

CHAPTER 11. CONSUMER SUB-GROUP ANALYSIS

TABLE OF CONTENTS

11.1	INTRODUCTION	11-1
11.2	SENIOR AND LOW-INCOME HOUSEHOLDS	11-1
	11.2.1 Sub-Groups Definition	11-1
	11.2.2 Inputs to the Life-Cycle Cost and Payback Period Sub-Group Analysis	11-2
	11.2.3 Results for Senior and Low-Income Households	11-3
11.3	NORTHERN AND SOUTHERN HOUSEHOLDS	11-6
	11.3.1 Sub-Groups Definition	11-6
	11.3.2 Inputs to the Life-Cycle Cost and Payback Period Sub-Group Analysis	11-7
	11.3.3 Results for Northern and Southern Households	11-8
	11.3.4 Energy Price Sensitivity Analysis for Northern and Southern Households Using AEO 2006 Energy Price Forecast	11-10

LIST OF TABLES

Table 11.2.1	RECS 2001 Definitions of Low-Income Households	11-2
Table 11.2.2	Comparison of Input Values for All Households, Senior-Only, and Low-Income Households	11-3
Table 11.2.3	Non-Weatherized Gas Furnaces: LCC and PBP Results for Senior Households	11-4
Table 11.2.4	Non-Weatherized Gas Furnaces: LCC and PBP Results for Low-Income Households	11-5
Table 11.3.1	Definition of Northern and Southern regions using RECS 2001	11-6
Table 11.3.2	Comparison of Input Values for All Households, Northern, and Southern Households	11-7
Table 11.3.3	Non-Weatherized Gas Furnaces: LCC and PBP Results for Northern Households (AEO 2005)	11-8
Table 11.3.4	Non-Weatherized Gas Furnaces: LCC and PBP Results for Southern Households (AEO 2005)	11-9
Table 11.3.5	Non-Weatherized Gas Furnaces: LCC and PBP Results for Northern Households (AEO 2006)	11-10
Table 11.3.6	Non-Weatherized Gas Furnaces: LCC and PBP Results for South Households (AEO 2006)	11-11

CHAPTER 11. CONSUMER SUB-GROUP ANALYSIS

11.1 INTRODUCTION

The intent of the consumer sub-group analysis is to evaluate impacts to identifiable groups or consumers who may be disproportionately affected by a revised national energy efficiency standard. This is accomplished in part by analyzing the life-cycle cost and payback periods for those households that fall into identifiable groups of consumers.

The Department is especially sensitive to increases in the purchase price of equipment, to avoid negative impacts on identifiable population groups, such as senior-only and low-income households, that may not be able to afford significant increases in equipment price. For customers that are sensitive to price increases, increases in first costs of a product can preclude the purchase of a new model of that product. As a result, some customers may retain existing products. These older products are generally less efficient to begin with, and their efficiency may deteriorate further if they are retained beyond their useful life.

The Department also evaluated a scenario to separately assess the impact on northern (cold-climate) states and southern (warm-climate) states for non-weatherized gas furnaces (NWGF).

The Department only evaluated non-weatherized gas furnaces for the different subgroup scenarios, since non-weatherized gas furnace are the predominant product class with shipments much larger than the other product classes.

11.2 SENIOR AND LOW-INCOME HOUSEHOLDS

11.2.1 Sub-Groups Definition

The consumer sub-group analysis evaluated households with senior-only occupants or low income levels using non-weatherized gas furnaces. Senior-only households have occupants who are all at least sixty-five years of age. As defined in the DOE's Energy Information Administration (EIA) Residential Energy Consumption Survey of 2001 (*RECS 2001*),¹ 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 criteria as given for selecting low-income households from the *RECS 2001* sample. The Department applied an additional criterion to select only those low-income households who own their home, since renters do not purchase furnaces.

Table 11.2.1 RECS 2001 Definitions of Low-Income Households

Household Size	Owner Age	Family Income
1	65 and over	less than \$7,525
1	64 and under	less than \$8,163
2	65 and over	less than \$9,491
2	64 and under	less than \$10,507
3	Any	less than \$12,516
4	Any	less than \$16,036
5	Any	less than \$18,952
6	Any	less than \$21,389
7	Any	less than \$24,268
8	Any	less than \$27,091
9 or more	Any	less than \$31,971

11.2.2 Inputs to the Life-Cycle Cost and Payback Period Sub-Group Analysis

The Department performed the consumer sub-group analysis by analyzing the life-cycle cost and payback periods of senior-only or low-income households with the spreadsheet models used for the LCC analysis. The Department used the same inputs in the sub-group analysis as it used in the LCC and payback period analysis (as described in Chapter 8) for non-weatherized gas furnace households considered to be senior-only or low-income.

