Appendix A: Tier 1 and Tier 2 Weatherization Estimated Statistical Model

ln_kwhd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
tms						
200901	-.8329145	.6298384	-1.32	0.186	-2.06756	.4017112
200902	.4622362	.5722324	0.81	0.419	-.6594688	1.583941
200903	.7657657	.569326	1.35	0.179	-.3502381	1.881769
200904	.9334862	.5691674	1.64	0.101	-.1822106	2.049183
200905	.9481663	.5688858	1.67	0.096	-.1669787	2.063311
200906	1.19478	.5684633	2.10	0.036	.0804635	2.309097
200907	1.266222	.568102	2.23	0.026	.1526136	2.379831
200908	1.156772	.5676975	2.04	0.042	.0439561	2.269589
200909	1.035637	.5675865	1.82	0.068	-.0769606	2.148235
200910	.9228351	.5671834	1.63	0.104	-.1889728	2.034643
200911	1.068179	.5670117	1.88	0.060	-.0432928	2.17965
200912	1.245449	.5667183	2.20	0.028	.1345532	2.356346
201001	1.344967	.5665858	2.37	0.018	.2343304	2.455603
201002	1.325987	.5665695	2.34	0.019	.2153827	2.436591
201003	1.208099	.5665329	2.13	0.033	.0975662	2.318632
201004	.8783108	.5663747	1.55	0.121	-.2319118	1.988533
201005	1.164885	.5662801	2.06	0.040	.0548478	2.274922
201006	1.395548	.5662387	2.46	0.014	.2855924	2.505504
201007	1.693842	.5662445	2.99	0.003	.5838754	2.80381
201008	1.501451	.5661232	2.65	0.008	.3917616	2.61122
201009	1.256342	.5661154	2.22	0.026	.1466282	2.366057
201010	1.139021	.5661176	2.01	0.044	.029302	2.248739
201011	1.252269	.5661215	2.21	0.027	.1425429	2.361995
201012	1.55673	.566126	2.75	0.006	.6469548	2.666465
201101	1.502499	.5661378	2.66	0.008	.3937409	2.613257
201102	1.298971	.5661862	2.29	0.022	.1891175	2.408824
201103	1.298655	.5662198	2.29	0.022	.1887364	2.408574
201104	1.041767	.5662326	1.84	0.066	-.0681773	2.151711
201105	1.242358	.5662684	2.19	0.028	.1323807	2.352331
201106	1.420078	.5662886	2.51	0.012	.3100243	2.530132
201107	1.724036	.5663927	3.04	0.002	.6138953	2.834176
201108	1.640617	.5663953	2.90	0.004	.5304251	2.75081
201109	1.277644	.5663812	2.26	0.024	.1674086	2.387879
201110	1.075689	.5664025	1.90	0.058	-.0345885	2.185967
201111	1.219093	.5664186	2.15	0.031	.1087853	2.329402
201112	1.327885	.5664393	2.34	0.019	.2175462	2.438245
201201	1.361766	.5664604	2.40	0.016	.2513754	2.472157
201202	1.274155	.566492	2.25	0.025	.1637025	2.384608
201203	.7816158	.5665442	1.33	0.185	-.3389349	1.862165
201204	-.7591516	.5715433	-1.33	0.184	-1.879506	.3612026
ptie_2	-.1361496	.0227221	-5.99	0.000	-.1806901	-.0916091
ptie_1	-.0514818	.0323651	-1.59	0.112	-.1149247	.0119611
_cons	2.0409	.5652845	3.61	0.000	.932815	3.148986

Appendix B: TIER Crosstab of Participation by Month

Count	Partmonth_id
47	201003
30	201004
9	201006
9	201007
17	201008
19	201009
6	201010
21	201011
18	201012
45	201101
26	201102
4	201104
26	201105
19	201106
12	201107
4	201108
3	201109
5	201111
16	201201
15	201202
1	201203

Appendix C: Overall Weatherization Impact

Findings

There were a total of 335 participants between March 2010 and April 2012. These are usable accounts could be included in the impact analysis after data cleaning and processing[3] for analysis in the billing analysis model. A panel model was used to determine program impacts, where the dependent variable was the natural log of daily electricity consumption. The savings analysis results (percent of consumption saved) from the billing analysis are presented in Table 4.

Table 4. Estimated Weatherization Program Impacts in Percentage: Overall

Per Participant Savings (%) Positive Indicates Saving	95% Confidence Interval		
	Lower Bound	Estimate	Upper Bound
Overall weatherization	3.1%	6.3%	9.5%

Analysis

This section of the report presents the results of a billing analysis conducted over the participants in the Kentucky Weatherization program. Billing data were obtained for all participants in the program between March 2010 and April 2012.

This table shows that the Weatherization program produced statistically significant savings of 6.3% for participants in Kentucky.

The effect of the Weatherization program was captured by including a variable which is equal to one for all months after the household participated in the program. The coefficient on the variable is the savings associated with the program. In order to account for differences in billing days, the usage was normalized by days in the billing cycle and temperature was calculated based on each bill start and end date. The estimated electric model for the Weatherization program is presented in the table below.

Independent Variable	Coefficient (% Savings/day)	t-value
Overall program	-0.063	-3.88
Sample Size	8,622 observations (335 homes)	
R-Squared	72%	

The complete estimated model, showing the weather and time factors, is presented in the section titled "Appendix D: Weatherization Estimated Statistical Model".

[3] Useable accounts are those accounts which have billing data for both a portion of the pre- and post-participation period. It was not required that the data covers the complete evaluation period, only that there is at least one observation in each period.

Appendix D: Weatherization Estimated Statistical Model

The section below shows the complete model estimated for the billing analysis of the Kentucky Weatherization program. The model includes indicators for each month (the yearmonth variable), temperature, the state the participant resides, and the participation variables.

```
                    Number of Observations Read        8622
                    Number of Observations Used        8622

Dependent Variable: ln_kwhd

                                      Sum of
Source                      DF       Squares     Mean Square    F Value    Pr > F

Model                      384    3278.998217       8.539058      55.18    <.0001

Error                     8237    1274.737690       0.154758

Corrected Total           8621    4553.735907

                R-Square     Coeff Var      Root MSE    ln_kwhd Mean

                0.720068      12.00265      0.393392        3.277546

Source                      DF      Type I SS     Mean Square    F Value    Pr > F

HUB_account_id             334    2891.551874       8.657341      55.94    <.0001
Part                         1      6.351229       6.351229      41.04    <.0001
monthID                     37    346.279733       9.358912      60.47    <.0001
AvgTemp*month               12     34.815381       2.901282      18.75    <.0001

Source                      DF     Type III SS     Mean Square    F Value    Pr > F

Part                         1     2.33336557      2.33336557      15.08    0.0001
monthID                     37    51.81562843      1.40042239       9.05    <.0001
AvgTemp*month               12    34.81538094      2.90128174      18.75    <.0001
```

