APPENDIX A

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Efficient Products[1]	Specialty LED 2 Watt	Light bulb	23,930	21.9	0.004	523,443	93.3	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 3 Watt	Light bulb	111,615	20.9	0.004	2,335,287	416.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 4 Watt	Light bulb	124,999	34.2	0.006	4,279,449	762.7	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 5 Watt	Light bulb	106,925	33.2	0.006	3,553,144	633.3	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 6 Watt	Light bulb	27,566	41.8	0.007	1,153,487	205.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 7 Watt	Light bulb	37,398	40.9	0.007	1,529,378	272.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 8 Watt	Light bulb	215,185	54.1	0.010	11,648,251	2076.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 9 Watt	Light bulb	13,882	53.2	0.009	738,808	131.7	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 10 Watt	Light bulb	158,425	52.3	0.009	8,286,589	1476.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 11 Watt	Light bulb	14,306	75.1	0.013	1,074,840	191.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 12 Watt	Light bulb	21,040	74.2	0.013	1,561,275	278.3	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 13 Watt	Light bulb	42,901	73.2	0.013	3,141,642	559.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 14 Watt	Light bulb	7,708	72.3	0.013	557,126	99.3	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 15 Watt	Light bulb	791	71.3	0.013	56,420	10.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 16 Watt	Light bulb	7,587	98.9	0.018	750,397	133.7	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 17 Watt	Light bulb	1,442	98.0	0.017	141,254	25.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 18 Watt	Light bulb	1,504	97.0	0.017	145,897	26.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 19 Watt	Light bulb	3,273	96.1	0.017	314,388	56.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 23 Watt	Light bulb	387	92.3	0.016	35,701	6.4	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 4 Watt	Light bulb	48,181	23.8	0.004	1,145,551	204.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 5 Watt	Light bulb	97,252	22.8	0.004	2,219,772	395.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 6 Watt	Light bulb	317,566	35.2	0.006	11,174,658	1991.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 7 Watt	Light bulb	25,496	34.2	0.006	872,917	155.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 8 Watt	Light bulb	632,598	33.3	0.006	21,056,764	3752.8	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 9 Watt	Light bulb	866,221	32.2	0.006	27,884,296	4969.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 10 Watt	Light bulb	211,813	31.2	0.006	6,612,185	1178.4	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 11 Watt	Light bulb	106,600	39.9	0.007	4,257,994	758.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 12 Watt	Light bulb	8,994	39.0	0.007	350,699	62.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 13 Watt	Light bulb	45,056	38.0	0.007	1,714,001	305.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 14 Watt	Light bulb	2,017	55.2	0.010	111,258	19.8	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 15 Watt	Light bulb	51,886	54.2	0.010	2,812,980	501.3	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 16 Watt	Light bulb	51,935	53.3	0.009	2,765,964	493.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 17 Watt	Light bulb	71,006	52.3	0.009	3,714,123	661.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 18 Watt	Light bulb	231	51.4	0.009	11,865	2.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 20 Watt	Light bulb	44	49.7	0.009	2,188	0.4	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 23 Watt	Light bulb	726	120.8	0.022	87,688	15.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Clothes Washer Tier 1/2	Washer	2,615	202.0	0.028	528,230	74.3	Draft Ohio 2010 Technical Reference Manual - Page 59
	Clothes Washer Tier N/A	Washer	7	0.0	0.000	-	0.0	Draft Ohio 2010 Technical Reference Manual - Page 59
	Clothes Washer Tier 3	Washer	1,548	233.0	0.033	360,684	50.7	Draft Ohio 2010 Technical Reference Manual - Page 59
	Dehumidifier N/A	Dehumidifier	5	0.0	0.000	-	0.0	Draft Ohio 2010 Technical Reference Manual - Page 64
	Dehumidifier ≤25 Pints/Day	Dehumidifier	198	54.0	0.012	10,692	2.4	Draft Ohio 2010 Technical Reference Manual - Page 64
	Dehumidifier > 25 to ≤35 Pints/Day	Dehumidifier	178	117.0	0.027	20,826	4.8	Draft Ohio 2010 Technical Reference Manual - Page 64
	Dehumidifier > 35 to ≤45 Pints/Day	Dehumidifier	33	213.0	0.048	7,029	1.6	Draft Ohio 2010 Technical Reference Manual - Page 64
	Dehumidifier > 45 to ≤ 54 Pints/Day	Dehumidifier	665	297.0	0.068	197,505	45.2	Draft Ohio 2010 Technical Reference Manual - Page 64
	Dehumidifier > 54 to ≤ 75 Pints/Day	Dehumidifier	1,197	185.0	0.042	221,445	50.3	Draft Ohio 2010 Technical Reference Manual - Page 64
	Dehumidifier > 75	Dehumidifier	65	374.0	0.085	24,310	5.5	Draft Ohio 2010 Technical Reference Manual - Page 64
	Refrigerator - N/A	Refrigerator	2	0.0	0.000	-	0.0	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator - Freezerless and Single Door	Refrigerator	1	30.0	0.018	30	0.0	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refigerator - Top Freezer	Refrigerator	73	122.0	0.022	8,908	1.6	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refigerator - Bottom Freezer	Refrigerator	434	149.0	0.026	64,666	11.3	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refigerator - Side by Side	Refrigerator	32	177.0	0.031	5,664	1.0	Draft Ohio 2010 Technical Reference Manual - Page 53
	Heat Pump Water Heater - N/A	Heat pump	1	0.0	0.000	-	0.0	Draft Ohio 2010 Technical Reference Manual - Page 86
	Heat Pump Water Heater - Electric Heat	Heat pump	61	499.0	0.068	30,439	4.1	Draft Ohio 2010 Technical Reference Manual - Page 86
	Heat Pump Water Heater - Heat Pump	Heat pump	91	1297.0	0.180	118,027	16.4	Draft Ohio 2010 Technical Reference Manual - Page 86
	Heat Pump Water Heater - Gas Heat	Heat pump	123	2076.0	0.280	255,348	34.4	Draft Ohio 2010 Technical Reference Manual - Page 86

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Efficient Products[1]	Smart Thermostat	Thermostat	4,811	270.7	0.060	1,302,165	290.2	IL - Illinois Technical Reference Manual- - Page 152
	Air Conditioner	Air conditioner	29	242.7	0.207	7,039	6.0	Draft Ohio 2010 Technical Reference Manual - Page 30
	Air Source Heat Pump	Heat pump	282	981.3	0.202	276,721	57.1	Draft Ohio 2010 Technical Reference Manual - Page 33
	Ductless Mini-Split	Heat pump	125	1223.1	0.134	152,891	16.7	Draft Ohio 2010 Technical Reference Manual - Page 33
	Ground Source Heat Pump	Heat pump	29	2816.8	0.492	81,686	14.3	Draft Ohio 2010 Technical Reference Manual - Page 82
	Pool Pump	Pool Pump	194	1170.0	1.730	226,980	335.6	Draft Ohio 2010 Technical Reference Manual - Page 118
	Faucet Aerators	Faucet aerator	2,675	26.2	0.003	70,072	8.7	Draft Ohio 2010 Technical Reference Manual - Page 89
	Low Flow Showerheads	Low flow showerhead	1,956	222.1	0.028	434,349	55.6	Draft Ohio 2010 Technical Reference Manual - Page 93
	LED Night Light	Night light	28,070	17.7	0.000	495,813	0.0	Based on 2017 Navigant Evaluation Result
	7-Plug Smart Strip	Smart strip	350	61.7	0.006	21,595	1.9	Draft Ohio 2010 Technical Reference Manual - Page 76
	Audits and Assessments	Unit	5,157	0.0	0.000	-	0.0	No direct savings
	Hot Water Pipe Insulation	Unit	9,024	30.9	0.004	279,071	31.9	Draft Ohio 2010 Technical Reference Manual - Page 97
	Door Sweep	Sweep	1,794	14.1	0.002	25,267	3.2	Based on 2014 Navigant Evaluation Result
	Outlet Gaskets	Per Gasket	709,306	0.8	0.000	593,369	0.0	Based on 2013 Navigant Evaluation Result
	Weatherstripping	Per Foot	463,777	0.3	0.000	145,337	0.0	Based on IL - Illinois Technical Reference Manual- - Page 290
	TOTAL					**134,587,836**	**24,048**	
Appliance Recycling	Freezer	Freezer	2,985	1,244.4	0.200	3,715,778	597.2	Draft Ohio 2010 Technical Reference Manual - Page 23
	Refrigerator	Refrigerator	15,245	1,376.2	0.220	20,980,783	3,354.1	Draft Ohio 2010 Technical Reference Manual - Page 23
	TOTAL					**24,696,561**	**3,951.3**	
Efficiency Crafted New Homes	Energy Star Single Family Home	Energy Star home	1,812	3,511.9	1.573	6,363,505	2,849.4	Residential Energy Modeling
	Energy Star Multi Family Home	Energy Star home	54	1,692.8	0.567	91,413	30.6	Residential Energy Modeling
	TOTAL					**6,454,918**	**2,880**	
New Manufactured Homes	New Manufactured Homes	Manufactured Home	51	5,965.5	2.64	**304,242**	**134.6**	Residential Energy Modeling
E3Smart	HW Temp Setback	Temp setback	621	81.6	0.009	50,674	5.59	Standard Engineering Calculation
	Bathroom Faucet Aerator	Faucet aerator	2,908	95.8	0.012	278,579	34.76	Draft Ohio 2010 Technical Reference Manual - Page 89
	Kitchen Faucet Aerator	Faucet aerator	2,745	55.4	0.007	151,995	18.96	Draft Ohio 2010 Technical Reference Manual - Page 89
	Low Flow Showerhead	Low flow showerhead	3,468	280.3	0.036	971,942	124.34	Draft Ohio 2010 Technical Reference Manual - Page 93
	11 Watt LED Replacing 13W CFL	Light bulb	782	2.1	0.000	1,644	0.20	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED 23 Replacing 23W CFL	Light bulb	621	12.6	0.002	7,832	0.97	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED Replacing 40W	Light bulb	886	17.6	0.003	15,588	2.78	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED Replacing 60W	Light bulb	4,079	31.3	0.006	127,582	22.74	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED Replacing 75W	Light bulb	2,278	41.1	0.007	93,517	16.67	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED Replacing 100W	Light bulb	1,282	59.6	0.011	76,437	13.62	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 13W CFL	Light bulb	1,782	4.2	0.001	7,492	0.93	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 23W CFL	Light bulb	1,096	14.7	0.002	16,127	2.00	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 40W	Light bulb	3,382	19.5	0.003	66,113	11.78	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 60W	Light bulb	11,093	33.2	0.006	368,649	65.70	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 75W	Light bulb	3,431	43.0	0.008	147,557	26.30	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 100W	Light bulb	1,599	61.6	0.011	98,463	17.55	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	LED Night Light	Light bulb	6,055	20.6	0.000	124,672	0.00	Based on 2013 Navigant Evaluation Result
	Weather Stripping	Square foot	7,340	11.1	0.001	81,474	5.83	Based on 2013 Navigant Evaluation Result
	Allocated Kits[2]	Kit	4,928	65.9	0.009	324,706	44.81	Calculation based on Program Year data
	TOTAL					**3,011,041**	**415.5**	
Intelligent Homes	Mobile Application	Units	63,721	-	0.000	-	-	Proprietary Regression Model
	Energy Bridge	Units	19,623	44.4	0.007	870,848	136.2	Proprietary Regression Model
	Connected Thermostat	Units	4,774	133.8	0.269	638,979	1,285.4	Proprietary Regression Model
	TOTAL					**1,509,827**	**1,421.6**	
Behavioral	Behavioral	Participant	524,337	140.0	0.018	94,703,052	12,311.4	Proprietary Regression Model
	Cross Participation Reduction[3]	Participant	524,337	(0.3)	(0.000)	(153,253)	(19.2)	Calculation based on Program Participation T-Tests
						94,549,798	**12,292.2**	

[1]Energy and Demand savings for the inactive AEP Ohio customers are zeroed out

[2]These are kits that have not had returned surveys, so a reduced installation rate was assigned for these units

[3]Cross Participation savings reduced from the program savings

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Low Income	Freezer replacement 9-15 upright	Freezer	145	26.0	0.005	3,770	0.7	Energy Star Qualified Product List
	Freezer replacement 16-18 upright	Freezer	208	47.0	0.008	9,776	1.7	Energy Star Qualified Product List
	Refrigerator replacement 14-16 TF	Refrigerator	587	100.0	0.018	58,700	10.6	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator replacement 17-19 TF	Refrigerator	1,259	100.0	0.018	125,900	22.7	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator replacement 20-22 TF	Refrigerator	169	100.0	0.018	16,900	3.0	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator replacement 19-22 BF	Refrigerator	59	119.0	0.021	7,021	1.2	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator replacement 20-23 SBS	Refrigerator	332	142.0	0.025	47,144	8.3	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator replacement 24-26 SBS	Refrigerator	237	142.0	0.025	33,654	5.9	Draft Ohio 2010 Technical Reference Manual - Page 53
	Audits and Appliance Metering	Unit	6,238	-	0.000	-	0.0	No direct savings
	Miscellaneous approved items	Unit	7	-	0.000	-	0.0	Health and Safety - No savings acquired
	Air Source Heat Pump	Heat pump	19	847.9	0.137	16,110	2.6	Draft Ohio 2010 Technical Reference Manual - Page 33
	DHW Temp Setback	Temp setback	4	146.0	0.000	584	0.0	Based on 2012 Navigant Evaluation Result
	HVAC Tune Up	Unit	5	68.0	0.036	340	0.2	Draft Ohio 2010 Technical Reference Manual - Page 26
	HW Tank Wrap	Unit	14	79.0	0.009	1,106	0.1	Draft Ohio 2010 Technical Reference Manual - Page 131
	Install bathroom vent fan (Energy Star)	Fan	10	44.3	0.010	443	0.1	NEEP TRM - Page 161
	Faucet Aerator	Faucet aerator	823	24.0	0.003	19,772	2.5	Draft Ohio 2010 Technical Reference Manual - Page 89
	Low flow showerhead	Low flow showerhead	615	142.8	0.017	87,851	10.5	Draft Ohio 2010 Technical Reference Manual - Page 93
	Replace electric water heater	Water heater	26	659.5	0.063	17,146	1.6	http://energy.gov/eere/buildings/residential-buildings-integration
	Smart Strips	Smart strip	3,120	81.8	0.000	255,348	0.0	Draft Ohio 2010 Technical Reference Manual - Page 76
	LED (60 w replacement) indoor	Light bulb	28,657	31.2	0.006	893,207	159.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 12
	LED (100 w replacement) indoor	Light bulb	5,513	51.4	0.009	283,603	50.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 13
	LED (40 w candelabra replacement) indoor	Light bulb	5,825	32.1	0.006	186,835	33.3	Based on Draft Ohio 2010 Technical Reference Manual - Page 14
	LED (40 w globe replacement) indoor	Light bulb	2,466	32.1	0.006	79,204	14.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 15
	LED (60 w replacement) outdoor	Light bulb	515	31.2	0.000	16,088	0.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 16
	LED (75 w floodlight replacement) outdoor	Light bulb	740	57.0	0.000	42,154	0.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 17
	LED (75 w replacement) indoor	Light bulb	4,220	36.7	0.007	154,907	27.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 18
	LED (3-way replacement)indoor	Light bulb	1,745	77.1	0.014	134,598	24.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 19
	Closable Foundation Vents	Unit	21	-	0.000	-	0.0	No direct savings
	Install 12x12 gable vent	Unit	3	-	0.000	-	0.0	No direct savings
	Install 12x18 gable vent	Unit	3	-	0.000	-	0.0	No direct savings
	Install 8` or 9` roof vent	Unit	11	-	0.000	-	0.0	No direct savings
	Duct Sealing per CFM reduction - Electric Heat No AC	CFM reduced	136	3.4	0.000	462	0.0	Draft Ohio 2010 Technical Reference Manual - Page 108
	Shell Air Sealing per CFM reduction - Electric Heat No AC	CFM reduced	1,489	1.8	0.000	2,624	0.2	Draft Ohio 2010 Technical Reference Manual - Page 104
	Shell Air Sealing per CFM reduction - Electric Heat w/AC	CFM reduced	2,431	1.8	0.000	4,332	0.0	Draft Ohio 2010 Technical Reference Manual - Page 104
	Attic Insulation (R-11 -> R-38) - Central Air Conditioning	Square footage installed	7,119	0.0	0.000	147	0.1	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-11 -> R-38) - Electric Heat No AC	Square footage installed	2,881	1.7	0.000	5,016	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-11 -> R-38) - Electric Heat w/AC	Square footage installed	4,074	1.9	0.000	7,705	0.1	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-19 -> R-38) - Central Air Conditioning	Square footage installed	4,062	0.0	0.000	53	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-19 -> R-38) - Heat Pump	Square footage installed	1,934	1.0	0.000	1,932	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-19 -> R-38) - Electric Heat No AC	Square footage installed	728	1.2	0.000	904	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-5 -> R-38) - Central Air Conditioning	Square footage installed	9,669	0.1	0.000	644	0.6	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-5 -> R-38) - Electric Heat No AC	Square footage installed	396	2.0	0.000	779	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R44) - Electric Heat No AC	Square footage installed	2,376	5.2	0.000	12,307	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Install floor insulation (crawlspace) - Electric Heat No AC	Square footage installed	1,833	3.8	0.000	6,997	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Install R-11 foundation wall insulation - Central Air Conditioning	Square footage installed	340	4.0	0.000	1,369	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Install R-11 foundation wall insulation - Electric Heat w/AC	Square footage installed	420	0.0	0.000	4	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Install R-27 blown cellulose-sloped ceiling - Electric Heat No AC	Square footage installed	168	1.9	0.000	313	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Install R-38 blown cellulose-floored attic - Heat Pump	Square footage installed	761	1.8	0.000	1,402	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Install R-38 blown cellulose-floored attic-Electric Heat No AC	Square footage installed	13,030	4.3	0.000	55,900	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Insulate band joist to R-11-Electric Heat w/AC	Square footage installed	170	4.0	0.000	684	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Insulate band joist to R-11-Electric Heat No AC	Square footage installed	132	5.0	0.000	661	0.0	Draft Ohio 2010 Technical Reference Manual - Page 36
	Mobile Home Belly Patch	Unit	7,928	-	0.000	-	0.0	No direct savings
	Mobile Home Roof Coat	Unit	4,170	-	0.000	-	0.0	No direct savings
	Mobile Home Underneath Vapor Retarder	Unit	12,529	-	0.000	-	0.0	No direct savings

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Low Income	R23 Mobile Home blown FG 6` - Heat Pump	Square footage installed	5,220	6.2	0.000	32,376	0.3	Draft Ohio 2010 Technical Reference Manual - Page 126
	R23 Mobile Home blown FG 6` - Electric Heat No AC	Square footage installed	1,108	4.6	0.000	5,078	0.1	Draft Ohio 2010 Technical Reference Manual - Page 126
	R23 Mobile Home blown FG 6` - Electric Heat w/AC	Square footage installed	4,578	4.6	0.000	20,912	0.3	Draft Ohio 2010 Technical Reference Manual - Page 126
	R38 Mobile Home blown FG 12` - Electric Heat No AC	Square footage installed	1,127	4.6	0.000	5,147	0.0	Draft Ohio 2010 Technical Reference Manual - Page 126
	Wall insulation- Framed siding(target R11) - Central Air Conditioning	Square footage installed	8,203	0.0	0.000	378	0.3	Draft Ohio 2010 Technical Reference Manual - Page 100
	Wall insulation- Framed siding(target R11) - Electric Heat No AC	Square footage installed	1,440	4.0	0.000	5,711	0.0	Draft Ohio 2010 Technical Reference Manual - Page 100
	Wall insulation- Brick Veneer(target R11) - Central Air Conditioning	Square footage installed	544	0.1	0.000	33	0.0	Draft Ohio 2010 Technical Reference Manual - Page 100
	Water Pipe Insulation	Square footage installed	345	15.9	0.002	5,493	0.6	Draft Ohio 2010 Technical Reference Manual - Page 97
	TOTAL					**2,671,520**	**383.2**	
Process Efficiency	The heat exchanger is desinged to take advantage of free cooling which serves to reduce the chiller load. It was found to be operational between 45F & 55F. Above 55F would stage the chiller online. This is primarily due to the building having a glass facade.	Custom measure	1	18,597.0	22.707	18,597.0	22.7	
	800HP DC Drive that they are wanting to retrofit to AC. In addition, they are debating on going to a soft start setup or a variable frequency drive The equipment runs 24/7 930 amps when its loaded 250 amps when its idle - turning with no equipment 5 - 600 amps on average loaded/idle	Custom measure	1	152,022.0	17.370	152,022.0	17.4	
	The Customer is looking to improve its refrigeration energy efficiency by using Root3 Tech's expertise and control system to better control and monitor the brewing process. Based on performance seen by implementing this equipment and controls in another plant, Root3 Tech has proven a 6% refrigeration savings at similiar the Customer plants. These controls allow for more accurate monitoring and forecasting which allows for increased energy and process efficiency. The new system can learn the process and will fine tune it to ensure optimum efficiency.	Custom measure	1	2,602,717.0	317.100	2,602,717.0	317.1	All Custom Measures are individually calculated using methodology consistent with the Draft Ohio 2010 Technical Reference Manual.
	Autoclave #1 - ceramic fiber insulation on large pressure vessel - interior and exterior that did not have insulation prior. The cleve unit is electric heat with 480 Volts. Majority of work has/will be completed in the next few weeks. A unit with little to no insulation will be the best for gathering baseline data. Autoclave #2 has insulation only on the exterior. The true savings comes from the interior insulation. Therefore, metering Autoclave #2 could be utilized as basesline.	Custom measure	1	668,509.0	88.430	668,509.0	88.4	
	Customer was running two 30HP fixed speed compressors. An Air Study was done and found there wree times when both compressors were running at the same time. Customer upgraded to two 40HP VSD Compressors. One 40HP compressor will run the entire plant and one will serve as a back up compressor.	Custom measure	1	41,116.0	-	41,116.0	-	
	Exisitng Insulation and Open Hoods on the Dry-Off Oven and Cure Oven to add New/Improved Insulation and Heat Capture Hoods for the Dry-Off Oven and Cure Oven-->Reducing the Heat Gain to Space----->> Reducing the Cooling Load	Custom measure	1	214,088.2	31.190	214,088.2	31.2	
	Existing Comperessed Air system	Custom measure	1	107,712.5	16.370	107,712.5	16.4	
	Exterior LPD	Custom measure	1	82,449.4	-	82,449.4	-	
	The Customer has completed multiple projects since the 2015-2016 fiscal year. Recent projects mainly incorporating efforts to be more energy efficient with their cooling load and process have resulted in overlapping savings which can be difficult to separate from one another. Through conversation with AEP and DNVGL, it was decided to look at an overall productivity rebate as a better way to prevent overlap in rebate payments and energy savings. The calculation below shows the productivity improvement from 17.7 kWh/lb to 11.8 kWh/lb, with subtracted savings from measures payed out since 2015-16 fiscal year. Projects not paid out resulting in these savings include: Ammonia Compressor Automation, Hydraulic to Electric Motors, Suction Trap Redesign with Freezer, Odenberg Split Suction Improvement, Sauce room Ammonia AHU's, and Waste Water VFD's.	Custom measure	1	1,941,734.0	221.659	1,941,734.0	221.7	
	Going from LED to LED (Efficacy Improvement and wattage reduction)	Custom measure	1	5,240.1	0.840	5,240.1	0.8	All Custom Measures are individually calculated using methodology consistent with the Draft Ohio 2010 Technical Reference Manual.
	Install EMS	Custom measure	2	99,948.0	0.980	199,896.0	2.0	
	Install Energy Star fryers	Custom measure	1	7,986.5	0.540	7,986.5	0.5	
	Install new EMS	Custom measure	4	98,324.5	7.250	393,298.0	29.0	
	Installation of 96 battery rectifiers. There are 6 cabinets, with each cabinet containing 16 battery rectifiers. The battery rectifiers to be replaced are of older technology and use bridge-diode rectification. The new battery rectifiers have the newest technology in IGBT rectification.	Custom measure	1	710,574.0	3.980	710,574.0	4.0	
	Installing a Master Controller, SAM 4.0, to improve compressor system performance	Custom measure	1	377,696.3	47.420	377,696.3	47.4	
	LED Case Lighting Upgrade	Custom measure	1	3,001.8	0.480	3,001.8	0.5	
	LED Refgrigerated Case Lighting (LED to LED) Older generation to new generation with higher efficacy	Custom measure	1	2,475.6	0.400	2,475.6	0.4	

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Process Efficiency	LED Refrigerated case lighting (older LED to newer more efficient LEDs)	Custom measure	1	29,926.5	4.820	29,926.5	4.8	All Custom Measures are individually calculated using methodology consistent with the Draft Ohio 2010 Technical Reference Manual.
	LED Refrigerated case upgrade. LED to LED, (lumens per watt improvement)	Custom measure	1	24,339.1	3.922	24,339.1	3.9	
	Looking to improve efficiency with a new VSD compressor and move one old 350hp unit to back up roll(primarily use new VSD). The solution provider performed an air study and revealed an annual savings of 1,098,282 kWh with this measure. Currently running one 350 hp unit, or the 150 hp and 200hp units to cover and both combinations are inefficient.	Custom measure	1	971,800.0	61.460	971,800.0	61.5	
	Old HVAC Fans being replaced by Q-PAC Fan Arrays	Custom measure	1	57,887.4	4.633	57,887.4	4.6	
	Old HVAC Fans being replaced with ECM Motors	Custom measure	3	41,043.0	15.036	123,128.9	45.1	
	The Customer has been implementing multiple waves of projects to relieve bottlenecks in their	Custom measure	1	10,759,355.0	-	10,759,355.0	-	
	The Customer has been implementing multiple waves of projects to relieve bottlenecks in their	Custom measure	1	5,893,190.0	-	5,893,190.0	-	
	Purchase a new state of the art STS Mc twin screw extruder. This is the next generation of	Custom measure	1	92,820.0	-	92,820.0	-	
	Replace (1) 300HP DC motor with (1) 300HP AC VFD motor.	Custom measure	1	165,034.0	6.000	165,034.0	6.0	
	Replace 27 of 400W MH with 100W LED in a Horse Arena	Custom measure	1	20,105.3	6.444	20,105.3	6.4	
	Replace 60HP air compressor with 1.5 HP air compressor during weekends and off hours	Custom measure	1	56,181.1	-	56,181.1	-	
	Replace Outdated Trane – Tracer Summit EMS with new EMS	Custom measure	1	238,199.1	96.810	238,199.1	96.8	
	Replace existing MicroBlend with a newer model (MicroBlend 2) Old MicroBlend requires 210	Custom measure	1	465,936.0	65.390	465,936.0	65.4	
	Replace old 1987 Milacron Hydraulic Injection Machine with new 2018 FCS Servo Power	Custom measure	1	167,734.0	17.376	167,734.0	17.4	
	Replace outdated EMS with new EMS	Custom measure	1	651,992.0	-	651,992.0	-	
	Replace outdated Trane – Tracer Summit EMS with new EMS	Custom measure	2	230,768.5	69.150	461,537.0	138.3	
	Replace two 10-hp load/unload control compressors w/ one 30-hp VFD compressor	Custom measure	1	6,684.0	4.800	6,684.0	4.8	
	Replace two of 25-hp load/unload compressors w/ one 25-hp VFD compressor.	Custom measure	1	8,451.0	9.150	8,451.0	9.2	
	Replacing an existing Husky Injection molding machine GL500 RS -19 years old and is in need of replacement. Replacing with a Husky H4L 400 RS95/95L Injection Molding Machine.	Custom measure	1	335,360.0	30.153	335,360.0	30.2	
	Replacing existing Compressor Units with 2 new Compressors, A 50 HP VFD compressor and a	Custom measure	1	239,810.0	29.970	239,810.0	30.0	
	The Customer is looking to save energy by upgrading their existing compressor system to better	Custom measure	1	148,016.0	-	148,016.0	-	
	Sullair 2 compressor system	Custom measure	1	189,429.0	20.510	189,429.0	20.5	
	The chilled water system in the C building at NCH consists of (3) 409 ton centrifugal water cooled	Custom measure	1	223,184.0	-	223,184.0	-	
	The current Operating Rooms airflow control strategy is characterized as a constant volume system and maintains approx. 22 ACH (1140 to 2250 CFM depending on size of OR). The air handling units serving this system is 20% minimum outside air, having considerable latent heat during the cooling season. The current operation has no reduction in airflow. To allow the unit to go to an unoccupied mode, dampers and actuators will be added to the return ducts, this will allow for reduced airflow (approx. 750 CFM) and still be able to maintain the positive pressure of the OR to the corridor with the reduced supply CFM. There will be a motion sensor installed in the space to detect occupancy and return the system to the occupied CFM and pressure relations ship. There will also be a room pressure monitoring system that will be used to maintain positive pressure in the room during both occupied and unoccupied modes. This will allow for maintaining compliance, trending the compliance and alarming when the system in not in compliance. There are 5 OR's each with their own VAV boxes are on RTU#4 (Roof Top Unit). This unit is already equipped with a VFD that maintains a duct static pressure. With the reduced airflow, the VFD will be able to slow down the fan speed and save additional energy during the unoccupied mode. The upgrade will result in considerable energy savings, better environmental control, and improved facility maintenance.	Custom measure	1	127,113.0	12.600	127,113.0	12.6	
	This project will upgrade and exisiting bridge rectifier charging system to IGBT charging.	Custom measure	1	710,574.0	3.980	710,574.0	4.0	

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Process Efficiency	The Customer is making a number of improvements to the plant that will allow them to increase production and lower energy intensity. A new refrigeration system needs to be added to allow for new process changes. A new syrup heater that will allow them to extract more syrup so that they can dry less DDGS. This will impact on the fans used in the drying portion of the plant and allow for them to run more efficiently (Main dryer and RTO included). The Customeris also adding a new control system that has better controls, accuracy and features which will allow for these process improvements and an overall better energy intensity for the plant. This will result in less down time and more efficient conversion of Ethanol. The last item involves installing drives on 5 motors. The overall impact to the plant should increase production by more than 12% with minimum impact to electric usage. New Refrigeration: Existing: No Cooler. New: Carroll Coolers custom built refrigeration. Units provided by Heatcraft Refrigeration model #: PTT133H6CE. New Syrup Heater: Existing: Live steam injection into a tank. New: Kinergetics Custom Built Syrup Heater - (2) pumps – (1) booster pump 6.5HP, 75gpm, 60psig – (1) condensate pump 1 HP, 2.4gpm, 35psig New VFD's: Altivar ATV660 VFD's on 5 motors (200HP, 150HP, 125HP and (2) 100HP) New Controls:Direct Automation - Siemens PCS7 to version 8.1 Productivity Executive Summary List: -New refrigeration system for new processes - New efficient syrup heater with downstream fan savings -New controls to increase conversion of ethanol with less downtime, and VFD's on large existing motors. Hours of Operation: o 8,760 hrs/yr	Custom measure	1	5,791,410.0	469.240	5,791,410.0	469.2	All Custom Measures are individually calculated using methodology consistent with the Draft Ohio 2010 Technical Reference Manual.
	Two of 100-hp constant speed compressors were replaced with one 150-hp VFD compressor and one 100-hp constant speed compressor. One pre-retrofit 100-hp compressor was left as back-up	Custom measure	1	185,565.0	-	185,565.0	-	
	Upgraded refrigerator and freezer door lighting from older generation LED to lower-wattage,	Custom measure	1	20,603.8	3.320	20,603.8	3.3	
	We are proposing to install a new low pressure compressed air system (48-52 psi discharge), to	Custom measure	1	1,942,050.0	219.910	1,942,050.0	219.9	
	Retro-Commissioning of HVAC System to include control sequence adjustments: 1) System	Custom measure	1	203,862.0	-	203,862.0	-	
	Retro-Commissioning of HVAC System to include control sequence adjustments: 1) System	Custom measure	1	58,941.0	-	58,941.0	-	
	Retro-Commissioning of building systems expected to include the following controls based	Custom measure	1	1,295,292.0	147.860	1,295,292.0	147.9	
	No Loss Condensate Drain	Drain	7	1,913.6	0.265	13,395.2	1.9	Vendor Internal TRM - Compressed Air
	Ice Maker 401-1000 lbs/day	Icemaker	1	847.0	0.159	847.0	0.2	Vendor Internal TRM - Food Service
	Interior Occupancy Sensor	Watt controlled	2,700	0.2	0.000	518.4	0.2	Vendor Internal TRM - Lighting
	Advanced Lighting Controls: Low Lumen High Density	Square foot	179,288	2.2	0.000	395,247.7	67.2	Individually modeled by Implementer
	ENERGY STAR Solid Door Freezer	Unit	3	519.2	0.059	1,557.6	0.2	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Refrigerator	Unit	4	197.7	0.023	790.8	0.1	Vendor Internal TRM - Refrigeration
	LED Refrigeration Case Lighting - With Doors	Unit	73	413.3	0.067	29,964.3	4.8	Vendor Internal TRM - Refrigeration
	TOTAL					**39,636,945**	**2,276**	

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
New Construction	Six months of data was gathered to quantify annual savings for greenhouse (process) lighting.	Custom measure	1	7,568.2	0.000	7,568.2	0.0	All Custom Measures are individually calculated using methodology consistent with the Draft Ohio 2010 Technical Reference Manual.
	Anti-sweat heater controls	Custom measure	1	12,046.8	0.155	12,046.8	0.2	
	CO2 high efficiency refrigeration rack	Custom measure	3	23,311.0	2.661	69,933.0	8.0	
	Custom Compressed Air VFD	Custom measure	1	181,203.0	20.700	181,203.0	20.7	
	Efficient refrigerated cases over federal baseline	Custom measure	11	19,491.4	2.225	214,405.3	24.5	
	NEMA Premium Motors and VFDs in lieu of standard motors with throttle valves. Incentive tiered.	Custom measure	1	5,601,230.7	891.632	5,601,230.7	891.6	
	Night covers for display cases	Custom measure	1	2,277.6	0.000	2,277.6	0.0	
	No LPD values available for street lighting so a custom calculation was completed.	Custom measure	1	25,729.2	0.000	25,729.2	0.0	
	New display case lighting.	Custom measure	1	32,245.1	3.681	32,245.1	3.7	
	Servo driven press	Custom measure	1	245,144.3	34.777	245,144.3	34.8	
	25% LPD reduction	Square foot	18,792	0.6	0.000	11,161.3	2.7	Implementer Prescriptive Model
	35% LPD reduction	Square foot	27,206	0.9	0.000	24,695.2	5.5	Implementer Prescriptive Model
	45% LPD reduction	Square foot	2,279	1.5	0.000	3,399.1	0.7	Implementer Prescriptive Model
	55% LPD reduction	Square foot	5,750	2.4	0.001	13,976.5	3.3	Implementer Prescriptive Model
	Above code Roof & Wall Insulation with Air Barrier	Square foot	22,397	0.5	0.000	10,235.4	1.8	Implementer Prescriptive Model
	CEE Tier 1 cooling efficiencies	Square foot	4,424	1.0	0.000	4,320.9	1.2	Implementer Prescriptive Model
	CEE Tier 2 efficiency, DCV, variable speed supply fans, and fan static pressure reduction	Square foot	4,079	1.3	0.000	5,102.8	1.4	Implementer Prescriptive Model
	Code-compliant VAV system with electric reheat with fan static pressure reduction, economizers	Square foot	74,861	1.1	0.000	83,844.3	12.7	Implementer Prescriptive Model
	Common Area - 50% LPD Reduction	Square foot	43,816	1.0	0.000	44,057.0	7.4	Implementer Prescriptive Model
	Common Area incentives and elective points	Square foot	43,816	0.0	0.000	0.0	0.0	Implementer Prescriptive Model
	Ductless heat pumps with CEE Tier 2 efficiencies	Square foot	5,750	7.3	0.001	42,083.7	3.6	Implementer Prescriptive Model
	ENERGY STAR - Residential refrigerator and dishwasher	Square foot	1	11,820.1	0.000	11,820.1	0.0	Implementer Prescriptive Model
	High-performance windows	Square foot	14,385	0.1	0.000	1,511.7	0.4	Implementer Prescriptive Model
	Improved wall insulation with Insulated concrete forms	Square foot	1	44,235.6	0.407	44,235.6	0.4	Implementer Prescriptive Model
	Interior New Construction - Lighting Power Density	Square foot	7,548	8.8	0.001	66,116.1	7.5	Implementer Prescriptive Model
	Living Area - 30% LPD Reduction	Square foot	302,258	0.2	0.000	69,126.4	0.0	Implementer Prescriptive Model
	Living Area incentives and elective points	Square foot	302,258	0.0	0.000	0.0	0.0	Implementer Prescriptive Model
	Packaged single-zone gaspack CEE Tier 1 cooling efficiencies	Square foot	31,139	1.0	0.000	32,035.8	8.7	Implementer Prescriptive Model
	Showerhead (MF) - electric DHW - 1.75 gpm	Unit	4	65,869.6	0.000	263,478.3	0.0	Implementer Prescriptive Model
	Whole building - >30% (Owner)	Project	7	363,941.6	61.600	2,547,591.0	431.2	Individually modeled by Implementer
	Whole building - e10 and <20% (Owner)	Project	5	235,114.2	91.828	1,175,571.0	459.1	Individually modeled by Implementer
	Whole building - e20 and <30% (Owner)	Project	3	1,394,584.0	130.433	4,183,752.0	391.3	Individually modeled by Implementer
	Cycling Air Dryer	Unit	1	1,446.5	0.344	1,446.5	0.3	Vendor Internal TRM - Compressed Air
	Floating Head Pressure Control	Unit	1	50,490.0	0.000	50,490.0	0.0	Vendor Internal TRM - Compressed Air
	Air Cooled Chiller	Unit	1	14,144.6	(5.363)	14,144.6	(5.4)	Vendor Internal TRM - Cooling
	Air-Side Economizer on RTU AHU DX or UV	Unit	11	195.2	0.000	2,147.0	0.0	Vendor Internal TRM - Cooling
	Cental Air Conditioner - < 5.4 tons	Unit	84	884.4	0.191	74,289.8	16.1	Vendor Internal TRM - Cooling
	Cental Air Conditioner - > 63.3 tons	Unit	11	91,763.3	4.092	1,009,396.2	45.0	Vendor Internal TRM - Cooling
	Cental Air Conditioner - 11.25 -19.9 tons	Unit	34	2,852.6	0.785	96,988.6	26.7	Vendor Internal TRM - Cooling
	Cental Air Conditioner - 20 -63.2 tons	Unit	15	6,341.3	1.687	95,119.4	25.3	Vendor Internal TRM - Cooling
	Cental Air Conditioner - 5.4 -11.24 tons	Unit	24	1,443.6	0.396	34,645.7	9.5	Vendor Internal TRM - Cooling
	Chillers: Water-Cooled, Centrifugal	Unit	3	22,323.6	4.159	66,970.8	12.5	Vendor Internal TRM - Cooling
	Demand Control Ventilation for Office	Square foot	43,977	0.9	0.000	37,823.4	4.0	Vendor Internal TRM - Cooling
	ECMs for HVAC - Heating Only	Unit	2	966.9	0.234	1,933.8	0.5	Vendor Internal TRM - Cooling
	EnergyStar Exhuast Fan (1.4 CFM/watt)	Unit	4	4,783.2	0.756	19,132.9	3.0	Vendor Internal TRM - Cooling
	Fan static pressure reduction	SCFM	31,139	0.1	0.000	2,288.7	0.6	Vendor Internal TRM - Cooling
	GSHP & WSHP	Unit	6	1,650.7	0.264	9,904.1	1.6	Vendor Internal TRM - Cooling
	PTAC/PTHP	Unit	49	211.6	0.118	10,366.4	5.8	Vendor Internal TRM - Cooling

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
New Construction	Room Air Conditioners	Unit	1	313.6	0.152	313.6	0.2	Vendor Internal TRM - Cooling
	Smart Thermostat	Unit	1	17,804.2	0.000	17,804.2	0.0	Vendor Internal TRM - Cooling
	Toilet Room Exhaust Occupancy Sensor	Unit	12	41.4	0.003	496.9	0.0	Vendor Internal TRM - Cooling
	VFD for HVAC	Unit	21	10,050.3	0.858	211,056.8	18.0	Vendor Internal TRM - Cooling
	VRF Air Conditioners	Unit	6	1,099.0	0.148	6,594.1	0.9	Vendor Internal TRM - Cooling
	Efficient Standard Vat Fryer	Unit	7	952.0	0.000	6,664.0	0.0	Vendor Internal TRM - Food Service
	Hot Holding Cabinet	Unit	4	1,730.0	0.290	6,920.0	1.2	Vendor Internal TRM - Food Service
	Ice Maker >1001 lbs/day	Unit	2	1,442.0	0.190	2,884.0	0.4	Vendor Internal TRM - Food Service
	Ice Maker 101-400 lbs/day	Unit	6	434.0	0.040	2,604.0	0.2	Vendor Internal TRM - Food Service
	Ice Maker 401-1000 lbs/day	Unit	6	1,153.0	0.140	6,918.0	0.8	Vendor Internal TRM - Food Service
	Building utilizes high end trim by dimming to 75% during open hours	Unit	1	96,873.3	15.145	96,873.3	15.1	Vendor Internal TRM - Lighting
	Exterior New Construction - Lighting Power Density	Square foot	736,537	4.1	0.000	3,043,957.8	0.0	Vendor Internal TRM - Lighting
	Interior Daylighting Controls	Watt controlled	140	446.4	0.094	62,496.3	13.1	Vendor Internal TRM - Lighting
	Interior New Construction - Lighting Power Density	Square foot	2,627,376	5.1	0.001	13,513,506.2	2,212.6	Vendor Internal TRM - Lighting
	Interior Occupancy Sensor	Watt controlled	200,268	0.8	0.000	158,149.6	34.9	Vendor Internal TRM - Lighting
	Occupancy and daylight sensors, 35% LPD reduction	Watt controlled	66,226	0.5	0.000	35,225.6	6.0	Vendor Internal TRM - Lighting
	45 kVA Three Phase Dry Type Low Voltage Transforme	Unit	4	1,039.8	0.255	4,159.1	1.0	Vendor Internal TRM - Miscellaneous
	High Frequency Battery Charger	Unit	40	3,449.1	0.973	137,965.6	38.9	Vendor Internal TRM - Miscellaneous
	NEMA Premium Efficiency Motor	Unit	8	320.8	0.082	2,566.2	0.7	Vendor Internal TRM - Motors and Drives
	VFD for HVAC	Unit	15	89,744.2	9.204	1,346,163.5	138.1	Vendor Internal TRM - Motors and Drives
	ENERGY STAR Solid Door Freezer	Unit	3	826.7	0.091	2,480.0	0.3	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Refrigerator	Unit	78	535.7	0.056	41,782.0	4.4	Vendor Internal TRM - Refrigeration
	LED lighting for refrigerated cases	Unit	1	27,768.2	3.170	27,768.2	3.2	Vendor Internal TRM - Refrigeration
	TOTAL					**35,292,334**	**4,958.2**	
Efficient Products for Business	Efficient Grain Dryer Capacity >1000 and <2000 Bushels per hour	Unit	1	16,000.0	0.000	16,000.0	0.0	Vendor Internal TRM - Agriculture
	Efficient Grain Dryer Capacity >500 and <1000 Bushels per hour	Unit	1	9,000.0	0.000	9,000.0	0.0	Vendor Internal TRM - Agriculture
	Fan Thermostat Controller	HP	29	1,586.0	0.000	46,517.4	0.0	Vendor Internal TRM - Agriculture
	High Speed Fans 24" to 35"	Fan	1	372.0	0.120	372.0	0.1	Vendor Internal TRM - Agriculture
	High Speed Fans 48" to 71"	Fan	29	1,122.0	0.360	32,538.0	10.4	Vendor Internal TRM - Agriculture
	Scroll Compressors for Dairy Refrigeration	Unit	19,140	0.2	0.000	3,695.2	1.3	Vendor Internal TRM - Agriculture
	VSD on Dairy Transfer Pump	100 gallons milk/day	35	142.4	0.013	4,955.5	0.5	Vendor Internal TRM - Agriculture
	VSD on Dairy Vacuum Pump	Horsepower	10	2,409.7	0.440	24,482.7	4.5	Vendor Internal TRM - Agriculture
	Water Pre-Heat Heat Exchanger (Water Heating Savings)	Pounds of milk per day	19,140	2.0	0.001	38,050.3	11.7	Vendor Internal TRM - Agriculture
	Compressed Air Leak Repair 24hr Operation	CFM	510	1,400.0	0.173	714,000.0	88.2	Vendor Internal TRM - Compressed Air
	Cycling Air Dryer	SCFM	1,850	12.8	0.002	23,698.5	3.3	Vendor Internal TRM - Compressed Air
	Low Pressure Drop Filter	SCFM	500	25.0	0.003	12,480.0	1.7	Vendor Internal TRM - Compressed Air
	New VFD Compressor	Horsepower	1,185	1,732.3	0.240	2,052,775.5	284.6	Vendor Internal TRM - Compressed Air
	No Loss Condensate Drain	Drain	1	1,913.6	0.270	1,913.6	0.3	Vendor Internal TRM - Compressed Air
	Air Cooled Chiller <150 Tons	Unit	8	16,854.8	8.106	134,838.4	64.9	Vendor Internal TRM - Cooling
	Air Cooled Chiller >= 150 Tons	Unit	7	42,506.4	23.926	297,544.7	167.5	Vendor Internal TRM - Cooling
	Air Source Heat Pump - >= 63.3 tons	Unit	1	19,429.3	16.620	19,429.3	16.6	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 11.25 - 19.9 tons	Unit	81	2,677.5	1.546	216,875.0	125.2	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 20 - 63.2 tons	Unit	37	5,592.9	3.816	206,937.6	141.2	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 5.4 - 11.24 tons	Unit	65	1,097.0	0.661	71,303.5	42.9	Vendor Internal TRM - Cooling
	Air Source Heat Pump < 5.4 tons	Unit	95	511.0	0.294	48,544.4	27.9	Vendor Internal TRM - Cooling
	Centralized Energy Management System Controls (Elec Heat)	Square foot of conditioned	529,719	1.6	0.000	845,634.4	0.0	Vendor Internal TRM - Cooling
	Centralized Energy Management System Controls (Non Elec Heat)	Square foot of conditioned	1,110,208	1.9	0.000	2,097,555.7	0.0	Vendor Internal TRM - Cooling
	Chillers: Water-Cooled, Positive Displacement - >= 300 Tons	Unit	2	45,171.9	29.020	90,343.9	58.0	Vendor Internal TRM - Cooling
	Chillers: Water-Cooled, Positive Displacement - 150 to 299 Tons	Unit	2	21,194.3	14.795	42,388.7	29.6	Vendor Internal TRM - Cooling
	Demand Control Ventilation for Office	Square foot	56,517	0.5	0.000	28,916.9	0.0	Vendor Internal TRM - Cooling
	Occupancy Sensor Control for HVAC Systems	Unit	146	455.9	0.055	66,562.7	8.0	Vendor Internal TRM - Cooling
	PTAC	Unit	12	145.4	0.000	1,744.4	0.0	Vendor Internal TRM - Cooling
	PTHP	Unit	8	141.6	0.000	1,133.1	0.0	Vendor Internal TRM - Cooling
	Room AC Two Tons or Less	Unit	31	50.7	0.029	1,571.8	0.9	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow AC - >= 20 Tons	Unit	2	5,630.4	8.855	11,260.8	17.7	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow Heat Pumps < 5.4 tons	Unit	1	5,892.2	0.160	5,892.2	0.2	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow Heat Pumps - 5.4 - 11.24 tons	Unit	1	13,540.7	1.230	13,540.7	1.2	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow Heat Pumps 11.25-19.9 tons	Unit	7	29,771.4	3.676	208,400.1	25.7	Vendor Internal TRM - Cooling
	Water cooled, electrically operated, centrifugal chiller - < 300 Tons	Unit	4	46,505.1	25.223	186,020.5	100.9	Vendor Internal TRM - Cooling
	Water cooled, electrically operated, centrifugal chiller - >= 600 Tons	Unit	4	134,928.7	73.545	539,714.9	294.2	Vendor Internal TRM - Cooling

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Efficient Products for Business	Water cooled, electrically operated, centrifugal chiller - 300 to 599 Tons	Unit	3	59,263.4	26.060	177,790.3	78.2	Vendor Internal TRM - Cooling
	Beverage Machine Controls	Unit	1	1,613.0	0.000	1,613.0	0.0	Vendor Internal TRM - Food Service
	Hot Holding Cabinet	Unit	3	3,369.4	0.310	10,108.1	0.9	Vendor Internal TRM - Food Service
	Ice Maker 101-400 lbs/day	Icemaker	3	581.0	0.110	1,743.0	0.3	Vendor Internal TRM - Food Service
	Ice Maker 401-1000 lbs/day	Icemaker	1	847.0	0.160	847.0	0.2	Vendor Internal TRM - Food Service
	Steam Cookers	Unit	1	25,545.0	3.530	25,545.0	3.5	Vendor Internal TRM - Food Service
	Advanced Lighting Controls: High Lumen Low Density	Square foot	302,141	2.8	0.001	832,339.5	177.5	Individually modeled by Implementer
	Advanced Lighting Controls: Low Lumen High Density	Square foot	440,953	3.1	0.001	1,367,755.8	423.5	Individually modeled by Implementer
	Directional (Reflector, MR, PAR) Screw-in/Pin Based LED	Unit	5,372	179.7	0.040	965,161.9	216.9	Vendor Internal TRM - Lighting
	Downlights LED	Unit	4,721	224.3	0.050	1,058,784.4	236.2	Vendor Internal TRM - Lighting
	ENERGY STAR Screw-in LED - Exterior	Unit	2,233	145.8	0.015	325,469.7	34.4	Vendor Internal TRM - Lighting
	ENERGY STAR Screw-in LED - Interior	Unit	21,215	143.4	0.027	3,043,091.9	563.3	Vendor Internal TRM - Lighting
	ENERGY STAR Screw-in LED - Suite	Unit	29,742	31.8	0.005	946,424.1	138.7	Vendor Internal TRM - Lighting
	Exterior Bi-Level Lighting Controls	Watts controlled	1,464	0.6	0.000	913.8	0.0	Vendor Internal TRM - Lighting
	Exterior Daylighting Controls	Watt controlled	85,319	0.3	0.000	28,001.5	0.0	Vendor Internal TRM - Lighting
	Exterior DLC/ES LED	Unit	12,569	1,342.5	0.000	16,873,689.0	0.0	Vendor Internal TRM - Lighting
	Interior Exit Sign	Sign	1,095	89.7	0.012	98,231.1	13.4	Vendor Internal TRM - Lighting
	Exterior New T8/T5 Fixture	Unit	16	291.3	0.000	4,660.3	0.0	Vendor Internal TRM - Lighting
	Exterior Other LED	Unit	1,473	697.1	0.000	1,026,762.8	0.0	Vendor Internal TRM - Lighting
	Exterior Screw-in LED	Unit	935	137.4	0.018	128,510.3	17.1	Vendor Internal TRM - Lighting
	Exterior Time Clocks for Lighting	Watt controlled	109,409	0.4	0.000	40,542.2	0.0	Vendor Internal TRM - Lighting
	Flat Panel LEDs	Unit	3,507	140.5	0.032	492,621.4	110.6	Vendor Internal TRM - Lighting
	Garage Bi-Level Lighting Controls	Watts controlled	7,663	1.3	0.150	10,069.2	1,149.5	Vendor Internal TRM - Lighting
	Garage DLC/ES LED	Unit	666	1,105.6	0.126	736,333.2	84.1	Vendor Internal TRM - Lighting
	Garage Other LED	Unit	15	513.3	0.059	7,700.0	0.9	Vendor Internal TRM - Lighting
	Garage Screw-in LED	Unit	1	47.2	0.000	47.2	0.0	Vendor Internal TRM - Lighting
	Interior Daylighting Controls	Watt controlled	347,819	1.3	0.001	442,630.4	245.2	Vendor Internal TRM - Lighting
	Interior DLC/ES LED	Unit	202,580	291.4	0.065	59,036,782.8	13,266.7	Vendor Internal TRM - Lighting
	Exterior Exit Sign	Sign	12	78.8	0.009	946.1	0.1	Vendor Internal TRM - Lighting
	New Exit Sign Fixture	Sign	1,246	142.2	0.016	177,128.6	20.2	Vendor Internal TRM - Lighting
	Interior New T8/T5 Fixture	Unit	901	158.1	0.036	142,458.3	32.0	Vendor Internal TRM - Lighting
	Interior Occupancy + Daylighting Sensor	Watt controlled	57,383	1.5	0.000	83,351.7	19.8	Vendor Internal TRM - Lighting
	Interior Occupancy Sensor	Watt controlled	1,171,721	1.4	0.000	1,686,242.1	98.4	Vendor Internal TRM - Lighting
	Interior Other LED	Unit	82,117	112.1	0.035	9,201,928.6	2,902.4	Vendor Internal TRM - Lighting
	Interior Screw-in LED	Unit	15,291	116.6	0.024	1,782,273.9	365.6	Vendor Internal TRM - Lighting
	Interior Time Clocks for Lighting	Watt controlled	112,702	0.4	0.000	47,676.3	0.0	Vendor Internal TRM - Lighting
	LED Traffic Lights - Green 12"	Unit	32	519.8	0.059	16,633.6	1.9	Vendor Internal TRM - Lighting
	LED Traffic Lights - Red 12"	Unit	32	693.8	0.079	22,201.6	2.5	Vendor Internal TRM - Lighting
	LED Wallpacks (<=60W)	Unit	243	292.4	0.000	71,061.6	0.0	Vendor Internal TRM - Lighting
	LED Wallpacks (>60W)	Unit	256	535.9	0.000	137,201.0	0.0	Vendor Internal TRM - Lighting
	Screw-in HID LED <80W	Unit	1,294	247.1	0.056	319,731.8	71.8	Vendor Internal TRM - Lighting
	Screw-in HID LED >80W	Unit	968	788.2	0.177	763,023.7	171.3	Vendor Internal TRM - Lighting
	Suite Exit Sign	Sign	100	84.2	0.011	8,416.2	1.1	Vendor Internal TRM - Lighting
	TLED - Type A & B	Unit	38,609	71.4	0.016	2,757,665.0	619.7	Vendor Internal TRM - Lighting
	Plug Load Occ Sensors	Unit	13	169.0	0.000	2,197.0	0.0	Vendor Internal TRM - Miscellaneous
	Chilled Water Pump	Unit	2	7,682.2	3.555	15,364.3	7.1	Vendor Internal TRM - Motors and Drives
	Condenser Water Pump	Unit	3	18,829.5	5.430	56,488.5	16.3	Vendor Internal TRM - Motors and Drives
	Cooling Tower Fan with Single Speed Baseline	Unit	4	17,041.4	3.378	68,165.7	13.5	Vendor Internal TRM - Motors and Drives
	Cooling Tower Fan with Two Speed Baseline	Unit	4	7,794.2	2.228	31,177.0	8.9	Vendor Internal TRM - Motors and Drives
	Green Motor Rewind	Unit	13	4,704.4	0.603	61,157.5	7.8	Vendor Internal TRM - Motors and Drives
	NEMA Premium Efficiency Motor	Unit	14	2,467.2	0.482	34,541.2	6.8	Vendor Internal TRM - Motors and Drives
	Other HVAC Motor	Unit	12	8,058.6	1.793	96,702.7	21.5	Vendor Internal TRM - Motors and Drives
	Pool Pump Motor	Unit	2	54,505.6	0.465	109,011.1	0.9	Vendor Internal TRM - Motors and Drives
	Process Motor	Unit	186	6,738.9	0.985	1,253,426.4	183.1	Vendor Internal TRM - Motors and Drives
	Supply/Return Fan	Unit	28	14,483.2	1.724	405,529.4	48.3	Vendor Internal TRM - Motors and Drives
	Anti-Sweat Heater Controls	Unit	13	528.0	0.060	6,600.0	0.8	Vendor Internal TRM - Refrigeration
	EC Motor for Reach-in Refrigerator and Freezer cases	Unit	218	625.0	0.071	136,250.0	15.5	Vendor Internal TRM - Refrigeration
	EC Motor for Walk-in Cooler and Freezer	Unit	14	1,250.0	0.143	17,500.0	2.0	Vendor Internal TRM - Refrigeration
	ENERGY STAR Glass Door Freezer	Unit	4	725.9	0.083	2,903.6	0.3	Vendor Internal TRM - Refrigeration
	ENERGY STAR Glass Door Refrigerator	Unit	23	356.0	0.040	8,188.5	0.9	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Freezer	Unit	29	519.2	0.059	15,056.8	1.7	Vendor Internal TRM - Refrigeration

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Efficient Products for Business	ENERGY STAR Solid Door Refrigerator	Unit	7	197.7	0.023	1,383.9	0.2	Vendor Internal TRM - Refrigeration
	LED Refrigeration Case Lighting - Open Cases	Unit	1,146	365.1	0.063	418,199.1	71.6	Vendor Internal TRM - Refrigeration
	LED Refrigeration Case Lighting - With Doors	Unit	3,064	413.3	0.067	1,266,487.6	204.1	Vendor Internal TRM - Refrigeration
	New Doors on Medium Temp Open Refrigerated Case	Unit	244	395.6	0.045	96,516.6	11.0	Vendor Internal TRM - Refrigeration
	Stirling Engine ULT Freezer	Unit	110	204.5	0.023	22,495.0	2.6	Vendor Internal TRM - Refrigeration
	TOTAL					**117,144,083**	**23,222**	
Self Direct	The Customer had (9) existing loader pump systems that were larger 10-25HP systems. These ran 24/7 and did not hae any controls to turn off when bins were full. These were replaced in August 2016 with (35) individual systems per extruder station that only run at 1.3HP and only operate when the bins need to be filled. These operate about 40% of the time that the original system was running. Existing trend data and makes/models of the vacuum system are not available. New vacuums are (35) Conair PM15 brushless conveying vacuum loaders (1.3HP each).	Custom Measure	1	509,426.0	60.650	509,426.0	60.7	All Custom Measures are individually calculated using methodology consistent with the Draft Ohio 2010 Technical Reference Manual.
	The Customer had 12 old Hussmann Protocol Refrigeration units which had 4 compressors each for a total of 48 compressors for the grocery store. The customer brought in Comfort Refrigeration which re-designed the refrigeration needs and brought in new units designed for each individual portion of the grocery store that needed refrigeration. By replacing these units and looking at the compressor savings, the customer was able to save nearly 200,000 kWh over 2018. In addition, the customer was also able to remove their cooling tower as part of the project which prevented the need of a large 30hp fan and 2 pumps.	Custom Measure	1	180,560.5	129.160	180,560.5	129.2	
	Install 300 HP VFD	Custom Measure	1	128,442.0	24.220	128,442.0	24.2	
	Installed a 60% energy savings press over a traditional convensional hydraulic press. The Servo motor system is able to regenerate power under deceleration. This equipment is already installed at the facility. There is an oprotunity to monitor the old equiptment from an existing press similar in production and usage. They actually installed 2 newer presses, one this year, and one last year. Pres.0201 is new this year Pres.0202 was installed last year Pres.0203 is the hydraulic press that can be montiored for calculations	Custom Measure	1	43,770.0	18.690	43,770.0	18.7	All Custom Measures are individually calculated using methodology consistent with the Draft Ohio 2010 Technical Reference Manual.
	The measure is deemed to utilize the legacy prescriptive measure, interior new constructions	Custom Measure	1	50,178.0	18.158	50,178.0	18.2	
	The measure is deemed to utilize the legacy prescriptive measure, outdoor new constructions	Custom Measure	1	36,637.0	8.365	36,637.0	8.4	
	Whole building energy efficient improment	Custom Measure	1	307,968.0	27.800	307,968.0	27.8	
	New VFD Compressor	Horsepower	30	1,732.3	0.240	51,969.0	7.2	Vendor Internal TRM - Compressed Air
	Air Source Heat Pump - 11.25 - 19.9 tons	Unit	2	1,744.2	1.132	3,488.4	2.3	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 5.4 - 11.24 tons	Unit	4	826.2	0.527	3,304.8	2.1	Vendor Internal TRM - Cooling
	Air Source Heat Pump < 5.4 tons	Unit	7	303.4	0.188	2,123.8	1.3	Vendor Internal TRM - Cooling
	Demand Control Ventilation for Office	Square foot	49,728	0.5	0.000	25,443.3	-	Vendor Internal TRM - Cooling
	Room AC Two Tons or Less	Unit	22	60.5	0.034	1,330.5	0.8	Vendor Internal TRM - Cooling
	Interior Daylighting Controls	Watt controlled	1,970	1.1	0.000	2,071.4	0.8	Vendor Internal TRM - Lighting
	Interior Screw-in LED	Unit	264	97.5	0.021	25,750.5	5.6	Vendor Internal TRM - Lighting
	Interior LPD	Square foot	1,822	5.5	0.001	10,025.1	2.3	Vendor Internal TRM - Lighting
	Interior Exit Sign	Unit	7	88.5	0.012	619.7	0.1	Vendor Internal TRM - Lighting
	Exterior ES or DLC LED	Unit	22	1,024.7	0.000	22,544.3	-	Vendor Internal TRM - Lighting
	Exterior Other LED	Unit	8	1,177.6	0.000	9,420.5	-	Vendor Internal TRM - Lighting
	Interior ES or DLC LED	Unit	3,980	249.2	0.056	991,886.9	222.9	Vendor Internal TRM - Lighting
	Interior Other LED	Unit	118	467.3	0.105	55,146.7	12.4	Vendor Internal TRM - Lighting
	Anti-Sweat Heater Controls	Unit	240	528.0	0.060	126,720.0	14.4	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Refrigerator	Unit	13	197.7	0.023	2,570.1	0.3	Vendor Internal TRM - Refrigeration
	EC Motor for Evaporator Fan Controls	Unit	8	1,351.0	0.154	10,808.0	1.2	Vendor Internal TRM - Refrigeration
	LED Refrigeration Case Lighting - With Doors	Unit	1,472	413.3	0.067	608,377.6	98.0	Vendor Internal TRM - Refrigeration
	New Doors on Low Temp Open Refrigerated Case	Unit	160	975.4	0.111	156,070.4	17.8	Vendor Internal TRM - Refrigeration
	New Doors on Medium Temp Open Refrigerated Case	Unit	80	395.6	0.045	31,644.8	3.6	Vendor Internal TRM - Refrigeration
	Chilled Water Pump	Unit	2	309,395.9	33.570	618,791.9	67.1	Vendor Internal TRM - Motors and Drives
	TOTAL					**4,017,089**	**747**	

APPENDIX A -- Ohio Savings Terms FINAL 12/31/2019

Program	Measure	Unit	Units	Ex Ante Per unit kWh impact	Ex Ante Per unit kW impact	Ex Ante kWh Savings	Ex Ante kW Savings	Source Document
Express	Occupancy Sensor	Unit	324	69.3	0.000	22,449.9	0.0	New York State TRM - Lighting
	Photocells	Unit	107	92.1	0.000	9,851.1	0.0	New York State TRM - Lighting
	Exterior Light - Disconnect Only	Unit	4	2,006.0	0.000	8,024.2	0.0	New York State TRM - Lighting
	Exterior LED	Unit	2,527	746.1	0.000	1,885,282.4	0.0	New York State TRM - Lighting
	Exterior T8 Fluorescent	Unit	29	441.8	0.000	12,812.6	0.0	New York State TRM - Lighting
	Garage Exit Signs	Unit	8	257.5	0.043	2,059.8	0.3	New York State TRM - Lighting
	Garage LED	Unit	2,456	644.9	0.190	1,583,895.1	466.0	New York State TRM - Lighting
	Interior Light - Disconnect Only	Unit	9	281.8	0.091	2,536.5	0.8	New York State TRM - Lighting
	Interior Exit Signs	Unit	516	159.8	0.031	82,457.2	15.8	New York State TRM - Lighting
	Interior LED	Unit	31,825	253.3	0.061	8,060,506.9	1,942.0	New York State TRM - Lighting
	Interior T8 Fluorescent	Unit	55	39.2	0.007	2,156.6	0.4	New York State TRM - Lighting
	Anti Sweat Heater Control	Project	19	7,649.8	0.205	145,345.3	3.9	Pennsylvania TRM - Refrigeration
	Compressor and Intelligent Fan Management	Unit	337	954.9	0.109	321,808.1	36.7	New York State TRM - Refrigeration
	Refrigeration LED Case Lighting	Project	26	4,713.5	0.670	122,549.9	17.4	New York State TRM - Refrigeration
	TOTAL					**12,261,735**	**2,483.4**	
Data Center	Computer Room Air Conditioner	Unit	10	52,026.4	8.930	520,264.0	89.3	Standard Engineering Calculation
	IT/Equipment/Relocation	Unit	1	1,430,851.0	161.900	1,430,851.0	161.9	Standard Engineering Calculation
	Non Residential Whole Building	Unit	12	2,039,583.8	240.892	24,475,006.0	2,890.7	Individually modeled by Implementer
	TOTAL					**26,426,121**	**3,141.9**	
Continuous Energy Improvement	Multivariate Linear Regression	Project	115	177,842.6	(7.287)	20,451,900	(838.0)	Individually modeled by Implementer
	TOTAL					**20,451,900**	**(838)**	
Combined Heat & Power	Combined Heat & Power	Project	1	37,602,231.0	4176.040	37,602,231	4,176.0	Measured meter readings
	TOTAL					**37,602,231**	**4,176.0**	

APPENDIX B

Efficient Products Program

2019 Evaluation Report

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April 20, 2020

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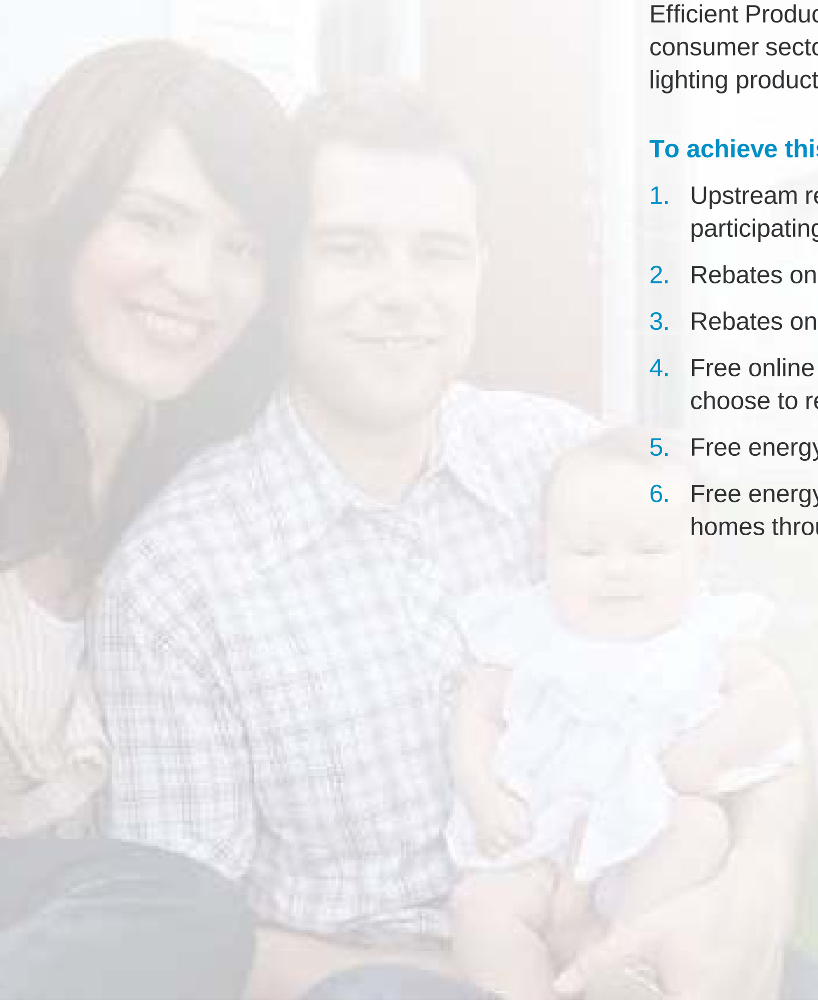
01 Introduction

Introduction



What is the Efficient Products Program?

