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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	6,800	21.9	0.004	148,743	26.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 3 Watt	Light bulb	33,320	21.0	0.004	698,275	124.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 4 Watt	Light bulb	62,488	34.1	0.006	2,132,988	380.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 5 Watt	Light bulb	30,589	33.3	0.006	1,018,614	181.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 6 Watt	Light bulb	23,200	32.4	0.006	751,640	134.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 7 Watt	Light bulb	30,409	31.6	0.006	961,652	171.4	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 8 Watt	Light bulb	235,735	49.5	0.009	11,659,260	2077.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 9 Watt	Light bulb	18,329	48.5	0.009	889,466	158.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 10 Watt	Light bulb	140,560	50.6	0.009	7,105,660	1266.4	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 11 Watt	Light bulb	14,243	60.9	0.011	866,717	154.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 12 Watt	Light bulb	8,418	59.9	0.011	504,507	89.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 13 Watt	Light bulb	12,785	59.0	0.011	753,941	134.4	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 14 Watt	Light bulb	11,771	58.1	0.010	683,434	121.8	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 15 Watt	Light bulb	3,192	57.4	0.010	183,170	32.7	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 16 Watt	Light bulb	2,435	79.9	0.014	194,541	34.7	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 17 Watt	Light bulb	1,344	78.9	0.014	106,095	18.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 18 Watt	Light bulb	2,376	78.0	0.014	185,293	33.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 19 Watt	Light bulb	1,782	77.0	0.014	137,275	24.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 23 Watt	Light bulb	239	120.8	0.022	28,867	5.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Specialty LED 26 Watt	Light bulb	99	117.9	0.021	11,675	2.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 4 Watt	Light bulb	20,607	23.8	0.004	489,952	87.3	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 5 Watt	Light bulb	167,347	22.9	0.004	3,826,318	681.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 6 Watt	Light bulb	121,198	21.9	0.004	2,653,958	473.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 7 Watt	Light bulb	110,469	21.1	0.004	2,327,250	414.8	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 8 Watt	Light bulb	392,588	33.3	0.006	13,074,537	2330.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 9 Watt	Light bulb	1,134,499	32.5	0.006	36,820,200	6562.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 10 Watt	Light bulb	240,422	31.5	0.006	7,569,063	1349.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 11 Watt	Light bulb	10,649	40.3	0.007	428,951	76.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 12 Watt	Light bulb	22,909	39.0	0.007	893,280	159.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 13 Watt	Light bulb	11,688	38.2	0.007	446,262	79.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 14 Watt	Light bulb	858	37.1	0.007	31,792	5.7	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 15 Watt	Light bulb	56,931	36.1	0.006	2,058,005	366.8	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 16 Watt	Light bulb	11,867	53.4	0.010	633,132	112.8	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 17 Watt	Light bulb	36,970	52.3	0.009	1,933,896	344.7	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 18 Watt	Light bulb	16,670	51.8	0.009	863,918	154.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 23 Watt	Light bulb	505	120.8	0.022	60,995	10.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	Standard LED 40 Watt	Light bulb	3	104.6	0.019	314	0.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	LED Seasonal	Light bulb	38	0.0	0.000	-	0.0	No direct savings
	Room Air Purifiers	Air purifier	7	29.6	0.004	207	0.0	NEEP Technical Reference Manual - page 234
	Clothes Washer Tier 1/2	Washer	1,614	202.0	0.028	325,422	45.8	Draft Ohio 2010 Technical Reference Manual - Page 59
	Clothes Washer Tier N/A	Washer	2	0.0	0.000	-	0.0	Draft Ohio 2010 Technical Reference Manual - Page 59
	Clothes Washer Tier 3	Washer	667	233.0	0.032	155,178	21.8	Draft Ohio 2010 Technical Reference Manual - Page 59
	Dehumidifier > 25 to ≤35 Pints/Day	Dehumidifier	194	117.0	0.027	22,347	5.2	Draft Ohio 2010 Technical Reference Manual - Page 64
	Dehumidifier > 54 to ≤ 75 Pints/Day	Dehumidifier	28	213.0	0.048	5,964	1.3	Draft Ohio 2010 Technical Reference Manual - Page 64
	Dehumidifier > 35 to ≤45 Pints/Day	Dehumidifier	489	297.0	0.068	145,233	33.3	Draft Ohio 2010 Technical Reference Manual - Page 64
	Dehumidifier > 45 to ≤ 54 Pints/Day	Dehumidifier	953	185.0	0.042	176,120	40.0	Draft Ohio 2010 Technical Reference Manual - Page 64
	Dehumidifier > 75	Dehumidifier	8	374.0	0.085	2,992	0.7	Draft Ohio 2010 Technical Reference Manual - Page 64
	Refrigerator - Bottom Freezer	Refrigerator	2,099	100.4	0.022	240,630	44.4	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator - Top Freezer	Refrigerator	406	99.5	0.018	40,400	7.3	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator - Side-by-Side	Refrigerator	198	115.8	0.025	27,195	4.9	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator - Freezerless and Single Door	Refrigerator	8	52.3	0.018	318	0.1	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator - N/A	Refrigerator	2	100.0	0.018	200	0.0	Draft Ohio 2010 Technical Reference Manual - Page 53
	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	93	1297.0	0.180	119,324	16.6	Draft Ohio 2010 Technical Reference Manual - Page 86
