2009$)*			Life-Cycle Cost Savings				Payback Period *(years)***	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings *(2009$)*	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
0.90	$550	$2,653	$3,204						
0.91	$590	$2,620	$3,211	-$6	11%	62%	28%	4.0	14.2
0.92	$612	$2,591	$3,203	-$3	15%	39%	46%	4.2	12.4
0.93	$620	$2,576	$3,196	$1	16%	36%	48%	4.2	12.2
0.94	$666	$2,530	$3,196	$0	29%	14%	57%	5.5	11.1
0.95	$697	$2,501	$3,197	-$1	38%	9%	53%	7.1	11.3
2.00	$1,587	$1,545	$3,132	$61	54%	5%	41%	10.1	28.4
2.35	$1,711	$1,367	$3,078	$114	54%	1%	45%	9.9	23.0

* "No impact" means that the base case product assigned to the household has greater efficiency than the level indicated, so the household is not affected.
** Based on the payback calculation, a very small change in operating cost can result in a few extremely large paybacks, which will skew the average payback. In these cases, median is probably a better indicator.

Table 11.4.7 Electric Storage Water Heaters: LCC and PBP Results for Multi-Family Households

EF	Life-Cycle Cost *(2009$)*			Life-Cycle Cost Savings				Payback Period *(years)***	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings *(2009$)*	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
0.90	$536	$1,478	$2,013						
0.91	$576	$1,443	$2,020	-$4	11%	54%	36%	3.8	12.4
0.92	$595	$1,419	$2,015	-$2	14%	35%	50%	4.0	11.6
0.93	$601	$1,408	$2,009	$1	15%	32%	52%	4.0	11.3
0.94	$655	$1,362	$2,017	-$6	31%	13%	56%	5.6	11.7
0.95	$679	$1,339	$2,018	-$7	37%	9%	54%	6.9	11.6
2.00	$1,536	$932	$2,468	-$436	79%	5%	16%	25.5	67.9
2.35	$1,656	$823	$2,479	-$447	81%	1%	18%	24.4	50.8

* "No impact" means that the base case product assigned to the household has greater efficiency than the level indicated, so the household is not affected.
** Based on the payback calculation, a very small change in operating cost can result in a few extremely large paybacks, which will skew the average payback. In these cases, median is probably a better indicator.

Table 11.4.8 Electric Storage Water Heaters: LCC and PBP Results for Manufactured Home Households

EF	Life-Cycle Cost *(2009$)*			Life-Cycle Cost Savings				Payback Period *(years)***	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings *(2009$)*	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
0.90	$536	$2,566	$3,102						
0.91	$606	$2,534	$3,141	-$25	22%	56%	22%	20.3	23.7
0.92	$641	$2,511	$3,152	-$32	31%	35%	33%	7.0	21.8
0.93	$652	$2,500	$3,151	-$31	33%	33%	35%	7.7	21.4
0.94	$696	$2,457	$3,153	-$33	47%	14%	40%	13.0	15.4
0.95	$721	$2,433	$3,154	-$35	54%	9%	38%	12.9	14.8
2.00	$1,622	$1,481	$3,103	$14	56%	5%	39%	10.5	25.0
2.35	$1,744	$1,311	$3,055	$61	55%	1%	44%	10.1	21.4

* "No impact" means that the base case product assigned to the household has greater efficiency than the level indicated, so the household is not affected.
** Based on the payback calculation, a very small change in operating cost can result in a few extremely large paybacks, which will skew the average payback. In these cases, median is probably a better indicator.

11.4.2 Direct Heating Equipment

Tables 11.4.9 through 11.4.13 below summarize the LCC results for gas wall fan DHE and gas wall gravity DHE. The LCC results provide the average installed price, average lifetime operating cost (discounted), average life-cycle cost, average life-cycle savings, the percentage of consumers that are burdened with net costs, realize net savings, or are not impacted, and the median and average payback period.

Table 11.4.9 Gas Wall Fan DHE: LCC and PBP Results for Senior-Only Households

AFUE (%)	Life-Cycle Cost *(2009$)*			Life-Cycle Cost Savings				Payback Period *(years)***	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings *(2009$)*	Households with			Median	Average
					Net Cost	Net Benefit	No Impact*		
74	$1,795	$6,657	$8,452						
75	$1,852	$6,346	$8,198	$102	0%	60%	40%	2.6	2.5
76	$1,877	$6,268	$8,145	$127	2%	53%	45%	2.9	3.5
77	$1,922	$6,192	$8,114	$149	15%	26%	59%	4.4	8.5
80	$2,160	$5,981	$8,142	$123	42%	7%	51%	9.3	28.6

* "No impact" means that the base case product assigned to the household has greater efficiency than the level indicated, so the household is not affected.
** Based on the payback calculation, a very small change in operating cost can result in a few extremely large paybacks, which will skew the average payback. In these cases, median is probably a better indicator.