The Efficient Products Program provides both free equipment and financial incentives for energy-efficient lighting and appliances. The objective of the Efficient Products Program is to produce long-term electric energy savings in the consumer sector by increasing the market share of ENERGY STAR® qualified lighting products and appliances.

To achieve this objective, AEP Ohio provides:

1. Upstream rebates on ENERGY STAR® qualified screw-in LEDs purchased at participating retail locations and the Online Energy Efficiency Marketplace
2. Rebates on select ENERGY STAR® qualified appliances
3. Rebates on select heating and cooling (HVAC) equipment
4. Free online home energy use assessment, after which a customer can choose to receive a free energy efficiency kit
5. Free energy efficiency measure direct installations in multi-family homes
6. Free energy efficiency measure direct installations in select single-family homes through a partnership with Columbia Gas of Ohio

Program Summary

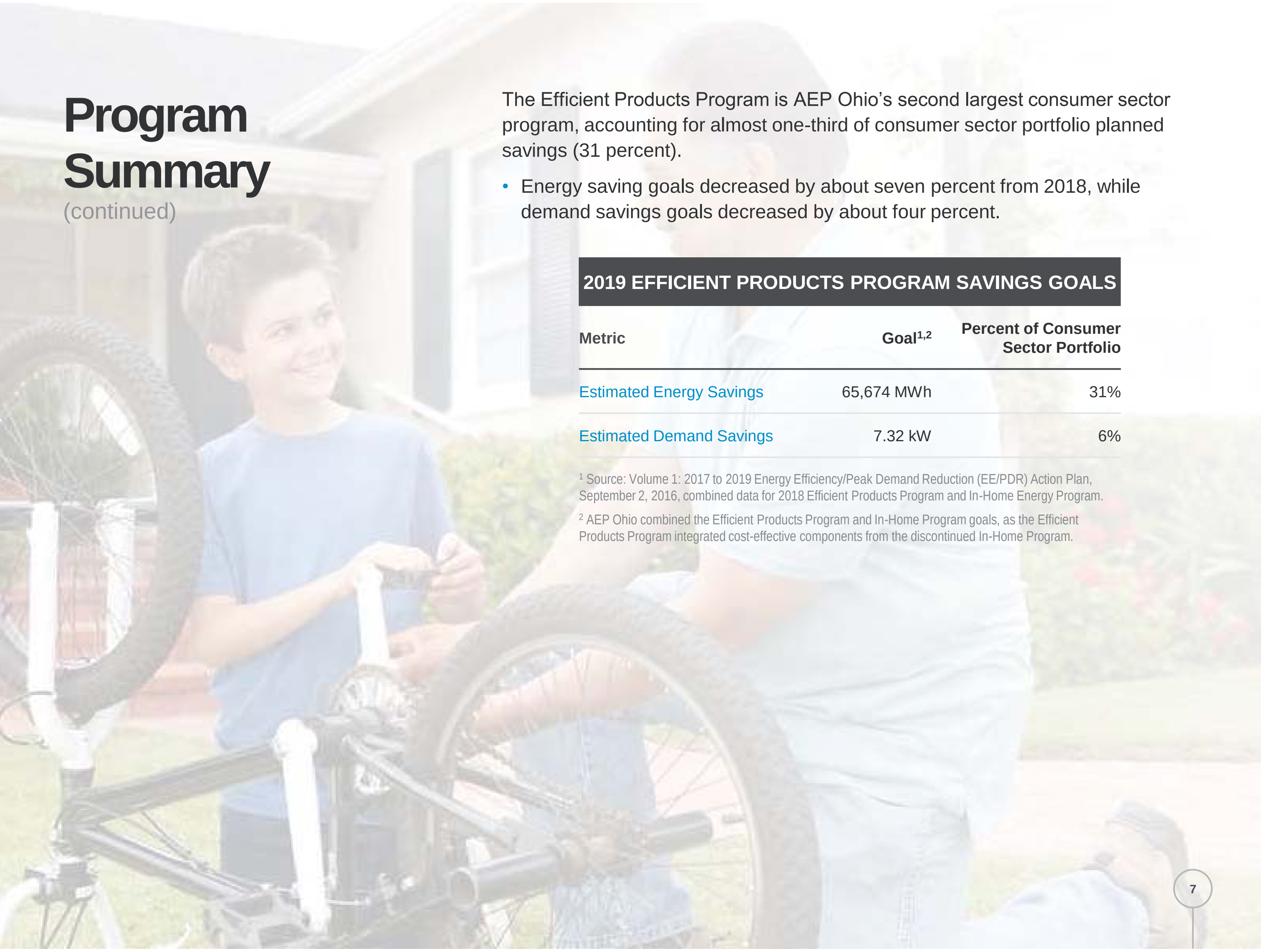
EFFICIENT PRODUCTS PROGRAM COMPONENTS		
Component	**Type**	**Measures**
Upstream Products	Upstream	Standard LEDs, Specialty LEDs, Door Sweeps, Pipe Wrap
Downstream Rebates[1]	Direct Purchase through the Online Energy Efficiency Marketplace or other retailer with Online Application[2]	Standard LEDs, Specialty LEDs, Smart Thermostats, Clothes Washers, Heat Pump Water Heaters, Dehumidifiers, Pool Pumps
HVAC Equipment	Rebate through Approved Installation Contractor	Air Source Heat Pumps, Ductless Mini-Splits, Ground Source Heat Pumps, Smart Thermostats
Energy Efficiency Kits	Free Upon Request through HVAC Application or Upon Completion of the Online Home Energy Profile	Standard LEDs, Nightlights, Outlet Covers, Weather Stripping, Faucet Aerators, Showerheads[3]
Multi-Family Direct Installation	Direct Installation	Faucet Aerators, Standard LEDs, Specialty LEDs, Showerheads, Nightlights, Smart Power Strips[4]
Single-Family Direct Installation	Direct Installation through Partnership with Columbia Gas of Ohio	Faucet Aerators, Standard LEDs, Specialty LEDs, Showerheads, Nightlights, Smart Power Strips[4]

[1] A few refrigerators incentivized in 2018 were included in 2019 savings, however, refrigerators were not offered in 2019.

[2] For customers who are unable to complete an online rebate, AEP Ohio allows customers to apply over the phone.

[3] AEP Ohio stopped delivering water-saving measures (aerators and showerheads) in energy efficiency kits early in 2019.

[4] AEP Ohio stopped including nightlights and smart strips in the MFDI and SFDI components in 2019.



Program Summary
(continued)

The Efficient Products Program is AEP Ohio’s second largest consumer sector program, accounting for almost one-third of consumer sector portfolio planned savings (31 percent).

- Energy saving goals decreased by about seven percent from 2018, while demand savings goals decreased by about four percent.

2019 EFFICIENT PRODUCTS PROGRAM SAVINGS GOALS

Metric	Goal[1,2]	Percent of Consumer Sector Portfolio
Estimated Energy Savings	65,674 MWh	31%
Estimated Demand Savings	7.32 kW	6%

[1] Source: Volume 1: 2017 to 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, September 2, 2016, combined data for 2018 Efficient Products Program and In-Home Energy Program.

[2] AEP Ohio combined the Efficient Products Program and In-Home Program goals, as the Efficient Products Program integrated cost-effective components from the discontinued In-Home Program.

Program Summary
(continued)

The program surpassed the savings goals for 2019. The program achieved 205 percent of the energy savings goal of 65.7 GWh and 328 percent of the demand savings goal of 7.32 MW.

The realization rates for 2019 were 1.00 for energy savings and 1.00 for demand savings.

- To estimate the ex post savings, the evaluation team applied the methods and assumptions outlined in the Draft 2010 Ohio Technical Reference Manual (TRM).
- For measures that were not included in the TRM, the evaluation team applied methods used by other nearby TRMs (typically the Illinois TRM), and used AEP Ohio-specific primary research for parameters within those methods whenever possible. See the Appendix for detailed methodology.

PROGRAM EVALUATION SUMMARY RESULTS

	2019 Program Goals[1,2] (a)	Ex Ante Savings (b)	Ex Post Savings (c)	Realization Rate RR = (c) / (b)	Percent of Goal = (c) / (a)
Energy Savings (MWh)	65,674	134,588	134,633	1.00	205%
Demand Savings (MW)	7.32	24.05	24.03	1.00	328%

[1] Source: Volume 1: 2017 to 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, September 2, 2016, combined data for 2018 Efficient Products Program and In-Home Energy Program.

[2] AEP Ohio combined the Efficient Products Program and In-Home Program goals, as the Efficient Products Program integrated cost-effective components from the discontinued In-Home Program.

02 Methodology

Methodology

The objectives of the evaluation were to:

Impacts

01 Quantify the energy and peak demand savings impacts

02 Verify quantities against the tracking system

03 Determine program cost-effectiveness

Process

04 Determine key process-related program strengths and weaknesses

05 Identify ways in which the program can be improved

Data Collection Activities

DATA COLLECTION TYPE

1 Tracking Data Analysis

Targeted Population
All Program Participants

Supported Evaluation Activities
Impact and Process Evaluation

2 In-Depth Telephone Interviews

Targeted Population
Program Staff

Sample Frame
Contacts at AEP Ohio and Implementation Contractors

Sample Size
3

Timing
Oct – Nov 2019

3 Appliance Rebate Online Survey

Targeted Population
Smart Thermostat Rebate Participants

Sample Frame
Tracking Database

Sample Size
109 Respondents

Timing
Jan 2020

4 Energy Efficiency Kits Online Survey

Targeted Population
Energy Efficiency Kit Recipients

Sample Frame
Tracking Database

Sample Size
304 Respondents

Timing
Jan 2020

5 MFDI On-Site Audits

Targeted Population
MFDI Treated Units

Sample Frame
Tracking Database

Sample Size
39 Site Visits

Timing
Dec 2019

Material Review

Tracking Data Review Methodology

The tracking data was provided by AEP Ohio for review. The evaluation team subsequently:

- Determined key data fields essential for consideration in the impact and process evaluations
- Examined frequency distributions for each of the key fields, identifying missing, incomplete, or inconsistent data
- Assessed key characteristics of equipment rebated through the program

Program Documentation Review Methodology

The evaluation team reviewed all program materials provided to date by AEP Ohio, and the implementation contractors (CLEAResult and Enervee). This included:

- Program tracking data
- Program marketing plans
- Program marketing materials
- AEP Ohio Efficient Products Program website

Secondary Data Review

To verify the equipment specifications in the program tracking data, the evaluation team utilized the ENERGY STAR® Qualified Products List [1] (QPL) for:

- LEDs
- Refrigerators

[1] http://www.energystar.gov/productfinder/product/

03

Evaluation Findings

Program Energy Impacts by Component

The upstream lighting component produced the majority of energy savings (90 percent). The second-highest energy-saving component, downstream rebates, produced 4 percent of energy savings.

Realization Rate Adjustments

- The downstream rebate component achieved a higher realization rate (1.02) due to a greater percentage of manual thermostats being replaced by smart thermostats, and consequently a greater heat reduction value.[1]
- The single-family direct installation (SFDI)[2] and multi-family direct installation (MFDI)[3] components achieved lower realization rates due to lower ex post installation rates.
- While the realization rate for lighting was 1.0, LED wattages in the Marketplace tracking data were irregular, in that they were not whole numbers. The evaluation team was unable to determine the source of these LED wattages and computed efficient wattages based on data from the EnergyStar Qualified Products List (QPL).

PROGRAM ENERGY IMPACTS BY COMPONENT

Product	Number of Units	Average Ex Post Per-Unit Energy Savings (kWh)	Total Ex Ante Energy Savings (MWh)	Total Ex Post Energy Savings (MWh)	Percent of Ex Post Energy Savings	Realization Rate
Upstream Lighting	3,235,522	37.37	120,916	120,927	90%	1.00
Downstream Rebates	65,566	80.36	5,183	5,269	4%	1.02
Multi-Family Direct Installation	65,544	35.65	2,381	2,337	2%	0.98
Energy Efficiency Kits	1,313,309	4.01	5,271	5,268	4%	1.00
HVAC Equipment	465	1,114.70	519	518	< 1%	1.00
Single-Family Direct Installation	7,831	40.08	317	314	< 1%	0.99
TOTAL VALUE	**4,688,237**		**134,588**	**134,633**	**100%**	**1.00**

Note. Totals may not sum due to rounding.

[1] Based on results from the 2019 Appliance Rebate Survey.
[2] Based on results from the 2016 In-Home Evaluation Report.
[3] Based on results from 2019 Multi-Family In-Home Audits.

Program Demand Impacts by Component

The upstream lighting component produced the majority of demand savings (90 percent). The second-most demand-saving component (downstream rebates) produced 5 percent.

Demand savings realization rates varied for the same reasons as energy savings realization rates varied.

PROGRAM DEMAND IMPACTS BY COMPONENT

Product	Number of Units	Average *Ex Post* Per-Unit Demand Savings (W)	Total *Ex Ante* Demand Savings (kW)	Total *Ex Post* Demand Savings (kW)	Percent of *Ex Post* Demand Savings	Realization Rate
Upstream Lighting	3,235,522	6.66	21,550	21,552	90%	1.00
Downstream Rebates	65,566	18.51	1,232	1,214	5%	0.99
Multi-Family Direct Installation	65,544	6.04	400	396	2%	0.99
Energy Efficiency Kits	1,313,309	0.54	717	714	3%	1.00
HVAC Equipment	465	202.30	94	94	< 1%	1.00
Single-Family Direct Installation	7,831	7.10	56	56	< 1%	0.99
TOTAL VALUE	**4,688,237**		**24,048**	**24,026**	**100%**	**1.00**

Note. Totals may not sum due to rounding. Averages are weighted at the measure level.

IMPACT

Energy Savings Results

ENERGY IMPACTS BY COMPONENT AND EQUIPMENT TYPE

Product	Total Ex Ante Energy Savings (MWh)	Total Ex Post Energy Savings (MWh)	Percent of Ex Post Energy Savings	Realization Rate
Standard LEDs	81,127	81,127	60.26%	1.00
Specialty LEDs	39,789	39,800	29.56%	1.00
Total Savings for Upstream Lighting	**120,916**	**120,927**	**89.82%**	**1.00**
Standard LEDs	1,095	1,125	0.84%	1.03
Specialty LEDs	401	299	0.22%	0.75
Smart Thermostats	1,302	1,459	1.08%	1.12
Clothes Washers	889	889	0.66%	1.00
Refrigerators	79	79	0.06%	1.00
Heat Pump Water Heaters	404	404	0.30%	1.00
Dehumidifiers	482	482	0.36%	1.00
Pool Pumps	227	227	0.17%	1.00
Pipe Wrap	279	279	0.21%	1.00
Door Sweeps	25	25	0.02%	1.00
Total Savings for Downstream Rebates	**5,183**	**5,268**	**3.91%**	**1.02**
Multi-Family DI LEDs	1,936	1,957	1.45%	1.01
Multi-Family DI Nightlights	2	3	0.00%	1.34
Multi-Family DI Smart Power Strips	21	21	0.02%	0.98
Multi-Family DI Showerheads	362	308	0.23%	0.85
Multi-Family DI Faucet Aerators	60	48	0.04%	0.81
Total Savings Multi-Family DI	**2,381**	**2,337**	**1.74%**	**0.98**
Energy Efficiency Kit LEDs	3,973	3,953	2.94%	0.99
Energy Efficiency Kit Nightlights	493	515	0.38%	1.04
Energy Efficiency Kit Outlet Covers	593	614	0.46%	1.04
Energy Efficiency Kit Weather stripping	145	147	0.11%	1.01
Energy Efficiency Kit Faucet Aerators	8.95	8	0.01%	0.90
Energy Efficiency Kit Showerheads	58	31	0.02%	0.53
Total Savings Energy Efficiency Kits	**5,271**	**5,268**	**3.91%**	**1.00**
Central Air Conditioners	7	7	0.01%	1.01
Air Source Heat Pumps	277	277	0.21%	1.00
Ductless Mini-Splits	153	153	0.11%	1.00
Ground Source Heat Pumps	82	82	0.06%	1.00
Total Savings for HVAC Equipment	**519**	**518**	**0.38%**	1.00
Single-Family DI LEDs	301	301	0.22%	1.00
Single-Family DI Nightlights	0.385	0.38	0.00%	1.00
Single-Family DI Smart Power Strips	1.03	1.03	0.00%	1.00
Single-Family DI Showerheads	14.22	11	0.01%	0.76
Single-Family DI Faucet Aerators	1.27	1.11	0.00%	0.88
Total Savings Single-Family DI	**317**	**314**	**0.23%**	**0.99**

Note. Totals may not sum due to rounding.

Demand Savings Results

DEMAND IMPACTS BY COMPONENT AND EQUIPMENT TYPE				
Product	**Total Ex Ante Demand Savings (kW)**	**Total Ex Post Demand Savings (kW)**	**Percent of Ex Post Demand Savings**	**Realization Rate**
Standard LEDs	14,459	14,459	60.18%	1.00
Specialty LEDs	7,091	7,093	29.52%	1.00
Total Savings for Upstream Lighting	**21,550**	**21,552**	**89.71%**	**1.00**
Standard LEDs	195	201	0.84%	1.03
Specialty LEDs	71	53	0.22%	0.75
Smart Thermostats	290	284	1.18%	0.98
Clothes Washers	125	125	0.52%	1.00
Refrigerators	14	14	0.06%	1.00
Heat Pump Water Heaters	55	55	0.23%	1.00
Dehumidifiers	110	110	0.46%	1.00
Pool Pumps	336	336	1.40%	1.00
Pipe Wrap	32	32	0.13%	1.00
Door Sweeps	3	3	0.01%	1.00
Total Savings for Downstream Rebates	**1,232**	**1,214**	**5.05%**	**0.99**
Multi-Family DI LEDs	345	349	1.45%	1.01
Multi-Family DI Nightlights	-	-	-	-
Multi-Family DI Smart Power Strips	2	2	0.01%	1.00
Multi-Family DI Showerheads	46	39	0.16%	0.85
Multi-Family DI Faucet Aerators	7	6	0.02%	0.86
Total Savings Multi-Family DI	**400**	**396**	**1.65%**	**0.99**
Energy Efficiency Kit LEDs	708	709	2.95%	1.00
Energy Efficiency Kit Nightlights	-	-	-	-
Energy Efficiency Kit Outlet Covers	-	-	-	-
Energy Efficiency Kit Weather stripping	-	-	-	-
Energy Efficiency Kit Faucet Aerators	1	1	< 0.01%	0.90
Energy Efficiency Kit Showerheads	7	4	0.02%	0.53
Total Savings Energy Efficiency Kits	**717**	**714**	**2.97%**	**1.00**
Central Air Conditioners	6	6	0.02%	1.00
Air Source Heat Pumps	57	57	0.24%	1.00
Ductless Mini-Splits	17	17	0.07%	1.00
Ground Source Heat Pumps	14	14	0.06%	1.00
Total Savings for HVAC Equipment	**94**	**94**	**0.39%**	**1.00**
Single-Family DI LEDs	54	54	0.22%	1.00
Single-Family DI Nightlights	-	-	-	-
Single-Family DI Smart Power Strips	< 1	< 1	< 0.01%	1.00
Single-Family DI Showerheads	2	1	0.01%	0.76
Single-Family DI Faucet Aerators	< 1	< 1	< 0.01%	0.88
Total Savings Single-Family DI	**56**	**56**	**0.23%**	**0.99**

Note. Totals may not sum due to rounding.

Cost-Effectiveness Review

Table 1 summarizes the unique inputs used in the TRC test. Based on these inputs, the TRC ratio is 2.7, as shown in Table 2. Therefore, the program passes the TRC test.

**TABLE 1:
INPUTS TO COST-EFFECTIVENESS MODEL FOR THE EFFICIENT PRODUCTS PROGRAM**

Item	Value
Average Measure Life	16
Units	4,688,237
Annual Energy Savings (kWh)	134,632,743
Coincident Peak Savings (kW)	24,026
Third-Party Implementation Costs	$3,511,275
Utility Administration Costs	$1,502,322
Utility Incentive Costs	$7,954,042
Participant Contribution to Incremental Measure Costs	$11,199.074

**TABLE 2:
COST-EFFECTIVENESS RESULTS FOR THE EFFICIENT PRODUCTS PROGRAM**

Benefit-Cost Test Results – Efficient Products	Ratio
Total Resource Cost	2.7
Participant Cost Test	10.4
Ratepayer Impact Measure	0.4
Utility Cost Test	5.1

PROCESS

Changes Since 2018 – Downstream Rebates

Changes in 2019

- Began offering a $50 SPIF (Sales Performance Incentive Fund) to contractors who install qualified HVAC appliances or Heat Pump Water Heaters and apply for the rebate for the customer.
- Administration of the Online Energy Efficiency Marketplace transitioned back to CLEAResult from Enervee.
- Added rebates for pipe wrap and door sweeps.
- Discontinued rebates for refrigerators.
- Rebates for all measures can be no greater than 50 percent of the purchase price (excluding lighting measures).
- Reduced rebate for heat pump water heaters to $400.

DOWNSTREAM REBATE AMOUNTS IN 2019

Equipment Type	Rebate Amounts	Purchase Mechanism
Standard LEDs	$1.50	Direct Purchase through Marketplace
Specialty LEDs	$1.75 – 3.75	
Smart Thermostats – Gas Heated Homes	$25	OR Direct Purchase through Marketplace or through Contractor or Downstream Rebate for Purchases through Retailer
Smart Thermostats – Electric Heated Homes	$75	
Clothes Washers	$40	Through Contractor or Downstream Rebate for Purchases through Retailer
Dehumidifiers	$25	
Water Heater – Electric Heat Pump	$400[2]	
Pool Pumps – Variable Speed Drive	$350[2]	
Pipe Wrap	$1 per 6ft roll	
Door Sweeps	$3	

[1] Select products continue to receive instant rebates through Enervee on the Marketplace.

[2] Maximum rebate provided was restricted to 50% of the purchase price.

PROCESS

Changes Since 2018 – Lighting & HVAC

Lighting

- Ended lighting coupon program.
- Rebates for most specialty bulbs increased to $1.50 - $3.75.

LIGHTING REBATE AMOUNTS IN 2019

Type	Minimum Rebate	Average Rebate	Maximum Rebate
Standard LEDs	$0.25	$1.45	$2.00
Specialty LEDs	$1.00	$2.45	$4.00
LEDs Overall	**$0.25**	**$1.72**	**$4.00**

HVAC

- Discontinued rebates for central air conditioners due to low cost-effectiveness.
- Rebates were consistent throughout the year for HVAC equipment.

HVAC EQUIPMENT REBATE AMOUNTS IN 2019

Appliance Type	Rebate Amounts
Air Source Heat Pumps	$300
Ductless Mini-Split Heat Pumps	$300
Ground Source Heat Pumps	$1,200

Changes Since 2018 – Energy Efficiency Kits & Multi-Family Direct Installation

Energy Efficiency Kits

- Discontinued water measures in kits, including faucet aerators and shower heads.
  - Some kits sent out in early 2019 received faucet aerators and showerheads as implementer sent out backlog of water measures.
- Added weather stripping and outlet covers to kits.
- Began allowing customers to choose the type of bulb they would like included in their kit. Options included BR30, standard, or candelabra.

Multi-Family Direct Installation

- Discontinued nightlights and smart strips from Multi-Family Direct Installation program.
  - Implementer installed backlog of LED nightlights and smart strips left from 2018.

Program Activity

Across all components, specialty LEDs represented 27 percent of all program-incentivized LEDs. This portion grew from 21 percent in 2018.

- AEP Ohio increased rebate amounts for specialty bulbs in 2019 to increase sales.
- The number of program-incentivized standard LEDs increased from 2018 to 2019.

LEDS ACROSS ALL EFFICIENT PRODUCT PROGRAM COMPONENTS

Product	2018 LED Units	2019 LED Units
Standard LEDs	2,357,644	2,537,622
Specialty LEDs	638,650	948,934
Specialty LEDs as a Percent of All Incentivized LEDs	**21%**	**27%**

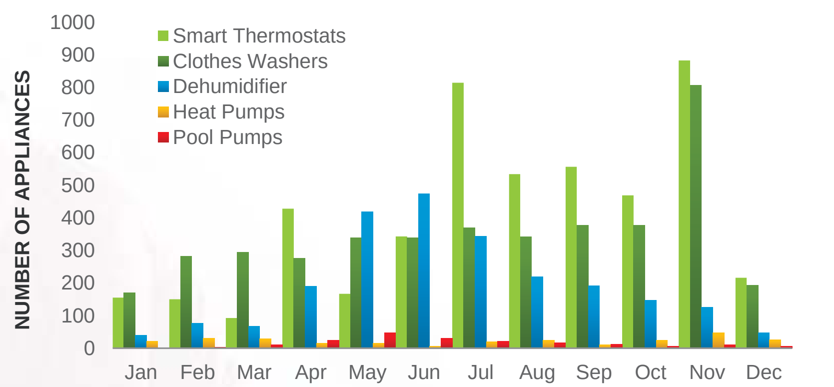
Note: Total unit counts do not match those found on pp 13 - 14 as this table represents counts of all LEDs across all program components (not just upstream lighting).

Program Activity

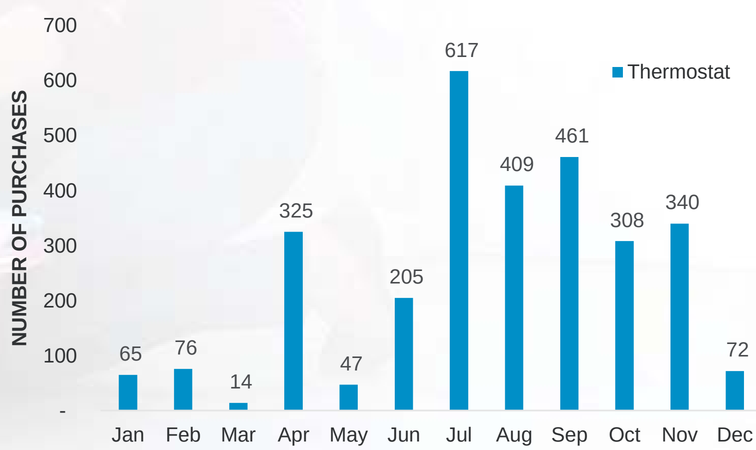
(continued)

- The appliance rebate component incented a similar number of units in 2019 (12,344 units) as in 2018 (11,926 units).[1,2,3]
- Sixty-seven percent of equipment rebates occurred June through November, with sixteen percent in November. Spikes in July and November were driven by smart thermostat rebates.
- Clothes washers spiked in November, with 19 percent of clothes washer rebates (806 units) occurring in November. Smart thermostats peaked in July (814) and November (883).
- Similar to last year, direct purchases through the Marketplace were low at the beginning of the year, with participation spiking in July for smart thermostats (617 units).
- Standard LEDs incentivized through the Marketplace spiked in February (5,178 units) and again in August through October (28,394). Specialty bulbs spiked in August (4,068) and October (1,729). Spikes in LED rebates coincide with marketing efforts for lighting in February and October.

APPLIANCE SALES BY MONTH[1]



DIRECT PURCHASES THROUGH THE MARKETPLACE BY MONTH[1,3]



[1] Based on "MeasInstallDate" field.
[2] 542 refrigerators were rebated in 2019 but installed in 2018
[3] Only includes appliances; does not include 42,414 LEDs sold through the Marketplace in 2019.

PROCESS

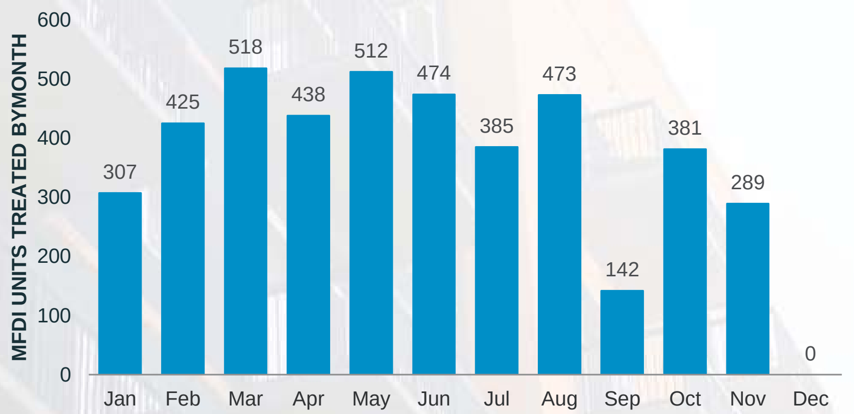
Program Activity

(continued)

Program staff treated 4,344 multi-family units in 2019, visiting 41 different multi-family properties.

- Program staff installed fewer MFDI measures in 2019 than in 2018 (88,298 in 2018 versus 65,544 in 2019). This is partially due to the removal of smart strips and nightlights from MFDI in 2019.
- Program staff treated an average of 106 units per participating multi-family property.

MFDI UNITS TREATED BY MONTH[1]



[1] Based on "MeasInstallDate" field.

Implementation Contractors

CLEAResult

Role

The implementation contractor responsible for the majority of program components.

Responsibilities

- Administered the lighting, HVAC equipment, multi-family direct installation, single-family direct installation program components.
- Administered the downstream rebate component including the Online Energy Efficiency Marketplace beginning January 2019.
- Also responsible for most marketing activities for the Efficient Products Program.
- Handled incoming customer phone calls regarding appliance rebate applications.
- Coordinated with contractors participating in the SPIF.

Enervee

Role

Provides and runs platform for Online Energy Efficiency Marketplace.

Responsibilities

- Developed and supported the Online Energy Efficiency Marketplace platform.
- Processed instant rebates for direct purchases of smart thermostats and lighting through the marketplace website.

EFI

Role

Handles tracking of sales data and rebate payments to participants as well as fulfillment of purchases through the Online Energy Efficiency Marketplace.

Responsibilities

- Subcontractor to CLEAResult.
- Handled the tracking of participant and sales data.
- Processed invoice payments to manufacturers and retailers for downstream lighting component of program and handled payment of rebates to contractors and customers for the appliance component.

Marketing Activities

Program staff also undertook similar marketing activities as last year:

- Seasonal promotions through the Marketplace such as Black Friday specials
- In-store outreach
- In-store training of retail associates
- Retail POP signage including more vivid, eye-catching colors
- Quarterly bill inserts
- Email promotion (e-blasts) & manufacturer-sponsored emails
- Social media posts (Facebook and Twitter)
- Commercial radio spots[1]
- Contextual ads placed on home improvement, DIY, and green/sustainable living websites
- Google Adwords
- Direct mail letters
- Cross-promotion with the Appliance Recycling Program and through the partnership with Columbia Gas of Ohio
- Repeat direct outreach to multi-family building managers to build relationships
- Paid search marketing

[1] New marketing channel in 2019

Challenges Cited by Program Staff

Program staff identified the following challenges with the administration of the program:

Low Participation in Lighting Coupon Program

Participation in the lighting coupons was declining prior to 2019, and this program element had become outdated.

- The system used to process coupons could no longer validate and pay out coupons.
  - It would be too large an expense to build out the validation for that style of program in the new system.
- Impacted mom-and-pop retailers, who were the primary participants in the coupon program. AEP Ohio offered the Markdown program to these stores, but some store owners decided not to participate.

Response: AEP Ohio decided to sunset the lighting coupon program in April 2019.

Customer Complaints of Difficulty Activating Pre-Paid Mastercard

Customers reported frustration activating their pre-paid MasterCards received through the Appliance Rebate program.

- AEP Ohio began offering pre-paid MasterCards in 2019, after receiving complaints from customers about issues with electronic gift cards in 2018.

Response: AEP Ohio is considering offering check payments for rebates instead of pre-paid MasterCards.

Challenges Cited by Program Staff

(continued)

Issues Determining Home Heat Type

Beginning in 2018, there was a large difference in rebate amounts based on customer-identified home heat type. AEP Ohio found that customers mis-reported their home heating source, stating that they had electric heat when they did not.

- This issue is a concern for smart thermostats, which vary in rebate amount based on home heat-type.
- In 2019, home heat-type reported by the customer was verified against the home heat type that was reported by AEP Ohio. Analysts at AEP Ohio determine home heat type by looking at load shape.
- In 2019, there was a smaller but still present margin of variance, indicating that customers could still be incorrect on the application.

Response: AEP Ohio verifies home heat-type using customer load shapes.

Concern about Efficacy of HVAC Contractor SPIF

In 2019, the program began offering a $50 SPIF to contractors who install qualified HVAC appliances or Heat Pump Water Heaters and apply for the rebate for the customer.

- Rebating this equipment through a contractor seemed a more appropriate channel because customers do not frequently shop for these appliances online.
- The contractor must deduct the rebate from the invoice so the customer receives it instantly.
- The program has not seen as much participation as hoped, with the number of units rebated lower than the previous year. AEP Ohio had hoped that the SPIF would drive sales to make up for the removal of central air conditioner rebates from the program.

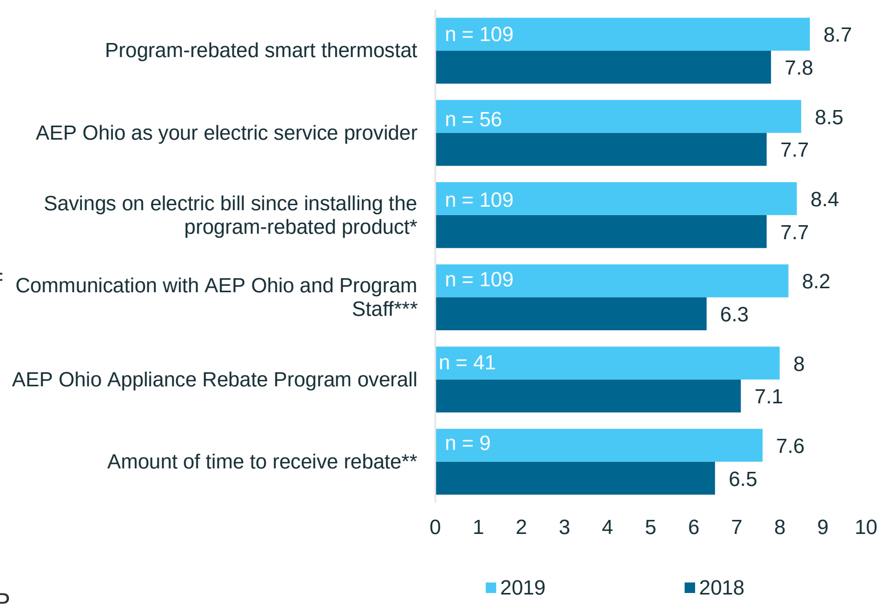
Response: AEP Ohio is considering the efficacy of the contractor SPIF.

Appliance Rebate Survey

Satisfaction

- All appliance rebate survey satisfaction results were higher across every category in 2019 as compared to 2018.
- Similar to last year, respondents provided the highest average satisfaction rating for their program-rebated product (mean = 8.7) which was an increase from last year's mean of 7.8.
- Respondents provided the lowest satisfaction ratings for the amount of time it took to receive their rebate (mean = 7.6).
  - One respondent rated their satisfaction below a five, and said it took longer than four weeks to receive the rebate.
- Respondents (n = 24) offered feedback on program improvements, including: offering a check or bill credit option for rebates, including more products and equipment eligible for rebates, increasing promotion of the program, and simplifying the rebate process.
- Respondents were, on average, highly satisfied with AEP Ohio as an electric service provider (mean = 8.5, up from 7.7 in 2018).
  - Satisfied customers (rating of 8 to 10) noted AEP Ohio's: reliability, good value, prompt response to outages and/or customer service (particularly via the website).
  - Dissatisfied customers (rating of less than 5) noted: high costs of energy and/or problems receiving their gift card.

OVERVIEW OF SATISFACTION RESULTS



** Question only asked of respondents who noticed reduced energy usage on their electric bill since installing the program-rebated product.*
*** Question asked of participants who recalled receiving their pre-paid MasterCard.*
**** Question asked of participants who contacted AEP Ohio/program staff with questions in the course of participating in the program.*

PROCESS

Appliance Rebate Survey

(continued)

Rebates and Rebate Processing Time

- Over half of the respondents (54 percent) were very satisfied (rated 8 to 10) with the amount of time it took to receive their pre-paid Mastercard.
  - One respondent rated their satisfaction a 0 for the amount of time the rebate process took, an improvement from 2018 when 14 respondents rated their satisfaction a zero.
  - Mean satisfaction with the time it took to receive the rebate increased from 6.5 in 2018 to 7.6 in 2019.[1]

- All respondents who received their rebate as a pre-paid MasterCard recalled receiving it. This is an improvement from 2018 when 14 respondents reported never receiving their rebate.

- Of those respondents who reported receiving a mailed MasterCard, 47 percent (n = 20) stated that they would have preferred to receive their rebate as a mailed check.
  - When asked if they would be equally, less, or more satisfied with a check than the MasterCard, over half (54 percent) of respondents said they would be equally satisfied with receiving a MasterCard as would be with receiving a rebate check in the mail.
  - Those who preferred to receive their rebate as a mailed check gave reasons including: difficulties activating the card and finding retailers who accepted it and a desire to deposit the money directly into their accounts or use it to pay their utility bill.

[1] Question asked only to respondents who submitted an application for their rebate, thus does not include customers who received an instant rebate.

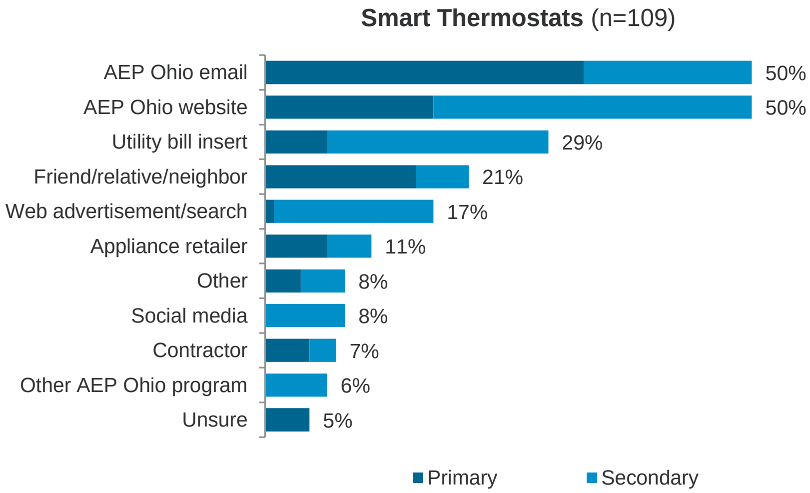
Appliance Rebate Survey

(continued)

Awareness

- Similar to 2018, smart thermostat respondents most often reported learning about the program through AEP Ohio emails (50 percent) and the AEP Ohio website (50 percent).[1]
- The third most often cited source of awareness overall was utility bill inserts.
- The third most common *primary* source of awareness was through friends/relative/neighbor.

SOURCES FROM WHICH CUSTOMERS LEARNED ABOUT THE APPLIANCE REBATE



Note: Multiple responses allowed. Sources accounting for less that 5% were excluded: newspaper, community events and AEP Ohio Online Energy Efficiency Marketplace. "Other AEP Ohio programs" mentioned included: Home Energy Report, Appliance Recycling, It's Your Power, Community Energy Savers and Efficient Lighting Discounts.

[1]It is unclear if respondents were referring to Marketplace or some other AEP Ohio website.

Appliance Rebate Survey

(continued)

Experience in Retail Stores

- Fifty-two percent of respondents (n = 22) who applied for rebates through the Appliance Rebate program purchased their smart thermostat in a physical retail store.
- Of the people who did purchase their product at a store, 41 percent remembered seeing AEP Ohio promotional materials at the store. The remainder either reported that they did not see materials (46 percent) or were unsure whether they did (14 percent).
- Respondents who purchased their smart thermostat through a physical retailer most commonly learned of the rebate through the appliance retailer (n = 6). The next most common way was through an AEP Ohio email (n = 5).
  - Eighteen respondents who purchased their smart thermostats in a physical store reported that they did not speak with a retail sales associate about the AEP Ohio rebate available for their product.
  - Respondents ranked the influence of the in-store promotional materials on their purchase decision as a 5.7 (0-10 scale, not at all influential to very influential).

PROCESS

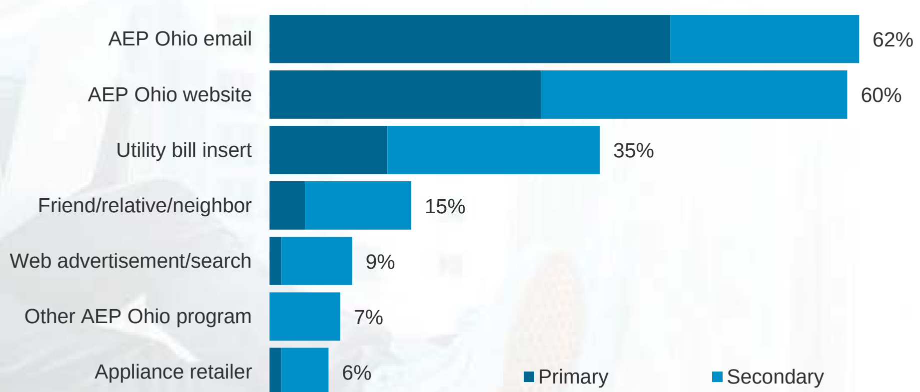
Appliance Rebate Survey

(continued)

Energy Efficient Marketplace

- Forty-four percent of all respondents used the AEP Ohio Online Energy Efficiency Marketplace to research products (n=48), an increase from 2018 when 19 percent of respondents stated that they used the Marketplace to research products.
- Respondents most commonly learned about the Marketplace through emails from AEP Ohio, the AEP Ohio website, and utility bill inserts. Fewer respondents stated that they learned about the Marketplace through an appliance retailer, which was the third-most popular response in 2018.
- When asked why they chose to browse products using the Marketplace instead of using another online source, the most common responses were:
  - Ease of using the fast-track rebate through AEP Ohio (n=24).
  - I trust AEP Ohio to recommend the best products (n=14).
  - Marketplace had the best price (n=12).

SOURCES FROM WHICH CUSTOMERS LEARNED ABOUT MARKETPLACE



Note: Multiple responses allowed. Sources accounting for less that 5% were excluded: Other, Social Media, Contractor, Newspaper, Community Event.

PROCESS

Appliance Rebate Survey

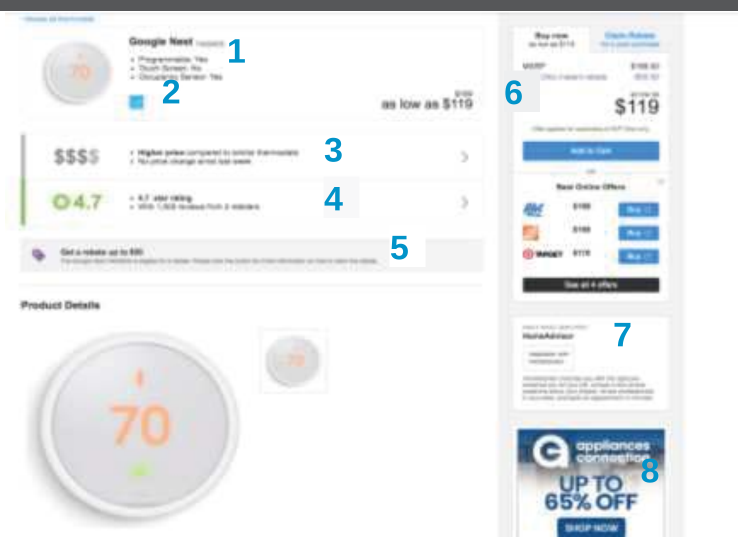
(continued)

HomeAdvisor & the Energy Efficiency Marketplace

The evaluation team asked respondents to reflect on their recollection of various components of AEP Ohio Energy Efficiency Marketplace website and their experience with the HomeAdvisor feature.

- The 48 respondents who reported using the Energy Efficiency Marketplace to research their equipment purchases were shown screenshots of the marketplace website and asked to respond to two questions:
  1. Did they recall seeing certain elements on the page?
  2. Did they hire a smart thermostat installer using the HomeAdvisor service?

ELEMENTS OF SURVEY FOCUSED ON MARKETPLACE WEBSITE



Appliance Rebate Survey

(continued)

HomeAdvisor Element

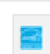
The HomeAdvisor button is not frequently used by customers purchasing products through the Marketplace.

- Eight respondents (17 percent of those using the Marketplace) recalled seeing the HomeAdvisor button while researching their product on the Marketplace.
- Of these, 5 accessed the Marketplace through a PC or tablet and 3 accessed the Marketplace through their mobile phone.

Two respondents stated that they clicked through the HomeAdvisor link to explore the HomeAdvisor offerings.

- Of these, one said that they hired a smart thermostat installer based on the information provided by the HomeAdvisor service.

RECALL OF MARKETPLACE WEBSITE ELEMENTS (n=48)

Element Description	Number that Recalled Seeing Element	Image of Element
Link to buy now/claim past purchase rebate	23	
Product specs	17	
Product rating (PC/tablet)	13	
Price rating (PC/tablet)	12	
Link to claim rebate (PC/tablet)	9	
HomeAdvisor	8	
Link to instant rebate (mobile)	7	
ENERGY STAR® logo	2	
Link to Appliance Connection (PC/tablet)	3	

Note: Customers were asked whether they accessed the Marketplace via their mobile device or a PC/tablet. Visual elements differed slightly across platforms depending on how the site was accessed.

MFDI Audits

Multi-Family Installations

The evaluation team examined all 2019 multi-family direct installation data to characterize this component of the program.

According to program tracking data, in 2019, LED lighting constituted approximately 67 percent of all multi-family measures.

- Similar to previous years, the multi-family direct installation audits found some program bulbs installed in traditionally low-use sockets (i.e. closets).
  - It is unknown if the bulbs were initially installed in low-use sockets, or if tenants relocated the bulbs after these were initially installed in more high-use sockets.
  - Auditors did their best to differentiate program bulbs versus tenant-purchased bulbs, however, auditors were not able to verify individual bulb serial numbers. It is possible that tenants installed their own bulbs in these sockets.

Eight percent of bulbs installed in audited units were candelabras (n=35), and all of these were located in high-use sockets.

Four units reported removing their LEDs. All four reported they did so because they did not like the light levels.

MULTI-FAMILY AUDIT: LOCATION OF BULBS

Location	Bulb Count
HIGH-USE LOCATIONS	
Kitchen (Mean HOU = 4.24)	86
Living Room (Mean HOU = 3.68)	63
Dining (Mean HOU = 3.37)	45
Exterior (Mean HOU = 6.82)	9
MEDIUM-USE LOCATIONS	
Hallway (Mean HOU = 2.55)	28
Bathroom (Mean HOU = 2.13)	117
Bedroom (Mean HOU = 2.20)	86
Laundry (Mean HOU = unknown; Utility = 2.26)	6
LOW-USE LOCATIONS	
Closet (Mean HOU = 0.99)	18

Note: Hours of Use (HOU) are from the *Residential Lighting Metering Study Final Report*, dated March 25, 2015, Completed for AEP Ohio by Navigant and EMI Consulting.

MFDI Audits

(continued)

In-unit In-Service Rates

To compute the In-Service Rates (ISR), the auditor verified the installation of measures and asked process-related questions of tenants present during the audit.

- The LED lighting ISR for multi-family direct installations was 0.83. This is similar to 2017 and 2018 audit results.
- On-site audits of multi-family direct installations revealed one tenant had 14 LED bulbs installed in the home and had removed 6 of these bulbs.
- The results from this single unit (out of the 39 units audited) decreased the overall ISR by 0.03.
- Nine audits were found to have a greater number of LED bulbs installed in the home than were originally installed by AEP Ohio. We were unable to determine which were program bulbs and which were installed by the tenant. The evaluation team capped units with an ISR greater than one at 1.00.

EX POST ISRS: MFDI AUDITS

Location	ISR	Number of Units
LED Bulb	0.83	39
Showerhead	0.85	25
Faucet Aerator	0.81	34

MFDI Audits

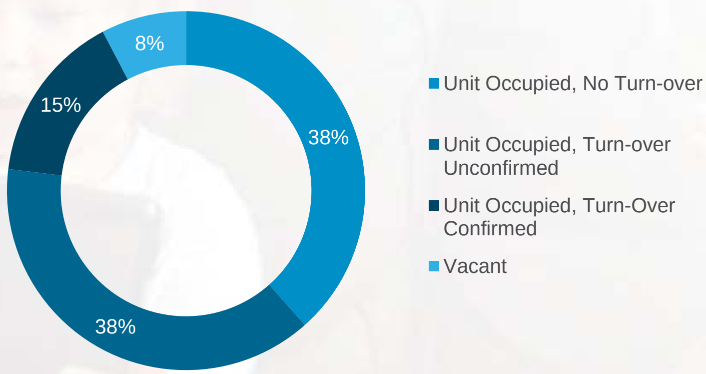
(continued)

Tenancy Turnover and Occupation

The evaluation team also observed multi-family unit “turn-over” during site visits, though the sample sizes were too small to detect significance and auditors were unable to determine “turn-over” on units for which the tenant was not present during the audit.

- At least 15 percent of units were currently occupied by a different tenant than when measure installation occurred.
- For another 38 percent of units, the tenant was not present for the audit, thus, auditors were unable to determine the “turn-over” for these units.

It is worth noting that, qualitatively, occupied units had higher ISRs for LEDs (0.85) compared to vacant units (0.79). However, sample sizes were too small to detect significant differences.



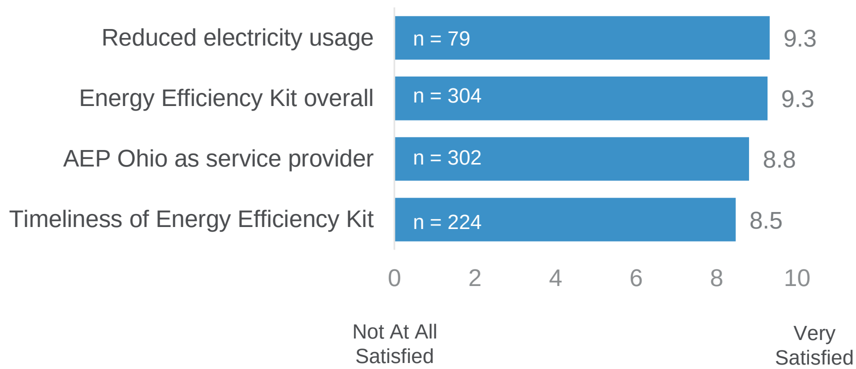
Energy Efficiency Kits Survey

Satisfaction

Satisfaction with Energy Efficiency Kits was high across every category in 2019.

- Aspects of the Energy Efficiency Kit that received high satisfaction ratings were the respondent's reduced electricity usage resulting from the kit and the Energy Efficiency Kit overall.
  - Respondents who rated their satisfaction lower than a 5 for the Energy Efficiency Kit overall said that they did not receive all the equipment in their kit (missing weather stripping or outlet covers).
- Respondents provided the lowest satisfaction ratings for the amount of time it took to receive their kit (mean = 8.5).
  - Respondents who rated their satisfaction a 5 or below (n = 10) said they would have liked their kit to arrive within 1 to 4 weeks.
  - Respondents who could recall how long it took their kit to arrive (n = 99), reported it took an average of 3.94 weeks to arrive.
- Respondents were, on average, highly satisfied with AEP Ohio as an electric service provider (mean = 8.8).
  - Satisfied customers (rating of 8 to 10) noted AEP Ohio's: reliability, good value, environmental conscious, the ease of the website, and that they are happy with the kits.
  - Dissatisfied customers (rating of less than 5) noted high costs of energy and lack of energy options.

OVERVIEW OF SATISFACTION RESULTS



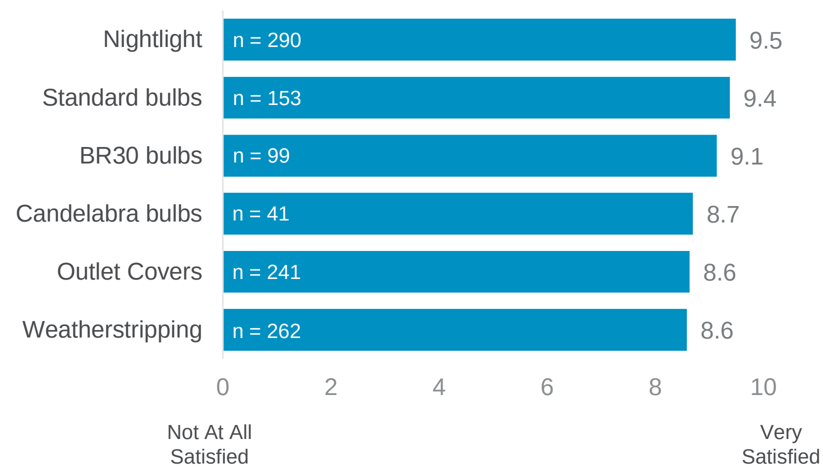
Energy Efficiency Kits Survey

Satisfaction with Kit Equipment

Satisfaction with Energy Efficiency Kits equipment was high across every category in 2019.

- Respondents provided the highest average satisfaction rating for nightlights (9.5), followed closely by standard bulbs (9.4).
  - The kit components with the lowest satisfaction score were outlet covers and weather stripping, which were both rated an average of 8.6.

SATISFACTION WITH KIT EQUIPMENT



Energy Efficiency Kits Survey

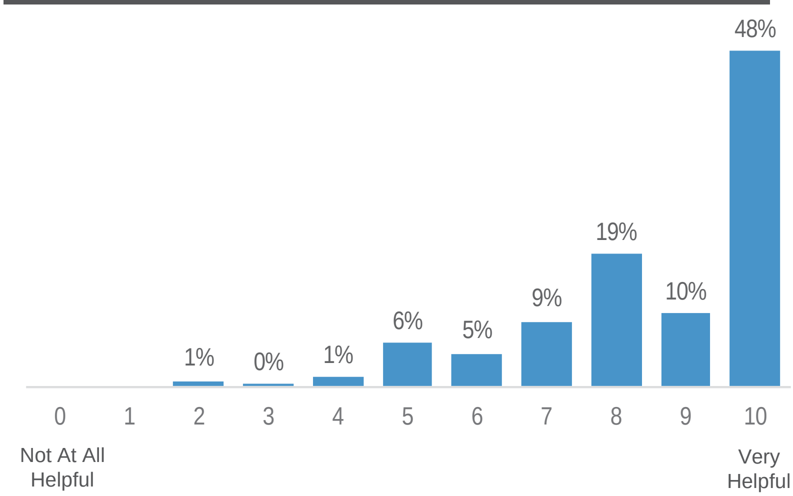
(continued)

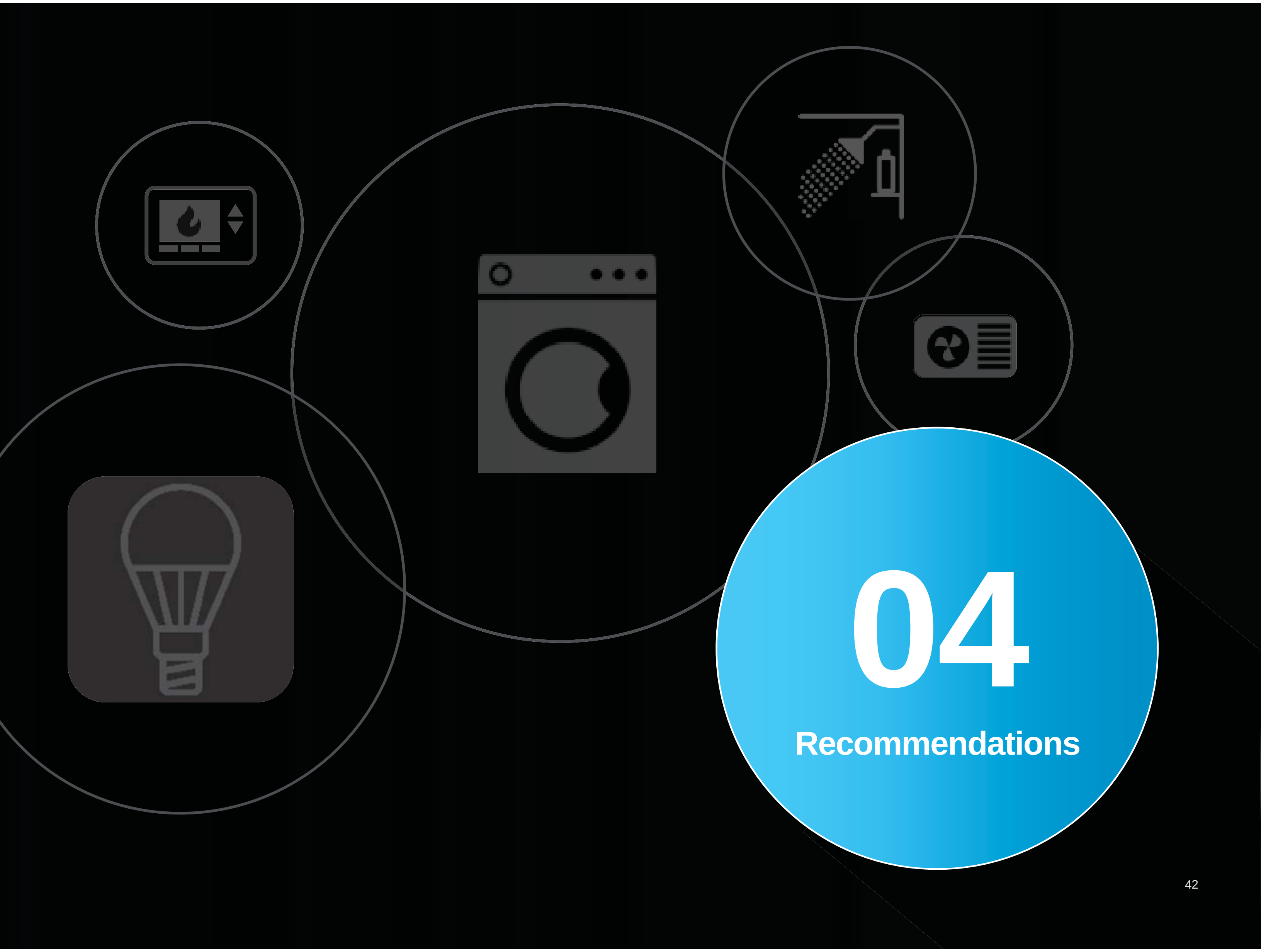
Energy Efficiency Kits Informational Material

Beginning in 2018, customers who received Energy Efficiency Kits also received educational materials included with the kits. The materials include an Energy Efficiency Action Plan checklist with information on each of the various pieces of equipment in the kit, details on the programs that AEP Ohio offers to residential customers, and a flyer for the Appliance Recycling program..

- Fifty-nine percent of respondents recalled receiving educational materials in their kit (n = 178).
- Most respondents felt the kit educational materials were very helpful, with an average rating of 8.6 (1 to 10 scale, not at all helpful to very helpful).

HELPFULNESS OF EDUCATIONAL MATERIALS





04 Recommendations

Review Marketplace LED Efficient Wattages

The evaluation team recommends that AEP Ohio review the efficient wattages reported in the Marketplace program tracking data. As shown below, wattages in the tracking data are irregular, in that they are not whole numbers. AEP Ohio should work with Enervee to identify the source of these wattages or the calculation method used to determine these wattages. For ex post savings, the evaluation team used the 2019 QPL to determine efficient wattage based on model number.

MARKETPLACE LED WATTAGES AS REPORTED IN THE PROGRAM TRACKING DATA

Marketplace LED Measure Wattages
4.38
5.48
6.02
7.66
8.10
8.21
9.31
9.86
10.40
11.50
12.04
17.52
19.71

Update ISRs for MFDI, SFDI, and Energy Efficiency Kits

The Draft Ohio TRM does not apply an ISR value for several measures in the SFDI and MFDI components (faucet aerators, showerheads, and LEDs). More recently researched ISRs are available for these and other measures in the MFDI, SFDI, and energy efficiency kit components.

The evaluation team recommends using the ISRs shown in the table below for faucet aerators, showerheads, and LEDs, and updating the Ohio TRM accordingly. The evaluation team's findings also suggest that the ex ante ISRs used for nightlights, outlet covers, and weather stripping are appropriate. We recommend using the ex post ISRs for these measures to update the Ohio TRM.

EX ANTE AND RECOMMENDED ISRS

Measure	Component	2019 Ex Ante ISR	Recommended ISR	Source of Recommended ISR
Faucet Aerators	MFDI[1]	1.00	0.81	2019 Multi-Family Direct Installation Audits
	SFDI	1.00	0.88	2016 In-Home Evaluation Report
Showerheads	MFDI[1]	1.00	0.85	2019 Multi-Family Direct Installation Audits
	SFDI	1.00	0.76	2016 In-Home Evaluation Report
LEDs	MFDI	0.90	0.83	2019 Multi-Family Direct Installation Audits
Nightlights	Energy Efficiency Kits	0.84	0.88	2019 Energy Efficiency Kits survey
Outlet Covers	Energy Efficiency Kits	0.48	0.50	2019 Energy Efficiency Kits survey
Weather stripping	Energy Efficiency Kits	0.48	0.49	2019 Energy Efficiency Kits survey

[1] AEP Ohio did not apply an ISR in the equation, effectively applying an ISR of 1.00.

Support and Training for HVAC & Water Heating Contractors

Increase Training and Support for Participating Contractors

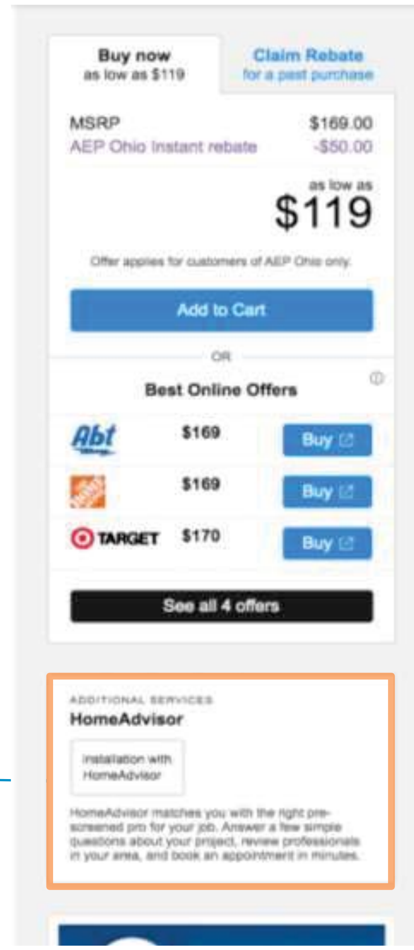
- A new program element this year included a $50 SPIF provided to contractors who sold rebate-eligible HVAC equipment or heat pump water heaters and applied for the rebate – giving their customer an instant rebate off their invoice.
- Despite the SPIF, program staff reported that participation among contractors was average.
  - Sales of rebate eligible heat pump water heaters decreased in 2019, from 285 in 2018 to 276 in 2019, as did sales of rebate-eligible air-source heat pumps, which decreased from 328 units in 2018 to 282 units in 2019 (164 of which received the $50 SPIF).
- To increase contractor participation and increase sales of rebate-eligible heat pump water heaters and HVAC equipment, AEP Ohio could provide additional support to contractors through marketing materials and other collateral, training on sales strategies for efficient equipment, and training on the rebate submission process.

