Don't Know	14	2.1%	56	3.3%
All or part of ceiling insulated				
Part of ceiling	39	12.7%	82	11.2%
All of ceiling	267	87.3%	649	88.8%
Type of insulation				
Fiberglass	191	68.5%	505	71.8%
Cellulose	58	20.8%	126	17.9%
Foam	15	5.4%	38	5.4%
Other	15	5.4%	34	4.8%
Inches of thickness added				
1-2	21	8.2%	81	12.8%
2-4	84	32.7%	223	35.1%
5-6	81	31.5%	163	25.7%
7-8	36	14.0%	77	12.1%
9-10	21	8.2%	49	7.7%
11+	14	5.4%	42	6.6%
Inches of thickness already there				
1-2	75	34.7%	207	41.5%
2-4	66	30.6%	174	34.9%
5-6	38	17.6%	61	12.2%
7-8	18	8.3%	30	6.0%
9-10	7	3.2%	9	1.8%
11+	12	5.6%	18	3.6%

The myriad of responses in the survey regarding this recommendation (and the following recommendation of insulation of sidewalls) require a more complex table than the other measures. Those that responded are broken down into six groups:

1. Yes, installed attic insulation. These respondents provided full details by answering all of the four follow-up questions.
2. Yes, installed attic insulation, but only partial detail. These respondents answered only 2 or 3 of the follow-up questions.
3. Yes, installed attic insulation, but little or no detail. These respondents answered 0 or 1 of the follow-up questions.
4. No, but plan to install attic insulation. These respondents provided full details by answering all of the four follow-up questions.
5. No, but plan to install attic insulation, but only partial detail. These respondents answered only 2 or 3 of the follow-up questions.
6. No, but plan to install attic insulation but little or no detail. These respondents answered 0 or 1 of the follow-up questions.

The impacts for groups 2, 3, 5 and 6 are estimated using the mean value of the responses of those that provided the needed details. The impacts are presented in Table 48 below.

Table 48. Total Impact Estimates for Attic Insulation

	Population	Total kW	Total kWh	Total Therm

		Savings	Savings	Savings
Kentucky Kits	741			
Yes, installed attic insulation	247	25.107	15,843	267.5
Yes, installed, but only partial detail	38	1.644	3,119	57.1
Yes, installed, but little or no detail	18	0.894	1,494	27.0
No, but plan to, with full detail	5	0.098	97	3.6
No, but plan to, but only partial detail	2	0.052	51	2.8
No, but plan to, but little or no detail	57	4.465	9,367	85.1
Kentucky No Kits	1879			
Yes, installed attic insulation	628	31.440	56,639	875.4
Yes, installed, but only partial detail	81	5.578	10,798	136.1
Yes, installed, but little or no detail	124	8.589	17,726	211.1
No, but plan to, with full detail	9	0.299	593	3.9
No, but plan to, but only partial detail	1	0.028	27	1.4
No, but plan to, but little or no detail	97	6.801	13,031	149.8

Table 49. Mean Impact Estimates for Participants Installing Attic Insulation

	Population	Mean kW Savings	Mean kWh Savings	Mean Therm Savings
Kentucky Kits	741			
Yes, installed attic insulation	247	0.10165	64.1	1.1
Yes, installed, but only partial detail	38	0.04326	82.1	1.5
Yes, installed, but little or no detail	18	0.04967	83.0	1.5
Kentucky No Kits	1879			
Yes, installed attic insulation	628	0.05006	90.2	1.4
Yes, installed, but only partial detail	81	0.06886	133.31	1.7
Yes, installed, but little or no detail	124	0.06927	142.95	1.7

Sidewall Insulation

Less than 10% have taken this action as a result of the PER recommendation, with another 3-5% planning on doing this. The energy savings are higher for this measure than for attic insulation, since the base assumption is that the wall is uninsulated.

Table 50. Frequency of Recommendation Taken: Sidewall Insulation

Action	Kentucky Kits (n)	Kentucky Kits (%)	Kentucky No Kits (n)	Kentucky No Kits (%)
Sidewalls insulated				
Yes	34	5.0%	133	7.7%
No	606	88.5%	1,486	86.3%
No, but plan to do this	32	4.7%	57	3.3%
Don't Know	13	1.9%	45	2.6%
Number of sidewalls insulated				
1	4	14.3%	5	5.1%
2	1	3.6%	8	8.2%
3	6	21.4%	15	15.3%
4+	17	60.7%	70	71.4%
Type of insulation				
Fiberglass	12	42.9%	59	60.2%
Cellulose	3	10.7%	14	14.3%
Foam	9	32.1%	13	13.3%
Other	4	14.3%	12	12.2%
Inches of thickness added				
1-3	14	53.8%	46	50.9%
4-6	11	42.3%	34	39.3%
7-12	1	3.8%	6	8.0%
13+	0	0.0%	2	1.8%

Table 51. Total Impact Estimates for Sidewall Insulation

	Population	Total kW Savings	Total kWh Savings	Total Therm Savings
Kentucky Kits	741			
Yes, installed sidewall insulation	20	6.948	2,656	61.9
Yes, installed, but only partial detail	8	1.273	752	31.0
Yes, installed, but little or no detail	62	4.509	9,232	238.1
No, but plan to, with full detail	1	.447	499	31
No, but plan to, but only partial detail	0	0	0	0
No, but plan to, but little or no detail	31	2.415	7,003	101.9
Kentucky No Kits	1879			

Yes, installed sidewall insulation	76	5.746	13,714	276.3
Yes, installed, but only partial detail	16	1.284	3,503	54.6
Yes, installed, but little or no detail	199	15.919	41,563	700.9
No, but plan to, with full detail	4	0.329	1,104	3.5
No, but plan to, but only partial detail	2	0.134	500	3.9
No, but plan to, but little or no detail	51	4.084	10,591	173.3

Table 52. Mean Impact Estimates for Participants Installing Sidewall Insulation

	Population	Mean kW Savings	Mean kWh Savings	Mean Therm Savings
Kentucky Kits	741			
Yes, installed sidewall insulation	20	0.34738	132.8	3.1
Yes, installed, but only partial detail	8	0.15913	94	3.9
Yes, installed, but little or no detail	62	0.07273	149	3.8
Kentucky No Kits	1879			
Yes, installed sidewall insulation	76	0.07561	180.4	3.6
Yes, installed, but only partial detail	16	0.08025	218.9	3.4
Yes, installed, but little or no detail	199	0.07999	208.9	3.5

Duct Insulation/Repair

Respondents were more likely to repair the ducts than to insulate them, but many report that they plan on taking both actions. Unfortunately, over 60% of the ducts are located in heated areas of the home in which insulation or repair will not provide savings.

Table 53. Frequency of Recommendation Taken: Duct Insulation or Repair

Action	Kentucky Kits (n)	Kentucky Kits (%)	Kentucky No Kits (n)	Kentucky No Kits (%)
Insulated ducts				
Yes	75	10.7%	202	11.7%
No	558	79.8%	1,403	81.6%
No, but plan to do this	48	6.9%	64	3.7%
Don't Know	18	2.6%	51	3.0%

Repaired holes in ducts				
Yes	77	23.2%	173	19.9%
No	230	69.3%	599	68.9%
No, but plan to do this	8	2.4%	24	2.8%
Don't Know	17	5.1%	73	8.4%
Location of ducts insulated				
Unheated area	74	26.2%	193	25.9%
Heated area	183	64.9%	462	62.0%
Don't Know	25	8.9%	90	12.1%

The tables below present the savings for the duct work, and the breakdown of how many of them repaired or insulated ducts in heated areas.

Table 54. Total Impact Estimates for Duct Insulation

	Population	Total kW Savings	Total kWh Savings	Total Therm Savings
Kentucky Kits	741			
Yes, insulated ducts	41	4.071	3,896	88.1
Yes, insulated ducts, but they were in a heated area	32	0	0	0
No, but plan to	48	1.213	2,808	45.6
Kentucky No Kits	1879			
Yes, insulated ducts	104	6.688	16,648	210.1
Yes, insulated ducts, but they were in a heated area	96	0	0	0
No, but plan to	64	3.173	6,692	65.7

Table 55. Mean Impact Estimates for Participants Installing Duct Insulation

	Population	Mean kW Savings	Mean kWh Savings	Mean Therm Savings
Kentucky Kits	741			
Yes, insulated ducts	41	0.09928	95.0	2.1
Kentucky No Kits	1879			
Yes, insulated ducts	104	0.06431	160.1	2.0

Table 56. Total Impact Estimates for Duct Repair

	Population	Total kW	Total kWh	Total Therm

		Savings	Savings	Savings
Kentucky Kits	741			
Yes, repaired ducts	37	7.495	4,408	58.1
Yes, repaired ducts, but they were in a heated area	36	0	0	0
No, but plan to	8	..155	362	9.9
Kentucky No Kits	1879			
Yes, repaired ducts	92	7.754	16,255	94.1
Yes, repaired ducts, but they were in a heated area	79	0	0	0
No, but plan to	24	1.155	2,486	23.9

Table 57. Mean Impact Estimates for Participants Performing Duct Repair

	Population	Mean kW Savings	Mean kWh Savings	Mean Therm Savings
Kentucky Kits	741			
Yes, repaired ducts	37	0.20257	119.1	1.6
Kentucky No Kits	1879			
Yes, repaired ducts	92	0.08429	176.7	1.0

Installed a New Central Air Unit

Just over 20% of the respondents indicated that they have installed a new central air unit at least in part because of the PER program. Over half of the participants report that their new units are high efficiency units. Most of the respondents did not know the SEER number for their new unit, and many of the responses had to be adjusted in this analysis as a result. For example, some respondents said that they installed a high efficiency unit and also reported that it had an SEER of 12. When this occurred, we assumed the SEER number was correct and changed the efficiency to "standard". We also distributed the SEER values of the people who could report them across the values for the individuals that could not report them. This provided a way to adjust the SEER ratings for the people who reported buying a high efficiency unit, but did not know the SEER rating to account for the fraction of the participants who actually purchased a more standard SEER unit.

Close to 3% of the respondents indicated that they planned on installing a new central air unit.

Table 58. Frequency of Recommendation Taken: New Central Air Unit

Action	Kentucky Kits (n)	Kentucky Kits (%)	Kentucky No Kits (n)	Kentucky No Kits (%)
Installed a new central air unit				
Yes	154	22.1%	386	22.3%
No	519	74.6%	1,291	74.8%
No, but plan to do this	18	2.6%	43	2.5%
Don't Know	5	0.7%	6	0.4%
Efficiency of unit				
High efficiency	139	52.1%	325	49.2%
Standard	65	24.3%	135	20.4%
Don't Know	63	23.6%	201	30.4%
SEER number for unit				
=<11	14	6.0%	16	2.8%
12	12	5.2%	26	4.5%
13	21	9.1%	53	9.2%
14+	20	8.6%	33	5.7%
Don't Know	165	71.1%	451	77.9%

Only 58 respondents who also received the kits provided any details on the new central air unit they installed. The other 96 cases provided partial or no details, so we used the mean responses from the 58 cases that provided purchase details to determine impact estimates. We used this same method for the 269 cases in the "no kits" group who also were unable to provide full details about the efficiency of their units. We only calculated estimated savings for those that plan to install a new central air unit if they provided the details on the efficiency level that they planned to purchase.

Table 59. Total Impact Estimates for New Central Air Units

	Population	Total kW Savings	Total kWh Savings	Total Therm Savings
Kentucky Kits	741			
Yes, installed a new central air unit	58	12.865	17,411	0
Yes, installed, but little or no detail	96	19.463	22,531	0
No, but plan to, with full detail	1	0.129	118	0
No, but plan to, but little or no detail	17	2.439	3,597	0
Kentucky No Kits	1879			
Yes, installed a new central air unit	117	26.778	34,523	0
Yes, installed, but little or no detail	269	58.680	68,558	0
No, but plan to, with full detail	7	1.545	2,244	0
No, but plan to, but little or no detail	36	4.988	4,939	0

Table 60. Mean Impact Estimates for Participants Installing New Central Air Units

	Population	Mean kW Savings	Mean kWh Savings	Mean Therm Savings
Kentucky Kits	741			
Yes, installed a new central air unit	58	0.79103	300.2	0
Yes, installed, but little or no detail	96	0.20274	234.7	0
Kentucky No Kits	1879			
Yes, installed a new central air unit	117	0.22887	295.1	0
Yes, installed, but little or no detail	269	0.21814	254.9	0

Installed a New Heat Pump

About 7% of the respondents indicated that they installed a new heat pump, but most of them do not know the SEER of their new units. However, they indicated that more than half of them were high efficiency. Here again, we used the efficiency distributions from the participants who did report their SEER, at the same ratio for those who did not know the SEER.

Table 61. Frequency of Recommendation Taken: Installed a New Heat Pump

Action	Kentucky Kits (n)	Kentucky Kits (%)	Kentucky No Kits (n)	Kentucky No Kits (%)
Installed a new heat pump				
Yes	48	7.3%	110	6.8%
No	549	83.6%	1,363	84.6%
No, but plan to do this	54	8.2%	119	7.4%
Don't Know	6	0.9%	19	1.2%
Efficiency of heat pump				
High efficiency	34	54.8%	74	50.7%
Standard	9	14.5%	20	13.7%
Don't Know	19	30.7%	52	35.6%
SEER number for heat pump				
=<11	4	7.4%	8	6.6%
12	1	1.9%	6	5.0%
13	6	11.1%	18	14.9%
14+	9	16.7%	15	12.4%
Don't Know	34	63.0%	74	61.2%

Table 62. Total Impact Estimates for New Heat Pumps

	Population	Total kW Savings	Total kWh Savings	Total Therm Savings

Kentucky Kits	741			
Yes, installed a new heat pump	16	5.126	11,288	0
Yes, installed, but little or no detail	32	9.831	18,921	0
No, but plan to, with full detail	0			
No, but plan to, but little or no detail	54	13.410	18,474	0
Kentucky No Kits	1879			
Yes, installed a new heat pump	33	10.626	24,289	0
Yes, installed, but little or no detail	77	25.318	48,152	0
No, but plan to, with full detail	5	1.184	1,910	0
No, but plan to, but little or no detail	114	30.079	36,313	0

Table 63. Mean Impact Estimates for Participants Installing New Heat Pumps

	Population	Mean kW Savings	Mean kWh Savings	Mean Therm Savings
Kentucky Kits	741			
Yes, installed a new heat pump	16	0.32038	705.5	0
Yes, installed, but little or no detail	32	0.30722	591.3	0
Kentucky No Kits	1879			
Yes, installed a new heat pump	33	0.32199	736.0	0
Yes, installed, but little or no detail	77	0.32881	625.4	0

Installed a New Furnace

About 20% of the respondents indicated that they installed a new furnace at least in part because of the PER report, and about 2-3% indicated that they plan on taking this action.

Table 64. Frequency of Recommendation Taken: New Furnace

Action	Kentucky Kits (n)	Kentucky Kits (%)	Kentucky No Kits (n)	Kentucky No Kits (%)
Installed a new furnace				
Yes	131	19.3%	278	16.9%
No	526	77.4%	1,323	80.6%
No, but plan to do this	18	2.6%	30	1.8%

Don't Know	5	0.7%	11	0.7%
Exhaust/efficiency				
Plastic pipe	133	78.7%	245	62.0%
Chimney or flue	27	16.0%	94	23.8%
Don't Know	9	5.3%	56	14.2%

Most of the respondents that plan to install a new furnace did not provide details on the efficiency of the units, so only a small number of participants have impact estimates applied. The 409 respondents that did install a new furnace and who could provide information on energy efficiency are saving an estimated 61 therms annually.