Parameter		Estimate	Standard Error	t Value	Pr > |t|	95% Confid	ence Limits
Part		-0.06293	0.01620539	-3.88	0.0001	-0.09469	-0.03116
monthID	200903	-0.37474	0.36678532	-1.02	0.307	-1.09373	0.344252
monthID	200904	-0.09046	0.1033128	-0.88	0.3813	-0.29298	0.112056
monthID	200905	-1.05973	0.86700456	-1.22	0.2216	-2.75927	0.63982
monthID	200906	-3.17798	0.50039881	-6.35	<.0001	-4.15889	-2.19708
monthID	200907	-5.75365	0.87307644	-6.59	<.0001	-7.4651	-4.0422
monthID	200908	-1.96964	0.9112646	-2.16	0.0307	-3.75595	-0.18333
monthID	200909	-4.53063	0.62410479	-7.26	<.0001	-5.75404	-3.30723
monthID	200910	-2.02061	0.48020749	-4.21	<.0001	-2.96193	-1.07928
monthID	200911	-0.38782	0.49229229	-0.79	0.4308	-1.35284	0.577196
monthID	200912	-0.3937	0.38728698	-1.02	0.3094	-1.15288	0.365484
monthID	201001	-0.70386	0.46923932	-1.5	0.1337	-1.62369	0.215968
monthID	201002	0.130272	0.45916279	0.28	0.7766	-0.7698	1.030347
monthID	201003	-0.41938	0.3603802	-1.16	0.2446	-1.12581	0.287058
monthID	201004	-0.13145	0.08933798	-1.47	0.1412	-0.30658	0.043672
monthID	201005	-1.14323	0.87372322	-1.31	0.1908	-2.85595	0.569483
monthID	201006	-3.12906	0.50659584	-6.18	<.0001	-4.12212	-2.13601
monthID	201007	-5.84815	0.91834673	-6.37	<.0001	-7.64834	-4.04796
monthID	201008	-1.76641	0.98798713	-1.79	0.0738	-3.70311	0.170294
monthID	201009	-4.5783	0.65428654	-7	<.0001	-5.86086	-3.29573
monthID	201010	-2.09243	0.51326455	-4.08	<.0001	-3.09856	-1.0863
monthID	201011	-0.31932	0.50487231	-0.63	0.5271	-1.309	0.670357
monthID	201012	-0.36449	0.38158447	-0.96	0.3395	-1.11249	0.38351
monthID	201101	-0.67605	0.47015551	-1.44	0.1505	-1.59768	0.245569
monthID	201102	0.211433	0.47956174	0.44	0.6593	-0.72863	1.151495
monthID	201103	-0.35927	0.36409886	-0.99	0.3238	-1.07299	0.354458
monthID	201104	-0.14462	0.09475512	-1.53	0.127	-0.33036	0.041129
monthID	201105	-1.12107	0.84889976	-1.32	0.1867	-2.78513	0.542984
monthID	201106	-3.10636	0.50575506	-6.14	<.0001	-4.09776	-2.11495
monthID	201107	-5.84211	0.91365158	-6.39	<.0001	-7.6331	-4.05113
monthID	201108	-1.74216	0.99277848	-1.75	0.0793	-3.68825	0.203938
monthID	201109	-4.43601	0.62911541	-7.05	<.0001	-5.66924	-3.20279
monthID	201110	-2.1183	0.49073228	-4.32	<.0001	-3.08025	-1.15634
monthID	201111	-0.37785	0.49436341	-0.76	0.4447	-1.34693	0.591228
monthID	201112	-0.38128	0.3897361	-0.98	0.328	-1.14526	0.382702
monthID	201201	-0.74254	0.53135034	-1.4	0.1623	-1.78412	0.299039
monthID	201202	0.260945	0.51689263	0.5	0.6137	-0.7523	1.274184
monthID	201203	-0.33601	0.36720933	-0.92	0.3602	-1.05584	0.383808
AvgTemp*month	1	-0.00538	0.00874502	-0.62	0.5385	-0.02252	0.011764
AvgTemp*month	2	-0.02868	0.00852912	-3.36	0.0008	-0.0454	-0.01196
AvgTemp*month	3	-0.01372	0.0022911	-5.99	<.0001	-0.01821	-0.00923
AvgTemp*month	4	-0.0177	0.00501184	-3.53	0.0004	-0.02753	-0.00788
AvgTemp*month	5	-0.00291	0.01154936	-0.25	0.8008	-0.02555	0.019725
AvgTemp*month	6	0.026021	0.00485053	5.36	<.0001	0.016513	0.03553
AvgTemp*month	7	0.059593	0.01016889	5.86	<.0001	0.03966	0.079527
AvgTemp*month	8	0.012967	0.01043329	1.24	0.214	-0.00748	0.033419
AvgTemp*month	9	0.043412	0.00625709	6.94	<.0001	0.031147	0.055678
AvgTemp*month	10	0.011544	0.00465962	2.48	0.0133	0.002409	0.020678
AvgTemp*month	11	-0.01433	0.00523929	-2.73	0.0063	-0.0246	-0.00406
AvgTemp*month	12	-0.01338	0.00259133	-5.16	<.0001	-0.01846	-0.0083

Appendix E: Payment Plus Impact Analysis

Payment Plus Methodology

The study looked at Payment Plus participants who participated in this program from September 2010 through March 2012

For these analyses, data are available both across households (i.e., cross-sectional) and over time (i.e., time-series). With this type of data, known as "panel" data, it becomes possible to control, simultaneously, for differences across households as well as differences across periods in time through the use of a "fixed-effects" panel model specification. The fixed-effect refers to the model specification aspect that differences across homes that do not vary over the estimation period (such as square footage, heating system, etc.) can be explained, in large part, by customer-specific intercept terms that capture the net change in consumption due to the program, controlling for other factors that do change with time (e.g., the weather).

Because the consumption data in the panel model include months before and after the installation of measures through the program, the period of program participation (or the participation window) may be defined specifically for each customer. This feature of the panel model allows for the pre-installation months of consumption to effectively act as controls for post-participation months. In addition, this model specification, unlike annual pre/post-participation models such as annual change models, does not require a full year of post-participation data. Effectively, the participant becomes their own control group, thus eliminating the need for a non-participant group. We know the exact month of participation in the program for each participant, and are able to construct customer-specific models that measure the change in usage consumption immediately before and after the date of program participation, controlling for weather.

The fixed effects model can be viewed as a type of differencing model in which all characteristics of the home, which (1) are independent of time and (2) determine the level of energy consumption, are captured within the customer-specific constant terms. In other words, differences in customer characteristics that cause variation in the level of energy consumption, such as building size and structure, are captured by constant terms representing each unique household.

Algebraically, the fixed-effect panel data model is described as follows:

$$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it},$$

where:

- y_{it} = energy consumption for home i during month t
- α_I = constant term for site i
- β = vector of coefficients
- x = vector of variables that represent factors causing changes in energy consumption for home i during month t (i.e., weather, time, and participation)
- ε = error term for home i during month t.

With this specification, the only information necessary for estimation are those factors that vary month to month for each customer, and that will affect energy use, which effectively are weather conditions and program participation. Other non-measurable factors can be captured through the use of monthly indicator variables (e.g., to capture the effect of potentially seasonal energy loads).

Findings

There were a total of 262 usable accounts after cleaning and processing the data to ready it for the billing analysis model[4]. A panel model was used to determine program impacts, where the dependent variable was the natural log of daily electricity consumption. The results of the billing analysis are presented in Table 5.