Energy Efficiency Marketplace: Home Advisor Element

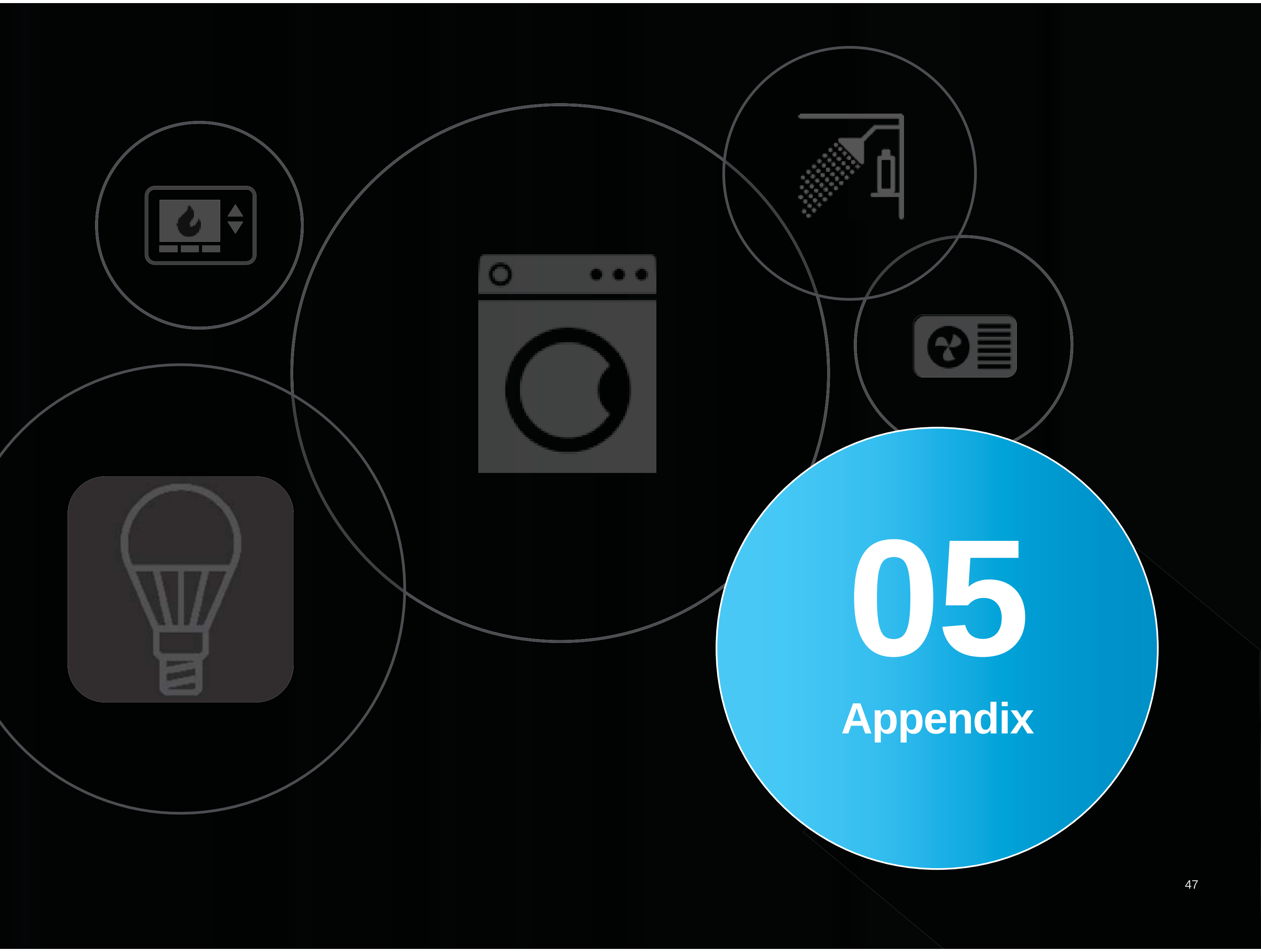
The evaluation team asked respondents who used the Energy Efficiency Marketplace how they interacted with the HomeAdvisor element, finding that eight respondents recalled the HomeAdvisor box (17% of respondents who used to Marketplace). Two respondents reported clicking on the element. One respondent said they found an installation contractor using HomeAdvisor.

To increase engagement with this element, the evaluation team recommends adding eye-catching color or a picture of a contractor to indicate the purpose of the element. Rather than “HomeAdvisor,” text on the clickable button should be actionable, such as “Find A Contractor”. Additionally, the amount of explanatory text should be reduced and a question such as “Need Help Finding an Installation Contractor?” could be added.

Further research, in the form of User Experience (UX) testing could provide additional information on the the most useful or engaging aspects of the HomeAdvisor feature and the Marketplace as a whole.



Current HomeAdvisor element on Marketplace page



05 Appendix

Appendix: Impacts Details

Impact Evaluation Analysis Details

This section provides detailed descriptions of the methods, assumptions, and parameters from the impact evaluation.

LED Ex Ante Savings

As LEDs are not included in the TRM, AEP Ohio modified the methods and parameters used for CFLs to account for differences in the two technologies. Instead of delta Watt multipliers, AEP Ohio calculated the difference between program LED wattages and equivalent baseline wattages. The following equations (Equation A-1 and Equation A-2) were used for ex ante energy and demand savings.

Equation A-1. Ex Ante Energy Savings for LEDs

$$\text{Annual kWh Savings} = (\text{BaselineWatts} - \text{LEDWatts}) * ISR_{LED} * HOU_{LED} * WHF_{E, LED} / 1{,}000$$

Equation A-2. Ex Ante Demand Savings for LEDs

$$\text{Summer Coincident Peak kW Savings} = (\text{BaselineWatts} - \text{LEDWatts}) * ISR_{LED} * CF_{LED} * WHF_{D, LED} / 1{,}000$$

Appendix: Impacts Details

(continued)

For LED ex ante savings, AEP Ohio applied the following parameters:

- ISR equal to 0.973 for energy efficiency kits, Markdown lighting, and Marketplace lighting; ISR equal to 1.00 for Single-Family Direct Install; ISR equal to 0.90 for Multi-Family Direct Install
- HOU value of 1,051 hours per year [1]
- CF of 0.13 [2]
- WHFE of 0.93 and 1.34 for WHFD [3]

Table A-1 presents the baseline wattages used by AEP Ohio to calculate ex ante savings for each program wattage range. AEP Ohio applied baseline wattage equivalencies recommended in the 2018 evaluation.

TABLE A-1: EX ANTE LED BASELINE WATTAGE, BY PROGRAM MEASURE WATTAGE

Program LED Measure Wattage	Ex Ante Baseline Wattage	Count of LEDs
Specialty		
2 - 3	25	135,545
4 - 5	40	231,924
6 – 7	50	64,968
8 – 10	65	387,488
11 – 15	90	86,746
16 – 23	120	14,193
Standard		
3 – 5	29	145,433
6 – 10	43	2,053,694
11 – 13	53	160,650
14 – 22	72	177,119
22 +	150	726
TOTAL	**–**	**3,458,486**

Note. From AEP Ohio program tracking data.
There were no standard 2-3 W LED bulbs incented in 2019.

[1] Residential Lighting Metering Study (Final Report), March 25, 2015.
[2] Residential Lighting Metering Study (Final Report), March 25, 2015.
[3] AEP Ohio Residential Lighting Interactive Effects Modeling Results memo, January 2016.

Appendix: Impacts Details

(continued)

LED Ex Post Savings

For LED ex post savings, the evaluation team followed an approach similar to AEP Ohio's method for calculating ex ante savings. For ISR, the value varied by component, as shown in Table A-2.

TABLE A-2: *EX POST* LED ISR BY PROGRAM TYPE

Component	ISR
Upstream Lighting (Markdown)	0.97 [1]
Online Energy Efficiency Marketplace	0.97 [1]
Energy Efficiency Kits	0.97 [2]
Multi-Family Direct Installation	0.83 [3]
Single-Family Direct Installation	1.00 [4]

[1] Based on a 2014 LED survey of 101 AEP Ohio customers.
[2] Based on 2019 Energy Efficiency Kits Survey
[3] Based on 2019 Multi-Family Direct Installation audits.
[4] Based on AEP Ohio assumption of direct installation rate as reported in the 2016 In-Home evaluation report

Appendix: Impacts Details

(continued)

Table A-5 summarizes the differences in savings parameters for ex ante and ex post savings.

TABLE A-5. KEY EX ANTE AND EX POST PARAMETERS FOR LEDS

Parameter Description	Parameter	Ex Ante Value	Ex Post Value	Ex Post Source
Average Program Wattage (W) - Marketplace	LEDWatts	10.2	9.3	Tracking Data; Evaluation based on 2019 ENERGY STAR® product list, Tracking Data
Average Program Wattage (W) – Markdown, Kit, SFDI, and MFDI	LEDWatts	8.6	8.6	
Average Standard Wattage (W) - Marketplace	BaselineWatts	53.9	53.9	Evaluation based on 2019 ENERGY STAR® product list, Tracking Data
Average Standard Wattage (W) – Markdown, Kit, SFDI, and MFDI	BaselineWatts	52.3	52.3	
Hours of Use (hours/year)	HOU_{LED}	1,051	1,051	Lighting Metering Study[1]
Coincidence Factor	CF_{LED}	0.13	0.13	
Waste Heat Factor for Energy	$WHF_{E, LED}$	0.93	0.93	Interactive Effects Modeling Study[2]

[1] Residential Lighting Metering Study (Final Report), March 25, 2015.
[2] AEP Ohio Residential Lighting Interactive Effects Modeling Results" memo, January 2016.

Appendix: Impacts Details

(continued)

Smart Thermostat Savings Analysis Details

This sub-section describes the analysis methods applied to smart thermostats.

Smart Thermostat Ex Ante Savings

As smart thermostats are not included in the TRM, AEP Ohio chose to use the Illinois Technical Reference Manual (IL TRM) approach for advanced thermostats as well as the heat reduction parameter developed for the 2018 evaluation, as seen in Equation A-3 and Equation A-4.

Equation A-3. Ex Ante Energy Savings for Smart Thermostats

Annual kWh Savings = Annual kWh Heating Savings + Annual kWh Cooling Savings

*Annual kWh Heating Savings = %ElectricHeat * ElecHeatingConsumption * HeatingReduction * HF * ISR + (GasHeatFlag * F_e)*

*Annual kWh Cooling Savings = %AC * ((FLH * Btu / hr * 1 / SEER) / 1000) * CoolingReduction * ISR*

Equation A-4. Ex Ante Demand Savings for Smart Thermostats

*Summer Coincident Peak kW Savings = (CoolingReduction * Btu / hr * (1 / EER)) / 1000 * ISR * CF*

Appendix: Impacts Details

(continued)

In 2017, AEP Ohio began to collect data on the baseline home cooling equipment (%AC). For homes without baseline home cooling equipment data, AEP Ohio assumed customers did not have cooling equipment.

AEP Ohio applied the heating reduction value recommended in the 2018 ex post impact calculations. This value was calculated based on the baseline thermostat technology reported in the 2018 appliance rebate survey and using the IL TRM formula, as shown in Equation A-5. The heating reduction value in the past few years were trending downward; thus, to align the heating reduction value with the trend and to prevent overstated ex ante savings for smart thermostats in 2019, the evaluation team recommended assuming that all installed thermostats replace programmable thermostats (resulting in a heating reduction value of 0.056).

Equation A-5. Ex Ante Heating Reduction Formula

*HeatingReduction = 0.088 * %ManualThermostats + 0.056 * %ProgrammableThermostats*

Where:

%ManualThermostats = The percentage of homes replacing manual thermostats (Assumed to be zero, as AEP Ohio assumed that all installed thermostats replaced programmable thermostats, based on 2018 evaluation results)

%ProgrammableThermostats = The percentage of homes replacing programmable thermostats (100 percent, based on 2018 evaluation results)

Appendix: Impacts Details

(continued)

Smart Thermostat Ex Post Savings

To calculate ex post impacts, the evaluation team mirrored AEP Ohio's approach. Unlike AEP Ohio, the evaluation team updated the heat reduction parameter and the ISR based on responses to the 2019 appliance rebate survey.

Table A-5 presents the differences in key parameter values for ex ante and ex post calculations. Parameters not described in Table A-6 were values pulled from the tracking database.

TABLE A-5. KEY *EX ANTE* AND *EX POST* PARAMETERS FOR SMART THERMOSTATS

Parameter Description	*Ex Ante* Value	*Ex Post* Value	*Ex Post* Source
Electric Heating Consumption – Electric Forced Air	17,789 kWh/year	17,789 kWh/year	IL TRM
Electric Heating Consumption – Heat Pump	10,464 kWh/year	10,464 kWh/year	IL TRM
Heating Reduction	0.056	0.070	IL TRM and 2019 Appliance Rebate Survey
Household Factor – Multi-Family	0.65	0.65	IL TRM
Household Factor – Single-Family	1	1	IL TRM
Cooling Full Load Hours	552	552	Draft OH TRM
Cooling System Efficiency (SEER)	9.734	9.734	Calculated by AEP Ohio using In-home Energy program data
Cooling System Size (BTU/hr)	33,600	33,600	IL TRM
ISR	1.00	0.98	2019 Appliance Rebate Survey

Appendix: Impacts Details

(continued)

The ex post heating reduction values were calculated based on the baseline thermostat technology reported in the 2019 appliance rebate survey. In 2019, survey respondents reported a smaller portion of programmable thermostats than in 2018 (54 percent in 2019; 58 percent in 2018; 61 percent in 2017; 23 percent in 2016). No 2019 respondents reported replacing smart thermostats with the program-rebated smart thermostats (receiving no heating reduction at all), down from 10 percent of respondents in 2018.

Equation A-6. Ex Post Heating Reduction Formula

$$HeatingReduction = 0.088 * \%ManualThermostats + 0.056 * \%ProgrammableThermostats + 0 * \%SmartThermostats$$

Where:

%ManualThermostats = The percentage of homes replacing manual thermostats (45 percent in the 2019 appliance rebate survey)

%ProgrammableThermostats = The percentage of homes replacing programmable thermostats (54 percent in the 2019 appliance rebate survey)

%SmartThermostats = The percentage of homes replacing smart thermostats (0 percent in the 2019 appliance rebate survey)

Appendix: Impacts Details

(continued)

Clothes Washer Savings Analysis Details

This sub-section describes the analysis methods applied to clothes washers.

Clothes Washer Ex Ante Savings

To determine ex ante savings for clothes washers, the evaluation team first assessed the methodologies used by AEP Ohio. The evaluation team confirmed AEP Ohio applied the deemed savings values specified in the TRM. According to the TRM, savings for clothes washers are deemed for two levels of efficiency (ENERGY STAR® and CEE Tier 3) using the per-unit savings shown in Table A-7.

TABLE A-7. DRAFT 2010 OHIO TRM PER-UNIT SAVINGS VALUES FOR CLOTHES WASHERS

Efficiency Level	Per-Unit Energy Savings (kWh)	Per-Unit Peak Demand Savings (kW)
ENERGY STAR® (CEE Tier 1 and 2)	202	0.028
CEE Tier 3	233	0.033

Source: Clothes Washer – ENERGY STAR® and CEE TIER 3 (Time of Sale), Draft 2010 State of Ohio Energy Efficiency Technical Reference Manual, August 6, 2010. p. 59.

Clothes Washer Ex Post Savings

The clothes washer ex post savings methodology also followed the TRM. The evaluation team calculated the ex post savings using the same parameters and equations as previously described. Therefore, the ex post savings are equal to the ex ante savings.

Appendix: Impacts Details

(continued)

Refrigerator Savings Analysis Details

Refrigerator Ex Ante Savings

To determine ex ante savings for refrigerators, the evaluation team first assessed the methodologies used by AEP Ohio. The evaluation team confirmed AEP Ohio applied the TRM-specified deemed savings values for those refrigerator configurations described in the TRM. For refrigerators, the TRM deemed savings values are based on whether the appliance meets ENERGY STAR® or CEE Tier 2 specifications. Savings are based on the specification and the unit configuration as shown in Table A-9. For compact refrigerators, AEP Ohio used deemed savings values found in the ENERGY STAR® refrigerator QPL.[1]

TABLE A-9. DRAFT 2010 OHIO TRM PER-UNIT SAVINGS VALUES FOR REFRIGERATORS

Efficiency Level	Refrigerator Configuration	Per-Unit Energy Savings (kWh)	Per-Unit Demand Savings (kW)
ENERGY STAR®	Bottom Freezer	119	0.021
	Top Freezer	100	0.018
	Side by Side	142	0.025
CEE Tier 2	Bottom Freezer	149	0.026
	Top Freezer	124	0.022
	Side by Side	177	0.031

Source: Efficient Refrigerator – ENERGY STAR® and CEE TIER 2 (Time of Sale), Draft 2010 State of Ohio Energy Efficiency Technical Reference Manual, August 6, 2010. p. 53.

[1] Compared AEP Ohio's deemed savings values to those found in the following source: ENERGY STAR® Certified Residential Refrigerators, downloaded December 30, 2019. http://www.energystar.gov/productfinder/download/certified-residential-refrigerators/

Appendix: Impacts Details

(continued)

Refrigerator Ex Post Savings

The refrigerator ex post savings methodology also followed the TRM. The evaluation team calculated the ex post savings using the same parameters and equations as previously described. Therefore, the ex post savings are equal to the ex ante savings.

Appendix: Impacts Details

(continued)

Heat Pump Water Heater Savings Analysis Details

This sub-section describes the analysis methods applied to heat pump water heaters.

Heat Pump Water Heater Ex Ante Savings

To determine ex ante savings for heat pump water heaters, the evaluation team first assessed the methodologies used by AEP Ohio. The evaluation team confirmed AEP Ohio continue to apply TRM-specified savings values with the modifications suggested by the evaluation team in the 2016 evaluation. For heat pump water heaters, TRM-specified savings values are based on the following equations:

Equation A-7. *Ex Ante* Energy Savings for Heat Pump Water Heaters

*Annual kWh Savings = kWhbase * ((COPnew - COPbase)/COPnew) + KWHcooling – KWHheating*

Where:

kWhbase = Average electric domestic hot water consumption (TRM deemed value of 3,460)

COPnew = Coefficient of Performance (efficiency) of Heat Pump water heater (TRM deemed value of 2.0)

COPbase = Coefficient of Performance (efficiency) of standard electric water (TRM deemed value of 0.904)

KWHcooling = Cooling savings from conversion of heat in home to water heat (TRM deemed value of 180)

KWHheating = Heating cost from conversion of heat in home to water heat (based on heating fuel type (TRM deemed value of 1,577 for electric resistance, 799 for heat pump, and 0 for fossil fuel)

Appendix: Impacts Details

(continued)

Equation A-7. Ex Ante Demand Savings for Heat Pump Water Heaters

*Summer Coincident Peak kW Savings = Annual kWh Savings / Hours * CF*

Where:

Hours = Full load hours of hot water heater (TRM deemed value of 2,533)

CF = Summer Peak Coincidence Factor for measure (TRM deemed value of 0.346)

Table A-11 presents the per-unit savings values estimated using these equations.

TABLE A-11. DRAFT 2010 OHIO TRM PER-UNIT SAVINGS VALUES FOR HEAT PUMP WATER HEATERS

Home Heating System	Per-Unit Energy Savings (kWh)	Per-Unit Demand Savings (kW)
Fossil Fuel	2,076	0.280
Heat Pump	1,297	0.180
Electric Resistance Heat	499	0.068

Source: Heat Pump Water Heaters (Time of Sale), Draft 2010 State of Ohio Energy Efficiency Technical Reference Manual, August 6, 2010. p. 86.

Heat Pump Water Heater Ex Post Savings

The evaluation team verified that AEP Ohio correctly applied the TRM methods and the modifications suggested in the 2016 evaluation. AEP Ohio was able to define a heating type for all homes receiving heat pump water heaters in 2019. In previous years, the evaluation team had calculated savings for unknown heating types using data from the 2013 AEP Ohio Residential Appliance Saturation Survey (RASS) survey, which indicated 31 percent of electric heating came from heat pumps and 69 percent came from electric resistance heaters.

Appendix: Impacts Details

(continued)

Dehumidifier Savings Analysis Details

This sub-section describes the analysis methods applied to dehumidifiers.

Dehumidifier Ex Ante Savings

To determine ex ante savings for dehumidifiers, the evaluation team first assessed the methodologies used by AEP Ohio. The evaluation team confirmed AEP Ohio applied the TRM-specified deemed savings values. According to the TRM, savings for dehumidifiers are deemed based on the capacity of the dehumidifier.

Dehumidifier Ex Post Savings

The dehumidifier ex post savings methodology also followed the TRM. The evaluation team calculated the ex post savings using the same parameters and equations as previously described. Therefore, the ex post savings are equal to the ex ante savings.

Appendix: Impacts Details

(continued)

Central Air Conditioners Savings Analysis Details

Central Air Conditioner Ex Ante Savings

To determine ex ante savings for central air conditioners, the evaluation team first assessed the methodologies used by AEP Ohio. AEP Ohio rebated both air conditioner purchases at the time of sale and the early replacement of central air conditioners. The evaluation team confirmed AEP Ohio applied the TRM-specified equations for central air conditioners rebated at the time of sale, as detailed in Equation A-10 and Equation A-11.

Equation A-10. Ex Ante Energy Savings for Central Air Conditioners

$$\textit{Annual kWh Savings} = (FLH_{cool} * BtuH * (1/ SEER_{base} - 1 / SEER_{ee})) / 1000$$

Equation A-11. Ex Ante Demand Savings for Central Air Conditioners

$$\textit{Summer Coincident Peak kW Savings} = (BtuH * (1 / EER_{base} - 1 / EER_{ee})) / 1000 * CF$$

AEP Ohio applied the TRM deemed parameter values for full load cooling hours (FLH_{cool}), SEER baseline efficiency ($SEER_{base}$), EER baseline efficiency (EER_{base}), and coincidence factor (CF). For the remaining variables, AEP Ohio used values from the tracking data.

Central Air Conditioner *Ex Post* Savings

The evaluation team reviewed the savings calculations used by AEP Ohio and mirrored their methodology to calculate ex post savings, and therefore, the ex post savings are equal to the ex ante savings.

Appendix: Impacts Details

(continued)

Air Source Heat Pumps Savings Analysis Details

This sub-section describes the analysis methods applied to air source heat pumps.

Air Source Heat Pump Ex Ante Savings

To determine ex ante savings for air source heat pumps, the evaluation team first assessed the methodologies used by AEP Ohio. The evaluation team verified that AEP Ohio correctly applied the TRM calculations detailed in Equation A-14 and Equation A-15. AEP Ohio applied most parameters as described in the TRM, however, they updated the SEER baseline value (14) and heating season performance factor (HSPF) baseline value (8.2) based on updated Federal Regional Standards for cooling equipment that went it to effect on Jan 1, 2015.[1] If records were missing baseline measure size information ($SEER_{base}$ and EER_{base}), AEP Ohio would have estimated savings as the average per-unit savings. No records in 2019 were missing baseline measures size information.

Equation A-14. Ex Ante Energy Savings for Air Source Heat Pumps

*Annual kWh Savings = (FLHcool * BtuH * (1/SEERbase - 1/SEERee))/1000 + (FLHheat * BtuH * (1/HSPFbase – 1/HSPFee))/1000*

Equation A-15. Ex Ante Demand Savings for Air Source Heat Pumps

*Summer Coincident Peak kW Savings = BtuH * (1/EERbase - 1/EERee))/1000 * CF*

Air Source Heat Pump Ex Post Savings

The evaluation team applied the same savings calculations used by AEP Ohio, and therefore, ex post energy savings were the same as ex ante values.

[1] http://www.sgtorrice.com/files/Pages/News/2015-Regional-Standards-Cooling-Heating%20Products-rev1.pdf

Appendix: Impacts Details

(continued)

Ductless Mini-Split Savings Analysis Details

Ductless Mini-Split Ex Ante Savings

To determine ex ante savings for air source heat pumps, the evaluation team first assessed the methodologies used by AEP Ohio. As ductless mini-split systems are not included specifically in the TRM, AEP Ohio applied the air source heat pump savings algorithms as seen in Equation A-14 and Equation A-15. AEP Ohio applied all of the air source heat pump parameter assumptions found in the TRM.

Ductless Mini-Split Ex Post Savings

The evaluation team reviewed the savings calculations used by AEP Ohio and determined their methodology was appropriate. The evaluation team mirrored their methodology to calculate ex post savings, and therefore, the ex post savings are equal to the ex ante savings.

Appendix: Impacts Details

(continued)

Ground Source Heat Pumps Savings Analysis Details

This sub-section describes the analysis methods applied to ground source heat pumps.

Ground Source Heat Pump Ex Ante Savings

To determine ex ante savings for ground source heat pumps, the evaluation team first assessed the methodologies used by AEP Ohio. AEP Ohio applied the TRM calculations detailed in Equation A-16 and Equation A-17.

Equation A-16. Ex Ante Energy Savings for Ground Source Heat Pumps

*Annual kWh Savings = (FLHcool * BtuH * (1/SEERbase – (1/(EERee * 1.02))/1000 + (FLHheat * BtuH * (1/HSPFbase – (1/COPee * 3.412))/1000*

Equation A-17. Ex Ante Demand Savings for Ground Source Heat Pumps

*Summer Coincident Peak kW Savings = BtuH * (1/EERbase - 1/(((EERee * 1.02) * 0.37) + 6.43))/1000 *CF*

Ground Source Heat Pump Ex Post Savings

The evaluation team applied the same savings calculations used by AEP Ohio, and therefore, ex post energy savings were the same as *ex* ante values.

Appendix: Impacts Details

(continued)

Nightlights Savings Analysis Details

This subsection describes the analysis methods applied to nightlights.

Nightlight Ex Ante Savings

Methodologies for determining savings achieved from nightlights are not present in the TRM, thus AEP Ohio used the ex-post savings results of the 2012 In-Home Energy Program evaluation report (per-unit value of 21.07 kWh). No savings values were claimed for demand kW savings. AEP Ohio applied ISR values that varied by component, as seen in Table A-16.

Nightlight Ex Post Savings

The evaluation team applied the same methodologies as AEP Ohio to calculate ex post savings but applied a Multi-Family Direct Installation ISR of 0.69 based on results from the 2018 Multi-Family onsite audits and an Energy Efficiency Kit ISR of 0.88 based on results from the 2019 Energy Efficiency Kit survey, as shown in Table A-16.

TABLE A-16. EX ANTE & EX POST ISRS – NIGHTLIGHTS

Component	Ex Ante ISR Adjustment	Ex Post ISR Adjustment	Source of Ex Post ISR Adjustment
Energy Efficiency Kits	0.84[1]	0.88	2019 Energy Efficiency Kits survey
Single-Family Direct Installation	0.83[2]	0.83	2016 In-Home Evaluation Report
Multi-Family Direct Installation	0.57[3]	0.69	2018 Multi-Family onsite audits

[1] Source of ex ante ISR = 2017 Energy Efficiency Kits survey.

[2] Source of ex ante SFDI is the same as ex post, the 2016 In-Home Evaluation Report.

[3] Source of ex ante ISR = 2017 Multi-Family onsite audits.

Appendix: Impacts Details

(continued)

Showerheads Savings Analysis Details

Showerheads Ex Ante Savings

The evaluation team verified that AEP Ohio calculated ex ante savings for showerheads using an adapted version of the methodology detailed in the TRM.[1] Equation A-18 and Equation A-19 show the TRM equations used by AEP Ohio for showerhead energy and demand savings.

Equation A-18. Draft 2010 Ohio TRM-Specified Energy Savings for Showerheads

*ΔkWh = ISR * (GPMbase - GPMlow) * kWh/GPMreduced*

Equation A-19. Draft 2010 Ohio TRM-Specified Demand Savings for Showerheads

*ΔkW = ΔkWh / Hours * CF*

The following parameters were used by AEP Ohio:

- ISR = 0.81 (Customer self-install) / ISR = 1.00 (Direct install)
- GPMbase = 2.87 (Gallons per minute of baseline showerhead)
- GPMlow = 1.5 (Gallons per minute of low flow showerhead)
- kWh / GPMreduced = 173 (Assumed kWh savings per GPM reduction)[2]
- Hours = Gal/person * #people * days / y) / SH/home / GPM / 60 (Average number of hours per year spent using showerhead)
  - gals/day = 11.6 (Average gallons per day used for showering)
  - # people = 2.46 (Average number of people per household)
  - days/y = 365 (Days shower used per year)
  - SH/home = 2.1 (Average number of showers in the home)
- CF = 0.0037 ([11.6 * 2.46 * 365] / 2.1 / 2.87 / 60 = 29 hours = Summer peak coincidence factor for measure)

[1] Replies from Vermont Energy Investment Corporation (VEIC) to Joint Objections and Comments to the August 6, 2010 Draft Technical Reference Manual from Ohio Electric Distribution Utilities and IEU, Ohio Gas Utilities, Ohio Consumers' Counsel and Other Advocacy Groups, and OPower INC. (2010).

[2] AEP Ohio adjusted this value from 179 to 173 based on VEIC comments

Appendix: Impacts Details

(continued)

Showerheads Ex Post Savings

The evaluation team applied ISR values that varied by component, as seen in Table A-17.

TABLE A-17. *EX POST* ISR ADJUSTMENTS - SHOWERHEADS

Component	ISR Adjustment	Source of ISR Adjustment
Energy Efficiency Kits	0.43	2017 Energy Efficiency Kits Survey
Single-Family Direct Installation	0.76	2016 In-Home Evaluation Report
Multi-Family Direct Installation	0.85	2019 Multi-Family onsite audits[1]

[1] In 2018, the evaluation team only audited a single MFDI unit with a program-installed showerhead, thus, the evaluation team applied the ISR value from the previous evaluation year.

Appendix: Impacts Details

(continued)

Faucet Aerators Savings Analysis Details

Faucet Aerators Ex Ante Savings

The evaluation team verified that AEP Ohio calculated ex ante savings for faucet aerators based on modified calculations from the TRM, as described in Equation A-20 and Equation A-21.[1]

Equation A-20. Draft 2010 Ohio TRM-Specified Energy Savings for Faucet Aerators

$\Delta kWh = ISR * ((GPMbase - GPMlow / GPMbase) * 97.02$[2]

Equation A-21. Draft 2010 Ohio TRM-Specified Demand Savings for Faucet Aerators

$\Delta kW = \Delta kWh * 0.000125$

The evaluation team verified the following parameters were used by AEP Ohio:

- GPMbase = 2.2 (Gallons per minute of baseline faucet)
- GPMlow = 1.5 (Gallons per minute of low flow aerator)

AEP Ohio applied the following ISRs for each component:

EX ANTE ISR ADJUSTMENTS - FAUCET AERATORS	
Component	**ISR Adjustment**
Energy Efficiency Kits	0.48
Single-Family Direct Installation	1.00
Multi-Family Direct Installation	1.00

[1] Replies from Vermont Energy Investment Corporation (VEIC) to Joint Objections and Comments to the August 6, 2010 Draft Technical Reference Manual from Ohio Electric Distribution Utilities and IEU, Ohio Gas Utilities, Ohio Consumers' Counsel and Other Advocacy Groups, and OPower INC. (2010).

[2] AEP Ohio adjusted this value from 77.0 to 97.02 based on VEIC comments.

Appendix: Impacts Details

(continued)

Faucet Aerators Ex Post Savings

The evaluation team applied ISR values that varied by component, as seen in Table A-18.

TABLE A-18. *EX POST* ISR ADJUSTMENTS - FAUCET AERATORS

Component	ISR Adjustment	Source of ISR Adjustment
Energy Efficiency Kits	0.43	2017 Energy Efficiency Kits survey
Single-Family Direct Installation	0.88	2016 In-Home Evaluation Report
Multi-Family Direct Installation	0.81	2019 Multi-Family onsite audits

Appendix: Impacts Details

(continued)

Smart Power Strips Savings Analysis Details

Smart Power Strips Ex Ante Savings

Equation A-22 and Equation A-23 shown are the equations used by AEP Ohio for smart power strips energy and demand savings:

Equation A-22. Energy Savings for Smart Power Strips

Deemed kWh Savings ($\Delta kWh_{7\text{-}Plug}$) *= TRM kWh / TRM HOU * VEIC HOU*

Where:

- *TRM kWh* = Deemed energy savings value from the Draft Ohio TRM = 102.8
- *TRM HOU* = Annual number of hours during which the controlled standby loads are turned off by the smart strip used by Draft Ohio TRM = 7,129
- *VEIC HOU* = Annual number of hours during which the controlled standby loads are turned off by the smart strip recommended by VEIC = 7,152.5

Equation A-23. Draft 2010 Ohio TRM-Specified Demand Savings for Smart Power Strips

Summer Coincident Peak Demand Savings(ΔkW) = ΔkWh */ Hours *CF*

Where:

- Hours = Annual number of hours during which the controlled standby loads are turned off by the smart strip = 7,152.5[2]
- CF = Summer peak coincidence factor for measure = 0.64[2]

AEP Ohio applied an ISR of 0.83 for Single-Family Direct Installation based on the 2016 In-Home Evaluation Report and 0.59 for Multi-Family Direct Installation, based on the 2018 Multi-Family onsite audits.

[2] Updated annual hours of use and coincidence factor based on VEIC response document.

Source: Replies from Vermont Energy Investment Corporation (VEIC) to Joint Objections and Comments to the August 6, 2010 Draft Technical Reference Manual from Ohio Electric Distribution Utilities and IEU, Ohio Gas Utilities, Ohio Consumers' Counsel and Other Advocacy Groups, and OPower INC. (2010).

Appendix: Impacts Details

(continued)

Smart Power Strips Ex Post Savings

The evaluation team reviewed the savings calculations used by AEP Ohio and determined their methodology was appropriate. The evaluation team mirrored their methodology to calculate ex post savings, and therefore, the ex post savings are equal to the ex ante savings

Appendix: Impacts Details

(continued)

Pool Pump Savings Analysis Details

Pool Pump Ex Ante Savings

AEP Ohio used the TRM per-unit variable speed pool pump deemed savings values to estimate ex ante savings for both energy and demand. Those values were:

- Energy savings per unit (kWh): 1,170
- Demand savings per unit (kW): 1.73

Pool Pump Ex Post Savings

The evaluation team applied the same methodologies as AEP Ohio to calculate ex post savings. Therefore, ex ante is equal to ex post.

Appendix: Impacts Details

(continued)

Door Sweep Savings Analysis Details

Door Sweep Ex Ante Savings

To determine ex ante savings for door sweeps, the evaluation team first assessed the methodologies used by AEP Ohio. As door sweeps are not included specifically in the TRM, AEP Ohio applied the door sweep savings algorithms as seen in Equation A-24 and Equation A-25. AEP Ohio applied parameters for energy and demand savings as described in the 2014 evaluation of the E3Smart Program.

Equation A-24. Per Unit Energy Savings for Door Sweeps

$$\Delta kWh = kWhSales * ISR * Percentage\ of\ All\text{-}Electric\ Homes$$

Where:

- *kWhSales* = 70.42
- *Percentage of All-Electric Homes = 20%*
- *ISR* = 1.00

Equation A-25. Per Unit Demand Savings for Door Sweeps

$$\Delta kW = kWSales * ISR * Percentage\ of\ All\text{-}Electric\ Homes$$

Where:

- *kWSales* = 0.009
- *Percentage of All-Electric Homes = 20%*
- *ISR* = 1.00

Door Sweep Ex Post Savings

The evaluation team reviewed the savings calculations used by AEP Ohio and determined their methodology was appropriate. The evaluation team mirrored their methodology to calculate ex post savings, and therefore, the ex post savin are equal to the ex ante savings.

Appendix: Impacts Details

(continued)

Pipe Wrap Savings Analysis Details

Pipe Wrap Ex Ante Savings

The evaluation team verified that AEP Ohio calculated ex ante savings for pipe wrap based on calculations from the Draft Ohio TRM, as described in Equation A-26 and Equation A-27.

Equation A-26. Draft 2010 Ohio TRM-Specified Energy Savings for Pipe Wrap

Deemed kWh Savings $(\Delta kWh) = ((1/R_{exist} - 1/R_{new}) * (L * C) * \Delta T * 8{,}760) / \eta DHW / 3413$

Where:

- R_{exist} = Pipe heat loss coefficient of uninsulated pipe (existing) (Btu/hr-°F-ft) = 1.0[1]
- R_{new} = Pipe heat loss coefficient of insulated pipe (new) (Btu/hr-°F-ft)
- *L* = Length of pipe from water heating source covered by pipe wrap (ft)
- *C* = Circumference of pipe (ft) (Diameter (in) * π * 0.083)
- ΔT = Average temperature difference between supplied water and outside air temperature (°F) = 65°F
- *8,760* = Hours per year
- ηDHW = Recovery efficiency of electric hot water heater = 0.98
- *3,413* = Conversion from Btu to kWh

Equation A-27. Draft 2010 Ohio TRM-Specified Demand Savings for Pipe Wrap

$\Delta kW = \Delta kWh/8760$

Where:

- ΔkWh = kWh savings from pipe wrap installation
- *8,760* = Hours per year

[1] Navigant Consulting Inc., April 2009; "Measures and Assumptions for Demand Side Management (DSM) Planning; Appendix C Substantiation Sheets", p77.
[2] Assumes 130°F water leaving the hot water tank and average temperature of basement of 65°F.
[3] Electric water heater have recovery efficiency of 98%: http://www.ahrinet.org/ARI/util/showdoc.aspx?doc=576

Appendix: Impacts Details

(continued)

Pipe Wrap Ex Post Savings

The evaluation team reviewed the savings calculations used by AEP Ohio and determined their methodology was appropriate. The evaluation team mirrored their methodology to calculate ex post savings, and therefore, the ex post savings are equal to the ex ante savings.

Appendix: Impacts Details

(continued)

Weather stripping Savings Analysis Details

Weather stripping Ex Ante Savings

To determine ex ante savings for weather stripping, the evaluation team first assessed the methodologies used by AEP Ohio. As weather stripping is not included specifically in the TRM, AEP Ohio applied a deemed savings value based on research for AEP Ohio's 2019 e^{3}smart^{SM} evaluation, as seen in Table A-20. No savings values were claimed for demand kW savings.

TABLE A-19. WEATHERSTRIPPING DEEMED SAVINGS VALUE

Component	Deemed Savings	Source of Value
Energy Efficiency Kits	11.1 per 17ft roll	2019 e^{3}smart^{SM} Evaluation

AEP Ohio applied an ISR of 0.48, using the ISR for faucet aerators from the Draft 2010 Ohio TRM.

Weather stripping Ex Post Savings

The evaluation team reviewed the savings calculations used by AEP Ohio and determined their methodology was appropriate. The evaluation team mirrored their methodology to calculate ex post savings, but applied an adjusted ISR of 0.49 based on primary research from the 2019 Energy Efficiency Kit survey.

TABLE A-21. WEATHERSTRIPPING DEEMED SAVINGS VALUE

Component	Adjusted ISR	Source of Value
Energy Efficiency Kits	0.49	2019 Energy Efficiency Kits Survey

Appendix: Impacts Details

(continued)

Outlet Covers Savings Analysis Details

Outlet Covers Ex Ante Savings

To determine ex ante savings for outlet covers, the evaluation team first assessed the methodologies used by AEP Ohio. As outlet covers are not included in the Draft Ohio TRM, AEP Ohio chose to use the Illinois Technical Reference Manual (IL TRM) approach for “prescriptive infiltration reduction measures”, as seen in Equation A-28. No savings were claimed for demand.

Equation A-28. Ex Ante Energy Savings for Outlet Covers

Per-unit annual kWh Savings = $((kWh/gasket_{electric} * \%ElectricHeat) + (kWh/gasket_{heatpump} * \%HeatPump)) * \%ReductioninHDD$

Where:

- $kWh/gasket_{electric}$ *(Springfield)*[1] = 8.8 kWh (electric resistance)
- $kWh/gasket_{heatpump}$ (Springfield) = 4.4 kWh (heat pump)
- *%ReductioninHDD = HDD (Columbus) / HDD (Springfield)* = 4,379/4,033
- *%ElectricHeat* = Estimated Electric Fuel = 17.2%[2]
- *%HeatPump* = Estimated Heat Pump Fuel = 8.6%

AEP Ohio applied an ISR of 0.48, using the ISR for faucet aerators from the Draft 2010 Ohio TRM.

[1]Used Springfield because the HDD (4,379) is closer to that of Columbus (4,033).

[2] Based on 2016 RASS Heating Mix.

Appendix: Impacts Details

(continued)

Outlet Covers Savings Analysis Details

Outlet Covers Ex Post Savings

The evaluation team reviewed the savings calculations used by AEP Ohio and determined their methodology was appropriate. The evaluation team mirrored their methodology to calculate ex post savings, but applied an adjusted ISR of 0.50 based on primary research from the 2019 Energy Efficiency Kit survey.

TABLE A-22. OUTLET COVERS DEEMED SAVINGS VALUE

Component	Adjusted ISR	Source of Value
Energy Efficiency Kits	0.50	2019 Energy Efficiency Kits Survey

Appendix: Appliance Rebate Participant Survey

Methodology:

In January 2020, the evaluation team conducted a survey with 2019 program participants to address multiple process evaluation research questions. The evaluation team targeted customers who rebated smart thermostats through the program, receiving their rebate payment either via a pre-paid mailed MasterCard or via instant rebate. A link to the online survey was sent to participants via email and implemented using Qualtrics survey software.

2019 PARTICIPANT SURVEY COMPLETIONS AND POPULATION-LEVEL SAMPLING ERROR

Rebate Type	2019 Population Size[1]	Survey Target Completions	Survey Completions	Sampling Error
Instant Rebate	1,276	70	67	10%
Mailed MasterCard	2,918		42	13%
Total	**4,194**	**70**	**109**	**8%**

[1] Population excludes 516 customers who received an instant rebate but were not required to enter an account number.
Note: Sampling error is at 90% confidence level.

Appendix: MFDI On-Site Audits

The evaluation team managed a subcontractor to conduct audits (fielded between December 3 – 5, 2019) of units receiving measures through the multi-family direct installation program.

The audit verified the installation of measures and asked process-related questions of tenants present during the audit. These process related questions include:

- Whether tenants were present during the installation of program equipment.
- Whether tenants received equipment that was not directly installed.
- Whether tenants uninstalled equipment.
- What types of light bulbs the program LEDs replaced.

The evaluation team performed a census attempt of all multi-family direct installation participants and performed 39 audits to attain 90 percent confidence and +/- 10 percent precision at the component level.

SUMMARY OF COMPLETED MULTI-FAMILY DIRECT INSTALLATION AUDITS

	2019 Population Size	Survey Target Completes	Survey Completes	Sampling Error [1]
Multi-Family Direct Installation Participants	4,344	39	39	13%

[1] Sampling error of key impact response questions with a 90% response distribution.

APPENDIX C

Appliance Recycling Program

2019 Evaluation Report

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March 9, 2020

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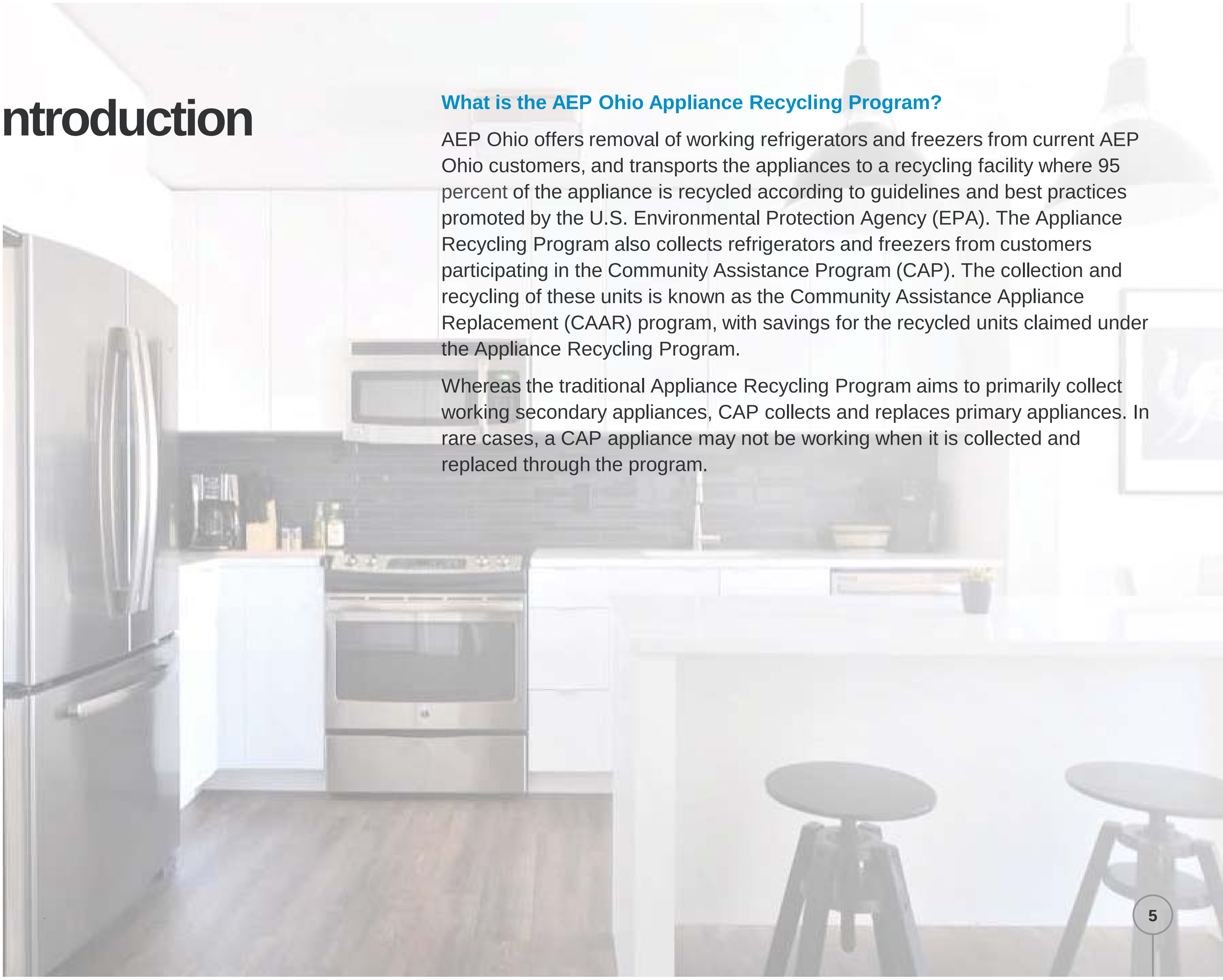
Introduction



Introduction

What is the AEP Ohio Appliance Recycling Program?

AEP Ohio offers removal of working refrigerators and freezers from current AEP Ohio customers, and transports the appliances to a recycling facility where 95 percent of the appliance is recycled according to guidelines and best practices promoted by the U.S. Environmental Protection Agency (EPA). The Appliance Recycling Program also collects refrigerators and freezers from customers participating in the Community Assistance Program (CAP). The collection and recycling of these units is known as the Community Assistance Appliance Replacement (CAAR) program, with savings for the recycled units claimed under the Appliance Recycling Program.

Whereas the traditional Appliance Recycling Program aims to primarily collect working secondary appliances, CAP collects and replaces primary appliances. In rare cases, a CAP appliance may not be working when it is collected and replaced through the program.

Program Summary

The objective of the Appliance Recycling program is to:

REMOVE

Remove old, inefficient refrigerators and freezers from operation as secondary units in homes and therefore reduce energy use and peak demand.

RECYCLE

Recycle 95 percent of each unit in an environmentally safe and friendly manner to prevent appliances from being sold into the secondary market or retained and used as secondary units.

To achieve these objectives, AEP Ohio provides:

PICK-UP

Convenient, no-cost pick-up and recycling of the appliance, provided the appliance is between 10 to 30 cubic feet in size, and is empty and operational at the time of pick-up.

INCENTIVE

Incentives ($50) to non-CAP participants for recycling their appliance through the program.

Program Summary
(continued)

Program Additions in 2019

01 The program added opt-in text message alerts for customers, which first provide two reminders noting the date and four-hour pick-up timeframe, and then alert the customer when crew members are on their way to pick up an appliance.

Program Summary

(continued)

The program surpassed the savings goals for 2019. The program achieved 208 percent of the energy savings goal of 11.9 GWh and 218 percent of the demand savings goal of 1.8 kW.

PROGRAM EVALUATION SUMMARY RESULTS

Measure	2019 Program Goals[1] (a)	Ex Ante Savings (b)	Ex Post Savings (c)	Realization Rate RR = (c) / (b)	Percent of Goal = (c) / (a)
Energy Savings (MWh)	11,895	**24,697**	**24,694**	100%	208%
Demand Savings (kW)	1,815	**3,951**	**3,951**	100%	218%

[1] Volume 1: 2017 to 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, June 15, 2016.

02

Methodology

Evaluation Objectives

The 2019 evaluation activities follow the below objectives:

Impact

01 Quantify the energy and demand savings impacts

02 Verify quantities against the tracking system

03 Determine program cost-effectiveness

Process

04 Determine key process-related program strengths and weaknesses

05 Identify ways to improve the program

Data Collection Activities

DATA COLLECTION TYPE

1. Tracking Data Analysis

Targeted Populations
Appliance Recycling Participants

Community Assistance Appliance Replacement (CAAR) Participants

Sample Frame
Tracking Database

Full Population
18,230

CAAR Population
2,704 (15% of total)

Timing
Jan-20

2. In-Depth Telephone Interviews

Targeted Population
Program Staff

Sample Frame
Contacts from AEP Ohio

Sample Size
2

Timing
Nov-19

3. Participant Online Survey

Targeted Populations
Appliance Recycling Participants

CAAR Participants[1]

Sample Frame
Tracking Database

Sample Size
173 Traditional Program Respondents

46 CAAR Program Participants

Timing
Dec-19 – Feb-20

[1]The evaluation team also conducted a shortened form of the program survey with CAAR (Community Assistance Appliance Recycling) participants who had received a new appliance and had their old appliance recycled. This survey was conducted as part of the CAP participant survey and results were used for the process analysis only.

Material Review

Tracking System Review

The evaluation team reviewed the program tracking data provided by AEP Ohio. This included:

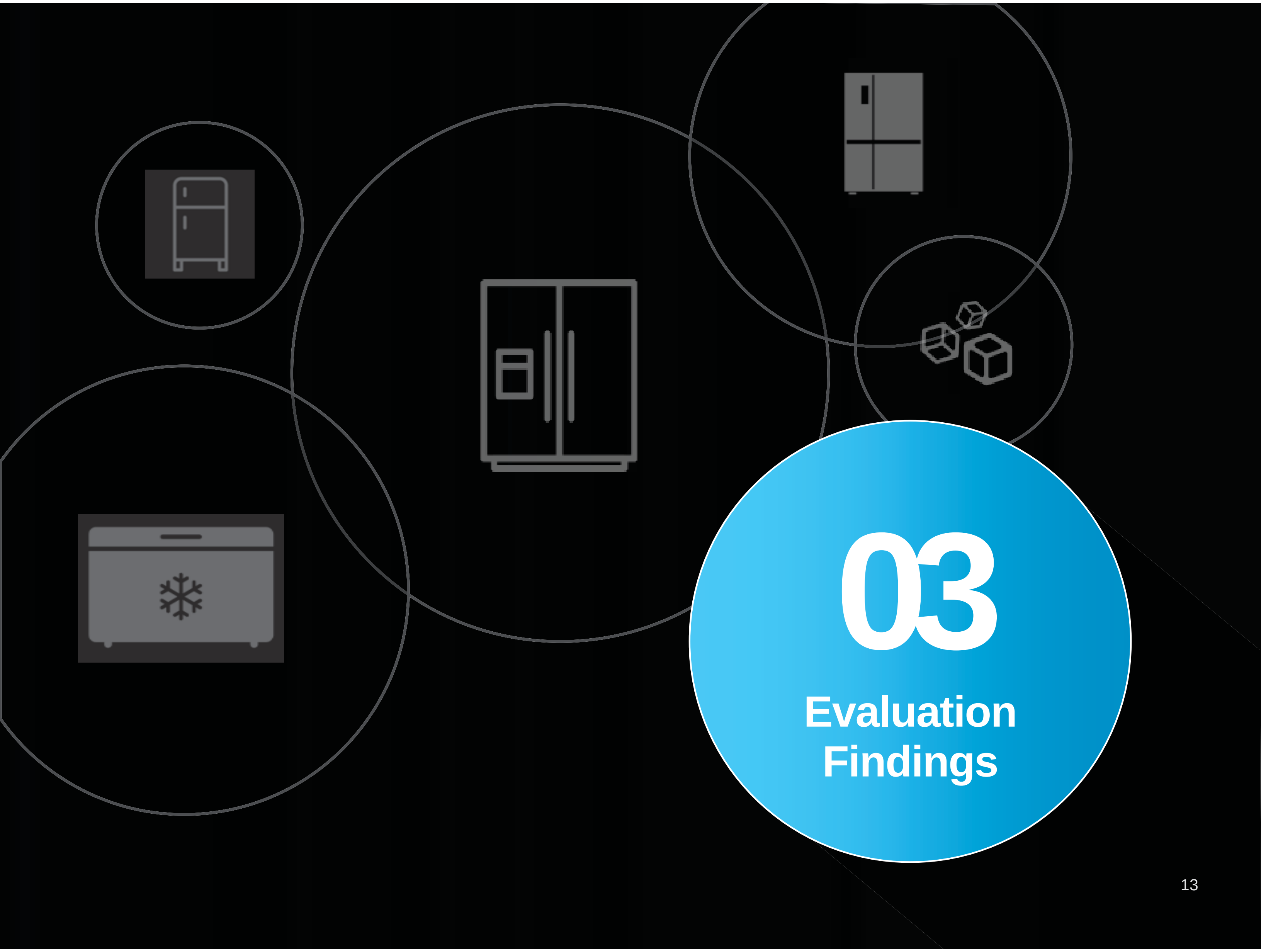
- Reviewing data fields essential for consideration in the impact and process evaluations.
- Examining distributions for each of the key fields, identifying missing, incomplete, or inconsistent data.
- Resolving any inconsistencies with AEP Ohio.
- Assessing key characteristics of appliances recycled in the program
- Determining duplicate entries or customers who recycled more than one appliance through a review of process dates and customer IDs.

The evaluator did not address whether the tracking system is adequate for regulatory prudence reviews or corporate requirements.

Program Material Review

EMI Consulting reviewed all program materials provided to date by AEP Ohio and Recleim, the implementation contractor. This included:

- Program tracking data
- Program marketing plans from 2019
- Program marketing materials
- AEP Ohio Appliance Recycling Program website



03 Evaluation Findings

Evaluation Savings Results

Ex post savings were very similar to the program ex ante values, resulting in realization rates of 1.00.

Ex Ante and Ex Post Energy Savings and Realization Rates

Product	Ex Ante Number of Units (a)	Ex Post Number of Units (b)	Per Unit kWh Energy Savings (c)	Total Ex Ante MWh Energy Savings d = (a) * (c)	Total Ex Post MWh Energy Savings e = (b) * (c)	Percent of Ex Post Energy Savings	Realization Rate
Refrigerator	15,245	15,245	1,376.15	20,981	20,979	85%	1.00
Freezer	2,985	2,985	1,244.40	3,716	3,715	15%	1.00
All Products	**18,230**	**18,230**	**N/A**	**24,697**	**24,694**	**100%**	**N/A**

Note: AEP Ohio accounted for savings from one additional refrigerator and one additional freezer, although the number of ex ante units was accurate.

Ex Ante and Ex Post Demand Savings and Realization Rates

Product	Ex Ante Number of Units (a)	Ex Post Number of Units (b)	Per Unit kW Demand Savings (c)	Total Ex Ante kW Demand Savings d = (a) * (c)	Total Ex Post kW Demand Savings e = (b) * (c)	Percent of Ex Post Demand Savings	Realization Rate
Refrigerator	15,245	15,245	0.22	3,354	3,354	85%	1.00
Freezer	2,985	2,985	0.20	597	597	15%	1.00
All Products	**18,230**	**18,230**	**N/A**	**3,951**	**3,951**	**100%**	**N/A**

Note: AEP Ohio accounted for savings from one additional refrigerator and one additional freezer, although the number of ex ante units was accurate. However, when rounded to the nearest kW, ex post and ex ante demand savings are equivalent.

Cost-Effectiveness Review

This section addresses the cost-effectiveness of the Appliance Recycling Program. Cost-effectiveness is assessed using the Total Resource Cost (TRC) test.

COST-EFFECTIVENESS MODEL INPUTS	
Item	**Value**
Average Measure Life	8
Units	18,230
Annual Energy Savings (kWh)	24,693,941
Coincident Peak Savings (kW)	3,951
Third Party Implementation Costs	$1,165,045
Utility Administration Costs	$338,871
Utility Incentive Costs	$1,425,272
Participant Contribution to Incremental Measure Costs	$0

Based on these inputs, the TRC ratio is 1.8. Therefore, the program passes the TRC test. Results are presented for the Total Resource Cost test, the Ratepayer Impact Measure Test, and the Utility Cost Test.

COST-EFFECTIVENESS RESULTS	
Benefit-Cost Ratio–Test Results	**Ratio**
Total Resource Cost	1.8
Participant Cost Test	N/A
Ratepayer Impact Measure	0.3
Utility Cost Test	2.2

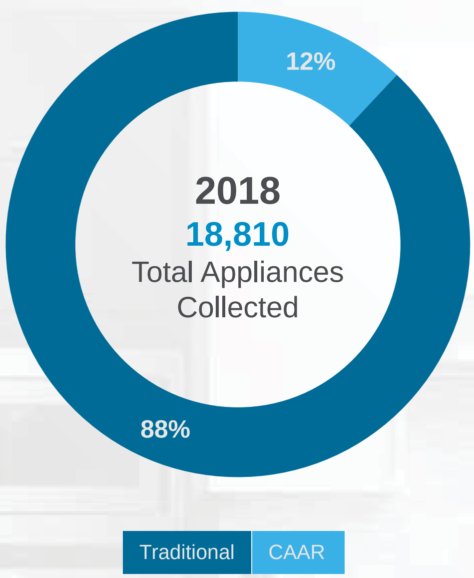
Additional benefits related to the reduction of greenhouse gas emissions have not been quantified in the calculation of the TRC.

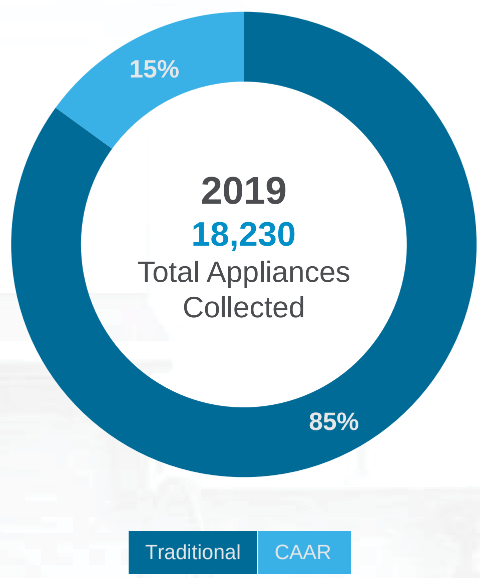
Program Activity Review

Number of Appliances Recycled

The 2019 AEP Ohio Appliance Recycling Program collected a total of 18,230 appliances. These units were collected through 16,749 unique orders. Of these 18,230 recycled appliances, 2,704 (15%) were collected through the CAAR program. Overall, 2,985 (16%) of the appliances collected were freezers, and 15,245 (84%) were refrigerators.

This is similar to 2018, when 18,810 appliances were collected.



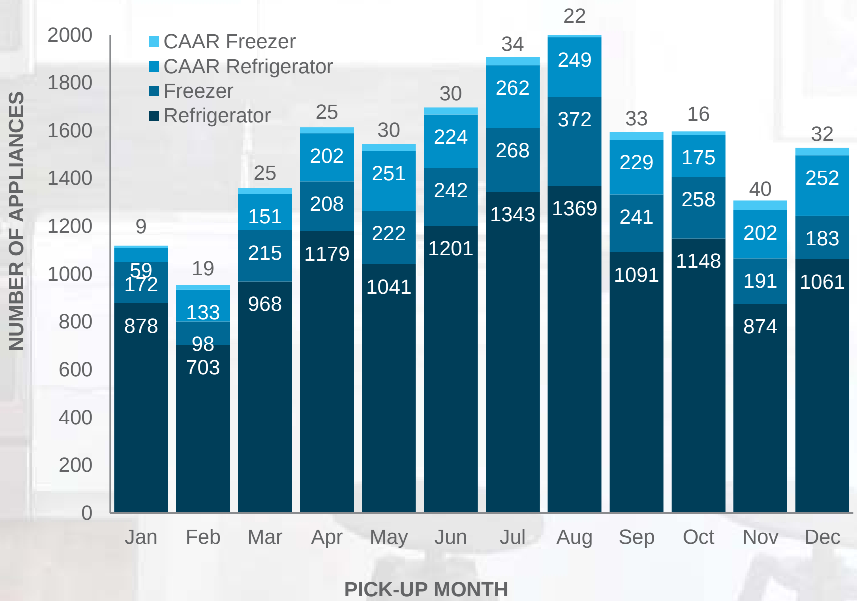


Program Activity Review
(continued)

August 2019 was the month with the highest number of appliances recycled, with 1,618 refrigerators and 394 freezers picked up between August 1st and August 31st.

- This is similar to previous years; historical data shows that the late summer months often have the highest volume.

PROGRAM APPLIANCES RECYCLED BY MONTH



Program Activity Review

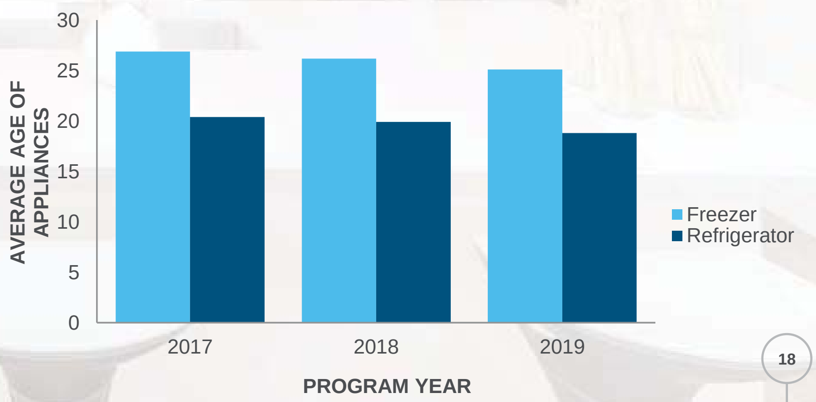
(continued)

Appliance Characteristics (Age)

The average age of recycled appliances has trended downward over the past few years.

- The average age of recycled appliances in 2019 overall was 18.8 years for refrigerators and 25.1 years for freezers.
  - The average age of CAAR refrigerators was 13.9 while the average age of traditional program refrigerators was 19.7 years. The younger age of CAAR refrigerators skews the overall average down.
  - For the traditional program, the average age of recycled refrigerators is **similar to the expected average age of greater than twenty years** as stated in the Draft Ohio TRM. Recycled CAAR refrigerators are on average younger than assumed in the Draft Ohio TRM.
  - This is younger than the average age of units in 2018 (19.7 years for refrigerators and 26.2 years for freezers) and 2017 (20.4 years for refrigerators and 26.9 years for freezers).
- The middle 50 percent of appliances were between 13 and 26 years old.
- The oldest appliances in the tracking data were an 80-year-old refrigerator and a 73-year-old freezer.

AVERAGE APPLIANCE AGE OVER TIME



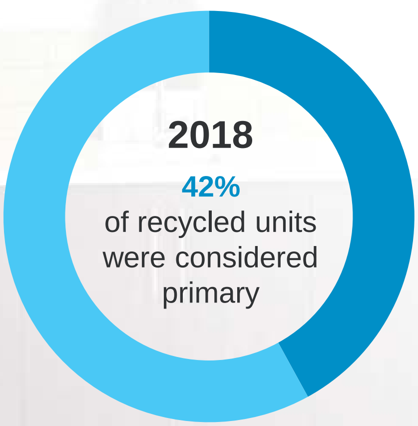
Program Activity Review

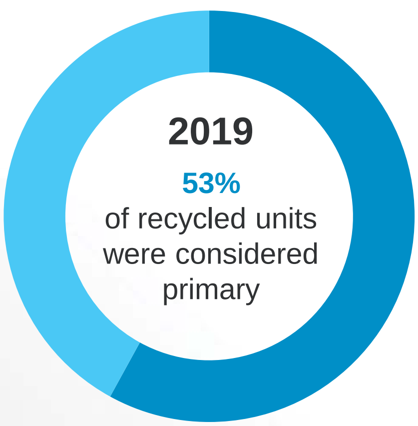
(continued)

Appliance Characteristics (Primary vs. Secondary)

Most refrigerators (53%) were primary units, according to the program tracking data.[1]

- This is a change from 2018, in which 42 percent of refrigerators were considered primary units.
- Tracking data indicated that most CAAR participants (93%) were recycling their primary refrigerator.
- The increase in primary units recycled was reflected in the traditional program participant survey, where 55 percent of recycled appliances were considered primary by survey respondents and 44 percent were considered secondary. In the separate survey conducted with CAAR participants, 90 percent of appliances recycled were considered primary.





[1] The 2013 Appliance Metering Brief, dated 2/27/2014, found that primary appliances have somewhat higher energy savings compared to secondary appliances.

PROCESS

Program Operation Evaluation Results

This section provides a summary of process findings for the 2019 Appliance Recycling Program. Data collection activities informing the process evaluation include:

Key process findings center around general high levels of satisfaction with the program.

- Ratings were high for a number of program components, including the collection team, the enrollment experience, the program overall, reduced energy usage, and the time between scheduling and pickup.
- Five percent of traditional program survey respondents (n=9) were dissatisfied with the program, reporting they had not yet received their incentive at the time of the survey.

Marketing and Program Awareness

There were no major changes to marketing channels compared to 2018.

MARKETING CHANNELS IN 2019					
Email Blasts	Bill Inserts	Facebook	Customer Newsletter	Direct Mail	Educational Tear-off Pads
Door Hangers	In-Store Recycling Fact Sheets	Efficient Products Energy Kit Mailings	Cross-Promotion	Paid Search Text Ads	Banner Ads on AEP Ohio Website

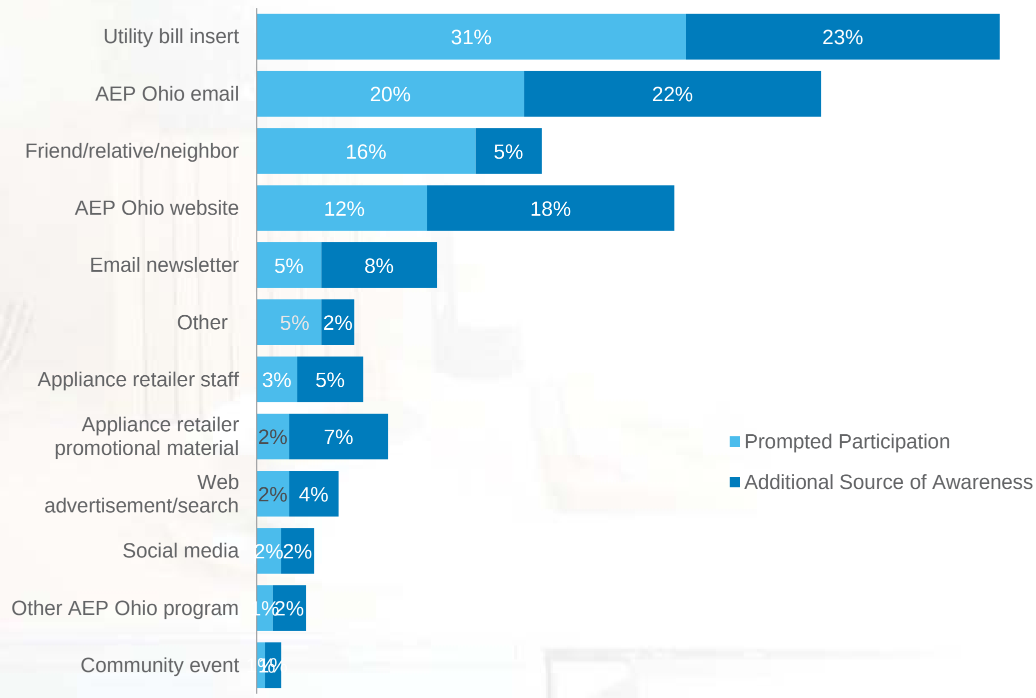
Marketing and Program Awareness
(continued)

Source of Awareness (Participant Survey)

Survey respondents reported the sources through which they became aware of the program, as well as which source primarily prompted their participation.