Table 65. Total Impact Estimates for New Furnaces

	Population	Total kW Savings	Total kWh Savings	Total Therm Savings
Kentucky Kits	741			
Yes, installed a new furnace	131	-	-	381.9
No, but plan to	18	-	-	94.9
Kentucky No Kits	741			
Yes, installed a new furnace	131	-	-	841.3
No, but plan to	18	-	-	104.7

Table 66. Mean Impact Estimates for Participants Installing New Furnaces

	Population	Mean kW Savings	Mean kWh Savings	Mean Therm Savings
Kentucky Kits	741			
Yes, installed a new furnace	131	0.00000	0.00	2.9
Kentucky No Kits	1,879			
Yes, installed a new furnace	278	0.00000	0.00	3.0

Visited the Duke Energy Web Site

Most of the respondents have not visited the Duke Energy web site. Only about 20-30% said that they have or that they plan to visit the site. Of those that have visited the site, over half of them said that they found the web site helpful.

Action	Kentucky Kits (n)	Kentucky Kits (%)	Kentucky No Kits (n)	Kentucky No Kits (%)

Visited Duke web site				
Yes	96	13.6%	155	8.6%
No	498	70.6%	1,427	79.6%
No, but plan to do this	107	15.2%	191	10.7%
Don't Know	4	0.6%	19	1.1%
Web site was helpful				
Yes	53	55.2%	70	53.8%
Somewhat	40	41.7%	54	41.5%
Don't Know	3	3.1%	6	4.6%

All Recommendations

The following tables summarize the number of recommendations taken and the savings estimates based on those recommendations. These tables do not include the savings estimates of those that plan to take the recommendation.

Those customers who received the kits followed about 21.7% of the recommendations overall, and were able to save 406 kW, over 2 million kilowatt hours, and almost 47,000 therms. If the information they provided on their survey is accurate. The following table summarizes the savings achieved.

Table 67. Summary of Total Savings for All Recommendations Taken by Those Receiving Kits

	Population	Percent Installed	Total kW Savings	Total kWh Savings	Total Therm Savings
Lowered the temperature in winter	608	82.1%			
Daytime savings			-	121,733	2,727
Nighttime savings			-	56,733	1,080
Purchased and installed CFLs	393	53.0%	25.255	151,396	-67
Switched to cold water	386	52.1%	5.582	27,404	3,876
Replaced furnace filter	143	19.3%	-2.24	-3,934	-21
Closed off fireplace	191	25.8%	0.642	1,103	21
Stopped heating unused rooms	405	54.7%	86.488	35,061	437
Window Shrink	68	9.2%	2.127	1,018	19
Insulated water heater	102	13.8%	1.134	3,282	354
Manages draperies	589	79.5%	-	36,371	1,641
Cleaned baseboards	5	0.7%	-	40	-
Installed attic insulation	247	33.3%	25.107	15,843	268
Installed, but only partial detail	*38*	*5.1%*	*1.644*	*3,119*	*57*
Installed, but little or no detail	*18*	*2.4%*	*0.894*	*1,494*	*27*
Installed sidewall insulation	20	2.7%	6.948	2,656	62
Installed, but only partial detail	*8*	*1.1%*	*1.273*	*752*	*31*
Installed, but little or no detail	*62*	*8.4%*	*4.509*	*9,232*	*238*
Insulated ducts	41	5.5%	4.071	3,896	88
Repaired ducts	37	5.0%	7.495	4,408	58
Installed a new central air unit	58	7.8%	12.865	17,411	-
Installed a central air unit, but little or no detail	*96*	*13.0%*	*19.463*	*22,531*	-
Installed a new furnace	131	17.7%	-	-	382
Installed a new heat pump	16	2.2%	5.126	11,288	-

Installed heat pump, but little or no detail	*32*	*4.3%*	*9.831*	*18,921*	-
Total			**180.6**	**485,709**	**10,925**

Those that did not receive the kits also followed 21.7% of the recommendations, but had much higher total savings due to the number of participants providing the survey.

Table 68. Summary of Total Savings for All Recommendations Taken by Those Not Receiving Kits

	Population	Percent Installed	Total kW Savings	Total kWh Savings	Total Therm Savings
Lowered the temperature in winter	1559	83.0%			
Daytime savings			-	464,354	7,255
Nighttime savings			-	96,373	2,778
Purchased and installed CFLs	899	47.8%	5.503	45,864	-136
Switched to cold water	987	52.5%	7.159	62,702	10,211
Replaced furnace filter	458	24.4%	-0.880	-4617	41
Closed off fireplace	509	27.1%	0.340	1,201	23
Stopped heating unused rooms	1032	54.9%	81.334	123,535	1,270
Window Shrink	166	8.8%	2.147	3,516	49
Insulated water heater	265	14.1%	1.288	11,278	901
Manages draperies	1,446	77.0%	-	96,373	4,372
Cleaned baseboards	7	0.4%	-	51	-
Installed attic insulation	628	33.4%	31.440	56,639	857
Installed, but only partial detail	*81*	*4.3%*	*5.578*	*10,798*	*136*
Installed, but little or no detail	*124*	*6.6%*	*8.589*	*17,726*	*211*
Installed sidewall insulation	76	4.0%	5.746	13,714	276
Installed, but only partial detail	*16*	*0.9%*	*1.284*	*3,503*	*55*
Installed, but little or no detail	*199*	*10.6%*	*15.919*	*41,563*	*701*
Insulated ducts	104	5.5%	6.688	16,648	210
Repaired ducts	92	4.9%	7.754	16,255	94
Installed a new central air unit	117	6.2%	26.778	34,523	-
Installed a central air unit, but little or no detail	*269*	*14.3%*	*56.590*	*68,558*	-
Installed a new furnace	278	14.8%	-	-	841
Installed a new heat pump	33	1.8%	10.626	24,289	-
Installed heat pump, but little or no detail	*77*	*4.1%*	*25.318*	*48,152*	-
Total			**185.923**	**1,062,698**	**29,042**

The following two tables show the mean savings for the recommendation based on the total savings and the number of respondents following the recommendation.

Table 69. Summary of Mean Savings for All Recommendations Taken by Those Receiving Kits

	Mean kW Savings	Mean kWh Savings	Mean Therm Savings
Lowered the temperature in winter			
Daytime savings	-	200.2	4.5
Nighttime savings	-	93.3	1.8

Purchased and installed CFLs	0.06426	385.2	-0.2
Switched to cold water	0.01446	71.0	10.0
Replaced furnace filter	-0.01779	-36.06	-0.12
Closed off fireplace	0.00336	5.8	0.1
Stopped heating unused rooms	0.21345	86.6	1.1
Window Shrink	0.03128	15.0	0.3
Insulated water heater	0.01112	32.2	3.5
Manages draperies	-	61.8	2.8
Cleaned baseboards	-	8.0	-
Installed attic insulation	0.10165	64.1	1.1
Installed, but only partial detail	*0.04326*	*82.1*	*1.5*
Installed, but little or no detail	*0.04967*	*83.0*	*1.5*
Installed sidewall insulation	0.34738	132.8	3.1
Installed, but only partial detail	*0.15913*	*94*	*3.9*
Installed, but little or no detail	*0.07273*	*149*	*3.8*
Insulated ducts	0.09928	95.0	2.1
Repaired ducts	0.20257	119.1	1.6
Installed a new central air unit	0.79103	300.2	-
Installed a central air unit, but little or no detail	*0.020274*	*234.7*	-
Installed a new furnace	-	-	2.9
Installed a new heat pump	0.32038	705.5	-
Installed heat pump, but little or no detail	*0.30722*	*591.36*	-
Mean Total Savings, if all measures installed	**2.18243**	**2,339.7**	**34.58**

Table 70. Summary of Mean Savings for All Recommendations Taken by Those Not Receiving Kits

	Mean kW Savings	Mean kWh Savings	Mean Therm Savings
Lowered the temperature in winter			
Daytime savings	-	297.9	4.7
Nighttime savings	-	138.1	1.8
Purchased and installed CFLs	0.00612	51	-0.2
Switched to cold water	0.00725	63.5	10.3
Replaced furnace filter	-0.01885	-41.18	-0.01
Closed off fireplace	0.00067	2.4	0.0
Stopped heating unused rooms	0.07881	119.7	1.2
Window Shrink	0.01293	21.2	0.3
Insulated water heater	0.00486	42.6	3.4
Manages draperies	-	66.6	3.0
Cleaned baseboards	-	7.2	-
Installed attic insulation	0.05006	90.2	1.4
Installed, but only partial detail	*0.06886*	133.31	1.7
Installed, but little or no detail	*0.06927*	142.95	1.7
Installed sidewall insulation	0.07561	90.2	3.6
Installed, but only partial detail	*0.08025*	*218.9*	*3.4*
Installed, but little or no detail	*0.07999*	*208.9*	*3.5*
Insulated ducts	0.06431	160.1	2.0

Repaired ducts	0.08429	176.7	1.0
Installed a new central air unit	1.22887	295.1	-
Installed a central air unit, but little or no detail	*0.21814*	254.9	-
Installed a new furnace	-	-	3.0
Installed a new heat pump	1.32199	736.0	-
Installed heat pump, but little or no detail	*0.32881*	625.4	-
Mean Total Savings, if all measures installed	**2.91692**	**2,317.32**	**35.49**

Savings Distributions

There are substantial risks associated with relying on self-reported behavioral changes, because the foundation of the savings estimates are based solely on the participant's responses, with no means to verify that the respondent has installed the kit's measures or has actually taken the recommendation provided in the Personalized Energy Report. There are two main sources of bias with these types of surveys that directly impact the conclusions drawn from the responses. These sources of bias are Self-Selection Bias and False Response Bias. There is also an issue regarding the accuracy of the baseline energy use conditions used by the evaluation contractor to estimate savings in that many of these conditions need to be based on assumptions rather than on measurements. These three conditions significantly impact the evaluation contractor's ability to provide accurate estimates of energy impact. These issues are discussed in more detail in the following paragraphs.

Self-Selection Bias

The survey was sent to 5,401 PER Program participants – 3,562 customers that did not receive the kit, and 1,839 customers that did receive the Energy Efficiency Starter Kit. The data collection efforts resulted in 1,879 responses from PER participants who only received the PER (response rate = 52.8%), and 741 responses (response rate = 40.3%) from Kentucky PER participants who received the Energy Efficiency Kit. The people that filled out and returned the survey are the participants that are more likely to install measures from the Energy Efficiency Kit and consider taking actions based on the recommendations from the Personalized Energy Report. That is, they self-selected themselves to return the survey because they have a higher interest in the subject matter than the people who did not. These individuals also will often respond to a survey in order to let it be known that they did the right thing, and that they are taking steps to be more energy efficient. The customers that did not return the survey are more likely to have a lower interest in the subject matter, and are less likely to take actions. Thus, the people who returned the survey are not the typical participant, but rather are the participant that is more likely to take actions. With 47.2% of the PER group and 59.7% of the Kit group not responding, we are setting the self-selection bias used to estimate the potential range of impacts at half of the non-response rate. As a result, all estimated energy impact estimates will be discounted 29.9% for customers that received the Energy Efficiency Kit and the Personalized Energy Report, and 23.6% for those that only received the Personalized Energy Report. All impact estimates will be discounted by this percentage in order to calculate the low end of the range of savings estimates for each measure and recommendation. This adjustment approach is subjective, and is not based on the evaluation literature or on completed research within the energy program evaluation field. Within the energy program evaluation field there is a substantial lack of research indicating the range of self-selection bias associated with energy efficiency programs. As a result, the authors of this study elected to apply a significant self-selection bias factor in order to be conservative in our estimates of program impacts. Setting the factor at half of the non-response rate is based on professional conservative judgment from conducting surveys and metering studies of energy efficiency programs for over 28 years and interacting with the evaluation community regarding these rates,

but we can point to no research that objectively assesses if this level of self-selection bias is too high or too low.

False Response Bias

False Response Bias is a problem with many self-reporting surveys. The participants respond not with the truth, but with the socially acceptable response. In short, they give the answer that they think is the *right answer* about what measures they installed or what actions they have taken as a result of the Personalized Energy Report. False response bias is typically not a large adjustment, depending on the controversy around the subject being discussed. False response bias adjustments typically range from a low of two or three percent to a high of 15 percent depending on the topic and the population being tested. The False Response Bias for this assessment was set at from a low of 10% to a high of 50% because of a specific rational relating to the conditions that act to increase or decrease this estimated average rate. A 10 % to 50% discount is be applied to each PER recommended measure impact estimate to calculate the low-end of the range of savings estimates for each measure and recommendation.

Baseline Energy Use Assumptions

When a mail survey is used to conduct an evaluation, the evaluation contractors are unsure of the actual conditions in the home that have experienced a change. For example, while a new showerhead may have been installed, it is impossible to estimate precise savings unless the flow rates and use conditions associated with the previous showerhead are well understood. For this study we established our baseline assumptions based on the survey results and our past research and experience with programs and program evaluations that have taken measurement of baseline conditions. We have also used housing-type computer models to estimate baseline conditions and behaviors. As a result, we are not adjusting the baseline conditions applied in this study, but rather using the survey results, the literature, our past research and field experience to set baseline conditions. However, because these are not program-participant measured baseline conditions, it is important to let the reader know that the baselines used in this study are estimated.

Methodology

The level of discounting used to determine the ranges for each of the measures and recommendations can be found in the table below. The self-selection bias discount factor for all measures and recommendations for the Kentucky PER is 29.9% for customers that received the Energy Efficiency Kit and the Personalized Energy Report, and 23.6% for those that only received the Personalized Energy Report.

Measure	False Response Bias	Other Discounting and Notes
CFLs	10%	Used ranges for wattage of bulb removed (as opposed to most common wattage in range) and hours of use for the lamp (as opposed to the mean of the range).
Weatherstripping	10%	
Outlet gaskets	10%	
Window shrink kit	10%	Adjusted square footage of window: if customer

		indicated "small" window, sq ft reduced by 1/3; if "average" or "large", sq ft reduced by ½.
Showerhead	20%	Used 2.75 gpm for base showerhead (as opposed to 3.1 gpm) to get the low range.
Aerators	20%	Removed the savings from cases in which there was already an aerator installed for the low estimates.