Table 11.2.2 summarizes the *weighted-average* input values for the senior-only and low-income households analyzed in the consumer sub-group analysis and compares them to the *weighted-average* input values for all households in the RECS 2001 using non-weatherized gas furnaces. Other than the sample size, the senior-only and low-income sub-groups do not differ significantly from the overall sample. For senior-only households, the average price for natural gas is one percent lower than for all households and the marginal price is one percent higher. For low-income households, the average natural gas price is three percent lower than for all households and the marginal price is six percent lower.

Table 11.2.2 Comparison of Input Values for All Households, Senior-Only, and Low-Income Households

Category	Non-Weatherized Gas Furnace		
	All Households	Senior-Only	Low-Income
Household Population Data			
Number of Household Records	1880	337	152
Sum of Weights (million households)	43.5	7.8	3.4
Percent of NWGF Household Population	100%	17.9%	7.8%
Weighted-Average Annual Energy Use for Baseline Furnace			
Space-Heating Natural Gas Use (MMBtu)	56.3	55.3	51.5
Space-Heating Electricity Use (kWh)	494	507	487
Weighted-Average Natural Gas Prices			
Average Natural Gas Price (\$/therm)	1.04	1.04	1.03
Marginal Natural Gas Price (\$/therm)	0.90	0.91	0.86
Weighted-Average Electricity Prices			
Average Electricity Price (¢/kWh)	9.5	9.7	9.6
Marginal Electricity Price (¢/kWh)	9.2	9.0	9.0

11.2.3 Results for Senior and Low-Income Households

Tables 11.2.3 and 11.2.4 below summarize the LCC results for senior-only and low-income households for non-weatherized gas furnaces, which can be compared to the overall results in Table 8.4.1 in Chapter 8. The tables provide the average or mean LCC and payback period, the LCC savings relative to the base case, and the percentage of consumers for whom the LCC will decrease compared to the base case forecast (positive benefit), those for whom the LCC will increase compared to the base case forecast (negative impact), and those for whom the LCC will not change because the specific design option is less efficient or the same as the base case forecast for that house (and therefore the standard has no impact).

Table 11.2.3 Non-Weatherized Gas Furnaces: LCC and PBP Results for Senior Households

Design Option by AFUE	Life-Cycle Cost			Life-Cycle Cost Savings				Payback Period (Years)**	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
78%	\$1,772	\$7,373	\$9,146						
80%	\$1,779	\$7,227	\$9,006	\$2	0%	99%	1%	0.6	0.8
80% 2-Stage Modulation	\$2,042	\$7,247	\$9,289	(\$195)	66%	32%	1%	46	77
81%	\$1,845	\$7,156	\$9,001	\$1	34%	32%	33%	13	26
81% 2-Stage Modulation	\$2,107	\$7,177	\$9,284	(\$198)	65%	32%	3%	40	73
90%	\$2,360	\$6,579	\$8,939	(\$2)	40%	32%	27%	14	21
92%	\$2,523	\$6,468	\$8,991	(\$48)	54%	17%	29%	15	22
92% 2-Stage Modulation	\$2,748	\$6,494	\$9,243	(\$290)	80%	4%	16%	23	54
92% Modulation (Continuous)	\$2,785	\$6,597	\$9,382	(\$422)	85%	4%	11%	26	70
96% Modulation (Continuous)	\$3,252	\$6,393	\$9,645	(\$676)	87%	4%	9%	32	79

* “No impact” means that the base case forecast furnace 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 11.2.4 Non-Weatherized Gas Furnaces: LCC and PBP Results for Low-Income Households

Design Option by AFUE	Life-Cycle Cost			Life-Cycle Cost Savings			Payback Period (Years)**		
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
78%	\$1,744	\$6,826	\$8,570						
80%	\$1,750	\$6,694	\$8,444	\$1	0%	98%	2%	1.2	1.9
80% 2-Stage Modulation	\$2,007	\$6,724	\$8,731	(\$222)	73%	24%	3%	39	70
81%	\$1,815	\$6,629	\$8,444	(\$3)	41%	24%	35%	15	35
81% 2-Stage Modulation	\$2,072	\$6,660	\$8,732	(\$228)	72%	23%	5%	38	74
90%	\$2,319	\$6,106	\$8,425	(\$20)	52%	23%	24%	20	34
92%	\$2,477	\$6,005	\$8,482	(\$74)	63%	12%	25%	21	36
92% 2-Stage Modulation	\$2,696	\$6,038	\$8,734	(\$321)	80%	3%	17%	29	78
92% Modulation (Continuous)	\$2,732	\$6,138	\$8,870	(\$451)	85%	3%	13%	34	101
96% Modulation (Continuous)	\$3,186	\$5,958	\$9,144	(\$720)	86%	3%	11%	43	120

* “No impact” means that the base case forecast furnace 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.