	Heat Pump Water Heater - Gas Heat	Heat pump	131	2076.0	0.280	271,956	36.7	Draft Ohio 2010 Technical Reference Manual - Page 86

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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	4,615	487.7	0.068	2,250,523	314.4	IL - Illinois Technical Reference Manual- - Page 152
	Air Conditioner	Air conditioner	2,060	283.5	0.230	584,076	473.0	Draft Ohio 2010 Technical Reference Manual - Page 30
	Air Source Heat Pump	Heat pump	328	641.1	0.203	210,271	66.5	Draft Ohio 2010 Technical Reference Manual - Page 33
	Ductless Mini-Split	Heat pump	119	1205.9	0.132	143,503	15.7	Draft Ohio 2010 Technical Reference Manual - Page 33
	Ground Source Heat Pump	Heat pump	21	3160.7	0.552	66,374	11.6	Draft Ohio 2010 Technical Reference Manual - Page 82
	Pool Pump	Pool Pump	352	1170.0	1.730	411,840	609.0	Draft Ohio 2010 Technical Reference Manual - Page 118
	Faucet Aerators	Faucet aerator	12,462	16.1	0.002	200,564	25.0	Draft Ohio 2010 Technical Reference Manual - Page 89
	Low Flow Showerheads	Low flow showerhead	6,048	174.8	0.022	1,056,932	135.2	Draft Ohio 2010 Technical Reference Manual - Page 93
	LED Night Light	Night light	19,132	16.0	0.000	306,799	0.0	Based on 2017 Navigant Evaluation Result
	7-Plug Smart Strip	Smart strip	4,303	103.1	0.009	443,497	39.7	Draft Ohio 2010 Technical Reference Manual - Page 76
	TOTAL					**110,371,941**	**20,332.8**	
Appliance Recycling	Freezer	Freezer	3,266	1,244.4	0.200	4,064,210	653.2	Draft Ohio 2010 Technical Reference Manual - Page 23
	Refrigerator	Refrigerator	15,544	1,376.2	0.220	21,390,876	3,419.7	Draft Ohio 2010 Technical Reference Manual - Page 23
	TOTAL					**25,455,086**	**4,072.9**	
Efficiency Crafted New Homes	Energy Star Home	Energy Star home	2,011	3,124.8	1.5	**6,283,917**	**3,010.6**	Residential Energy Modeling
New Manufactured Homes	New Manufactured Homes	Manufactured Home	58	6,870.3	2.6	**398,478**	**153.1**	Residential Energy Modeling
E3Smart	HW Temp Setback	Temp setback	602	81.6	0.009	49,123	5.4	Standard Engineering Calculation
	Bathroom Faucet Aerator	Faucet aerator	3,259	94.4	0.012	307,638	38.4	Draft Ohio 2010 Technical Reference Manual - Page 89
	Kitchen Faucet Aerator	Faucet aerator	3,123	55.1	0.007	172,210	21.5	Draft Ohio 2010 Technical Reference Manual - Page 89
	Low Flow Showerhead	Low flow showerhead	3,946	280.3	0.036	1,105,906	141.5	Draft Ohio 2010 Technical Reference Manual - Page 93
	11 Watt LED Replacing 13W CFL	Light bulb	794	2.1	0.000	1,669	0.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED 23 Replacing 23W CFL	Light bulb	605	12.6	0.002	7,630	0.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED Replacing 40W	Light bulb	949	17.6	0.003	16,696	3.0	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED Replacing 60W	Light bulb	4,383	31.3	0.006	137,090	24.4	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED Replacing 75W	Light bulb	2,129	41.1	0.007	87,400	15.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	11 Watt LED Replacing 100W	Light bulb	1,827	59.6	0.011	108,932	19.4	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 13W CFL	Light bulb	1,825	4.2	0.001	7,672	0.9	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 23W CFL	Light bulb	1,196	14.7	0.002	17,598	2.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 40W	Light bulb	3,498	19.5	0.003	68,381	12.2	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 60W	Light bulb	12,255	33.2	0.006	407,266	72.6	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 75W	Light bulb	3,274	43.0	0.008	140,805	25.1	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	9 Watt LED Replacing 100W	Light bulb	1,958	61.6	0.011	120,570	21.5	Based on Draft Ohio 2010 Technical Reference Manual - Page 11
	LED Night Light	Light bulb	6,117	20.6	0.000	125,949	-	Based on 2013 Navigant Evaluation Result
	Weather Stripping	Square foot	8,319	11.1	0.001	92,341	6.6	Based on 2013 Navigant Evaluation Result
	Allocated Kits[2]	Kit	4,470	68.0	0.009	303,889	42.2	Calculation based on Program Year data
	TOTAL					**3,278,765**	**453.6**	
Intelligent Homes	Mobile Application	Participant	23,471	-	0.000	-	-	Proprietary Regression Model
	Energy Bridge	Participant	9,816	-	0.000	-	-	Proprietary Regression Model
	Connected Thermostat	Participant	2,153	358.4	0.662	768,688	1,420.0	Proprietary Regression Model
	TOTAL					**768,688**	**1,420.0**	
Behavioral	Behavioral	Participant	531,283	140.0	0.018	89,090,065	11,581.0	Proprietary Regression Model
	Cross Participation Reduction[3]	Participant	531,283	0.99	0.0001	(504,103)	(65.5)	Calculation based on Program Participation T-Tests
	TOTAL					**88,585,962**	**11,515.5**	

[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

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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	Retirement of additional freezer	Freezer	1	1,244.0	0.200	1,244	0.20	Draft Ohio 2010 Technical Reference Manual - Page 23
	Freezer replacement 9-15 upright	Freezer	18	882.2	0.135	15,880	2.43	Draft Ohio 2010 Technical Reference Manual - Page 23
	Freezer replacement 16-18 upright	Freezer	114	882.2	0.135	100,571	15.38	Draft Ohio 2010 Technical Reference Manual - Page 23
	Freezer replacement 16-18 upright	Freezer	129	47.0	0.008	6,063	1.06	Energy Star Qualified Product List
	Freezer replacement 19-21 upright	Freezer	26	882.2	0.135	22,937	3.51	Draft Ohio 2010 Technical Reference Manual - Page 23
	Freezer replacement 5-10 Chest	Freezer	69	882.2	0.135	60,872	9.31	Draft Ohio 2010 Technical Reference Manual - Page 23
	Freezer replacement 11-15 Chest	Freezer	74	882.2	0.135	65,283	9.98	Draft Ohio 2010 Technical Reference Manual - Page 23
	Freezer replacement 11-15 Chest	Freezer	14	26.0	0.005	364	0.06	Energy Star Qualified Product List