Recommendation	False Response Bias	Other Discounting and Notes
CFLs	50%	Used ranges for wattage of bulb removed (as opposed to most common wattage in range) and hours of use for the lamp (as opposed to the mean of the range). Used ranges for wattage of CFL installed. For high range, used 15 CFL replacements when respondent indicated they replaced 10+ bulbs.
Clean baseboards	50%	
Close off fireplace	50%	
Install new central air unit	50%	Low end of savings obtained by further cutting savings by half under the assumption that half of new installations were normal replacement instead of early replacement.
Install new furnace	50%	Low end of savings obtained by further cutting savings by half under the assumption that half of new installations were normal replacement instead of early replacement.
Install a new refrigerator	50%	Used 1700 for base.
Install a new heat pump	50%	Low end of savings obtained by further cutting savings by half under the assumption that half of new installations were normal replacement instead of early replacement.
Install attic insulation	50%	For partial installation, used a range of 25% coverage instead of 50%. Used a low range of 225 square feet per room.
Install sidewall insulation	50%	Removed savings for those that indicated that they installed 7-12" or 13"+ of sidewall insulation. Used a low range of 225 square feet per room. Halved the fraction used in calculating wall area as a fraction of floor area.
Install window shrink kits	50%	Adjusted square footage of window: if customer indicated "small" window, sq ft reduced by 1/3; if "average" or "large", sq ft reduced by ½.
Insulate or repair ducts	50%	Savings cut in half based on having less insulation than before and lower leakage rates.
Insulate water heater	50%	UA table modified to reflect a 1" blanket. Also used a lower set point of 120 degrees.
Lower temperature in winter	50%	
Manage draperies	50%	Reduced the savings by ½ for 2/3 of the windows to account for direction of window.
Replace furnace filter	50%	
Stop heating unused rooms	50%	Further reduced savings by 20% because of the inability to completely shut off a room, and the conductive losses through the uninsulated walls.

Switch to cold water for laundry	50%	

Savings Estimates

Each of the Kit measures and PER recommendations are recalculated here in order to provide reasonable ranges of energy savings associated with each item. The tables below provide the low and high estimates for each of the measures and recommendations provided to the Indiana participants. Savings estimates are provided for only those participants who indicated that they installed the measure. For recommendations, savings are provided for only those who indicated that they took the action, and provided full details on follow-up questions on the survey.

Table 71. Kentucky Kit Participants' Range of Kilowatt Savings

Measure	Total kW Savings		Mean kW Savings (per install)	
	Low	High	Low	High
15-watt CFL	1.928	5.243	0.00295	0.00802
20-watt CFL	1.867	5.166	0.00316	0.00876
Weatherstripping	0.327	0.683	0.00126	0.00264
Outlet gaskets	0.768	1.850	0.00210	0.00505
Window shrink kit	0.737	2.286	0.00730	0.02263
Showerhead	1.759	4.053	0.00377	0.00868
Bathroom aerator	0.020	0.035	0.00005	0.00009
Kitchen aerator	0.014	0.025	0.00004	0.00007

Table 72. Kentucky Kit Participants' Range of Kilowatt-Hour Savings

Measure	Total kWh Savings		Mean kWh Savings (per install)	
	Low	High	Low	High
15-watt CFL	19,966	88,829	30.5	135.8
20-watt CFL	18,737	82,917	31.8	140.5
Weatherstripping	853	2,231	3.3	8.6
Outlet gaskets	2,629	6,351	7.2	17.4
Window shrink kit	1,279	3,957	12.7	39.2
Showerhead	16,048	36,983	34.4	79.2
Bathroom aerator	1,513	2,651	3.8	6.7
Kitchen aerator	1,168	2,083	3.2	5.7

Table 73. Kentucky Kit Participants' Range of Therm Savings

Measure	Total Therm Savings		Mean Therm Savings (per install)	
	Low	High	Low	High
15-watt CFL	-31.7	-141.3	0.0	-0.2
20-watt CFL	-29.5	-130.8	-0.1	-0.2
Weatherstripping	19.7	51.3	0.1	0.2
Outlet gaskets	533.3	126.4	1.5	0.3
Window shrink kit	14.5	44.9	0.1	0.4
Showerhead	1,624.4	3,724.6	3.5	8.0
Bathroom aerator	85.7	149.5	0.2	0.4

Kitchen aerator	75.5	134.6	0.2	0.4

Table 74. Kentucky Kit Participants' Range of Kilowatt Savings for Recommendations

Recommendation	Total kW Savings		Mean kW Savings (per install)	
	Low	High	Low	High
CFLs	25.255	45.505	0.06426	0.11579
Clean baseboards	-	-	-	-
Close off fireplace	0.642	0.898	0.00336	0.00470
Install new central air unit	12.865	73.408	0.79103	1.26566
Install new furnace	-	-	-	-
Install a new heat pump	5.126	29.242	0.32038	1.82763
Install attic insulation	25.107	40.171	0.10165	0.16264
Install sidewall insulation	6.948	11.116	0.34738	0.55580
Install window shrink kits	2.127	3.832	0.03128	0.05635
Insulate ducts	4.071	6.513	0.09928	0.15885
Repair ducts	7.495	11.992	0.20257	0.32411
Insulate water heater	1.134	2.044	0.01112	0.02004
Lower temp in winter - day	-	-	-	-
Lower temp in winter - night	-	-	-	-
Manage draperies	-	-	-	-
Replace furnace filter	-2.240	-2.240	-0.01779	-0.01779
Stop heating unused rooms	86.448	86.448	0.21345	0.21345
Switch to cold water for laundry	5.582	8.931	0.01446	0.02314

Table 75. Kentucky Kit Participants' Range of Kilowatt-Hour Savings for Recommendations

Recommendation	Total kWh Savings		Mean kWh Savings (per install)	
	Low	High	Low	High
CFLs	151396	640,140	385.2	1628.9
Clean baseboards	40	115	8.0	23.0
Close off fireplace	1103	3,277	5.8	17.2
Install new central air unit	17411	99,349	300.2	1712.9
Install new furnace	-	-	-	-
Install a new heat pump	11288	64,407	705.5	4025.4
Install attic insulation	15843	67,490	64.1	273.2
Install sidewall insulation	2656	22,796	132.8	1139.8
Install window shrink kits	1018	5,795	15.0	85.2
Insulate ducts	3896	22,228	95.0	542.1
Repair ducts	4408	25,155	119.1	679.9
Insulate water heater	3282	17,904	32.2	175.5
Lower temp in winter - day	121733	347,312	200.2	571.2
Lower temp in winter - night	56733	161,864	93.3	266.2
Manage draperies	36371	43,960	61.8	74.6
Replace furnace filter	-3,934	-3,934	-36.1	-36.1

Stop heating unused rooms	35061	125,041	86.6	308.7
Switch to cold water for laundry	27404	78,186	71.0	202.6

Table 76. Kentucky Kit Participants' Range of Therm Savings for Recommendations

Recommendation	Total Therm Savings		Mean Therm Savings (per install)	
	Low	High	Low	High
CFLs	-67.2	-980	-0.2	-2.5
Clean baseboards	-	-	-	-
Close off fireplace	20.7	68	0.1	0.4
Install new central air unit	-	-	-	-
Install new furnace	381.9	2,178	2.9	16.6
Install a new heat pump	-	-	-	-
Install attic insulation	267.5	1,159	1.1	4.7
Install sidewall insulation	61.9	554	3.1	27.7
Install window shrink kits	18.9	106	0.3	1.6
Insulate ducts	88.1	504	2.1	12.3
Repair ducts	58.1	333	1.6	9.0
Insulate water heater	354.1	1,868	3.5	18.3
Lower temp in winter - day	2727.0	7,781	4.5	12.8
Lower temp in winter - night	1080.0	3,080	1.8	5.1
Manage draperies	1641.0	2,145	2.8	3.6
Replace furnace filter	-21	-21	-0.1	-0.1
Stop heating unused rooms	437.0	1,560	1.1	3.9
Switch to cold water for laundry	3875.6	11,057	10.0	28.6

Table 77. Kentucky No Kit Participants' Range of Kilowatt Savings for Recommendations

Recommendation	Total kW Savings		Mean kW Savings (per install)	
	Low	High	Low	High
CFLs	5.503	47.649	0.00612	0.05300
Clean baseboards	-	-	-	-
Close off fireplace	0.340	0.891	0.00067	0.00175
Install new central air unit	26.778	140.328	0.22887	1.19938
Install new furnace	-	-	-	-
Install a new heat pump	10.626	55.632	0.32199	1.68582
Install attic insulation	31.440	123.745	0.05006	0.19705
Install sidewall insulation	5.746	50.692	0.07561	0.66700
Install window shrink kits	2.147	11.163	0.01293	0.06725
Insulate ducts	6.688	35.017	0.06431	0.33670
Repair ducts	7.754	40.600	0.08429	0.44130
Insulate water heater	1.288	6.303	0.00486	0.02378
Lower temp in winter - day	-	-	-	-
Lower temp in winter - night	-	-	-	-
Manage draperies	-	-	-	-
Replace furnace filter	-0.880	-1.520	-0.0185	-0.00332
Stop heating unused rooms	81.334	266.144	0.07881	0.25789
Switch to cold water for laundry	7.159	18.741	0.00725	0.01899

Table 78. Kentucky No Kit Participants' Range of Kilowatt-Hour Savings for Recommendations

Recommendation	Total kWh Savings		Mean kWh Savings (per install)	
	Low	High	Low	High
CFLs	45,864	1,132,047	51	1259.2
Clean baseboards	51	133	7.2	19.0
Close off fireplace	1201	3,142	2.4	6.2
Install new central air unit	34523	180,749	295.1	1544.9
Install new furnace	-	-	-	-
Install a new heat pump	24289	127,167	736.0	3853.5
Install attic insulation	56639	222,542	90.2	354.4
Install sidewall insulation	13714	105,277	180.4	1385.2
Install window shrink kits	3516	18,294	21.2	110.2
Insulate ducts	16648	87,162	160.1	838.1
Repair ducts	16255	85,106	176.7	925.1
Insulate water heater	11278	55,215	42.6	208.4
Lower temp in winter - day	464354	1,215,587	297.9	779.7
Lower temp in winter - night	96373	563,414	138.1	361.4
Manage draperies	96373	756,481	66.6	523.2
Replace furnace filter	-4594	-4,594	-3.4	-10.0
Stop heating unused rooms	123535	404,237	119.7	391.7
Switch to cold water for laundry	62702	164,141	63.5	166.3

Table 79. Kentucky No Kit Participants' Range of Therm Savings for Recommendations

Recommendation	Total Therm Savings		Mean Therm Savings (per install)	
	Low	High	Low	High
CFLs	-136.0	-1,852.9	-0.2	-2.1
Clean baseboards	-	-	-	-
Close off fireplace	22.5	58.9	0.0	0.1
Install new central air unit	-	-	-	-
Install new furnace	841.3	4,404.8	3.0	15.8
Install a new heat pump	-	-	-	-
Install attic insulation	857.4	3,389.7	1.4	5.4
Install sidewall insulation	276.3	2,121.1	3.6	27.9
Install window shrink kits	48.9	253.6	0.3	1.5
Insulate ducts	210.1	1,100.1	2.0	10.6
Repair ducts	94.1	492.7	1.0	5.4
Insulate water heater	901.4	4,358.4	3.4	16.4
Lower temp in winter - day	7255.2	18,992.8	4.7	12.2
Lower temp in winter - night	2778.1	7,272.6	1.8	4.7
Manage draperies	4371.6	34,315.0	3.0	23.7
Replace furnace filter	5.5	16.0	0.0	0.0
Stop heating unused rooms	1270.4	4,157.0	1.2	4.0
Switch to cold water for laundry	10210.6	26,729.3	10.3	27.1

Appendix A: PER and Energy Efficiency Kit Survey

Please answer the questions in this survey by darkening the circles next to the responses associated with each question using blue or black ink. For example ○ is fully filled in when it looks like this: ●

Duke Energy

QUESTIONS FOR KIT MATERIAL USE

The first set of questions ask about the materials you received in the Energy Efficiency Kit mailed to you from Duke Energy. This kit included a number of items such as a showerhead, aerators, compact fluorescent light bulbs and other items. Please provide your response to each of the following questions about the materials you received in the kit.

15-WATT MINI COMPACT FLORESCENT LIGHT (CFL)

1. Have you installed the 15-watt CFL bulb in a light fixture? ○ Yes ○ No ○ Don't know

If yes...

2. How many watts was the old bulb you took out? ○ ≥45 ○ 45-30 ○ 31-99 ○ 100≥
3. On average, how many hours per day do you use this bulb? ○ <1 ○ 1-2 ○ 3-4 ○ 5-10 ○ 11-12 ○ 13-24

20-WATT MINI COMPACT FLORESCENT LIGHT

1. Have you installed the 20-watt CFL bulb in a light fixture? ○ Yes ○ No ○ Don't know

If yes...

2. How many watts was the old bulb you took out? ○ ≥45 ○ 45-30 ○ 31-99 ○ 100≥
3. On average, how many hours per day do you use this bulb? ○ <1 ○ 1-2 ○ 3-4 ○ 5-10 ○ 11-12 ○ 13-24

CLOSED CELL WEATHER-STRIPPING – 17 FEET

1. Have you installed any of the weather-stripping on your doors or windows or used it to seal cracks? ○ Yes ○ No ○ Don't know
2. If yes, how many feet of the 17 received have you used? ○ 1-5 ○ 6-10 ○ 11-17

WINDOW COVERING SHRINK-FIT STORM WINDOW

1. Have you installed the window shrink-film? ○ Yes ○ No ○ Don't know

If yes...

2. What size would you consider the window on which you used the kit to be? ○ Small ○ Average ○ Large
3. What type of window is it? ○ Single pane ○ Single with storm ○ Double pane

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SHOWERHEAD

1. Have you installed the energy-efficient showerhead? ○ Yes ○ No ○ Don't know

If yes...

2. Typically, how many showers per week are taken using this showerhead? ○ 0-4 ○ 5-10 ○ 11-15 ○ 16-20 ○ 21≥
3. Would you estimate that the amount of water coming through the new showerhead is: ○ Less than the old unit ○ About the same ○ More than the old unit

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BATHROOM FAUCET AERATOR

1. Have you installed the faucet aerator in your bathroom? ○ Yes ○ No ○ Don't know

If yes...

2. Was there an aerator on the faucet that you had to remove? ○ Yes ○ No ○ Don't know
3. If yes, would you estimate that the amount of water coming through the new aerator is: ○ Less than the old unit ○ About the same, or ○ More than the old unit

KITCHEN FAUCET AERATOR

1. Have you installed the faucet aerator in your kitchen? ○ Yes ○ No ○ Don't know

If yes...

2. Was there an aerator on the faucet that you had to remove? ○ Yes ○ No ○ Don't know
3. If yes, would you estimate that the amount of water coming through the new aerator is: ○ Less than the old unit ○ About the same ○ More than the old unit

WALL PLUG OUTLET AND SWITCH INSULATORS

1. Have you installed the insulating gaskets on any outlet boxes or wall switches? ○ Yes ○ No ○ Don't know
2. If yes, how many have you installed? ○ 1-2 ○ 3-5 ○ 6-8

REPORT RECOMMENDATIONS

This set of questions ask about the actions you have taken or plan to take based on the recommendations that were included on your Personalized Energy Report. These questions are only about things that you have done after receiving your report.

LOWERED THE TEMPERATURE IN THE HOME DURING THE WINTER

1. Have you lowered the temperature of your home to save money or energy during the winter months?

○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. How many degrees have you lowered the temperature at night? ○ 1-3 ○ 4-6 ○ 7-10 ○ 11+
3. How many degrees have you lowered the temperature during the day? ○ 1-3 ○ 4-6 ○ 7-10 ○ 11+

PURCHASED AND INSTALLED COMPACT FLORESCENT LIGHTS (CFLS)

1. Have you purchased and used additional compact fluorescent lightbulbs in your home? ○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. How many CFLs have you purchased and installed since receiving the report? ○ 1-2 ○ 3-5 ○ 6-9 ○ 10+
3. On average, what wattage bulb did you remove from the fixture before you installed the CFL? ○ <41 ○ 41-70 ○ 71-99 ○ 100+
4. Considering all CFL locations and uses, on average, how many hours per day do you use these bulbs?