Table 5. Estimated Kentucky Payment Plus Program Impacts in Percentage: Overall

Per Participant Annual Savings (%) Positive Indicates Saving	95% Confidence Interval			Annual kWh Saving
	Lower Bound	Estimate	Upper Bound	
Overall Program Recent	2.0%	5.6%	9.3%	835
Without Weatherization	1.3%	5.1%	8.8%	760
With Weatherization	2.6%	7.7%	12.8%	1,148

Analysis

Billing data were obtained for all participants in the analysis. The effect of Payment Plus program was captured by including a variable which is equal to one for all months after the household participated in the program. The coefficients for these variables are the savings associated with the program. Payment Plus achieved significant saving at approximately 5.6%. If participants only took classes without weatherization, the saving is estimated to be significant at approximately 5.1% whereas if participants added weatherization the saving is estimated to be significant at approximately 7.7%.

The model result is summarized in the table below:

Independent Variable	Coefficient (% Savings/day)	t-value
Overall program	-0.056	-3.00
Without Weatherization	-0.051	-2.62
With Weatherization	-0.077	-2.97
Sample Size	12,049 observations (262 homes)	
R-Squared	61%	

[4] Useable accounts are those accounts which have billing data for both a portion of the pre- and post-participation period. It was not required that the data covers the complete evaluation period, only that there are at least some observations in each of the customer-specific records over the pre and post program analysis period.

Appendix F: Payment Plus Estimated Statistical Model – Overall

Number of Observations Read 12049
Number of Observations Used 12049

Dependent Variable: ln_kwhd

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	375	3325.249871	8.867333	48.98	<.0001
Error	11673	2113.432277	0.181053		
Corrected Total	12048	5438.682148			

R-Square	Coeff Var	Root MSE	ln_kwhd Mean
0.611407	12.16432	0.425503	3.497961

Source	DF	Type I SS	Mean Square	F Value	Pr > F
HUB_account_id	261	2723.912797	10.436447	57.64	<.0001
Part	1	8.344957	8.344957	46.09	<.0001
monthID	99	526.808469	5.321298	29.39	<.0001
AvgTemp*month	12	63.401322	5.283444	29.18	<.0001
Humidity*summer	1	1.663492	1.663492	9.19	0.0024
Wind*winter	1	1.118834	1.118834	6.18	0.0129

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Part	1	1.6340396	1.6340396	9.03	0.0027
monthID	99	144.9347578	1.4639875	8.09	<.0001
AvgTemp*month	12	40.3340270	3.3611689	18.56	<.0001
Humidity*summer	1	1.6611332	1.6611332	9.17	0.0025
Wind*winter	1	1.1188335	1.1188335	6.18	0.0129

Parameter		Estimate	Standard Error	t Value	Pr > |t|
Part		-0.05611	0.01867862	-3	0.0027
monthID	200901	-0.497	0.41521368	-1.2	0.2313
monthID	200902	-0.29192	0.40564781	-0.72	0.4718
monthID	200903	-0.52533	0.30926937	-1.7	0.0894
monthID	200904	-0.10826	0.06722652	-1.61	0.1073
monthID	200905	-1.40705	0.50166606	-2.8	0.005
monthID	200906	-2.6387	0.48679204	-5.42	<.0001
monthID	200907	-1.46165	0.94015566	-1.55	0.12
monthID	200908	-3.83713	0.8117151	-4.73	<.0001
monthID	200909	-5.94467	0.53313623	-11.15	<.0001
monthID	200910	-2.32365	0.36881979	-6.3	<.0001
monthID	200911	-0.18219	0.39674331	-0.46	0.6461
monthID	200912	0.172485	0.31618647	0.55	0.5854
monthID	201001	-0.34225	0.37651174	-0.91	0.3634
monthID	201002	-0.16816	0.38429862	-0.44	0.6617
monthID	201003	-0.37034	0.29653289	-1.25	0.2117
monthID	201004	-0.0401	0.05516641	-0.73	0.4673
monthID	201005	-1.42468	0.50529064	-2.82	0.0048
monthID	201006	-2.55894	0.48693831	-5.26	<.0001
monthID	201007	-1.26247	0.98918666	-1.28	0.2019
monthID	201008	-3.81578	0.88412221	-4.32	<.0001
monthID	201009	-6.13732	0.5605853	-10.95	<.0001
monthID	201010	-2.5124	0.39352693	-6.38	<.0001
monthID	201011	-0.07446	0.40597704	-0.18	0.8545
monthID	201012	0.15846	0.30930369	0.51	0.6084
monthID	201101	-0.32399	0.38245989	-0.85	0.3969
monthID	201102	-0.11282	0.40327651	-0.28	0.7797
monthID	201103	-0.3535	0.30233002	-1.17	0.2423
monthID	201104	-0.02702	0.06477474	-0.42	0.6766
monthID	201105	-1.36228	0.49324605	-2.76	0.0058
monthID	201106	-2.4454	0.49509814	-4.94	<.0001
monthID	201107	-1.24448	0.98366521	-1.27	0.2058
monthID	201108	-3.85135	0.88769282	-4.34	<.0001
monthID	201109	-5.95164	0.53385716	-11.15	<.0001
monthID	201110	-2.56954	0.37689209	-6.82	<.0001
monthID	201111	-0.12261	0.39915497	-0.31	0.7587
monthID	201112	0.249419	0.3193586	0.78	0.4348
monthID	201201	-0.36604	0.42973355	-0.85	0.3944
monthID	201202	-0.18093	0.43640612	-0.41	0.6785
monthID	201203	-0.48863	0.30796898	-1.59	0.1126
AvgTemp*month	1	0.008172	0.00951336	0.86	0.3904
AvgTemp*month	2	0.003063	0.00990426	0.31	0.7571
AvgTemp*month	3	0.007029	0.00678321	1.04	0.3001
AvgTemp*month	4	-0.01329	0.00387099	-3.43	0.0006
AvgTemp*month	5	0.006231	0.0060623	1.03	0.304
AvgTemp*month	6	-0.04381	0.02507374	-1.75	0.0806
AvgTemp*month	7	-0.0573	0.02711392	-2.11	0.0346
AvgTemp*month	8	-0.02749	0.02442985	-1.13	0.2606
AvgTemp*month	9	0.066647	0.00556928	11.97	<.0001
AvgTemp*month	10	0.02206	0.00346293	6.37	<.0001
AvgTemp*month	11	-0.01174	0.00441225	-2.66	0.0078
AvgTemp*month	12	-0.00424	0.00608977	-0.7	0.4866
Humidity*summer		0.07626	0.02517667	3.03	0.0025
Wind*winter		-0.01928	0.00775594	-2.49	0.0129

Appendix G: Payment Plus Estimated Statistical Model – With and Without Weatherization

Number of Observations Read 12049
Number of Observations Used 12049

Dependent Variable: ln_kwhd

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	376	3325.492506	8.844395	48.85	<.0001
Error	11672	2113.189641	0.181048		
Corrected Total	12048	5438.682148			

R-Square	Coeff Var	Root MSE	ln_kwhd Mean
0.611452	12.16415	0.425497	3.497961

Source	DF	Type I SS	Mean Square	F Value	Pr > F
HUB_account_id	261	2723.912797	10.436447	57.64	<.0001
Cpart	1	4.361677	4.361677	24.09	<.0001
WPart	1	4.329674	4.329674	23.91	<.0001
monthID	99	526.571903	5.318908	29.38	<.0001
AvgTemp*month	12	63.533176	5.294431	29.24	<.0001
Humidity*summer	1	1.663295	1.663295	9.19	0.0024
Wind*winter	1	1.119985	1.119985	6.19	0.0129