	Refrigerator replacement 14-16 TF	Refrigerator	203	976.0	0.156	198,128	31.67	Draft Ohio 2010 Technical Reference Manual - Page 23
	Refrigerator replacement 14-16 TF	Refrigerator	363	100.0	0.018	36,300	6.53	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator replacement 17-19 TF	Refrigerator	552	976.0	0.156	538,752	86.11	Draft Ohio 2010 Technical Reference Manual - Page 23
	Refrigerator replacement 17-19 TF	Refrigerator	1,235	100.0	0.018	123,500	22.23	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator replacement 20-22 TF	Refrigerator	202	976.0	0.156	197,152	31.51	Draft Ohio 2010 Technical Reference Manual - Page 23
	Refrigerator replacement 20-22 TF	Refrigerator	126	100.0	0.018	12,600	2.27	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator replacement 19-22 BF	Refrigerator	105	976.0	0.156	102,480	16.38	Draft Ohio 2010 Technical Reference Manual - Page 23
	Refrigerator replacement 19-22 BF	Refrigerator	44	119.0	0.021	5,236	0.92	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator replacement 20-23 SBS	Refrigerator	53	976.0	0.156	51,728	8.27	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator replacement 20-23 SBS	Refrigerator	233	142.0	0.025	33,086	5.83	Draft Ohio 2010 Technical Reference Manual - Page 53
	Refrigerator replacement 24-26 SBS	Refrigerator	190	976.0	0.156	185,440	29.64	Draft Ohio 2010 Technical Reference Manual - Page 23
	Refrigerator replacement 24-26 SBS	Refrigerator	139	142.0	0.025	19,738	3.48	Draft Ohio 2010 Technical Reference Manual - Page 53
	Audits and Metering Fees	Unit	5,333	-	0.000	-	0.00	No direct savings
	Miscellaneous approved items	Unit	(8)	-	0.000	-	0.00	Health and Safety - No savings acquired
	Air Source Heat Pump	Heat pump	24	626.5	0.129	15,036	3.09	Draft Ohio 2010 Technical Reference Manual - Page 33
	DHW Temp Setback	Temp setback	17	146.0	0.000	2,482	0.00	Based on 2012 Navigant Evaluation Result
	HVAC Tune Up	Unit	7	73.7	0.000	516	0.00	Draft Ohio 2010 Technical Reference Manual - Page 26
	HW Tank Wrap	Unit	47	77.3	0.009	3,634	0.41	Draft Ohio 2010 Technical Reference Manual - Page 131
	Install bathroom vent fan (Energy Star)	Fan	71	44.3	0.010	3,145	0.72	NEEP TRM - Page 161
	Faucet Aerator	Faucet aerator	831	24.5	0.003	20,335	2.54	Draft Ohio 2010 Technical Reference Manual - Page 89
	Low flow showerhead	Low flow showerhead	598	52.6	0.006	31,440	3.59	Draft Ohio 2010 Technical Reference Manual - Page 93
	Replace electric water heater	Water heater	29	411.7	0.023	11,940	0.67	http://energy.gov/eere/buildings/residential-buildings-integration
	Remove Space Heater	Space heater	3	1,435.4	0.000	4,306	0.00	Based on Draft Ohio 2010 Technical Reference Manual - Page 33
	Replace wall switch (single pole)	Wall switch	4	-	0.000	-	0.00	No direct savings
	Smart Strips	Smart strip	3,668	81.9	0.000	300,448	0.00	Draft Ohio 2010 Technical Reference Manual - Page 76
	LED (60 w replacement) indoor	Light bulb	30,348	33.2	0.006	1,008,111	179.67	Based on Draft Ohio 2010 Technical Reference Manual - Page 12
	LED (100 w replacement) indoor	Light bulb	5,827	54.7	0.010	318,893	56.83	Based on Draft Ohio 2010 Technical Reference Manual - Page 13
	LED (40 w candelabra replacement) indoor	Light bulb	7,587	34.2	0.006	259,552	46.26	Based on Draft Ohio 2010 Technical Reference Manual - Page 14
	LED (40 w globe replacement) indoor	Light bulb	2,588	34.2	0.006	88,399	15.76	Based on Draft Ohio 2010 Technical Reference Manual - Page 15
	LED (60 w replacement) outdoor	Light bulb	362	33.2	0.000	12,030	0.00	Based on Draft Ohio 2010 Technical Reference Manual - Page 16
	LED (75 w floodlight replacement) outdoor	Light bulb	951	60.6	0.000	57,631	0.00	Based on Draft Ohio 2010 Technical Reference Manual - Page 17
	LED (75 w replacement) indoor	Light bulb	2,928	39.1	0.007	114,398	20.39	Based on Draft Ohio 2010 Technical Reference Manual - Page 18
	LED (3-way replacement)indoor	Light bulb	1,574	82.0	0.015	129,068	23.00	Based on Draft Ohio 2010 Technical Reference Manual - Page 19
	Closable Foundation Vents	Unit	25	-	0.000	-	0.00	No direct savings
	Install 12x12 gable vent	Unit	9	-	0.000	-	0.00	No direct savings
	Install 12x18 gable vent	Unit	11	-	0.000	-	0.00	No direct savings
	Install 12` roof vent (average)	Unit	57	-	0.000	-	0.00	No direct savings
	Install 12` roof vent (difficult)	Unit	15	-	0.000	-	0.00	No direct savings
	Install 8` or 9` roof vent	Unit	15	-	0.000	-	0.00	No direct savings
	Duct Sealing per CFM reduction - Heat Pump	CFM reduced	295	2.5	0.000	735	0.14	Draft Ohio 2010 Technical Reference Manual - Page 108
	Duct Sealing per CFM reduction - Electric Heat No AC	CFM reduced	220	3.8	0.000	832	0.10	Draft Ohio 2010 Technical Reference Manual - Page 108
	Duct Sealing per CFM reduction - Electric Heat w/AC	CFM reduced	682	3.8	0.000	2,578	0.32	Draft Ohio 2010 Technical Reference Manual - Page 108
	Duct Insulation R-7 per sq ft	Square footage installed	838	3.1	0.000	2,584	0.29	Draft Ohio 2010 Technical Reference Manual - Page 108
	Shell Air Sealing per CFM reduction - Heat Pump	CFM reduced	2,560	1.8	0.000	4,487	0.28	Draft Ohio 2010 Technical Reference Manual - Page 104
	Shell Air Sealing per CFM reduction - Electric Heat No AC	CFM reduced	10,947	1.6	0.000	17,512	0.89	Draft Ohio 2010 Technical Reference Manual - Page 104
	Shell Air Sealing per CFM reduction - Electric Heat w/AC	CFM reduced	7,157	1.9	0.000	13,385	0.78	Draft Ohio 2010 Technical Reference Manual - Page 104