Table 11.4.10 Gas Wall Fan DHE: LCC and PBP Results for Low-Income Households

AFUE (%)	Life-Cycle Cost *(2009$)*			Life-Cycle Cost Savings				Payback Period *(years)***	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings *(2009$)*	Households with			Median	Average
					Net Cost	Net Benefit	No Impact*		
74	$1,821	$7,960	$9,781						
75	$1,877	$7,692	$9,569	$85	0%	60%	40%	2.7	2.8
75	$1,902	$7,596	$9,498	$118	1%	53%	46%	3.0	3.5
77	$1,948	$7,503	$9,451	$153	11%	26%	63%	4.1	7.9
80	$2,190	$7,249	$9,439	$163	38%	7%	55%	8.3	18.1

* "No impact" means that the base case product assigned to the household has greater efficiency than the level indicated, so the household is not affected.
** Based on the payback calculation, a very small change in operating cost can result in a few extremely large paybacks, which will skew the average payback. In these cases, median is probably a better indicator.

Table 11.4.11 Gas Wall Gravity DHE: LCC and PBP Results for Senior-Only Households

AFUE (%)	Life-Cycle Cost *(2009$)*			Life-Cycle Cost Savings				Payback Period *(years)***	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings *(2009$)*	Households with			Median	Average
					Net Cost	Net Benefit	No Impact*		
64	$1,385	$6,610	$7,995						
66	$1,446	$6,431	$7,877	$30	7%	75%	18%	5.4	11.6
68	$1,482	$6,262	$7,745	$97	11%	50%	39%	3.9	9.0
69	$1,562	$6,182	$7,744	$97	25%	37%	38%	7.8	18.2
70	$1,862	$5,951	$7,813	$28	56%	0%	44%	11.8	19.4

* "No impact" means that the base case product assigned to the household has greater efficiency than the level indicated, so the household is not affected.
** Based on the payback calculation, a very small change in operating cost can result in a few extremely large paybacks, which will skew the average payback. In these cases, median is probably a better indicator.

Table 11.4.12 Gas Wall Gravity DHE: LCC and PBP Results for Low-Income Households

AFUE (%)	Life-Cycle Cost *(2009$)*			Life-Cycle Cost Savings				Payback Period *(years)***	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings *(2009$)*	Households with			Median	Average
					Net Cost	Net Benefit	No Impact*		
64	$1,417	$7,900	$9,317						
66	$1,478	$7,681	$9,160	$39	6%	75%	19%	4.5	8.1
68	$1,515	$7,476	$8,990	$124	9%	50%	42%	3.2	5.5
69	$1,594	$7,377	$8,971	$135	20%	37%	43%	6.3	12.5
70	$1,903	$7,206	$9,110	-$3	63%	0%	37%	13.8	20.3

* "No impact" means that the base case product assigned to the household has greater efficiency than the level indicated, so the household is not affected.
** Based on the payback calculation, a very small change in operating cost can result in a few extremely large paybacks, which will skew the average payback. In these cases, median is probably a better indicator.

Table 11.4.13 Gas Hearth DHE: LCC and PBP Results for Senior-Only Households

AFUE (%)	Life-Cycle Cost *(2009$)*			Life-Cycle Cost Savings				Payback Period *(years)***	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings *(2009$)*	Households with			Median	Average
					Net Cost	Net Benefit	No Impact*		
64	$1,614	$4,298	$5,912						
67	$1,695	$3,886	$5,581	$131	2%	61%	38%	0.0	2.7
72	$2,088	$3,643	$5,732	$15	49%	23%	28%	13.8	27.3
93	$2,890	$2,910	$5,801	-$54	68%	1%	31%	17.4	57.6

* "No impact" means that the base case product assigned to the household has greater efficiency than the level indicated, so the household is not affected.
** Based on the payback calculation, a very small change in operating cost can result in a few extremely large paybacks, which will skew the average payback. In these cases, median is probably a better indicator.

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