The senior and low-income consumer sub-groups show the same general pattern in average LCC savings and consumer impacts (i.e., percentage of consumers with net cost or benefit) as the overall sample. For the 81 percent AFUE level, the average LCC savings and the percent of households with a benefit for the sub-groups is approximately the same as for all households with non-weatherized gas furnaces (see Table 8.4.1 in Chapter 8). For the 90 percent AFUE level, the average LCC savings and the percent of households with a benefit is less favorable for senior and low-income households as for all households. The negative impact of the 90 percent AFUE level on low-income households is due to the fact that they have lower natural gas prices and lower average baseline space heating energy use than the overall sample, while the negative impact of the 90 percent AFUE level on low-income households is due to the slightly lower average baseline space heating energy use than the overall sample. Therefore, the operating cost savings from higher furnace efficiency have a lower value, because of lower natural gas prices in low-income households. In addition, the average baseline space heating energy use is smaller for senior and low-income households than for all households (mainly because senior and low-income households tend to have smaller houses), so efficiency improvement yields less energy savings.

11.3 NORTHERN AND SOUTHERN HOUSEHOLDS

11.3.1 Sub-Groups Definition

The Department evaluated a scenario to separately assess the impact on northern (cold-climate) states and southern (warm-climate) states for non-weatherized gas furnace. This sub-group scenario assumes that most households in the northern states would be above 5,000 heating degree days (HDD), while most households in the southern states would be below 5,000 HDD. It analyzed alternative cases in which all States set standards corresponding to each of the TSLs. To model these cases, the Department divided the States into two regions, as shown in Table 11.3.1.

Table 11.3.1 Definition of Northern and Southern regions using RECS 2001

Region	Census Divisions and Four Large States	States Represented
Northern (Cold-climate) states	New England	Connecticut, Maine, Massachusetts, New Hampshire, Vermont, and Rhode Island
	Middle Atlantic ^a	New Jersey and Pennsylvania
	East North Central	Illinois, Indiana, Michigan, Ohio, and Wisconsin
	West North Central	Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota
	Mountain (HDD>5,000) ^b	Colorado, Idaho, Montana, Nevada, Utah, and Wyoming
	Pacific ^c	Alaska, Hawaii, Oregon, and Washington
	New York	New York
Southern (Warm-climate) states	South Atlantic ^d	Delaware, the District of Columbia, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia
	East South Central	Alabama, Kentucky, Mississippi, and Tennessee
	West South Central ^e	Arkansas, Louisiana, and Oklahoma
	Mountain (HDD<5,000) ^b	Arizona and New Mexico
	California	California
	Texas	Texas
	Florida	Florida

(a) Not including New York, which is included separately as one of the four large states.

(b) It is assumed that using this criteria most households in the northern states region would come from Colorado, Idaho, Montana, Nevada, Utah and Wyoming, while most households in the southern region would come from Arizona and New Mexico.

(c) Not including California, which is included separately as one of the four large states. Hawaii is included in the Northern states even though it's average HDD is less than 5,000 HDD.

(d) Not including Texas, which is included separately as one of the four large states. West Virginia is included in the Southern States even though it's average HDD is greater than 5,000 HDD.

(e) Not including Florida, which is included separately as one of the four large states.

11.3.2 Inputs to the Life-Cycle Cost and Payback Period Sub-Group Analysis

The Department performed the consumer sub-group analysis by analyzing the life-cycle cost and payback periods of northern and southern households with the spreadsheet models used for the LCC analysis. The Department used the same inputs in the sub-group analysis as it used in the LCC and payback period analysis (as described in Chapter 8) for non-weatherized gas furnace households considered to be northern or southern households.

Table 11.3.2 summarizes the *weighted-average* input values for the northern and southern households analyzed in the consumer sub-group analysis and compares them to the *weighted-average* input values for all households in the RECS 2001 using non-weatherized gas furnaces. The northern households represent 55.4 percent of all households, while the southern households represent the other 44.6 percent. The northern households have on average higher energy use and lower energy prices than the southern households. Northern households have 78 percent greater average natural gas use and 74 percent greater electricity use than southern households. Northern households have 15 percent lower average natural gas price, 14 percent lower marginal natural gas price, 3 percent lower average electricity price, and 16 percent lower marginal electricity price as compared to southern households.