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Cpart	1	1.2414707	1.2414707	6.86	0.0088
WPart	1	1.5923745	1.5923745	8.80	0.0030
monthID	99	145.0203803	1.4648523	8.09	<.0001
AvgTemp*month	12	40.4468018	3.3705668	18.62	<.0001
Humidity*summer	1	1.6609339	1.6609339	9.17	0.0025
Wind*winter	1	1.1199855	1.1199855	6.19	0.0129

Parameter		Estimate	Standard Error	t Value	Pr > |t|
Cpart		-0.05052	0.01929308	-2.62	0.0088
WPart		-0.07698	0.02595706	-2.97	0.003
monthID	200901	-0.50533	0.41527001	-1.22	0.2237
monthID	200902	-0.2927	0.40564245	-0.72	0.4706
monthID	200903	-0.52852	0.30927715	-1.71	0.0875
monthID	200904	-0.11377	0.06739377	-1.69	0.0914
monthID	200905	-1.40968	0.50166389	-2.81	0.005
monthID	200906	-2.64478	0.4868133	-5.43	<.0001
monthID	200907	-1.45413	0.94016444	-1.55	0.122
monthID	200908	-3.85254	0.81181244	-4.75	<.0001
monthID	200909	-5.96465	0.53340775	-11.18	<.0001
monthID	200910	-2.31921	0.36883439	-6.29	<.0001
monthID	200911	-0.18023	0.39674115	-0.45	0.6496
monthID	200912	0.170699	0.31618562	0.54	0.5893
monthID	201001	-0.34999	0.37656561	-0.93	0.3527
monthID	201002	-0.16936	0.38429441	-0.44	0.6594
monthID	201003	-0.37369	0.29654267	-1.26	0.2076
monthID	201004	-0.04607	0.05540638	-0.83	0.4057
monthID	201005	-1.42761	0.50528961	-2.83	0.0047
monthID	201006	-2.56525	0.48696176	-5.27	<.0001
monthID	201007	-1.25445	0.98919646	-1.27	0.2048
monthID	201008	-3.8323	0.88422443	-4.33	<.0001
monthID	201009	-6.16119	0.56095616	-10.98	<.0001
monthID	201010	-2.50867	0.39353439	-6.37	<.0001
monthID	201011	-0.07329	0.4059724	-0.18	0.8567
monthID	201012	0.156115	0.30930582	0.5	0.6138
monthID	201101	-0.33021	0.38249196	-0.86	0.388
monthID	201102	-0.11377	0.40327146	-0.28	0.7779
monthID	201103	-0.35516	0.30232901	-1.17	0.2401
monthID	201104	-0.03065	0.06485001	-0.47	0.6364
monthID	201105	-1.36344	0.49323988	-2.76	0.0057
monthID	201106	-2.44988	0.49510605	-4.95	<.0001
monthID	201107	-1.23438	0.98368954	-1.25	0.2096
monthID	201108	-3.8662	0.88777264	-4.35	<.0001
monthID	201109	-5.97319	0.53417403	-11.18	<.0001
monthID	201110	-2.56413	0.37691559	-6.8	<.0001
monthID	201111	-0.11973	0.3991569	-0.3	0.7642
monthID	201112	0.251426	0.31935865	0.79	0.4311
monthID	201201	-0.37073	0.42974642	-0.86	0.3883
monthID	201202	-0.17706	0.43641254	-0.41	0.685

monthID	201203	-0.48783	0.30796527	-1.58	0.1132
AvgTemp*month	1	0.008313	0.00951401	0.87	0.3822
AvgTemp*month	2	0.003018	0.0099042	0.3	0.7606
AvgTemp*month	3	0.007043	0.00678312	1.04	0.2991
AvgTemp*month	4	-0.01324	0.00387113	-3.42	0.0006
AvgTemp*month	5	0.00623	0.00606221	1.03	0.3041
AvgTemp*month	6	-0.04376	0.02507341	-1.75	0.0809
AvgTemp*month	7	-0.05743	0.02711374	-2.12	0.0342
AvgTemp*month	8	-0.02733	0.02442988	-1.12	0.2633
AvgTemp*month	9	0.066859	0.00557222	12	<.0001
AvgTemp*month	10	0.021946	0.00346428	6.33	<.0001
AvgTemp*month	11	-0.01182	0.00441273	-2.68	0.0074
AvgTemp*month	12	-0.00425	0.0060897	-0.7	0.4848
Humidity*summer		0.076256	0.0251763	3.03	0.0025
Wind*winter		-0.01929	0.00775583	-2.49	0.0129

Appendix G: Counts of Payment Plus Participant / Non-participants

This appendix presents the counts of participants and non-participants in each month. The first row is always the first month when the first participant joined, such that for KY the first participant's start date was Sep. 2010. The last row is the last month of billing data included in the billing analysis such that the last couple month with non-participant count being zero (because every account had become participant at the end).

Month ID	Non-participant count	Participant count
201009	139	99
201010	143	82
201011	135	80
201012	147	80
201101	117	71
201102	142	65
201103	154	81
201104	133	74
201105	153	69
201106	150	62
201107	140	65
201108	154	65
201109	38	174
201110	37	110
201111	33	152
201112	29	155
201201	27	145
201202	4	177
201203	0	177
201204	0	121

Appendix H: DSMore Table

Per Measure Impacts Summary for Low Income Weatherization Kentucky

Impacts ⇨ / Technology ⇩	Product code	State	EM&V gross savings (kWh/unit)	EM&V gross kW (customer peak/unit)	EM&V gross kW (coincident peak/unit)	Unit of measure	Combined spillover less freeridership and bias adjustment	EM&V net savings (kWh/unit)	EM&V net kW (customer peak/unit)	EM&V net kW (coincident peak/unit)	EM&V load shape (yes/no)	EUL (whole number)
Low Income Weatherization - Tier 1		KY	425.0	N/A	N/A	home	0.0%	425.0	N/A	N/A	no	15
Low Income Weatherization - Tier 2		KY	1,888.0	N/A	N/A	home	0.0%	1,888.0	N/A	N/A	no	15
Program wide			**2,313**	**N/A**	**N/A**			**2,313**	**N/A**	**N/A**		

Notes: EM&V load shape: "no" if using standard DSMore load shape for technology units, "yes" if an evaluation-provided load shape should be used for DSMore.

Final Report

Process and Impact Evaluation of Duke Energy's Residential Appliance Recycling Program (ARP) in Ohio and Kentucky

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Executive Summary

Key Findings

This section presents the key findings and recommendations identified through the evaluation of the Ohio and Kentucky Residential Appliance Recycling Program. Table 1 presents the estimated overall ex post energy impacts from the engineering analysis.

Table 1. Estimated Overall Impacts

Net Savings	Refrigerators	Freezers
Annual Savings Per Participant Per Year		
kWh	414	357
kW	0.0441	0.0468

These net savings estimates are based on the net assessment approach described in the *Sixteen Path Direct Net Analysis Approach* section of this report. This 16-path approach is consistent with the newly released USDOE Uniform Evaluation Protocols (UMP) because it provides a direct-net assessment approach by assessing the way in which the program impacts energy use in the homes of participants and non-participants. As USDOE points out in their UMP, these programs change the way the appliance market operates and provides savings beyond the home of the participant that are typically missed in evaluations that focus only on participants' homes. The 16-path analysis approach developed in coordination with the drafting of the UMP by TecMarket Works expands on the USDOE UMP approach by allowing the consumers of evaluation results to see the program's effects or lack of effects on all of the market operations channels that can be impacted by these types of programs.