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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	Attic Insulation (R-11 -> R-38) - Central Air Conditioning	Square footage installed	21,201	0.0	0.000	598	0.54	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-11 -> R-38) - Heat Pump	Square footage installed	3,847	1.2	0.000	4,554	0.10	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-11 -> R-38) - Electric Heat No AC	Square footage installed	1,888	1.9	0.000	3,570	0.05	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-11 -> R-38) - Electric Heat w/AC	Square footage installed	6,993	1.8	0.000	12,556	0.18	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-19 -> R-38) - Central Air Conditioning	Square footage installed	23,281	0.0	0.000	262	0.24	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-19 -> R-38) - Heat Pump	Square footage installed	960	0.5	0.000	463	0.01	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-19 -> R-38) - Electric Heat No AC	Square footage installed	2,026	0.8	0.000	1,561	0.02	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-19 -> R-38) - Electric Heat w/AC	Square footage installed	6,966	0.7	0.000	4,914	0.07	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-28 -> R-38) - Central Air Conditioning	Square footage installed	1,430	-	0.000	6	0.01	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-28 -> R-38) - Heat Pump	Square footage installed	2,240	0.2	0.000	386	0.01	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-5 -> R-38) - Central Air Conditioning	Square footage installed	15,590	0.1	0.000	1,182	1.07	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R-5 -> R-38) - Electric Heat w/AC	Square footage installed	3,058	5.1	0.000	15,550	0.21	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R44) - Central Air Conditioning	Square footage installed	292	0.1	0.000	23	0.02	Draft Ohio 2010 Technical Reference Manual - Page 36
	Attic Insulation (R44) - Heat Pump	Square footage installed	3,311	5.1	0.000	17,014	0.23	Draft Ohio 2010 Technical Reference Manual - Page 36
	Install floor insulation (crawlspace) - Central Air Conditioning	Square footage installed	786	0.1	0.000	47	0.04	Based on Draft Ohio 2010 Technical Reference Manual - Page 36
	Install floor insulation (crawlspace) - Heat Pump	Square footage installed	2,025	2.5	0.000	5,103	0.01	Based on Draft Ohio 2010 Technical Reference Manual - Page 36
	Install floor insulation (crawlspace)-Electric Heat No AC	Square footage installed	800	4.0	0.000	3,221	0.00	Based on Draft Ohio 2010 Technical Reference Manual - Page 36
	Install floor insulation (crawlspace)-Electric Heat w/AC	Square footage installed	388	4.0	0.000	1,562	0.00	Based on Draft Ohio 2010 Technical Reference Manual - Page 36
	Mobile Home Belly Patch	Unit	11,994	-	0.000	-	0.00	No direct savings
	Mobile Home Roof Coat	Unit	2,624	-	0.000	-	0.00	No direct savings
	Mobile Home Underneath Vapor Retarder	Unit	31,100	-	0.000	-	0.00	No direct savings
	R15 Mobile Home blown FG 4` - Central Air Conditioning	Square footage installed	(740)	0.1	0.000	(43)	(0.04)	Draft Ohio 2010 Technical Reference Manual - Page 126
	R15 Mobile Home blown FG 4` - Heat Pump	Square footage installed	980	2.4	0.000	2,395	0.05	Draft Ohio 2010 Technical Reference Manual - Page 126
	R15 Mobile Home blown FG 4` - Electric Heat No AC	Square footage installed	1,444	3.9	0.000	5,637	0.08	Draft Ohio 2010 Technical Reference Manual - Page 126
	R15 Mobile Home blown FG 4` - Electric Heat w/AC	Square footage installed	3,140	3.9	0.000	12,258	0.17	Draft Ohio 2010 Technical Reference Manual - Page 126
	R23 Mobile Home blown FG 6` - Central Air Conditioning	Square footage installed	(1,809)	0.1	0.000	(124)	(0.11)	Draft Ohio 2010 Technical Reference Manual - Page 126
	R23 Mobile Home blown FG 6` - Heat Pump	Square footage installed	2,688	4.1	0.000	11,025	0.17	Draft Ohio 2010 Technical Reference Manual - Page 126
	R23 Mobile Home blown FG 6` - Electric Heat No AC	Square footage installed	5,887	4.6	0.000	26,810	0.21	Draft Ohio 2010 Technical Reference Manual - Page 126
	R23 Mobile Home blown FG 6` - Electric Heat w/AC	Square footage installed	6,900	4.6	0.000	31,620	0.43	Draft Ohio 2010 Technical Reference Manual - Page 126
	R30 Mobile home blown FG 8` - Heat Pump	Square footage installed	5,526	3.5	0.000	19,544	0.36	Draft Ohio 2010 Technical Reference Manual - Page 126
	R30 Mobile home blown FG 8` - Electric Heat No AC	Square footage installed	3,113	4.9	0.000	15,138	0.16	Draft Ohio 2010 Technical Reference Manual - Page 126
	R30 Mobile home blown FG 8` - Electric Heat w/AC	Square footage installed	2,955	4.9	0.000	14,419	0.20	Draft Ohio 2010 Technical Reference Manual - Page 126
	R38 Mobile Home blown FG 12` - Heat Pump	Square footage installed	495	8.2	0.000	4,055	0.03	Draft Ohio 2010 Technical Reference Manual - Page 126
	R38 Mobile Home blown FG 12` - Electric Heat No AC	Square footage installed	1,554	5.0	0.000	7,784	0.00	Draft Ohio 2010 Technical Reference Manual - Page 126
	R38 Mobile Home blown FG 12` - Electric Heat w /AC	Square footage installed	655	5.1	0.000	3,331	0.05	Draft Ohio 2010 Technical Reference Manual - Page 126
	R45 Mobile home blown FG 12` - Heat Pump	Square footage installed	650	3.3	0.000	2,118	0.05	Draft Ohio 2010 Technical Reference Manual - Page 126
	R45 Mobile home blown FG 12` - Electric Heat w/AC	Square footage installed	3,416	5.2	0.000	17,780	0.24	Draft Ohio 2010 Technical Reference Manual - Page 126
	Wall insulation- Framed siding(target R11) - Central Air Conditioning	Square footage installed	21,433	0.1	0.000	1,287	1.17	Draft Ohio 2010 Technical Reference Manual - Page 100
	Wall insulation- Framed siding(target R11) - Heat Pump	Square footage installed	408	2.5	0.000	1,028	0.02	Draft Ohio 2010 Technical Reference Manual - Page 100
	Wall insulation- Framed siding(target R11) - Electric Heat w/AC	Square footage installed	1,526	4.0	0.000	6,143	0.08	Draft Ohio 2010 Technical Reference Manual - Page 100
	Wall insulation- Brick Veneer(target R11) - Heat Pump	Square footage installed	1,444	0.1	0.000	87	0.08	Draft Ohio 2010 Technical Reference Manual - Page 100