○ <1 ○ 1-2 ○ 3-4 ○ 5-9 ○ 10-12 ○ 13-24

WASHED LAUNDRY IN COLD WATER

1. Have you switched from using hot water to do your laundry instead of cold water? ○ Yes ○ No but plan to do this ○ No ○ Don't know
2. If yes, how many loads of laundry do you do per week? ○ 1-2 ○ 3-4 ○ 5-6 ○ 7-8 ○ 9-10 ○ 11-12 ○ 13+

REPLACED FURNACE FILTERS

1. Have you replaced your furnace filter? ○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. How often do you now change the filter? ○ Less than once a year ○ Once a year ○ Twice a year ○ More than twice a year ○ Don't know
3. How often did you change your filter prior to receiving the personalized energy report? ○ Less than once a year ○ Once a year ○ Twice a year ○ More than twice a year ○ Don't know

TURNED OFF HEAT IN UNUSED ROOMS

1. Have you closed the heating vents or covered the heat outlets in unused rooms? ○ Yes ○ No but plan to do this ○ No ○ Don't know
2. If yes, how many rooms do you close/cover? ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6+

INSTALLED WINDOW COVERING SHRINK-FIT STORM WINDOWS

1. Have you purchased and installed any plastic wrap-type window kits that cover the entire window to help keep the cold out?

○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. How many windows have you covered with these kits? ○ 1-3 ○ 4-7 ○ 8-10 ○ 11+
3. On average, what size would you consider the window on which you used the kits to be? ○ Small ○ Average ○ Large
4. What type of window is it? ○ Single pane ○ Single with storm ○ Double pane

INSULATED HOT WATER HEATER TANK

1. Have you insulated your hot water tank? ○ Yes ○ No but plan to do this ○ No ○ Don't know
2. If yes, how many gallons of water does your tank hold? ○ 30 ○ 50 ○ 60 ○ 75 ○ 80+ ○ Don't know

KEEP DRAPERIES OPEN ON SUNNY DAYS AND CLOSED AT NIGHT

1. Do you manage your window coverings and draperies so that they are open when the sun is shining in and closed at other times?

○ Yes ○ No but plan to do this ○ No ○ Don't know

2. If yes, how many windows do you manage the coverings to save energy? ○ 1-3 ○ 4-7 ○ 8-12 ○ 13+

CLEANED ELECTRIC BASEBOARD HEATING REGISTERS OF DUST

1. For electrically heating homes, have you cleaned any of the baseboards?

○ Yes ○ No but plan to do this ○ No ○ Don't know

2. If yes, how many baseboards have you cleaned? ○ 1-3 ○ 4-6 ○ 7-10 ○ 11+

INSULATED THE CEILING OR ATTIC

1. Have you had your attic insulated? ○ Yes ○ No but plan to do this ○ No ○ Don't know
2. Did you insulate part of the ceiling or attic? ○ Part of ceiling ○ Entire ceiling
3. What type of insulation did you add? ○ Fiberglass ○ Cellulose ○ Foam ○ Other
4. How many inches of thickness did you add? ○ 1-2 ○ 3-4 ○ 5-6 ○ 7-8 ○ 9-10 ○ 11+
5. How close was the insulation before you added more? ○ 1-2 ○ 3-4 ○ 5-6 ○ 7-8 ○ 9-10 ○ 11+

INSULATED SIDEWALLS OF HOME

1. Have you had the sidewalls of your home insulated since you received your Personalized Energy Report?

○ Yes ○ No but plan to do this ○ No ○ Don't know

2. How many walls did you have insulated? ○ 1 ○ 2 ○ 3 ○ 4+
3. What type of insulation did you add? ○ Fiberglass ○ Cellulose ○ Foam ○ Other
4. How many inches of thickness did you add? ○ 1-3 ○ 4-6 ○ 7-12 ○ 13+

CLOSED-OFF OR SEAL-UP THE FIREPLACE

1. Have you stopped using a fireplace to reduce the heat loss going up the chimney during the winter?

○ Yes ○ No but plan to do this ○ No ○ Don't know

2. Have you closed-off or sealed the fireplace to reduce the heat loss?

○ Yes ○ No but plan to do this ○ No ○ Don't know

INSULATED OR REPAIRED HEATING OR AIR CONDITIONING DUCTS

1. Have you insulated any of your heating or cooling ducts that deliver air to the rooms of the home?

○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. Are these ducts located in a heated or unheated part of the home?

○ Unheated area ○ Heated area ○ Don't know

3. Have you repaired or fixed holes in any of your heating or cooling ducts that deliver air to the rooms of the home?

○ Yes ○ No but plan to do this ○ No ○ Don't know

INSTALLED NEW CENTRAL AIR CONDITIONING

1. Have you installed a new central air conditioning unit in your home?

○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. Is the air conditioner a high efficiency unit (>= 13 SEER) or a standard efficiency unit (< 13 SEER)? ○ High efficiency ○ Standard ○ Don't know

3. What is the SEER number for your unit? ○ < 11 ○ 12 ○ 13 ○ 14+ ○ Don't know

---

INSTALLED A NEW NATURAL GAS OR PROPANE FURNACE

1. Have you installed a new natural gas or propane furnace in your home?

○ Yes ○ No but plan to do this ○ No ○ Don't know

2. If yes, is the furnace a high efficiency unit in which the exhaust exits a plastic pipe coming through the side of the home, or does the exhaust go up a chimney or flue similar to a standard efficiency unit? ○ Plastic pipe ○ Chimney or flue ○ Don't know

---

INSTALLED NEW HEAT PUMP

1. Have you installed a new heat pump in your home? ○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. Is the heat pump a high efficiency unit (>= 13 SEER) or a standard efficiency unit (< 13)? ○ High efficiency ○ Standard ○ Don't know

3. What is the SEER number for your unit? ○ < 11 ○ 12 ○ 13 ○ 14+ ○ Don't know

---

INSTALLED NEW REFRIGERATOR

1. Have you purchased a new refrigerator? ○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. Is the refrigerator Energy Star compliant? ○ Yes ○ No ○ Don't know

3. Are you keeping your old refrigerator plugged in as a backup? ○ Yes ○ No ○ Don't know

---

THE DUKE ENERGY WEB SITE

1. Have you visited the Duke Energy Web site that is referenced in your Personalized Energy Report to identify additional ways to save energy in your home?

○ Yes ○ No but plan to do this ○ No ○ Don't know

2. If yes, did you find this Web site helpful? ○ Yes ○ Somewhat ○ No

Appendix B: PER Survey

Please answer the questions in this survey by darkening the circles next to the responses associated with each question using blue or black ink. For example, ○ is fully filled in when it looks like this: ●

Duke Energy

REPORT RECOMMENDATIONS

This set of questions ask about the actions you have taken or plan to take based on the recommendations that were included in your Personalized Energy Report. These questions are only about things that you have done after receiving your report.

LOWERED THE TEMPERATURE IN THE HOME DURING THE WINTER

1. Have you lowered the temperature of your home to save money or energy during the winter months?

○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. How many degrees have you lowered the temperature at night? ○ 1-3 ○ 4-6 ○ 7-10 ○ 11+

3. How many degrees have you lowered the temperature during the day? ○ 1-3 ○ 4-6 ○ 7-10 ○ 11+

PURCHASED AND INSTALLED COMPACT FLORESCENT LIGHTS (CFLs)

1. Have you purchased and used additional compact florescent lightbulbs in your home? ○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. How many CFLs have you purchased and installed since reading the report? ○ 1-2 ○ 3-5 ○ 6-9 ○ 10+

3. On average, what wattage bulb did you remove from the fixture before you installed the CFL? ○ <44 ○ 45-70 ○ 71-99 ○ 100+

4. Considering all CFL lighting and uses, on average, how many hours per day do you use these bulbs?

○ <1 ○ 1-2 ○ 3-4 ○ 5-9 ○ 10-12 ○ 12-24

WASHED LAUNDRY IN COLD WATER

1. Have you switched from using hot water to do your laundry instead of cold water? ○ Yes ○ No but plan to do this ○ No ○ Don't know

2. If yes, how many loads of laundry do you do per week? ○ 1-2 ○ 3-4 ○ 5-6 ○ 7-8 ○ 9-10 ○ 11-12 ○ 13+

REPLACED FURNACE FILTERS

1. Have you replaced your furnace filter? ○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. How often do you now change the filter? ○ Less than once a year ○ Once a year ○ Twice a year
○ More than twice a year ○ Don't know

3. How often did you change your filter prior to reading the personalized energy report? ○ Less than once a year ○ Once a year
○ Twice a year ○ More than twice a year ○ Don't know

TURNED OFF HEAT IN UNUSED ROOMS

1. Have you closed the heating vents or shades on the unused rooms? ○ Yes ○ No but plan to do this ○ No ○ Don't know

2. If yes, how many rooms do you now heat in the winter? ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6+

INSTALLED WINDOW COVERING OR RIGID-FIT STORM WINDOWS

1. Have you purchased and installed any plastic wrap-type window kits that cover the entire window to help keep the cold out?

○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes, ...

2. How many windows have you covered with these kits? ○ 1-3 ○ 4-7 ○ 8-10 ○ 11+

3. On average, what size would you consider the window on which you used the kits to be? ○ Small ○ Average ○ Large

4. What type of window is it? ○ Single pane ○ Single with storm ○ Double pane

INSULATED HOT WATER HEATER TANK

1. Have you insulated your hot water tank? ○ Yes ○ No but plan to do this ○ No ○ Don't know

2. If yes, how many gallons of water does your tank hold? ○ 30 ○ 50 ○ 60 ○ 75 ○ 80+ ○ Don't know

KEEP DRAPERIES OPEN ON SUNNY DAYS AND CLOSED AT NIGHT

1. Do you manage your window coverings and draperies so that they are open when the sun is shining in and closed at other times?

○ Yes ○ No but plan to do this ○ No ○ Don't know

2. If yes, how many windows do you manage the coverings to save energy? ○ 1-3 ○ 4-7 ○ 8-12 ○ 13+

CLEANED ELECTRIC BASEBOARD HEATING REGISTERS OF DUST

1. For electrically heating homes, have you cleaned any of the baseboards?

○ Yes ○ No but plan to do this ○ No ○ Don't know

2. If yes, how many baseboards have you cleaned? ○ 1-3 ○ 4-6 ○ 7-10 ○ 11+

INSULATED THE CEILING OR ATTIC

1. Have you had your attic insulated? ○ Yes ○ No but plan to do this ○ No ○ Don't know

2. Did you insulate part of the ceiling or attic? ○ Part of ceiling ○ Entire ceiling

3. What type of insulation did you add? ○ Fiberglass ○ Cellulose ○ Foam ○ Other

4. How many inches of thickness did you add? ○ 1-3 ○ 3-4 ○ 5-6 ○ 7-8 ○ 9-10 ○ 11+

5. How thick was the insulation before you added more? ○ 1-3 ○ 3-4 ○ 5-6 ○ 7-8 ○ 9-10 ○ 11+

INSULATED SIDE WALLS OF HOME

1. Have you had the sidewalls of your home insulated since you received your Personalized Energy Report?

○ Yes ○ No but plan to do this ○ No ○ Don't know

2. How many walls did you have insulated? ○ 1 ○ 2 ○ 3 ○ 4+

3. What type of insulation did you add? ○ Fiberglass ○ Cellulose ○ Foam ○ Other

4. How many inches of thickness did you add? ○ 1-3 ○ 4-6 ○ 7-12 ○ 13+

CLOSED-OFF OR SEAL-UP THE FIREPLACE

1. Have you stopped using a fireplace to reduce the heat loss going up the chimney during the winter?

○ Yes ○ No but plan to do this ○ No ○ Don't know

2. Have you closed-off or sealed the fireplace to reduce the heat loss?

○ Yes ○ No but plan to do this ○ No ○ Don't know

INSULATED OR REPAIRED HEATING OR AIR CONDITIONING DUCTS

1. Have you insulated any of your heating or cooling ducts that deliver air to the rooms of the home?

○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. Are these ducts located in a heated or unheated part of the home?

○ Unheated area ○ Heated area ○ Don't know

3. Have you repaired or sealed leaks in any of your heating or cooling ducts that deliver air to the rooms of the home?

○ Yes ○ No but plan to do this ○ No ○ Don't know

INSTALLED NEW CENTRAL AIR CONDITIONING

1. Have you installed a new central air conditioning unit in your home?

○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. Is the air conditioner a high efficiency unit (>= 13 SEER) or a standard efficiency unit (< 13 SEER)? ○ High efficiency ○ Standard ○ Don't know

3. What is the SEER number for your unit? ○ <11 ○ 12 ○ 13 ○ 14+ ○ Don't know

INSTALLED A NEW NATURAL GAS OR PROPANE FURNACE

1. Have you installed a new natural gas or propane furnace in your home?

○ Yes ○ No but plan to do this ○ No ○ Don't know

2. If yes, is the furnace a high efficiency unit in which the exhaust exits a plastic pipe coming through the side of the home, or does the exhaust go up a chimney or flue similar to a standard efficiency unit? ○ Plastic pipe ○ Chimney or flue ○ Don't know

INSTALLED NEW HEAT PUMP

1. Have you installed a new heat pump in your home? ○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. Is the heat pump a high efficiency unit (>= 13 SEER) or a standard efficiency unit (< 13)? ○ High efficiency ○ Standard ○ Don't know

3. What is the SEER number for your unit? ○ <11 ○ 12 ○ 13 ○ 14+ ○ Don't know

INSTALLED NEW REFRIGERATOR

1. Have you purchased a new refrigerator? ○ Yes ○ No but plan to do this ○ No ○ Don't know

If yes...

2. Is the refrigerator Energy Star compliant? ○ Yes ○ No ○ Don't know

3. Are you keeping your old refrigerator plugged in as a backup? ○ Yes ○ No ○ Don't know

THE DUKE ENERGY WEB SITE

1. Have you visited the Duke Energy Web site that is referenced in your Personalized Energy Report to identify additional ways to save energy in your home?