- The source that most prompted participation was the utility bill insert, followed by AEP Ohio email blasts.

SOURCES OF AWARENESS AND PARTICIPATION



Marketing and Program Awareness
(continued)

Motivations for Program Participation

Survey respondents identified the most important reason for recycling their appliance.[1] These included:

- The cash incentive (32%) ↓ A four percent decrease from 2018 (35%)
- The convenience of the home pick-up (29%) ↑ A ten percent increase from 2018 (19%)
- The appliance was recycled in a way that was good for the environment (27%) ↓ A four percent decrease from 2018 (31%)
- The no-cost pick-up (6%) ↓ An eight percent decrease from 2018 (14%)

[1] The remaining 6% of survey respondents gave a response of "other."

Program Effectiveness and Satisfaction

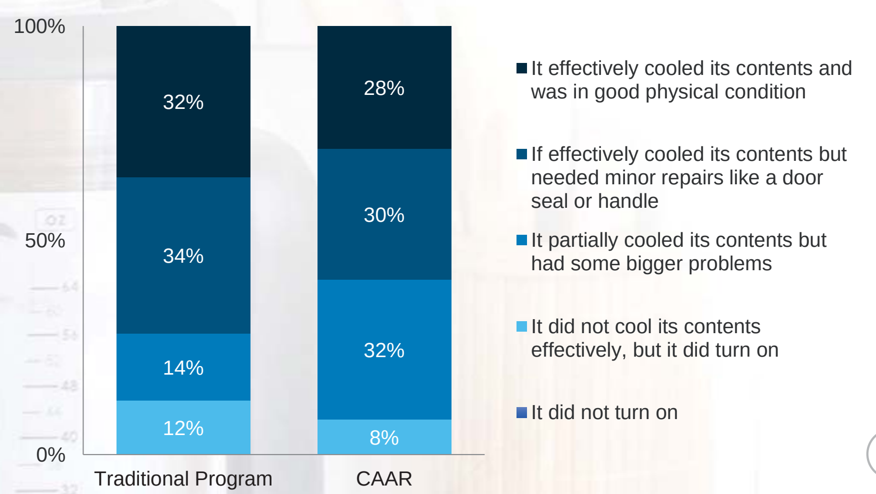
Condition of the Appliance Prior to Recycling

The 12 percent of traditional program survey respondents indicating their appliance did not cool its contents effectively is an increase from 5 percent in 2018, but similar to the proportion in 2017, 11 percent.

Eight percent of CAAR respondents indicated the appliance did not cool its contents effectively, although it did turn on. This is a decrease from 2018, when 21 percent of CAAR respondents stated that the appliance did not cool its contents but did turn on.

Some appliances appear to be not working prior to pick-up.

- 14 traditional program participants (8% of respondents) said their appliance did not cool its contents and they were not using it.
- 2 CAAR participants (4% of respondents) said their appliance did not cool its contents and they were not using it. The program does allow for pick-up of these appliances in emergency situations.
- However, across both CAAR and traditional survey respondents, none (0%) reported their appliance did not turn on at all.



PROCESS

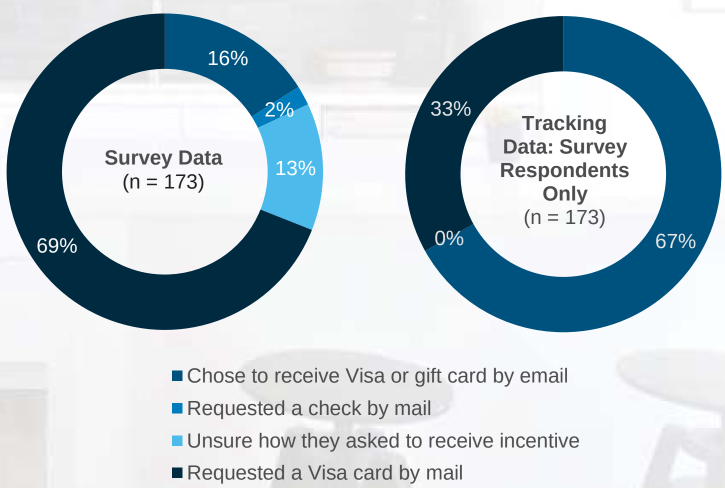
Program Effectiveness and Satisfaction

(continued)

Reported vs. Recorded Payment Type

Chosen payment type as reported by survey respondents often does not match what was recorded in the tracking data.[1]

- Visa card or gift card by mail was the most popular form of chosen payment as reported in the participant survey (69%).
- This differed from survey respondent's recorded payment method in the tracking data, which showed 33% selected a Visa card by mail.
- This suggests program participants may not correctly remember their chosen incentive type.



[1] The Appendix contains a breakdown of incentive payment type for all program participants, as recorded in the program tracking data.

Program Effectiveness and Satisfaction

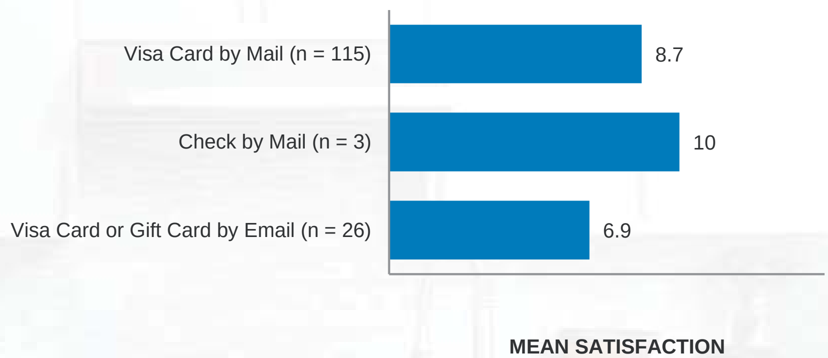
(continued)

Satisfaction with Payment Type

Overall satisfaction with the incentive type according to survey respondents was relatively high, at 8.4, although lower than 2018 when it was 9.0.

Respondents who were less satisfied reported that they received an emailed incentive (i.e., Digital Choice). Although, when referencing the incentive type noted in the program tracking data, mean satisfaction for those who received the digital choice incentive was not much lower (8.2) that those those received a prepaid card in the mail (8.6).

- Five respondents rated their satisfaction lower than 5 for the electronic gift card, with two rating it a 0.
- Specific reasons provided by these dissatisfied respondents included that it was difficult to use or that certain retailers would not accept them.



Program Effectiveness and Satisfaction
(continued)

Perceived Energy Savings

Just over a third (35%) of respondents reported noticing energy savings on their bill. The same percentage of respondents reported noticing energy savings in 2018.

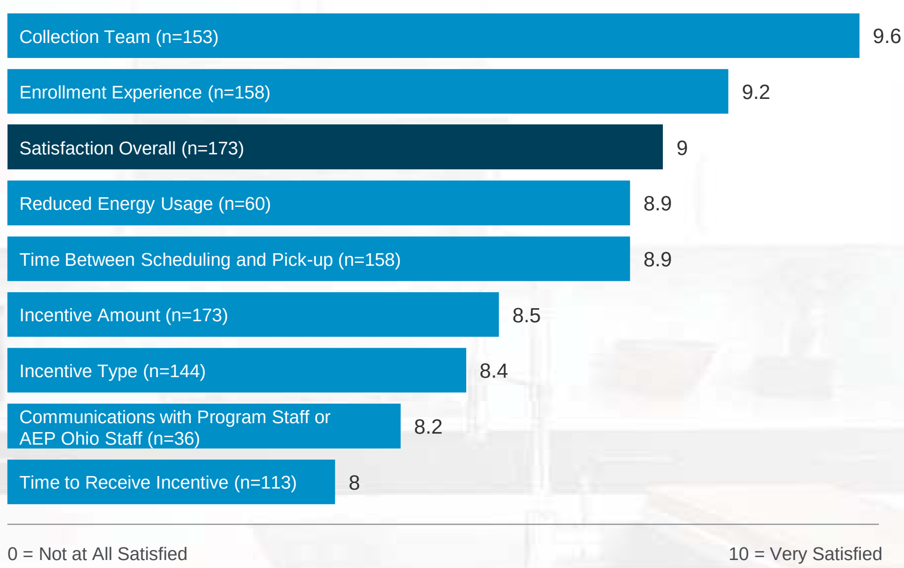
- Compared to those who recycled refrigerators (33%), a greater percentage of those who recycled freezers (40%) noticed energy savings. This is similar to 2018, when 32% of those who recycled refrigerators saw savings and 44% of those who recycled freezers saw savings.
- The majority of the respondents who noticed energy savings were highly satisfied with the amount of energy savings they saw in their utility bills (82%). One respondent ranked their satisfaction lower than a five. This is similar to 2018, when 80% of respondents who noticed energy savings were highly satisfied.

Program Effectiveness and Satisfaction
(continued)

Program Satisfaction

Participants were very satisfied with the program.

- Results showed high levels of satisfaction with the collection team, the enrollment experience, the program overall, reduced energy usage, and time between scheduling and pickup.
- Respondents were, on average, least satisfied with the time it took to receive the incentive, although satisfaction was still high at 8.0. Nine respondents reported that they had not yet received their incentive, reducing average satisfaction in this category.
- This is fairly consistent with previous years, with the exception of communications with Program Staff or AEP Ohio staff, which was rated somewhat lower in 2019 (8.2) compared to 2018, when it was 9.1 on a 0-to-10 scale. Low communication scores were often related to the incentive payments.



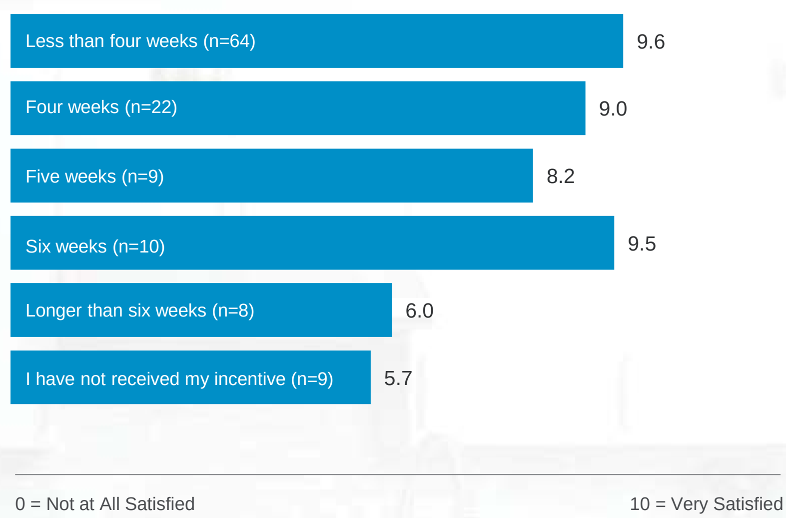
Program Effectiveness and Satisfaction

(continued)

Satisfaction with Program and Incentive Receipt Time

Satisfaction with the program is somewhat correlated with the time it took to receive an incentive.

- Respondents who received their incentive in less than four weeks rated the program highest, with a mean satisfaction of 9.6. Respondents whose incentives took the longest time to reach them rate the program lowest, with a mean satisfaction of 6.



Program Effectiveness and Satisfaction
(continued)

Satisfaction with AEP Ohio Overall

Respondents were satisfied with AEP Ohio.

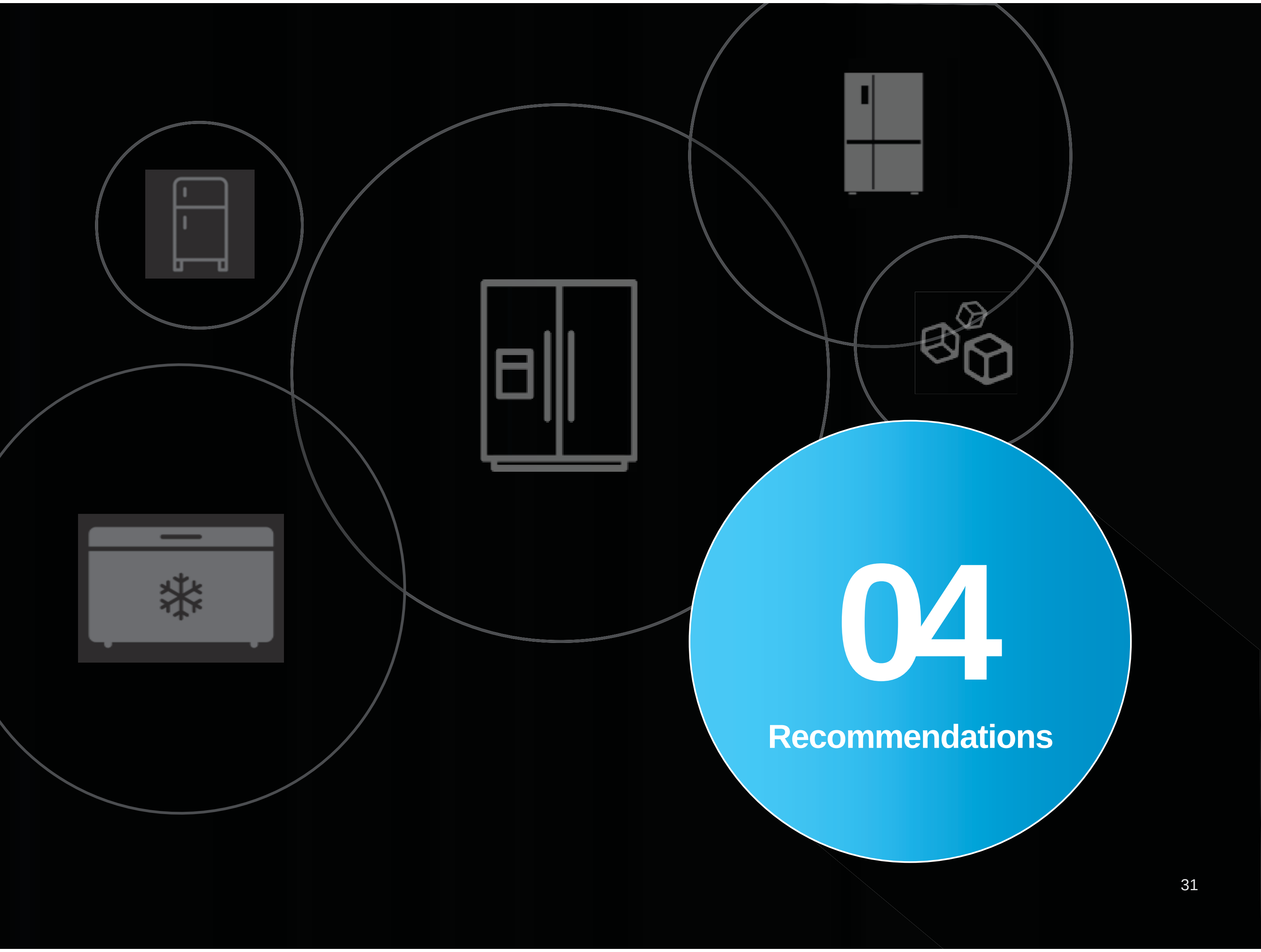
- When asked about their overall level of satisfaction with AEP Ohio as their utility, the majority of respondents (80%) reported satisfaction scores of 8 or higher.
- The average satisfaction score was 8.6.
- Out of the respondents who reported low satisfaction (rating of 5 or below) with AEP Ohio (9%), one respondent ranked their satisfaction as a 3 or lower.

Sixty-five percent of respondents viewed AEP Ohio more favorably after participating in the program.

Effect of Program Participation on Favorability Toward AEP Ohio

Response	Frequency	Percent
More Favorable Toward AEP Ohio	111	65%
No Different About AEP Ohio	56	33%
Less Favorable About AEP Ohio	3	2%
Total	**170**	**100%**

Note: Analysis does not include 3 participants who responded “Unsure”.



04 Recommendations

Improve Response to Customers Who Do Not Receive Incentives

The evaluation team recommends improving processes for responding to customers who do not recall receiving their incentive payments.

Satisfaction with communication with program staff among survey respondents declined this year, from 9.1 in 2018 to 8.2 in 2019. Respondents who ranked this aspect of the program a five or less reported having problems related to their incentives which were never resolved. Respondents reported contacting program staff to troubleshoot their missing incentives, but coming away without a resolution.

Five percent of survey respondents reporting a missing incentive, slightly higher than the 3 percent of respondents in 2018.[1,2]

> "The issue has never been resolved. I have never received a thing for recycling my appliance"

> "Every time I called about getting the incentive they just kept saying they were having problems with the payment. I gave up on that. then, [later] I got an email…saying my payment was now available, I tried to claim it online and went thru the procedure but never got it."

As recommended in 2018, one possible solution is to explore options with the digital incentive vendor to offer a website where a customer can track the status of their rebate (which can help reinforce with customers that they should be checking their email for their incentive on a specific date). The vendor could also follow-up directly with customers who have not received their cards.

Another possible option is to discontinue digital choice as an incentive option. Additionally, 3 of 5 participants dissatisfied with the incentive format suggested offering a bill credit as an incentive choice.

[1] Of the nine respondents who said they did not recall ever receiving their incentive payment, five said they never contacted AEP Ohio in the course of participating in the program. Two said they contacted AEP Ohio once, one said 2-3 times, and one said four or more times.

[2] According to AEP Ohio records, one had already redeemed their incentive, while the remaining incentives had expired. AEP Ohio reissued the expired incentives.

Improve Guidance for Digital Choice Incentives

Ensure incentive choices are very clear, and provide instructions for where and how to use the Digital Choice incentive option.

Digital Choice incentives had the lowest satisfaction rating among the incentive options. Survey respondents who provided low scores had trouble determining which retailers accepted the card and how to use it. AEP Ohio should consider providing additional instructions for the Digital Choice card when participants are prompted to select their incentive choice. (One option is to suggest they use the cards when purchasing an item greater than the amount of the gift card to avoid having to track small remaining balances on the card.) Providing thorough information in advance could help prevent customers from experiencing unexpected frustrations when they try to use the emailed card.

Because customers did not always correctly recall which incentive they had selected, this may indicate they accidentally chose an option they did not prefer. Ensuring the choices are clearly labeled and explained can help make sure customers are satisfied with their incentive type.

Digital "gift cards" are often rejected and often can not be used as partial payment toward a purchase. It's a pain to find something to buy that, with tax and shipping, is the exact amount. You get stuck managing "cards" that have a few cents left on them.

“Electronic gift Visa is not easy to use”

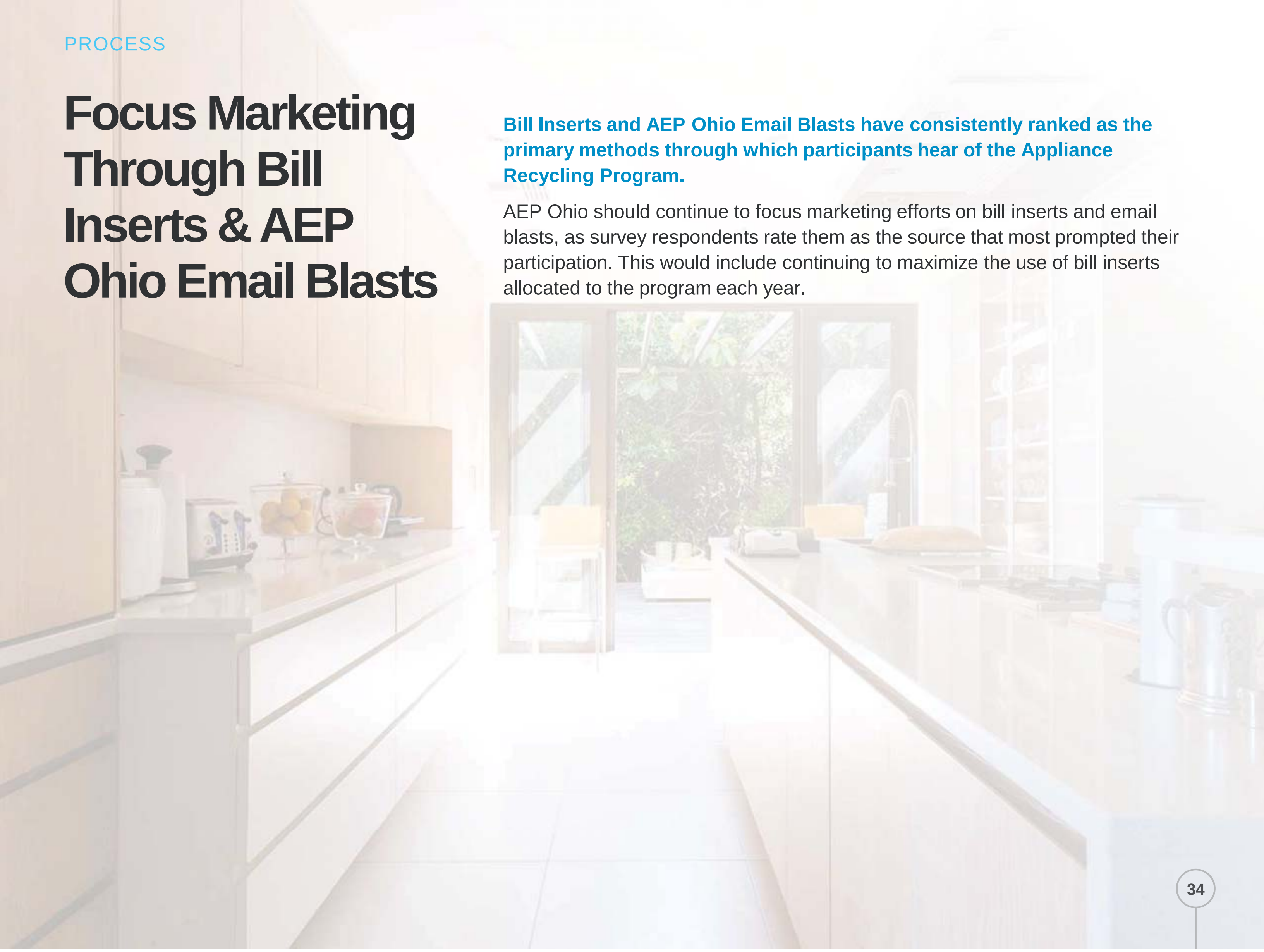
“Hard to use and you can never use the full amount.”

PROCESS

Focus Marketing Through Bill Inserts & AEP Ohio Email Blasts

Bill Inserts and AEP Ohio Email Blasts have consistently ranked as the primary methods through which participants hear of the Appliance Recycling Program.

AEP Ohio should continue to focus marketing efforts on bill inserts and email blasts, as survey respondents rate them as the source that most prompted their participation. This would include continuing to maximize the use of bill inserts allocated to the program each year.



05 Appendix

Appendix
Program Activity Review

Appliance Characteristics (Configuration and Size)

Most refrigerators were top freezer refrigerators (62%). Other types included side-by-side (29%), bottom freezer (5%), single door (2%), and French door (1%) refrigerators. This is similar to 2018.

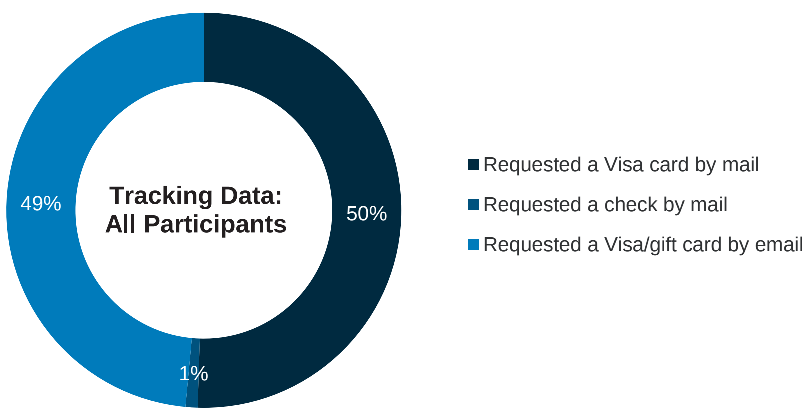
Most freezers were upright freezers (65%). The remaining 35 percent of freezers were chest freezers. This is similar to 2018.

The average size of refrigerators recycled through the program was 18 ft^3. The average size of freezers was 16 ft^3. Appliance sizes ranged from 10 ft^3 to 30 ft^3. The average sizes have remained relatively unchanged from 2018.

Appendix Program Activity Review

Payment Type

About half of customers chose to receive the incentive as a Visa card by mail and half chose the digital choice incentive (Visa/gift card by email). Less than 1% requested a check by mail.



Appendix Participant Survey

Methodology

In January 2020, the evaluation team conducted a survey with 2019 program participants to address multiple process evaluation research questions. A link to the online survey was sent to participants via email and implemented using Qualtrics survey software.

The evaluation team also conducted a shortened form of the program survey with Community Assistance Program (CAP) participants who had received a new appliance and had their old appliance recycled. This survey was conducted as part of the CAP participant survey.

2019 Participant Survey
Completions and Population-Level Sampling Error

Appliances Collected	2019 Population Size	Survey Target Completions	Survey Completions	Sampling Error
Refrigerators	15,245	80	128	7%
Freezers	2,985	20	45	12%
Total	**18,230**	**100**	**173**	**6%**

Note: Results are not shown for CAP participant survey.

Appendix Participant Survey
(continued)

Program Enrollment

Program enrollment methods were similar across tracking data and participant survey results.

Program Enrollment Methods from Tracking Data and Survey

Enrollment Method	Tracking Data Frequency	Tracking Data Percent	Survey Frequency	Survey Percent
Online	7,695	47%	73	54%
Telephone	7,818	53%	63	46%
Total	**15,513**	**100%**	**136**	**100%**

Note: Results are not shown for CAP participants or survey respondents who responded "Unsure".

Appendix Participant Survey
(continued)

Appliance Pick-up Process:

The implementation contractor is largely successful in ensuring pick-ups are scheduled within fourteen days or less of a customer's original request to have their appliance picked up.

- More than three-quarters (87%) of respondents stated the time lapse between scheduling the pick-up appointment and actual appliance pick-up was two weeks or less.
- Thirteen percent of customers stated it took longer than two weeks to have their appliance picked up.
- This delay in pick-up could be due to the customer's location, as collection trucks are sent less frequently to more remote areas. It is also unclear if the delay in pick-up was due to the customer's availability or the implementation contractor's availability.

Reported Time between Program Enrollment and Appliance Pick-up

Time	Frequency	Percent
1 week or less	30	24%
More than 1 week to 2 weeks	80	63%
More than 2 weeks to 3 weeks	11	9%
More than 3 weeks to 4 weeks	4	3%
More than 4 weeks	1	1%
Total	**126**	**100%**

Appendix CAP Participant Survey

Satisfaction with the Appliance Recycling Program:

Respondents were highly satisfied with their experience with the Appliance Recycling Program through CAP.

- Ninety-four percent of participants ranked their satisfaction as an 8 or higher on a 0 (Not at all satisfied) to 10 (Very satisfied) scale.
- One respondent rated their satisfaction as a 5 and no respondents ranked their satisfaction below 5.
- The mean satisfaction ranking was 9.7.

APPENDIX D

e³smart℠ Program

2019 Evaluation Report

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Disclaimer

Content of Report

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January, 24 2020

Table of Contents

01 Introduction

What is the *e*^{3}*smart*^{SM} Program?

The *e*^{3}*smart*^{SM} Program is an educational program for grades 4th through 12th sponsored by AEP Ohio. Each student is offered a free energy efficiency kit with high-quality energy efficient items that the student can take home and install. Ohio Energy Partners (OEP) implements the e3smartSM program on behalf of AEP Ohio.

The program educates students about energy and energy efficiency. The lesson plans are designed to meet grade-appropriate Ohio state standards. The implementer trains teachers on how to implement the lesson plans and conduct the interactive labs.

The e3smartSM program is a best practice program due to the lesson material and the teachers being the front line implementers. The lesson material is incorporated into different subject areas throughout the year, offering long term exposure to energy efficiency education. The approach of having teachers be the primary conveyors of the program material is unique. Similar programs outside of Ohio typically have an implementer who conducts a presentation and provides the teacher with lesson plans about the material, and often no instruction is given to the teachers on how to implement the lesson plans. The *e*^{3}*smart*^{SM} approach of having teachers lead the program throughout the year provides numerous opportunities for students to engage with the material.

Energy Efficiency Items in Kits the Students Take Home

11-Watt Light Emitting Diode (1 Bulb)	**9-Watt Light Emitting Diode** (2 Bulbs)	**LED Nightlight**
Kitchen Faucet Aerator (1.5 GPM)	**Bathroom Faucet Aerator** (1.0 GPM)	**Earth Massage Showerhead** (1.25 GPM)
Closed Cell Foam Weather Strip (17" Roll)	**Hot Water Temperature Gauge Card**	**Small Roll of Teflon Tape**
Flow Meter Bag	**Refrigerator/Freezer Thermometer**	**Marketing Materials**

Program Summary

PROGRAM EVALUATION SUMMARY RESULTS					
Measure	2019 Program Goals[1] (a)	Ex Ante Savings (b)	Ex Post Savings (c)	Realization Rate RR = (c) / (b)	Percent of Goal = (c) / (a)
Energy Savings (MWh)	6,897	3,011	3,251	108%	47%
Demand Savings (MW)	0.535	0.416	0.445	107%	83%

1. Volume 1: 2017 to 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, June 15, 2016.

02 Methodology

Evaluation Objectives

The 2019 evaluation activities follow the objectives identified in Section 2 including:

Impact

01 Validate the deemed energy savings values

02 Verify measure installations against the tracking system

03 Determine program cost-effectiveness

Process

04 Gauge program satisfaction

05 Identify ways to improve the program

Data Collection Activities

DATA COLLECTION TYPE

1. Tracking Data Analysis
(Participant Online Survey)

TARGETED POPULATION
Student / Parent Participants

SAMPLE FRAME
Tracking Database

SAMPLE SIZE
20,385

TIMING
Nov-19

2. In-Depth Telephone Interview

TARGETED POPULATION
Implementation Contractor and AEP Ohio Project Manager

SAMPLE FRAME
Contact from Implementation Contractor

SAMPLE SIZE
1

TIMING
Dec-19

3. Teacher Surveys

TARGETED POPULATION
All Teacher Participants

SAMPLE FRAME
Ohio Energy Project (OEP) Tracking Data

SAMPLE SIZE
351

TIMING
Nov-19

Material Review

Tracking System Review

Guidehouse conducted a review of program data in the AEP Ohio e^3*smart*^{SM} audit tracking system to assess its accuracy and effectiveness for use in recording, tracking and reporting the processes and impacts of the program. The evaluator did not address whether the tracking system is adequate for regulatory prudence reviews or corporate requirements.

Engineering Algorithm Review

Guidehouse conducted a review of measure savings algorithms and underlying assumptions for each measure compared to the Draft 2010 Ohio TRM algorithms. Navigant also calculated energy and demand savings for each measure in the tracking database to ensure the algorithms were applied correctly.

Program Material Review

Guidehouse reviewed all program materials provided to date by AEP Ohio and OEP including:

- Program tracking data
- Program impact algorithms and assumptions
- Program lesson plans and teacher instructions

03

Evaluation Findings

Evaluation Saving Results

The following table presents the kWh energy savings analysis.

The *e³smart*^SM Program distributed 25,313 energy efficiency kits to participants during the 2018–2019 school year through 375 teachers participating from 262 schools. Of those kits distributed, 20,385 kit recipients returned information regarding the energy efficiency measures they installed. These values were then applied to all kits distributed during the 2018-2019 school year. In contrast, AEP Ohio applies 50 percent of the savings, determined by the tracking data, to the remaining kits without a returned survey.

ENERGY SAVINGS ESTIMATES

Measure	Ex Ante Number of Installed Measures (a)	Ex Post Number of Installed Measures (b)	Ex Ante kWh Savings per Measure (c)	Ex Post kWh Savings per Measure (d)	Total Ex Ante kWh (e) = (a) * (c)	Total Ex Post kWh (f) = (b) * (d)
11 W LED (1 Bulb)[1]	9,928	12,328	32.49	32.49	322,599	400,587
9 W LED (2 Bulbs)[2]	22,383	25,089	31.47	31.47	704,401	789,544
Kitchen Aerators (1.5 GPM)	2,745	3,409	55.37	55.37	151,995	188,739
Bathroom Aerators (1.0 GPM)	2,908	3,611	95.80	95.80	278,579	345,924
LED Nightlight	6,055	7,519	20.59	20.59	124,672	154,812
Lower Water Heater Temperature	621	771	81.60	81.60	50,674	62,924
Earth Massage Showerhead (1.25 GPM)	3,468	4,306	280.26	280.26	971,942	1,206,905
Weather Stripping	7,340	9,114	11.10	11.10	81,474	101,170
Outboard Non-Response Adjustment[3]	4,928	N/A	65.89	N/A	324,706	N/A
Total	-	-	-	-	**3,011,041**	**3,250,604**

1. The savings per measure for 11 W LEDs is a weighted average of the reported replaced wattage bulbs.
2. The savings per measure for 9 W LEDs is a weighted average of the reported replaced wattage bulbs.
3. AEP Ohio applied 50 percent of per-kit savings from the tracking data to kits without returned surveys.

* Note: The numbers in this table are the actual numbers from the evaluation analysis. Totals may not sum due to rounding.

Evaluation Saving Results
(continued)

The following table presents the kW summer peak demand savings analysis.

Ex post savings estimates for the *e³smart*SM Program were developed by the evaluation team using the installation rates gathered from the student survey. These values were then applied to all kits distributed during the 2018-2019 school year. In contrast, AEP Ohio applies 50 percent of the savings, determined by the tracking data, to the remaining kits without a returned survey.

SUMMER PEAK DEMAND SAVINGS ESTIMATES

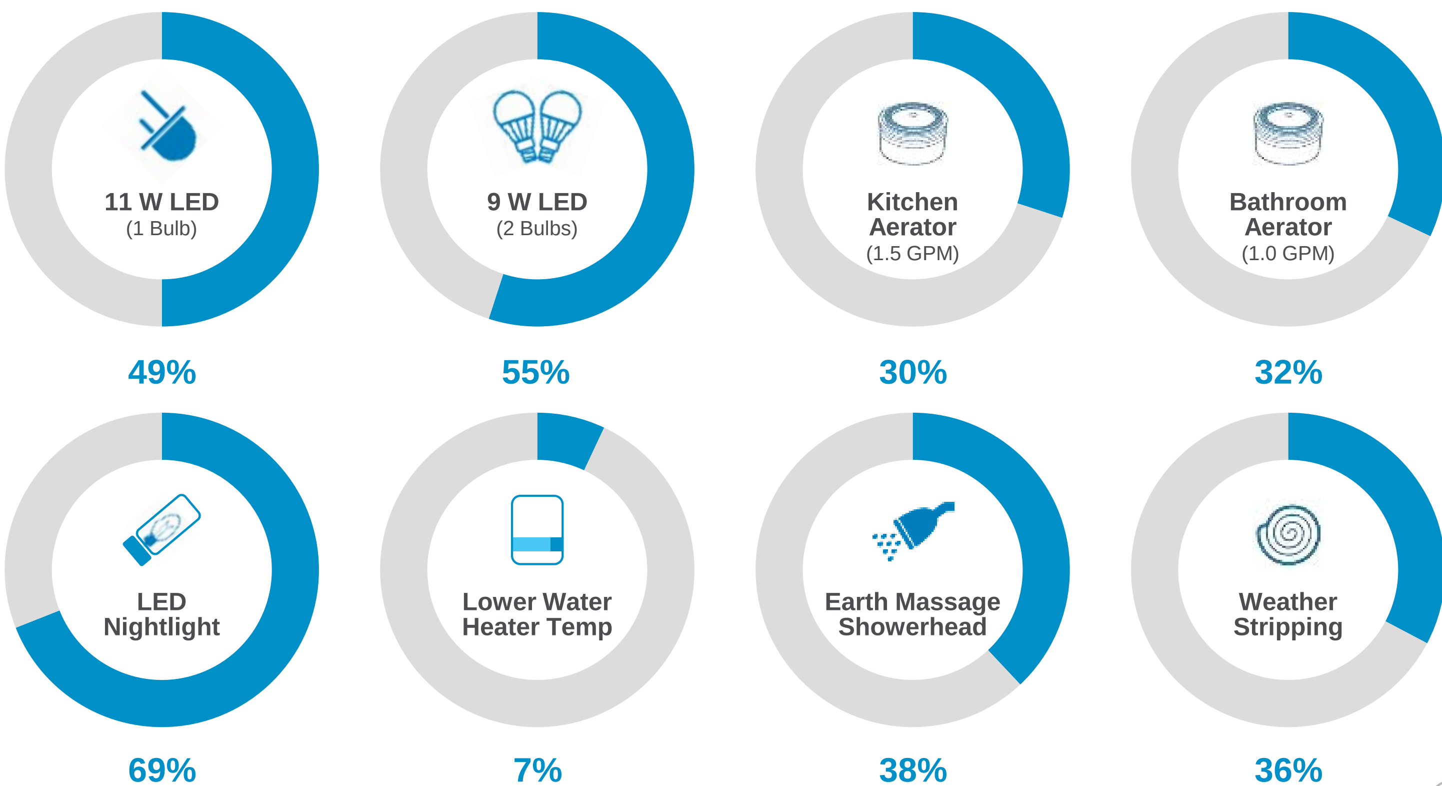
Measure	Ex Ante Number of Installed Measures (a)	Ex Post Number of Installed Measures (b)	Ex Ante kW Savings per Measure (c)	Ex Post kW Savings per Measure (d)	Total Ex Ante kW (e) = (a) * (c)	Total Ex Post kW (f) = (b) * (d)
11 W LED (1 Bulb)[1]	9,928	12,328	0.006	0.006	57	71
9 W LED (2 Bulbs)[2]	22,383	25,089	0.006	0.006	124	139
Kitchen Aerators (1.5 GPM)	2,745	3,409	0.007	0.007	19	24
Bathroom Aerators (1.0 GPM)	2,908	3,611	0.012	0.012	35	43
LED Nightlight	6,055	0	0.000	0.000	0	0
Lower Water Heater Temperature	621	771	0.009	0.009	6	7
Earth Massage Showerhead (1.25 GPM)	3,468	4,306	0.036	0.036	124	154
Weather Stripping[3]	4,222	5,243	0.001	0.001	6	7
Outboard Non-Response Adjustment[4]	4,928	N/A	0.009	N/A	45	N/A
Total	**-**	**-**			**416**	**445**

1. The savings per measure for 11 W LEDs is a weighted average of the reported replaced wattage bulbs.
2. The savings per measure for 9 W LEDs is a weighted average of the reported replaced wattage bulbs.
3. The number of installed measures differs from the kWh table due to kW savings only being allocated for respondents who reported having CAC or Air source heat pumps.
4. AEP Ohio applied 50% of per kit savings from the tracking data to kits without returned surveys.
5. * Note: The numbers in this table are the actual numbers from the evaluation analysis. Totals may not sum due to rounding.

Kit Items In-Service Rates

Installation Rate Based on Returned Surveys

The graphic below demonstrates the measure installation rates for the 2018 -2019 e^3*smart*^{SM} Program. The installation rates are based on the parent / student survey administered by the implementer. The survey return rate has been consistently above 70 percent for many years, with consistent installation rates for the different measures.



Cost-Effectiveness Review

This section addresses the cost-effectiveness of the e^3*smart*^{SM} Program. Cost-effectiveness is assessed using the Total Resource Cost (TRC) test.

COST-EFFECTIVENESS MODEL INPUTS	
Item	**Value**
Average Measure Life	15
Kit Recipients	25,313
Annual Energy Savings (kWh)	3,250,604
Coincident Peak Savings (kW)	445
Third Party Implementation Costs	318,305
Utility Administration Costs	108,484
Utility Incentive Costs	551,488
Participant Contribution to Incremental Measure Costs	$0

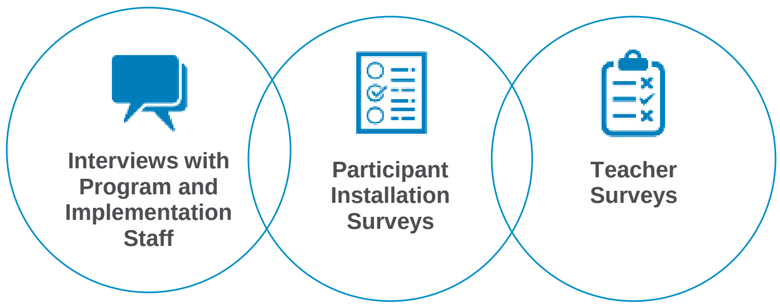
Based on these inputs, the TRC ratio is 1.5. Therefore, the program passes the TRC test. Results are presented for the Total Resource Cost test, the Participant Cost Test, the Ratepayer Impact Measure Test, and the Utility Cost Test.

COST-EFFECTIVENESS RESULTS	
Benefit-Cost Ratio–Test Results	**Ratio**
Total Resource Cost	1.5
Participant Cost Test	N/A
Ratepayer Impact Measure	0.3
Utility Cost Test	1.5

* Note: Additional benefits related to the reduction of greenhouse gas emissions have not been quantified in the calculation of the TRC.

Program Operation Evaluation Results

This section provides the process findings for the 2018–2019 *e*^{3}*smart*^{SM} Program. Data collection activities informing the process evaluation include:



The *e*^{3}*smart*^{SM} Program is running well based on the process data collection. The *e*^{3}*smart*^{SM} Program is a best practice utility-sponsored school educational program based on the way the lesson material is incorporated into the teacher's curriculum. The implementer continues to make improvements to the program material to make it as ready to use as possible. The administration of the program is functioning as expected with continual efforts to improve the delivery of the program.

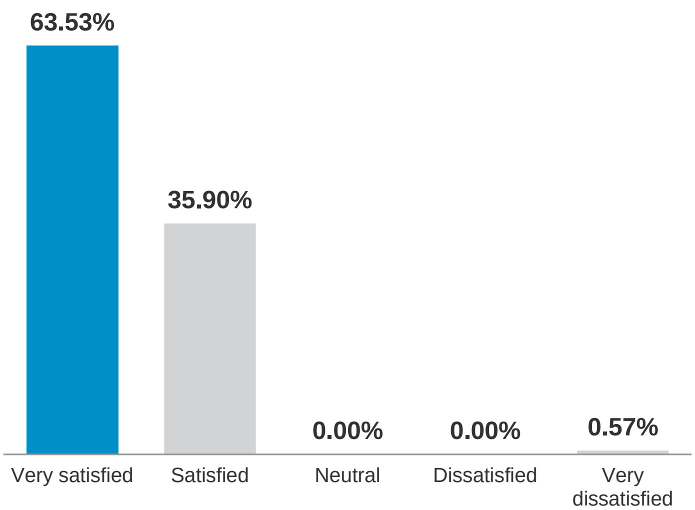
In past evaluations, the time to implement the lesson plans has been the main challenge for teachers. Teachers mentioned "time" as a challenge 135 times in last year's teacher survey. This year "time" was mentioned as a challenge five times. The primary change this year in teacher's comments than in previous years is the frequency with which they praised the educational material as being easily incorporated into their lesson plans. The improved lesson plans make it easier for the teachers to implement the lessons, saving them time.

Teacher Input

Teachers are the key component of implementing the *e*^{3}*smart*^{SM} Program. The following graph and text illustrate teachers appreciation of the program.

How satisfied were you with the overall experience you had during this program?

N=351



The following quotes are representative of the hundreds of comments teachers provided.

"It is the center of our energy resource unit every year."

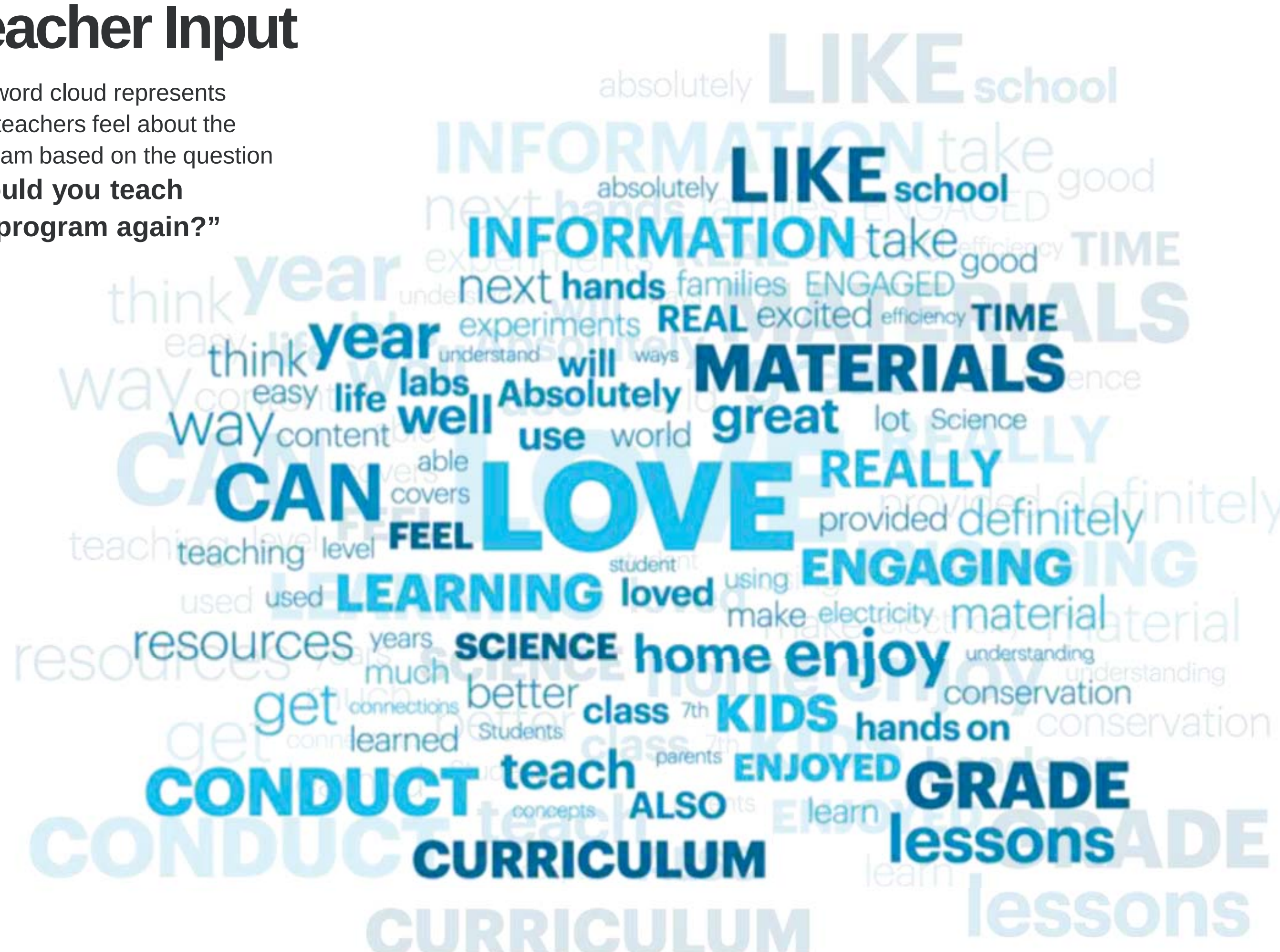
"I will absolutely use this unit again! I love it. It covers my standards utilizing strategies that are meaningful to students."

- Note: Two teachers responded that they were very dissatisfied; these responses were likely mistaken entries based on the positive program feedback they gave in their open-ended responses.

Teacher Input

The word cloud represents how teachers feel about the program based on the question **"Would you teach the program again?"**

n=351



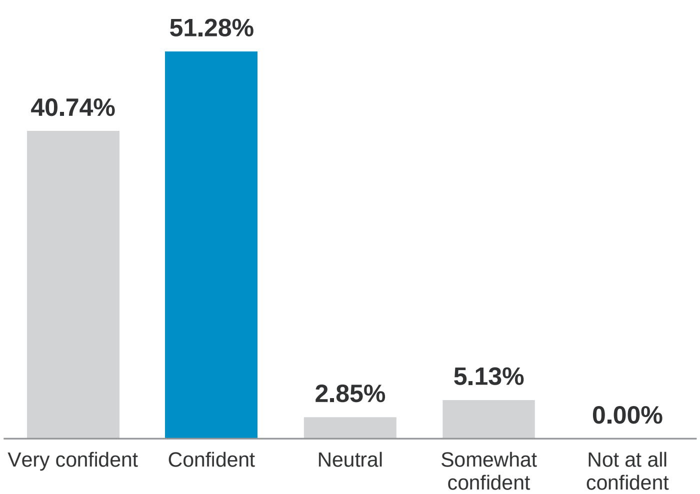
Teacher Input

(continued)

The program material is improved each year based on feedback from teachers. Another reason for identifying *e³smart*SM as a best practice program is the support the implementer provides to the teachers on how to implement the program material.

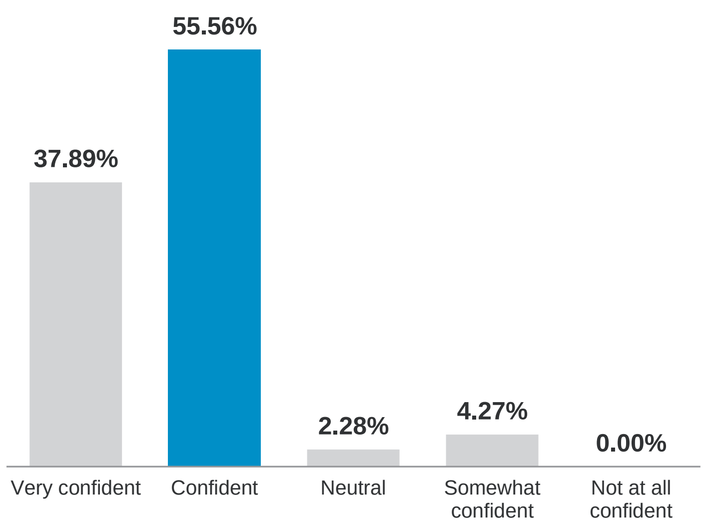
How confident are you that the program teaches your grade level's energy content standards?

N=351



How confident are you in using the activities and materials from this program?

N=351



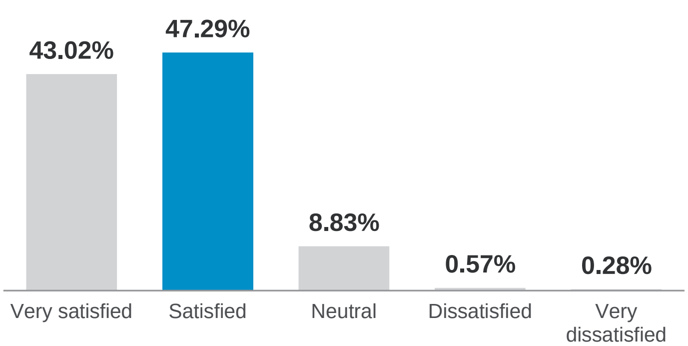
Teacher Input

(continued)

The program customizes the material to the Ohio state standards and the specific grade levels. Teachers said that they would recommend the program to other teachers due to: program materials, classroom activities that demonstrate the lessons, and the energy efficiency kits.

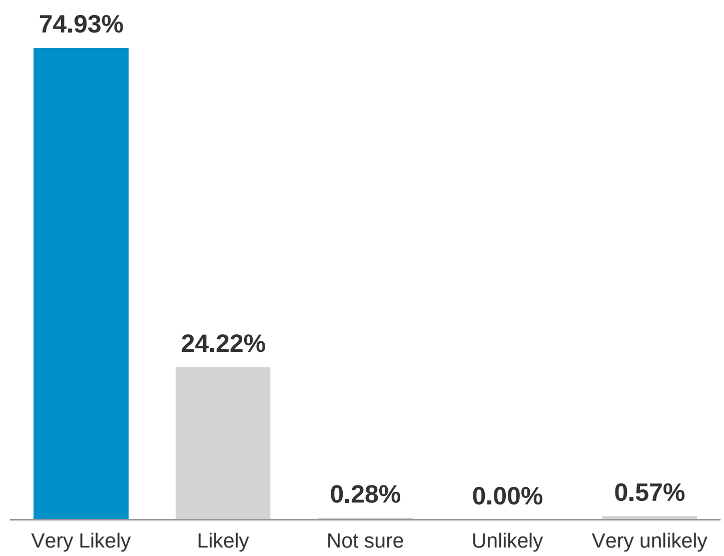
How satisfied were you with the activities meeting your grade level content standards?

N=351



How likely are you to recommend this program to other teachers?

N=351



Teacher Input

(continued)

> “The lessons are fun and engaging for the students and having the materials provided made it so easy.”

> “I would definitely conduct the unit again. I feel it teaches real life information that the students and families need to know and understand.”

What are the biggest challenges you face in teaching this unit? What worked well? What did not work well?

In past evaluations, the time to implement the lesson plans was the main challenge for teachers. This year the issue of time was only mentioned by a few teachers. Teachers continually said how easy it was to implement the lesson plans, which saved them time.

The implementer provides a teacher guidebook and student/parent guidebooks. The guidebooks are aesthetically pleasing with numerous ready to use worksheets that meet Ohio state’s educational standards.

The implementer updates the lesson plans each year based on teacher feedback for improvements regarding the quality of the material and the ease with which it can be inserted into the teacher’s lessons.

The most common statement teachers made about what went well was that the program raised the awareness of the students and their families about energy and energy efficiency.

> “I love having the kids that did the experiments at home come in and share.”

> “The unit provides materials and activities to help me cover the standards in a fun and engaging manner.”

> “I enjoyed teaching the curriculum and the students enjoyed learning about energy. The activities we did in class really sparked their interests.”

Teacher Input

(continued)

Teacher's engagement in the program is reflected in the thought they put into the survey question that asks them to give advice to other teachers.

What tips or strategies would you offer to new energy efficiency teachers starting the program?

The most common advice for teachers who are implementing the program for the first time revolves around managing time.

01

Don't try to do everything, do one lesson at a time, and be prepared for additional discussions and learning opportunities to arise.

02

Review the lessons and labs before class so that you can focus on answering student's questions.

Another common advice topic was that teachers should stick to the designed lesson plans the first time they teach the class. Teachers suggested that first-time teachers should add notes to the lesson plan as they go along to identify what may work better for them in the following years.

This suggestion to stick to the lesson plan highlights the effort the implementer has put into creating the lessons and modifying it based on the recommendations of teachers.

Also, teachers advised new teachers not to become overwhelmed with the amount of material the program provides. They suggested picking one or two lessons that they were confident would go well and expand from there. The underlying idea of this suggestion is that the material is useful and that once a teacher completes a lesson or two they will want to do more.

04

Recommendations

IMPACT

In-Service Rates Evaluation

The current method of calculating in-service rates may not give participants enough time to install the measures. (See slide 15 for in-service application method.)

The evaluation team researched another similar program that had been calculating its in-service rates with parent / student surveys similar to the way AEP Ohio is currently calculating in-service rates.

Guidehouse reviewed programs similar to e3smartSM throughout the country. The review found that a similar program, outside of Ohio, had a slight wording change to its survey that revealed many participants were planning on installing the kit measures later. The program evaluation had also been conducting an online survey for several years at approximately the same time as the implementer's survey, with consistent in-service rates.

Due to the survey finding that participants might be installing the kit items later, the following year the evaluation team decided to delay the survey to see if there was a difference in the in-service rates. The delayed survey reported increases in in-service rates for all measures of at least 20%, except for LED nightlights which already had high in-service rates in this example.

Last year’s evaluation report made this in-service rate evaluation change suggestion. Conducting this research is not possible at this time since parent contact information is not gathered. The implementer is attempting to gather this information for future research.

Variable Change in Low-Flow Showerheads and Overall Update of Showerhead algorithm

The evaluation team recommends changing the person per home variable for low-flow showerheads to the survey reported value as is currently done for faucet aerators.

Currently, the Draft 2010 Ohio TRM does not account for people per household in its kWh energy savings algorithm. For savings accuracy, the low-flow showerhead algorithm in the Draft 2010 Ohio TRM should be updated so that it includes variables AEP Ohio is currently gathering, as well as new research into low-flow showerheads. The Illinois TRM includes an example of a current low-flow showerhead algorithm and inputs.[1]

Parameter Description – Showerheads	Parameter	Draft 2010 Ohio TRM Value
GPM of Baseline Showerhead	GPMbase	2.87
GPM of Low-Flow Showerhead	GPMlow	1.25 program specified
Assumed kWh Savings per GPM Reduction	kWh/GPM reduced	173 kWh
Hours of Use per Year	Hours	29
Summer Peak Coincidence Factor	CF	0.0037

Hours = Average number of hours per year spent using shower head
= (Gal/person * # people * days/yr) / SH/home / GPM / 60
Gals/day = Average gallons per day used for showering = 11.6
People = Average number of people per household = 2.46
Days/yr = Days shower used per year = 365
Showers/home = Average number of showerheads in the home = 2.1

The current value for the number of people per household is based on an average of the regional population. The e^3*smart*[SM] Program survey gathers the number of people per household.

1 http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_7/Final_9-28-18/IL-TRM_Effective_010119_v7.0_Vol_3_Res_092818_Final.pdf#page=193&zoom=100,0,96

Gamification

Using games to reinforce educational material (gamification) is increasingly being used by all kinds of energy efficient programs. Since using games as a teaching method is common in the grades that the *e^{3}smart^{SM}* Program targets, gamification could be a useful addition to the *e^{3}smart^{SM}* Program. AEP Ohio currently has programs that use apps to allow customers to monitor and respond to their energy use. AEP Ohio's current apps could be modified for gamification in the *e^{3}smart^{SM}* Program.

AEP Ohio already uses games to teach about energy efficiency and safety with Louie the Lightning Bug's®.

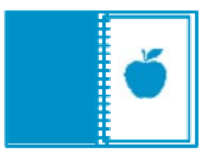
http://www.aep.electricuniverse.com/louies-games.html

Gamification options have a wide range; following are the main types of gamification options.

- Give virtual rewards based on answering questions
- Demonstrates home energy usage
- Awards virtual rewards for doing some action
  - kWh energy savings can be assigned to actions
- Compete with other individuals or groups (classes or schools)
- Use customer utility data to track savings
  - These types of games can be used in individual or group competition

The appendix has several examples of successful gamification programs that could provide guidance to the *e^{3}smart^{SM}* Program.

Teacher Program Implementation Guide



Explore the possibility of the implementer creating a guide from teachers' experiences. This guide would aid teachers new to the program and teachers looking for program teaching suggestions.

Teachers shared useful comments in the survey that mostly focused on presentation preparation and lesson plan management.

The implementer is currently highly engaged with teachers; this guide could be used to access recommendations quickly.

05 Appendix

Appendix Measure Algorithms LEDs

Equations

*Annual kWh Energy Savings = (Wb – LED Watts) / 1000 * HOURs * IEFe*

*Summer Peak Coincident kW Savings = ((Wb – LED Watts)/1000) * IEFd * CF*

KEY PARAMETERS

Parameter Description	Parameter	Value	Source
Average Hours of Use per Year	HOURs	1051	AEP Ohio 2016 Residential Lighting Metering Study
Waste Heat Factor for Energy	IEFe	0.93	AEP Ohio 2016 Residential Lighting Metering Study
Waste Heat Factor for Demand	IEFd	1.34	AEP Ohio 2016 Residential Lighting Metering Study
Summer Peak Coincidence Factor	CF	0.13	AEP Ohio 2016 Residential Lighting Metering Study
Baseline Watts	Wb	Varies by size	Draft 2010 Ohio TRM
Installation Rate 11 W LEDs	IR	49%	2018-2019 Participant Survey
Installation Rate 9 W LEDs	IR	55%	2018-2019 Participant Survey

ALGORITHM REVIEW FINDINGS

Measure	Ex Ante per-unit kWh Savings (a)	Ex Ante per-unit kW Savings (b)	Ex Post per-unit kWh Savings (c)	Ex Post per-unit kW Savings(d)	kWh Realization Rate RR = (c) / (a)	kW Realization Rate RR = (d) / (b)
11 W LED (1 Bulb)	32.49	0.006	32.49	0.006	100%	100%
9 W LED (2 Bulbs)	31.47	0.006	31.47	0.006	100%	100%

*Note: The ex ante and ex post per-unit savings are weighted averages. The savings values varied based on the bulb replaced.

Appendix Measure Algorithms Low Flow Showerheads

Equations

*Annual kWh Energy Savings = (GPMbase – GPMlow) * kWh/GPMreduced*

*Annual kW Savings = kWh Savings/Hours * CF*

KEY PARAMETERS		
Parameter Description	**Parameter**	**Draft 2010 Ohio TRM Value**
GPM of Baseline Showerhead	GPMbase	2.87
GPM of Low-Flow Showerhead	GPMlow	1.25 program specified
Assumed kWh Savings per GPM Reduction	kWh/GPMreduced	173 kWh
Hours of Use per Year	Hours	29
Summer Peak Coincidence Factor	CF	0.0037

ALGORITHM REVIEW FINDINGS			
Low-Flow Showerheads	**Ex Ante Savings (a)**	**Ex Post Savings (b)**	**Realization Rate RR = (b) / (a)**
Energy (kWh)	280.26	280.26	100%
Demand (kW)	0.036	0.036	100%

Appendix Measure Algorithms Faucet Aerators

Equations

*Annual kW Savings = kWh savings/ hours * CF*

*Annual kWh Energy Savings = ((GPMbase – GPMlow) / GPMbase) * (# people * gals/day * days/year * DR) / F/home) * 8.3 * (Tft - Tmains) / 1,000,000)) / DHW Recovery Efficiency / 0.003412*

KEY PARAMETERS

Parameter Description – Faucet Aerators	Parameter	Draft 2010 Ohio TRM Value
GPM of Baseline Faucet	GPMbase	2.2
GPM of Low-Flow Faucet	GPMlow	1.5 GPM for kitchen faucet aerators 1.0 GPM for bathroom faucet aerators Program specified
Average Number of People per Household	# people	2018 -2019 participant survey
Average Gallons per Day Used by all Faucets in Home	gals/day	10.9
Days Faucet Used per Year	days/y	365
Percentage of Water Flowing Down Drain	DR	63%
Average Number of Faucets in the Home	F/home	3.5
Constant to Convert Gallons to Pounds	-	8.3
Assumed Temperature of Water Used by Faucet	Tft	80
Assumed Temperature of Water Entering House	Tmains	57.8
Recovery Efficiency of Electric Water Heater	DHW Recovery Efficiency	0.98
Constant to Converts MMBtu to kWh	-	0.003412
Average Number of Hours per Year Spent Using Faucet	Hours	21
Summer Peak Coincidence Factor	CF	0.00262

BATHROOM AERATOR ALGORITHM REVIEW FINDINGS

Bathroom Aerator (1.0 GPM)	Ex Ante Savings (a)	Ex Post Savings (b)	Realization Rate RR = (b) / (a)
Energy (kWh)	95.80	95.80	100%
Demand (kW)	0.012	0.012	100%

KITCHEN AERATOR ALGORITHM REVIEW FINDINGS

Kitchen Aerator (1.5 GPM)	Ex Ante Savings (a)	Ex Post Savings (b)	Realization Rate RR = (b) / (a)
Energy (kWh)	55.37	55.37	100%
Demand (kW)	0.007	0.007	100%

Appendix Measure Algorithms Weather Stripping

Equations

*Annual kWh savings per foot of weather stripping = (Maximum savings potential from weatherization) * (Fraction of air leaks through windows, ceiling, walls, and floors) * (Fraction of heat transfer due to air leakage [versus conductive heat transfer]) * (Percentage of total leakage area covered per foot of weather stripping)*

Maximum savings potential from weatherization = (Average annual usage Maximum energy savings potential from weatherization measures)*

*Average annual usage = All Electric Residences Average Annual Usage * Percentage of homes that are all electric + Non-All Electric Residences Average Annual Usage * (1- Percentage of homes that are all electric)*

Percentage of total leakage area covered per foot of weather stripping = Area covered per foot of weather stripping / Average leakage area per house

*Annual kW savings per foot of weather stripping = Cooling savings per foot of weather stripping / Full Load Cooling Hours * Percent runtime during peak period * Summer peak coincidence factor*

*Cooling savings per foot of weather stripping = kWh savings * Percent of HVAC kWh expenditure on cooling*

Appendix Measure Algorithms Weather Stripping

(continued)

KEY PARAMETERS	
Parameter Description – Weather Stripping	**Ex Post Value**
All Electric Residences Average Annual Usage	15,202[1]
Percentage of Homes that are All Electric	19.27%[1]
Non-All Electric Residences Average Annual Usage	10,469[1]
Maximum Energy Savings Potential from Weatherization Measures	35%[2]
Fraction of Air Leaks through Windows, Ceiling, Walls, and Floors	41%[3]
Fraction of Heat Transfer due to Air Leakage	60%[3]
Area Covered per Foot of Weather Stripping	12 * average width of leakage area
Average Width of Leakage Area	0.253
Average Leakage Area per House	374.4 square inches[4]

1. Williams, J: All Electric Homes, 07/26/2012
2. http://energy.gov/articles/weatherized-homes-saving-money-families-across-us
3. Guidehouse engineering estimate.
4. Krarti, Moncef. Energy audit of building systems: an engineering approach. 2nd ed. CRC Press 2011.

Appendix Measure Algorithms Weather Stripping

(continued)

KEY PARAMETERS

Parameter Description	Ex Post Value	Source
Percent of HVAC kWh Expenditure on Cooling	50%	Guidehouse engineering estimate
Full Load Cooling Hour	503.1	Draft Ohio TRM, average of all locations
Percent Runtime During Peak Period	25%	Guidehouse engineering estimate
Summer Peak Coincidence Factor	35%	http://energy.gov/articles/weatherized-homes-saving-money-families-across-us.
Fraction of Air Leaks through Windows, Ceiling, Walls, and Floors	0.5	Draft Ohio TRM
Fraction of Heat Transfer due to Air Leakage	60%	Guidehouse engineering estimate
Area Covered per Foot of Weather Stripping	12 * Average width of leakage area	-
Average Width of Leakage Area	0.25	Guidehouse engineering estimate
Average Leakage Area per House	374.4 square inches	Krarti, Moncef. Energy audit of building systems: an engineering approach. 2nd ed. CRC Press 2011

ALGORITHM REVIEW FINDINGS

Weather Stripping	Ex Ante Savings (a)	Ex Post Savings (b)	Realization Rate RR = (b) / (a)
Energy (kWh)	11.1	11.1	100%
Demand (kW)	0.001	0.001	100%

Appendix Measure Algorithms Lower Water Heater Temperature

Equations

*Annual kWh savings = (UA * (Tpre – Tpost) * Hours) / (3412 * RE_electric)*

*Annual kW savings = ΔkWh / Hours * CF*

KEY PARAMETERS

Parameter Description – Lower Water Heater Temperature	Parameter	Ex Post Value
Overall heat transfer coefficient of tank	U	0.083
Surface area of storage tank (square feet)	A	24.991
Actual hot water setpoint prior to adjustment	Tpre	135
Actual new hot water setpoint	Tpost	120
Number of hours in a year	Hours	8,766
Conversion from Btu to kWh		3,412
Recovery efficiency of electric water heater	RE electric	0.982
Summer Peak Coincidence Factor for measure	CF	1

ALGORITHM REVIEW FINDINGS

Lower Water Heater Temperature	Ex Ante Savings (a)	Ex Post Savings (b)	Realization Rate RR = (b) / (a)
Energy (kWh)	81.6	81.6	100%
Demand (kW)	0.009	0.009	100%

Gamification Examples

Power House uses the virtual world of a typical family home to educate players about household energy consumption.