Significant Impact Evaluation Findings

The estimated net impacts are presented in the *Impact Estimates: Engineering* section of the report. A summary of the results is shown in Table 2.

Table 2. Engineering Analysis Estimated Impacts

Estimate	Gross Savings		Net Savings	
	kWh	kW	kWh	kW
Per Participant Annual kWh Savings: Overall	528	0.0601	411	0.0468
Per Participant Annual kWh Savings: Refrigerator	485	0.0516	414	0.0441
Per Participant Annual kWh Savings: Freezer	665	0.0872	357	0.0468

- The average secondary refrigerator has an in-service rate of 75.2% (9.02 months out of 12). The weighted average in-service rate for all refrigerators is 80.4%. The average freezer has an in-service rate of 73.9%.
    - See Table 8 on page 25.

- The average annual kWh consumption of a replacement refrigerator is 530 kWh. A replacement freezer is 511 kWh. Adjusting for the ISR drops average annual kWh consumption to 426 kWh and 378 kWh for refrigerators and freezers respectively.
    - See Table 11 on page 29.
- Six (28.6%) out of the 21 units recycled through the program that, in the absence of the program, would have been picked up by a dealer or donated were reported to be in saleable condition and would likely have ended up on the secondary market.
    - See paragraph under Table 11 on page 29.
- Net to gross ratios for refrigerators and freezers are 85.4% and 53.7% respectively.
    - See *Net to Gross Analysis* on page 35.
- Program wide average remaining useful life (RUL) is calculated to be 5 years.
    - See *Remaining Useful Life* on page 34.

Significant Process Evaluation Findings

From the Management Interviews

- The program employs a multi-pronged marketing strategy that combines Duke Energy customer communications (bill inserts, emails, website and online services [OLS] promotions), with paid advertising (print, broadcast, and digital), and creative public relations events staged for the public and the news media.
    - See section titled *Marketing* on page 39.
- Each marketing activity is tracked and measured for effectiveness. Every caller to the call center is asked how they heard about the program, while digital marketing uses unique URLs and Google Analytics to track web traffic. Bill inserts represent the most popular source for both calls and website visits.
    - See section titled *Scheduling and Customer Inquiries* starting on page 43.
- Customers can make an appointment for collection via phone or internet. Appointments placed via the call center outnumber web appointments by approximately two to one. No operational challenges were reported with either method. A Duke Energy-JACO review of cancellations showed that customers sometimes enrolled by internet and then placed a phone call to enroll as well.
    - See section titled *Scheduling and Customer Inquiries* starting on page 43.
- The program had an overall cancellation rate of 15% in Ohio and 14% in Kentucky during 2012, and slightly higher rates of 19.3% in Ohio and an 18.8% rate in Kentucky during 2013. TecMarket Works identifies these cancellation rates as an area for additional investigation to determine reasons for them and to categorize them into those for corrective action and those such as the deletions of duplicate customer enrollments. This may help to improve program performance since the marketing and scheduling

teams have already effectively executed their assigned roles and obtained the customers' commitment to program participation.

  - See section titled *Scheduling and Customer Inquiries* starting on page 43.

- No challenges or issues with refrigerator or freezer collection were reported.
  - See section titled *Appliance Collection* on page 48.

- Duke Energy never comes into legal possession of the units. All dismantling and recycling activities are specific to JACO and meet or exceed state and federal laws, as well as the more stringent Responsible Appliance Disposal[1] (RAD) program guidelines.
  - See section titled *Dismantling and Recycling* on page 51.

- The financial incentive levels for the program are currently set at $30 per unit for Ohio and Kentucky customers. JACO processes and mails most checks within two to four weeks, which is less than the contracted six week time frame. No challenges or issues were reported with incentive processing or accounting.
  - See section titled *Incentive Payments* on page 52.

- All parties report clear and regular communication, smooth functioning, and collaborative teamwork in the accomplishment of shared goals.
  - See section titled *Management Coordination and Communication* on page 54.

- The program did not meet its goal for 2012. In its first three months of operation in Ohio the program recycled 387 refrigerators and 137 freezers for a total of 524 units, toward an initial goal of 563 units. This represents 93% of goal. In that same time period in Kentucky, the program collected 91 refrigerators and 32 freezers for a total of 123 units. The program had no budgeted goal in Kentucky for 2012.
  - See section titled *Program Goals and Participation* on page 17.

- Between January 1 and July 31, performance in Ohio stood at 1,558 refrigerators and 526 freezers for a total of 2,084 units or 48% of its annual goal. In Kentucky, year to date performance was 357 refrigerators and 98 freezers for a total of 455 units or 43% of its goal for 2013.
  - See section titled *Program Goals and Participation* on page 17.

- Overall in the first 10 months of operations, the program collected 2,608 units in Ohio and 578 units in Kentucky, for a total of 3,186 units throughout the combined service territories.
  - See section titled *Program Goals and Participation* on page 17.

- While noting the opportunity for incremental improvements in call center processing, the availability of appointments, and cancellation rates, TecMarket Works considers low

[1] See http://www.epa.gov/ozone/partnerships/rad/ for more information.

performance against goals to be largely attributable to the current incentive level of $30 per unit and the initial harvest rate projections upon which the program's annual goals are based.

o See section titled *Incentive Payments* on page 52.

- Duke Energy faced considerable delays between the original filing and the first approval in Indiana in early 2012. A Market Potential Study (MPS) was used as the basis for projections regarding annual collections and establishing the incentive level for the program. The targets based on this older MPS may not have been as appropriate as those of a newer study, by the time of the actual launch.

o See section titled *Program Goals and Participation* on page 17

- Raising incentive amounts from $30 to $40 or $50 per unit may increase participation and help the program to reach its targeted goals. However, as refrigerators become more efficient and savings levels erode, it will be important to set levels that keep a careful eye on cost effectiveness.

o See section titled *Incentive Payments* on page 52.

- A controlled test of incentive amounts among 240,000 Duke Energy customers in North Carolina and South Carolina during September of 2013 demonstrated that higher incentive levels of $40 and $50 result in increased participation levels and greater energy savings associated with the additional units collected. These findings should be considered for their applicability and cost effectiveness in the Ohio and Kentucky service territories.

o See section titled *Incentive Payments* on page 52.

- Although collection numbers lag behind projected goals, overall program administration and daily operations appear to be strategically well-considered, carefully timed and coordinated, and effectively executed.

o See section titled *Evaluation* on page 55.

From the New and Used Appliance Dealer Interviews

For more details on the findings below see section titled *Appliance Dealer Interview Results* beginning on page 58.

- New and used appliance dealers are generally reluctant to discuss their sales volume and business practices, thereby making it difficult to quantify for this evaluation the number of used units sold annually.
- Knowledge of the program among new and used appliance dealers is modest, with more used dealers indicating awareness than new dealers.
- Market volume of used units is down markedly from years past. Duke Energy's Appliance Recycling Program is contributing to this decline, but the dealers we spoke with cited other factors as being more significant, including business decisions by major

retailers, the federal government's Cash-for-Clunkers appliance recycling effort, and the price of scrap metal.