○ Yes ○ No but plan to do this ○ No ○ Don't know

2. If yes, did you find this Web site helpful? ○ Yes ○ Somewhat ○ No

Appendix C: Impact Algorithms Used

CFLs

General Algorithm

Gross Summer Coincident Demand Savings

$$\Delta kW_S = \text{units} \times \left[\frac{(Watts \times DF_s)_{base} - (Watts \times DF_s)_{ee}}{1000} \right] \times CF_S \times (1 + HVAC_{d,\,s})$$

Gross Annual Energy Savings

$$\Delta kWh = \text{units} \times \left[\frac{(Watts \times DF)_{base} - (Watts \times DF)_{ee}}{1000} \right] \times FLH \times (1 + HVAC_c)$$

$$\Delta therm = \Delta kWh \times HVAC_g$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
$\Delta therm$	= gross annual therm interaction
units	= number of units installed under the program
$Watts_{ee}$	= connected (nameplate) load of energy-efficient unit
$Watts_{base}$	= connected (nameplate) load of baseline unit(s) displaced
FLH	= full-load operating hours (based on connected load)
DF	= demand diversity factor
CF	= coincidence factor
$HVAC_c$	= HVAC system interaction factor for annual electricity consumption
$HVAC_d$	= HVAC system interaction factor for demand
$HVAC_g$	= HVAC system interaction factor for annual gas consumption

15 W CFL Measure

$Watts_{ee}$ = 15, which is the input power of program supplied CFL

$Watts_{base}$ - calculated from survey responses as shown below:

Wattage of bulb removed	$Watts_{base}$	Notes
<= 44	40	Most popular size < 44 W
45 - 70	60	Lumen equivalent of 15 W CFL
71 - 99	75	Most popular size in range
> = 100	100	Most popular size in range

FLH - calculated from survey responses as shown below:

Hours of use per day	FLH	Notes
<1	183	Average value over range
1-2	548	Average value over range
3-4	1278	Average value over range
5-10	2738	Average value over range
11-12	4198	Average value over range
13-24	6753	Average value over range

DF = 1.0 and CF = 0.10

The coincidence factor for this analysis was taken as the average of the coincidence factors estimated by PG&E and SCE for residential CFL program peak demand savings. The PG&E and SCE coincidence factors are combined factors that consider both coincidence and diversity, thus the diversity factor for this analysis was set to 1.0

$HVAC_C$ - the HVAC interaction factor for annual energy consumption depends on the HVAC system, heating fuel type, and location. The HVAC interaction factors for annual energy consumption were taken from DOE-2 simulations of the residential prototype building described at the end of this Appendix.

Covington, KY

Heating Fuel	Heating System	Cooling System	HVACc	HVACg
Other	Any except Heat Pump	Any except Heat Pump	0	0
Any	Heat Pump	Heat Pump	-0.16	0
Gas Propane Oil	Central Furnace	None	0	-0.0021
		Room/Window	0.079	-0.0021
		Central AC	0.079	-0.0021
	Other	None	0	-0.0021
		Room/Window	0.079	-0.0021
		Central AC	0.079	-0.0021
Electricity	Central furnace	None	-0.45	0
		Room/Window	-0.36	0
		Central AC	-0.36	0
	Electric baseboard	None	-0.45	0
		Room/Window	-0.36	0
		Central AC	-0.36	0
	Other	None	-0.45	0
		Room/Window	-0.36	0
		Central AC	-0.36	0

$HVAC_d$ - the HVAC interaction factor for demand depends on the cooling system type. The HVAC interaction factors for summer peak demand were taken from DOE-2 simulations of the residential prototype building described at the end of this Appendix.

Covington, KY

Cooling System	HVACd
None	0
Room/Window	.17
Central AC	.17
Heat Pump	.17

20W CFL Measure

$Watts_{ee}$ = 20, which is the input power of program supplied CFL
$Watts_{base}$ - calculated from survey responses as shown below:

Wattage of bulb removed	$Watts_{base}$	Notes
<= 44	40	Most popular size < 44 W
45 - 70	60	Most popular size in range
71 - 99	75	Lumen equivalent of 20 W CFL
> = 100	100	Most popular size in range

Weatherstripping, Outlet Gaskets, and Fireplace Closure

Gross Summer Coincident Demand Savings

$\Delta kW_S = units \times (\Delta cfm/unit) \times (kW / cfm) \times DF_S \times CF_S$

Gross Annual Energy Savings

$\Delta kWh = units \times (\Delta cfm/unit) \times (kWh / cfm)$

$\Delta therm = units \times (\Delta cfm / unit) \times (therm / cfm)$

where:

ΔkW = gross coincident demand savings
ΔkWh = gross annual energy savings

units = number of buildings sealed under the program
Δcfm/unit = unit infiltration airflow rate (ft^3/min) reduction for each measure
DF = demand diversity factor = 0.8
CF = coincidence factor = 1.0
kW/cfm = demand savings per unit cfm reduction
kWh/cfm = electricity savings per unit cfm reduction
therm/cfm = gas savings per unit cfm reduction

Unit cfm savings per measure

The cfm reductions for each measure were estimated from equivalent leakage area (ELA) change data taken from the ASHRAE Handbook of Fundamentals (ASHRAE, 2001). The equivalent leakage area changes were converted to infiltration rate changes using the Sherman-Grimsrud equation:

$$Q = ELA \times \sqrt{A \times \Delta T + B \times v^2}$$

where:

A = stack coefficient (ft^3/min-in^4-°F)
= 0.015 for one-story house
ΔT = average indoor/outdoor temperature difference over the time interval of interest (°F)
B = wind coefficient (ft^3/min-in^4-mph^2)
= 0.0065 (moderate shielding)
v = average wind speed over the time interval of interest measured at a local weather station at a height of 20 ft (mph)

The location specific data are shown below:

Location	Average outdoor temp	Average indoor/outdoor temp difference	Average wind speed (mph)	Specific infiltration rate (cfm/in^2)
Covington	33	35	22	1.92

Measure ELA impact and cfm reductions are as follows:

Measure	Unit	ELA change (in^2/unit)	ΔCfm/unit (KY)
Outlet gaskets	Each	0.357	0.69
Weather strip	Foot	0.089	0.17
Fireplace	Each	1.86	3.57

Unit energy and demand savings

The energy and peak demand impacts of reducing infiltration rates were calculated from infiltration rate parametric studies conducted using the DOE-2 residential building prototype models, as described at the end of this Appendix. The savings per cfm reduction by heating and cooling system type are shown below:

Heating Fuel	Heating System	Cooling System	kWh/cfm	kW/cfm	therm/cfm
Other	Any except Heat Pump	Any except Heat Pump	1.14	0.00000	0.000
Any	Heat Pump	Heat Pump	12.85	0.00248	0.000
Gas Propane Oil	Central Furnace	None	0	0	0.124
		Room/Window	1.14	0.00000	0.124
		Central AC	1.14	0.00000	0.124
	Other	None	0	0	0.124
		Room/Window	1.14	0.00000	0.124
		Central AC	1.14	0.00000	0.124
Electricity	Central furnace	None	23.27	0.01238	0.000
		Room/Window	23.84	0.01485	0.000
		Central AC	23.84	0.01485	0.000
	Electric baseboard	None	23.27	0.01238	0.000
		Room/Window	23.84	0.01485	0.000
		Central AC	23.84	0.01485	0.000
	Other	None	23.27	0.01238	0.000
		Room/Window	23.84	0.01485	0.000
		Central AC	23.84	0.01485	0.000

Window Shrink Kit

Gross Summer Coincident Demand Savings
ΔkW_S = no. windows ×SF/window × (ΔkW/SF) × DF_S × CF_S

Gross Annual Energy Savings
ΔkWh = no. windows ×SF/window × (ΔkWh/SF)

Δtherm = no. windows ×SF/window × (Δtherm/SF)

where:

ΔkW = gross coincident demand savings
ΔkWh = gross annual energy savings
No windows = quantity of windows treated with window film from survey

SF/window = window square feet based on window size
DF = demand diversity factor
CF = coincidence factor
ΔkW/SF `= electricity demand savings per square foot of window treated
ΔkWh/SF `= electricity consumption savings per square foot of window treated
Δtherm/SF `= gas consumption savings per square foot of window treated

Coincidence and Diversity Factors:

DF = 0.8
CF = 1.0

The diversity and coincidence factors were taken from *Engineering Methods for Estimating the Impacts of DSM Programs, Volume 2* (EPRI, 1993). These values are typical for residential cooling loads in summer peaking utilities.

Window area assumptions (per window):

Window Type	Size (SF)
Small	9
Average	18
Large	30

Unit energy and demand savings data

The unit energy savings were taken from DOE-2 simulations of the residential prototype building described at the end of this Appendix. The basic simulation assumptions for window U-value and solar heat gain coefficient (SHGC) were taken from the ASHRAE Handbook of Fundamentals (ASHRAE, 2001), and are described below:

	Without window film		**With window film**	
Window type	**U-value (Btu/hr-SF-°F)**	**SHGC**	**U-value (Btu/hr-SF-°F)**	**SHGC**
Single	1.27	0.86	0.81	0.76
Single with storm	0.81	0.76	0.67	0.68
Double	0.81	0.76	0.67	0.68

The unit energy savings depend on the heating fuel, heating system, cooling system and window type:

Heating Fuel	Other
Heating System	Any except Heat Pump
Cooling System	None

Window	**ΔkWh/SF**	**ΔkW/SF**	**Δtherm/SF**

type			
All	0	0	0

Heating Fuel Other
Heating System Any except Heat Pump
Cooling System Room/Window or Central AC

Window type	ΔkWh/SF	ΔkW/SF	Δtherm/SF
Single	0.795	0.000853	0
Single with storm	0.566	0.000498	0
Double	0.566	0.000498	0

Heating Fuel Any
Heating System Heat Pump
Cooling System Heat Pump

Window type	ΔkWh/SF	ΔkW/SF	Δtherm/SF
Single	4.757	0.001280	0.000
Single with storm	1.621	0.000711	0.000
Double	1.621	0.000711	0.000

Heating Fuel Gas, propane or oil
Heating System Any except Heat Pump
Cooling System None

Window type	ΔkWh/SF	ΔkW/SF	Δtherm/SF
Single	0	0	0.039
Single with storm	0	0	0.011
Double	0	0	0.011

Heating Fuel Gas, propane or oil
Heating System Any except Heat Pump
Cooling System Room/Window or Central AC

Window type	ΔkWh/SF	ΔkW/SF	Δtherm/SF
Single	0.795	0.000853	0.039
Single with storm	0.566	0.000498	0.011
Double	0.566	0.000498	0.011

Heating Fuel	Electricity
Heating System	Any except Heat Pump
Cooling System	None

Window type	ΔkWh/SF	ΔkW/SF	Δtherm/SF
Single	8.748	0.004979	0.000
Single with storm	2.431	0.001351	0.000
Double	2.431	0.001351	0.000

Heating Fuel	Electricity
Heating System	Any except Heat Pump
Cooling System	Room/Window or Central AC

Window type	ΔkWh/SF	ΔkW/SF	Δtherm/SF
Single	9.335	0.005690	0.000
Single with storm	2.940	0.001849	0.000
Double	2.940	0.001849	0.000

Low-Flow Showerhead

Gross Summer Coincident Demand Savings

$$\Delta kW_S = units \times \frac{(GPD_{base} - GPD_{ee}) \times 8.33 \times \overline{\Delta T}}{3413_s} \times DF_x \times CF_s$$

Gross Annual Energy Savings

$$\Delta kWh = units \times \frac{(GPD_{base} - GPD_{ee}) \times 8.33 \times \overline{\Delta T}}{3413} \times 365$$

$$\Delta therm = units \times \frac{(GPD_{base} - GPD_{ee}) \times 8.33 \times \overline{\Delta T}}{\eta_{waterheater}} \times \frac{365}{100000}$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
units	= number of units installed under the program

GPD_{base} = daily hot water consumption before installation
GPD_{ee} = daily hot water consumption after flow reducing measure installation
ΔT = average difference between entering cold water temperature and the shower use temperature
DF = demand diversity factor for electric water heating
CF = coincidence factor
8.33 = conversion factor (Btu/gal-°F)
3413 = conversion factor (Btu/kWh)
24 = conversion factor (hr/day)
365 = conversion factor (days/yr)
100000 = conversion factor (Btu/therm)

Showerhead

GPD_{base} = showers/week / 7 x 3.1 gpm x 5 minutes/shower

GPD_{ee} = showers/week / 7 x 1.5 gpm x 5 minutes/shower

ΔT

City	Average cold water temperature	Shower use temperature	Average ΔT
Covington	53.9°F	100°F	46.1°F

Water heater efficiency

Combustion efficiency for residential gas water heater = 0.70

Demand diversity factor = 0.1

Coincidence factor = 0.4

The diversity and coincidence factors were taken from *Engineering Methods for Estimating the Impacts of DSM Programs, Volume 2* (EPRI, 1993). These values are typical for the residential water heating end-use in a summer peaking utility.

Faucet Aerators

This measure used the Efficiency Vermont deemed savings (Efficiency Vermont, 2003) adjusted for entering water temperature:

Demand Savings
$\Delta kW = 0.0171 \text{ kW} \times \Delta T / \Delta T_{VT} \times DF \times CF$

Energy Savings
$\Delta kWh_i = 57\ kWh \times \Delta T / \Delta T_{VT}$
$\Delta therms = 2.0 \times \Delta T / \Delta T_{VT\,i}$

City	Average cold water temperature	Hot water use temperature	Average ΔT
Covington	53.9°F	100°F	46.1°F
Burlington VT	44.5	100°F	55.5

Demand diversity factor = 0.1

Coincidence factor = 0.4

The diversity and coincidence factors were taken from *Engineering Methods for Estimating the Impacts of DSM Programs, Volume 2* (EPRI, 1993). These values are typical for the residential water heating end-use in a summer peaking utility.

Lowering the Temperature in Winter

Gross Annual Energy Savings
ΔkWh = (ΔkWh/unit)

Δtherm = (Δtherm/unit

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
DF	= demand diversity factor
CF	= coincidence factor
ΔkWunit	`= electricity demand savings per dwelling
ΔkWh/SF	`= electricity consumption savings per dwelling
Δtherm/SF	`= gas consumption savings dwelling

Unit energy savings data

The unit energy savings were taken from DOE-2 simulations of the residential prototype building described at the end of this Appendix. The basic assumptions used in the simulations are shown below:

Setback strategy	Setback schedule	Setback temperature
Night 1-3	10 pm to 5 am 7 days per week	68°F
Night 4-6		65°F
Night 7-10		61.5°F

Night 11+		59°F
Day 1-3	5 am to 10 pm 7 days per week	68°F
Day 4-6		65°F
Day 7-10		61.5°F
Day 11+		59°F

The baseline heating setpoint is assumed to be 70°F with no setback.

The unit energy savings depend on the heating fuel, heating system, cooling system and setback strategy. Since this is a heating season measure, there are no summer peak demand savings.