	Water Pipe Insulation	Square footage installed	654	160.2	0.018	104,786	11.96	Draft Ohio 2010 Technical Reference Manual - Page 97
	TOTAL					**4,560,483**	**660.7**	

APPENDIX A -- Ohio Savings Terms FINAL **12/31/2018**

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	Replacing (2) 1000 HP compressor with a 600 HP VFD driven compressor. No change to the existing (1) 500 HP Compressor	Custom Measure	1	1,336,238.9	186.770	1,336,238.9	186.8	
	The existing system consists of three (3) KAESER BSD 50 (50 HP) fixed speed dual control compressors of various generations. One of the compressor has an integrated refrigerated dryer, while the other two feed through a KAESER TE 142 cycling refrigerated dryer. The system has storage of 1020 gallons in the compressor room. - Replace with: In addition to the above equipment, the proposed system consists of KAESER SAM 4.0 master controller to effectively and efficiently coordinate the operation of compressed air system. SAM 4.0's unique 3D Advanced control algorithm not only operates only the right compressors for given air demand but also adjusts system setpoint pressure in real-time to optimize the correct pressure settings for a given system demand. This in addition to reduction in overall system pressure resulted in system specific power of 19.51 kW/100 CFM. That is 8.6% efficient compared to the system without SAM 4.0 controller.	Custom Measure	1	44,095.0	15.150	44,095.0	15.2	
	Compressed air system retrofit installing 150-hp VFD compressor & removing two of 100-hp contstant speed compressors	Custom Measure	1	159,349.0	57.290	159,349.0	57.3	
	Could have installed 250 HP rotary screw air compressor. To Installed 250 HP VFD air compress	Custom Measure	1	249,808.0	32.830	249,808.0	32.8	
	Install digital automation to control compressors	Custom Measure	1	852,642.0	141.620	852,642.0	141.6	
	Replace 3 compressors, 20 HP each with one compressor 75 HP	Custom Measure	1	66,684.0	-	66,684.0	-	
	Replacing existing compressor with new compressors and adding central management system	Custom Measure	1	524,886.0	87.660	524,886.0	87.7	
	1. A new 125 HP Ingersoll Rand Variable Speed, 2 stage compressor will provide approximately 10% more air capacity and will use less energy than the existing 125 HP, single speed compressor. 2. A new 1,000 cfm air dryer will replace the existing, unreliable 700 cfm air dryer. The increased dryer capacity will help ensure that we provide moisture free compressed air to the plant even during high humidity weather conditions. 3. A 2,000 gallon air receiver will be installed to replace the existing 600 gallon air receiver.	Custom Measure	1	298,070.0	-	298,070.0	-	
	Centralized Energy Management Control System	Custom Measure	1	44,376.0	-	44,376.0	-	
	Retrofit uncontrolled 169W heat mats with controllers that lower the temperature and power consumption of heat mats as piglets getolder (60 mats total)	Custom Measure	1	32,362.0	4.590	32,362.0	4.6	
	Retrofit uncontrolled 169W heat mats with controllers that lower the temperature and power consumption of heat mats as piglets getolder (96 mats total)	Custom Measure	1	51,780.0	7.340	51,780.0	7.3	
	Occupancy sensors were installed and integrated with existing HVAC equipment to set air handlers back when unoccupied.	Custom Measure	1	208,685.0	30.350	208,685.0	30.4	
	Upgrading existing inoperable DDC controls with new DDC control system	Custom Measure	1	187,033.2	9.861	187,033.2	9.9	
	HVAC Optimization: Reduce Building Stack Effect	Custom Measure	1	695,188.0	185.590	695,188.0	185.6	
	Replace 2nd generation LED with 6th generation LED	Custom Measure	1	24,895.5	2.430	24,895.5	2.4	
	Replace a 40hp constant speed exhaust fan with a 15hp vfd exhaust fan, reduce existing supply air volume, reduce chiller load.	Custom Measure	1	389,269.0	27.360	389,269.0	27.4	
	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	
	Replaced a mechanical stamping press with a servo motor stamping press	Custom Measure	1	42,763.5	9.500	42,763.5	9.5	
	Existing equipment was cooling pre-blend fluid with the cooling tower loop. This was replaced with a 209B heat X in parrallel with 209A which allows for pre-blend cooling load to be removed from exisiting cooling tower loop.	Custom Measure	1	1,286,133.0	146.820	1,286,133.0	146.8	
	Cooling tower water was used to cool down the pre-blend fluid that bypassed 209A heat exchanger. This put a large heating load on the cooling tower. Replaced with: 209B heat exchanger was put in parrallel with 209A to allow all pre-blend to be cooled using the beer line rather than cooling tower water. Thus pulling load off cooling tower.	Custom Measure	1	708,669.6	80.900	708,669.6	80.9	
	Replaced old immersion water bath system with ARS system	Custom Measure	1	278,276.7	-	278,276.7	-	
	LED Refgrigerated Case Lighting (LED to LED) Older generation to new generation with higher e	Custom Measure	1	49,246.0	7.940	49,246.0	7.9	
	LED Refrigerated Case Lighting - older generation model to new more efficient generation)	Custom Measure	1	27,342.6	4.410	27,342.6	4.4	
	LED Refrigerated Case Lighting (LED to more efficient LED)	Custom Measure	2	21,120.3	3.400	42,240.6	6.8	
	LED Refrigerated Case Lighting (Old LED to new LED)	Custom Measure	1	15,528.0	2.500	15,528.0	2.5	
	LED Refrigerated case lighting (replace old LEDs with more efficient LED)	Custom Measure	1	12,413.5	2.000	12,413.5	2.0	
	LED refrigerated case lighting. Older generation LED to newer more efficient LED	Custom Measure	1	25,865.2	4.170	25,865.2	4.2	
	LED Refrigerated case upgrade. LED to LED, (lumens per watt improvement)	Custom Measure	1	8,203.2	1.320	8,203.2	1.3	
	Newer generation LED refrigerated case lighting replacing older generation refrigerated case ligh	Custom Measure	1	15,266.3	2.460	15,266.3	2.5	