- The reduction of the availability of used units is adversely affecting small used appliance dealers who rely on individual people with spare units to obtain stock they can resell. Dealers who sell units that are less than five years old and dealers who purchase used appliances in bulk from wholesalers and auctions appear to better able to withstand program-induced market changes. Targeting bulk units headed for the used market may be an opportunity for additional reductions to the used appliance market.
- Demand for used refrigerators and freezers remains strong. The dealers we spoke with reported that while some customers will opt to purchase new units when used ones are unavailable, most of their customers are financially unwilling or unable to purchase new units due to price sensitivity or other factors such as creditworthiness. This ensures that the demand for used units remains high.
- With strong demand and low inventories, the market for used refrigerators is supply constrained, meaning there are not enough used units to meet demand. All appliance dealers we surveyed agreed that they are able to sell every used unit that they obtain, and those who only sell used units indicated that they could sell more units if they could obtain them.
- With used unit supplies down and costs for replacement parts high, sales prices for used units are rising. But the price increases are not proportionate to the differential between supply and demand, since many dealers do not feel their customers will tolerate the higher sticker prices. As a result used dealer profit margins are being squeezed.
- The perceived effect of the program on appliance dealer businesses appears to be correlated with their business model. The more reliant the dealers are upon obtaining older units from individual people, the more adversely the program is thought to be impacting their businesses. Regardless of business model, no used appliance dealers felt the program was good for their business.
- According to the used appliance dealers we spoke with, landlords may account for up to half of their annual sales of used refrigerators and freezers. While in years past a single appliance dealer used to be able to supply one landlord with all or most of the units desired, landlords now need to visit several dealers in order to obtain enough used units to meet their needs.
- Overall the program appears to be having little to no measurable effect on new unit sales. However, the gap between used unit availability and demand has to be filled by a lack of purchase or by the acquisition of a new more energy efficient unit, thereby further increasing savings in the market. One retailer indicated that its salespeople sometimes mention the program as a way for customers to lower the final purchase price of a new unit.

From the Customer Surveys

- TecMarket Works surveyed 161 customers in Ohio and Kentucky who recycled 94 refrigerators and 81 freezers (including fourteen customers who recycled two units apiece). Twenty-six (27.7% of 94) of the recycled refrigerators were being used as the

main refrigerator in the household, while 68 (72.3% of 94) of the recycled refrigerators were secondary or "spare" units.

- See sections titled *Participant Survey Results* and *Characteristics of Recycled Units: Refrigerators* on page 66.

- Most recycled freezers (60.5% or 49 out of 81) and spare refrigerators (52.9% or 36 out of 68) were kept in the basement, and nearly half of these units were not kept in rooms that are heated in winter or cooled in the summer. Customers report the average age of their recycled freezers is 26.4 years, older than the average age of recycled primary refrigerators (15.3 years), but about the same average age as secondary refrigerators (29.1 years). The majority of recycled units were kept plugged in and running year-round (100% of 26 primary refrigerators, 73.5% of 68 secondary refrigerators, and 69.1% of 81 freezers). While 76.5% (62 out of 81) of recycled freezers were described as being in good physical condition, only 57.4% (54 out of 94) of recycled refrigerators were described as being in good physical condition.
  - See sections titled *Characteristics of Recycled Units: Refrigerators* and *Characteristics of Recycled Units: Freezers* on pages 66 and 70.

- Nearly half of Ohio and Kentucky participants learned about Duke Energy's Appliance Recycling program from inserts with their monthly bills (46.0% or 74 out of 161 respondents), with about one in four mentioning advertising (28.0% or 45 out of 161) and 17.4% (28 out of 161) mentioning referrals from friends, family, neighbors or co-workers.
  - See section titled *Program Awareness and Reasons for Participation* on page 71.

- The most-mentioned main reason for customers getting rid of a refrigerator was that it was a spare unit that was not being used much (38.0% or 35 out of 92 customers), followed by it not working properly (17.4% or 16 out of 92) and wanting to save energy (13.0% or 12 out of 92). For freezers, the most-mentioned main reason for disposal was also that the unit was a spare that was not used much (55.7% or 54 out of 79 customers), and the next most-mentioned main reasons are that the unit was not working properly (11.4% or 9 out of 79) and wanting to save energy (13.8% or 12 out of 87). When asked why they chose to dispose of their old units through the Appliance Recycling program from Duke Energy, the main reason given by customers was the convenience of home pick-up (39.8% or 64 out of 161), followed by the cash incentive (23.6% or 38 out of 161). Customers who recycled one refrigerator are significantly more likely to mention the cash incentive, while customers who recycled a freezer are more likely to mention the convenience of home pick-up; customers who recycled multiple units were significantly more likely to say that they did not know of any other options for disposal (28.6% or 4 out of 14).
  - See sections titled *Customers' Reasons for Recycling Refrigerators*, *Customers' Reasons for Recycling Freezers* and *Customers' Reasons for Recycling Appliances through the Duke Energy Program* on pages 73, 75 and 76.

- Surveyed customers were asked if the incentive and the program information had any influence on their decision to participate in this program; 74.5% (120 out of 161) indicated that the incentive was an influence for them, and 70.2% (113 out of 161) indicated that the program information was an influence.
    - See section titled *Customers' Reasons for Recycling Appliances through the Duke Energy Program* on page 76.

- About two-thirds of surveyed customers (64.6% 104 out of 161) signed up for the program by telephone, and 21.1% (34 out of 161) signed up online. Most of the remaining customers either did not sign up themselves (someone else in the household did), or else cannot recall how they signed up. Among those who signed up by telephone, only 7.7% (8 out of 104) had to place more than one call. Among all surveyed participants, only three (1.9% of 161) said they were not able to schedule a convenient pick-up time, while another three (1.9% of 161) reported that the collection team did not arrive on time, and no one (0% of 161) said that they did not receive a confirmation call prior to pick-up.
    - See section titled *Participation in the Program* on page 79.

- Four-fifths of customers surveyed (81.4% or 131 out of 161) correctly recalled that the incentive for the program is $30 per unit recycled. All but two (1.2% of 161) of the remaining customers guessed an amount within $10 of the correct amount, and 3.7% (6 out of 161) could not recall. Ten surveyed customer (6.2% of 161) donated their incentive to the Helping Hands Assistance program and the remainder (93.8% or 151 out of 161) kept the cash. The median length of time between appliance pick-up and receipt of the incentive payment was three weeks; only four participants (2.5% of 161) waited for 6 weeks or longer, and none (0% of 166) reported that they had not received payment by the time of this survey.
    - See section titled *Incentive Payments* on page 81.