Heating Fuel	Other
Heating System	Any except Heat Pump
Cooling System	None

Setback strategy	ΔkWh/unit	Δtherm/unit
All	0	0

Heating Fuel	Other
Heating System	Any except Heat Pump
Cooling System	Room/Window or Central AC

Setback strategy	ΔkWh/unit	Δtherm/unit
Night 1-3	58	0
Night 4-6	107	0
Night 7-10	138	0
Night 11+	149	0
Day 1-3	80	0
Day 4-6	159	0
Day 7-10	204	0
Day 11+	232	0

Heating Fuel	Any
Heating System	Heat Pump
Cooling System	Heat Pump

Setback strategy	ΔkWh/unit	Δtherm/unit
Night 1-3	386	0.0
Night 4-6	1,114	0.0
Night 7-10	2,080	0.0
Night 11+	2,767	0.0

Day 1-3	951	0.0
Day 4-6	2,518	0.0
Day 7-10	4,394	0.0
Day 11+	5,715	0.0

Heating Fuel — Gas, propane or oil
Heating System — Any except Heat Pump
Cooling System — None

Setback strategy	ΔkWh/unit	Δtherm/unit
Night 1-3	0.0	4.0
Night 4-6	0.0	10.0
Night 7-10	0.0	16.0
Night 11+	0.0	19.8
Day 1-3	0.0	8.5
Day 4-6	0.0	20.5
Day 7-10	0.0	33.3
Day 11+	0.0	41.3

Heating Fuel — Gas, propane or oil
Heating System — Any except Heat Pump
Cooling System — Room/Window or Central AC

Setback strategy	ΔkWh/unit	Δtherm/unit
Night 1-3	58	4.0
Night 4-6	107	10.0
Night 7-10	138	16.0
Night 11+	149	19.8
Day 1-3	80	8.5
Day 4-6	159	20.5
Day 7-10	204	33.3
Day 11+	232	41.3

Heating Fuel — Electricity
Heating System — Any except Heat Pump
Cooling System — None

Setback strategy	ΔkWh/unit	Δtherm/unit
Night 1-3	918	0.0
Night 4-6	2,164	0.0
Night 7-10	3,390	0.0
Night 11+	4,095	0.0

Day 1-3	1,863	0.0
Day 4-6	4,419	0.0
Day 7-10	7,030	0.0
Day 11+	8,615	0.0

Heating Fuel	Electricity
Heating System	Any except Heat Pump
Cooling System	Room/Window or Central AC

Setback strategy	ΔkWh/unit	Δtherm/unit
Night 1-3	957	0.0
Night 4-6	2,228	0.0
Night 7-10	3,467	0.0
Night 11+	4,171	0.0
Day 1-3	1,903	0.0
Day 4-6	4,492	0.0
Day 7-10	7,100	0.0
Day 11+	8,686	0.0

Using Cold Water for Laundry

The energy and demand savings for this measure were taken from the Efficiency Vermont Technical Reference Manual (Efficiency Vermont, 2001), based on the savings per load and the number of loads reported by the survey respondents.

	Gas	Electric	
Loads/wk	therm/yr	kWh/yr	kW
1-2	13.2	166	0.019
3-4	30.8	388	0.044
5-6	48.3	609	0.070
7-8	65.9	830	0.095
9-10	83.5	1052	0.120
11-12	101.0	1273	0.145
13+	114.2	1439	0.164

Replacing Furnace Filter

Gross Summer Coincident Demand Savings

$\Delta kW_S = (kW/unit_{pre} - kW/unit_{post}) \times DF_S \times CF_S$

Gross Annual Energy Savings

$\Delta kWh = (kWh/unit_{pre} - kWh/unit_{post})$

$\Delta therm = (therm/unit_{pre} - therm/unit_{post})$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
DF	= demand diversity factor
CF	= coincidence factor
$kWunit_{pre}$	= HVAC electricity demand per dwelling based on pre report filter change frequency
$kWunit_{post}$	= HVAC electricity demand per dwelling based on post report filter change frequency
$kWh/unit_{pre}$	= HVAC electricity consumption per dwelling based on pre report filter change frequency
$kWh/unit_{post}$	= HVAC electricity consumption per dwelling based on post report filter change frequency
$therm/unit_{pre}$	= HVAC gas consumption per dwelling based on pre report filter change frequency
$therm/unit_{post}$	= HVAC gas consumption per dwelling based on post report filter change frequency

Coincidence and Diversity Factors:

DF = 0.8
CF = 1.0

The diversity and coincidence factors were taken from *Engineering Methods for Estimating the Impacts of DSM Programs, Volume 2* (EPRI, 1993). These values are typical for residential cooling loads in summer peaking utilities.

Unit energy and demand data

The unit energy and demand savings were taken from DOE-2 simulations of the residential prototype building described at the end of this Appendix. The analysis assumes that furnace filter change outs result in a 5% savings relative to an un-maintained system. The 5% overall savings were allocated to the survey responses as follows:

Filter change frequency	Percent savings
< 1/yr	0%
1x / yr	1.7%
2x / yr	3.3%
> 2x / yr	5%

Data depend on the heating fuel, heating system, cooling system type and the pre and post filter change frequency

Heating Fuel	Other
Heating System	Any except Heat Pump
Cooling System	None

Filter change frequency	kWh	kW	therm
all	0	0	0

Heating Fuel	Other
Heating System	Any except Heat Pump
Cooling System	Central AC

Filter change frequency	kWh	kW	therm
< 1/yr	4,453	5.2	0
1x / yr	4,375	5.1	0
2x / yr	4,302	5.0	0
> 2x / yr	4,231	4.9	0

Heating Fuel	Any
Heating System	Heat Pump
Cooling System	Heat Pump

Filter change frequency	kWh	kW	therm
< 1/yr	21,793	11.7	0
1x / yr	21,410	11.5	0
2x / yr	21,054	11.3	0
> 2x / yr	20,704	11.1	0

Heating Fuel	Gas, propane or oil
Heating System	Furnace
Cooling System	None

Filter change frequency	kWh	kW	therm
< 1/yr	0	0	148

1x / yr	0	0	146
2x / yr	0	0	143
> 2x / yr	0	0	141

Heating Fuel Gas, propane or oil
Heating System Furnace
Cooling System Central AC

Filter change frequency	kWh	kW	therm
< 1/yr	4,453	5.2	148
1x / yr	4,375	5.1	146
2x / yr	4,302	5.0	143
> 2x / yr	4,231	4.9	141

Heating Fuel Electricity
Heating System Furnace
Cooling System None

Filter change frequency	kWh	kW	therm
< 1/yr	31,073	19.5	0
1x / yr	30,527	19.2	0
2x / yr	30,020	18.8	0
> 2x / yr	29,520	18.5	0

Heating Fuel Electricity
Heating System Furnace
Cooling System Central AC

Filter change frequency	kWh	kW	therm
< 1/yr	34,936	24.3	0
1x / yr	34,322	23.9	0
2x / yr	33,752	23.5	0
> 2x / yr	33,190	23.1	0

Stopping Heating Unused Rooms

Gross Summer Coincident Demand Savings
$\Delta kW_S = (\Delta kW/unit) \times DF_S \times CF_S$

Gross Annual Energy Savings
$\Delta kWh = (\Delta kWh/unit)$

$\Delta therm = (\Delta therm/unit$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
DF	= demand diversity factor
CF	= coincidence factor
ΔkWunit	`= electricity demand savings per dwelling
ΔkWh/SF	`= electricity consumption savings per dwelling
Δtherm/SF	`= gas consumption savings dwelling

Coincidence and Diversity Factors:

DF = 0.8
CF = 1.0

The diversity and coincidence factors were taken from *Engineering Methods for Estimating the Impacts of DSM Programs, Volume 2* (EPRI, 1993). These values are typical for residential cooling loads in summer peaking utilities.

Unit energy and demand savings data

The unit energy and demand savings were taken from DOE-2 simulations of the residential prototype building described at the end of this Appendix. The analysis assumes that each room is 220 SF in size. Savings data depend on the heating fuel, heating system, cooling system and duct treatment

Heating Fuel	Other
Heating System	Any except Heat Pump
Cooling System	None

Number of rooms	ΔkWh/unit	ΔkW/unit	Δtherm/unit
All	0	0	0

Heating Fuel Other

Heating System	Any except Heat Pump
Cooling System	Central AC

Number of rooms	ΔkWh/unit	ΔkW/unit	Δtherm/unit
1	80	0.09	0
2	161	0.19	0
3	241	0.28	0
4	321	0.37	0
5	401	0.47	0
6+	482	0.56	0

Heating Fuel	Any
Heating System	Heat Pump
Cooling System	Heat Pump

Number of rooms	ΔkWh/unit	ΔkW/unit	Δtherm/unit
1	393	0.21	0
2	786	0.42	0
3	1,179	0.63	0
4	1,571	0.84	0
5	1,964	1.05	0
6+	2,357	1.26	0

Heating Fuel	Gas, propane or oil
Heating System	Furnace
Cooling System	None

Number of rooms	ΔkWh/unit	ΔkW/unit	Δtherm/unit
1	0	0	3
2	0	0	5
3	0	0	8
4	0	0	11
5	0	0	13
6+	0	0	16

Heating Fuel	Gas, propane or oil
Heating System	Furnace

Cooling System Central AC

Number of rooms	ΔkWh/unit	ΔkW/unit	Δtherm/unit
1	80	0.09	3
2	161	0.19	5
3	241	0.28	8
4	321	0.37	11
5	401	0.47	13
6+	482	0.56	16

Heating Fuel Electricity
Heating System Furnace
Cooling System None

Number of rooms	ΔkWh/unit	ΔkW/unit	Δtherm/unit
1	560	0.35	0
2	1,120	0.70	0
3	1,680	1.05	0
4	2,241	1.41	0
5	2,801	1.76	0
6+	3,361	2.11	0

Heating Fuel Electricity
Heating System Furnace
Cooling System Central AC

Number of rooms	ΔkWh/unit	ΔkW/unit	Δtherm/unit
1	630	0.44	0
2	1,260	0.88	0
3	1,889	1.31	0
4	2,519	1.75	0
5	3,149	2.19	0
6+	3,779	2.63	0

Insulated Water Heater

Gross Summer Coincident Demand Savings

$$\Delta kW_S = \text{units} \times \frac{(UA_{base} - UA_{ee}) \times \Delta T_s}{3413} \times DF_s \times CF_s$$

Gross Annual Energy Savings

$$\Delta kWh = units \times \frac{(UA_{base} - UA_{ee}) \times \overline{\Delta T}}{3413} \times 8760$$

$$\Delta therm = units \times \frac{(UA_{base} - UA_{ee}) \times \overline{\Delta T}}{\eta_{waterheater}} \times \frac{8760}{100000}$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
units	= number of water heaters installed under the program
UA_{base}	= overall heat transfer coefficient of base water heater (Btu/hr-°F)
UA_{ee}	= overall heat transfer coefficient of improved water heater (Btu/hr-°F)
ΔT	= temperature difference between the tank and the ambient air (°F)
DF	= demand diversity factor
CF	= coincidence factor
3413	= conversion factor (Btu/kWh)
8760	= conversion factor (hr/yr)
100000	= conversion factor (Btu/therm)
$\eta_{waterheater}$	= water heater efficiency

Water heater tank UA

Water heater size (gal)	Electric		Gas	
	UAbase	UAee	UAbase	UAee
30	3.84	1.69	4.21	1.76
50	4.67	1.83	5.13	1.91
60	4.13	2.06	4.54	2.14
75	5.00	2.42	5.50	2.52
80+	5.72	2.53	6.28	2.64

ΔT = 140°F water setpoint temp – 65°F room temp = 75°F

DF = 1.0
CF= 1.0
$\eta_{waterheater}$ = 0.7

The diversity and coincidence factors were taken from *Engineering Methods for Estimating the Impacts of DSM Programs, Volume 2* (EPRI, 1993). These values are typical for residential water heaters meeting standby losses.

Manage Draperies

Gross Summer Coincident Demand Savings
ΔkW_S = windows × (ΔkW/window) × DF_S × CF_S

Gross Annual Energy Savings
ΔkWh = windows × (ΔkWh/ window)

Δtherm = windows × (Δtherm/ window)

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
Windows	= number of windows managed
DF	= demand diversity factor
CF	= coincidence factor
ΔkW/ window	`= electricity demand savings per window
ΔkWh/window	`= electricity consumption savings per window
Δtherm/window	`= gas consumption savings per window

Coincidence and Diversity Factors:

DF = 0.8
CF = 1.0

The diversity and coincidence factors were taken from *Engineering Methods for Estimating the Impacts of DSM Programs, Volume 2* (EPRI, 1993). These values are typical for residential cooling loads in summer peaking utilities.

Unit energy and demand savings data

The unit energy and demand savings were taken from DOE-2 simulations of the residential prototype building described at the end of this Appendix. The analysis assumes drapes open during daylight hours on south facing windows only. The savings depend on the heating fuel, heating system, cooling system and number of windows managed.

Heating Fuel	Other
Heating System	Any except Heat Pump
Cooling System	Any or none

Number of windows	ΔkWh/unit	ΔkW/unit	Δtherm/unit
All	0	0	0

Heating Fuel	Any
Heating System	Heat Pump
Cooling System	Heat Pump

Number of windows	ΔkWh/unit	ΔkW/unit	Δtherm/unit
1-3	99	0	0
4-7	274	0	0
8-12	497	0	0
13+	647	0	0

Heating Fuel	Gas, propane or oil
Heating System	Any except Heat Pump
Cooling System	Any or none

Number of windows	ΔkWh/unit	ΔkW/unit	Δtherm/unit
1-3	0	0	3
4-7	0	0	5
8-12	0	0	8
13+	0	0	11

Heating Fuel	Electricity
Heating System	Any except Heat Pump
Cooling System	Any or none

Number of windows	ΔkWh/unit	ΔkW/unit	Δtherm/unit
1-3	164	0	0
4-7	451	0	0
8-12	821	0	0
13+	1067	0	0

Cleaned Electric Baseboards

Savings are based on reduced heat losses from back of electric baseboard unit through insulated wall to the outside. Cleaning unit is assumed to reduce the average temperature inside the unit from 115°F to 90°F. Heat losses are estimated based on an R-11 wall and 40°F outside temperature. Each unit is assumed to be 8 ft long. Heat loss reductions are estimated to be 0.13% of the baseboard rated input, resulting in 4.25 kWh per baseboard unit cleaned. Apply only when heating fuel = electric and heating system type = baseboard. No kW savings.

Attic Insulation

Gross Summer Coincident Demand Savings
$\Delta kW_S = SF \times (kW/SF_{base} - kW/SF_{ee}) \times DF_S \times CF_S$

Gross Annual Energy Savings
$\Delta kWh = SF \times (kWh/SF_{base} - kWh/SF_{ee})$

$\Delta therm = SF \times (therm/SF_{base} - therm/SF_{ee})$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
SF	= insulation square feet installed
DF	= demand diversity factor
CF	= coincidence factor
kW/SF	`= electricity demand per square foot of insulation installed
kWh/SF	`= electricity consumption per square foot of insulation installed
therm/SF	`= gas consumption per square foot of insulation installed

Coincidence and Diversity Factors:

DF = 0.8
CF = 1.0

The diversity and coincidence factors were taken from *Engineering Methods for Estimating the Impacts of DSM Programs, Volume 2* (EPRI, 1993). These values are typical for residential cooling loads in summer peaking utilities.

Insulation square foot assumptions:

Average house size from site data (Carolinas), or estimated from number of rooms (Kentucky)

Size of house = number of rooms * 330 SF/room

Average ceiling area = house size / 1.2

If partial insulation, then reduce ceiling area by 50%

R value assumptions

Rbase:

Base thickness	R_{base}
2	7
4	14
6	21
8	28
10	35

Assumes existing insulation is fiberglass or cellulose, at R-3.5 per inch. This assumption addresses insulation R-value only. The R-value assumptions for other materials within the ceiling construction are embedded in the simulation model.

Ree

The R-value of the wall with added insulation depends on base thickness, added insulation thickness and insulation type: Fiberglass, cellulose and "other" insulation is assumed to have an R-value of 3.5 per inch. Foam insulation is assumed to have an R-value of 5.6 per inch.