	Newer generation refrigerated case LED lighting replacing older generation LED lighting	Custom Measure	1	46,632.8	7.520	46,632.8	7.5	
	Replace older generation refrigerated case LED lighting with newer generation LED lighting	Custom Measure	1	777.5	0.120	777.5	0.1	
	replace older refrigerated case LED lighting with newer generation refrigerated case LED lighting	Custom Measure	1	24,640.7	3.970	24,640.7	4.0	
	Replacing existing LED Refrigeration Door Strip Lighting with new, more energy efficient LED's.	Custom Measure	1	35,741.1	5.760	35,741.1	5.8	

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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
	Replacing existing Refrigeratiion LED lighting with more energy efficient Refrigeration LED	Custom Measure	1	23,487.0	3.790	23,487.0	3.8	
	Replacing Existing refrigeration LED's with More Energy Efficienct LED's	Custom Measure	2	36,543.0	5.890	73,086.0	11.8	
	Cycling Air Dryer	SCFM	800	12.8	-	10,248.0	-	Vendor Internal TRM - Compressed Air
	Compressed Air Leak Repair	CFM	84	600.0	0.170	50,400.0	14.3	Vendor Internal TRM - Compressed Air
	No Loss Condensate Drain	Drain	2	1,913.6	0.265	3,827.2	0.5	Vendor Internal TRM - Compressed Air
	LED Refrigeration Case Lighting - With Doors	Unit	502	413.3	0.067	207,270.0	33.4	Vendor Internal TRM - Refrigeration
	TOTAL					**8,197,190**	**1,157.5**	
New Construction	Controlled heat lamps that decrease temperature & energy use	Custom measure	1	17,486.0	0.000	17,486.0	0.0	
	2 30hp Ground Source Heat Pumps (30 tons)	Custom measure	1	32,171.7	25.419	32,171.7	25.4	
	3 Energy Recovery Ventilators	Custom measure	1	11,312.0	0.000	11,312.0	0.0	
	New RTU installed in fitness center with Heat Recovery Wheel.	Custom measure	1	25,052.0	21.983	25,052.0	22.0	
	LED Theater lighting (interior)	Custom measure	1	192,501.1	48.164	192,501.1	48.2	
	VFD Aeration Blowers, Influent VFD Pumps, VFD ATAD Blowers and Pumps.	Custom measure	1	863,739.8	85.710	863,739.8	85.7	
	Expert Variable flow refrigeration system	Custom measure	1	441,528.0	56.880	441,528.0	56.9	
	Insulated concrete form (ICF) wall construction	Custom measure	1	52,418.7	0.626	52,418.7	0.6	
	Water Pre-Heat Heat Exchanger	Custom measure	1	20,383.6	2.324	20,383.6	2.3	
	HVAC optimization	Custom measure	1	762.4	0.157	762.4	0.2	
	Prescriptive Whole Building	Unit	99,729	2.7	0.000	268,613.0	45.0	Implementer Prescriptive Model
	Whole building - >30% (Owner)	Project	8	734,205.6	105.475	5,873,645.0	843.8	Individually modeled by Implementer
	Whole building - e10 and <20% (Owner)	Project	3	390,297.0	126.567	1,170,891.0	379.7	Individually modeled by Implementer
	Whole building - e20 and <30% (Owner)	Project	6	362,852.1	85.067	2,177,112.7	510.4	Individually modeled by Implementer
	Cycling Air Dryer	Unit	2	5,150.9	0.588	10,301.8	1.2	Vendor Internal TRM - Compressed Air
	No Loss Condensate Drain	Unit	3	2,368.2	0.305	7,104.7	0.9	Vendor Internal TRM - Compressed Air
	Air Compressor Motor	Unit	2	170,018.7	10.120	340,037.5	20.2	Vendor Internal TRM - Compressed Air
	Low Pressure Drop Filter	Unit	3	8,561.4	1.270	25,684.2	3.8	Vendor Internal TRM - Compressed Air
	Air Cooled, electrically operated chiller: <150 tons	Unit	3	4,522.0	6.834	13,565.9	20.5	Vendor Internal TRM - Cooling
	Air Cooled, electrically operated chiller: >=150 tons	Unit	1	25,850.1	54.594	25,850.1	54.6	Vendor Internal TRM - Cooling
	Water cooled, centrifugal chiller: 300 to 599 Tons	Ton	3	18,076.3	20.095	54,228.9	60.3	Vendor Internal TRM - Cooling
	Water cooled, centrifugal chiller: >= 600 Tons	Ton	2	41,300.7	99.400	82,601.5	198.8	Vendor Internal TRM - Cooling
	Air Source Heat Pump < 5.4 tons	Unit	2	1,111.4	0.460	2,222.8	0.9	Vendor Internal TRM - Cooling
	Air-Side Economizer on RTU AHU DX or UV	Unit	21	238.1	0.000	5,001.1	0.0	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow AC - 11.25 - 19.9 tons	Unit	2	872.3	0.308	1,744.5	0.6	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow AC - 5.4 - 11.24 tons	Unit	4	1,029.4	0.645	4,117.5	2.6	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow - < 5.4 tons	Unit	33	142.8	0.057	4,712.2	1.9	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow AC	Unit	1	11,088.7	0.535	11,088.7	0.5	Vendor Internal TRM - Cooling
	Cental Air Conditioner - 11.25 -19.9 tons	Unit	11	2,452.3	0.430	26,974.8	4.7	Vendor Internal TRM - Cooling
	Cental Air Conditioner - 20 -63.2 tons	Unit	20	6,631.2	1.914	132,624.1	38.3	Vendor Internal TRM - Cooling
	Cental Air Conditioner - 5.4 -11.24 tons	Unit	32	1,228.0	0.389	39,295.5	12.4	Vendor Internal TRM - Cooling
	Cental Air Conditioner - < 5.4 tons	Unit	80	390.4	0.221	31,229.9	17.6	Vendor Internal TRM - Cooling
	Cental Air Conditioner - > 63.3 tons	Unit	12	24,496.7	4.190	293,960.9	50.3	Vendor Internal TRM - Cooling
	Hotel Guest Room Occupancy Sensor (Electric Heat)	Room controlled	119	1,117.0	0.159	132,923.0	18.9	Vendor Internal TRM - Cooling
	Toilet Room Exhaust Occ Sensor	Fan	4	71.0	0.003	283.9	0.0	Vendor Internal TRM - Cooling
	PTAC/PTHP	Ton	551	101.2	0.044	55,758.3	24.5	Vendor Internal TRM - Cooling
	Room AC < 2 tons	Ton	3	193.9	0.188	581.8	0.6	Vendor Internal TRM - Cooling
	Ground-source Heat Pump	Ton	6	1,683.1	0.497	10,098.7	3.0	Vendor Internal TRM - Cooling
	Ice Maker >1001 lbs/day	Icemaker	8	1,195.0	0.130	9,560.0	1.0	Vendor Internal TRM - Food Service
	Ice Maker 101-400 lbs/day	Icemaker	1	581.0	0.109	581.0	0.1	Vendor Internal TRM - Food Service
	Ice Maker 401-1000 lbs/day	Icemaker	20	1,005.7	0.137	20,114.0	2.7	Vendor Internal TRM - Food Service
	Hot Holding Cabinet	Cabinet	5	3,155.2	0.330	15,776.0	1.6	Vendor Internal TRM - Food Service
	Combination Oven	Unit	1	6,368.0	0.590	6,368.0	0.6	Vendor Internal TRM - Food Service