Power House involves a set of games that can be played in the virtual house. In the game, a player begins by following one family member around the house. As each appliance is turned on and off, the game shows the amount of energy it uses.

Power House also encourages players to transfer the energy knowledge they have gained in their virtual house to their real-world energy use. Using real-time data from participating utilities, each player's dashboard displays a graph of their real-world energy use over the past 24 hours and compares it to past data. Players get credits (called Upgrade Bucks) for reducing their usage from day to day, and they can exchange the credits for virtual items like energy-saving upgrades to their virtual house, or for real-world rewards like gift cards, total credits.

Players can also invite their Facebook friends to compete in a real-world energy-saving challenge. They can see their own and their friends' real houses represented in a virtual neighborhood.

A dashboard enables players to check competition results, view a leaderboard of individual and team rankings, and see their results.

Source: Grossberg, F., Wolfson, M., Mazur-Stommen, S., Farley, K., & Nadel (2015). "Gamified Energy Efficiency Programs." ACEEE, https://aceee.org/research-report/b1501

Gamification Examples
(continued)

Cool Choices game iChoose: Players received a new deck of action cards every month, with each card featuring a specific sustainability-focused action.

Each month has a theme: household energy (electricity and natural gas), transportation, water, waste, and indoor environmental quality.

- Each month's set of actions is divided into four categories based on the type of action: step, leap, focus, and create.
- Steps are one-time (but repeatable) actions such as "Turn off the lights," for five points.
- Leaps are habitual actions, such as optimizing car tire pressure, for 25 points.

Focus actions, such as "Explore how your home uses electricity" (also for 25 points) encourages investigation, learning, and discovery.

The Create category asks the players to innovate and develop a repeatable new practice, such as devising a new way to share seldom-used items (e.g., camping equipment), for 50 points.

Energy Center of Wisconsin (ECW) conducted an independent impact evaluation of iChoose. A billing analysis of these participants found average electricity use reductions of 400 kWh annually per active player (95 percent confidence interval of 100–800 kWh). Participants used an average of about 10,000 kWh annually, thus the 400 kWh saved represent about four percent of annual consumption.

Source: Grossberg, F., Wolfson, M., Mazur-Stommen, S., Farley, K., & Nadel (2015). "Gamified Energy Efficiency Programs." ACEEE, https://aceee.org/research-report/b1501

Gamification Examples
(continued)

JOULEBUG: An application designed to promote sustainability-oriented actions and behavior changes.

The participant downloads a free app to a smartphone, tablet, or computer, and sets up a profile. The profile asks for basic data about the user's home (square footage, age, type of heating, and so on) to improve the accuracy of energy and financial savings calculations.

JouleBug can connect to and import data from some utility accounts. The app and website both have a professional and appealing aesthetic and are designed for a generation of young users accustomed to sleek and attractive app designs and graphics.

Actions reward one with virtual trophies. One also competes with others also playing the game. When one completes an action, it can be shared with others on social media encouraging others to perform actions.

Source: Grossberg, F., Wolfson, M., Mazur-Stommen, S., Farley, K., & Nadel (2015). "Gamified Energy Efficiency Programs." ACEEE, https://aceee.org/research-report/b1501

APPENDIX E

Intelligent Home Program

2019 Evaluation Report

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March 24, 2020

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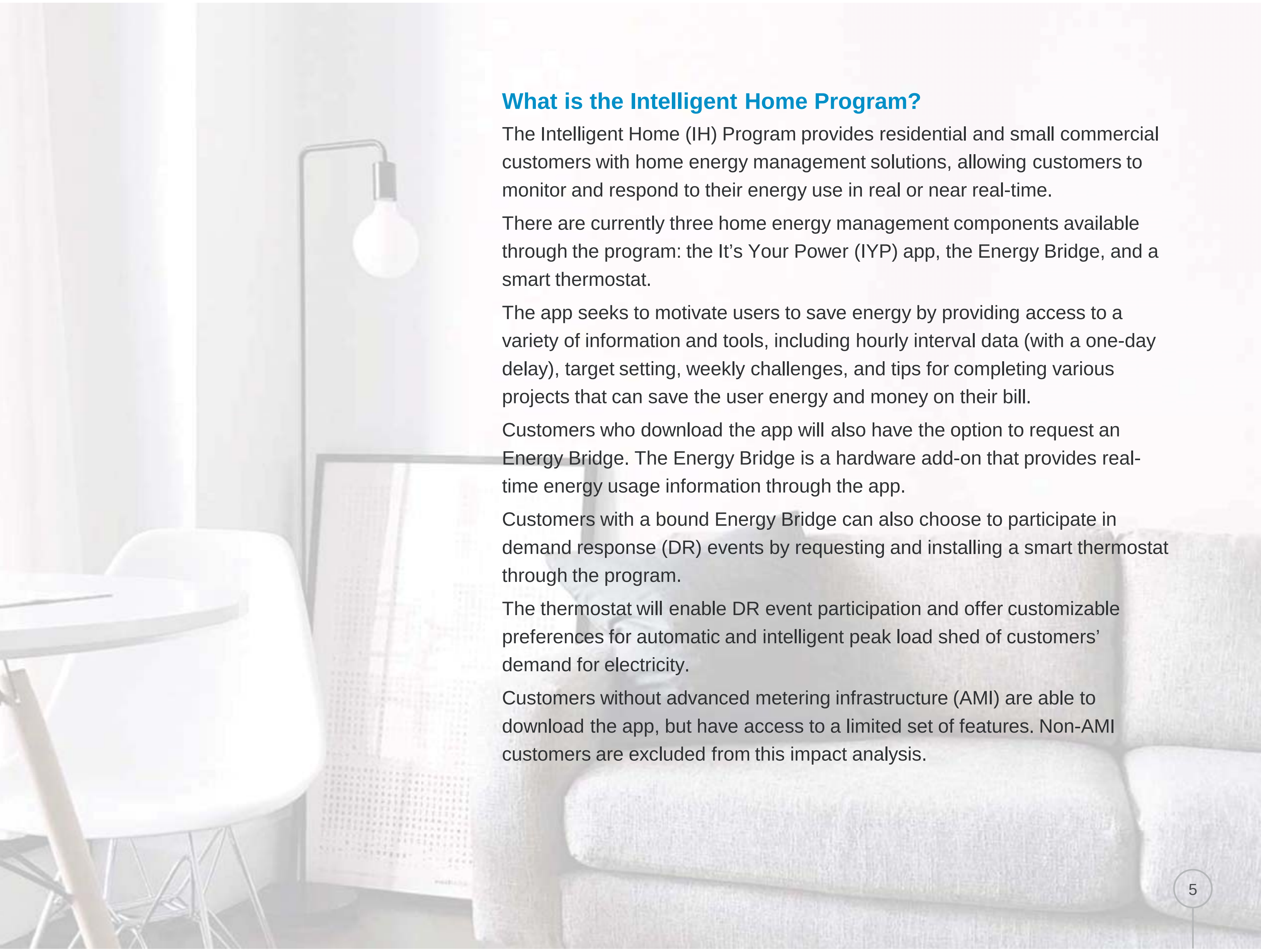


What is the Intelligent Home Program?

The Intelligent Home (IH) Program provides residential and small commercial customers with home energy management solutions, allowing customers to monitor and respond to their energy use in real or near real-time.

There are currently three home energy management components available through the program: the It's Your Power (IYP) app, the Energy Bridge, and a smart thermostat.

The app seeks to motivate users to save energy by providing access to a variety of information and tools, including hourly interval data (with a one-day delay), target setting, weekly challenges, and tips for completing various projects that can save the user energy and money on their bill.

Customers who download the app will also have the option to request an Energy Bridge. The Energy Bridge is a hardware add-on that provides real-time energy usage information through the app.

Customers with a bound Energy Bridge can also choose to participate in demand response (DR) events by requesting and installing a smart thermostat through the program.

The thermostat will enable DR event participation and offer customizable preferences for automatic and intelligent peak load shed of customers' demand for electricity.

Customers without advanced metering infrastructure (AMI) are able to download the app, but have access to a limited set of features. Non-AMI customers are excluded from this impact analysis.

Energy saving features of the It's Your Power app

Electricity Usage

Always On

Usage Target

Power Scan

Home Advisor

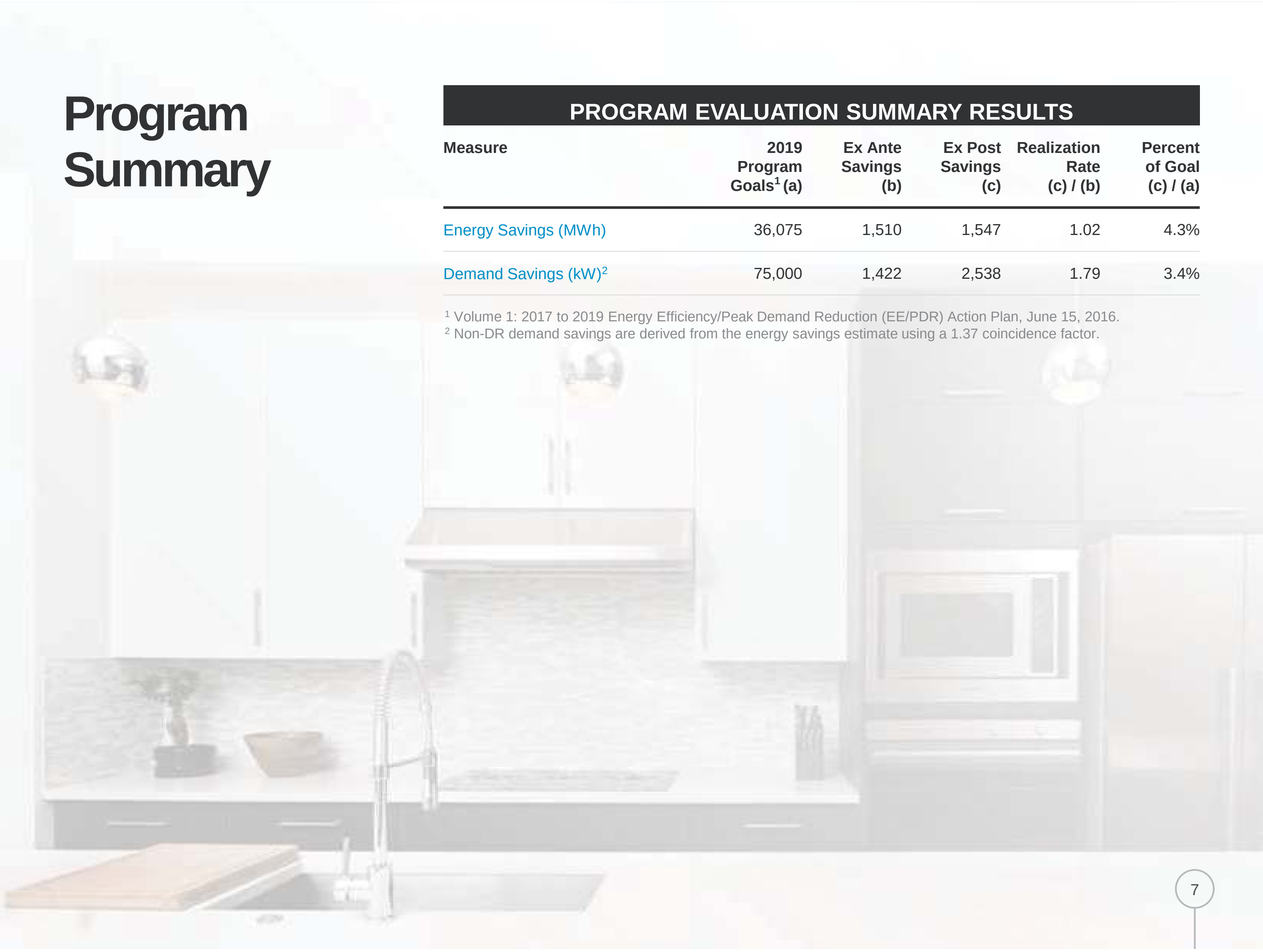
Energy Tips & Projects

Challenges

Thermostat

Note: the app also includes pages for Bill Pay, an Outage Map, and the AEP Ohio Energy Efficiency Marketplace.

Program Summary



PROGRAM EVALUATION SUMMARY RESULTS

Measure	2019 Program Goals[1] (a)	Ex Ante Savings (b)	Ex Post Savings (c)	Realization Rate (c) / (b)	Percent of Goal (c) / (a)
Energy Savings (MWh)	36,075	1,510	1,547	1.02	4.3%
Demand Savings (kW)[2]	75,000	1,422	2,538	1.79	3.4%

[1] Volume 1: 2017 to 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, June 15, 2016.
[2] Non-DR demand savings are derived from the energy savings estimate using a 1.37 coincidence factor.

02 Methodology

Evaluation Objectives

The 2019 evaluation activities align with the following objectives:

Impact

01 Determine if the program provides energy and demand savings

02 Quantify the energy savings from the program

03 Quantify the peak demand savings from program

04 Quantify the peak demand savings from the demand response events

05 Determine program cost effectiveness

Process

01 Confirm the program is functioning as expected

02 Investigate how customers are engaging with the app

Data Collection Activities

DATA COLLECTION TYPE		
Participant Billing, AMI, and Tracking Data	**Cross-Participation Data**	**In-Depth Telephone Interview**
Targeted Population **Census**	Targeted Population **Census**	Targeted Population **Program Manager and Implementation Contractor**
Sample Frame **Customer Billing Database**	Sample Frame **EE Program Tracking Database**	Sample Frame **Contacts for Program Manager and Implementation Contractor**
Sample Size **Census**	Sample Size **Census**	Sample Size **2**
Timing **Jan-20**	Timing **Jan-20**	Timing **Feb-20**
1	2	3

Analytical Methods

Econometric Modeling

Guidehouse estimated the IH app, bridge, and thermostat impacts using an approach called regression with pre-program matching (RPPM). First, IH participants with AMI were matched to non-participants based on similar electric use profiles in the twelve months before the participant downloaded the app. After selecting a matched control group, energy savings were estimated using a lagged dependent variable (LDV) regression analysis with lagged controls. For the demand response events, demand savings were estimated using a fixed-effects regression model that leveraged the Randomized Controlled Trial (RCT) design of the thermostat DR component.

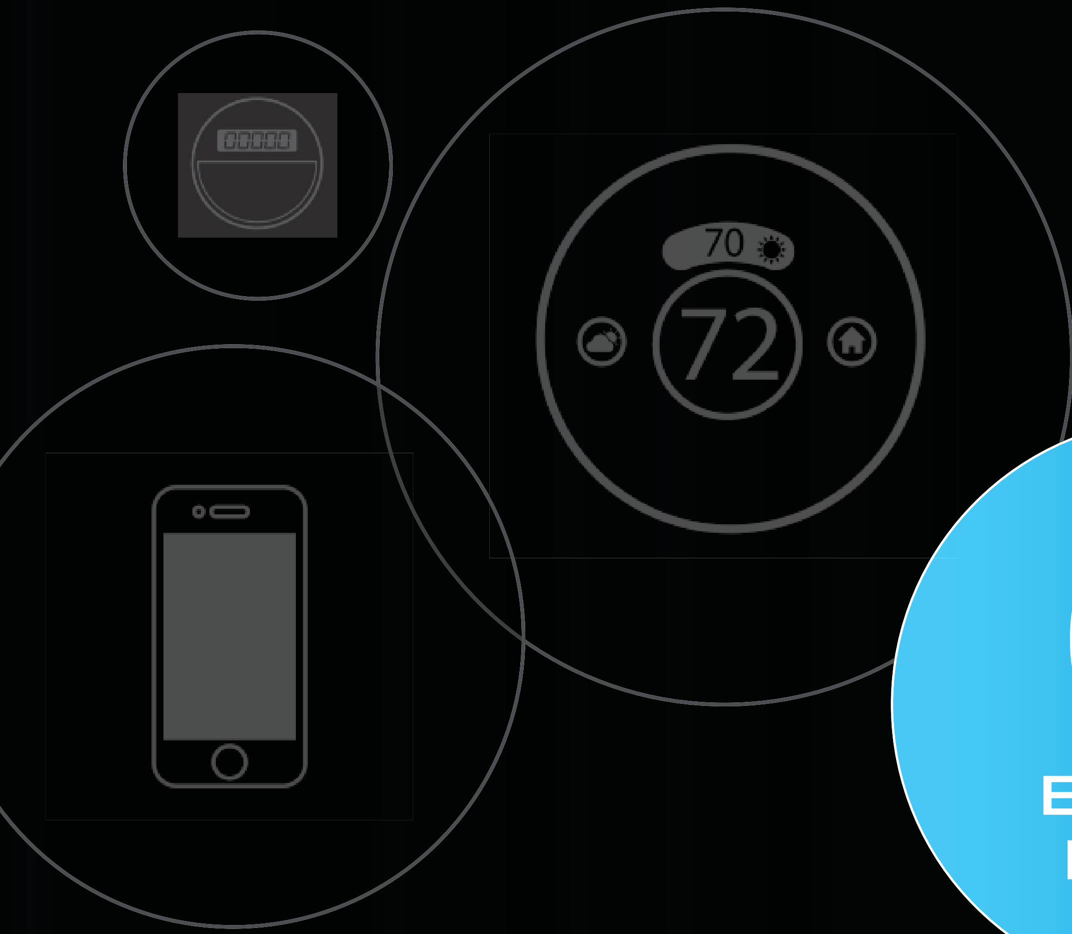
Uplift Analysis

Guidehouse investigated the effect of the IH program on increasing participation in AEP Ohio's other residential energy efficiency programs in order to account for the possibility of double counted savings. For each customer group, Guidehouse compared the difference in the rate of participation between the treatment group and the matched control group in the 2019 program year via the post-only differences (POD) statistic.

In-Depth Staff Interviews

Guidehouse conducted in-depth interviews in February 2020. The purpose of these interviews was to understand changes in program design and implementation, collect feedback on research priorities, and understand stakeholders' experiences with the program.

Note: the evaluation did not address whether the tracking system is adequate for regulatory prudence reviews or corporate requirements.



03 Evaluation Findings

Evaluation Saving Results

Almost 45,000 customers downloaded the app by the end of 2019, with just under half successfully installing a bridge.

About a quarter of bridge customers had a program thermostat. In 2019, the app generated no statistically significant savings.

IH SEGMENT SAVINGS ESTIMATES

Group	Number of Participants[1]	Number of Active Participants[2]	Estimated Daily Energy Savings (kWh)	Estimated Non-DR Demand Savings (kW)	Estimated Percent Savings	Annualized Total (kWh)[3]	Estimated Total Energy Savings (MWh)	Total Peak Demand Savings (kW)[4]
App[5]	44,595	32,134	-0.018	-0.001	-0.06%	-	-	-
Energy Bridge + App	19,545	16,300	0.114	0.006	0.34%	41	441	69
Thermostat + Energy Bridge + App	4,756	4,588	1.181	0.067	3.71%	431	1,381	2,512
Total	**44,595**	**41,366**	-	-	-	-	**1,822**	**2,581**

Note: Totals may not sum due to rounding-.
[1] Participants who change tiers during 2019 are counted in all applicable tiers.
[2] Participants who have logged in at least 1 day in 2019 are considered active. If a participant changes tiers during 2019, they are counted in all applicable tiers.
[3] Annualized total corresponds to the savings for a customer who is enrolled for the full year.
[4] Total peak demand savings are the sum of non-DR demand savings and DR demand savings. Non-DR demand savings are derived from the energy savings estimate using a 1.37 coincidence factor.
[5] Negative savings estimates are zeroed out when calculating total energy and peak demand savings.

TOTAL SAVINGS

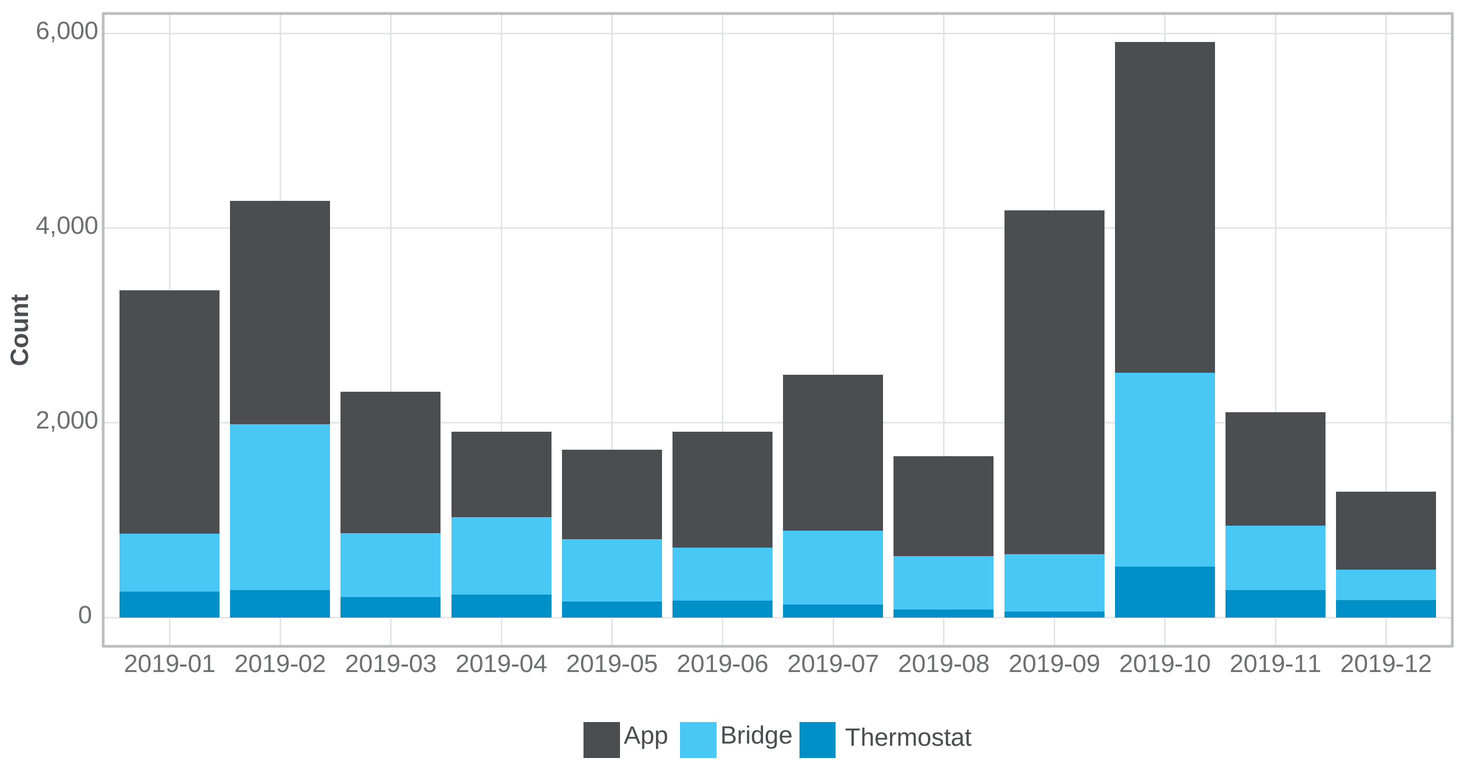
Metric	Total MWh Savings	Total kW Savings[1]
Estimated Total Savings	1,822	2,581
Double Counted Savings	274	43
Total	**1,547**	**2,538**

Note: Totals may not sum due to rounding.
[1] Total peak demand savings are the sum of non-DR demand savings and DR demand savings. Non-DR demand savings are derived from the energy savings estimate using a 1.37 coincidence factor.

Enrollment Trends

In 2019, app enrollments peaked in September, while bridge binds and thermostat installations peaked in October. Fall enrollment peaks coincide with an email message marketing the program sent by AEP Ohio, rather than the program implementer. Enrollments slowed in December, likely due in part to technical issues related to the integration of the AEP Ohio and program implementer's systems, as reported by the program and implementation managers.

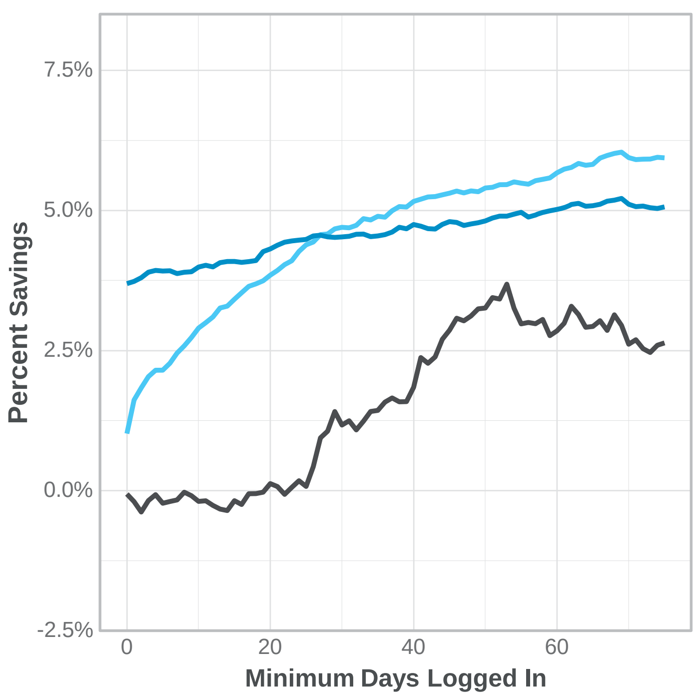
Number of New Accounts Enrolled



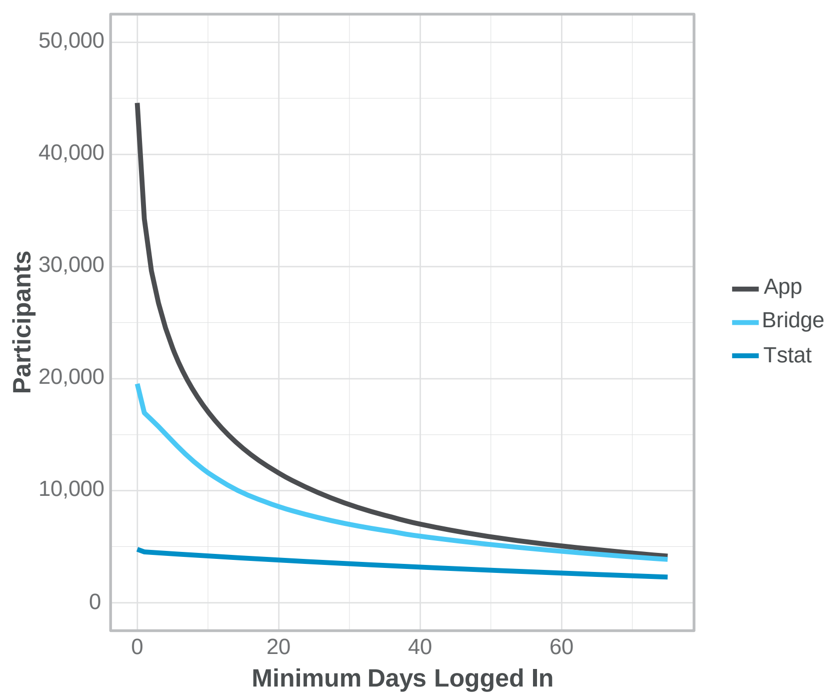
Savings by Level of Engagement

Savings for app customers hover around zero until a customer reaches 25 days logged in, then trend upward. Savings for bridge and thermostat customers trend upward as the number of days logged in increases; however, the savings increase for thermostat customers is much more gradual. This is likely due to the greater frequency at which thermostat customers use the app. Customers with the thermostat use the app more regularly, so fewer customers are dropped with each threshold increase.

Average Savings by Engagement Level

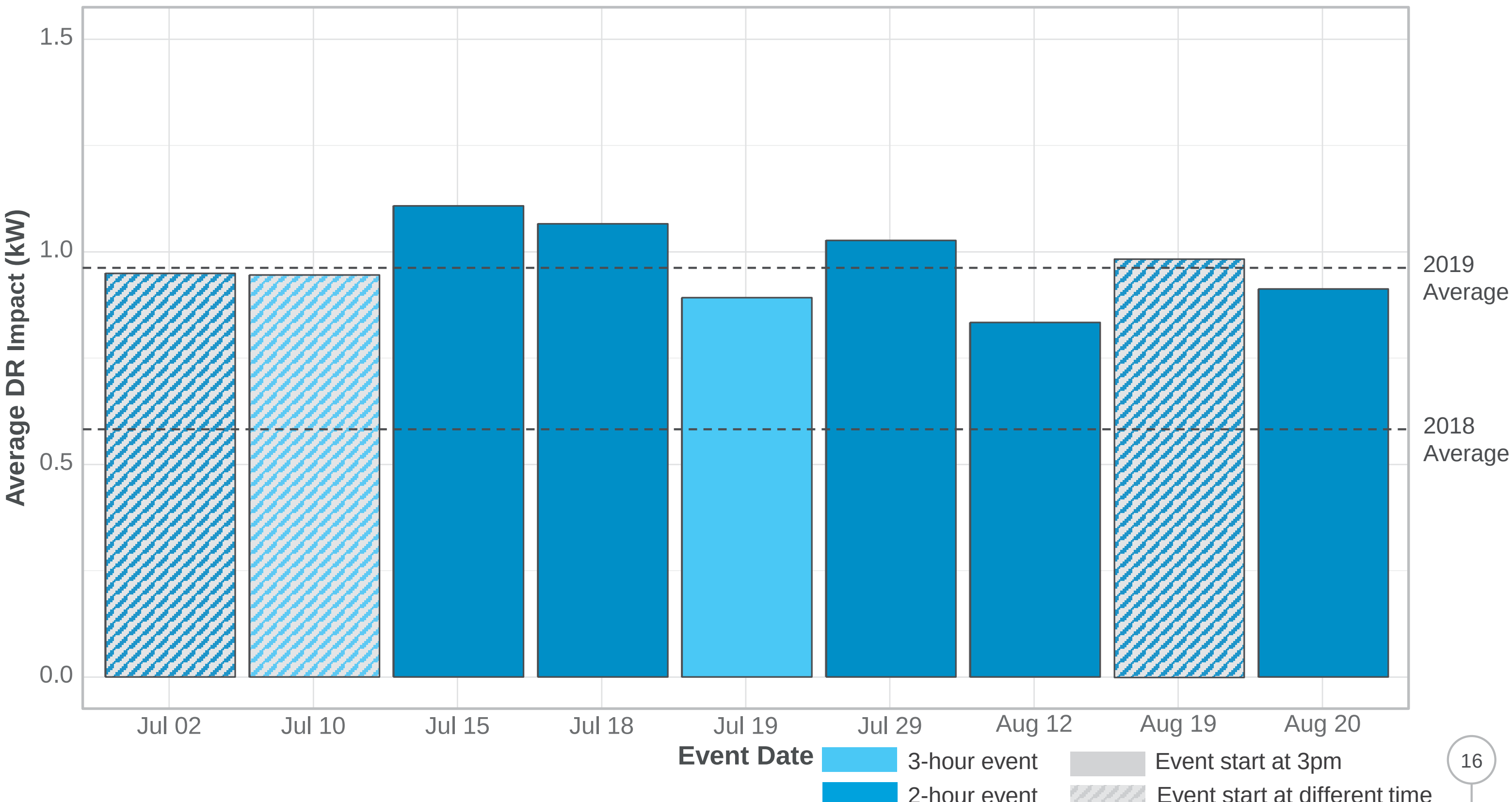


Participants by Engagement Level



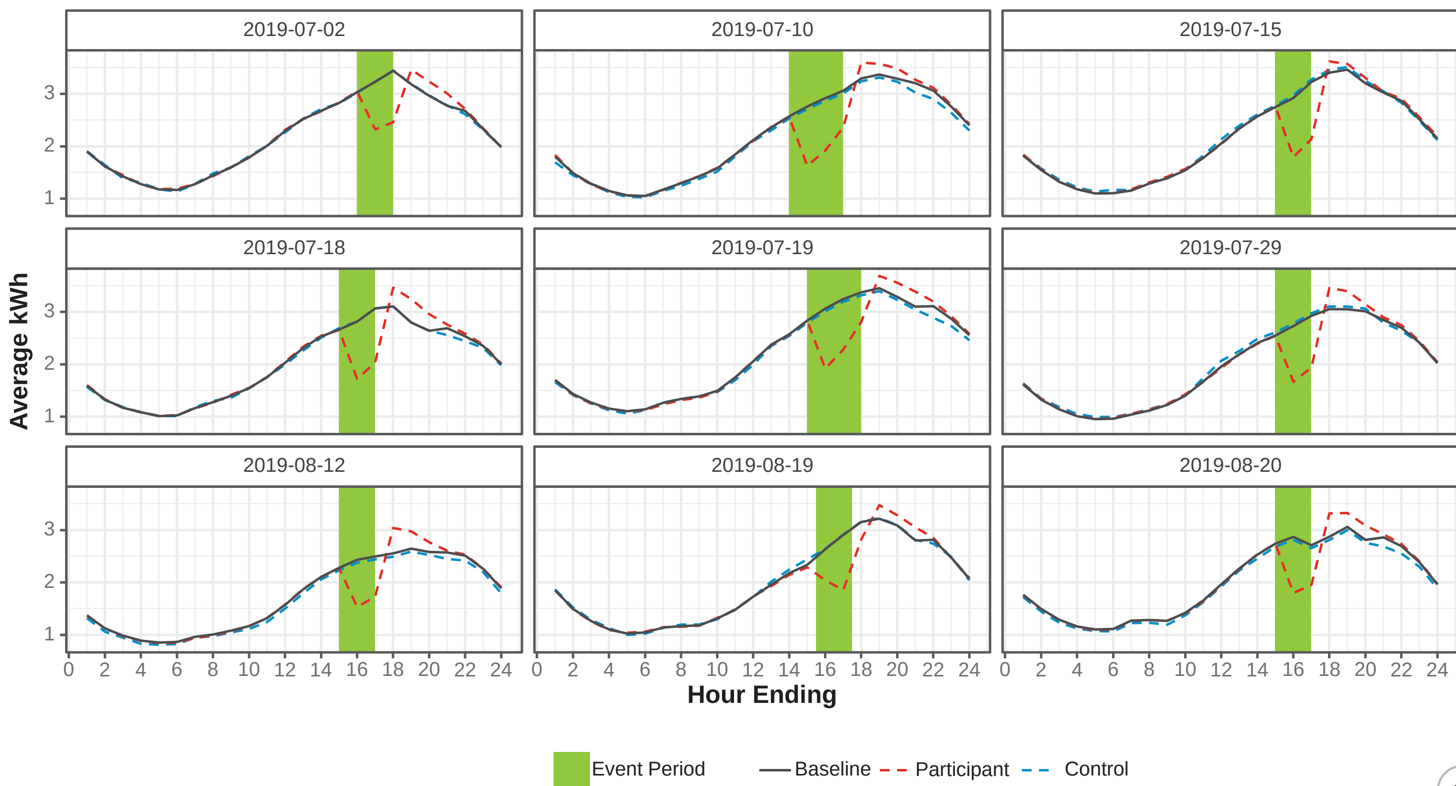
Demand Response Impacts

The IH program called a total of nine DR events in the summer of 2019. Individual event impacts ranged from 0.83 kW to 1.11 kW. Across all nine events, average per-customer impacts were 0.97 kW, up from 0.59 kW in 2018. The increase is likely due to most 2019 events being two hours in duration, compared to three hours in 2018; impacts are highest in the first hour of the event and decrease as the event continues. The average total event impact was 2,296 kW, up from 468 kW in 2018. The increase is largely due to the approximately 300 percent increase in the number of DR customers, in addition to the increase in per-customer impacts.



Demand Response Events

DR impacts are largest in the first hour of the event, then begin to fade in the second and third hours of the event as more homes surpass their thermostat setpoint causing air conditioners to engage. Snapback occurred after each event. However, the magnitude of the snapback does not entirely offset energy savings that occurred during the DR event. On average, DR participants' daily energy use decreased by one and a half percent (0.75 kWh) on event days.[1]



[1] On average, DR participants saved a total of 4.5 kWh in the 2019 DR season. This value is well within the error bound of the annual program energy savings, so no adjustments were made.

Uplift Results

Guidehouse utilized the POD statistic to estimate the savings captured in the billing analysis for the IH Program that is already accounted for in the savings estimate for five other AEP Ohio programs. A portion of the uplifted savings is likely attributable to self-selection bias, since customers who participate in one energy efficiency program are likely to participate in other programs. Past participation and demographic characteristics were not accounted for when selecting matched controls.

The Community Assistance Program (CAP) generated negative uplifted savings, indicating that IH program participants are participating in CAP at a lower rate than the comparison group. Decreased participation is likely due to differences in income amongst IH participants and the comparison group, which was selected based on usage patterns and did not account for demographics (such as income).

ENERGY SAVINGS ATTRIBUTABLE TO OTHER AEP OHIO EE/PDR PROGRAMS

Program	Appliance Recycling (kWh)	Community Assistance Program (kWh)	Efficient Products Rebates (kWh)	Efficient Products In-Home (kWh)	Total Uplift Energy Savings (kWh)
Intelligent Home	58,194	-4,193	51,613	168,867	274,481

Note: Totals may not sum due to rounding.

Cost-Effectiveness Review

This section addresses the cost-effectiveness of the IH Program. Cost-effectiveness is assessed using the Total Resource Cost (TRC) test.

COST-EFFECTIVENESS MODEL INPUTS	
Item	**Value**
Measure Life	1
Participants	44,595
Annual Energy Savings (kWh)	1,547,357
Coincident Peak Savings (kW)	2,538
Third Party Implementation Costs	$512,079
Utility Administration Costs	$595,933
Utility Incentive Costs	$629,334
Participant Contribution to Incremental Measure Costs	$0

Based on these inputs, the TRC ratio is 0.1. Therefore, the program does not pass the TRC test. Results are presented for the Total Resource Cost test, the Participant Cost Test, the Ratepayer Impact Measure Test, and the Utility Cost Test.

COST-EFFECTIVENESS RESULTS	
Benefit-Cost Ratio–Test Results	**Ratio**
Total Resource Cost	0.1
Participant Cost Test	N/A
Ratepayer Impact Measure	0.1
Utility Cost Test	0.1

Additional benefits related to the reduction of greenhouse gas emissions have not been quantified in the calculation of the TRC.

Program Operation Evaluation Results

This section provides the process findings for the 2019 IH program.

The following data collection activities inform the process evaluation:

Interviews with Program and Implementation Staff

The interviews with program and implementation staff indicate the IH Program is running well. The administration of the program is functioning as expected with continual effort to enhance the delivery of the program.

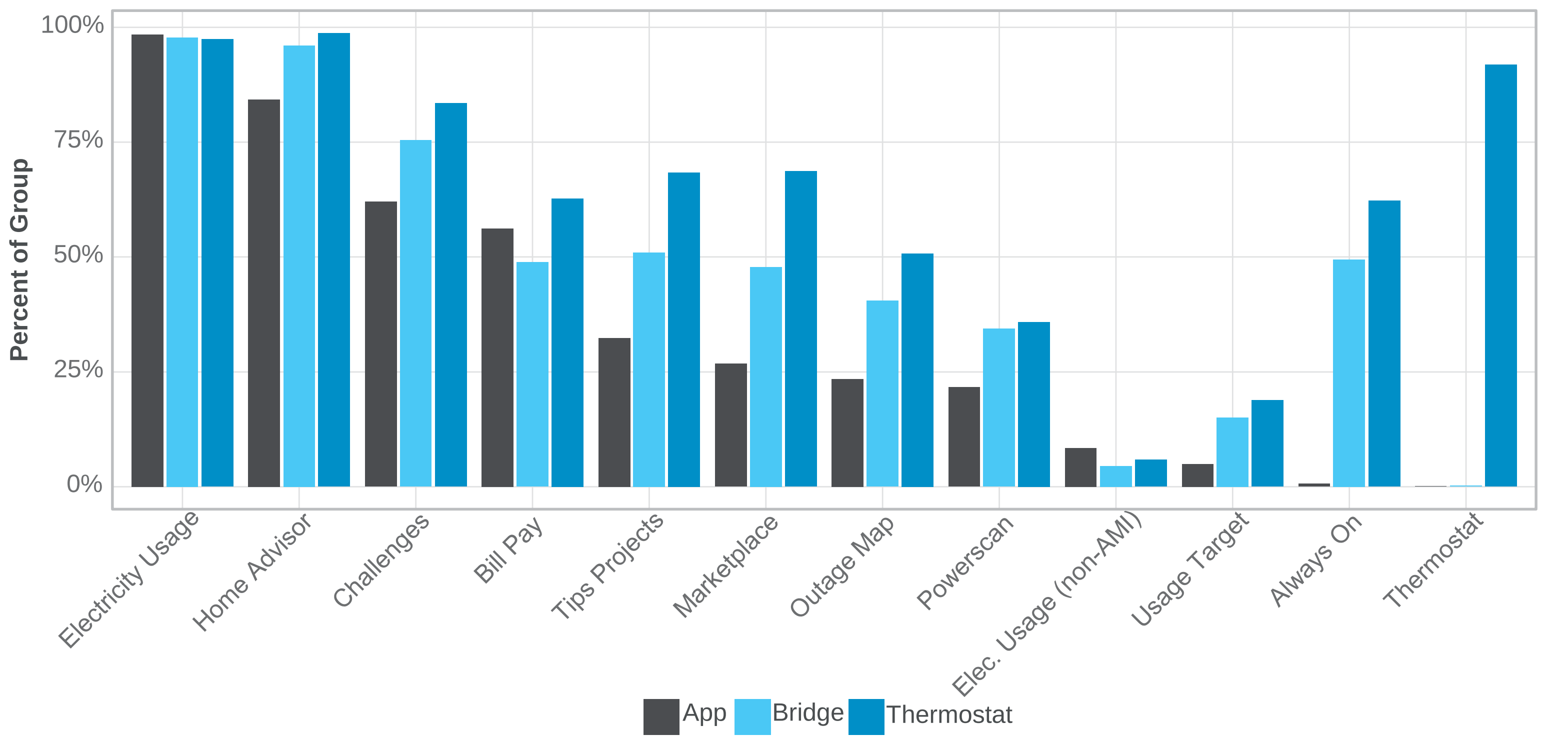
The number of participants with the app doubled from 2018 to 2019, a result of increased marketing cadence. Marketing efforts targeted customers who have downloaded the app, but have not requested an energy bridge, and AMI customers who have not downloaded the app. AEP Ohio and the program implementer continue to work on growing the program to improve cost effectiveness, according to the implementation manager. Both the program manager and implementation manager mentioned the potential to target marketing messages to various customer segments.

Starting in December 2019, technical issues were preventing energy bridges from binding to the meter. As of early February 2020, these technical issues were still being resolved, but a manual work-around was in place.

App Analytics

Page Visits by Customer Type

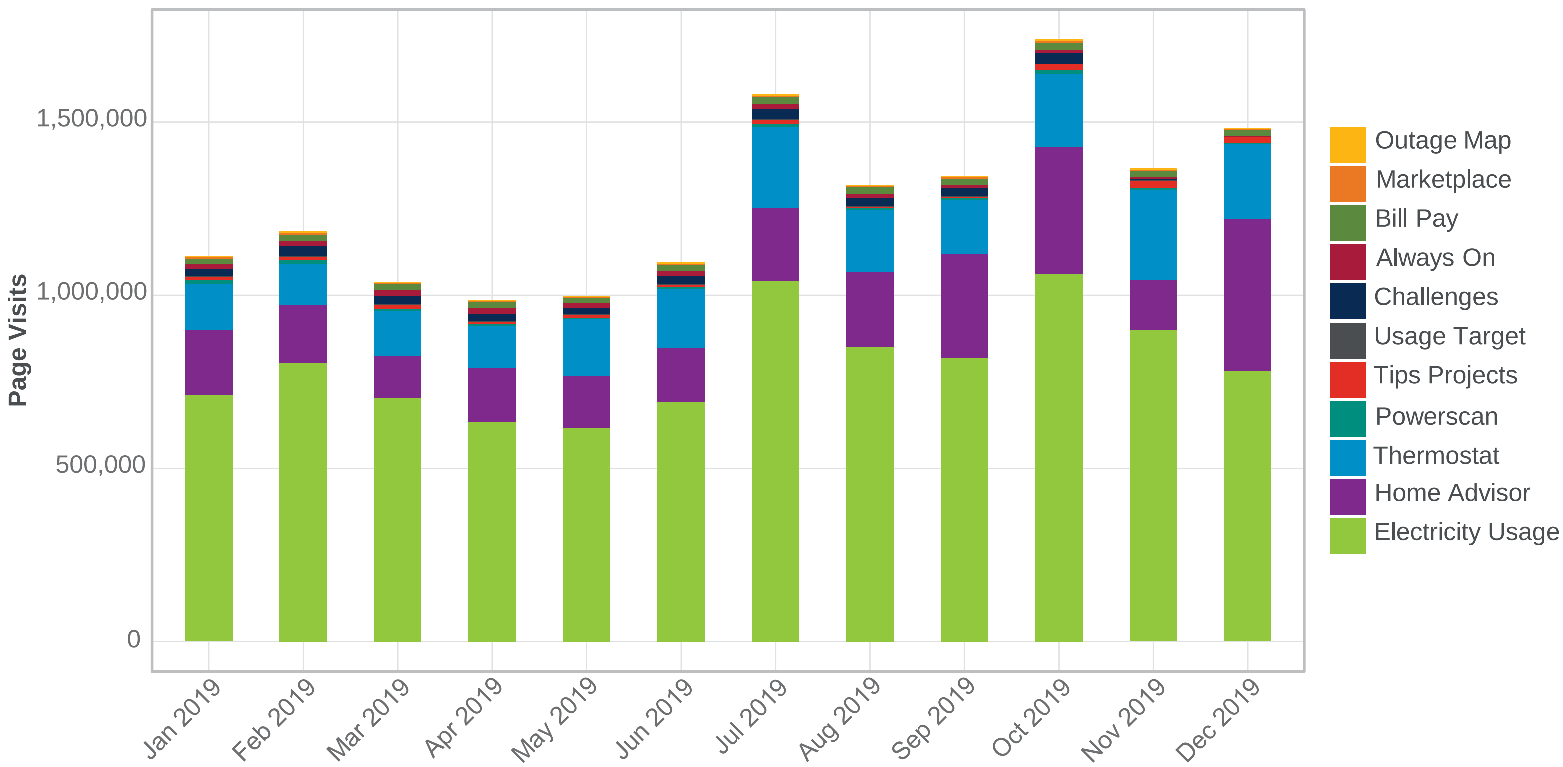
Nearly all app downloaders visit the home page of the app, which shows the hourly or sub-hourly electricity usage. Other pages visited by most downloaders include home advisor, challenges, and bill pay. The majority of thermostat customers visited the tips & projects, marketplace, outage map, always on, and thermostat pages.



App Analytics

Page Visits by Month

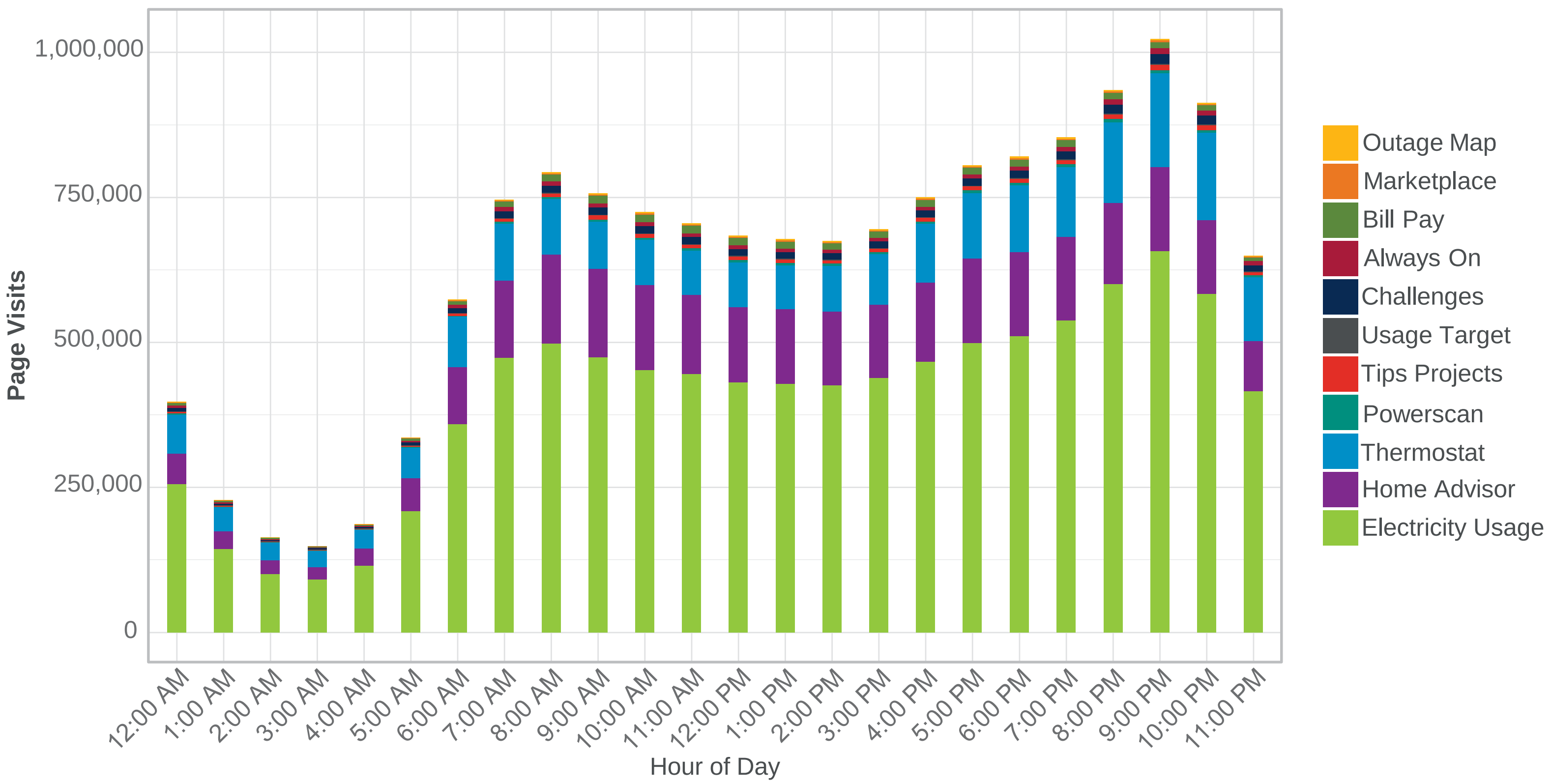
App traffic was higher in 2019 compared to 2018, with page visits totaling near one million or more in each month. App traffic increased in the second half of 2019, likely due to marketing efforts, including an August bill insert featuring the Intelligent Home program. October had the highest number of page visits, surpassing 1.7 million. The Electricity Usage page is the app landing page; all other pages required a click to view.



App Analytics

Page Visits by Hour of Day

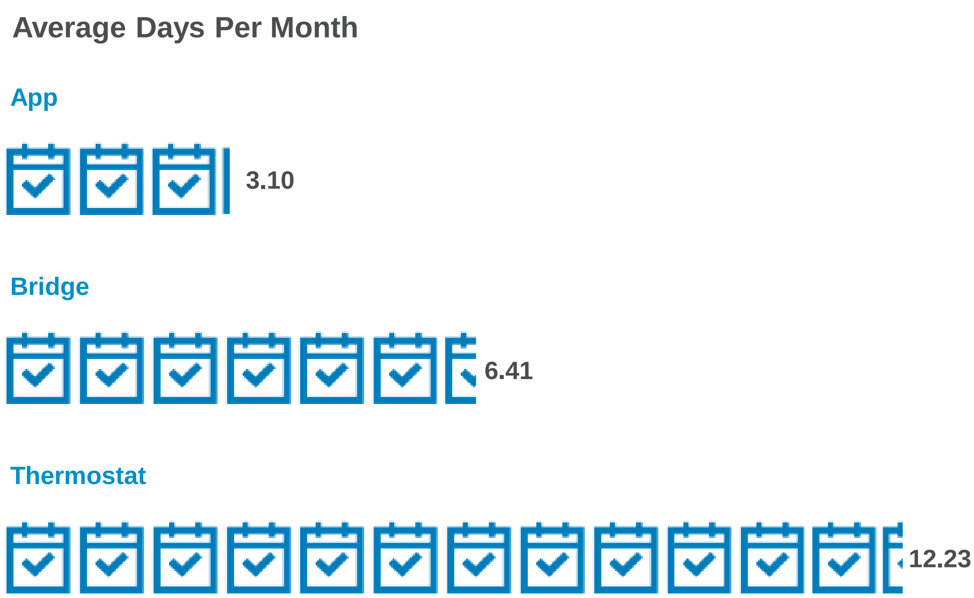
App traffic continues to be heaviest during the evening, peaking around 9 PM. This peak could be due to users wishing to see their electricity pattern for the day as the day is ending. Traffic is lowest during the middle of the night.



App Analytics

Visits per Month

The app is visited most-frequently by customers with a thermostat and least frequently by customers with only the app. Thermostat customers likely use the app most-frequently because the app allows them to control the thermostat. App-only customers have the fewest available features within the app, so there is less to spur engagement for these customers. Average days per month has increased by approximately 10 percent in 2019 compared to 2018.



04
Recommendations

Recommendations

FINDING 1

The app alone continues to not produce statistically significant savings, similar to the pilot phase of the program.

Average savings for customers with an installed energy bridge decreased from 2018 to 2019, with average savings no longer being statistically significant. Decreased average savings may reflect the natural increase in the proportion of “inactive” users as the program matures.

RECOMMENDATION 1

As recommended in the 2018 evaluation, AEP Ohio should consider exploring savings by length of time with the energy bridge. Similar programs have seen savings ramp up over time.

FINDING 2

The engagement analysis revealed an upward trend in savings with higher levels of engagement for app and energy bridge customers.

RECOMMENDATION 2

As recommended in the 2018 evaluation, AEP Ohio should continue to test new ways of encouraging customers to return to and use the app, such as gamification, which may drive higher savings. AEP Ohio should monitor “active users” of the app relative to overall downloads.

AEP Ohio should also consider imposing an engagement threshold during future evaluation years. As more customers download the app and the program continues over several years, the number of “inactive” users will increase, potentially diminishing average savings.

APPENDIX F

Community Assistance Program

2019 Evaluation Report

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March, 27 2020

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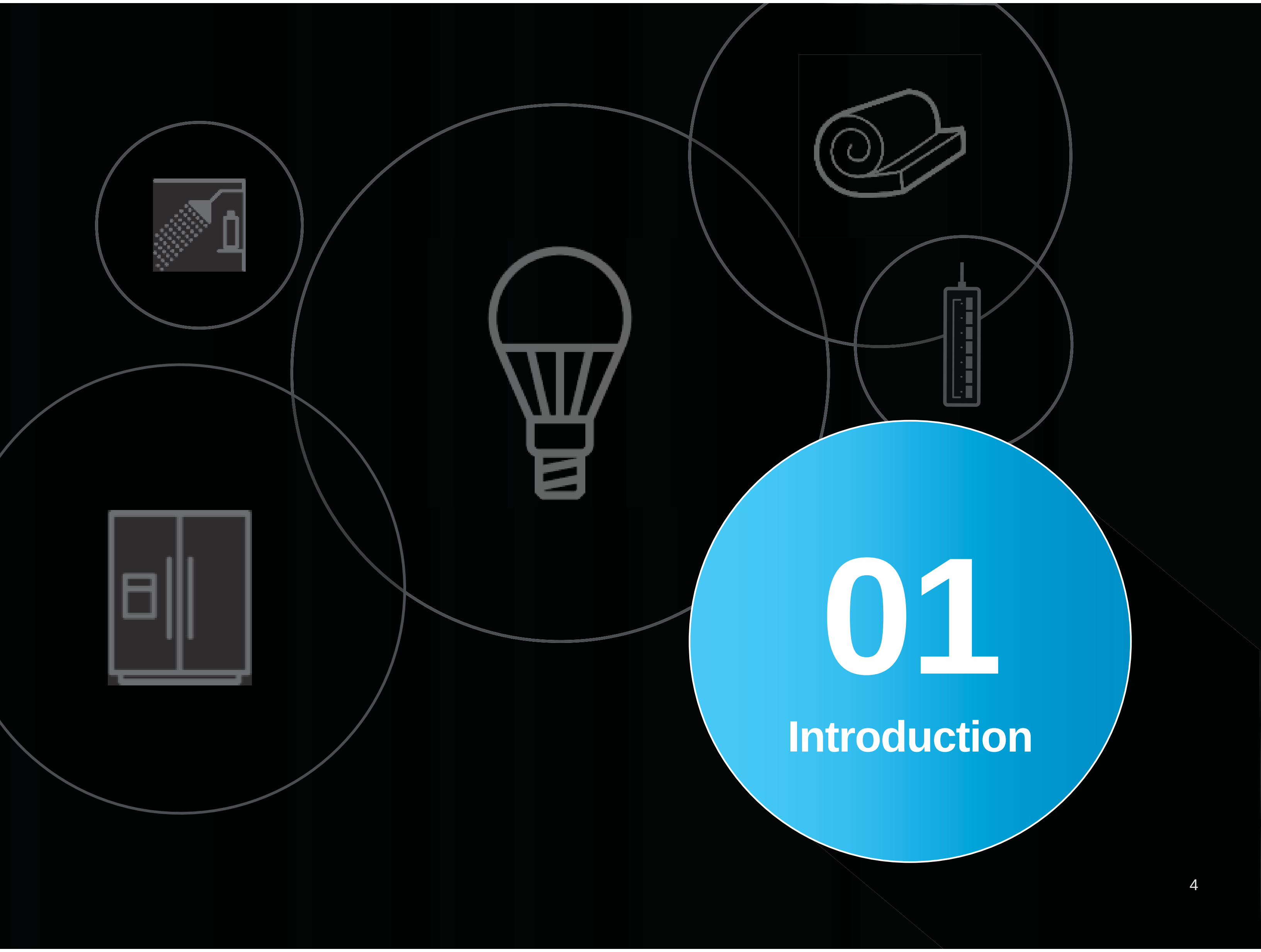
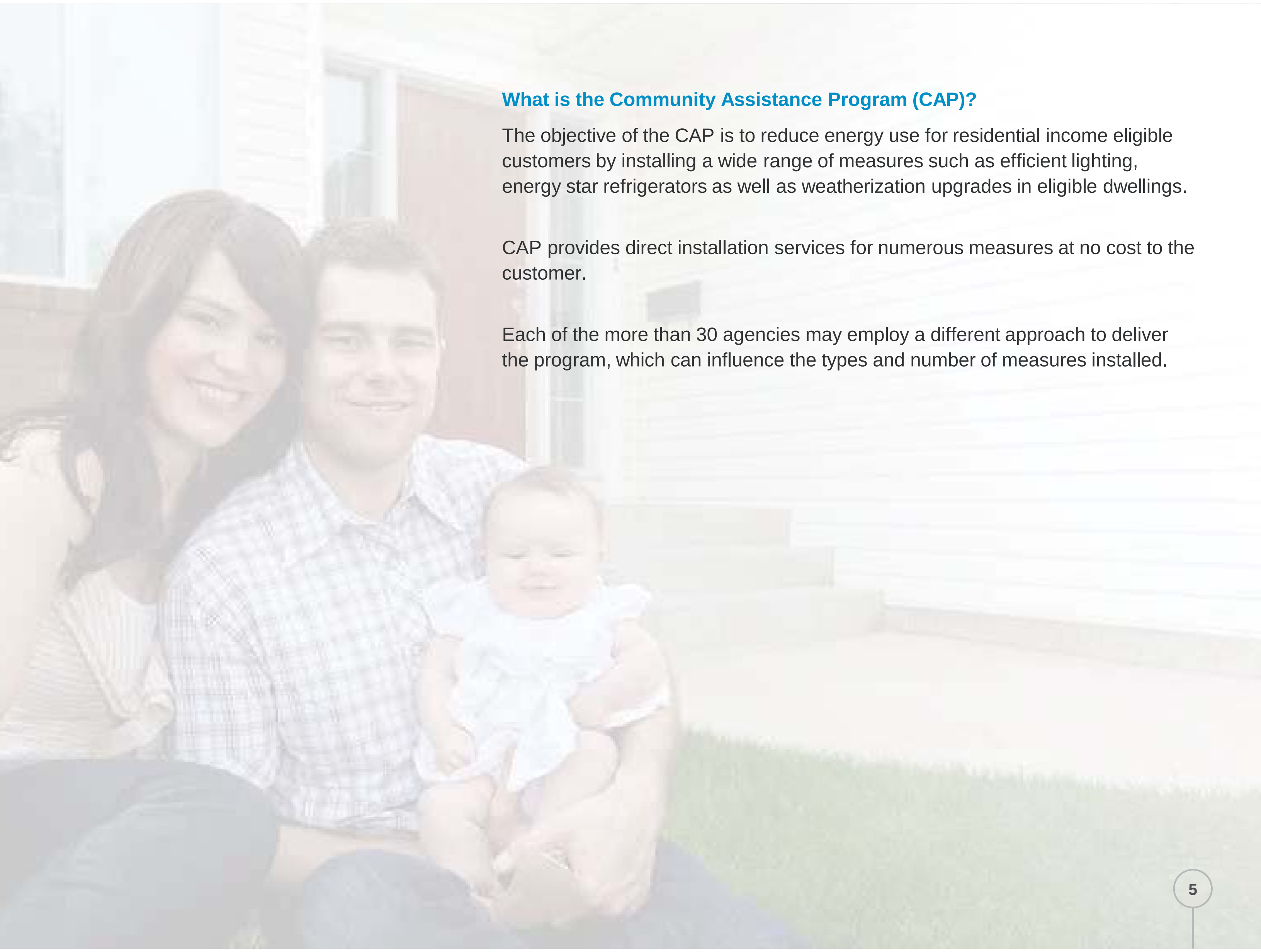


01 Introduction



What is the Community Assistance Program (CAP)?

The objective of the CAP is to reduce energy use for residential income eligible customers by installing a wide range of measures such as efficient lighting, energy star refrigerators as well as weatherization upgrades in eligible dwellings.

CAP provides direct installation services for numerous measures at no cost to the customer.

Each of the more than 30 agencies may employ a different approach to deliver the program, which can influence the types and number of measures installed.

Program Summary

In 2019, CAP was administered by AEP Ohio through the implementer, and agencies.

CAP provides agencies with a price list that includes set prices for the measures they install. If a measure is not on the price list, the agency seeks approval from AEP Ohio.

Eligible participants must have a total annual household income at or below 200 percent of federal poverty guidelines and be the active customer of record for AEP Ohio.

The program's objective is to reduce energy use for residential low-income customers by installing a range of cost-effective weatherization upgrades and energy efficiency measures in income eligible dwellings.

The overall implementation strategy for CAP is to provide funding to the agencies to target weatherization services and energy-efficient measure installations in the low-income sector.

Program Summary

The realization rates for 2019 were 0.97 for energy savings and 1.04 for demand savings. The program achieved 2,604 MWh and 400 kW in energy and demand savings, respectively.

PROGRAM EVALUATION SUMMARY RESULTS

	2019 Program Goals[1](a)	Ex Ante Savings (b)	Ex Post Savings (c)	Realization Rate RR = (c) / (b)	Percent of Goal = (c) / (a)
Energy Savings (MWh)	8,499	**2,672**	**2,604**	0.97	31%
Demand Savings (kW)	774	**383**	**400**	1.04	52%

[1] Volume 1: 2017 to 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, June 15, 2016.