Table 11.3.2 Comparison of Input Values for All Households, Northern, and Southern Households

Category	Non-Weatherized Gas Furnace		
	All Households	Northern Households	Southern Households
Household Population Data			
Number of Household Records	1880	1067	813
Sum of Weights (million households)	43.5	24.1	19.4
Percent of NWGF Household Population	100%	55.4%	44.6%
Weighted-Average Annual Energy Use for Baseline Furnace			
Space-Heating Natural Gas Use (MMBtu)	56.3	70.9	39.8
Space-Heating Electricity Use (kWh)	494	618	355
Weighted-Average Natural Gas Prices			
Average Natural Gas Price (\$/therm)	1.04	0.97	1.14
Marginal Natural Gas Price (\$/therm)	0.90	0.84	0.98
Weighted-Average Electricity Prices			
Average Electricity Price (¢/kWh)	9.5	9.4	9.7
Marginal Electricity Price (¢/kWh)	9.2	8.5	10.1

11.3.3 Results for Northern and Southern Households

Tables 11.3.3 and 11.3.4 below summarize the LCC results for the northern and southern households for non-weatherized gas furnaces, using EIA's *Annual Energy Outlook 2005* (AEO 2005)² Reference Case, which can be compared to the overall results in Table 8.4.1 in Chapter 8. The tables provide the average or mean LCC and payback period, the LCC savings relative to the base case, and the percentage of consumers for whom the LCC will decrease compared to the base case forecast (positive benefit), those for whom the LCC will increase compared to the base case forecast (negative impact), and those for whom the LCC will not change because the specific design option is less efficient or the same as the base case forecast for that house (and therefore the standard has no impact).

Table 11.3.3 Non-Weatherized Gas Furnaces: LCC and PBP Results for Northern Households (AEO 2005)

Design Option by AFUE	Life-Cycle Cost			Life-Cycle Cost Savings			Payback Period (Years)**		
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
78%	\$1,889	\$9,494	\$11,383						
80%	\$1,897	\$9,305	\$11,202	\$2	0%	99%	1%	0.6	0.6
80% 2-Stage Modulation	\$2,184	\$9,298	\$11,474	-\$143	49%	48%	3%	39	71
81%	\$1,965	\$9,215	\$11,179	\$10	23%	48%	30%	11	17
81% 2-Stage Modulation	\$2,252	\$9,199	\$11,451	-\$135	48%	48%	5%	34	64
90%	\$2,517	\$8,473	\$10,990	\$79	24%	48%	28%	12	15
92%	\$2,697	\$8,330	\$11,027	\$49	36%	36%	28%	14	17
92% 2-Stage Modulation	\$2,946	\$8,327	\$11,273	-\$183	75%	6%	19%	21	39
92% Modulation (Continuous)	\$2,987	\$8,453	\$11,440	-\$341	83%	6%	12%	25	47
96% Modulation (Continuous)	\$3,503	\$8,192	\$11,695	-\$582	85%	6%	9%	34	65

* "No impact" means that the base case forecast furnace 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 11.3.4 Non-Weatherized Gas Furnaces: LCC and PBP Results for Southern Households (AEO 2005)

Design Option by AFUE	Life-Cycle Cost			Life-Cycle Cost Savings			Payback Period (Years)**		
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
78%	\$1,871	\$6,488	\$8,359						
80%	\$1,879	\$6,364	\$8,242	\$1	0%	98%	2%	2.0	2.1
80% 2-Stage Modulation	\$2,162	\$6,404	\$8,567	-\$259	79%	20%	1%	59	93
81%	\$1,946	\$6,304	\$8,250	-\$9	44%	20%	35%	17	32
81% 2-Stage Modulation	\$2,230	\$6,345	\$8,575	-\$272	78%	19%	2%	53	95
90%	\$2,490	\$5,814	\$8,305	-\$79	57%	19%	23%	20	29
92%	\$2,668	\$5,720	\$8,388	-\$151	64%	14%	22%	21	32
92% 2-Stage Modulation	\$2,913	\$5,767	\$8,680	-\$440	86%	1%	13%	32	71
92% Modulation (Continuous)	\$2,953	\$5,854	\$8,807	-\$565	89%	1%	9%	38	92
96% Modulation (Continuous)	\$3,461	\$5,679	\$9,140	-\$894	91%	1%	7%	45	110

* “No impact” means that the base case forecast furnace 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.