- All but one of the primary refrigerators recycled by surveyed customers (96.2% or 25 out of 26 units) have already been replaced, and the remaining customer plans to replace their recycled unit within the next year (since almost every home has at least one refrigerator, this is expected). Less than a third of recycled freezers (29.6% or 24 out of 81) and secondary refrigerators (30.9% or 21 out of 68) have been replaced. Another eight customers (5.0% of 161) still intend to purchase replacement freezers or secondary refrigerators in the next 12 months (five freezers and three secondary refrigerators). Most replacement units for primary refrigerators (84.0% or 21 out of 25) and freezers (75.0% or 18 out of 24) were purchased new, however only a third (33.3% or 7 out of 21) of replaced secondary refrigerators were replaced with new units. About one in four (28.6% or 6 out of 21) of the replacement secondary refrigerators were moved from somewhere else in the home (often representing the demotion of a main refrigerator to secondary status), as was one (4.2% of 24) of the replacement freezers, though none (0% of 28) of the replacement primary refrigerators were moved from elsewhere in the home.
    - See section titled *Replacing Recycled Units* on page 83.

- Most replacement freezers (62.5% or 15 out of 24) were acquired before the old unit was recycled, as were most primary refrigerators (64.0% or 16 out of 25); however, replacement refrigerators used as secondary units were usually not acquired before recycling the old unit (33.3% or 7 out of 21). By better than a five-to-one margin, replacement freezers were smaller (70.8% or 17 out of 24) rather than larger (12.5% or 3 out of 8) than the recycled units that they replaced. Most main refrigerators were replaced with units of about the same size (60.0% or 15 out of 25), though more of these replacement refrigerators are larger (28.0% or 7 out of 25) rather than smaller (12.0% or 3 out of 25) compared to the recycled units. For secondary refrigerators, approximately equal numbers of replacements are larger (38.1% or 8 out of 21), smaller (28.6% or 6 out of 14) and the same size (33.3% or 7 out of 21). A minority of respondents were able to state the exact cubic footage of their new units; among those who provided the cubic footage, the average sizes of replacement refrigerators are 22.9 cubic feet for main units and 20.9 cubic feet for secondary units, while the average freezer size was reported as 14.2 cubic feet.
    - See sections titled *Replacing Recycled Units* and *Characteristics of Replacement Units* on pages 83 and 86.

- If the Duke Energy Appliance Recycling program had not been available, the most likely outcomes for recycled refrigerators would be giving them away for free (29.3% or 27 out of 92 customers recycling refrigerators). The most likely outcomes for freezers in the absence of the program would be giving them away for free (29.1% or 23 out of 79 customers who recycled freezers), keeping them (20.3% or 16 out of 79) and hiring someone to take the units away for disposal at a dump or recycling center (15.2% or 12 out of 79). In total, only 28.3% (26 out of 92) of refrigerator recyclers and 27.8% (22 out of 79) of freezer recyclers would have disposed of the units in a way that would ensure they are not used again in the future (taken it to a dump, paid someone else to take it to a dump, or left it on the curb for garbage pick-up).
    - See section titled *Intentions in the Absence of the Recycling Program* on page 88.

- More than half of customers would have had their units removed at a later time (or not at all) in the absence of the recycling program (63.0% or 58 out of 92 who recycled refrigerators, 58.2% or 46 out of 79 for those who recycled freezers). Only 13.0% (12 out of 92) of refrigerator recyclers and 3.8% (3 out of 79) of freezer recyclers would have disposed of their units sooner without the Duke Energy Appliance Recycling Program.
    - See section titled *Intentions in the Absence of the Recycling Program* on page 88.

- Most customers who replaced or did not replace their recycled units would have done the same thing in the absence of the program. Among refrigerator recyclers, just 5.4% (5 out of 92) did not replace their unit but say they would have without the program, while 1.1% (1 out of 92) say they did replace their unit but would not have without the program. For freezers, 5.1% (4 out of 79) did not replace but would have without the program, while 3.8% (3 out of 79) did replace but would not have without the program.
    - See section titled *Intentions in the Absence of the Recycling Program* on page 88.

- This program gets very high satisfaction ratings from participants: on a 10-point scale, the average rating for the program overall is 9.75, with the ratings for specific aspects of the program ranging from 9.34 up to 9.91. Overall satisfaction with Duke Energy is somewhat lower (but still high) at 8.81 using the same scale. Overall, 67.1% (108 out of 161) of surveyed customers said that participating in this program made them feel more favorable toward Duke Energy, while none (0% of 161) said it made them feel less favorable.
    - See section titled *Program Satisfaction* on page 93.
- Surveyed participants' favorite aspects of this program are the convenience of home pick-up (mentioned by 26.7% or 43 out of 161), getting rid of old units (24.8% or 40 out of 161), the incentive payment (23.0% or 37 out of 161), and the ease of participation (19.9% or 32 out of 161). Customers who recycled multiple units are more likely to mention getting rid of old units and creating space/reducing clutter, and are less likely to mention the incentive money. Two-thirds of survey participants (66.5% or 107 out of 161) could not name a least favorite aspect of the program; among those who did name least favorite aspects of the program, the most frequently mentioned complaints involve scheduling the appliance pick-up (wanting to schedule a pick-up sooner, not enough scheduling options, having to reschedule, etc.)
    - See section titled *Favorite and Least Favorite Aspects of the Program* on page 101.
- Only 24.2% (39 out of 161) of surveyed program participants report that they have seen a reduction in their electric bills since they recycled their old appliances. There is no statistically significant difference between customers who recycled a refrigerator, a freezer, or multiple units.
    - See section titled *Customers Noticing a Reduction in Their Electric Bill after Removing Appliances* on page 104.
- About a third of customers surveyed (30.4% or 49 out of 161) report having taking additional energy efficiency actions since participating in the Appliance Recycling program, and the average influence rating of the program on these actions is 6.1 on a 10-point scale. The most common action reported is switching to efficient light bulbs (11.8% or 19 out of 161), and a similar 13.0% (12 out of 92) report that they received free CFLs from Duke Energy. Seven customers (4.3% of 161) report having a Home Energy House Call audit since recycling their appliances, and a similar number report having joined Power Manager (also 4.3% or 7 out of 161).
    - See sections titled *Additional Energy Efficiency Actions since the Program* and *Participation in Other Duke Energy Programs* on pages 104 and 106.

Recommendations

- It seems logically sound that cancellation rates will diminish with a greater number of appointment time slots and with shorter time intervals between customer calls and pick up dates. However, that will remain an indirect effect until more customers begin making

appointments. Therefore, Duke Energy and JACO should also take multiple actions to increase program enrollments and direct steps to reduce cancellations wherever possible.

- Raising incentive amounts from $30 to $40 or $50 per unit will likely increase participation and help the program to reach its targeted goals. This should be studied and compared with the effectiveness of increasing marketing spent per unit to make a wider audience aware of the program and its benefits. The Duke Energy and JACO conducted an incentive level effectiveness study in North Carolina and South Carolina with 240,000 Duke Energy customers during September and October 2013 to assess participation levels at higher inventive levels. The study found a 230% increase in customer enrollments when the incentive was raise to a $50 over the current $30. These findings should be considered for their cost effectiveness as means of increasing program participation compared with the costs of increasing marketing spend per unit to make more people aware of the program and its benefits at lower incentive levels.
- Because landlords represent the largest group of appliance purchasers, consider developing an aspect of the program that targets property management companies to encourage their participation either with collections of individual refrigerators that require replacement or via large scale replacements at one time, linked to a replacement incentive for energy efficient units. Such a move could increase the energy savings of the program, while providing landlords with cash offsets to replace inefficient refrigerators, making their rental units more attractive to tenants. Because this would also encourage these market actors to acquire new units (rather than used), it could make the replacement process more convenient by avoiding multiple search, purchase, delivery and installation efforts.
- To better reach its goals the program team may also consider expanding eligibility beyond residential customers to other types of buildings, including schools, offices, and industrial locations.
- Duke Energy may be able to generate leads for the program by adding a question about secondary refrigerators and freezers to future customer surveys, such as the Home Energy House Call survey.
- Consider taking advantage of Duke Energy's internal customer satisfaction and net promoter scores to develop an initiative that encourages program participants to refer their families and friends.
- Arranging joint promotions with municipal and private recycling firms to promote environmentally appropriate recycling may be a way to increase awareness at fairly low cost.