02
Methodology

Evaluation Objectives

The four major objectives of the evaluation were to:

01 Quantify energy and demand savings impacts from the program

02 Determine key process-related program strengths and weaknesses

03 Determine program cost-effectiveness

04 Identify ways in which the program can be improved

Guidehouse conducted the following activities to collect the information necessary to achieve the evaluation objectives:

01 In-depth interviews with the agencies

02 Tracking system review

03 In-depth interviews with AEP Ohio staff

04 Onsite verification of installed measures, quantities, and other parameters critical to estimating energy and demand savings

05 Online survey of Community Assistance Appliance Recycling (CAAR) participants

Data Collection Activities

DATA COLLECTION TYPE

1	2	3	4	5
Tracking Data Analysis	**AEP Ohio PM Telephone Interview**	**Onsite Field Surveys**	**Online Surveys**	**Community Action Agencies Telephone Surveys**
Targeted Population **Program Participants**	Targeted Population **Program Project Manager**	Targeted Populations **Program Participants**	Targeted Population **Program Participants**	Targeted Population **Participating Agencies**
Sample Size **4,096**	Sample Size **1**	Sample Size **4,096**	Sample Size **352 valid email addresses**	Sample Size **34**
Completes **Census**	Completes **2 separate interviews**	Completes **65**	Completes **46**	Completes **5**
Timing **October 2019 – February 2020**	Timing **October 2019 – February 2020**	Timing **January 2020 – February 2020**	Timing **January 2020 – February 2020**	Timing **January 2020 – February 2020**

Material Review

Tracking System Review

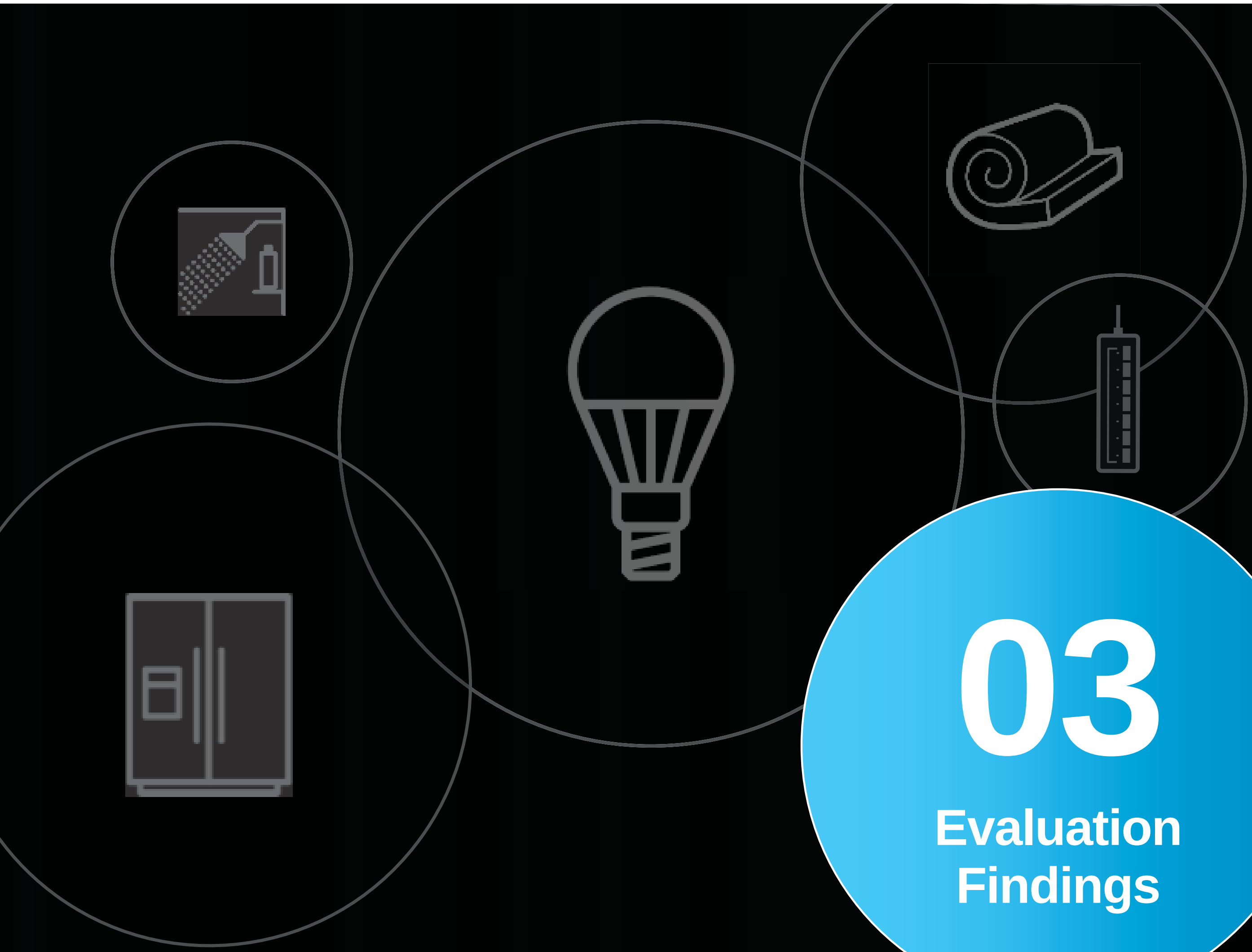
The evaluation team performed a review of the tracking system database to examine outliers, missing values, and potentially missing variables. The purpose of the tracking system review was to ensure it gathered the data required to enable program managers to monitor key aspects of program performance at regular intervals and to support evaluation activities. The evaluator did not address whether the tracking system is adequate for regulatory prudence reviews or corporate requirements.

Ex Post Savings Evaluation Methods

Program savings were assessed using the program tracking data and the Draft 2010 Ohio TRM. Guidehouse conducted a review of measure savings recorded in the tracking system to verify the algorithms matched the Draft 2010 Ohio TRM (TRM) and were correctly applied for each project. The evaluation team independently calculated energy savings for each measure in the database using the ex ante calculation methods based on the TRM. For measures not included in the TRM, the evaluation team used the most appropriate calculation methods from secondary sources (i.e., other TRMs). Ex post savings estimates then were used to calculate adjusted energy and demand savings for each measure.

Program Material Review

The evaluation team reviewed all program materials provided by AEP Ohio for 2019 and conducted a review of best practices for implementing residential low-income programs.



03 Evaluation Findings

Measure Energy Saving Results

164,937 measures were installed to 4,096 participants during the 2019 year as a part of the program.

The verified energy savings are 2,604,384 kWh. Guidehouse found a realization rate of 0.97.

Measure Category	Ex Ante Number of Units	Ex Post Number of Units[1]	Total Ex Ante Energy Savings (kWh) (a)	Total Ex Post Energy Savings (kWh) (b)	Energy Savings Realization Rate RR = (b) / (a)
LED	49,681	49,184	1,790,595	1,772,690	0.99
Refrigerator	2,643	2,643	289,319	289,319	1.00
Smart Strip	3,120	2,746	255,348	218,440	0.88
A-R-C Insulation	59,231	59,231	150,615	150,615	1.00
Showerhead	615	541	87,851	77,309	0.88
Faucet Aerator	823	749	19,772	17,992	0.91
WH Replacement	26	26	17,146	17,146	1.00
Heat Pump	19	19	16,110	16,110	1.00
Wall/Floor Insulation	13,082	13,082	15,836	15,836	1.00
Freezer	353	353	13,546	13,546	1.00
Pipe Insulation	345	345	5,493	5,493	1.00
Air Sealing	2,431	2,431	4,332	4,332	1.00
Other[2]	9,512	9,512	3,990	3,990	1.00
HW Tank Wrap	14	14	1,106	1,106	1.00
Duct Sealing	136	136	462	462	1.00
MISC[3]	22,906	22,906	0	0	1.00
TOTAL	**164,937**	**163,918**	**2,671,520**	**2,604,384**	**0.97**

[1] Ex post numbers are different ex ante numbers due to the removal of measures with zero savings values and the ISR.
[2] Other, includes a mix of measures that individually had minor overall savings. The measures include; unique insulation, vent fans, hot water tank setbacks, metering for refrigerators/freezers, HVAC, and audits.
[3] Miscellaneous includes a mix of insulation measures
* Note: totals may not sum due to rounding.

Measure Demand Saving Results

continued

The following table shows the demand savings per measure. Guidehouse verified a total of 399.851 kW in peak demand savings. Guidehouse found a realization rate of 1.04.

Measure Category	Ex Ante Number of Units	Ex Post Number of Units[1]	Total Ex Ante Energy Savings (kW) (a)	Total Ex Post Energy Savings (kW) (b)	Energy Savings Realization Rate RR = (b) / (a)
LED	49,681	49,184	308.749	305.662	0.99
Refrigerator	2,643	2,643	51.734	51.734	1.00
Smart Strip	3,120	2,746	0	21.210	N/A
Showerhead	615	541	10.459	9.204	0.88
Heat Pump	19	19	2.596	2.596	1.00
Freezer	353	353	2.372	2.372	1.00
Faucet Aerator	823	749	2.471	2.249	0.91
WH Replacement	26	26	1.646	1.646	1.00
A-R-C Insulation	59,231	59,231	1.518	1.518	1.00
Pipe Insulation	345	345	0.627	0.627	1.00
Other	9,512	9,512	0.441	0.441	1.00
Wall/Floor Insulation	13,082	13,082	0.403	0.403	1.00
HW Tank Wrap	14	14	0.126	0.126	1.00
Air Sealing	2,431	2,431	0.026	0.026	1.00
Duct Sealing	136	136	0	0	0.00
MISC	22,906	22,906	0	0	0.00
TOTAL	**164,937**	**163,918**	**383.171**	**399.815**	**1.04**

[1] Ex post numbers are different ex ante numbers due to the removal of measures with zero savings values and the ISR.
[2] Other, includes a mix of measures that individually had minor overall savings. The measures include; unique insulation, vent fans, hot water tank setbacks, metering for refrigerators/freezers, HVAC, and audits.
[3] Miscellaneous includes a mix of insulation measures
* Note: totals may not sum due to rounding.

In-Service Rates

The evaluation team conducted 65 onsite visits to 2019 participant's homes to verify if measures were installed as described in the tracking database.

The evaluation team applied the 2019 In-service rates (ISRs) to the verified energy and demand savings.

Measure	Number of Claimed Units (a)	Number of Verified Installed Units (b)	In-Service Rate 2019 ISR = (b) / (a)	In-Service Rate 2018
LEDs	872	865	**99%**	94%
Low-Flow Showerhead	24	21	**88%**	62%
Faucet Aerator	34	31	**91%**	95%
Refrigerators	35	35	**100%**	100%
Smart Strips	48	42	**88%**	90%

Reduced Program Savings Compared to Previous Years

The overall savings for CAP were lower in 2019 than in previous years. The reduction in savings is mostly due to AEP Ohio's appliance recycling program receiving savings credit for the retirement of refrigerators and freezers. CAP refrigerator and freezer savings come from the savings resulting from the installation of an energy efficient refrigerator or freezer compared to the federally recognized standard refrigerator or freezer.

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Measure Calculation Methods

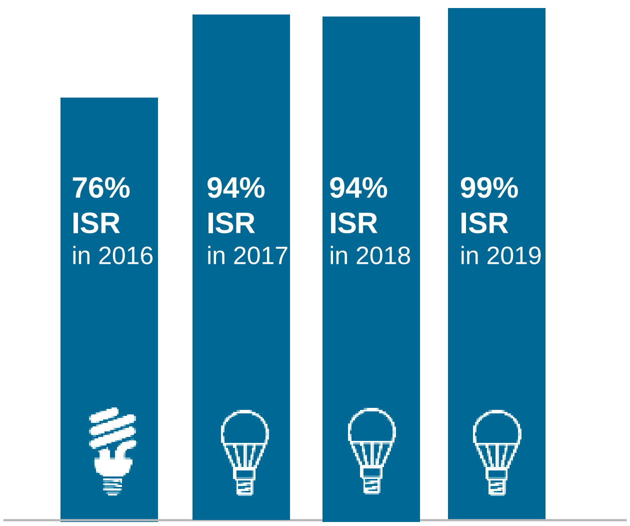
Smart Strips

AEP Ohio claims no demand savings for smart strips.

The tracking data does not indicate if the installed smart strip is 5-plug or 7-plug.

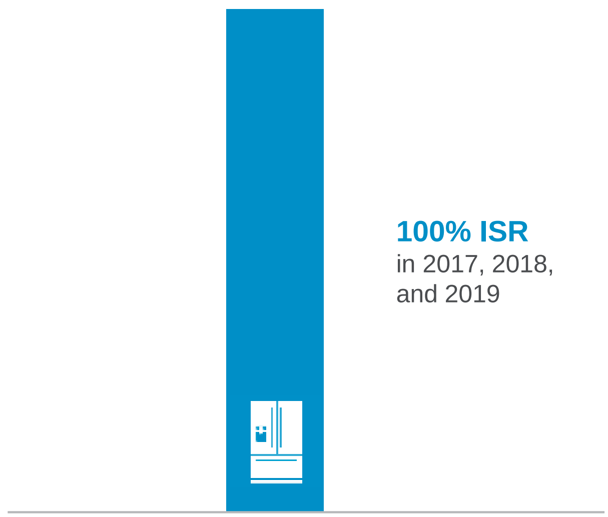
The evaluation team applied the average of 5-plug and 7-plug smart strip savings for the ex post savings estimates.

Onsite Verification



This year the in-service rate for LEDs increased to 99 percent, compared to the in-service rate of 94 percent for 2017 and 2018.

LEDs have exclusively been installed by CAP since 2017. The in-service rates have greatly increased since CAP switched from CFLs to LEDs.



For the past three years the evaluation on-site team has verified 100 percent of the refrigerators were installed.

This year 35 refrigerators that were in the tracking system were visually verified by the on-site evaluation team.

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Cost-Effectiveness Review

Cost effectiveness is assessed through the use of the Total Resource Cost (TRC) test. The table below summarizes the unique inputs used in the TRC test.

COST-EFFECTIVENESS MODEL INPUTS

Item	Value
Average Measure Life	14
Residences	4,096
Annual Energy Savings (kWh)	2,604,384
Coincident Peak Savings (kW)	400
Third Party Implementation Costs	$678,196
Utility Administration Costs	$561,697
Utility Incentive Costs	$4,249,735
Participant Contribution to Incremental Measure Costs	$0

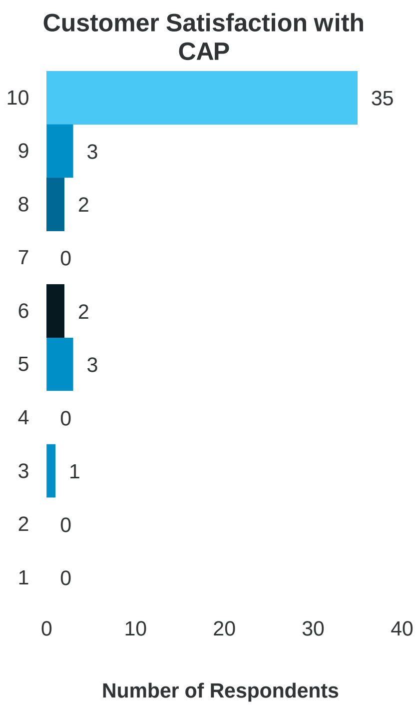
Based on these inputs, the TRC ratio is 0.2. Table below summarizes the results of the cost-effectiveness tests. Results are presented for the Total Resource Cost test, the Participant Cost Test, the Ratepayer Impact Measure Test, and the Utility Cost Test.

COST-EFFECTIVENESS RESULTS

Benefit-Cost Ratio–Test Results	Ratio
Total Resource Cost	0.2
Participant Cost Test	N/A
Ratepayer Impact Measure	0.1
Utility Cost Test	0.2

Additional benefits related to the reduction of non-energy benefits (such as greenhouse gas emissions) have not been quantified in the calculation of the TRC.

Guidehouse's Online Survey



The online surveys were conducted with customers who had their old refrigerators picked up and their new refrigerators delivered by Recleim. Recleim gathers email addresses in its database which were used to distribute the online survey. Currently, the AEP Ohio tracking system does not gather email addresses. The survey was completed by 46 CAP participants.

SURVEY QUESTION

On a scale of 0 to 10 with 10 being very satisfied and 1 being very dissatisfied how satisfied were you with the Community Assistance Program (CAP)?

Question Response n = 46

The average rating for the program was 9.20. The rating increased from last year's average rating of 8.99.

SURVEY QUESTION

Was it clear that AEP Ohio funded the CAP program?

The majority of CAP participants realize that AEP Ohio is funding the program. With the numerous different income-eligible programs the implementers are using to improve the participant's home, it is noteworthy that the customer recognizes AEP Ohio as a funding source.

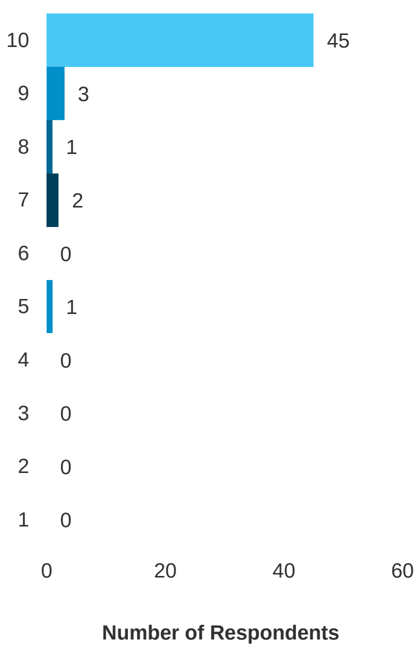
Question Response n = 46

Yes	36
No	6
Don't know	4

Guidehouse's Online Survey

Continued

Customer Satisfaction with Implementor



SURVEY QUESTION

Overall, how satisfied were you with your experience with having your old appliance recycled through the Community Assistance Program?

Question Response n = 52

On a scale of 0 to 10 the average rating for the refrigerator and freezer replacement was 9.69.

There were three respondents (out of 52 responses) who said that the delivery team did not clean up all the packing material before they left. Clean up was the only issue that multiple respondents mentioned.

Customer Comments

"I really enjoy the service I received, and I will recommend this to anyone that is a homeowner, I was very blessed."

"Thank you so much for offering this! My appliances were in good shape, but old and cost too much to run. This program is wonderful."

"I was very pleased with the people that delivered my new refrigerator and their performance and I thank you very much for your services."

Interviews

Community-Based Agency Interviews

In-depth interviews were conducted with five participating community-based agencies to engage those most intimately involved with program delivery.

The list of interview candidates was developed based on a review of the program database, the AEP Ohio PM interview, the online evaluation survey, and the evaluation onsite field visits.

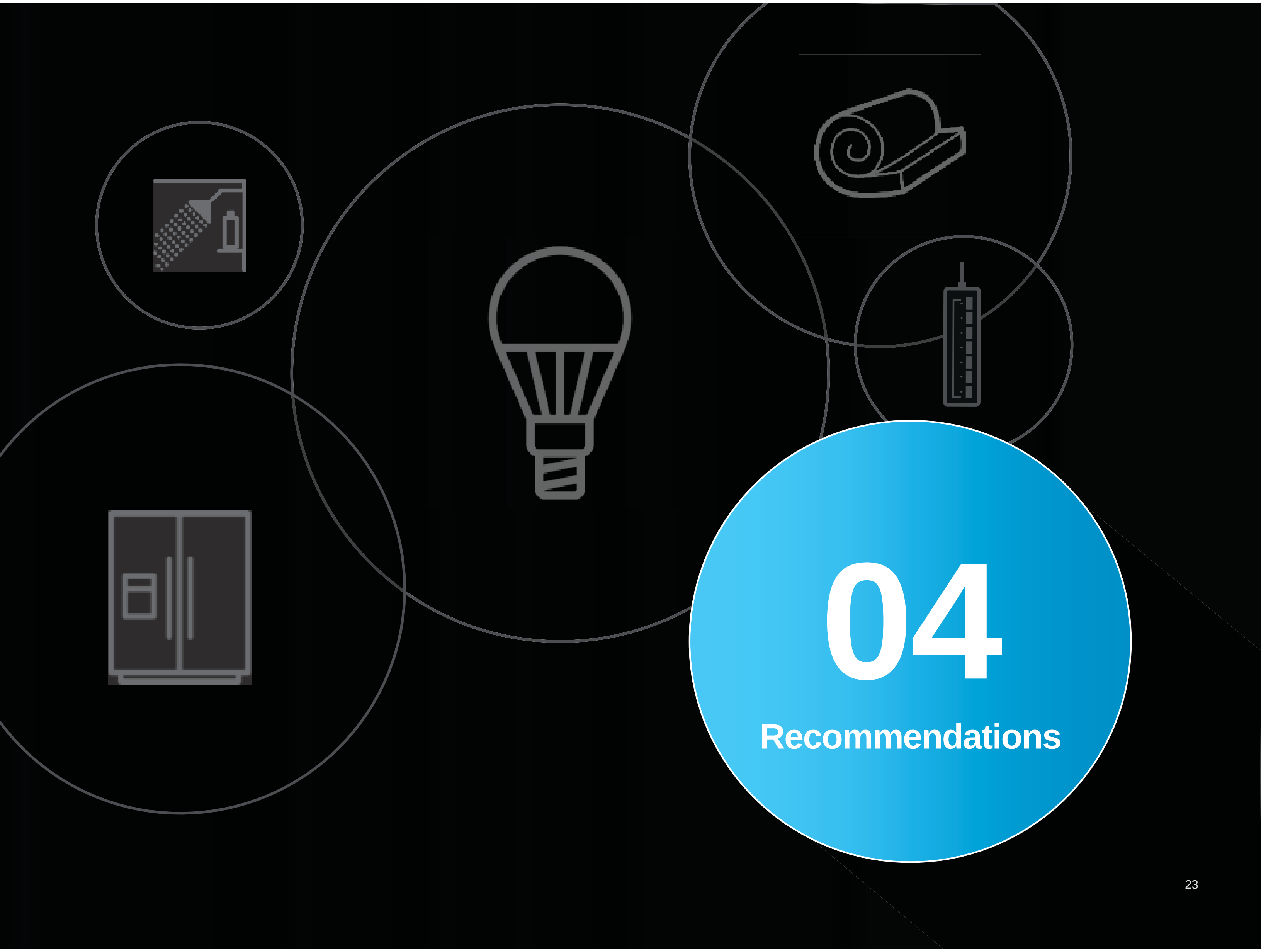
The principal objective of the interviews was to explore ways the program could improve for AEP Ohio and the agencies.

The interviews included questions about program quality control, installation procedures, program communications, the tracking system, program changes, and program delivery.

Questions were open-ended to facilitate an open discussion of the topics.

Key interview responses:

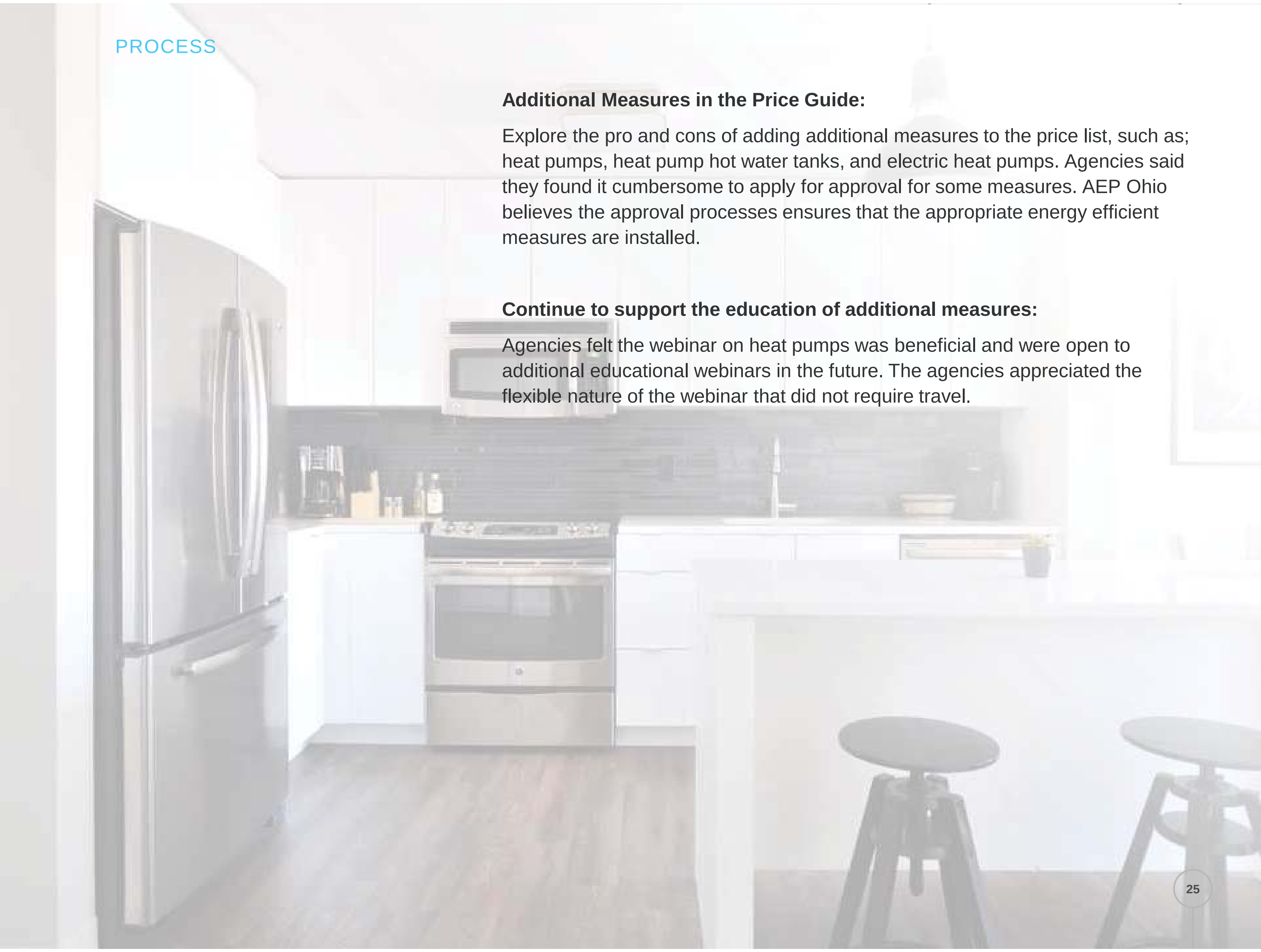
- Agencies mentioned that it would be easier if there were more measures in the price list, which would allow them to avoid applying for approval that takes additional time. Agencies said other utilities have more measures in their price list.
- Agencies were excited about the possibility of increasing the number of heat pumps they install but didn’t think the increase would be sudden due to some areas having mostly gas as their heating fuel. The agencies thought the heat pump webinar was useful and that it encouraged them to think of heat pumps when it was possible for the home.



04

Recommendations

Topic	Recommendation
Smart Strip	Currently, AEP Ohio claims no demand savings for smart strips. Calculate demand savings using the deemed savings outlined in the Draft 2010 Ohio TRM. Guidehouse recommends gathering data to identify if the smart strip is a 5-plug or 7-plug to provide more accurate savings estimates.

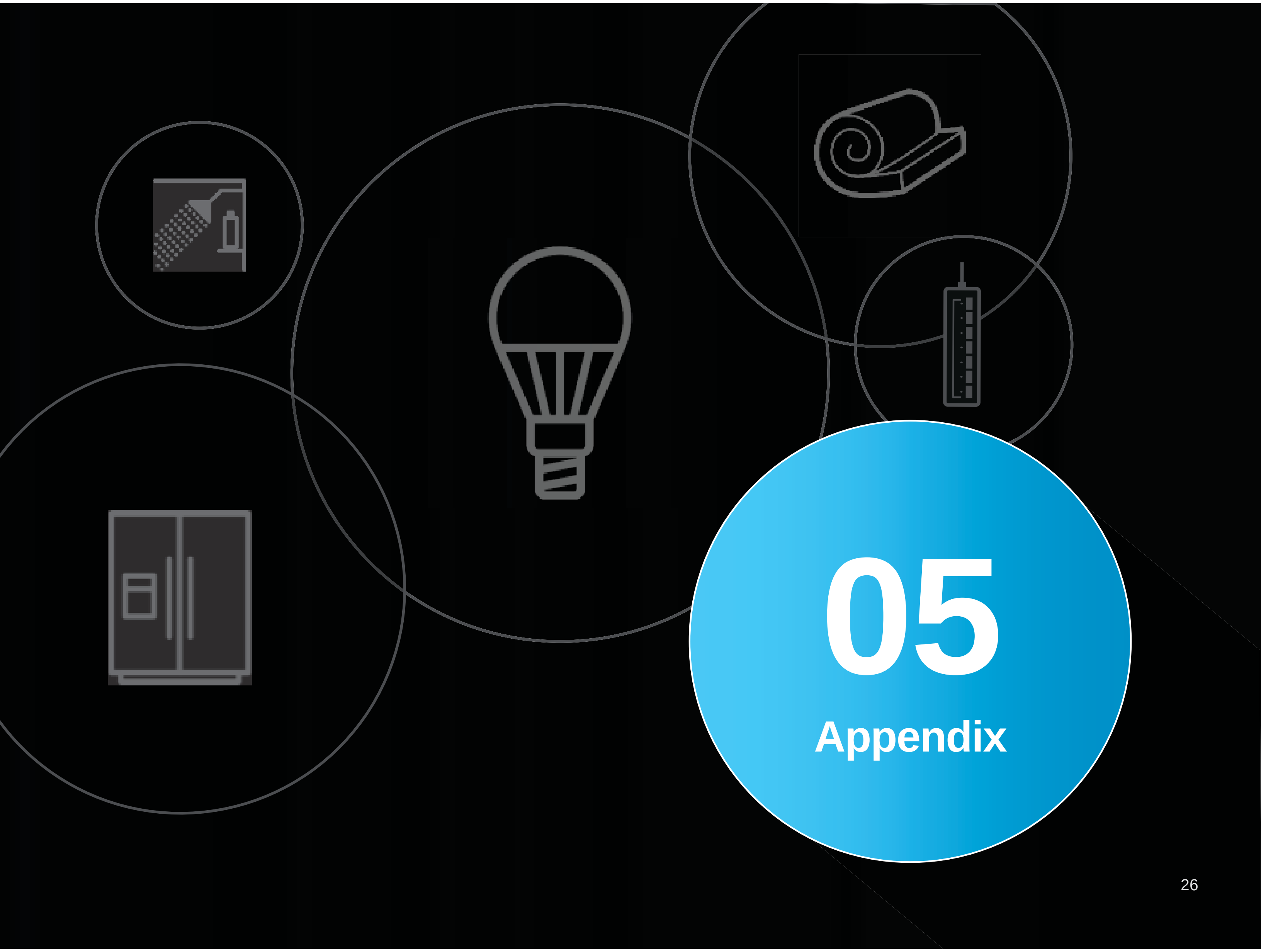


Additional Measures in the Price Guide:

Explore the pro and cons of adding additional measures to the price list, such as; heat pumps, heat pump hot water tanks, and electric heat pumps. Agencies said they found it cumbersome to apply for approval for some measures. AEP Ohio believes the approval processes ensures that the appropriate energy efficient measures are installed.

Continue to support the education of additional measures:

Agencies felt the webinar on heat pumps was beneficial and were open to additional educational webinars in the future. The agencies appreciated the flexible nature of the webinar that did not require travel.



05 Appendix

Appendix

Energy and Demand Savings Calculations for LEDs

Guidehouse used a combination of equations from the Draft 2010 Ohio TRM, the installation rate collected from onsite visits, tracking data LED wattages, AEP Ohio Residential Lighting Interactive Effects Modeling Study[1], and an AEP Ohio Residential Lighting Metering Study[2] in order to calculate savings for LEDs.

The Draft 2010 Ohio TRM equations are shown in the following equations.

The following table shows the values of the key parameters.

Ex Ante Energy Savings for LEDs

$$kWh\ Savings = (BaselineWatts - LEDWatts/1000) * ISR_{LED} * HOU_{LED} * WHF_{E,\ LED}$$

Ex Ante Demand Savings for LEDs

$$kW\ Savings = (BaselineWatts - LEDWatts/1000) * ISR_{LED} * CF_{LED} * WHF_{D,\ LED}$$

KEY PARAMETERS FOR LEDs

Parameter Description	Parameter	Value	Source
Energy efficient LED Wattage (W)	LEDWatts	Varies	Tracking Data
Replaced bulb Wattage (W)	BaselineWatts	Varies	Recommendation from 2016 Evaluation based on 2016 ENERGY STAR® product list[1], Tracking Data
In-Service Rate	ISR_{LED}	0.99	Evaluation onsite audit
Hours of Use (hours/year)	HOU_{LED}	1,051	Lighting Metering Study[2]
Coincidence Factor	CF_{LED}	0.13	
Waste Heat Factor for Energy	$WHF_{E,\ LED}$	0.93	Interactive Effects Modeling Study[3]
Waste Heat Factor for Demand	$WHF_{D,\ LED}$	1.34	

[1]2015 Efficient Products Evaluation Report.
[2]Residential Lighting Metering Study (Final Report), March 25, 2015.
[3]"AEP Ohio Residential Lighting Interactive Effects Modeling Results" memo, January 2016.

[1] AEP Ohio Residential Lighting Interactive Effects Modeling Results" memo, January 2016.
[2] *Residential Lighting Metering Study (Final Report), March 25, 2015.*

Appendix

Energy and Demand Savings Calculations for Refrigerator Replacement

Guidehouse used the deemed savings values from the Draft 2010 Ohio TRM for ex-post savings from refrigerator replacement and efficient refrigerator.

Guidehouse determined a realization rate of 1.00 for energy and demand savings.

Draft 2010 Ohio TRM-Specified Energy Savings Equations for Efficient Refrigerator
Annual kWh Savings = UECbase - UECee

Where: *UECexisting = Unit Energy Consumption of existing refrigerator*
UECbase = Unit Energy Consumption of new baseline refrigerator
UECee = Unit Energy Consumption of ENERGY STAR unit

Draft 2010 Ohio TRM-Specified Demand Savings Equations for Efficient Refrigerators
*ΔkW = (ΔkWh/8760) * TAF * LSAF*
Where: *TAF = Temperature Adjustment Factor = 1.30*
LSAFnew = Load Shape Adjustment Factor for new unit = 1.18

	UECbase	UECee	Annual kWh Savings per Unit	Summer Coincident Peak kW Savings per Unit
Bottom Freezer	596 kWh	477 kWh	119 kWh	0.021 kW
Top Freezer	497 kWh	397 kWh	100 kWh	0.018 kW
Side by Side	706 kWh	564 kWh	142 kWh	0.025 kW

REFRIGERATOR MEASURES

Measure	Ex Ante kWh Savings (a)	Ex Ante kW Savings (b)	Ex Post kWh Savings (c)	Ex Post kW Savings (d)	kWh RR = (c / a)	kW RR = (b / d)
Energy Star Refrigerator 16 CuFt Top Freezer	100.00	0.02	100.00	0.02	100%	100%
Energy Star Refrigerator 18 CuFt Top Freezer	100.00	0.02	100.00	0.02	100%	100%
Energy Star Refrigerator 19 CuFt Bottom Freezer	119.00	0.02	119.00	0.02	100%	100%
Energy Star Refrigerator 22 CuFt Bottom Freezer	119.00	0.02	119.00	0.02	100%	100%
Energy Star Refrigerator 21 CuFt Bottom Freezer	119.00	0.02	119.00	0.02	100%	100%
Energy Star Refrigerator 21 CuFt Side by Side Freezer	142.00	0.03	142.00	0.03	100%	100%
Energy Star Refrigerator 25 CuFt Side by Side Freezer	142.00	0.03	142.00	0.03	100%	100%
Energy Star Refrigerator 14 CuFt Top Freezer	100.00	0.02	100.00	0.03	100%	100%
Energy Star Refrigerator 19 CuFt Top Freezer	100.00	0.02	100.00	0.02	100%	100%
Energy Star Refrigerator 21 CuFt Top Freezer	100.00	0.02	100.00	0.02	100%	100%

Appendix

Energy and Demand Savings Calculations for Freezer Replacement

Guidehouse used the deemed savings values from the Draft 2010 Ohio TRM for ex post savings from freezer replacement and efficient freezer. Guidehouse determined a realization rate of 1.00 for energy and demand.

Guidehouse Savings Equations for Freezer Replacement

kWh for remaining life of existing unit (first 8 years) = UECexisting – UECES

Where: *UECexisting = Unit Energy Consumption of existing refrigerator = 1244 kWh*
UECES = Unit Energy Consumption of new ENERGY STAR refrigerator = 361.8 kWh
kWh for remaining life of existing unit (1st 8 years) = 1376 – 361.8 = 882.2 kWh

Average unit consumption of 16 cubic feet of the following Federal standard freezers: upright freezer with manual defrost, upright freezers with automatic defrost, chest freezer, and all other freezers except compact freezers.

Appendix

Energy and Demand Savings Calculations for Smart Strips

The evaluation took the average TRM savings values for 5-plug (56.5 kWh, 0.0063 kW) and 7-plug (102.8 kWh, 0.0092 kW) smart strips (79.56 kWh, 0.007725.)

The evaluation values differ from the tracking data, which assigns savings values of 82.00 kWh and 0 kW. A 88% ISR was also applied to the savings values.

DRAFT 2010 OHIO TRM-SPECIFIED SAVINGS FOR SMART STRIPS

	Average Annual kWh Savings per Unit	Average Summer Coincident Peak kW Savings per Unit
5-plug	56.5	0.0063
7-plug	102.8	0.012

Appendix

Energy and Demand Savings Calculations for Pipe Insulation

Draft 2010 Ohio TRM-Specified Energy Savings for Pipe Insulation

*Annual kWh Savings = ((1/Rexist – 1/Rnew) * (L * C) * ΔT * 8,760) / ηDHW / 3413*

Draft 2010 Ohio TRM-Specified Demand Savings for Pipe Insulation

ΔkW = ΔkWh / 8,760

KEY PARAMETERS FOR PIPE INSULATION

Parameter Description	Parameter	Value	Source
Pipe Heat Loss Coefficient of Uninsulated Pipe	Rexist	1	Draft 2010 Ohio TRM
Pipe Heat Loss Coefficient of Insulated Pipe	Rnew	Varies	Measure Description (Actual or deemed when input value is considered incorrect by being outside reasonable boundaries)
Length of Pipe from Water Heating Source Covered by Pipe Wrap	L	Varies	Measure Description (Actual or deemed when input value is considered incorrect by being outside reasonable boundaries)
Circumference of Pipe	C	0.13	Draft 2010 Ohio TRM
Average Difference between Supplied Water and Outside Air Temperature	Delta T	65	Draft 2010 Ohio TRM
Recovery Efficiency of Electric Hot Water Heater	ηDHW	0.98	Draft 2010 Ohio TRM

Appendix

Energy and Demand Savings Calculations for Attic-Roof-Ceiling Insulation

Guidehouse used a combination of the equations specified in the Draft 2010 Ohio with inputs as noted in the measure description from the program tracking database in order to calculate savings for this measure.

The attic-roof-ceiling (A-R-C) insulation measure category includes several different measure types differentiated by base and efficient R values, as well as electric cooling and/or heating applicability.

Guidehouse compared these measures separately.

The measure savings are rolled up to present category level summary realization rates.

Draft 2010 Ohio TRM-Specified Energy Savings for Attic-Roof-Ceiling Insulation

Air Conditioning Savings: $\Delta kWh = ((1/Rexist - 1/Rnew) * CDH * DUA * Area) / 1000 / \eta Cool$

Heating Savings: $((1/Rexist - 1/Rnew) * HDD * 24 * Area) / 1{,}000{,}000 / COP * 293.1$

Draft 2010 Ohio TRM-Specified Demand Savings for Attic-Roof-Ceiling Insulation

$\Delta kW = \Delta kWh / FLHcool * CF$

KEY PARAMETERS FOR ATTIC-ROOF-CEILING

Parameter Description	Parameter	Value	Source
Existing effective whole-assembly thermal resistance value or R-value	Rexist	Varies	Measure Description (Actual or deemed when input value is considered incorrect by being outside reasonable boundaries)
New total effective whole-assembly thermal resistance value or R-value	Rnew	Varies	Measure Description (Actual or deemed when input value is considered incorrect by being outside reasonable boundaries)
Cooling degree hours	CDH	4,367	Draft 2010 Ohio TRM
Discretionary use adjustment	DUA	0.75	Draft 2010 Ohio TRM
Efficiency of air conditioning equipment	ηCool	10	Deemed average
Full load cooling hours	FLHcool	552	Draft 2010 Ohio TRM
Summer Peak Coincidence Factor for measure	CF	0.5	Draft 2010 Ohio TRM
Heating degree days	HDD	4,100	Draft 2010 Ohio TRM
Coefficient of performance	COP	1 for electric resistance, 1.61 for heat pumps	Deemed average

Appendix

Energy and Demand Savings Calculations for Air Source Heat Pumps

Guidehouse used the Draft 2010 Ohio TRM to estimate energy and demand savings for air source heat pumps.

Draft 2010 Ohio TRM-Specified Energy Savings for Air Source Heat Pumps

*Annual kWh Savings = (FLHcool * BtuH * (1/13 - 1/SEERee))/1000 + (FLHheat * BtuH * (1/7.7 – 1/HSPFee))/1000*

Draft 2010 Ohio TRM-Specified Demand Savings for Air Source Heat Pumps

*Summer Coincident Peak kW Savings = (BtuH * (1/11 - 1/EERee))/1000 * 0.5*

Guidehouse used the actual size of equipment in British Thermal Units per Hour (BtuH), seasonal energy efficiency ratio (SEER) efficiency of unit, heating season performance factor (HSPF) efficiency of unit, and energy efficiency ratio (EER) of efficiency unit from AEP Ohio's tracking database.

The calculation results in unit energy savings exceeding those outlined in the Draft Ohio 2010 TRM.

The efficiency of installed rebated equipment has increased over time, while the Draft Ohio 2010 TRM baseline has stayed constant.

Therefore, the increase in savings is expected.

KEY PARAMETERS FOR AIR SOURCE HEAT PUMPS

Parameter Description	Parameter	Value	Source
Full load cooling hours	FLHcool	552	Draft 2010 Ohio TRM
Size of equipment in BtuH	BtuH	Varies	Database (Actual) Average
Seasonal Energy Efficiency Ratio (SEER) efficiency of unit	SEERee	Varies	Database (Actual) Average
Full load heating hours	FLHheat	1,272	Draft 2010 Ohio TRM
Heating Season Performance Factor (HSPFee)	HSPFee	Varies	Database (Actual) Average
Energy Efficiency Ratio (EER) Efficiency of unit	EERee	Varies	Database (Actual) Average

Appendix

Energy and Demand Savings Calculations for Low-Flow Showerheads

Guidehouse used the following calculations from the Draft 2010 Ohio TRM in order to calculate showerhead savings.

Draft 2010 Ohio TRM-Specified Energy Savings for Low-Flow Showerheads

*Annual kWh savings = ISR * (2.87 – GPMlow) * 179*

Where: *GPMlow = 2.5*

Draft 2010 Ohio TRM-Specified Demand Savings for Low-Flow Showerheads

*ΔkW = ΔkWh/Hours * CF*

Appendix

Energy and Demand Savings Calculations for Faucet Aerators

The Draft 2010 Ohio TRM specifies deemed values for faucet aerators.

Aerator savings realization rates are 1.00 for energy, and for demand.

AEP Ohio and the evaluation team calculated savings using the following equations from the Draft 2010 Ohio TRM.

Draft 2010 Ohio TRM-Specified Energy Savings for Faucet Aerators

*Annual kWh Savings =ISR *((2.2 – GPMlow) / 2.2) * 77*

GPMlow = 1.5

Draft 2010 Ohio TRM-Specified Demand Savings for Faucet Aerators

$\Delta kW = \Delta kWh * 0.000125$

Appendix

Energy and Demand Savings for Water Heater Replacement

DRAFT 2010 OHIO TRM-SPECIFIED SAVINGS FOR WATER HEATER REPLACEMENT

Heating System	Average Annual kWh savings per unit	Average Summer Coincident Peak kW savings per Unit	Average Annual Fossil Fuel heating fuel savings (MMBTU) per unit	Average Annual Water savings per unit
Electric Resistance Heat	499	0.068	N/A	N/A
Heat Pump	1297	0.18	N/A	N/A
Fossil Fuel	2076	0.28	-7.38	N/A

Draft 2010 Ohio TRM-Specified Energy Savings for Water Heater Replacement

*kWh Savings = KWHbase * ((COPnew – COPbase) / COPnew) + kWhcooling – kWhheating*

Where:

KWHbase = *Average electric DHW consumption = 3460*

COPnew = *Coefficient of Performance (efficiency) of Heat Pump water heater = 2.0*

COPbase = *Coefficient of Performance (efficiency) of standard electric water heater = 0.904*

kWhcooling = *Cooling savings from conversion of heat in home to water heat = 180*

kWhheating = *Heating cost from conversion of heat in home to water heat.*

Dependent on heating fuel as follows:

KWHheating (electric resistance) = 1,577

KWHheating (heat pump COP 2.0) = 779

KWHheating (fossil fuel) = 0

Draft 2010 Ohio TRM-Specified Demand Savings for Water Heater Replacement

$\Delta kW = \Delta kWh / Hours * CF$

Where:

Hours = *Full load hours of hot water heater = 2533*

CF = *Summer Peak = 0.346*

Appendix

Energy and Demand Savings Calculations for Duct Sealing

Draft 2010 Ohio TRM-Specified Energy Savings for Duct Sealing

*Annual Cooling kWh savings = (((CFM50Whole House – CFM50Envelope Only) * SCF)before – (CFM50Whole House – CFM50Envelope Only) * SCF)after) * 60 * CDH * 0.0135) / 1000 / ηCool*

*Annual Electric kWh savings = ((((CFM50Whole House – CFM50Envelope Only) * SCF)before – (CFM50Whole House – CFM50Envelope Only) * SCF)after) * 60 * 24 * HDD * 0.018) / 1,000,000 / ηHeat) * 293.1*

Draft 2010 Ohio TRM-Specified Demand Savings for Duct Sealing

*ΔkW = ΔkWh / FLHcool * CF*

Appendix

Energy and Demand Savings Calculations for Air Sealing

Draft 2010 Ohio TRM-Specified Energy Savings for Air Sealing

*Annual Cooling kWh Savings = (((CFM50Exist – CFM50New) /N-Factor) *60 * CDH * 0.0135) / 1000 / ηCool*

*kWh Savings (electric heating) = ((((CFM50Exist – CFM50New) / N-factor) *60 * 24 * HDD * 0.018) / 1,000,000 / COP) * 293.1*

Draft 2010 Ohio TRM-Specified Demand Savings for Air Sealing

*ΔkW = ΔkWh / FLHcool * CF*

KEY PARAMETERS FOR AIR SEALING

Parameter Description	Parameter	Value	Source
Existing cubic feet per minute at 50 Pascal pressure differential	CFM50Exist	Varies	Measure Description (Actual or deemed when input value is considered incorrect by being outside reasonable boundaries)
New cubic feet per minute at 50 Pascal pressure differential	CFM50New	Varies	Measure Description (Actual or deemed when input value is considered incorrect by being outside reasonable boundaries)
Cooling degree hours	CDH	4,367	Draft 2010 Ohio TRM
Cooling conversion factor to convert 50 Pascal air flows to natural airflow	N-factor	29.4	Draft 2010 Ohio TRM
Heating conversion factor to convert 50 Pascal air flows to natural airflow for cooling	N-factor	17.8	Draft 2010 Ohio TRM
Efficiency of air conditioning equipment	ηCool	10	Deemed average
Full load cooling hours	FLHcool	552	Draft 2010 Ohio TRM
Summer Peak Coincidence Factor for measure	CF	0.5	Draft 2010 Ohio TRM
Heating degree days	HDD	4,100	Draft 2010 Ohio TRM
Coefficient of performance	COP	1 for electric resistance, 1.61 for heat pumps	Deemed average

CFM50Exist–CFM50New is assumed to be the measure quantity recorded in the database, though it is unknown if this is from the actual blower door measures; there appeared to be bad or missing data within the actual blower door inputs in the database (the following database fields: before_blower_door_reading_whole, before_blower_door_reading_envel, before_pressure_subtraction_fact, after_blower_door_reading_whole, after_blower_door_reading_envelo, after_pressure_subtraction_fact).

APPENDIX G

EfficiencyCrafted℠ New Homes Program

2019 Evaluation Report

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APRIL 1, 2020

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April 1, 2020

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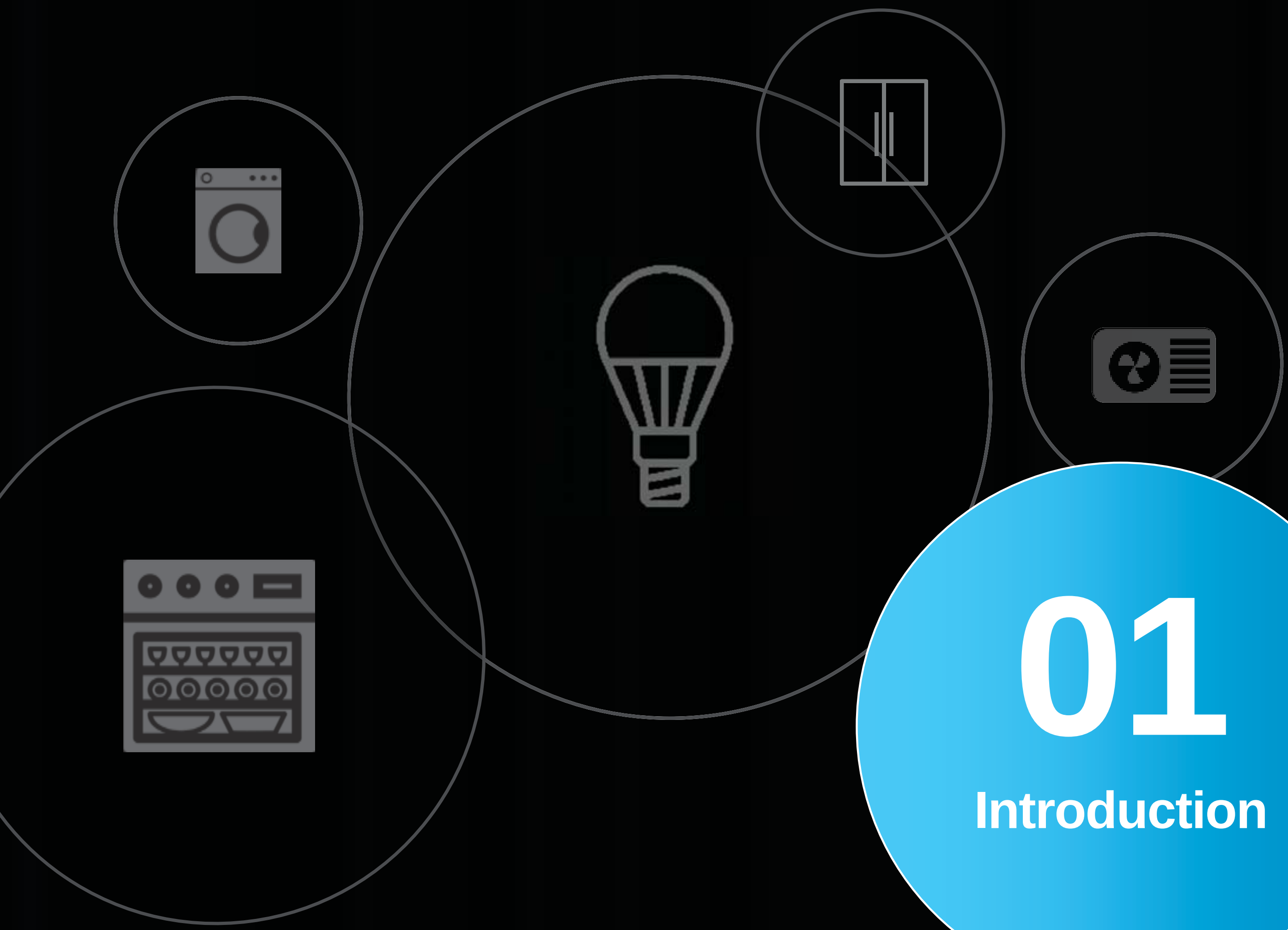


01 Introduction

Introduction

What is the EfficiencyCrafted℠ New Homes Program?

EfficiencyCrafted℠ New Homes program incentivizes builders for constructing energy efficient new homes in AEP Ohio's territory.

Purpose of the EfficiencyCrafted℠ New Homes Program is to:

1. Increase market penetration of energy efficient new homes in AEP Ohio's service territory, and
2. To move builders to even higher levels of energy savings through ENERGY STAR® certification.

- The program targets all builders in the AEP Ohio service territory.
- The program recruits and educates participating builders on the benefits associated with ENERGY STAR® homes, as well as building practices designed to improve upon baseline efficiency.
- Program-enrolled builders are provided with financial incentives to meet energy efficient building standards at two levels under the EfficiencyCrafted℠ brand – EfficiencyCrafted℠ and EfficiencyCrafted℠ plus ENERGY STAR®".
- Both performance levels require additional prescriptive requirements designed to boost the program's cost-effectiveness by increasing the energy savings per home.

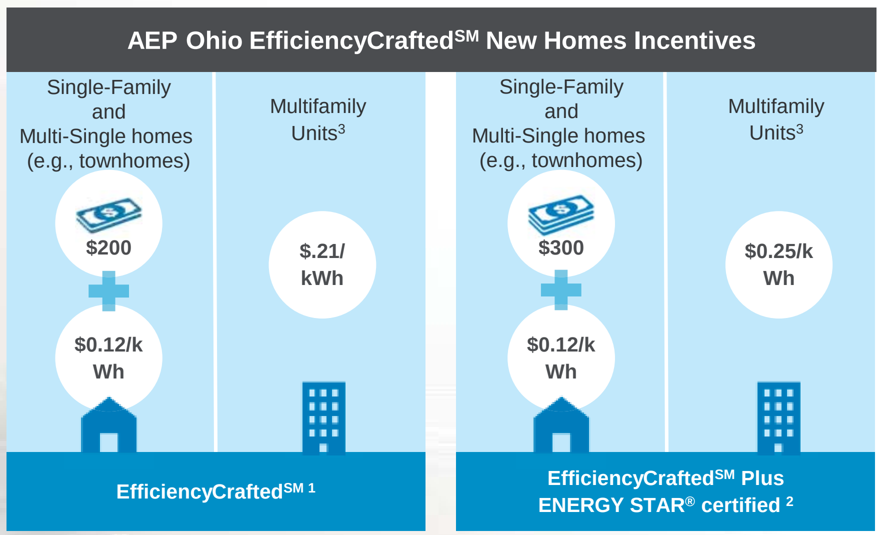
Code Update EfficiencyCrafted℠ New Homes Program is to:

- Residential Code of Ohio was updated to reflect the 2018 IECC code with Ohio amendments.
- EfficiencyCrafted℠ New Homes permitted between March 1, 2017 and June 30, 2019 complied with IECC 2009-based Residential Code of Ohio. However, new homes permitted on or after July 1, 2019 are required to comply with updated 2018 Residential Code of Ohio which reflects the 2018 IECC code with Ohio amendments.

Incentives for Homes Permitted between March 1, 2017 and June 30, 2019

AEP Ohio used a pay-for-performance incentive structure coupled with a base incentive for the EfficiencyCrafted℠ New Homes permitted between March 1, 2017 and June 30, 2019. Performance-based incentive amounts for homes are shown below.

These homes were built in compliance with 2009 IECC code.



[1] EfficiencyCrafted℠ is based on Version 2 of the ENERGY STAR® homes standard.
See https://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_v2_guidelines
[2] EfficiencyCrafted℠ plus ENERGY STAR®" is based on Version 3 of the ENERGY STAR® Homes standard.
See https://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_v3_guidelines
[3] Multifamily units do not qualify for a base incentive.

Updated Incentives for Homes Permitted on or after July 1, 2019

Effective June of 2019, the program was updated with a modified incentive structure for new homes permitted on or after July 1, 2019 as shown below. AEP Ohio will use only pay-for-performance incentive structure for the EfficiencyCrafted℠ New Homes.

These homes are built in compliance with 2018 IECC code.

These incentives amounts apply to all housing types: Single Family, Slab on Grade, Multi-Single Family and Multifamily

AEP Ohio EfficiencyCrafted℠ New Homes Incentives

	Gas-Heated Homes	All-Electric Homes[3]	Gas-Heated Homes	All-Electric Homes[3]
Incentive	$0.21/ kWh	$0.25/ kWh	$0.25/ kWh	$0.30/ kWh
Program	EfficiencyCrafted℠ [1]		EfficiencyCrafted℠ Plus ENERGY STAR® certified [2]	

[1] EfficiencyCrafted℠ is based on Version 2 of the ENERGY STAR® homes standard.
See https://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_v2_guidelines
[2] EfficiencyCrafted℠ plus ENERGY STAR®" is based on Version 3 of the ENERGY STAR® Homes standard.
See https://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_v3_guidelines
[3] All-electric is defined as having both electric heating and water heating equipment.

Implementation Strategy

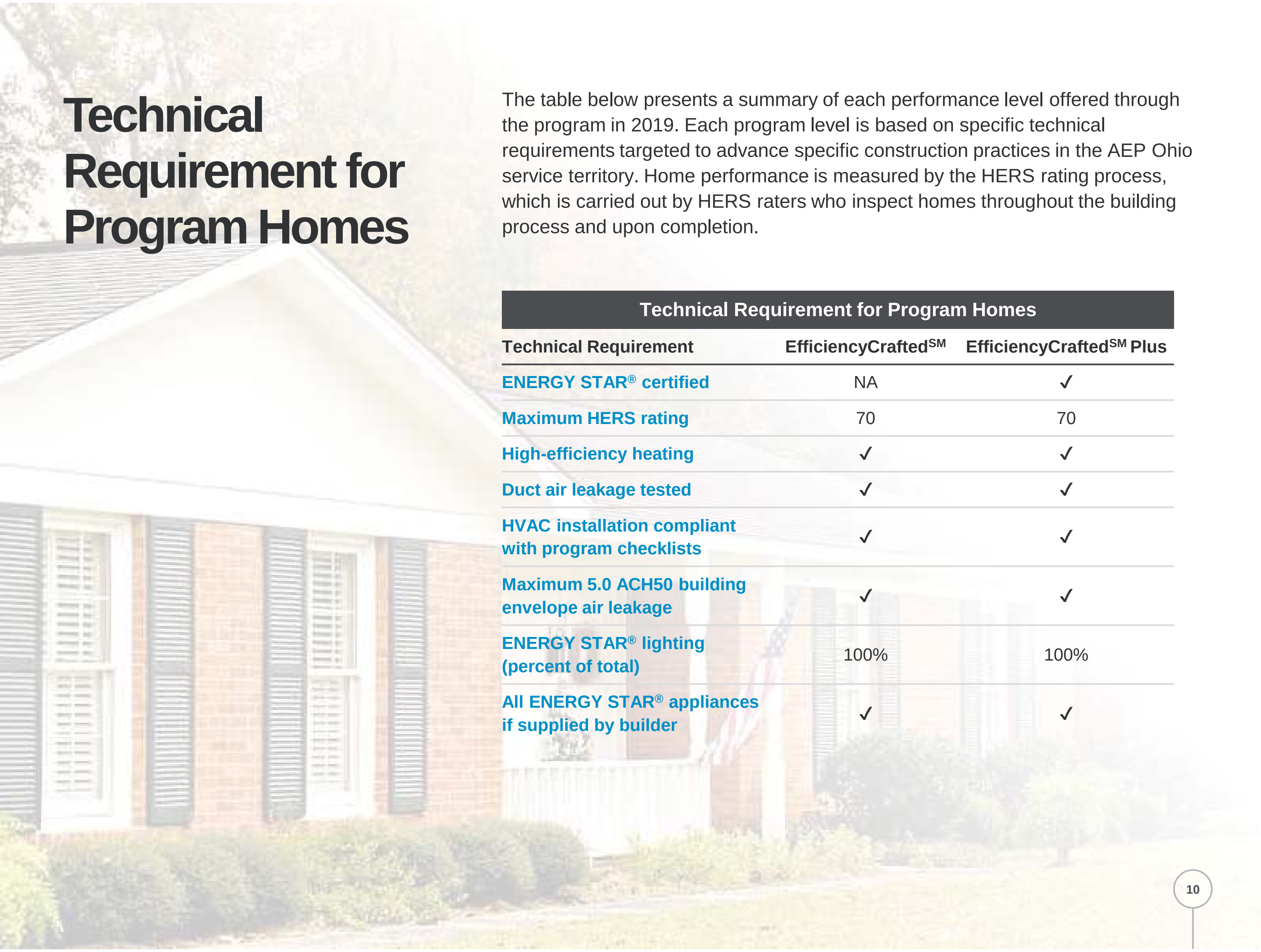
The delivery strategy for AEP Ohio's EfficiencyCrafted℠ New Homes Program focuses on:

- Offering education, financial incentives, and marketing support and materials to participating home builders
- Offering technical training to home builders, HERS raters, and realtors
- Educating industry professionals and homebuyers on the benefits of energy efficient and ENERGY STAR® construction

Implementation Strategy
(Continued)

Elements of the implementation include:

- Builder and rater recruitment, outreach, and orientation
- Rater or rating company enrollment
- Registration and tracking of committed homes
- Review, approval, and tracking of incentive applications for completed sites
- Incentive processing, including fund management, check issuance, reconciliation, and reporting
- Marketing and collaterals development and deployment
- Participant communications and update meetings
- Education sessions for builders, raters, and the construction community
- A technical and procedural quality assurance (QA) monitoring program
- Goal tracking, progress reporting, budgeting, and accrual processes



Technical Requirement for Program Homes

The table below presents a summary of each performance level offered through the program in 2019. Each program level is based on specific technical requirements targeted to advance specific construction practices in the AEP Ohio service territory. Home performance is measured by the HERS rating process, which is carried out by HERS raters who inspect homes throughout the building process and upon completion.

Technical Requirement for Program Homes		
Technical Requirement	**EfficiencyCrafted℠**	**EfficiencyCrafted℠ Plus**
ENERGY STAR® certified	NA	✓
Maximum HERS rating	70	70
High-efficiency heating	✓	✓
Duct air leakage tested	✓	✓
HVAC installation compliant with program checklists	✓	✓
Maximum 5.0 ACH50 building envelope air leakage	✓	✓
ENERGY STAR® lighting (percent of total)	100%	100%
All ENERGY STAR® appliances if supplied by builder	✓	✓

Program Summary

Program Evaluation Summary Results					
	2019 Program Goals[1] (a)	Ex Ante Savings (b)	Ex Post Savings (c)	Realization Rate RR = (c) / (b)	Percent of Goal= (c) / (a)
Energy Savings (MWh)	**6,063**	6,455	6,455	1.00	106%
Demand Savings (kW)	**1,178**	2,880	3,167	1.10	269%

[1]Volume 1: 2017 to 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, June 15, 2016.

02 Methodology

Methodology

The 2019 evaluation activities followed the objectives including:

Impacts

01 Quantify energy and summer peak demand savings impacts from the program during 2019

02 Determine program cost-effectiveness

Process

03 Gauge program satisfaction

04 Examine market penetration

05 Evaluate the effectiveness of marketing strategies

06 Identify ways to improve the program

Methodology
(continued)

DATA COLLECTION ACTIVITIES

1. Tracking System Review

Targeted Population
Participating New Homes

Sample Frame
Tracking Database

Sample Size
1,866

Timing
January 2020

2. Program Documentation Review

Sample Design
Marketing Materials
Operation Manual
Program Website

Timing
January - February 2020

3. In-Depth Telephone Interviews

Targeted Population
Program Staff - New Homes Program Coordinator
Staff of Program Implementer - Program Manager and Business and Quality Analyst

Sample Frame
Contacts from AEP Ohio and from Implementation Contractor

Sample Size
Program Staff -1
Program Implementer Staff - 3

Timing
January 2020

4. Builder Online Survey

Targeted Population
Participating Builders

Sample Frame
List of Participating Builders from Implementation Contractor

Sample Size
68

Total Completes
10

The first 5 participants to complete the survey received a $100 prepaid Visa gift card.

Timing
December 2019 – January 2020

5. Building Simulation Modeling

Targeted Population
Participating New Homes

Sample Frame
REM/Rate™ files

Sample Size
1,866

Strata	Target Completes	Actual Completes
Single-Family and Multi-Single homes compliant with 2009 IECC code	23	23
Multifamily homes compliant with 2009 IECC code	5	5
Single-Family and Multi-Single homes compliant with 2018 IECC code	5	5

Coefficient of Variation
0.3

Sampling Error (90% CI)
9%

Timing
January - February 2020

Material Review

Tracking Data Review

Guidehouse conducted a review of program data in the program tracking system to assess their accuracy and effectiveness for use in recording, tracking, and reporting the processes and impacts of the program. This review included an assessment of the incentive processing timeframes, a review of the project data for outliers and missing information, and an assessment of the data collected on incentive applications and recorded in the tracking systems.

The tracking review also included additional assessments of the data, including:

- Analysis of the key characteristics (e.g., size, equipment specifications, HERS rating, etc.) of homes participating in the program
- Analysis of REM/Rate™ files submitted by raters for completed homes

Program Material Review

Guidehouse reviewed all program materials provided by program implementation contractor to date including:

- Program marketing materials
- Program operation manual
- Program website

The evaluator did not address whether the tracking system is adequate for regulatory prudency reviews or corporate requirements.

Engineering Algorithm Review and REM/Rate™ Building Simulation

The Guidehouse team verified savings reported from participating homes by completing an engineering review of claimed savings calculated for a sample of projects using the REM/Rate™ building simulation model. Guidehouse audited savings through the following steps:

Reviewed baseline model characteristics against Draft 2010 Ohio TRM specifications, 2009 IECC code and 2018 IECC code requirements to verify that assumptions are appropriate and have been correctly applied.

Analyzed REM/Rate™ files and supporting documentation submitted for a sample of participating projects to verify that homes were built to program specifications.

Calculated savings for a sample of records in the tracking system per the TRM, compared to AEP Ohio's ex ante savings.

The annual energy and demand savings associated with each program home was calculated as the difference between the UDRH and program home simulation results within a sample of program homes. The energy and demand realization rates from the sample were applied to the entire program savings to determine program total ex post savings.

Builder Online Survey

Evaluation Questions

The evaluation team identified the following key evaluation questions:

i. **How satisfied are participants with the program?**

ii. **What is the program activity in 2019 compared to 2017?**

iii. **How do participants rate the program’s marketing and customer sales components?**

The team answered these questions by surveying program participants.

- Survey details:
  - **Guidehouse** programmed and administered online surveys via email
  - Online surveys fielded **between December 2019 and January 2020**
  - The first 5 participants to complete the survey received a $100 prepaid VISA gift card
  - 10 participants completed the survey

03

Evaluation Findings

Summary of Energy Savings

- The tables below summarize total unadjusted ex post energy savings from the tracking system and the average energy savings per home by each participation level, as well as by program compliance and building type.
- Guidehouse used the modeling procedures discussed in the section on methodology to compute the energy savings estimates for each participation level.
- Ex post energy savings for 2019 were 6,454,918 kWh. These savings exceeded the program energy savings goal by 392 MWh.
- The energy savings realization rate from the impact evaluation sample were applied to the remaining population of projects and aggregated to determine the total ex post energy savings. In 2019, the realization rate was 1.00 for energy savings.

Summary of Energy Savings by Participation Level

Tiers	Number of Units	Ex Ante Average Energy Savings/ Unit (kWh)	Total Ex Ante Energy Savings (MWh)	Ex Post Average Energy Savings/ Unit (kWh)	Total Ex Post Energy Savings (MWh)	Realization Rate
EfficiencyCrafted℠	1,646	3,488	5,741	3,488	5,741	1.00
EfficiencyCrafted℠ Plus ENERGY STAR® certified	220	3,244	714	3,244	714	1.00
Total or Overall Average	**1,866**	**3,459**	**6,455**	**3,459**	**6,455**	**1.00**

Summary of Energy Savings by Program Compliance and Building Type

Strata	Number of Units	Ex Ante Average Energy Savings/ Unit (kWh)	Total Ex Ante Energy Savings (MWh)	Ex Post Average Energy Savings/ Unit (kWh)	Total Ex Post Energy Savings (MWh)	Realization Rate
Single-Family and Multi-Single homes compliant with 2009 IECC code	1,723	3,526	6,075	3,526	6,075	1.00
Multifamily Homes compliant with 2009 IECC code	54	1,693	91	1,693	91	1.00
Single-Family and Multi-Single homes compliant with 2018 IECC code	89	3,247	289	3,247	289	1.00
Total or Overall Average	**1,866**	**3,459**	**6,455**	**3,459**	**6,455**	**1.00**

Note: The total in this table might not sum up due to rounding
Source: Guidehouse analysis

Summary of Demand Savings

- The tables below summarize total ex ante demand savings from the tracking system and average demand savings per home by each participation level, as well as by program compliance and building type.
- Guidehouse used the modeling procedures discussed in the section on methodology to compute the demand savings estimates for each participation level.
- The ex post demand savings for 2019 were 3,167 kW. These savings exceeded the program summer peak demand savings goal by 1,989 kW.
- The demand savings realization rate from the impact evaluation sample were applied to the remaining population of projects and aggregated to determine the total ex post demand savings. In 2019, the realization rate was 1.10 for peak demand savings.