Base thickness	Added thickness	Ree	
		fiberglass, cellulose or other	Foam
2	2	14.00	18.20
	4	21.00	29.40
	6	28.00	40.60
	8	35.00	51.80
	10	42.00	63.00
	12	49.00	74.20
4	2	21.00	25.20
	4	28.00	36.40
	6	35.00	47.60
	8	42.00	58.80
	10	49.00	70.00
	12	56.00	81.20
6	2	28.00	32.20
	4	35.00	43.40
	6	42.00	54.60

	8	49.00	65.80
	10	56.00	77.00
	12	63.00	88.20
	2	35.00	39.20
	4	42.00	50.40
	6	49.00	61.60
	8	56.00	72.80
	10	63.00	84.00
8	12	70.00	95.20
	2	42.00	46.20
	4	49.00	57.40
	6	56.00	68.60
	8	63.00	79.80
	10	70.00	91.00
10	12	77.00	102.20
	2	49.00	53.20
	4	56.00	64.40
	6	63.00	75.60
	8	70.00	86.80
	10	77.00	98.00
12	12	84.00	109.20

Unit energy and demand data

The unit energy savings were taken from DOE-2 simulations of the residential prototype building described at the end of this Appendix. The unit energy and demand savings depend on the heating fuel, heating system, cooling system type and Rvalue

Heating Fuel	Other
Heating System	Any except Heat Pump
Cooling System	None

R-value	kWh/SF	kW/SF	therm/SF
All	0	0	0

Heating Fuel	Other
Heating System	Any except Heat Pump
Cooling System	Room/Window or Central AC

R-value	kWh/SF	kW/SF	therm/SF

7	1.339	0.00157	0
14	1.272	0.00149	0
21	1.245	0.00145	0
28	1.231	0.00143	0
35	1.220	0.00142	0
42	1.214	0.00141	0
49	1.210	0.00141	0
56	1.206	0.00140	0
63	1.203	0.00140	0
70	1.201	0.00140	0
77	1.200	0.00140	0
84	1.196	0.00139	0
109	1.194	0.00139	0

Heating Fuel Any
Heating System Heat Pump
Cooling System Heat Pump

R-value	kWh/SF	kW/SF	therm/SF
7	6.550	0.00387	0.00000
14	6.121	0.00378	0.00000
21	5.937	0.00374	0.00000
28	5.833	0.00371	0.00000
35	5.768	0.00370	0.00000
42	5.724	0.00368	0.00000
49	5.689	0.00368	0.00000
56	5.665	0.00367	0.00000
63	5.644	0.00366	0.00000
70	5.628	0.00366	0.00000
77	5.616	0.00366	0.00000
84	5.605	0.00366	0.00000
109	5.576	0.00365	0.00000

Heating Fuel Gas, propane or oil
Heating System Any except Heat Pump
Cooling System None

R-value	kWh/SF	kW/SF	therm/SF
7	0	0	0.04418
14	0	0	0.04058
21	0	0	0.03908
28	0	0	0.03828
35	0	0	0.03768

42	0	0	0.03738
49	0	0	0.03708
56	0	0	0.03688
63	0	0	0.03668
70	0	0	0.03658
77	0	0	0.03648
84	0	0	0.03638
109	0	0	0.03618

Heating Fuel	Gas, propane or oil
Heating System	Any except Heat Pump
Cooling System	Room/Window or Central AC

R-value	kWh/SF	kW/SF	therm/SF
7	1.339	0.00157	0.04418
14	1.272	0.00149	0.04058
21	1.245	0.00145	0.03908
28	1.231	0.00143	0.03828
35	1.220	0.00142	0.03768
42	1.214	0.00141	0.03738
49	1.210	0.00141	0.03708
56	1.206	0.00140	0.03688
63	1.203	0.00140	0.03668
70	1.201	0.00140	0.03658
77	1.200	0.00140	0.03648
84	1.196	0.00139	0.03638
109	1.194	0.00139	0.03618

Heating Fuel	Electricity
Heating System	Any except Heat Pump
Cooling System	None

R-value	kWh/SF	kW/SF	therm/SF
7	9.063	0.00501	0.00000
14	8.254	0.00463	0.00000
21	7.915	0.00447	0.00000
28	7.728	0.00439	0.00000
35	7.610	0.00432	0.00000
42	7.528	0.00429	0.00000
49	7.468	0.00426	0.00000

56	7.423	0.00424	0.00000
63	7.387	0.00422	0.00000
70	7.358	0.00421	0.00000
77	7.334	0.00420	0.00000
84	7.313	0.00419	0.00000
109	7.262	0.00417	0.00000

Heating Fuel	Electricity
Heating System	Any except Heat Pump
Cooling System	Room/Window or Central AC

R-value	kWh/SF	kW/SF	therm/SF
7	10.184	0.00646	0.00000
14	9.327	0.00601	0.00000
21	8.969	0.00581	0.00000
28	8.773	0.00571	0.00000
35	8.645	0.00564	0.00000
42	8.560	0.00560	0.00000
49	8.497	0.00557	0.00000
56	8.448	0.00554	0.00000
63	8.410	0.00552	0.00000
70	8.380	0.00551	0.00000
77	8.356	0.00550	0.00000
84	8.331	0.00548	0.00000
109	8.279	0.00546	0.00000

Sidewall Insulation

Gross Summer Coincident Demand Savings

$\Delta kW_S = SF \times (kW/SF_{base} - kW/SF_{ee}) \times DF_S \times CF_S$

Gross Annual Energy Savings

$\Delta kWh = SF \times (kWh/SF_{base} - kWh/SF_{ee})$

$\Delta therm = SF \times (therm/SF_{base} - therm/SF_{ee})$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings

SF = insulation square feet installed
DF = demand diversity factor
CF = coincidence factor
kW/SF `= electricity demand per square foot of insulation installed
kWh/SF `= electricity consumption per square foot of insulation installed
therm/SF `= gas consumption per square foot of insulation installed

Coincidence and Diversity Factors:

DF = 0.8
CF = 1.0

The diversity and coincidence factors were taken from *Engineering Methods for Estimating the Impacts of DSM Programs, Volume 2* (EPRI, 1993). These values are typical for residential cooling loads in summer peaking utilities.

Insulation square foot assumptions:

Average house size from site data (Carolinas), or estimated from number of rooms (KY)

Size of house = number of rooms * 330 SF/room

Number of walls	Wall area as a fraction of floor area
1	0.26
2	0.52
3	0.72
4+	0.92

R value assumptions

Rbase:

Base thickness	R_{base}
0	0.91

The base case assumes an uninsulated wall with 3.5 inch air gap. This assumption addresses "insulation" R-value only. The R-value assumptions for other materials within the wall construction are embedded in the simulation model.

Ree

The insulated wall R-value depends on added insulation thickness and insulation type. Fiberglass, cellulose and "other" insulation is assumed to have an R-value of 3.5 per inch. Foam insulation is assumed to have an R-value of 5.6 per inch.

Added thickness	Ree	
	fiberglass, cellulose or other	Foam
1-3	7.9	12.1
4-6	18.4	28.9
7-12	30.7	48.5
13+	46.4	73.7

Unit energy and demand data

The unit energy and demand savings were taken from DOE-2 simulations of the residential prototype building described at the end of this Appendix. The unit energy and demand savings depend on the heating fuel, heating system, cooling system type and wall Rvalue:

Heating Fuel	Other
Heating System	Any except Heat Pump
Cooling System	None

R-value	kWh/SF	kW/SF	therm/SF
All	0	0	0

Heating Fuel	Other
Heating System	Any except Heat Pump
Cooling System	Room/Window or Central AC

R-value	kWh/SF	kW/SF	therm/SF
0.91	2.361	0.00273	0
7.9	2.046	0.00238	0
18.4	1.950	0.00227	0
30.7	1.908	0.00224	0
46.4	1.887	0.00220	0
12.1	1.988	0.00230	0
28.9	1.917	0.00224	0
48.5	1.886	0.00220	0
73.7	1.874	0.00220	0

Heating Fuel	Any
Heating System	Heat Pump
Cooling System	Heat Pump

R-value	kWh/SF	kW/SF	therm/SF

0.91	12.078	0.00655	0.00000
7.9	9.865	0.00605	0.00000
18.4	9.160	0.00588	0.00000
30.7	8.892	0.00581	0.00000
46.4	8.734	0.00578	0.00000
12.1	9.477	0.00597	0.00000
28.9	8.918	0.00583	0.00000
48.5	8.721	0.00578	0.00000
73.7	8.620	0.00575	0.00000

Heating Fuel	Gas, propane or oil
Heating System	Any except Heat Pump
Cooling System	None

R-value	kWh/SF	kW/SF	therm/SF
0.91	0	0	0.08530
7.9	0	0	0.06565
18.4	0	0	0.05974
30.7	0	0	0.05751
46.4	0	0	0.05623
12.1	0	0	0.06230
28.9	0	0	0.05767
48.5	0	0	0.05623
73.7	0	0	0.05543

Heating Fuel	Gas, propane or oil
Heating System	Any except Heat Pump
Cooling System	Room/Window or Central AC

R-value	kWh/SF	kW/SF	therm/SF
0.91	2.361	0.00273	0.08530
7.9	2.046	0.00238	0.06565
18.4	1.950	0.00227	0.05974
30.7	1.908	0.00224	0.05751
46.4	1.887	0.00220	0.05623
12.1	1.988	0.00230	0.06230
28.9	1.917	0.00224	0.05767
48.5	1.886	0.00220	0.05623
73.7	1.874	0.00220	0.05543

Heating Fuel	Electricity
Heating System	Any except Heat Pump
Cooling System	None

R-value	kWh/SF	kW/SF	therm/SF
0.91	17.807	0.00963	0
7.9	13.354	0.00749	0
18.4	12.045	0.00685	0
30.7	11.552	0.00663	0
46.4	11.277	0.00650	0
12.1	12.616	0.00712	0
28.9	11.599	0.00665	0
48.5	11.254	0.00649	0
73.7	11.075	0.00641	0

Heating Fuel	Electricity
Heating System	Any except Heat Pump
Cooling System	Room/Window or Central AC

R-value	kWh/SF	kW/SF	therm/SF
0.91	12.078	0.00655	0.00000
7.9	9.865	0.00605	0.00000
18.4	9.160	0.00588	0.00000
30.7	8.892	0.00581	0.00000
46.4	8.734	0.00578	0.00000
12.1	9.477	0.00597	0.00000
28.9	8.918	0.00583	0.00000
48.5	8.721	0.00578	0.00000
73.7	8.620	0.00575	0.00000

Duct Insulation and Repair

Gross Summer Coincident Demand Savings
$\Delta kW_S = (\Delta kW/unit) \times DF_S \times CF_S \times LF$

Gross Annual Energy Savings
$\Delta kWh = (\Delta kWh/unit) \times LF$

$\Delta therm = (\Delta therm/unit) \times LF$

where:

ΔkW = gross coincident demand savings
ΔkWh = gross annual energy savings
DF = demand diversity factor
CF = coincidence factor
LF = location factor
ΔkWunit `= electricity demand savings per dwelling
ΔkWh/SF `= electricity consumption savings per dwelling
Δtherm/SF `= gas consumption savings dwelling

Coincidence and Diversity Factors:

DF = 0.8
CF = 1.0

The diversity and coincidence factors were taken from *Engineering Methods for Estimating the Impacts of DSM Programs, Volume 2* (EPRI, 1993). These values are typical for residential air conditioners and heat pumps in summer peaking utilities.

The location factors used are as follows:

Heated Area	Unheated Area	DK/No Response
0	1	.43

Unit energy and demand savings data

The unit energy and demand savings were taken from DOE-2 simulations of the residential prototype building described at the end of this Appendix. The basic assumptions are listed below:

Assumption	Pre treatment	Post treatment	Notes
Duct insulation	Uninsulated	R-19	Consistent with Smart Saver program requirements
Duct sealing	26% leakage	8% leakage	Duct leakage assumptions used in CA for Title 24 and utility program design. Evenly distributed between supply and return

The unit energy and demand savings depend on the heating fuel, heating system, cooling system and duct treatment as follows:

Heating Fuel Other
Heating System Any except Heat Pump
Cooling System None

Duct treatment	ΔkWh/unit	ΔkW/unit	Δtherm/unit
All	0	0	0

Heating Fuel Other
Heating System Any except Heat Pump
Cooling System Central AC

Duct treatment	ΔkWh/unit	ΔkW/unit	Δtherm/unit
Insulate	384	0.10	0
Seal	466	0.25	0

Heating Fuel Any
Heating System Heat Pump
Cooling System Heat Pump

Duct treatment	ΔkWh/unit	ΔkW/unit	Δtherm/unit
Insulate	1,520	0.48	0.0
Seal	2,422	0.78	0.0

Heating Fuel Gas, propane or oil
Heating System Furnace
Cooling System None

Duct treatment	ΔkWh/unit	ΔkW/unit	Δtherm/unit
Insulate	0.0	0.0	17.3
Seal	0.0	0.0	16.5

Heating Fuel Gas, propane or oil
Heating System Furnace
Cooling System Central AC

Duct treatment	ΔkWh/unit	ΔkW/unit	Δtherm/unit
Insulate	384	0.10	17.3
Seal	466	0.25	16.5

Heating Fuel	Electricity
Heating System	Furnace
Cooling System	None

Duct treatment	ΔkWh/unit	ΔkW/unit	Δtherm/unit
Insulate	3,917	3.13	0.0
Seal	3,798	2.98	0.0

Heating Fuel	Electricity
Heating System	Furnace
Cooling System	Central AC

Duct treatment	ΔkWh/unit	ΔkW/unit	Δtherm/unit
Insulate	4,285	3.18	0.0
Seal	4,211	3.18	0.0

Installed a New AC or Heat Pump

Gross Summer Coincident Demand Savings
$\Delta kW_S = (\Delta kW/unit) \times DF_S \times CF_S$

Gross Annual Energy Savings
$\Delta kWh = (\Delta kWh/unit)$

$\Delta therm = (\Delta therm/unit$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
DF	= demand diversity factor
CF	= coincidence factor
ΔkWunit	`= electricity demand savings per dwelling
ΔkWh/SF	`= electricity consumption savings per dwelling
Δtherm/SF	`= gas consumption savings dwelling

Coincidence and Diversity Factors:

DF = 0.8
CF = 1.0

The diversity and coincidence factors were taken from *Engineering Methods for Estimating the Impacts of DSM Programs, Volume 2* (EPRI, 1993). These values are typical for residential air conditioners and heat pumps in summer peaking utilities.

Unit energy and demand savings data

The unit energy and demand savings were taken from DOE-2 simulations of the residential prototype building described at the end of this Appendix. Unit energy savings are based on replacement of an existing SEER 8.5 air conditioner or heat pump. The unit energy and demand savings depend on the heating fuel, heating system, cooling system and replacement efficiency.