	DCV for Kitchen Exhaust Hood	Horse power	9	15,930.3	2.699	143,372.6	24.3	Vendor Internal TRM - Food Service
	Exterior New Construction - Lighting Power Density	Watt reduced	571,647	4.5	0.000	2,592,948.0	0.0	Vendor Internal TRM - Lighting
	Interior Daylighting Controls	Unit	21	1,841.6	0.940	38,674.0	19.7	Vendor Internal TRM - Lighting
	Interior New Construction - Lighting Power Density	Watt reduced	2,707,216	4.9	0.001	13,400,345.0	2,335.0	Vendor Internal TRM - Lighting
	Interior Occupancy Sensor	Watt controlled	122,484	2.0	0.000	243,948.0	52.0	Vendor Internal TRM - Lighting
	Occupancy sensors, 45% LPD reduction	Watt controlled	36,662	1.3	0.000	48,408.5	7.3	Vendor Internal TRM - Lighting
	Engine Block Heater Timer	Timer	4	663.6	0.000	2,654.5	0.0	Vendor Internal TRM - Agriculture
	Livestock Waterers	Unit	8	629.6	0.000	5,036.8	0.0	Vendor Internal TRM - Agriculture
	High Speed Fans 24" to 35"	Fan	9	14,241.7	2.835	128,175.5	25.5	Vendor Internal TRM - Agriculture
	High Speed Fans 36" to 47"	Fan	2	625.0	0.198	1,250.0	0.4	Vendor Internal TRM - Agriculture
	High Speed Fans 48" to 71"	Fan	124	1,122.0	0.356	139,128.0	44.1	Vendor Internal TRM - Agriculture
	Scroll Compressors for Dairy Refrigeration With Plate Heat Exchanger	Pounds of milk/day	1	8,228.1	1.152	8,228.1	1.2	Vendor Internal TRM - Agriculture
	VSD's for Agricultural Pumps	Unit	2	7,999.1	0.950	15,998.2	1.9	Vendor Internal TRM - Agriculture

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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	ECM for HVAC - Heating Only	Motor	13	282.9	0.234	3,677.4	3.0	Vendor Internal TRM - Motors and Drives
	Chilled Water Pump	Unit	9	6,079.3	1.565	54,714.0	14.1	Vendor Internal TRM - Motors and Drives
	Cooling Tower Fan	Unit	24	1,406.3	0.348	33,750.0	8.4	Vendor Internal TRM - Motors and Drives
	Hot Water Pump	Unit	14	4,451.6	0.018	62,323.0	0.2	Vendor Internal TRM - Motors and Drives
	Other HVAC Motor	Unit	30	5,155.2	0.543	154,654.8	16.3	Vendor Internal TRM - Motors and Drives
	Other Non-HVAC Motor	Unit	41	34,370.3	3.632	1,409,184.1	148.9	Vendor Internal TRM - Motors and Drives
	Supply/Return Fan	Unit	24	6,987.2	1.052	167,692.0	25.3	Vendor Internal TRM - Motors and Drives
	300 kVA Three Phase Dry Type Low Voltage Transformers	Transformer	1	4,673.4	0.650	4,673.4	0.6	Vendor Internal TRM - Miscellaneous
	112.5 kVA Three Phase Dry Type Low Voltage Transformers	Transformer	4	1,729.1	0.425	6,916.4	1.7	Vendor Internal TRM - Miscellaneous
	75 kVA Three Phase Dry Type Low Voltage Transformers	Transformer	8	1,396.2	0.343	11,169.5	2.7	Vendor Internal TRM - Miscellaneous
	45 kVA Three Phase Dry Type Low Voltage Transformers	Transformer	7	1,024.9	0.252	7,174	1.8	Vendor Internal TRM - Miscellaneous
	30 kVA Three Phase Dry Type Low Voltage Transformers	Transformer	6	996.2	0.245	5,977	1.5	Vendor Internal TRM - Miscellaneous
	NEMA Premium transformer efficiency - My Solutions Application	Square Footage	60,759	0.1	0.000	4,636	0.6	Vendor Internal TRM - Miscellaneous
	ENERGY STAR Glass Door Freezer	Freezer	25	2,556.2	0.292	63,904	7.3	Vendor Internal TRM - Refrigeration
	ENERGY STAR Glass Door Refrigerator	Refrigerator	88	603.6	0.066	53,119	5.8	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Freezer	Freezer	30	1,837.9	0.193	55,137	5.8	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Refrigerator	Refrigerator	9	339.9	0.037	3,059	0.3	Vendor Internal TRM - Refrigeration
	LED Refrigeration Case Lighting - Open Cases	Unit	76	103.7	0.015	7,833	1.2	Vendor Internal TRM - Refrigeration
	LED Refrigeration Case Lighting - With Doors	Unit	277	226.5	0.036	62,734	10.0	Vendor Internal TRM - Refrigeration
	High-performance windows	Square Footage	97,421	0.2	0.000	18,354	3.9	My Solutions Application
	Above code Roof & Wall Insulation with Air Barrier	Square Footage	60,759	0.1	0.000	4,587	1.2	My Solutions Application
	TOTAL					**31,475,445**	**5,335.6**	
Efficient Products for Business	Advanced Lighting Controls: High Lumen Low Density	Watt reduced	1,204,805	6.4	0.001	7,659,063.1	837.7	Individually Modeled by Implementer
	Livestock Waterers	Unit	2	1,593.0	0.000	3,186.0	0.0	Vendor Internal TRM - Agriculture
	High Speed Fans 48" to 71"	Fan	20	1,122.0	0.360	22,440.0	7.2	Vendor Internal TRM - Agriculture
	High Volume Low Speed (HVLS) Fans 18'	Fan	2	4,938.0	1.800	9,876.0	3.6	Vendor Internal TRM - Agriculture
	High Volume Low Speed (HVLS) Fans 24'	Fan	4	10,018.0	3.700	40,072.0	14.8	Vendor Internal TRM - Agriculture
	VSD on Dairy Transfer Pump	100 gallons milk/day	16	142.4	0.013	2,207.2	0.2	Vendor Internal TRM - Agriculture
	VSD on Dairy Vacuum Pump	Horsepower	45	2,409.0	0.440	108,405.0	19.8	Vendor Internal TRM - Agriculture
	Milk Pre-Cooler Heat Exchanger (Chiller Savings)	Pounds of milk per day	12,960	1.4	0.000	17,742.2	5.5	Vendor Internal TRM - Agriculture
	Water Pre-Heat Heat Exchanger (Water Heating Savings)	Pounds of milk per day	30,000	2.0	0.001	59,640.0	18.4	Vendor Internal TRM - Agriculture
	Fan Thermostat Controller	HP	1	1,586.0	0.000	1,586.0	0.0	Vendor Internal TRM - Agriculture
	Cycling Air Dryer	SCFM	2,476	12.8	0.000	31,717.6	0.0	Vendor Internal TRM - Compressed Air
	Compressed Air Added Storage	Gallon	1,550	44.9	0.007	69,595.0	10.9	Vendor Internal TRM - Compressed Air
	Low Pressure Drop Filter	SCFM	2,100	25.0	0.003	52,416.0	7.3	Vendor Internal TRM - Compressed Air
	New VFD Compressor	Horsepower	1,220	1,732.3	0.240	2,113,406.0	293.0	Vendor Internal TRM - Compressed Air
	No Loss Condensate Drain	Drain	1	1,913.6	0.265	1,913.6	0.3	Vendor Internal TRM - Compressed Air
	Air Cooled Chiller <150 Tons	Unit	10	11,009.1	5.774	110,091.4	57.7	Vendor Internal TRM - Cooling
	Air Cooled Chiller >= 150 Tons	Unit	8	58,105.9	29.347	464,847.2	234.8	Vendor Internal TRM - Cooling