Summary of Demand Savings by Participation Level

Tiers	Number of Units	Ex Ante Average Demand Savings/ Unit (kW)	Total Ex Ante Demand Savings (kW)	Ex Post Average Demand Savings/ Unit (kW)	Total Ex Post Demand Savings (kW)	Realization Rate
EfficiencyCrafted℠	1,646	1.6	2,581	1.7	2,838	1.10
EfficiencyCrafted℠ Plus ENERGY STAR® certified	220	1.4	299	1.5	329	1.10
Total or Overall Average	**1,866**	**1.5**	**2,880**	**1.7**	**3,167**	**1.10**

Summary of Demand Savings by Program Compliance and Building Type

Strata	Number of Units	Ex Ante Average Demand Savings/ Unit (kW)	Total Ex Ante Demand Savings (kW)	Ex Post Average Demand Savings/ Unit (kW)	Total Ex Post Demand Savings (kW)	Realization Rate
Single-Family and Multi-Single homes compliant with 2009 IECC code	1,723	1.6	2,742	1.7	3,015	1.10
Multifamily Homes compliant with 2009 IECC code	54	0.6	31	0.6	34	1.10
Single-Family and Multi-Single homes compliant with 2018 IECC code	89	1.2	108	1.3	118	1.10
Total or Overall Average	**1,866**	**1.5**	**2,880**	**1.7**	**3,167**	**1.10**

Note: The total in this table might not sum up due to rounding
Source: Guidehouse analysis

Summary of Program Activity

Participation in the EfficiencyCrafted℠ New Homes Program in 2019 was above AEP Ohio (Volume 1: 2017 TO 2019 Energy Efficiency/Peak Demand Reduction) Action Plan forecasts. The program reported 1,866 building projects in 2019, submitted by 40 building companies. The table below shows a summary of key impact evaluation metrics over the past seven program years.

Summary of Key Program Activity Metrics

Program Activity Metric	2019	2018	2017	2016	2015	2014	2013
PARTICIPATION							
Number of Units	1,866	2,011	1,762	1,792	1,842	1,723	2,186
Number of Active Builders	40	44	39	41	35	32	35
Program Market Penetration[1]	33%	39%	34%	33%	24%	24%	24%
ENERGY STAR® Level Penetration[2]	4%	7%	7%	7%	6%	7%	7%
ENERGY SAVINGS							
Total *Ex Ante* Savings (MWh)	6,455	6,284	5,299	4,144	4,196	3,815	5,835
Average Savings / Unit (kWh)	3,459	3,125	3,007	2,313	2,278	2,214	2,669
Average Savings / SF (kWh/SF)	0.98	0.88	0.83	0.65	0.66	0.59	0.75
Average HERS Score[3]	61	62	60	57	55	55	59
INCENTIVE SPENDING							
Average Incentive / Home ($)	$629	$589	$562	$442	$333	$296	$999
Average Incentive / kWh ($)	$0.18	$0.19	$0.19	$0.19	$0.15	$0.13	$0.37
Participant Satisfaction (0-10)	9.6	N/A	9.5	N/A	8.8	8.6	8.6

[1] Represents the market penetration of all EfficiencyCrafted℠ homes completed in AEP Ohio territory
[2] Represents the market penetration of homes completed at the ENERGY STAR® level in AEP Ohio territory
[3] The lower the HERS score, the more energy efficient the home

Cost-Effectiveness Review

Cost effectiveness is assessed through the use of the Total Resource Cost (TRC) test. The table below summarizes the unique inputs used in the TRC test.

COST-EFFECTIVENESS MODEL INPUTS	
Item	**Value**
Average Measure Life	25
Residences	1,866
Annual Energy Savings (kWh)	6,454,918
Coincident Peak Savings (kW)	3,167
Third Party Implementation Costs	$987,743
Utility Administration Costs	$265,292
Utility Incentive Costs	$1,161,227
Participant Contribution to Incremental Measure Costs	$3,204,336

Based on these inputs, the TRC ratio is 1.0. Table summarizes the results of the cost-effectiveness tests. Results are presented for the Total Resource Cost test, the Participant Cost Test, the Ratepayer Impact Measure Test, and the Utility Cost Test.

COST-EFFECTIVENESS RESULTS	
Benefit-Cost Ratio–Test Results	**Ratio**
Total Resource Cost	1.0
Participant Cost Test	2.1
Ratepayer Impact Measure	0.5
Utility Cost Test	2.3

Additional benefits related to the reduction of greenhouse gas emissions have not been quantified in the calculation of the TRC.

PROCESS

Marketing and Promotion

The primary target for marketing and outreach activities is homebuilders. Those activities focus on recruiting and maintaining the network of builders and supporting them in advertising EfficiencyCrafted℠ homes to potential homebuyers. The EfficiencyCrafted℠ New Homes Program was promoted to homebuilders in 2019 through in-person meetings, a few webinars, outreach at industry meetings, and through television, print and digital advertisements. AEP Ohio also conducted program awareness trainings for realtors.

The secondary target for marketing efforts is potential homebuyers, who were reached through an advertising campaign (including digital advertising) with messaging focused around efficiency and comfort. AEP Ohio is working with builders to add EfficiencyCrafted℠ logos onto participating builder's websites to enhance homebuyers' awareness and demand for the EfficiencyCrafted℠ certified homes.

In 2019, AEP Ohio conducted three training sessions for builders and raters to provide them information about the new 2018 IECC code requirement and changes in the incentive levels for homes permitted on or after July 1, 2019. During the interview, IC stated that builders do not have any concerns regarding the new building code requirements. A few builders expressed dissatisfaction with the discontinuation of the base incentive for the homes permitted after July 1, 2019, however majority of builders expressed appreciation for the increased $/kWh multiplier and the higher earning potential under the new pay-for-performance only model.

In 2019, AEP Ohio launched a series of short videos to educate customers on energy efficiency and convey the value of an energy efficient home, including monetary savings through reduced energy usage and health benefits (e.g., improved air quality). The videos are currently being hosted at program's website (www.EfficiencyCraftedHomesAEPOhio.com). During the interview, IC stated that the videos are being well-received by the builders, raters and homebuyers.

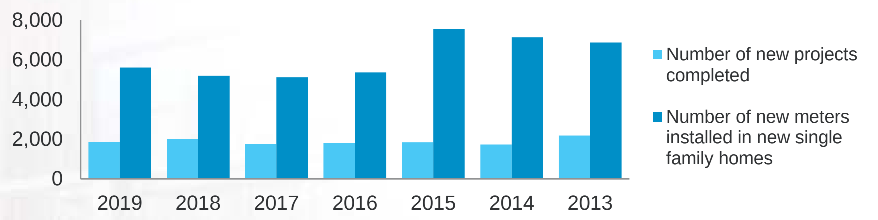
PROCESS

Market Progress

The program implementation contractor tracked market penetration in 2019 by comparing data provided by AEP Ohio on new meters installed in single-family new construction with the number of incentive payments issued.

The table below presents a comparison of program market penetration from 2013 to 2019.

Projects Submitted in 2019



The program implementation contractor reported that raters and builders like the pay-for-performance incentive structure.

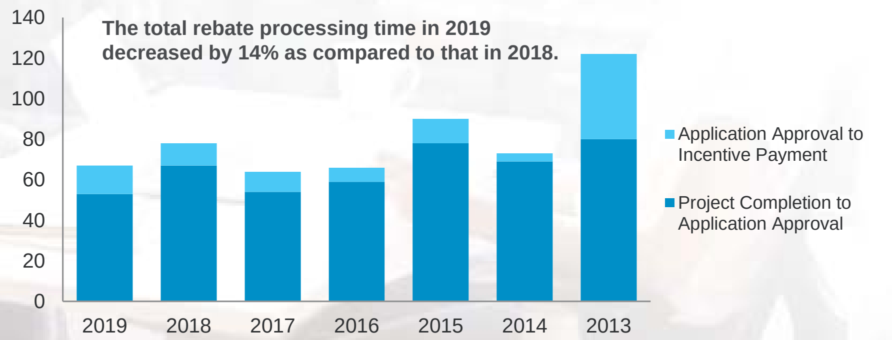
Market Penetration of the EfficiencyCrafted℠ New Homes Program

PROCESS

Application and Payment Processing

Guidehouse completed a review of the incentive processing times entered into the incentive tracking dataset. The table below breaks down the time period between project completion and incentive payment by showing the cumulative number of days between project completion, application approval, and incentive payment. The average duration between the project completion and incentive application approval was 53 days. Once incentive forms were approved, the average duration for incentive payment was 14 days. Therefore, the total duration between project completion and incentive payment was 67 days on average in 2019.

Incentive Processing Time (Average Days)



Participant Satisfaction

Overall satisfaction with the program and all of the elements of the program **increased in 2019** as compared to previous years.

Builder program satisfaction was a 9.6 out of a 0-10 point rating scale (n=10). Surveyed builders expressed **high satisfaction with training opportunities** offered through the program (9.5 out of 10) and **rebates amounts for EfficiencyCrafted[SM] Homes** (9.3 out of 10**)**.

Compared to 2017 builder survey results, the largest increase in participant satisfaction were seen in **rebate processing time** (an increase of 1.8 points) and **builder training opportunities** offered through the program (an increase of 1.7 points).

2019 Mean Builder Satisfaction Scores

Program Aspect	Satisfaction Rating (Scale of 0 to 10) 2019	2017	2015	2014	2013
Overall experience with the ENERGY STAR® Homes program	9.6	9.5	8.8	8.6	8.6
Site Submittal and Incentive Application Process	9.0	8.5	8.1	9.0	8.0
Time Required to Certify a Home	9.1	8.5	8.1	8.6	7.2
Training opportunities offered through the program	9.5	7.8	7.9	8.3	8.4
Incentive Amounts for EfficiencyCrafted[SM] Homes	9.3	8.3	7.5	7.4	6.0
Time to Receive Incentive	9.1	7.3	7.3	7.9	6.0
Incentive Amounts for ENERGY STAR® Homes	8.9	8.7	7.2	7.4	5.6

Question: On a scale of 0 to 10, where 0 is Very Dissatisfied, and 10 is Very Satisfied, please rate your overall satisfaction with the program aspect?
Note: Builder surveys are conducted in a 2-year evaluation cycle starting in 2015.
Source: Guidehouse analysis

Builders reported lower satisfaction score for incentive amounts for ENERGY STAR® homes.

"Rebate amounts are not high enough to drive a full commitment to the ENERGY STAR® tier."

BUILDER PARTICIPANT

"Limited availability of ENERGY STAR® certified HVAC companies/ contractors pose an obstacle to the market penetration of Energy Star homes."

IMPLEMENTATION CONTRACTOR

Program Activity

Builders who participated in the survey (n=10) indicated their program activity (number of homes completed) **remained the same or decreased** in 2019. Builders were asked to report several building statistics related to all the homes built by their company in 2019.

Ninety-three percent of all the homes built by respondents in 2019 received a rebate through the program, a decline of **4-percentage points** from 2017. One percent of homes built by respondents did not receive a rebate through the program, due to uncompleted inspections as noted by two builders. **Six percent** of homes did not meet the program standards, a **5-percentage point increase** from 2017.

Reasons for Decrease

FEWER HOMES BUILT IN 2019

Two out of eleven builders stated not building to the capacity as the previous year.

OUTSIDE OF AEP OHIO'S SERVICE TERRITORY

One respondent said new home builds were determined by available funding and happened to be outside of AEP Ohio's territory.

TIMING

One respondent also mentioned the timing to enroll and complete projects did not align with the program's timing requirements.

2019 Program Activity Compared to 2017

Builder Participation	Percent of all Homes Built by Company in 2019	Percent of all Homes Built by Company in 2017
Homes meeting Efficiency Crafted℠ standards and received an incentive through the program	93%	97%
Homes meeting Efficiency Crafted℠ standards but did not receive an incentive	1%	2%
Homes not meet program standards	6%	1%

Reasons for Not Meeting Program Standards

COST ANALYSIS OF ESTAR QUALIFICATION

Builders said investment required for compliance with ENERGY STAR® standards is not cost effective and there is also limited market demand for ENERGY STAR® homes in the AEP Ohio service territory.

PROGRAM REQUIREMENTS

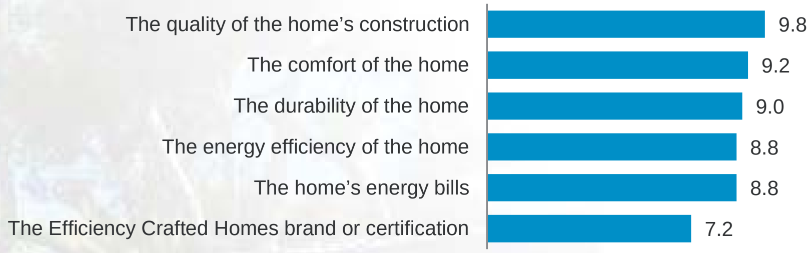
One respondent stated using a non-accredited HVAC contractor prevented the builder meeting program standards, while another mentioned building envelope requirements for air sealing, wall thickness, and foundation insulation contributed to homes not meeting program requirements.

PROCESS

Program Marketing

Surveyed builders were asked to rate the importance of program marketing and messages in their customer sales process. On a 0 to 10 rating scale, the **quality of construction** (9.8) and the **comfort of the home** (9.2) were the most important messaging during the sales process. Respondents stated the Efficiency Crafted℠ Homes brand or certification had the least importance (7.2 out of a 10).

Builder Importance In Customer Sales Process



Question: On a scale of 0 to 10, where 0 is Not at All Important, and 10 is Very Important, please rate how important each of the following are in your customer sales process.
Source: Guidehouse analysis

5.4 out of 10

Level of customer understanding of an Efficiency Crafted℠ Home

Question: On a scale of 0 to 10 where 10 is perfect understanding and 0 is no understanding, how well do you think your customers understand the benefits and value of an Efficiency Crafted℠ Home?
Source: Guidehouse analysis

Why do customers not understand the benefits of an Efficiency Crafted℠ Home?

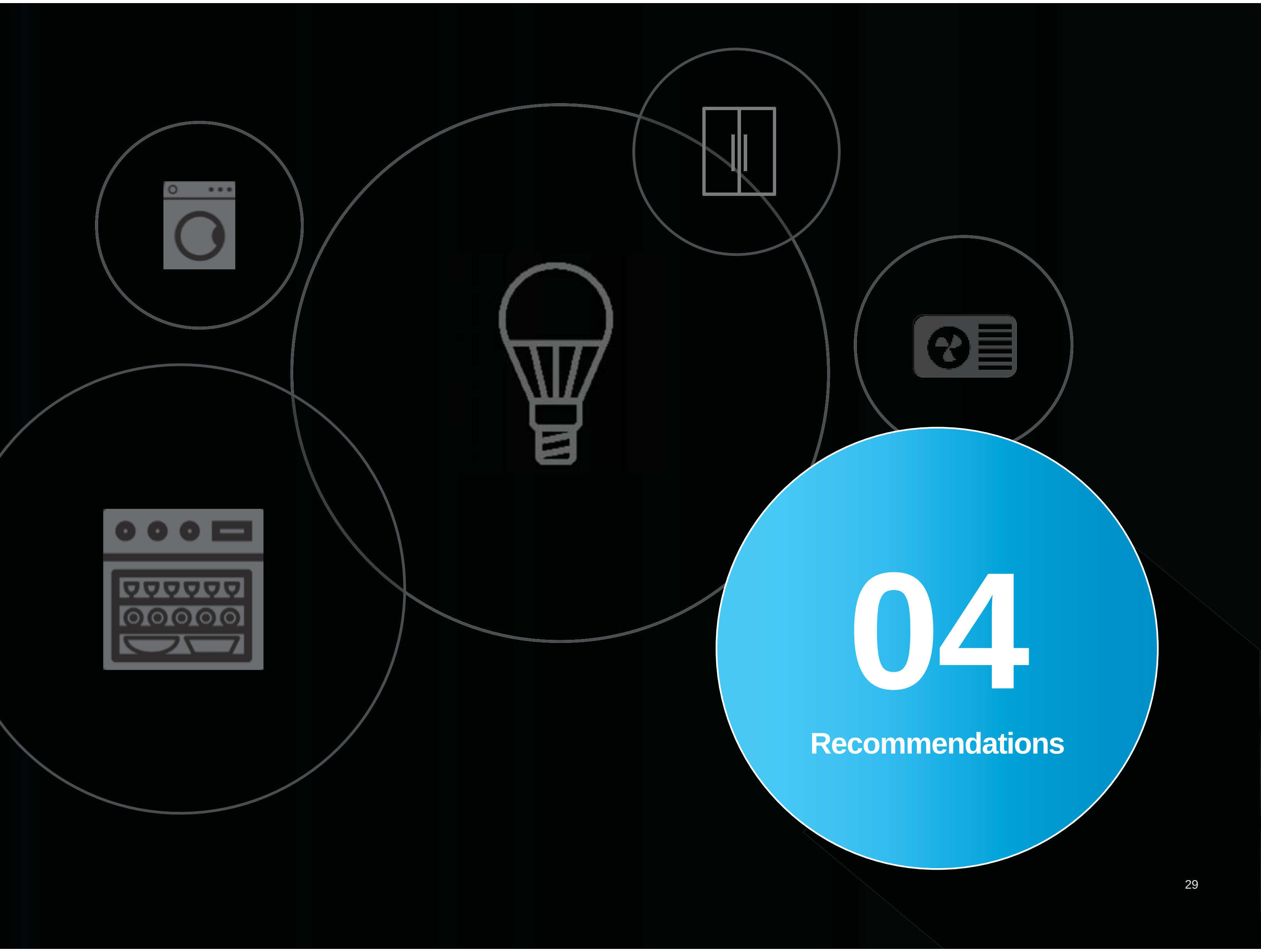
LACK OF INTEREST IN DETAILS

One builder stated customers focus on the benefits of an efficiently built home rather than the details of the program requirements.

LACK OF UNDERSTANDING

Builders indicated that customers struggle with the understanding the technical aspect of the program, particularly the building science behind the decisions to build homes more efficiently.

> "You get no value if a salesperson does not bring it up. Train at the sales floor level. Get into a sales meeting and help them better understand the benefits. If they buy in, it will then transfer to the consumer and ultimately add value to the process."
>
> **BUILDER PARTICIPANT**



04
Recommendations

Recommendations

FINDING 1

There was decrease in program participation by multifamily builders in 2019 with no multifamily home enrolled in the program when new IECC 2018 building code went into effect starting July 1, 2019. During the interview, the implementation contractor also recognized the opportunity to increase participation by multifamily builders.

ACTION 1

AEP Ohio should actively recruit multifamily builders. AEP Ohio should also continue developing training and awareness programs targeted at the multifamily builders to share information about the new IECC 2018 code and encourage multifamily builders to participate in the EfficiencyCrafted^{SM} New Homes program. As indicated by the Program Manager, Guidehouse recommends conducting in-depth interviews with multifamily builders to better understand multifamily builds with master metering which could contribute to the decrease of program participation by multifamily builders in 2019.

FINDING 2

Respondents stated the EfficiencyCrafted^{SM} Homes brand or certification had the least importance (7.2 out of a 10) during their customer sales process. Builders rated the level of customer understanding of the benefits and value of an Efficiency Crafted^{SM} Home 5.4 out of a 10 point-rating scale.

ACTION 2

Guidehouse recommends that AEP Ohio considers organizing more training programs for the real estate agents and sales staff with a focus on teaching them how to explain the benefits and value of EfficiencyCrafted^{SM} New Homes to the potential homebuyers. This will help increase market demand for the EfficiencyCrafted^{SM} New Homes.

FINDING 3

Guidehouse found that the total ex-ante demand savings for homes was less than the total ex-post demand savings calculated by the evaluation team, resulting in the demand realization rate of 1.10.

ACTION 3

Guidehouse recommends the implementation contractor ensures that the most updated version of building simulation files are used to calculate the demand impact. Building simulation files provided to Guidehouse were not the correct and updated versions for demand savings.

APPENDIX H

New Manufactured Homes Program

2019 Evaluation Report

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Disclaimer

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March 13, 2020

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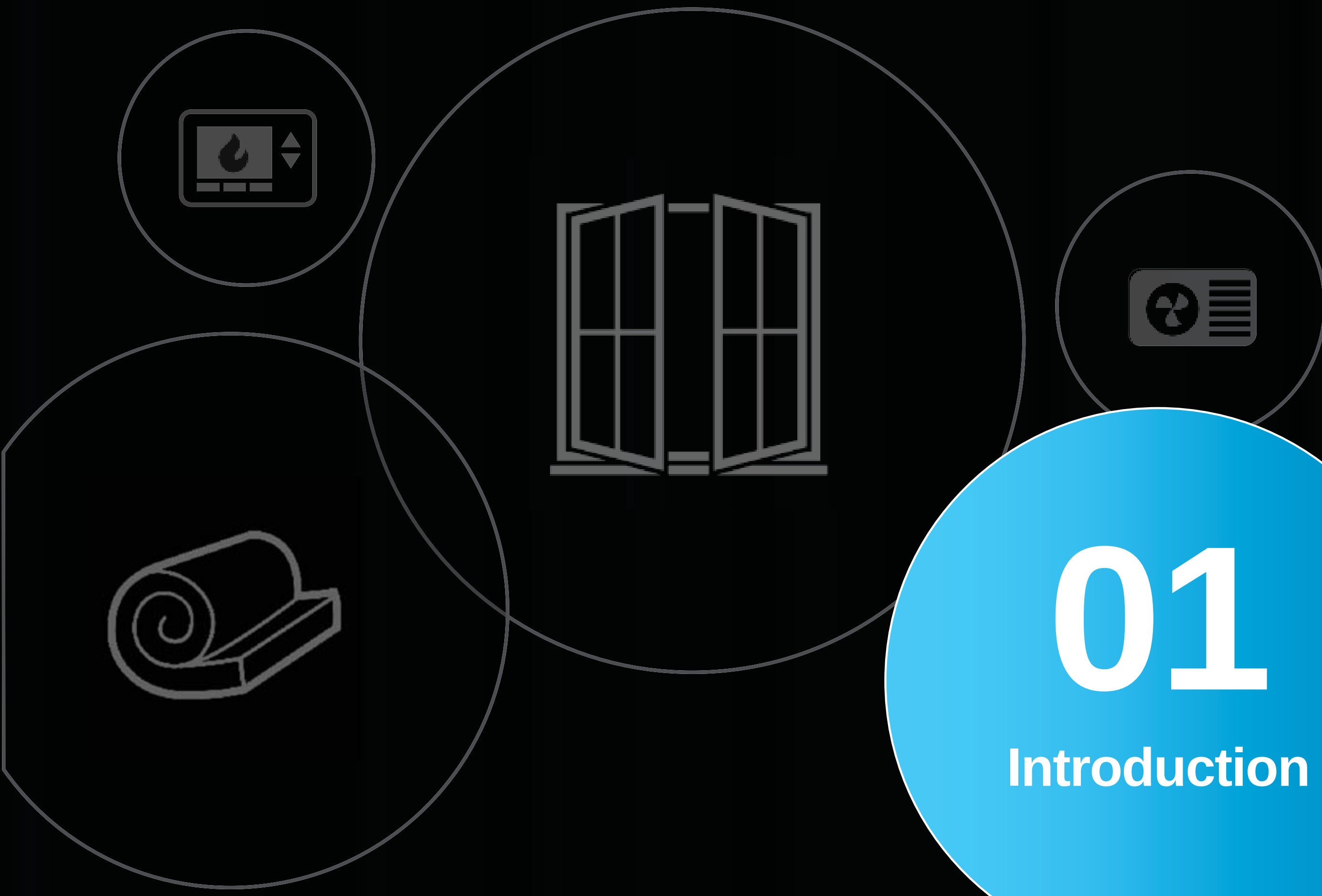


01 Introduction

Introduction

What is the New Manufactured Homes Program?

The New Manufactured Homes program incentivizes the sale of new all-electric manufactured homes meeting program energy efficiency requirements or receiving their ENERGY STAR® certification.

The objective of the New Manufactured Homes Program is to:

1. Bring energy efficient manufactured homes to the market in AEP Ohio territory.
2. Increase the awareness and sale of new energy efficient manufactured homes.
3. Encourage the installation of highly-efficient heat pumps in new manufactured homes.

To achieve this objective, AEP Ohio provides:

4. Incentives to retailers selling program-qualifying new manufactured homes.
5. Incentives to HVAC dealers and installers for the installation of air source heat pumps in those homes.
6. Marketing materials to retailers, explaining the operation of heat pumps.

[1] Retailers are defined as new manufactured homes retail sales centers and manufactured home communities that sell new manufactured homes.

Program Requirements

To qualify for the program, new manufactured homes must comply with program energy efficiency requirements, detailed below. The new manufactured home siting location must receive electric services from AEP Ohio. AEP Ohio offers incentives at two tiers.

Tier 1 incentives are described in the table below. For Tier 2 incentives, new manufactured homes must comply with all Tier 1 criteria and also receive their ENERGY STAR® certification. To receive their ENERGY STAR® certification, the plant manufacturing the new manufactured home must itself be ENERGY STAR® certified.

New Manufactured Home Requirements

Requirement	Tier 1	Tier 2
Heating Type	All-Electric with SEER 14 Heat Pump	Same as Tier 1, Plus ENERGY STAR® Certification
Heat Pump	Required, Properly Sized and Matched	
Certification	None	
Ceiling Insulation	R-33	
Wall Insulation	R-11	
Floor Insulation	R-22	
Window/glazing properties	Dual Glazed, Low-E	
Thermostat	Programmable	
Mate line construction	Gasketed	

Note: Window U-value ≤ 0.35; Window Solar Heat Gain Coefficient (SHGC) ≤ 0.34.

Implementation Contractor

The implementation contractor, MaGrann Associates, worked with AEP Ohio to launch the program in 2017 and has implemented the program since its inception.

Activities carried out by the implementation contractor include:

- Outreach to retailers and HVAC contractors.
- Outreach to trade groups and other local organizations.
- Work with AEP Ohio staff to verify that new manufactured homes are being sited at locations that will be served by AEP Ohio.
- Reviewing program applications, developing monthly reports on the program’s progress.
- Audits of sited manufactured homes.
- Teleconference meetings with AEP Ohio staff on a bi-weekly basis and face-to-face meetings with AEP Ohio staff on a monthly basis.

Program Incentives and Program Partners

In 2019, the program incentivized 47 Tier 1 homes and 4 Tier 2 homes, for a total of 51 homes.

- The program incentivized slightly fewer homes in 2019 than in 2018 (n = 58).
- Incentives were divided between retailers and HVAC dealers.
- The program partnered with three retailers and four HVAC dealers in 2019, an increase from two retailers and two HVAC dealers in 2018.

Incentives changed in 2019:

Incentives for Tier 1 homes decreased for HVAC dealers from $700 to $500. Incentives for Tier 2 homes decreased from $750 to $500 for Retailers/Communities.[1]

A bonus was added for new Retailers/Communities, providing an additional $200 incentive for each qualifying new home, for a total of up to $1,000.

New Manufactured Home Incentives

Recipient	Tier 1	Tier 2
Retailer/Community	$500	$500
HVAC Dealer/Installer	$500	$700
Total	**$1,000**	**$1,200**

Note: Program retailers and dealers are allowed to negotiate with one another to decide the portion of the total incentive that each organization will receive.

[1] "Communities" refer to housing developments that rent land to homeowners or renters. In this case, the communities are purchasing manufactured homes and then selling or renting the homes to tenants.

Program Impacts

The realization rates for 2019 were 0.88 for energy savings and 1.08 for demand savings. The program achieved 267 MWh and 0.14 MW in energy and demand savings, respectively.

- To estimate the ex post savings, the evaluation team modified the methods and assumptions outlined in the Draft 2010 Ohio Technical Reference Manual (Draft Ohio TRM) for traditional residential new construction.
  - For energy savings, the evaluation team used a modified billing analysis, comparing a modeled baseline to weather-normalized participant consumption.
  - For demand savings, the evaluation team modeled both the baseline and energy efficient case and added a coincidence factor.

PROGRAM EVALUATION SUMMARY RESULTS

	2019 Program Goals (a)	Ex Ante Savings (b)	Ex Post Savings (c)	Realization Rate RR = (c) / (b)	Percent of Goal = (c) / (a)
Energy Savings (MWh)	2,495	304	267	0.88	11%
Demand Savings (MW)	0.11	0.13	0.14	1.08	127%

Note: Goals are from AEP Ohio Volume 1: 2017 to 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, September 2, 2016.

Program Activity

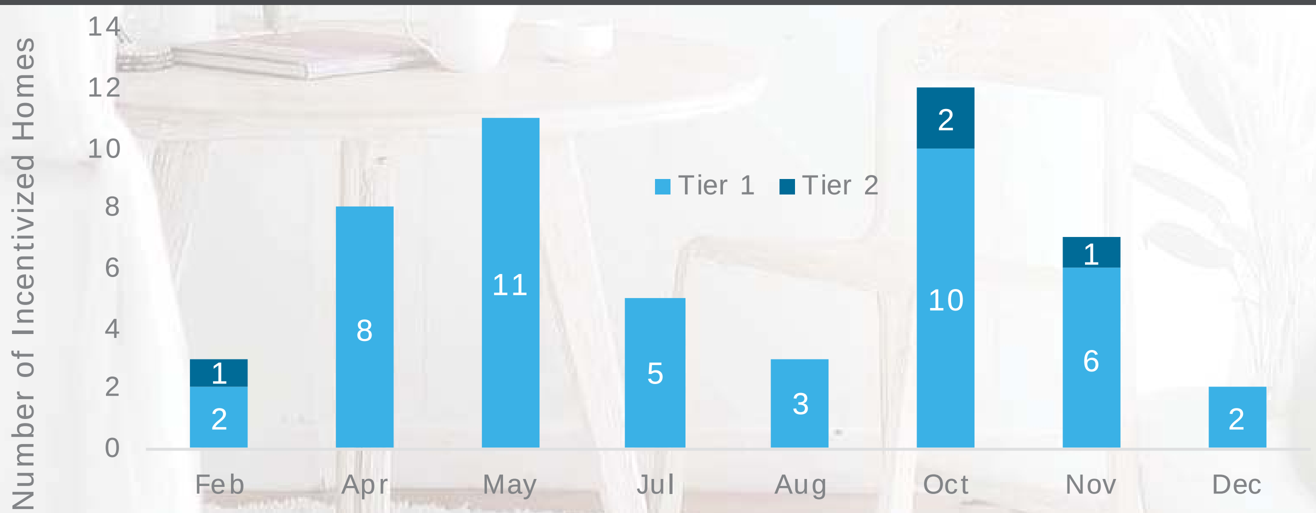
- **The program incentivized a total of 51 homes in 2019.**
  - Of the 51 homes, eight percent were Tier 2 participants.
  - This was a decrease from 2018, when 26 percent of homes were Tier 2.

New Manufactured Homes Incentivized Units

Tier	Number of Units	Percent of Total
Tier 1	47	92%
Tier 2	4	8%
Total	**51**	**100%**

- **The months of May and October had the highest participation.**
  - Most Tier 2 homes were incentivized in the last quarter of 2019.

Number of Incentivized New Manufactured Homes by Month



Program Activity

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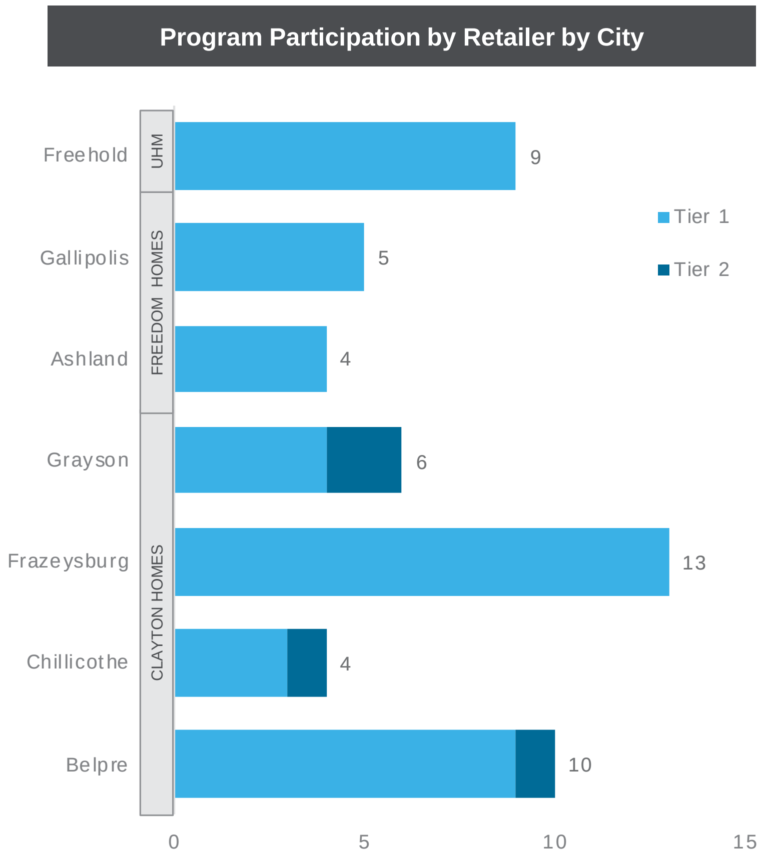
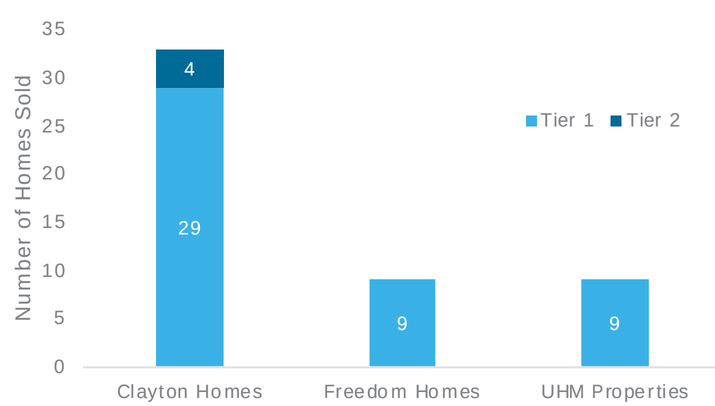


- **Clayton Homes sold two-thirds of all program incentivized new manufactured homes (65 percent).**
  - Freedom Homes sold less than one-quarter of program incentivized new manufactured homes.
  - Clayton Homes in Frazeysburg sold the most program incentivized homes overall.
  - Clayton Homes sold all four Tier 2 homes.
  - UHM (a community) only sold in Freehold.



Program Activity

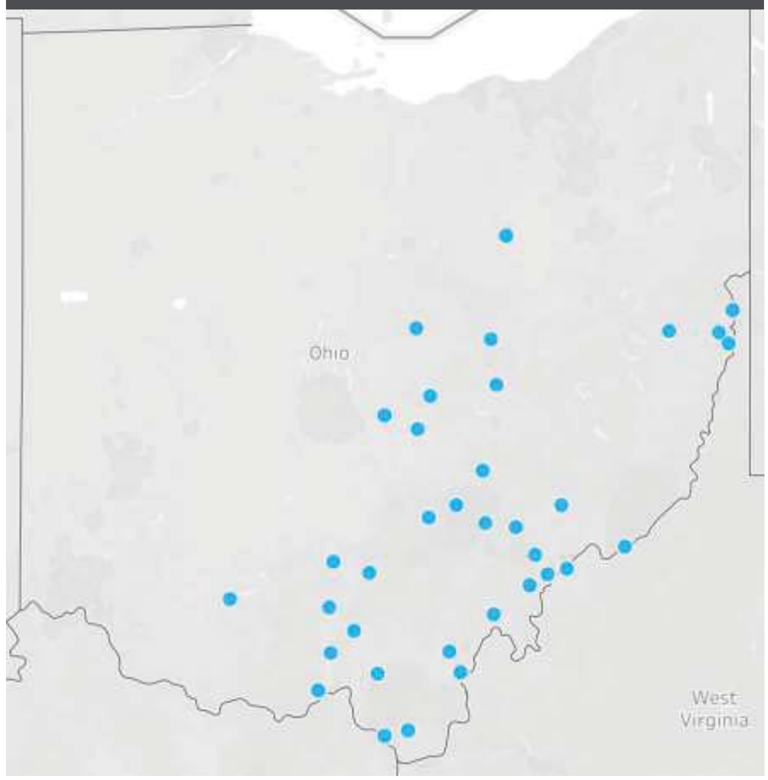
(continued)

- **Incentivized homes were spread out across rural areas.**
  - Incentivized homes were spread across more than 36 different cities/towns, and 27 cities/towns contained only a single incentivized home.
  - Toronto had five incentivized homes, the highest number of incentivized homes per city in 2019.

- **The average square footage of program incentivized homes was 1,262 feet.**
  - However, the size of incentivized homes varied by 1,432 square feet from the smallest (728) to the largest (2,160).

- **Blevins, Inc. functioned as the HVAC dealer for most of the new manufactured homes incentivized in 2019.**

Locations of Incentivized New Manufactured Homes



02 Methodology

Evaluation Objectives

The objectives of the evaluation were to:

Impacts

01 Quantify the energy and demand savings impacts

02 Determine program cost-effectiveness

Process

03 Determine key process-related program strengths and weaknesses

04 Identify ways in which the program can be improved

05 Document how program activities are linked to desired program outcomes

Data Collection Activities

DATA COLLECTION ACTIVITIES

Program Staff In-Depth Telephone Interviews

Targeted Population
Program Staff

Sample Frame
Contacts from AEP Ohio

Sample Size
2

Timing
Oct & Nov-19

1

Participant In-Depth Telephone Interviews

Targeted Population
Participating Retailers, Participating HVAC Dealers, and Manufacturers

Sample Frame
Implementer Contact Data

Sample Size
4 Retailers, 2 HVAC Dealers, & 1 Manufacturer Liaison

Timing
Jan & Feb-20

2

Material Review

Tracking Data Review Methodology

The tracking data was provided by AEP Ohio for review. The evaluation team subsequently:

- Determined key data fields essential for consideration in the impact and process evaluations.
- Examined frequency distributions for each of the key fields, identifying missing, incomplete, or inconsistent data.
- Assessed key characteristics of homes, including square footage and site location.

The evaluator did not address whether the tracking system is adequate for regulatory prudence reviews or corporate requirements.

Program Documentation Review Methodology

For the 2019 program evaluation, the evaluation team analyzed program documentation to understand the details of the program and to inform the evaluation. The evaluation team reviewed the following documents:

- AEP Ohio New Manufactured Homes Program website.
- Monthly implementer reports from the 2019 program year.
- Program marketing materials.

Along with the staff interviews, this information was used to develop the logic model diagram and document the program theory.

Impact Evaluation Methodology

The evaluation team calculated ex post energy savings using a modified billing analysis, which used building energy simulation software to estimate pre-program participation consumption and energy consumption data from 2018 and 2019 participating homes for post-period consumption. The evaluation team applied the following steps:

- Developed linear monthly energy consumption models using BEopt and calculated baseline consumption for all participants.
- Calculated weather normalized post-program participation annual energy consumption using participant billing data.
- Estimated energy savings for each participant.

For demand savings, the evaluation team used simulation software and modified the TRM-recommended equation for traditional new construction programs.

03

Evaluation Findings

Energy Savings Results

To calculate ex ante savings, program staff used a regression model developed by the evaluation team to estimate energy savings based on building square footage.

To calculate ex post savings, the evaluation team conducted a modified billing analysis using program participant data from 2018 and 2019 and a modeled baseline.[1]

- The evaluation team modified the typical billing analysis methods and used energy consumption data to calculate post-period consumption for participating homes and calculated pre-period consumption by using building models.
- Energy savings varied by square footage and geographic region where the home was located.
- The 2019 New Manufactured Homes Program ex post energy savings totaled 267 MWh and the realization rate was 0.88.

Ex Ante and Ex Post Energy Savings and Realization Rates

Number of Units	Per-Unit Ex Ante Energy Savings (kWh)	Per-Unit Ex Post Energy Savings (kWh)	Total Ex Ante Energy Savings (MWh)	Total Ex Post Energy Savings (MWh)	Realization Rate
51	5,966	5,237	304	267	0.88

[1]New manufactured homes lack the pre-period consumption data central to typical billing analyses. Additionally, AEP Ohio billing data does not contain a reliable identifier for manufactured homes, therefore, we were unable to identify a comparison group.

Demand Savings Results

The evaluation team modified the methods and assumptions outlined in the Draft Ohio TRM for traditional residential new construction to calculate ex post savings.

- Though the ex ante and ex post values are approximately eight percent different, the methods behind each estimate were very different.
  - The ex ante demand savings method estimated savings resulting from the “right-sizing” of HVAC equipment and improved envelope thermal performance. The ex post savings estimate modified the savings formula used in the Ohio TRM for traditional new construction and reflects savings from HVAC right-sizing, improved envelope thermal performance, and upgrading from a manual thermostat to a programmable thermostat.
  - Additionally, the ex ante savings estimate did not apply a coincidence factor, whereas the ex post savings estimate accounted for savings at the time of system peak. See the Appendix for more detailed information regarding this calculation.

Ex Ante and Ex Post Demand Savings and Realization Rates

Number of Units	Per-Unit Ex Ante Demand Savings (kW)	Per-Unit Ex Post Demand Savings (kW)	Total Ex Ante Demand Savings (MW)	Total Ex Post Demand Savings (MW)	Realization Rate
51	2.64	2.75	0.13	0.14	1.08

Cost-Effectiveness Review

Table 1 summarizes the unique inputs used in the TRC test. Based on these inputs, the TRC ratio is 0.4, as shown in Table 2. Therefore, the program passes the TRC test.

Table 1:
Inputs to Cost-Effectiveness Model for New Manufactured Homes Program[2]

Item	Value
Average Measure Life	18
Units	51
Annual Energy Savings (kWh)	267,074
Coincident Peak Savings (kW)	140
Third-Party Implementation Costs	$212,274
Utility Administration Costs	$60,837
Utility Incentive Costs	$58,050
Participant Contribution to Incremental Measure Costs	$150,450

Table 2:
Cost-effectiveness Results for the New Manufactured Homes Program

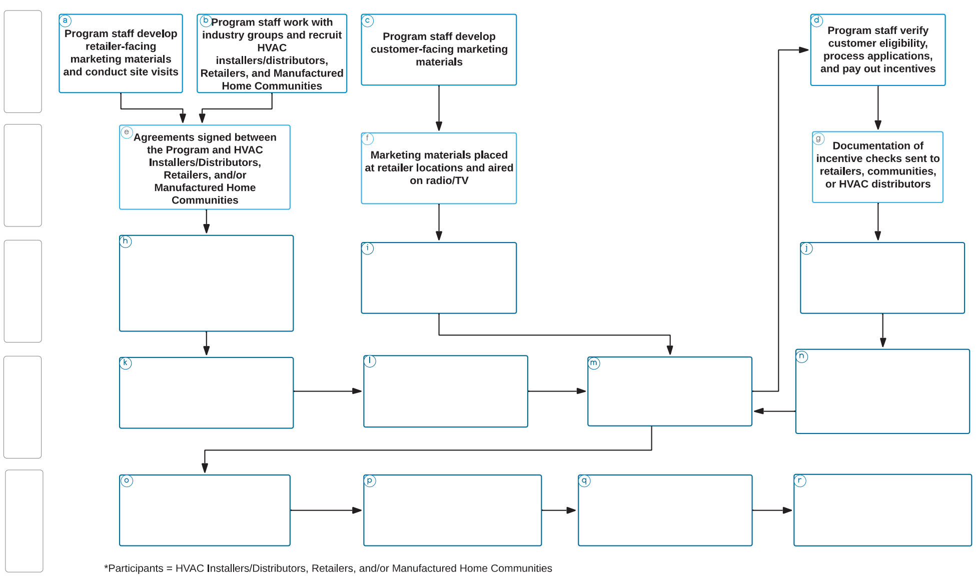
Benefit- Cost Test Results – New Manufactured Homes	Ratio
Total Resource Cost	0.4
Participant Cost Test	1.9
Ratepayer Impact Measure	0.3
Utility Cost Test	0.6

Program Theory and Logic Model

The logic model diagram shows the linkages between program activities, outputs and outcomes, and identifies barriers, assumptions, and potential external influences. Detailed portions of the logic model are displayed in the Appendix.

BARRIERS

- Few energy efficient new manufactured homes are produced for the Ohio market.
- Low price and consumer preference for natural gas may impact sales of all-electric new manufactured homes.
- The cost of an energy efficient new manufactured home is high compared to standard manufactured homes (least first cost).
- Access to capital or financing may pose a challenge for new manufactured home purchasers.
- Loans for new manufactured homes may be required to be a "chattel loan" instead of a traditional home loan and providing an incentive directly to customer may be considered down payment assistance by chattel loan providers.
- Program staff have difficulty reaching and maintaining contacts at retail centers due to high staff turnover.
- Verifying that new manufactured homes are located in AEP Ohio territory is difficult for retailers.
- Retailers may wait to verify the eligibility of energy efficient NMHs qualify until after the sale.
- Retailers also sell used manufactured homes and modular homes, which can cause confusion when determining eligibility for the NMH program.
- HVAC contractors may not be confident in heat pump technology.
- Planned metrics for tracking performance are not realistic.
- Manufacturers cannot easily include upgraded HVAC equipment at the plant, which complicates the manufacturer's ability to participate in the prorgam.



*Participants = HVAC Installers/Distributors, Retailers, and/or Manufactured Home Communities

ASSUMPTIONS

- Retailers and distributors/installers divide program incentives in a way that effectively promotes the sale of new energy efficient manufactured homes.
- Air source heat pumps are equally effective to electric furnaces in heating homes.

EXTERNAL FACTORS

- Delay of Federal Standards Update: Program staff anticipated that new manufactured home federal standard updates would make program participation more appealing for manufacturers. In 2017, the new federal administration began reviewing proposed code updates and decided to forego these updates.
- Department of Energy (DOE) Tax Credit: Program staff had also planned to capitalize on a Department of Energy (DOE) tax credit for new manufactured homes. This tax credit expired at the end of 2017 and the U.S. Congress has not reinstated the tax credit to date.
- Subsequent Feedback from Manufacturers: Due to the above-mentioned events and market conditions, in 2017, staff received feedback from manufacturers that there was not demand in the market for highly efficient new manufactured homes and therefore program incentives to manufacturers would not increase production.

Critical paths for achieving energy savings goals include:

- Recruiting participating retailers and HVAC dealers.
- Providing retailer-facing marketing materials and educating retailers so they can then work with HVAC dealers and promote qualifying homes to their customers.
- Marketing qualifying homes to customers to drive demand for energy efficient manufactured homes/heat pumps.
- Providing incentives so that participants are satisfied and continue to sell qualifying homes.

The remaining process evaluation activities focused on evaluating the success of these key pathways.

PROCESS

Marketing Activities

In 2019, program staff introduced customer-facing marketing materials placed inside model homes at participating retail locations. A postcard sent to retailers and manufactured home communities advertised additional incentives for new participants.

Marketing Methods by Target Audience	
Retailers, HVAC Contractors, Manufacturers, and Industry Professionals	• Meetings with the Ohio Manufactured Housing Association (OMHA) • Attended Manufactured Homes National Conference in Louisville, Kentucky. • Ads in the OMHA quarterly newsletters • Site visits to retail centers and manufactured homes community owners. • Postcards sent to retailers and communities advertising additional incentives • Program flyers/handouts
Residential Customers	• Customer-facing marketing materials placed in model homes (i.e., door mats, window clings, mirror clings, and ads in stands placed on tables) • TV commercials • Radio ads
General Marketing Activities	• Program website, with retail locations and online interactive AEP Ohio service territory map with customer zip code lookup

Challenges Cited by Program Staff

Program staff identified several challenges to the administration of the program related to retailers, customers, and the availability of natural gas in Ohio:

Ensuring Program Promotion by Bordering State Retailers

Retailers in bordering states sell homes to eligible AEP Ohio customers, but it is unclear how often these retailers are identifying eligible customers and marketing the program to them.

Difficulty Recruiting New Participants to the Program

Program staff have attempted to recruit new retailers to the program, but have encountered difficulties in doing so.

- A new participant incentive was introduced in 2019, but the incentive was not paid out to any new participants this program year.
- Program staff identified two retailers situated within AEP Ohio territory that could be successful participants, but were unable to recruit them this year.

High Turn-over of Retail Center Staff

Because of the quick turnover rate of retail center staff, implementers have found it hard to build support for the New Manufactured Homes Program and knowledge of the benefits of program participation.

- Additionally, high turnover makes training salespeople on selling efficient homes and heat pumps difficult and time-consuming for retail centers (this was also heard in retailer interviews).
- While program staff said salesperson comfort with selling heat pumps is increasing, it remains a hurdle.

Challenges Cited by Program Staff

(continued)

Difficulty Verifying Buyer Eligibility

Program staff reported that approximately 50 percent of buyer addresses submitted to AEP Ohio are outside of the utility's territory.

- This can be discouraging to retailers who are enthusiastic about participating in the program.
- Because AEP Ohio's territory does not fall simply on zip code or county lines, it is a hurdle for retailers to determine whether addresses are eligible.

High Degree of Access to Natural Gas in Ohio

A market barrier described by program staff was the degree to which natural gas is accessible to customers.

- Goals for program participation were developed based on neighboring states, where natural gas is much less available than it is in Ohio.
- Neighboring states have more rural areas that do not have access to natural gas connections, making electricity prevalent to a greater degree than in Ohio.

Retailer, HVAC Dealer, Manufacturer Interviews: Key Findings

Retailers (n = 4)

- Two retailers described the incentive partially as “free money” – getting money for something they were already doing (selling qualifying homes, though not always with heat pumps).
- Although retailers are generally already promoting energy-efficient homes, they are motived by the incentive to sell heat pumps.
- Two of four retailers described lack of salesperson knowledge of heat pumps as a barrier. These retailers felt that salespeople could not always speak knowledgably about the benefits of a heat pump.
- Two retailers said the end-user’s preference for gas as a fuel source was a barrier. Both described the cooler heat temperature coming from the register as a heat pump-related concern for their older customers.
- Two retailers felt that the turnaround time for incentive receipt was too long.

HVAC Dealers (n = 2)

- Both HVAC dealers felt the program was driving sales of rebate-eligible homes and heat pumps.
- One HVAC dealer said that while they did not currently use the program as a sales tool, they felt that there was an opportunity for them to do so. They suggested they could promote the program to their retailer partners not currently in the program.
- Both HVAC dealers described the administrative side of submitting rebate applications as cumbersome, though one felt it was a “necessary evil.”
- One distributor felt that determining whether the address was in AEP Ohio territory was “tricky.”

Manufacturers Liaison (n = 1)

- End-users of manufactured homes are often very concerned with affordability, which is a barrier for manufacturers to add features like energy efficiency packages, which are harder to see than something like a kitchen upgrade.
- On the other hand, offering add-ons like energy efficiency packages allows manufacturers to distinguish themselves in a competitive market.
- The interviewee offered the following suggestions for the program to consider:
  - Capitalize on the manufactured homes tax credit, which was re-established in December 2019 and extended through 2020. It also applies retroactively to homes built in 2018.
  - Make sure that the ENERGY STAR® upgrades are discussed early in the sales process to impact the end-user’s decision-making from the beginning.

04

Recommendations

Energy Saving Estimates for Program Planning

The modified billing analysis resulted in the following equations, based on the region where the home is located, as well as square footage of the home.

The evaluation team recommends that AEP Ohio use the following models to calculate energy savings, depending on the region where the home is located.[1]

Energy Savings Estimation Models

Region	Energy Savings Model
Central and Northwest[2]	-2,727 + 5.06 * SqFt
Northeast	1,599 + 5.06 * SqFt
Southwest	-318 + 5.06 * SqFt
Southeast	-1,749 + 5.06 * SqFt

[1] The team used the region definitions as presented in www.ohio.org/regions
[2] There were only two participants from the Northwest region and the regression estimates for Central and Northwest were almost the same, therefore, the evaluation team included the two customers in the Northwest region with the Central region.

PROCESS

Offer Training to Retail Centers

While many retailers noted that they primarily sell energy-efficient homes, selling heat pumps seemed to pose a barrier to selling program-qualifying homes. Knowledgeable sales staff will be better equipped to promote heat pumps to customers and overcome this barrier.

Interviewed retailers, HVAC dealers, and the manufacturer liaison all recommended training for retail sales staff, focusing on the advantages of heat pumps over baseline air conditioning units. Interviewees suggested that trainings should be non-technical and describe the benefits customers may expect to see, including the reduction of high utility bills and cost savings over time.

Training should also address barriers to customer participation, such as strategies to optimize comfort with a heat pump, accounting for cooler air temperatures from heat pump registers, and how to optimize efficiency and lower utility bills with their heat pump.

Many retailers described high turnover among sales staff and suggested that providing training to new staff on the advantages of energy-efficient homes and heat pumps could be burdensome to do frequently. Given high turnover among sales staff, the program could provide online videos as a training resource, which would be easily accessible for new staff.

PROCESS

Provide Customer-Facing Collateral to Help Retailers Sell Heat Pumps

While there are materials placed in model homes that target customers, retailers mentioned that they would like flyers that they can review with customers during the sales process. These flyers should present the benefits of heat pumps and give a high-level comparison with traditional air conditioners, while avoiding being overly technical. The flyers could also include information about the manufactured homes tax credit to further motivate customers to purchase a program-qualifying home. AEP Ohio-provided materials help lend credibility to the retailer in the sales process, because end-use buyers are more likely to trust that they are not being upsold without reason.

This marketing collateral could serve a dual purpose of not only a sales tool for retailers, but also to help inform sales staff that are new and have not had time to participate in formal training.

PROCESS

Advertise the Benefits of Heat Pump Technology to Consumers

Promoting the benefits of heat pumps, particularly ductless mini-splits, to residential customers may help increase demand for heat pumps, driving participation not just in the New Manufactured Homes program but also in the Efficient Products program. Given that heat pumps are an unknown technology for many customers, explaining the following may help overcome the barrier of customer preference for natural gas heating:

- the expected bill savings
- how to optimally use a heat pump (e.g., avoid large fluctuations in thermostat settings, as heat coming out of the register will not be as hot as a gas furnace -- making it more difficult and more costly to quickly increase the temperature inside a home)
- the non-energy benefits of heat pumps (e.g., air inside the home is less dry compared to a gas furnace).

There may be an opportunity to coordinate with the Efficient Products program to promote the benefits of heat pumps widely in the marketplace.

PROCESS

Leverage HVAC Contractors to Recruit Additional Retailers

Most program activity occurs within one retailer, and despite efforts to recruit additional retailers through a bonus incentive, no additional retailers were recruited in 2019.

Interviewed HVAC dealers noted that they are in a position to use the program as a sales tool with retailers that they regularly interface with. Bonuses could be split with HVAC dealers who successfully recruit new retailers to participate. The program should provide dealers with basic program information and a way to contact program staff for follow-up if they are interested.

PROCESS

Review Incentive Process & Timeline

Two of four retailers mentioned that the timeline for receiving incentives was too long. It is important that retailers are satisfied with the incentive payment and timeline as they are the ones promoting qualifying homes and making the sale to the customer.

Because retailers and HVAC dealers negotiate the incentive payments among themselves, and HVAC dealers are often the ones distributing the incentives to retailers once they receive payment from AEP Ohio, this may be somewhat outside of AEP Ohio’s control. However, AEP Ohio should investigate incentive timelines and consider providing guidelines to HVAC dealers stipulating turnaround time for passing incentives to retailers, if it is found that the HVAC dealer timelines are too lengthy. There may also be an opportunity for the implementer to manage this relationship by setting terms including incentive turnaround timelines with participating HVAC dealers.

05

Appendix

Appendix

Ex Ante Savings Calculations

Ex Ante Energy Savings

AEP Ohio used a regression equation recommended by the evaluation team to calculate ex ante energy savings. The regression equation was developed using BEopt Building Simulation software to run models both for the baseline case and the efficient case.

The resulting equation estimates ex ante energy savings as a function of square footage.

Ex Ante Energy Savings = 5.6917 * *SqFt* – 1219.1

- where *SqFt* = building square footage

Ex Ante Demand Savings

AEP Ohio relied on ex ante estimates provided by Systems Building Research Alliance (SBRA) for demand savings estimates. SBRA performed an engineering estimate of the “right-sizing” of HVAC equipment. Demand savings were the same for all homes, 2.64 kW.

Appendix

Ex Post Energy Savings Methodology

For the ex post energy savings, the evaluation team performed a modified billing analysis where pre-program annual consumption comes from building model simulation using the National Renewable Energy Laboratory (NREL) BEopt Building Simulation software. Post-program annual energy consumption comes from weather normalized participant billing data.

For inputs into the model, the evaluation relied on square footage and locational data. The team ran five BEopt models by using different square footages to generate a linear model to estimate energy consumption that uses square footage as an independent variable. The evaluation team modified the program participation requirement parameters slightly to fit the modeling software. The following table outlines those modifications.

Equivalency Between Program Requirements and Modeling Parameters

Component	Program Participation Requirement	EMI Energy-Efficient Model Parameter
Ceiling insulation	R-33 (nominal, uncompressed peak)	Unfinished Attic: Spray Foam, R-38 Vented
Wall insulation	R-11 (nominal), 2x4 framing	Wood Stud, 2x4, R-11
Floor insulation	R-22 (nominal)	Crawlspace: R-19 Spray Foam (ceiling)
Window/glazing properties	Dual glazed, low-E	Low-E, Non-metal, Double Glazed, Air, M-Gain
Thermostat	Programmable	Programmable
Heat pump	Required, properly sized and matched	14 SEER Air Source Heat Pump

Appendix

Ex Post Energy Savings Methodology

For the baseline building model, the evaluation team used the following parameters as inputs into the building model. The baseline model was used for both ex post energy and ex post demand savings calculations.

Ex Post Baseline Building Model Parameters

Component	Baseline	Source
Walls	R-7 Fiberglass Batt., 2x4, 16 in. o.c.	Combined with windows, attic and crawlspace to attain an estimated coefficient of heat transmission (Uo) value of 0.079, the federal standard for new manufactured homes.[1]
Unfinished Attic	Ceiling R-7, ventilated	Combined with windows, walls, and crawlspace to attain an estimated coefficient of heat transmission (Uo) value of 0.079, the federal standard for new manufactured homes.
Crawlspace	R-5 XPS	Combined with windows, walls, and attic to attain an estimated coefficient of heat transmission (Uo) value of 0.079, the federal standard for new manufactured homes.
Space Conditioning	14 SEER AC	Based on federal standard SEER value of new equipment purchased from home.[2]
Heating	Electric Baseboard	Standard heating equipment described during MaGrann's interviews with manufacturers.
Cooling Set Point	73	Based on the 2016 AEP Ohio Residential Appliance Saturation Survey (RASS) survey.
Heating Set Point	70	Based on the 2016 AEP Ohio Residential Appliance Saturation Survey (RASS) survey.
Window	Single pane, no glazing	Combined with crawlspace, walls, and attic to attain an estimated coefficient of heat transmission (Uo) value of 0.079, the federal standard for new manufactured homes.

[1] https://www.ecfr.gov/cgi-bin/text-idx?SID=a2c5655a37054c584f7dd6a0ed240fb8&node=pt24.5.3280&rgn=div5
[2] https://www.energy.gov/eere/femp/incorporate-minimum-efficiency-requirements-heating-and-cooling-products-federal

Appendix

Ex Post Energy Savings Methodology

Data Cleaning for Modified Billing Analysis

The evaluation team conducted a data cleaning process for the modified billing analysis, which used 2018 and 2019 participants' billing data. The team first examined both participation data and consumption data to determine which participants should be included in the modified billing analysis.

- 5 homes did not have program participation data (likely those who participated in 2017).
- 22 homes received incentives after the first three months of 2019.
- 2 customers did not have complete billing data even though they participated in the program in 2018.

Modified Billing Analysis Data Cleaning Steps

Screening Step	Remaining Customers	Number of Customers Removed
Raw Data – Total Sample	109	-
Missing Program Data	104	5
Participated After First Three Months of 2019	82	22
Incomplete Data	80	2
Remaining After Cleaning	80	-

Appendix

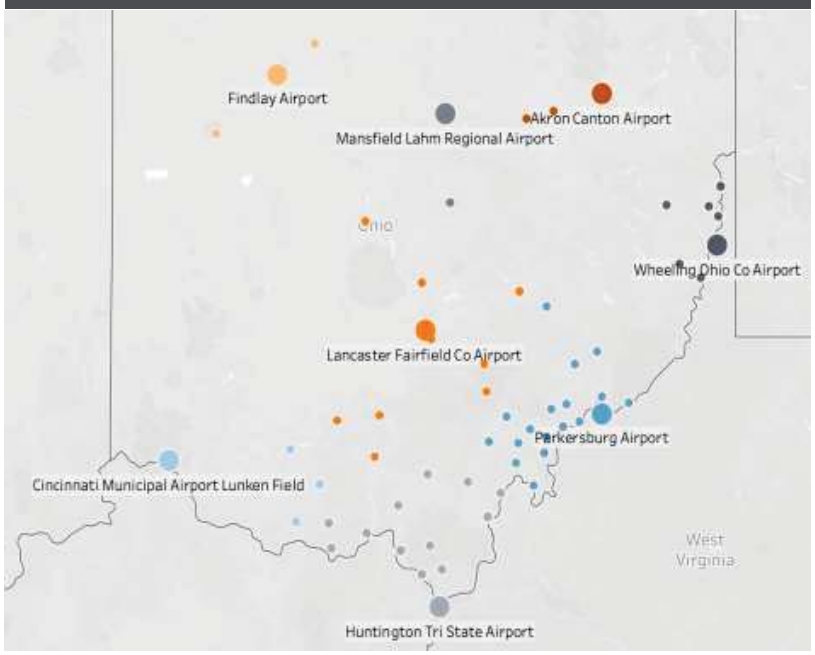
Ex Post Energy Savings Methodology

To account for energy usage related to weather, the evaluation team weather normalized actual post-program energy consumption based on nine different weather station regions within AEP Ohio territory. The evaluation team chose weather stations as the basis for regional groups and selected the most accurate weather stations (TMY3 data) that efficiently grouped participants. The evaluation team also determined the average building square footage of participating homes in each region. The following table displays the regions near weather stations, and the count of participating homes in each region, for the 80 customers included in the analysis.

Customer Locations - Post Screening Grouped by Weather Station (2018 and 2019)

Final Station	Count of Participating New Manufactured Homes
Parkersburg Airport	22
Huntington Tri State Airport	21
Lancaster Fairfield Co Airport	16
Wheeling Ohio Co Airport	10
Akron Canton Airport	4
Cincinnati Municipal Airport Lunken Field	3
Findlay Airport	2
Mansfield Lahm Regional Airport	2

Customer Locations Grouped by Weather Station



Appendix

Ex Post Energy Savings Methodology

The evaluation team applied the following formula (A-1) to estimate energy savings for customers used in the modified billing analysis and developed a regression model (A-2) that predicts 2019 savings based on square footage and region.

Equation A-1. Ex Post Energy Savings for New Manufactured Homes

Annual kWh Savings = (Baseline Model Energy Consumption – Weather Normalized Energy Consumption)

Equation A-2. Energy Savings Regression Model

$$\text{Annual kWh Savings}_i = \text{Square Footage}_i \times \beta_1 + Region_i \times \beta_2 + \varepsilon_i$$

Where:

Baseline Model Energy Consumption = The average energy consumption of the six regional baseline building models, weighted by participants in each region.[1]

The team used the five regions in Ohio. (Central, NW,[2] *NE, SW, SE)*

Ex Post *Energy* Savings Estimate Model	
Region	**Ex Post Savings Model**
Central and Northwest	-2,727 + 5.06 * SqFt
Northeast	1,599 + 5.06 * SqFt
Southwest	-318 + 5.06 * SqFt
Southeast	-1,749 + 5.06 * SqFt

[1]The team used the region definitions as presented in www.ohio.org/regions
[2]There were only two participants from the Northwest region and the regression estimates for Central and Northwest were almost the same, therefore, the evaluation team included the two customers in the Northwest region with the Central region.

Appendix

Ex Post Energy Savings Methodology

As shown below, the regression model significantly predicted weather normalized energy consumption using square footage and region. The team applied the same regression model to estimate savings.

While the region coefficients in the model predicting savings are technically not statistically significant, both models have the same standard error. The baseline consumption from BEopt is a linear model and therefore does not affect the variation in savings beyond actual consumption. Given the fact that the weather normalized annual energy consumption regression model generates statistically significant estimates for the Region variables, the team suggests using these to estimate savings going forward.

Weather Normalized Annual Energy Consumption Regression Model Parameters

Parameter	Estimate	Standard Error	T-Statistics
Square Footage	4.89	1.6	3.05**
Central and Northwest	10,362	2,547	4.07***
Northeast	6,036	2,229	2.71**
Southwest	7,953	2,400	3.31**
Southeast	9,384	2,832	3.31**

Level of Significance: *** - 0.1%, ** - 1%, *5%, . - 10%

Ex Post Savings Regression Model Parameters

Parameter	Estimate	Standard Error	T-Statistics
Square Footage	5.06	1.6	3.16**
Central and Northwest[1]	-2,727	2,547	-1.07
Northeast	1,599	2,229	0.72
Southwest	-318	2,400	-0.13
Southeast	-1,749	2,832	-0.62

Level of Significance: *** - 0.1%, ** - 1%, *5%, . - 10%

[1]There were only two participants from the Northwest region and the regression estimates for Central and Northwest were almost the same, therefore the evaluation team put the two customers from the Northwest region into Central bucket.

Appendix

Ex Post Demand Savings Methodology

For the demand savings estimate, The Systems Building Research Alliance (SBRA) provided the ex ante values, and as in 2018, we believe that their methods may not have accurately characterized demand savings. The AEP Ohio New Manufactured Homes program requires that the HVAC systems for participating units are “right-sized” for the particular new manufactured home. For new construction programs that require HVAC right-sizing, the Ohio TRM recommends calculating both the demand savings resulting from the energy efficiency of the home over a baseline efficiency unit, and the demand savings resulting from right-sizing of HVAC equipment.