Heating Fuel	Other
Heating System	Any except Heat Pump
Cooling System	None

Replacement efficiency	ΔkWh/unit	ΔkW/unit	Δtherm/unit
All	0	0	0

Heating Fuel	Other
Heating System	Any except Heat Pump
Cooling System	Central AC

Replacement efficiency	ΔkWh/unit	ΔkW/unit	Δtherm/unit
<11	674	0.92	0
12	944	1.28	0
13	1,213	1.65	0
14+	1,346	1.80	0

Heating Fuel	Any
Heating System	Heat Pump
Cooling System	Heat Pump

Replacement efficiency	ΔkWh/unit	ΔkW/unit	Δtherm/unit
<11	2,941	1.36	0
12	2,941	1.36	0
13	5,294	2.45	0
14+	6,496	2.98	0

Heating Fuel Gas, propane or oil
Heating System Any except Heat Pump
Cooling System None

Replacement efficiency	ΔkWh/unit	ΔkW/unit	Δtherm/unit
All	0.0	0.0	0

Heating Fuel Gas, propane or oil
Heating System Any except Heat Pump
Cooling System Central AC

Replacement efficiency	ΔkWh/unit	ΔkW/unit	Δtherm/unit
<11	674	0.92	0
12	944	1.28	0
13	1,213	1.65	0
14+	1,346	1.80	0

0

Heating Fuel Electricity
Heating System Any except Heat Pump
Cooling System None

Replacement efficiency	ΔkWh/unit	ΔkW/unit	Δtherm/unit
All	0.0	0.0	0

Heating Fuel Electricity
Heating System Any except Heat Pump
Cooling System Central AC

Replacement efficiency	ΔkWh/unit	ΔkW/unit	Δtherm/unit
<11	674	0.92	0
12	944	1.28	0
13	1,213	1.65	0
14+	1,346	1.80	0

Installed a New Furnace

Gross Annual Energy Savings
Δtherm = (Δtherm/unit)

where:

Δtherm/SF `= gas consumption savings dwelling

Unit energy and demand savings data

The unit energy and demand savings were taken from DOE-2 simulations of the residential prototype building described at the end of this Appendix. The basic assumptions are listed below:

Furnace Type	AFUE
Baseline	0.78
Standard efficiency (metal flue pipe) replacement	0.80
Condensing furnace (plastic flue pipe) replacement	0.90

The unit energy and demand savings depend on the heating fuel, heating system type, and replacement furnace type:

Heating Fuel	Gas, propane or oil
Heating System	Furnace

Replacement efficiency	Δtherm/unit
Standard (metal pipe)	3.0
Condensing (plastic pipe)	18.8

Otherwise 0

Prototypical Building Model Description

The impact analysis for many of the HVAC related measures are based on DOE-2.2 simulations of a set of prototypical residential buildings. The prototypical simulation models were derived from the residential building prototypes used in the California Database for Energy Efficiency Resources (DEER) study (Itron, 2005), with adjustments make for local building practices and climate. The prototype "model" in fact contains 4 separate residential buildings; 2 one-story and 2 two-story buildings. The each version of the 1 story and 2 story buildings are identical except for the orientation, which is shifted by 90 degrees. The selection of these 4 buildings is designed to give a reasonable

average response of buildings of different design and orientation to the impact of energy efficiency measures. A sketch of the residential prototype buildings is shown in Figure 1.

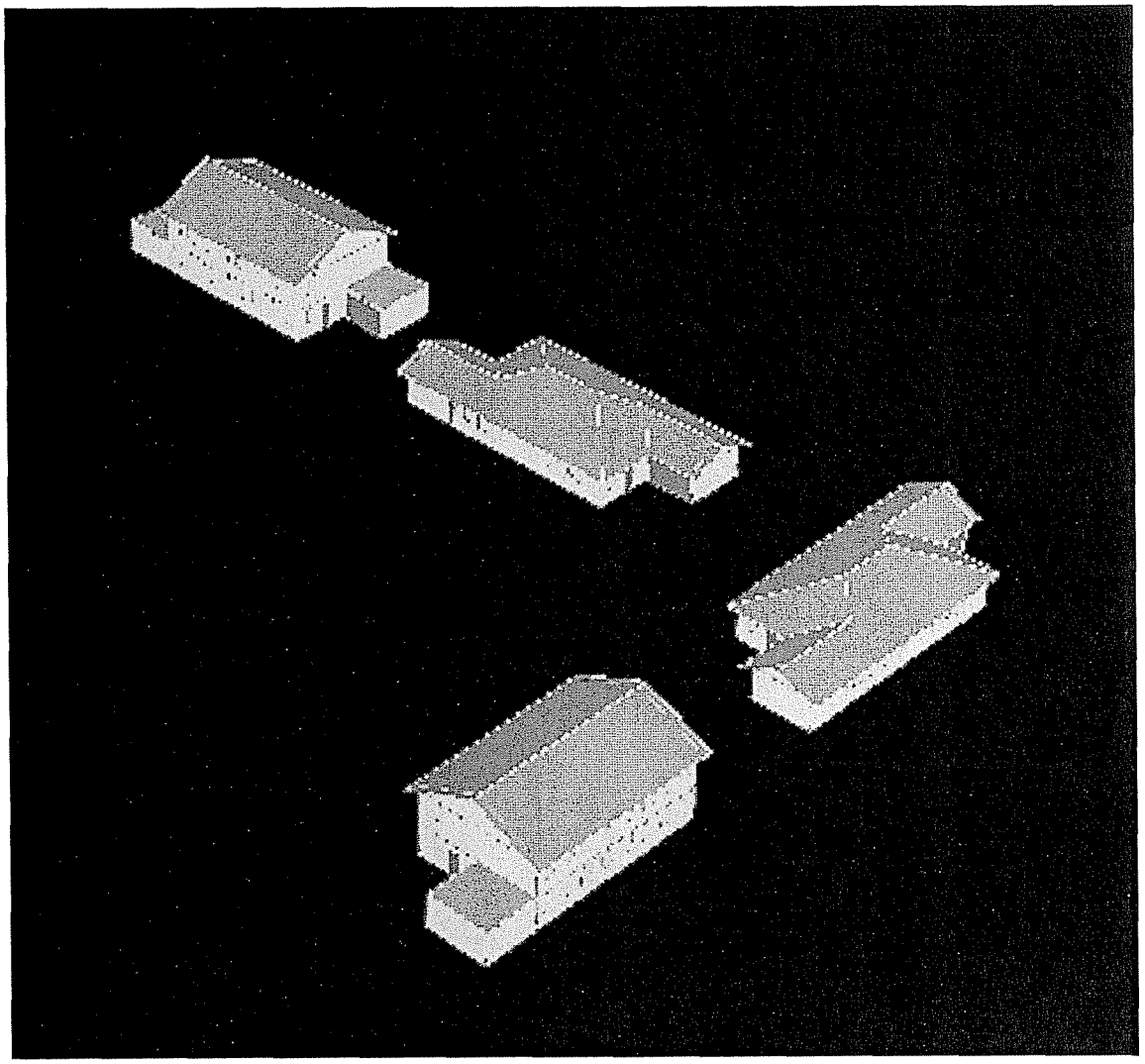

Figure 1. Computer Rendering of Residential Building Prototype Model

The general characteristics of the residential building prototype model are summarized below:

Residential Building Prototype Description

Characteristic	Value
Conditioned floor area	1 story house: 1465 SF 2 story house: 2930 SF
Wall construction and R-value	Wood frame with siding, R-11
Roof construction and R-value	Wood frame with asphalt shingles, R-19
Glazing type	Single pane clear
Lighting and appliance power density	0.51 W/SF average

Characteristic	Value
HVAC system type	Packaged single zone AC or heat pump
HVAC system size	Based on peak load with 20% oversizing. Average 640 SF/ton
HVAC system efficiency	SEER = 8.5
Thermostat setpoints	Heating: 70°F with setback to 60°F Cooling: 75°F with setup to 80°F
Duct location	Attic (unconditioned space)
Duct surface area	Single story house: 390 SF supply, 72 SF return Two story house: 505 SF supply, 290 SF return
Duct insulation	Uninsulated
Duct leakage	26%; evenly distributed between supply and return
Cooling season	Charlotte – April 17 to October 6 Covington
Natural ventilation	Allowed during cooling season when cooling setpoint exceeded and outdoor temperature < 65°F. 3 air changes per hour

References

ASHRAE, 2001. ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigeration and Airconditioning Engineers, Atlanta, GA, 2001.

Efficiency Vermont, 2003. Technical Reference Manual, Master Manual Number 4, Measure Savings Algorithms and Cost Assumptions, Efficiency Vermont, Burlington, VT. 2003.

EPRI, 1993. Engineering Methods for Estimating the Impacts of DSM Programs, Volume 2: Fundamental Equations for Residential and Commercial End-Uses, EPRI TR-100984 V2., Electric Power Research Institute, Palo Alto, CA. 1993.

Itron, 2005. "2004-2005 Database for Energy Efficiency Resources (DEER) Update Study, Final Report," Itron, Inc., J.J. Hirsch and Associates, Synergy Consulting, and Quantum Consulting. December, 2005. Available at http://eega.cpuc.ca.gov/deer

Appendix D: Housing Characteristics

Type of home

	Kentucky Kits			Kentucky No Kits		
	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
Detached single-family	654	88.26%	88.26%	1681	89.46%	89.46%
Manufactured/Modular home	23	3.10%	3.10%	56	2.98%	2.98%
Condominium	41	5.53%	5.53%	111	5.91%	5.91%
Duplex/2-family	14	1.89%	1.89%	23	1.22%	1.22%
Multi-family (3 or more units)	9	1.21%	1.21%	8	0.43%	0.43%
Total	741	100.00%	100.00%	1879	100.00%	100.00%

Year home was built

	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
Don't Know	5	0.67%	0.67%	16	0.85%	0.85%
Before 1959	227	30.63%	30.63%	548	29.16%	29.16%
1960-1979	177	23.89%	23.89%	514	27.35%	27.35%
1980-1989	83	11.20%	11.20%	183	9.74%	9.74%
1990-1997	103	13.90%	13.90%	269	14.32%	14.32%
1998-2000	65	8.77%	8.77%	157	8.36%	8.36%
2001-2006	81	10.93%	10.93%	192	10.22%	10.22%
Total	741	100.00%	100.00%	1879	100.00%	100.00%

Number of rooms in home (excluding bathrooms)

	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
Don't Know	3	0.40%	0.40%	8	0.43%	0.43%
1-3	11	1.48%	1.48%	34	1.81%	1.81%
4	40	5.40%	5.40%	91	4.84%	4.84%
5	111	14.98%	14.98%	279	14.85%	14.85%
6	145	19.57%	19.57%	377	20.06%	20.06%
7	158	21.32%	21.32%	426	22.67%	22.67%
8	131	17.68%	17.68%	305	16.23%	16.23%
9	68	9.18%	9.18%	156	8.30%	8.30%
10+	74	9.99%	9.99%	203	10.80%	10.80%
Total	741	100.00%	100.00%	1879	100.00%	100.00%

Number of occupants

	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
Don't Know	1	0.13%	0.13%	4	0.21%	0.21%
1	131	17.68%	17.68%	387	20.60%	20.60%
2	359	48.45%	48.45%	928	49.39%	49.39%
3	114	15.38%	15.38%	256	13.62%	13.62%
4	86	11.61%	11.61%	205	10.91%	10.91%
5	35	4.72%	4.72%	62	3.30%	3.30%
6	11	1.48%	1.48%	29	1.54%	1.54%
7	2	0.27%	0.27%	5	0.27%	0.27%
8+	2	0.27%	0.27%	3	0.16%	0.16%
Total	741	100.00%	100.00%	1879	100.00%	100.00%

Heating fuel

	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
electric	139	18.76%	18.86%	415	22.09%	22.12%
natural gas	524	70.72%	71.10%	1312	69.82%	69.94%
oil	2	0.27%	0.27%	4	0.21%	0.21%
propane	4	0.54%	0.54%	5	0.27%	0.27%
other	68	9.18%	9.23%	140	7.45%	7.46%
Total	737	99.46%	100.00%	1876	99.84%	100.00%
No Response	4	0.54%		3	0.16%	
Total	741	100.00%		1879	100.00%	

Heating system

	Kentucky Kits			Kentucky No Kits		
	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
Central furnace	600	80.97%	81.74%	1555	82.76%	83.11%
Electric baseboard	7	0.94%	0.95%	11	0.59%	0.59%
Other	49	6.61%	6.68%	114	6.07%	6.09%
Heat pump	78	10.53%	10.63%	191	10.16%	10.21%
Total	734	99.06%	100.00%	1871	99.57%	100.00%
No Response	7	0.94%		8	0.43%	
Total	741	100.00%		1879	100.00%	

Age of furnace

	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
Don't Know	21	2.83%	2.83%	68	3.62%	3.62%
0-4	213	28.74%	28.74%	491	26.13%	26.13%
5-9	220	29.69%	29.69%	548	29.16%	29.16%
10-14	124	16.73%	16.73%	383	20.38%	20.38%
15+	163	22.00%	22.00%	389	20.70%	20.70%
Total	741	100.00%	100.00%	1879	100.00%	100.00%

Type of cooling system

	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
Central air conditioning	595	80.30%	80.84%	1524	81.11%	81.45%
Room window unit	43	5.80%	5.84%	107	5.69%	5.72%
Central and room	12	1.62%	1.63%	22	1.17%	1.18%
Heat pump	78	10.53%	10.60%	191	10.16%	10.21%
None	8	1.08%	1.09%	27	1.44%	1.44%
Total	736	99.33%	100.00%	1871	99.57%	100.00%
No Response	5	0.67%		8	0.43%	
Total	741	100.00%		1879	100.00%	

Age of cooling system

	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
Don't Know	30	4.05%	4.05%	104	5.53%	5.53%
0-4	235	31.71%	31.71%	517	27.51%	27.51%
5-9	243	32.79%	32.79%	607	32.30%	32.30%
10-14	127	17.14%	17.14%	382	20.33%	20.33%
15+	106	14.30%	14.30%	269	14.32%	14.32%
Total	741	100.00%	100.00%	1879	100.00%	100.00%

Water heater fuel

	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
Electric	246	33.20%	33.47%	596	31.72%	31.92%
Natural gas	482	65.05%	65.58%	1252	66.63%	67.06%
Other	7	0.94%	0.95%	19	1.01%	1.02%
Total	735	99.19%	100.00%	1867	99.36%	100.00%
No Response	6	0.81%		12	0.64%	
Total	741	100.00%		1879	100.00%	

Water heater age

	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
Don't Know	7	0.94%	0.94%	20	1.06%	1.06%
0-4	291	39.27%	39.27%	704	37.47%	37.47%
5-9	305	41.16%	41.16%	746	39.70%	39.70%
10-14	112	15.11%	15.11%	321	17.08%	17.08%
15+	26	3.51%	3.51%	88	4.68%	4.68%
Total	741	100.00%	100.00%	1879	100.00%	100.00%

Stove fuel

	Kentucky Kits			Kentucky No Kits		
	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
Electric	556	75.03%	75.75%	1437	76.48%	76.76%
Natural gas	165	22.27%	22.48%	410	21.82%	21.90%
Other	13	1.75%	1.77%	25	1.33%	1.34%
Total	734	99.06%	100.00%	1872	99.63%	100.00%
No Response	7	0.94%		7	0.37%	
	741	100.00%		1879	100.00%	

Oven fuel

	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
Electric	513	69.23%	78.20%	1315	69.98%	79.12%
Natural gas	135	18.22%	20.58%	324	17.24%	19.49%
Other	8	1.08%	1.22%	23	1.22%	1.38%
Total	656	88.53%	100.00%	1662	88.45%	100.00%
No Response	85	11.47%		217	11.55%	
Total	741	100.00%		1879	100.00%	

Dryer fuel

	Frequency	Percent	Valid Percent	Frequency	Percent	Valid Percent
Electric	604	81.51%	82.18%	1504	80.04%	80.38%
Natural gas	114	15.38%	15.51%	336	17.88%	17.96%
No clothes dryer	17	2.29%	2.31%	31	1.65%	1.66%
Total	735	99.19%	100.00%	1871	99.57%	100.00%
No Response	6	0.81%		8	0.43%	
Total	741	100.00%		1879	100.00%	