The northern and southern consumer sub-groups differ significantly in terms of average LCC savings and consumer impacts (i.e., percentage of consumers with net cost or benefit). For the 81 percent AFUE level, in the northern households the average LCC savings is \$10 and the percent of households with net cost is 23 percent, while in the southern households the average LCC savings is negative \$9 and the percent of households with net cost is 44 percent. For the 90 percent AFUE level, in the northern households the average LCC savings is \$79 and the percent of households with net cost is 24 percent, while in the southern households the average LCC savings is negative \$79 and the percent of households with net cost is 57 percent. The higher LCC savings and lower economic impact in the northern households as compared to southern households is due to the much greater energy consumption which outweighs the lower operating cost due to lower energy prices.

11.3.4 Energy Price Sensitivity Analysis for Northern and Southern Households Using AEO 2006 Energy Price Forecast

Tables 11.3.5 and 11.3.6 below summarize the LCC energy price sensitivity analysis results for northern and southern households for non-weatherized gas furnaces, using EIA's *Annual Energy Outlook 2006* (AEO 2006)³ Reference Case.

Table 11.3.5 Non-Weatherized Gas Furnaces: LCC and PBP Results for Northern Households (AEO 2006)

Design Option by AFUE	Life-Cycle Cost			Life-Cycle Cost Savings				Payback Period (Years)**	
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
78%	\$1,899	\$10,946	\$12,835						
80%	\$1,897	\$10,728	\$12,625	\$2	0%	99%	1%	0.5	0.5
80% 2-Stage Modulation	\$2,184	\$10,731	\$12,916	-\$151	50%	48%	2%	40	76
81%	\$1,965	\$10,623	\$12,588	\$17	21%	48%	32%	9.1	15
81% 2-Stage Modulation	\$2,252	\$10,626	\$12,879	-\$137	48%	48%	5%	35	66
90%	\$2,517	\$9,769	\$12,286	\$138	20%	48%	32%	11	13
92%	\$2,697	\$9,603	\$12,300	\$122	31%	36%	33%	12	15
92% 2-Stage Modulation	\$2,946	\$9,614	\$12,560	-\$123	72%	6%	22%	19	36
92% Modulation (Continuous)	\$2,987	\$9,726	\$12,713	-\$268	79%	6%	16%	21	40
96% Modulation (Continuous)	\$3,503	\$9,423	\$12,926	-\$471	81%	6%	13%	29	55

* "No impact" means that the base case forecast furnace 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 11.3.6 Non-Weatherized Gas Furnaces: LCC and PBP Results for Southern Households (AEO 2006)

Design Option by AFUE	Life-Cycle Cost			Life-Cycle Cost Savings			Payback Period (Years)**		
	Average Installed Price	Average Operating Cost	Average LCC	Average Savings	Households with			Median	Average
					Net Cost	No Impact*	Net Benefit		
78%	\$1,871	\$7,403	\$9,274						
80%	\$1,879	\$7,260	\$9,139	\$1	0%	98%	2%	1.7	1.9
80% 2-Stage Modulation	\$2,162	\$7,312	\$9,474	-\$267	79%	20%	1%	62	96
81%	\$1,946	\$7,191	\$9,137	-\$2	42%	20%	38%	14	28
81% 2-Stage Modulation	\$2,230	\$7,243	\$9,473	-\$273	78%	19%	2%	54	96
90%	\$2,490	\$6,632	\$9,122	-\$20	53%	19%	27%	17	25
92%	\$2,668	\$6,523	\$9,191	-\$80	59%	14%	27%	19	27
92% 2-Stage Modulation	\$2,913	\$6,578	\$9,491	-\$377	83%	1%	15%	29	61
92% Modulation (Continuous)	\$2,953	\$6,656	\$9,609	-\$494	87%	1%	12%	33	83
96% Modulation (Continuous)	\$3,461	\$6,455	\$9,916	-\$796	89%	1%	10%	39	95

* “No impact” means that the base case forecast furnace 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.

REFERENCES

1. U.S. Department of Energy - Energy Information Administration. *Residential Energy Consumption Survey: Household Energy Consumption and Expenditures 2001*. 2001. (Last accessed May 18, 2005.)
<<http://www.eia.doe.gov/emeu/recs/recs2001/publicuse2001.html>>
2. U.S. Department of Energy - Energy Information Administration. *Annual Energy Outlook 2005: With Projections Through 2025*. February, 2005. Washington, DC. Report No. DOE/EIA-0383(2005). .
<[http://www.eia.doe.gov/oiaf/aeo/pdf/0383\(2005\).pdf](http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2005).pdf)>
3. U.S. Department of Energy - Energy Information Administration. *Annual Energy Outlook 2006: With Projections Through 2030*. February, 2006. Washington, DC. Report No. DOE/EIA-0383(2006).
<[http://www.eia.doe.gov/oiaf/aeo/pdf/0383\(2006\).pdf](http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2006).pdf)>