  Duke Energy launched a retailer-utility partnership with Sears in Indianapolis in the late fourth quarter of 2013 collecting 12 units thru December. If demonstrated to be effective in that territory, a similar effort may be worthwhile in Ohio and Kentucky as well. Such a partnership will need to address the potential for reducing Duke Energy's net to gross ratio through the collection of non-working units. In theory, the potential for such an arrangement exists among all new appliance dealers who collect older units, with the greatest opportunity lying in those companies that sell the largest number of units. Retailers who are already participating in the EPA's RAD program, such as Home Depot

and Best Buy may be ready partners for joint promotions and coordinated collections. While midsize companies that collect older units as a service to their customers may also represent possible partners. The program may be a more challenging "sell" at firms, such as Lowes, Menards, HH Gregg and others, which generate revenue from the used units that they collect.

- Duke Energy may also be able to increase the used appliance collections by new appliance dealers with point-of-sale promotion materials to encourage them to mention the program to customers shopping for new units. Freeridership can be minimized by not implementing this practice with firms that are actively participating in the EPA's RAD program.
- As permitted under filing requirements, consider accepting units from and paying incentives to used appliance dealers who are willing to recycle working units via the program instead of reselling them. A method for determining the portion of units that would go into the secondary market would have to be explored prior to implementation.
- The market for used appliances is influenced by a wide number of factors and continues to change with time. Thus it may be helpful to plan a follow up study of the marketplace within a few years in order to understand and appreciate those changes are influencing customer expectations, willingness to participate, and satisfaction with the program.

Introduction and Purpose of Study

Summary Overview

This document presents the process and impact evaluation report for Duke Energy's Residential Appliance Recycling Program as it was administered in Ohio and Kentucky. The evaluation was conducted by TecMarket Works, BuildingMetrics, and Matthew Joyce, subcontractors to TecMarket Works.

Summary of the Evaluation

TecMarket Works performed a process evaluation comprised of management interviews, new and used appliance dealer interviews, and a survey of residential program participants to identify program implementation issues, assess customer responses and satisfaction levels, and examine the effects of the program on the sale of used and new refrigerators and freezers, as well as to look at appliance dealer policies for deliveries and removal.

This impact evaluation utilized in situ metering study to assess the energy consumption of the old-but-operable appliances that remained in use until immediately prior to program participation. It incorporates a direct net energy impact analysis approach that complies with USDOE's Uniform Methods Protocol (UMP). The evaluation approach used in this study is considered a best practice approach because it accounts for in-home use conditions and usage patterns as well as market operations impacts that impact energy use on the local grid. The metering study used to identify energy impacts was supplemented by a participant survey, as presented in Table 3 below.

Table 3. Evaluation Date Ranges

Evaluation Component	Sample Pull: Start Date of Participation	Sample Pull: End Date of EMV Sample	Dates of Data Collection
Management Interviews	N/A	N/A	Interviews conducted from 5/28/13 to 11/20/13
Dealer Interviews	N/A	N/A	Interviews conducted from 7/28/13 to 8/22/13
Participant Surveys	09/26/2012	07/25/2013	Surveys conducted from 8/21/13 through 9/6/13
Participant Surveys	09/26/2012	07/25/2013	Surveys conducted from 8/21/13 through 9/6/13
Appliance Monitoring	05/13/2013	08/19/2013	September through November 2013

Between May and November of 2013, TecMarket Works conducted interviews with managers and staff members at the leading firms involved in the implementation of this program, including Duke Energy, JACO Environmental, and Runyon, Saltzman and Einhorn.

TecMarket Works also spoke with used and new appliance dealers operating within the Duke Energy services territories in Ohio and Kentucky. Their businesses were found via an internet search and were interviewed by phone between July 28 and August 22, 2013.

TecMarket Works conducted a phone survey with a random sample of 161 participants (who combined recycled 81 freezers and 94 refrigerators, including 14 customers who recycled multiple units) from Ohio and Kentucky between August 21 and September 6, 2013.

Metering participants were recruited over the phone, independent of the phone survey, from a list of upcoming scheduled appliance pickups. From a list of 410 customers, there were 33 sites recruited.

Evaluation Objectives

This evaluation of Duke Energy's residential Appliance Recycling Program was conducted in an effort to determine the program's energy savings, operational effectiveness, market effects, and customer satisfaction. This evaluation pertains to the program as it was administered in Ohio and Kentucky.

Program Description

The purpose of Duke Energy's Appliance Recycling Program (ARP) is to target residential customers in order to preempt the continued use of still-cooling refrigerators and freezers. Working primary and secondary units are collected, free of charge, from customer homes and taken to a central location where they are dismantled and recycled in an environmentally appropriate manner. To qualify, units must be between 10-30 cubic feet. To encourage participation, the program offers customers a financial incentive of $30 per unit that is paid by check after dismantling of the unit has been confirmed. Customers are allowed to recycle up to two units per year.

Depending upon their model, age, and condition, older refrigerators and freezers can consume several times as much energy as newer, more efficient units. Thus the primary goal of the program is to remove working refrigerators and freezers from customer homes and keep them off of the secondary market to ensure they do not continue to draw upon the power grid. This reduces base load demand upon the electric system and thereby also helps in lowering peak load requirements. Secondary objectives of the program include educating customers about the energy saving and environmental benefits of recycling older units.

Program Goals and Participation

Program goals were set in conjunction with advice from an external consultancy that helped to determine an annual harvest rate for collecting used refrigerators and freezers. This was calculated based upon the number of active residential accounts, estimates of homeownership, demographics, and other factors within the Ohio and Kentucky service territories. Harvest rate projections ramp up during the first three years of the program as shown in the table below.

Table 4. Appliance Recycling Harvest Rates

		Ohio	Kentucky
Total Residential Electric Service Accounts		447,069	123,928
2012	# of Units	3,380	0
	Harvest Rate	0.8%	0%
2013	# of Units	4,371	1,050
	Harvest Rate	1.0%	0.8%
2014	# of Units	4,875	1,300
	Harvest Rate	1.1%	1.1%

Because the program started in October of 2012, its initial year-end goals were prorated and used for calibration purposes for the first full year of the program. The program began with an initial goal of 563 units to be collected in Ohio and 0 units in Kentucky by the end of 2012. By December 31, 2012 program collections totaled 524 units (93% of goal) in Ohio, and 123 units in Kentucky. The 2013 program goals are 4,371 units in Ohio and 1,050 units in Kentucky. Between January 1 and July 31, 2013 the program had collected 2,084 units in Ohio (48% of goal), and 455 units in Kentucky (43% of goal). When both time periods are combined, the first 10 months of program operations resulted in 53% of combined goal for Ohio and 55% of combined goal for Kentucky. Table 5 summarizes the program's performance to date.