The ex ante values used by AEP Ohio account for the right-sizing of the HVAC equipment and improvements to the thermal envelope as discussed by SBRA in their memo from December 18, 2017. The ex ante estimate does not appear to have a coincidence factor applied to it, and therefore estimates the maximum potential demand savings from right-sized equipment instead of the demand savings at the time of system peak demand.

For the ex post demand savings calculation, the evaluation team modified the Ohio TRM-recommended equation for traditional new construction programs requiring right-sizing. The evaluation team used the following equation:

Equation A-3. Ex Post Demand Savings for New Manufactured Homes

*Summer Coincident Peak kW Savings = (Baseline Model Demand – Energy Efficient Model Demand) + (Right-Sizing Factor * Coincidence Factor)*

Where:

Baseline Model Demand = The average hourly energy usage during the peak period (3-6 PM) on the hottest day of the year

Energy Efficient Model Demand = The average hourly energy usage during the peak period (3-6 PM) on the hottest day of the year

Right-Sizing Factor = The right-sizing factor estimating the maximum potential demand savings from installing right-sized equipment instead of over-sized HVAC equipment

Coincidence Factor = Coincidence factor which equates the installed HVAC system’s demand to its demand at the time of system peak

Appendix

Ex Post Demand Savings Methodology

For the energy-efficient building model, the evaluation team used the following parameters as inputs. The building model was used for calculating demand savings. (For energy savings, the evaluation team compared billing data to the baseline model.)

Energy Efficient Building Model Parameters - Ex Post Demand Savings

Component	Baseline	Source
Walls	Wood Stud, 2x4, R-11	Required minimum rating of installed equipment for AEP Ohio home.
Unfinished Attic	Spray Foam, R-38 Vented	Substitute for ceiling insulation program participation requirement. Nearest value to AEP Ohio requirement that is available in modeling software. Assumed higher value than AEP Ohio requirement in attic to offset lower value than AEP Ohio requirement in crawlspace.
Crawlspace	R-19 Spray Foam (ceiling)	Substitute for floor insulation program participation requirement. Nearest value to AEP Ohio requirement that is available in modeling software. Assumed higher value than AEP Ohio requirement in attic to offset higher value than AEP Ohio requirement in attic.
Space Conditioning	14 SEER Air Source Heat Pump	Required minimum rating of installed equipment for AEP Ohio home.
Heating	14 SEER Air Source Heat Pump	Required minimum rating of installed equipment for AEP Ohio home.
Cooling Set Point	73 F w/ Setback 78 F (wkdy)	Setpoint based on RASS 2016 survey data. Setback based on Indiana TRM V2.2.
Heating Set Point	70 w/ Setback 67 F (wkdy & evenings)	Setpoint based on RASS 2016 survey data. Setback based on Indiana TRM V2.2.
Window	Low-E, Non-metal, Double Glazed, Air, M-Gain	Required minimum rating of installed equipment for AEP Ohio home.

Appendix

Ex Post Demand Savings Methodology

The following table lists the values, sources, and notes on each source (including differences from the Ohio TRM's traditional new construction demand savings equation). Baseline and energy efficient demand values vary from 2018 due to 1) a correction to how peak demand is defined when using TMY3 weather data, and 2) updating the square footage of 2019 participant homes.

Ex Post Demand Equation Parameters

Variable	Value	Source	Notes on Source
Baseline Model Demand	2.53	Baseline Building Model Estimates	The ex post Baseline Model Demand estimate is not multiplied by a coincidence factor because the method used already calculates demand usage at the peak period.
Energy Efficient Model Demand	1.10	Energy Efficient Baseline Building Model Estimates	The ex post Baseline Model Demand estimate is not multiplied by a coincidence factor because the method used already calculates demand usage at the peak period.
Right-Sizing Factor	2.64	SBRA ex ante estimate	The Right-Sizing Factor reflects an estimate of the OFUDRH and OFr parameters from the Ohio TRM's equation for traditional residential new construction. The ex post calculation uses the Systems Building Research Alliance (SBRA) estimates rather than the Ohio TRM OFUDRH and OFr parameters for three reasons: 1. The method used to calculate Baseline Model Demand and Energy Efficient Model Demand already calculate demand usage at the peak period and therefore should not have a coincidence factor applied to them. We therefore applied the Coincidence Factor to only the Right-Sizing Factor in this equation. 2. We believe that the TRM estimates for OFUDRH and OFr may not characterize conditions for new manufactured homes properly. We believe that SBRA are experts in their field and would produce an over-sizing estimate much closer to actual conditions for new manufactured homes. 3. We combined the OFUDRH and OFr parameters into the single Right-Sizing factor as we only received a single Right-Sizing estimate from the SBRA and their estimate should roughly account for both parameters.
Coincidence Factor	0.5	Ohio TRM Traditional New Construction Demand Savings Equation Parameter	We applied the Ohio TRM traditional New Construction demand savings Coincidence Factor because we did not find a manufactured home-specific coincidence factor in our secondary research.

To check the reasonableness of the ex post demand savings estimate, the evaluation team compared ex post estimates to the estimate for the EfficiencyCrafted Homes program in 2017. The EfficiencyCrafted Homes program does not require right-sizing of HVAC systems and only estimates demand savings using the first two terms of our equation (Baseline Model Demand – Energy Efficient Model Demand). The ex post demand savings estimates from the first two terms of our equation were only 11 percent lower than the EfficiencyCrafted Homes demand savings ex post estimates for 2017 (1.43 kW compared to 1.6 kW).

Appendix

Program Theory and Logic Model

The evaluation team developed a logic model (shown on subsequent slides) to illustrate the program theory underlying the New Manufactured Homes program.

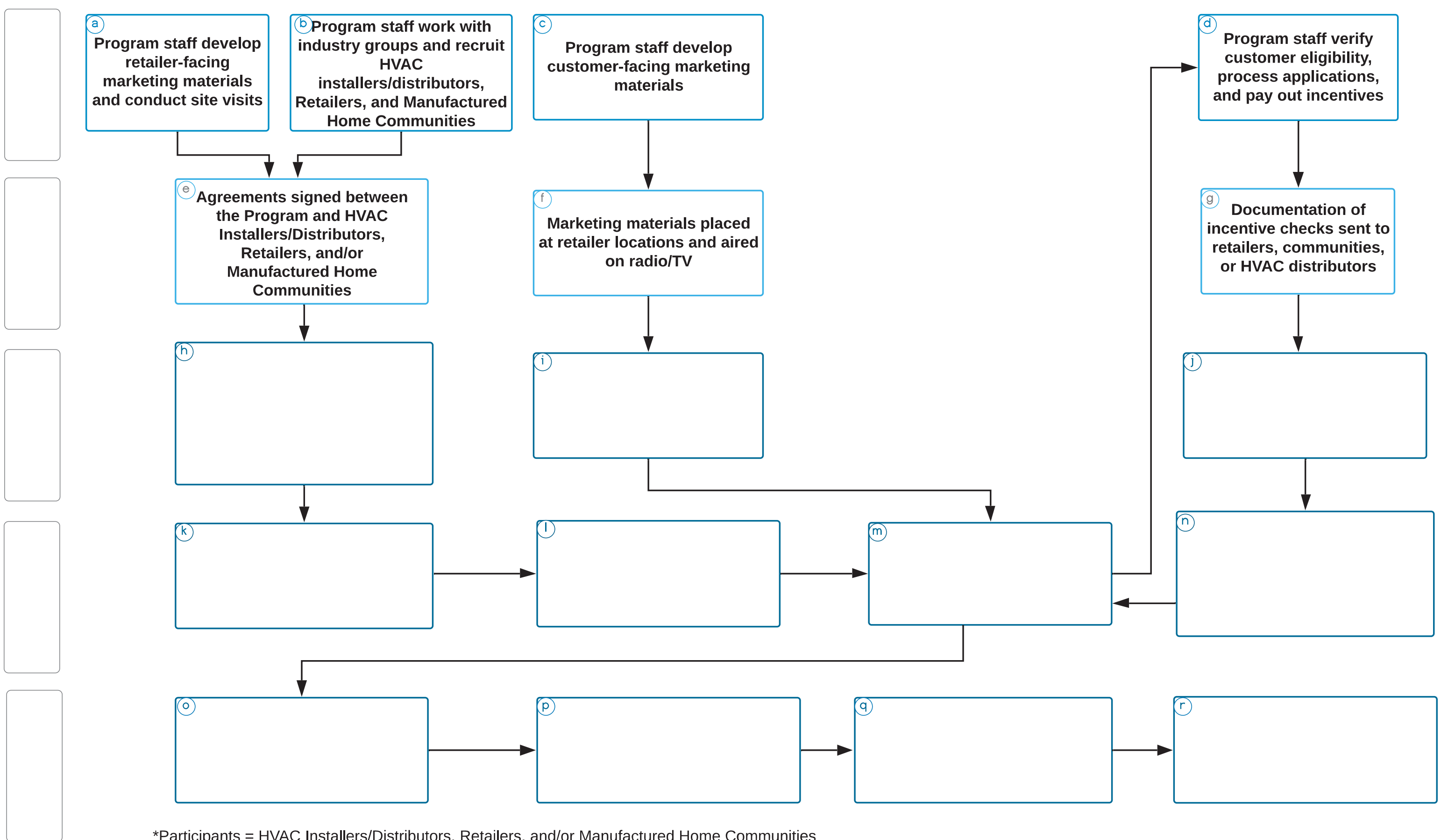
- Energy savings for this program are the result of a number of **Activities** performed by AEP Ohio and the implementation contractor.
- **Outputs** are defined as the immediate results from specific program activities. These results are typically easily identified and can often be counted by reviewing program records.
- **Outcomes** are distinguished from outputs by their less direct results from specific program activities. Outcomes represent anticipated results associated with the program activities and will vary over time as changes in attitudes lead to behavior changes. Finally, conditional outcomes will occur depending on the success of the attitudinal and behavioral outcomes.

On a continuum, program activities will lead to immediate outputs that, if successful, will collectively work toward achievement of anticipated outcomes with respect to attitudes and behaviors in the market, as well as conditional outcomes that depend on the success of the attitudinal and behavioral changes.

Appendix

Program Theory and Logic Model

Program activities (a – d), outputs (e – g), and outcomes (h – r) are shown below.



*Participants = HVAC Installers/Distributors, Retailers, and/or Manufactured Home Communities

Appendix

Program Theory and Logic Model

Barriers the program is designed to address are shown below. Also shown are assumptions underlying the program theory and external factors that could affect the success of the program.

BARRIERS

- Few energy efficient new manufactured homes are produced for the Ohio market.
- Low price and consumer preference for natural gas may impact sales of all-electric new manufactured homes.
- The cost of an energy efficient new manufactured home is high compared to standard manufactured homes (least first cost).
- Access to capital or financing may pose a challenge for new manufactured home purchasers.
- Loans for new manufactured homes may be required to be a "chattel loan" instead of a traditional home loan and providing an incentive directly to customer may be considered down payment assistance by chattel loan providers.
- Program staff have difficulty reaching and maintaining contacts at retail centers due to high staff turnover.
- Verifying that new manufactured homes are located in AEP Ohio territory is difficult for retailers.
- Retailers may wait to verify the eligibility of energy efficient NMHs qualify until after the sale.
- Retailers also sell used manufactured homes and modular homes, which can cause confusion when determining eligibility for the NMH program.
- HVAC contractors may not be confident in heat pump technology.
- Planned metrics for tracking performance are not realistic.
- Manufacturers cannot easily include upgraded HVAC equipment at the plant, which complicates the manufacturer's ability to participate in the prorgam.

ASSUMPTIONS

- Retailers and distributors/installers divide program incentives in a way that effectively promotes the sale of new energy efficient manufactured homes.
- Air source heat pumps are equally effective to electric furnaces in heating homes.

EXTERNAL FACTORS

- Delay of Federal Standards Update: Program staff anticipated that new manufactured home federal standard updates would make program participation more appealing for manufacturers. In 2017, the new federal administration began reviewing proposed code updates and decided to forego these updates.
- Department of Energy (DOE) Tax Credit: Program staff had also planned to capitalize on a Department of Energy (DOE) tax credit for new manufactured homes. This tax credit expired at the end of 2017 and the U.S. Congress has not reinstated the tax credit to date.
- Subsequent Feedback from Manufacturers: Due to the above-mentioned events and market conditions, in 2017, staff received feedback from manufacturers that there was not demand in the market for highly efficient new manufactured homes and therefore program incentives to manufacturers would not increase production.

Appendix

Detailed Findings from the Retailer, HVAC Dealer & Manufacturer Interviews:
Sources of Program Awareness & Motivation

Note: Findings that appear in the Key Findings summary in the body of the report are shown in **blue** text. Additional findings not shown in the body of the report appear in black text.

Retailers (n = 4)

Interviewed retailers primarily became aware of the program after being contacted by MaGrann staff.

- Three retailers described program staff conducting a site visit and coming to meet them at their retail center.
- All four retailers were motivated to join the program by the incentives. **Two retailers described it as "free money" – getting money for something they were already doing (selling qualifying homes).**
- One retailer worked for a community, where his qualifying homes were primarily used as rentals. He said that the program helps make heat pumps more accessible and helps him to keep the cost of heating affordable for his tenants.

HVAC Dealers (n = 2)

HVAC dealers became aware of the program through participating retailers, who approached them to make contracts for submitting and distributing the rebate.

- One HVAC dealer mentioned that the incentive motivated them to participate, but later described the rebate they received as relatively small, and more motivating for retailers.
- One HVAC dealer said they were motivated to participate in the program because the retailer they primarily contract with asked them to take over the the administrative requirements of the program.

Manufacturer Liaison (n = 1)

The manufacturer representative works with MaGrann staff to provide advice and give perspectives from other similar programs across the country.

He was motivated to participate in the program because his organization is working on promoting ENERGY STAR® certification in the manufactured home industry and is involved in utility programs that help retailers and customers get over the additional upfront costs associated with ENERGY STAR® .

He felt that manufacturers are motivated to produce energy efficient homes because end users are becoming more attuned to energy performance. Additionally, they want their brand and products to be viewed favorably in the market. Offering homes above code gives them a competitive edge.

Appendix

Detailed Findings from the Retailer, HVAC Dealer & Manufacturer Interviews:
Program Processes

Note: Findings that appear in the Key Findings summary in the body of the report are shown in **blue** text. Additional findings not shown in the body of the report appear in black text.

Retailers (n = 4)

- Two retailers said that their incentives are distributed by HVAC dealers. They felt this process increases the time it takes for retailers to be credited with their incentive money.
- Both these retailers felt that the turnaround time was too long.
- Reported rebate turnaround times ranged from two weeks to six months.
- Retailers noted that the marketing materials were useful tools for educating clients on the benefits of energy efficient homes and heat pumps.

HVAC Dealers (n = 2)

- Both HVAC dealers reported that rebate checks come to them from AEP Ohio and they then redistribute the incentives to retailer locations.
- One HVAC dealer reported that multiple people at their company complete pieces of the application, while the other said a dedicated administrative person did this.
- **One HVAC dealer said that they use the program as a sales tool to promote heat pumps with retailers. The other said they did not currently use the program as the sales tool but recognized that there was an opportunity for them to do so.**
- Neither HVAC dealer said that their company has SPIFs or other internal promotions related to the New Manufactured Homes program.

Manufacturer Liaison (n = 1)

- N/A (manufacturers are not involved in the program).

Appendix

Detailed Findings from the Retailer, HVAC Dealer & Manufacturer Interviews:
Program Influence

Note: Findings that appear in the Key Findings summary in the body of the report are shown in **blue** text. Additional findings not shown in the body of the report appear in black text.

Retailers (n = 4)

- Three out of four retailers said that they always or most times sell only energy-efficient homes (not always with heat pumps though). One stated that selling a baseline home would be a “disservice” to their customers.
- Retailers said they try to put heat pumps on all electric homes they sell, and that they use AEP Ohio-provided materials to show customers the long-term cost savings.
- Retailers felt that AEP Ohio’s promotion of energy-efficient homes through collateral materials for customers was a useful selling tool, because customers could see that salespeople were not trying to upsell them on something they did not need.

HVAC Dealers (n = 2)

- Both HVAC dealers indicated that they felt the program was driving sales of rebate-eligible homes and heat pumps, because “it’s a hefty rebate.”
- One HVAC dealer specifically said they were seeing a trend towards increased heat pumps sales because of Clayton and their promotion of the Energy Smart package.
- One HVAC dealer felt there was an opportunity for them to promote the program with other manufactured homes retailers.

Manufacturer Liaison (n = 1)

- **The interviewee stated that offering home upgrades allows manufacturers to stay competitive in the market and promote their brand; the program promotes these upgrades to end users, creating demand.**
- Incentive programs like AEP Ohio’s help retailers sell upgrades to end-users. It makes upgrades, like envelope upgrades and heat pumps, accessible to the target buyers of manufactured homes, who value affordability.
- The interviewee felt that retailers are best situated to promote the incentive program, so it is essential that they are well-trained on the benefits of program-qualifying energy upgrades.

Appendix

Detailed Findings from the Retailer, HVAC Dealer & Manufacturer Interviews:
Barriers

Note: Findings that appear in the Key Findings summary in the body of the report are shown in **blue** text. Additional findings not shown in the body of the report appear in black text.

Retailers (n = 4)

- Two retailers mentioned the high upfront costs of heat pumps as a barrier. One retailer said he felt the cost of ENERGY STAR® certification is not justified.
- **Two retailers said the end-user's preference for natural gas as a fuel source was a barrier. Additionally, both described the cooler heat temperature coming from the register as a concern for their customers, particularly older customers.**
- **Two retailers described lack of salesperson knowledge of heat pumps as a barrier. These retailers felt that salespeople could not always speak knowledgably about the benefits of a heat pump over a standard air conditioning unit.**

HVAC Dealers (n = 2)

- **Both HVAC dealers felt that the cooler heat from the register was a barrier to heat pumps, and one felt that contractors needed to better educate end-users about this aspect.**
- Both HVAC dealers described high costs as a barrier, though one mentioned upfront costs of heat pumps while the other mentioned the relatively higher costs of electricity as a fuel source when natural gas was available.
- Other barriers that HVAC dealers described included the need for a backup heat source, like a furnace or auxiliary heat strips; the requirement of an "extra wire"; and difficulties finding someone to service a heat pump.

Manufacturer Liaison (n = 1)

- One barrier described by the manufacturer representative to selling energy efficient manufactured homes was the additional costs associated with upgrades, when the **niche for manufactured homes centers on affordability.**
- **Additionally, when considering upgraded features, like energy efficiency packages, customers are more likely to prefer visible upgrades, like more square footage or upgraded kitchens over "invisible" upgrades like insulation or higher efficiency equipment.**
- Lenders don't take into consideration the lower operating costs associated with greater efficiency and therefore don't give credit for these upgrades.

Appendix

Detailed Findings from the Retailer, HVAC Dealer & Manufacturer Interviews:
Barriers, cont.

Note: Findings that appear in the Key Findings summary in the body of the report are shown in **blue** text. Additional findings not shown in the body of the report appear in black text.

Retailers (n = 4)

- **Two retailers said the time to receive the rebate was too long.** One said it could take up to six months to receive the incentive. Another remarked that he had no way of tracking the incentive check, "but it took too long," although he noted that it took the HVAC dealer 2-4 weeks to process the check and distribute it to them.
- While one said the turnaround had improved in the past year because their checks did not go through the HVAC dealer, another said their checks still were processed through the dealer and he did not understand why.

HVAC Dealers (n = 2)

- **Both HVAC dealers described the administrative side of submitting rebate applications as cumbersome, though one felt it was a "necessary evil."**
- **One dealer felt that determining whether the address was in AEP Ohio territory was "tricky."**

Manufacturer Liaison (n = 1)

- Retailers are not creating demand for energy-efficient homes because they are not skilled at *"selling the benefits that customers can't see,"* like energy efficiency upgrades.
- Manufactured homes can be built outside Ohio to HUD codes, whose energy efficiency standards are lower than Ohio's, and then shipped and sold in Ohio.

Appendix

Detailed Findings from the Retailer, HVAC Dealer & Manufacturer Interviews:
Program Improvements

Note: Findings that appear in the Key Findings summary in the body of the report are shown in **blue** text. Additional findings not shown in the body of the report appear in black text.

Retailers (n = 4)

- Retailers felt that AEP Ohio could continue to support the sales of energy-efficient homes by helping with salesperson training – particularly on heat pumps. Retailers suggested both trainings and additional non-technical materials for salespeople.
- Two retailers expressed interest in receiving more collateral marketing materials, particularly highlighting the benefits of heat pumps over standard air conditioners. Retailers asked for simple, non-technical, customer facing one-page sheets or flyers that they could give to customers or send out in mailings.
- Program improvements mentioned included streamlining the incentive payment process so that incentives are disbursed more quickly.

HVAC Dealers (n = 2)

- HVAC dealers felt that the program did a particularly good job of incenting retailers to sell heat pumps, but that it was overall a beneficial program for all participants – Retailers, HVAC dealers, and end-users.
- One HVAC dealer felt there was an opportunity to use HVAC dealers to promote the program with retailers more than they currently do, stating that they would benefit from training materials that their salespeople could distribute among their non-participating retail customers.
- One HVAC dealer said that the program could further support sales of energy efficient homes and heat pumps by encouraging utilities in neighboring states to create similar programs.

Manufacturer Liaison (n = 1)

The interviewee recommended that the program increase engagement and training for retail salespeople:

- **Make sure that the ENERGY STAR® upgrades are discussed early in the sales process to impact the end-user's decision-making from the beginning.**
- Be in close contact with retailers and salespeople, to provide training and support.
- **Take advantage of the manufactured homes tax credit, which was re-established in December 2019 and extended through 2020. It also applies retroactively to homes built in 2018.**

APPENDIX I

Home Energy Report Program

2019 Evaluation Report

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Disclaimer

Content of Report

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March 24, 2020

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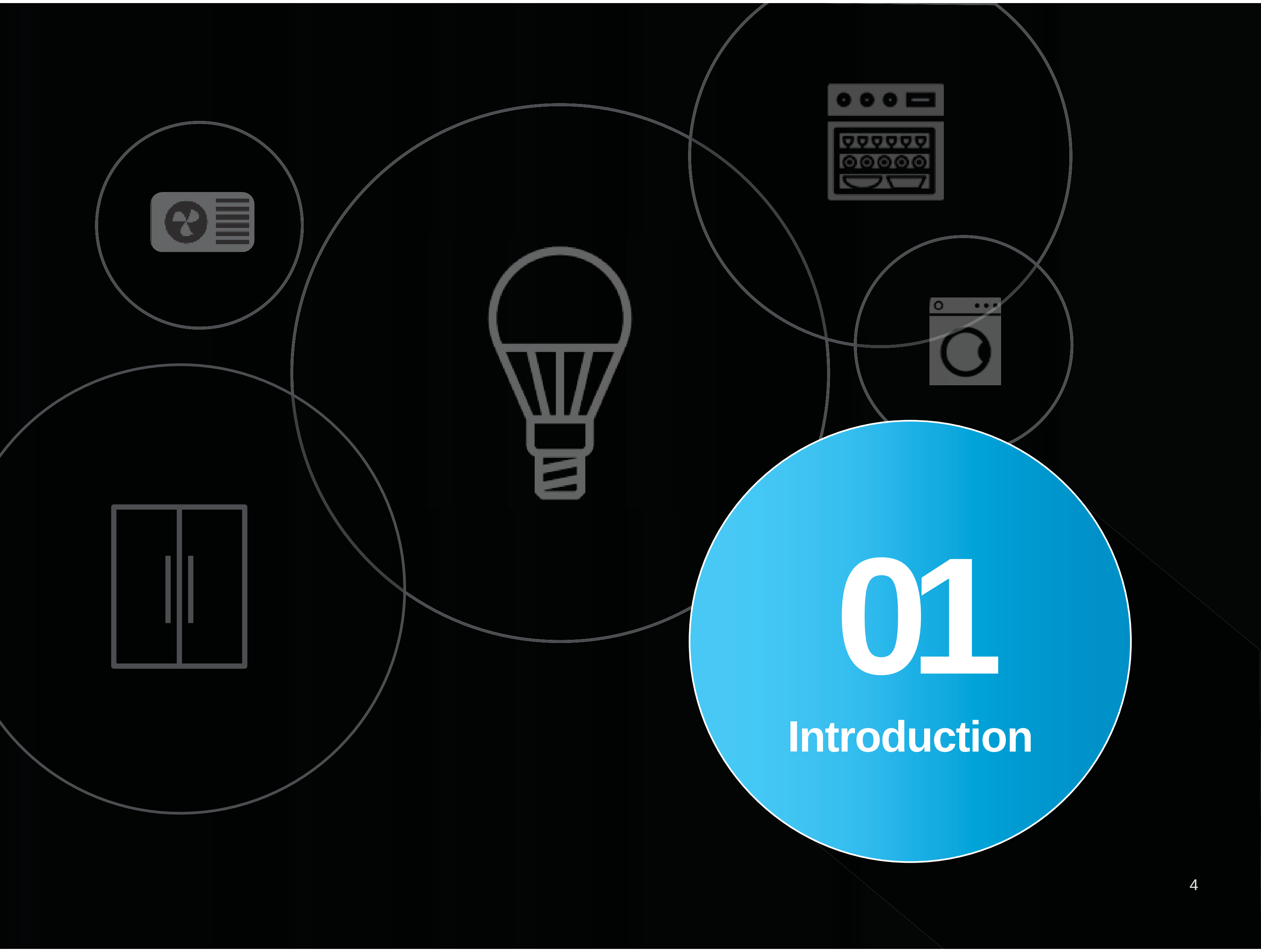
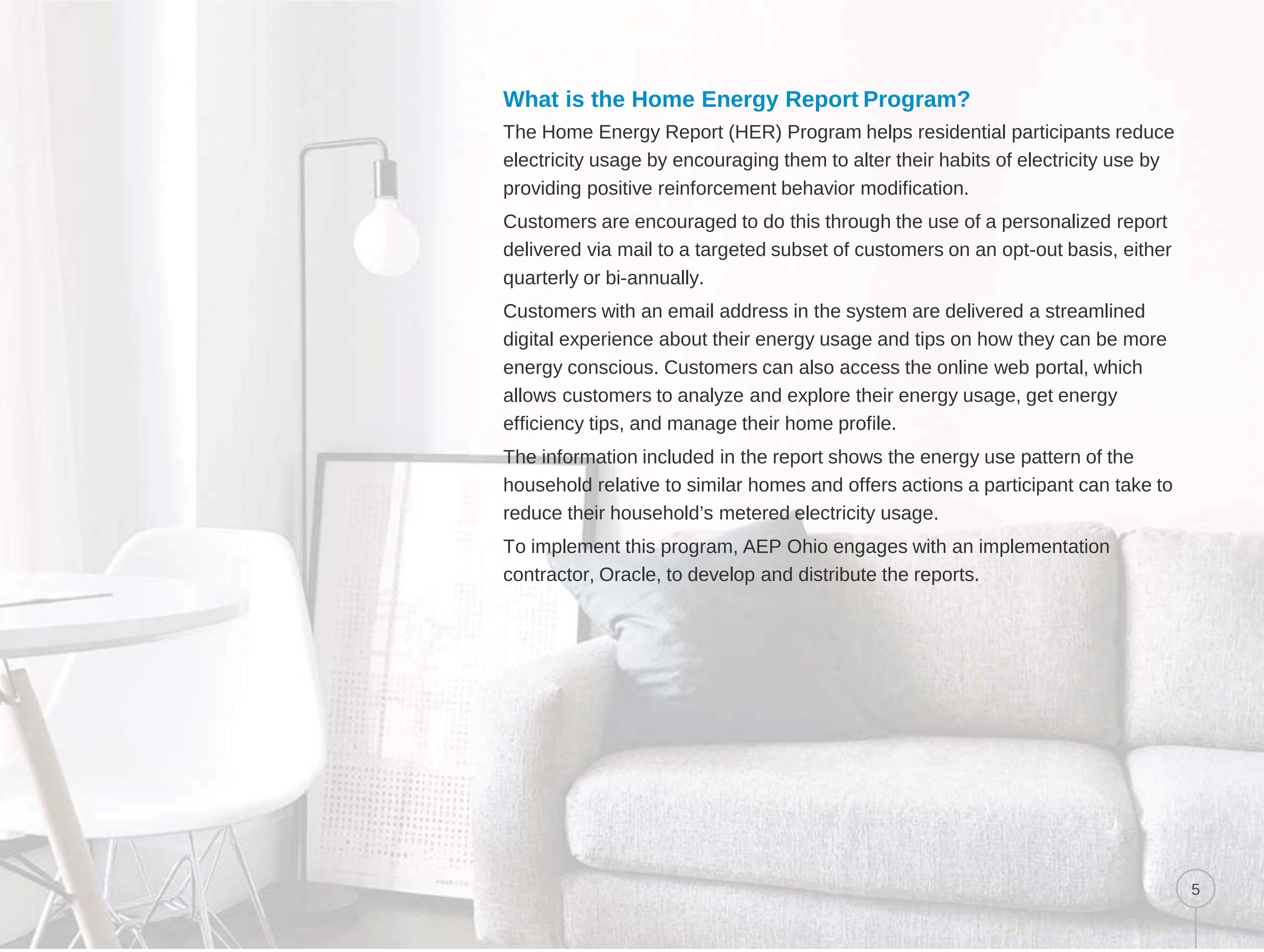


01 Introduction



What is the Home Energy Report Program?

The Home Energy Report (HER) Program helps residential participants reduce electricity usage by encouraging them to alter their habits of electricity use by providing positive reinforcement behavior modification.

Customers are encouraged to do this through the use of a personalized report delivered via mail to a targeted subset of customers on an opt-out basis, either quarterly or bi-annually.

Customers with an email address in the system are delivered a streamlined digital experience about their energy usage and tips on how they can be more energy conscious. Customers can also access the online web portal, which allows customers to analyze and explore their energy usage, get energy efficiency tips, and manage their home profile.

The information included in the report shows the energy use pattern of the household relative to similar homes and offers actions a participant can take to reduce their household's metered electricity usage.

To implement this program, AEP Ohio engages with an implementation contractor, Oracle, to develop and distribute the reports.

Features of Home Energy Reports

Similar Homes Comparison

Home Energy Analysis

Marketing Modules[1]

12 Month Costs/Savings

Energy Saving Tips

Progress Tracking

[1] Marketing modules to promote other energy efficiency programs offered by AEP Ohio.

Program Summary

PROGRAM EVALUATION SUMMARY RESULTS[1]

Measure	2019 Program Goals[2] (a)	Ex Ante Savings (b)	Ex Post Savings[3] (c)	Realization Rate[4] RR = (c) / (b)	Percent of Goal = (c) / (a)
Energy Savings (MWh)	75,000	94,550	101,435	1.07	135%
Demand Savings (kW)[5]	3,750	12,292	13,187	1.07	352%

[1] Savings estimates exclude the AMI segment.
[2] Volume 1: 2017 to 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, June 15, 2016.
[3] Ex post savings are adjusted for cross participation.
[4] A RR of 1.07% is within the error bound of the model. Therefore, ex ante and ex post savings are not statistically significantly different from each other.
[5] Demand savings are calculated using a 13 percent coincidence factor.

02

Methodology

Evaluation Objectives

The 2019 evaluation activities align with the following objectives:

Impact

01 Determine if the program provides energy and demand savings

02 Quantify the energy savings from the program

03 Quantify the demand savings from program

04 Determine program cost effectiveness

Process

01 Confirm the program is functioning as expected

Data Collection Activities

DATA COLLECTION TYPE

1	2	3
Participant Billing and Tracking Data	**Cross-Participation Data**	**In-Depth Telephone Interview**
Targeted Population **Census**	Targeted Population **Census**	Targeted Population **Program Manager and Implementation Contractor**
Sample Frame **Customer Billing Database**	Sample Frame **EE Program Tracking Database**	Sample Frame **Contacts for Program Manager and Implementation Contractor**
Sample Size **Census**	Sample Size **Census**	Sample Size **2**
Timing **Jan-20**	Timing **Jan-20**	Timing **Jan-20**

Analytical Methods

Econometric Modeling

Guidehouse estimated the HER program impacts using two approaches applied to monthly billing data: (1) a lagged dependent variable (LDV) regression analysis with lagged controls, and (2) a linear fixed-effects regression (LFER) analysis. Guidehouse uses the LDV results for reporting total program savings, but runs both models as a robustness check. Although the two models are structurally very different, assuming the randomized controlled trial (RCT) is well balanced with respect to the drivers of energy use, in a single sample the two approaches generate very similar estimates of program savings.

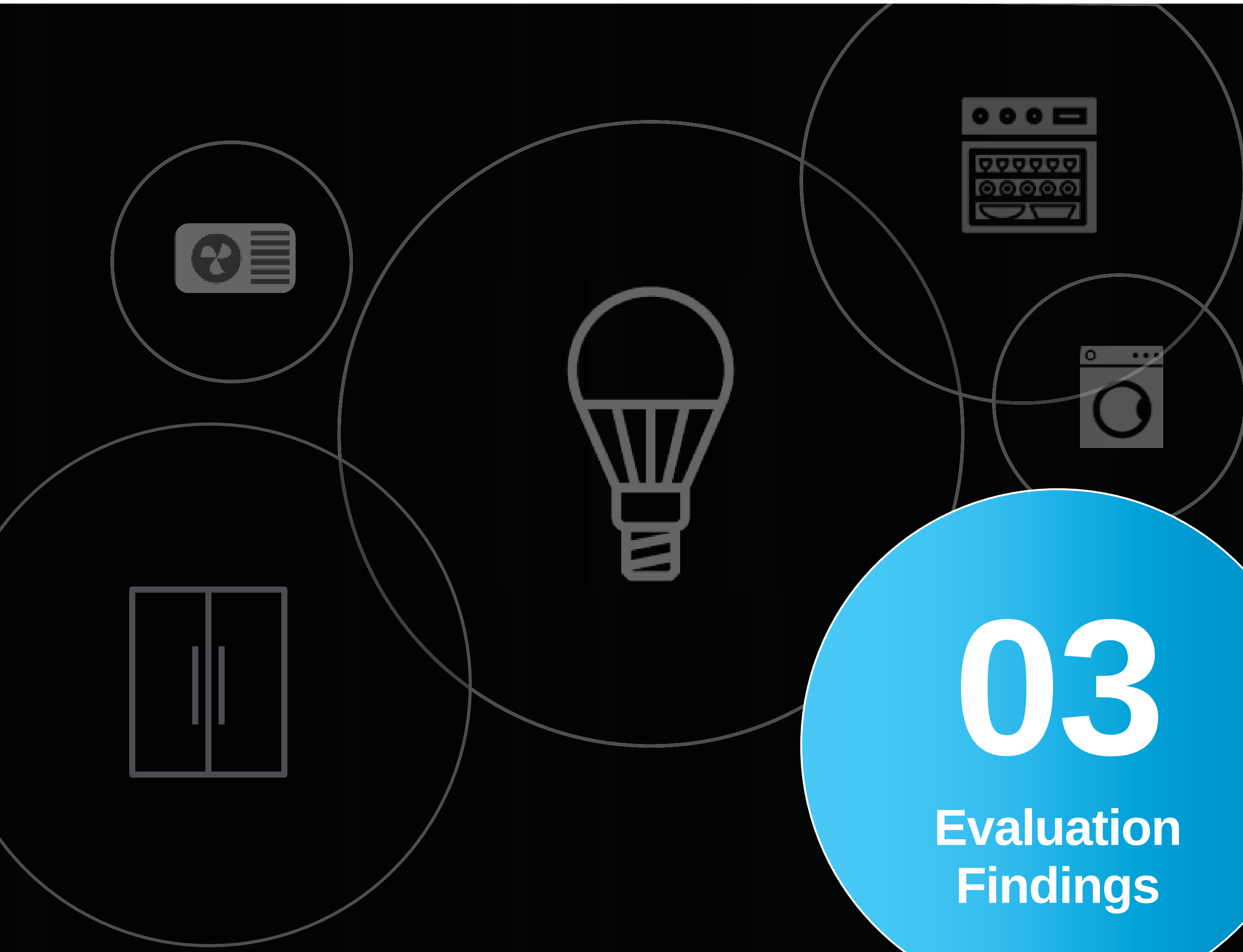
Uplift Analysis

Guidehouse investigated the effect of the HER Program on increasing participation in AEP Ohio's other residential energy efficiency programs that were promoted through the HER marketing modules in order to account for the possibility of double counted savings. For each customer group and cohort, Guidehouse compared the difference in the rate of participation between the treatment group and the control group in the 2019 program year via the post-only differences (POD) statistic.

In-Depth Staff Interviews

Guidehouse conducted in-depth interviews in January 2020. The purpose of these interviews was to understand changes in program design and implementation, collect feedback on research priorities, and understand stakeholders' experiences with the program.

Note: the evaluation did not address whether the tracking system is adequate for regulatory prudence reviews or corporate requirements.



03

Evaluation Findings

Evaluation Savings Results

527,107 high usage (HU) and low income participants were enrolled in the HER program during the 2019 program year. The majority of these customers are part of high usage cohorts, including one launched during 2019. The only non-high usage cohort is the PIPP cohort, made up of low-income customers.

Percent savings increased in 2019 compared to 2018 for all cohorts.

EE/PDR SEGMENT SAVINGS ESTIMATES

Cohort	Number of Participants[1] (a)	Estimated Daily Energy Savings (kWh) (b)	Estimated Percent Savings (c)	Estimated Total Energy Savings (MWh) (d)	Energy Savings Attributable to Other Programs[2] (MWh) (e)	Total Energy Savings (MWh) (f) = (d) - (e)	Total Peak Demand Savings[3] (kW) (g)
2010 HU	78,555	1.014	2.17%	28,421	0	28,421	3,695
2011 HU	13,212	0.894	1.46%	4,207	0	4,207	547
2013 HU	67,171	0.894	2.14%	21,253	27	21,226	2,759
Jan 2014 HU	48,568	0.502	1.40%	8,609	64	8,544	1,111
Aug 2014 HU	22,382	0.763	2.00%	5,941	74	5,867	763
2016 HU	38,215	0.464	1.08%	6,083	0	6,083	791
Feb 2017 HU	138,813	0.354	1.27%	16,951	0	16,951	2,204
Sep 2017 HU	20,854	0.134	0.34%	925	27	898	117
2018 HU	37,209	0.516	1.21%	6,182	0	6,182	804
2019 HU	54,646	0.038	0.11%	471	0	471	61
PIPP	7,482	0.993	2.48%	2,586	0	2,586	336
Total	**527,107**	-	-	**101,628**	**193**	**101,435**	**13,187**

Note: Totals may not sum due to rounding.
[1] AEP Ohio reported 524,337 active EE participants, which does not include customers who opted out prior to 2019.
[2] Excludes savings from the upstream lighting program. Double counted savings only occur for bulbs purchased by HER participants above and beyond those purchased by HER non-participants. Previous studies have found this to be a small impact.
[3] Demand savings are calculated using a 13 percent coincidence factor.

Evaluation Saving Results

(continued)

193,592 advanced metering infrastructure (AMI) participants were enrolled in the HER program during the 2019 program year. The majority of those participants come from the rolling AMI cohort that was launched in 2017.

Percent savings increased in 2019 compared to 2018 for the 2015, 2016, & 2017 AMI cohorts, and decreased for the 2010/2011 and 2014 AMI cohorts.

AMI SEGMENT SAVINGS ESTIMATES

Cohort	Number of Participants[1] (a)	Estimated Daily Energy Savings (kWh) (b)	Estimated Percent Savings (c)	Estimated Total Energy Savings (MWh) (d)	Energy Savings Attributable to Other Programs[2] (MWh) (e)	Total Energy Savings (MWh) (f) = (d) - (e)	Total Peak Demand Savings[3] (kW) (g)
2010/2011 AMI	25,883	0.196	0.68%	1,793	0	1,793	233
2013 AMI[4]	2,571	-0.734	-2.63%	0	0	0	0
2014 AMI	5,440	0.500	1.63%	943	12	931	121
2015 AMI	4,951	0.229	0.88%	379	8	371	48
2016 AMI	3,949	0.121	0.42%	159	0	159	21
2017 AMI	150,798	0.239	1.08%	10,226	76	10,151	1,320
Total	**193,592**	**-**	**-**	**13,501**	**96**	**13,405**	**1,743**

Note: Totals may not sum due to rounding.

[1] AEP Ohio reported 193,217 active AMI participants, which does not include customers who opted out prior to 2019.

[2] Excludes savings from the upstream lighting program. Double counted savings only occur for bulbs purchased by HER participants above and beyond those purchased by HER non-participants. Previous studies have found this to be a small impact.

[3] Demand savings are calculated using a 13 percent coincidence factor.

[4] Negative savings estimates are zeroed out when calculating total energy and peak demand savings.

Uplift Results

Guidehouse utilized the POD statistic to estimate the savings captured in the billing analysis for the HER Program that are already accounted for in the savings estimate for five other AEP Ohio programs. These programs were promoted through the HER marketing modules.

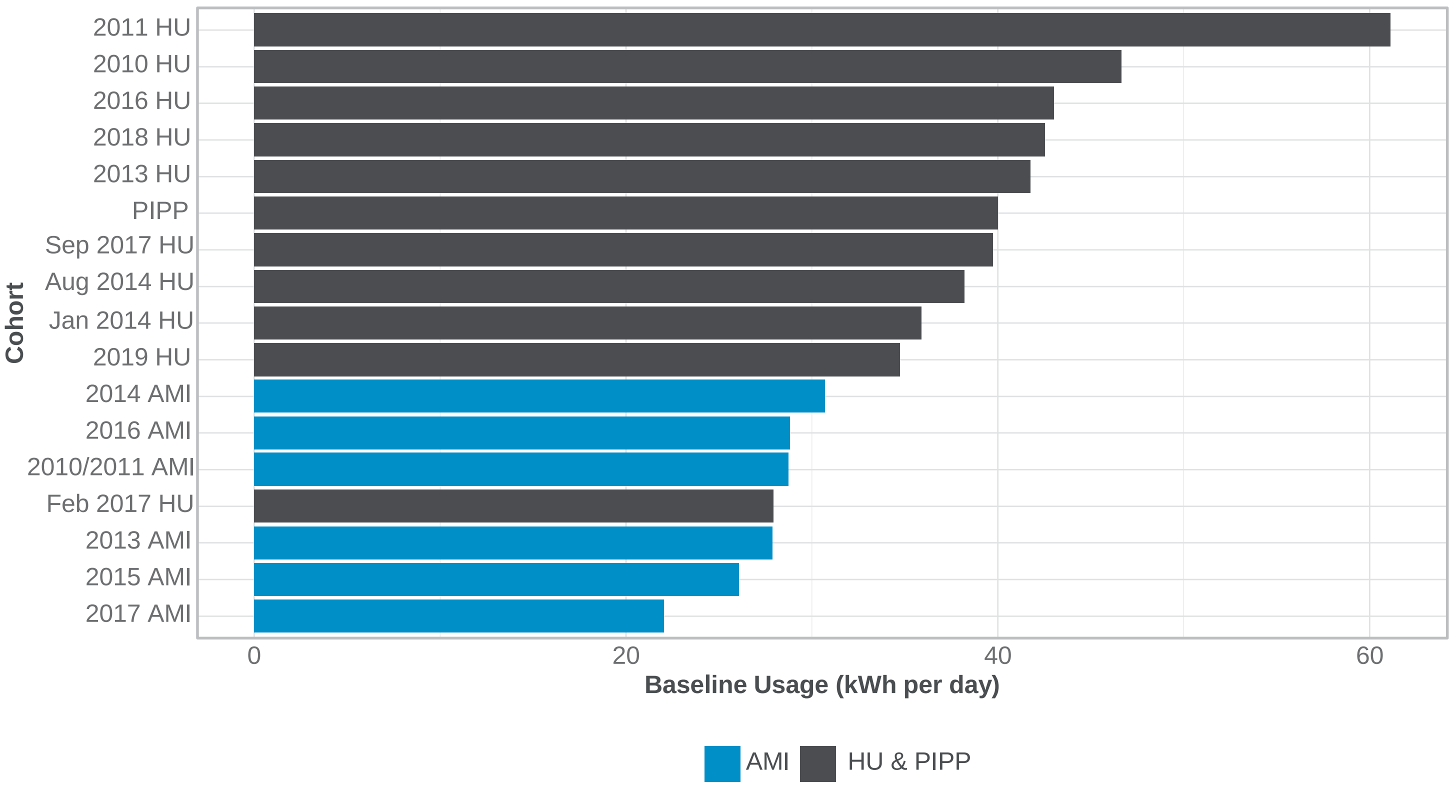
ENERGY SAVINGS ATTRIBUTABLE TO OTHER AEP OHIO EE/PDR PROGRAMS

Cohort	Appliance Recycling (kWh)	Community Assistance Program (kWh)	Efficient Products Rebates (kWh)	Efficient Products In-Home (kWh)	It's Your Power (kWh)	Total Uplift Energy Savings (kWh)
2010/2011 AMI	-57,642	-1,540	2,901	5,651	961	0
2013 AMI[1]	4,856	840	778	293	50	0
2014 AMI	8,306	2,227	-180	1,641	106	12,099
2015 AMI	3,702	2,169	141	2,003	126	8,140
2016 AMI	-8,878	-2,887	1,067	-473	148	0
2017 AMI	32,451	3,083	16,798	16,086	7,124	75,542
2010 HU	-63,916	-2,956	4,413	21,671	2,516	0
2011 HU	-13,966	-6,389	1,970	-68	-61	0
2013 HU	-35,210	3,789	12,599	43,115	2,649	26,943
Jan 2014 HU	40,634	618	11,058	12,109	-36	64,383
Aug 2014 HU	63,638	4,482	2,539	3,467	365	74,491
2016 HU	-80,251	-10,681	-1,077	6,108	1,141	0
Feb 2017 HU	-28,420	-6,876	13,319	5,638	1,094	0
Sep 2017 HU	23,308	1,153	1,231	428	960	27,080
2018 HU	-8,199	-1,392	162	3,050	2,293	0
2019 HU	-586	480	1,084	-2,274	-108	0
PIPP	-5,536	-6,047	-536	573	161	0
Total	**-125,708**	**-19,928**	**68,268**	**119,019**	**19,489**	**288,677**

Note: Totals may not sum due to rounding.
[1] The 2013 AMI cohort generated no savings, so no double-counted savings were removed.

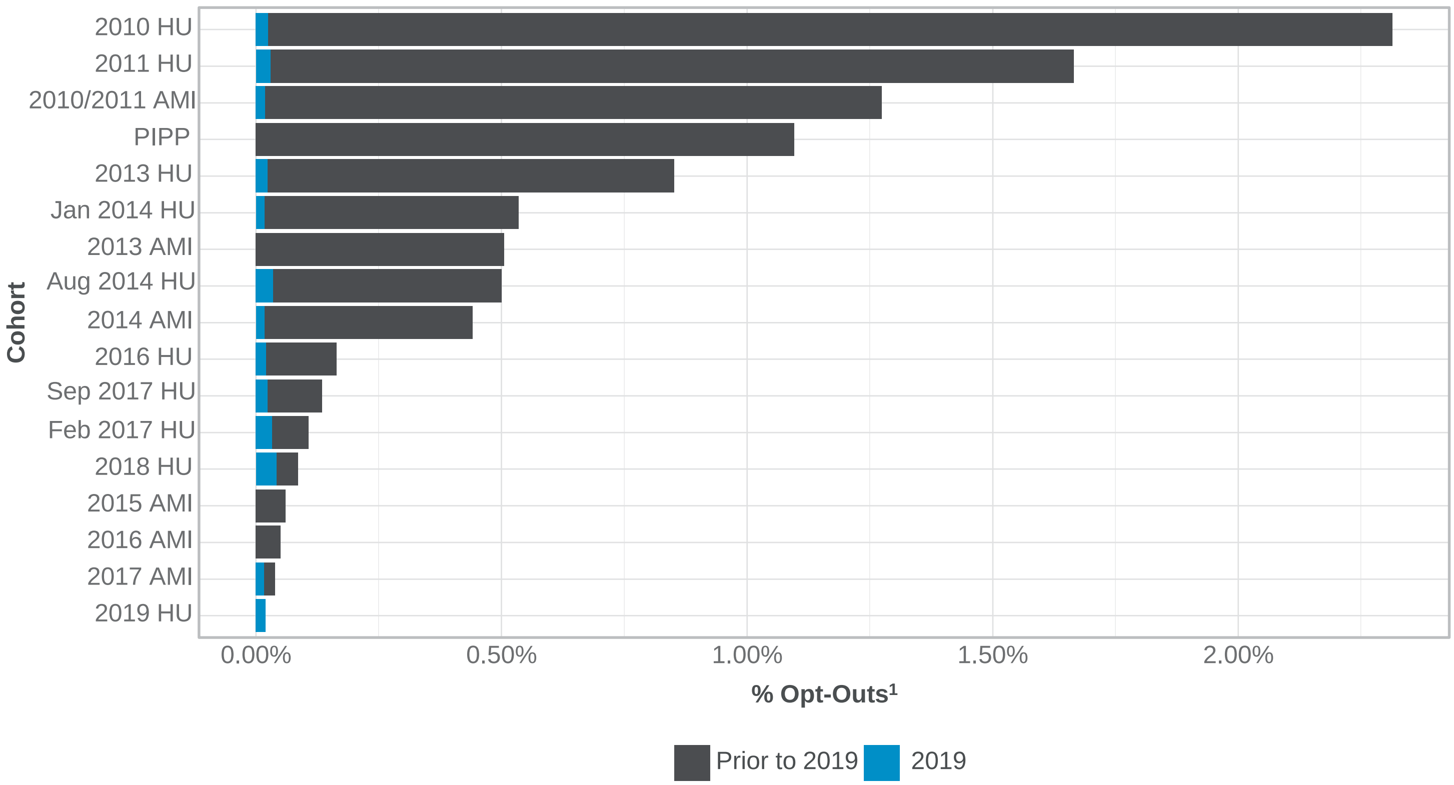
Participant Baseline Use

When creating a new refill cohort, Oracle selects the highest users amongst remaining customers. As the pool of non-HER customers shrinks, so do the available high users. The 2019 HU refill cohort has the second lowest average baseline use of all the HU & PIPP cohorts, with the February 2017 HU refill cohort having the lowest average baseline use. In general, the AMI cohorts have lower baseline use compared to the HU & PIPP cohorts.



Participant Opt-Outs

Participant opt-out rates remain low, with 2019 opt-outs rates below 0.05 percent for all cohorts. Cumulative opt-out rates are highest for the earliest cohorts, with the 2010 HU cohort having the highest cumulative opt-out rate. Most cohorts have cumulative opt-out rates below one percent.

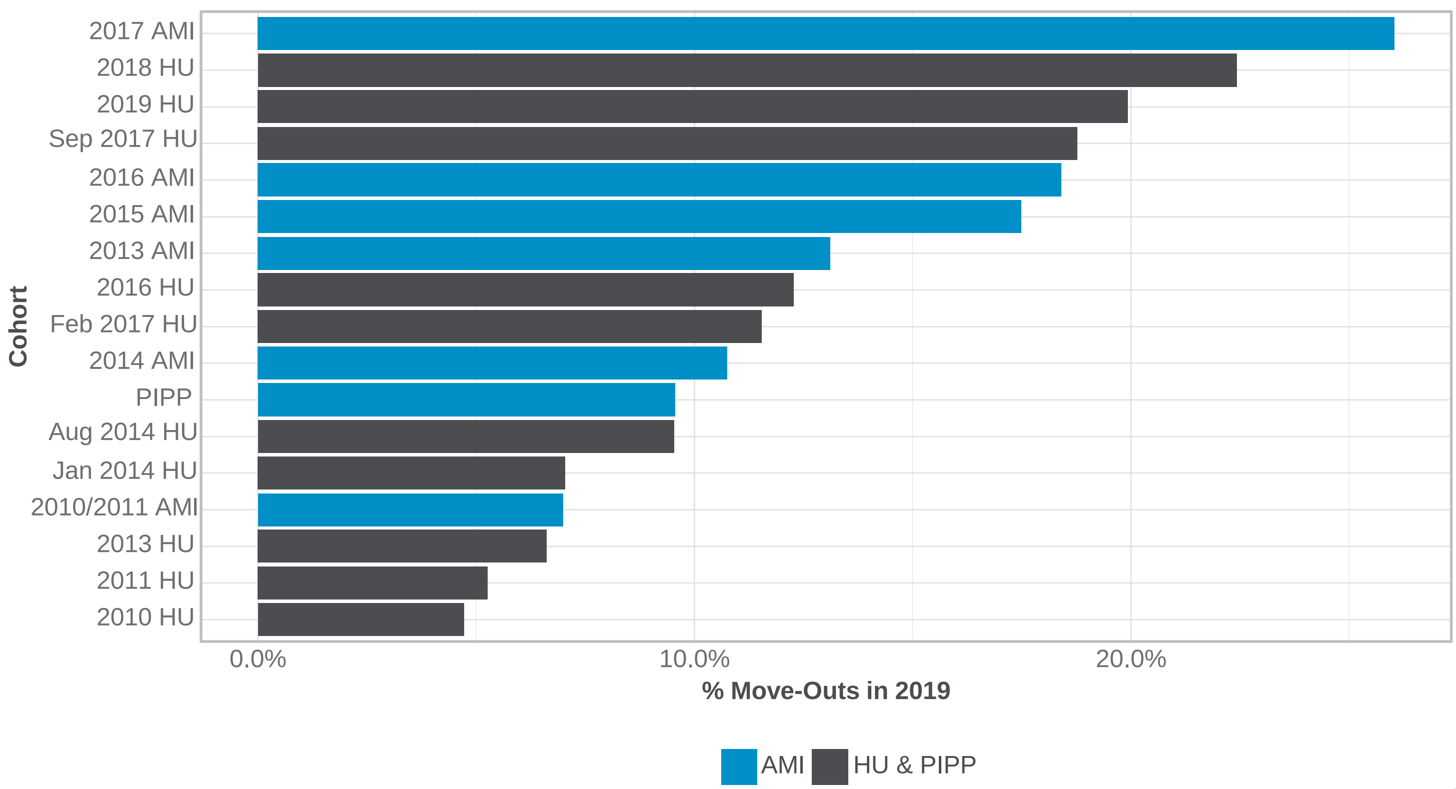


Note: Participants who opt-out remain in the analysis to preserve the RCT design.

[1] Opt-out rates exclude customers who became inactive prior to 2019.

Participant Move-Outs

Move-out rates in 2019 vary by cohort, with recent cohorts having higher move-out rates than earlier cohorts. Customers from the early cohorts who move frequently had already become inactive before 2019 (and therefore do not factor into the 2019 move-out rate). Nearly 20 percent of participants in the 2019 HU refill cohort moved out in 2019.



Notes: Participant & control accounts that become inactive are removed from the analysis after the inactivation date.
The RCT design remains valid so long as customers in the treatment and control groups move-out at approximately the same rate.

Cost-Effectiveness Review

This section addresses the cost-effectiveness of the HER Program.[1] Cost-effectiveness is assessed using the Total Resource Cost (TRC) test.

COST-EFFECTIVENESS MODEL INPUTS	
Item	**Value**
Measure Life	1
Participants	527,107
Annual Energy Savings (kWh)	101,435,378
Coincident Peak Savings (kW)	13,187
Third Party Implementation Costs	$1,234,094
Utility Administration Costs	$177,094
Utility Incentive Costs	$0
Participant Contribution to Incremental Measure Costs	$0

Based on these inputs, the TRC ratio is 2.8. Therefore, the program passes the TRC test. Results are presented for the Total Resource Cost test, the Participant Cost Test, the Ratepayer Impact Measure Test, and the Utility Cost Test.

COST-EFFECTIVENESS RESULTS	
Benefit-Cost Ratio–Test Results	**Ratio**
Total Resource Cost	2.8
Participant Cost Test	N/A
Ratepayer Impact Measure	0.3
Utility Cost Test	2.8

Additional benefits related to the reduction of greenhouse gas emissions have not been quantified in the calculation of the TRC.

[1] The cost effectiveness analysis excludes the AMI segment.

PROCESS

Program Operation Evaluation Results

This section provides the process findings for the 2019 HER Program.

The following data collection activities inform the process evaluation:

Interviews with Program and Implementation Staff

The interviews with program and implementation staff indicate the HER Program is running exceptionally well. The administration of the program is functioning as expected with continual effort to enhance the delivery of the program.

Customer satisfaction remains high, according to the program and implementation managers. Customer dissatisfaction, though rare, is often related to a lack of accurate information in their profile, according to the program manager. To encourage more customers to update their profiles, the link to update profile was moved from the back to the front of the HER in 2019.

Both the program and implementation staff highlighted the program's repeated ability to exceed savings goals. Despite this fact, both mentioned continued efforts to increase the number of email addresses available for receiving eHERs and discussions about customer segmentation for the marketing modules included in the HERs.

At this time there are no problems implementing the program.

04

Recommendations

Recommendations

FINDING 1

Guidehouse's analysis shows recent participant cohorts have a lower average daily energy usage and, relatedly, a lower average electricity savings.

Evidence from this analysis also suggests some of the more recent cohorts may have a lower relative level of electric savings beyond the initial ramp-up period, like the February & September 2017 HU cohorts.

RECOMMENDATION 1

Guidehouse recommends AEP Ohio continue the HER Program as long as regularly reported electric savings remain cost-effective, and monitor the incremental cost and savings of each new cohort introduced to ensure individual cohorts contribute to the cost-effectiveness of the program as a whole.

FINDING 2

The 2019 evaluation yielded total energy savings more than 35 percent above the program's annual goals.

RECOMMENDATION 2

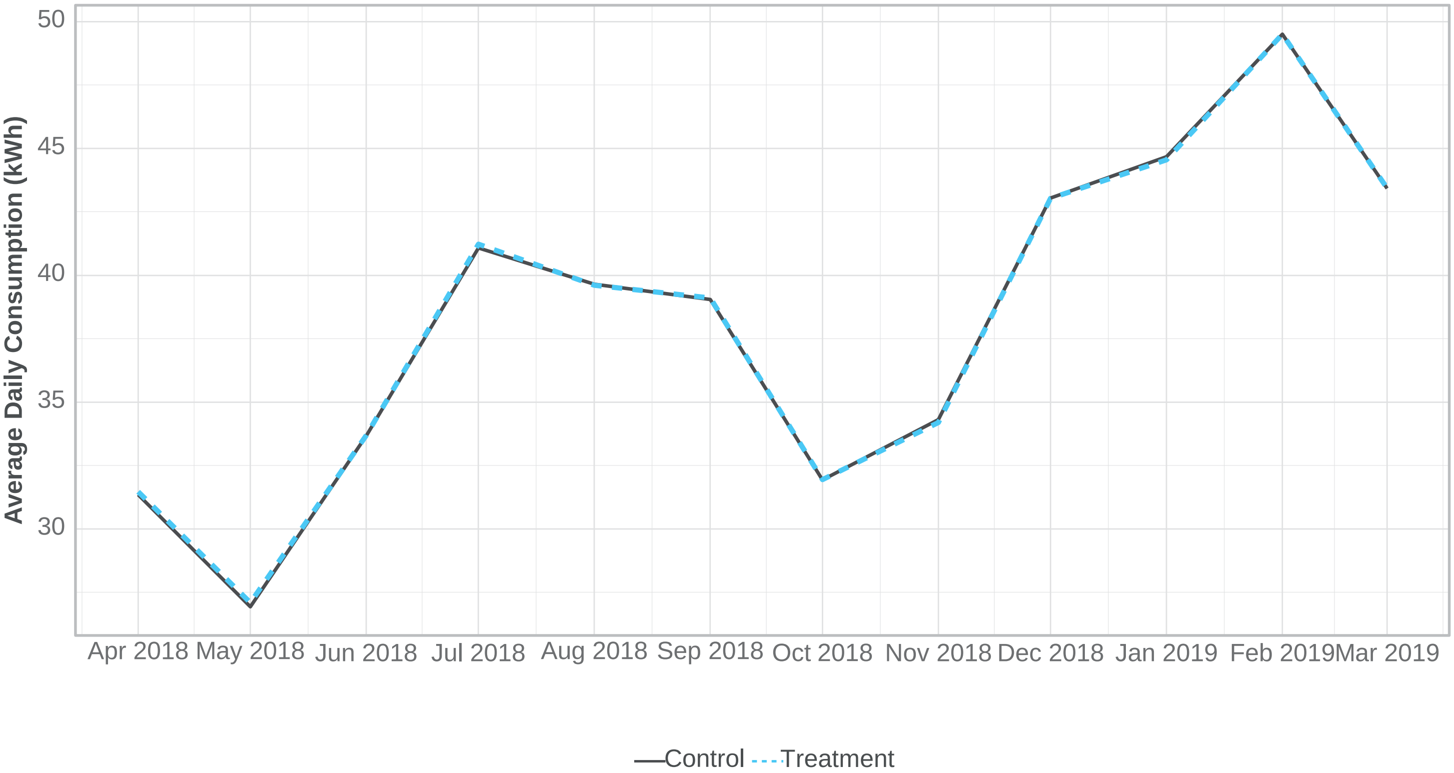
AEP Ohio should delay deployment of another refill cohort by 1 or 2 years. Natural growth in recently launched cohorts will likely compensate for reduced savings due to customers moving out. Delaying deployment will increase the pool of available high users, who are likely to generate higher energy savings.

05

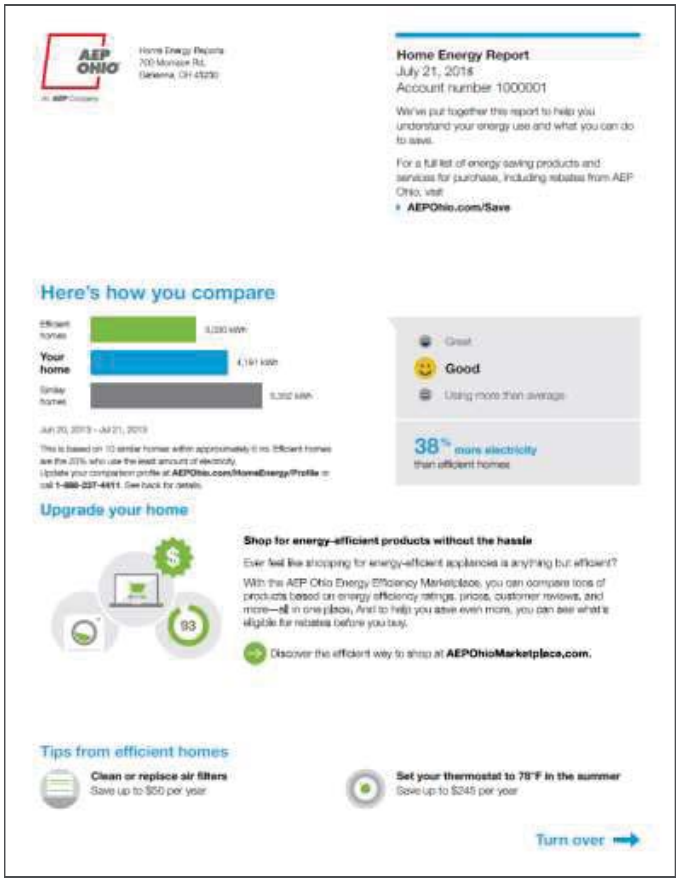
Appendix

2019 HU Cohort Pre-Period Comparison

The first time a cohort is evaluated, average use in the pre-program period is compared for the treatment and control households to assess the validity of the RCT. The average energy use and the distribution of energy use by month for treatment households in the pre-treatment period is comparable to control households for the 2019 HU cohort.

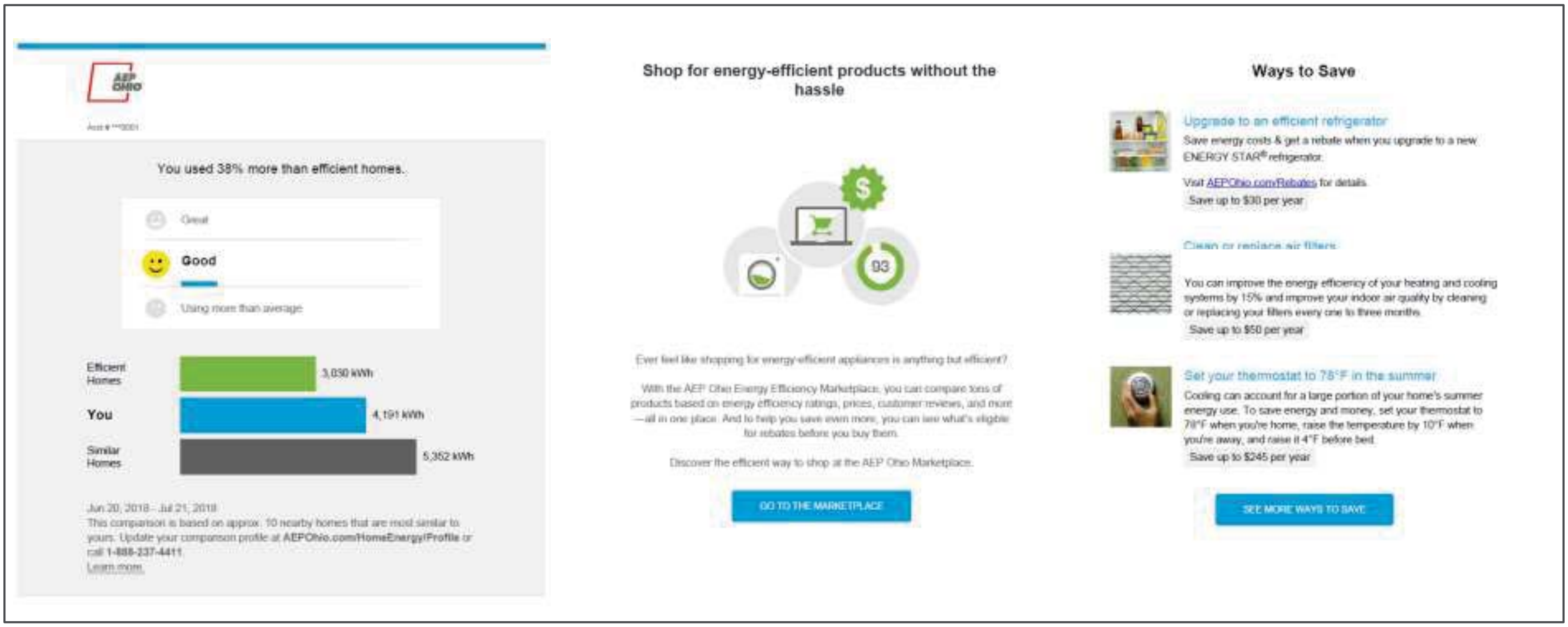


Example Printed Home Energy Report (pHER)



Source: AEP Ohio

Example Emailed Home Energy Report (eHER)



Source: AEP Ohio