	Air Source Heat Pump < 5.4 tons	Unit	70	519.5	0.329	36,363.2	23.0	Vendor Internal TRM - Cooling
	Air Source Heat Pump - >= 63.3 tons	Unit	3	14,606.9	11.612	43,820.6	34.8	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 11.25 - 19.9 tons	Unit	77	2,535.7	1.540	195,252.6	118.6	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 20 - 63.2 tons	Unit	37	5,013.8	3.367	185,509.4	124.6	Vendor Internal TRM - Cooling
	Air Source Heat Pump - 5.4 - 11.24 tons	Unit	92	1,119.5	0.731	102,998.5	67.3	Vendor Internal TRM - Cooling
	Air-Side Economizer on RTU AHU DX or UV	Unit	1	26,215.8	0.000	26,215.8	0.0	Vendor Internal TRM - Cooling
	Centralized Energy Management System Controls (Elec Heat)	Square foot of conditioned	243,394	1.3	0.000	320,359.9	0.0	Vendor Internal TRM - Cooling
	Centralized Energy Management System Controls (Non Elec Heat)	Square foot of conditioned	1,552,590	1.3	0.000	1,984,204.3	0.0	Vendor Internal TRM - Cooling
	ECMs for HVAC - Heating and Cooling	Motor	29	656.0	0.462	19,024.0	13.4	Vendor Internal TRM - Cooling
	Occupancy Sensor Control for HVAC Systems	Unit	1	9,151.2	0.000	9,151.2	0.0	Vendor Internal TRM - Cooling
	PTAC	Unit	540	125.1	0.071	67,549.3	38.5	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow Heat Pumps 11.25-19.9 tons	Ton	1	31,447.6	3.997	31,447.6	4.0	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow Heat Pumps < 5.4 tons	Ton	1	3,362.6	0.034	3,362.6	0.0	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow AC 11.25 - 19.9 tons	Ton	4	3,236.3	1.995	12,945.1	8.0	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow AC 5.4 - 11.24 tons	Ton	2	1,554.8	1.065	3,109.5	2.1	Vendor Internal TRM - Cooling
	Variable Refrigerant Flow AC < 5.4 tons	Ton	3	379.9	0.457	1,139.6	1.4	Vendor Internal TRM - Cooling
	Water cooled, electrically operated, centrifugal chiller - >= 600 Tons	Unit	2	119,677.1	51.769	239,354.1	103.5	Vendor Internal TRM - Cooling
	Water cooled, electrically operated, centrifugal chiller - 300 to 599 Tons	Unit	1	135,128.3	63.579	135,128.3	63.6	Vendor Internal TRM - Cooling
	Water cooled, electrically operated, centrifugal chiller - < 300 Tons	Unit	3	37,666.6	18.109	112,999.7	54.3	Vendor Internal TRM - Cooling
	Window Film	Square foot	60,665	2.7	0.001	164,402.2	72.8	Vendor Internal TRM - Cooling
	Demand Control Ventilation for Office	Square foot	45,314	0.5	0.000	23,184.9	0.0	Vendor Internal TRM - Cooling
	Variable-Speed Drives for HVAC Chillers	Units	1	91,876.2	70.242	91,876.2	70.2	Vendor Internal TRM - Cooling
	Beverage Machine Controls	Machine	13	1,613.0	0.000	20,969.0	0.0	Vendor Internal TRM - Miscellaneous

APPENDIX A -- Ohio Savings Terms FINAL **12/31/2018**

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	Combination Oven	Oven	4	11,502.0	1.059	46,008.0	4.2	Vendor Internal TRM - Food Service
	DCV for Kitchen Exhaust Hood - Retrofit	Unit	6	4,486.0	0.760	26,916.0	4.6	Vendor Internal TRM - Food Service
	Ice Maker >1001 lbs/day	Icemaker	2	1,114.0	0.209	2,228.0	0.4	Vendor Internal TRM - Food Service
	Ice Maker 401-1000 lbs/day	Icemaker	3	847.0	0.159	2,541.0	0.5	Vendor Internal TRM - Food Service
	Ice Maker 101-400 lbs/day	Icemaker	3	581.0	0.109	1,743.0	0.3	Vendor Internal TRM - Food Service
	Steam Cookers	Cooker	1	25,545.0	3.526	25,545.0	3.5	Vendor Internal TRM - Food Service
	Snack Machine Controls	Machine	2	387.0	0.000	774.0	0.0	Vendor Internal TRM - Miscellaneous
	Exterior Bi-Level Lighting Controls	Watts controlled	11,390	0.6	0.000	7,109.3	0.0	Vendor Internal TRM - Lighting
	Exterior ES or DLC LED	Unit	14,565	1,121.4	0.000	16,333,197.9	0.4	Vendor Internal TRM - Lighting
	Exterior Exit Sign	Sign	3	78.8	0.009	236.5	0.0	Vendor Internal TRM - Lighting
	Exterior Other LED	Unit	2,874	720.9	0.000	2,071,759.1	0.0	Vendor Internal TRM - Lighting
	Exterior Photocells	Watt controlled	73,469	0.3	0.000	24,150.8	0.0	Vendor Internal TRM - Lighting
	Exterior Screw-in LED	Unit / lamp	2,459	145.8	0.017	358,410.2	42.4	Vendor Internal TRM - Lighting
	Exterior Time Clocks for Lighting	Watt controlled	12,611	0.4	0.000	5,247.4	0.0	Vendor Internal TRM - Lighting
	Garage Bi-Level Lighting Controls	Watts controlled	1,360	1.3	0.150	1,787.0	204.0	Vendor Internal TRM - Lighting
	Garage ES or DLC LED	Unit	1,157	1,058.2	0.121	1,224,367.7	139.8	Vendor Internal TRM - Lighting
	Garage Other LED	Unit	216	836.0	0.095	180,578.6	20.6	Vendor Internal TRM - Lighting
	Garage Screw-in LED	Unit	37	306.9	0.015	11,353.5	0.6	Vendor Internal TRM - Lighting
	Garage Occupancy Sensor	Watt controlled	16,184	0.3	0.000	4,855.2	5.1	Vendor Internal TRM - Lighting
	Garage Occupancy + Daylighting Sensor	Watt controlled	7,500	0.3	0.001	2,415.0	10.1	Vendor Internal TRM - Lighting
	Interior Daylighting Controls	Watt controlled	10,065	0.9	0.001	9,066.8	6.8	Vendor Internal TRM - Lighting
	Interior ES or DLC LED	Unit	290,164	256.8	0.058	74,518,799.1	16,742.4	Vendor Internal TRM - Lighting
	Interior Exit Sign	Sign	1,800	92.7	0.012	166,790.5	22.0	Vendor Internal TRM - Lighting
	Interior Linear Fluorescent Retrofit	Lamp	42	277.7	0.062	11,662.6	2.6	Vendor Internal TRM - Lighting
	Interior New T8/T5 Fixture	Unit	576	247.5	0.056	142,575.5	32.0	Vendor Internal TRM - Lighting
	Interior New T8 Fluorescent Fixtures	Unit	28	828.6	0.186	23,200.5	5.2	Vendor Internal TRM - Lighting
	Interior Occupancy + Daylighting Sensor	Watt controlled	37,163	1.6	0.000	58,574.1	12.5	Vendor Internal TRM - Lighting
	Interior Occupancy Sensor	Watt controlled	1,296,154	1.1	0.000	1,488,853.7	117.9	Vendor Internal TRM - Lighting
	Interior Other LED	Unit	37,029	206.9	0.046	7,660,704.0	1,720.6	Vendor Internal TRM - Lighting
	Interior Screw-in LED	Unit	80,788	200.9	0.026	16,232,134.9	2,085.9	Vendor Internal TRM - Lighting
	Interior Time Clocks for Lighting	Watt controlled	71,032	0.4	0.000	28,709.0	0.0	Vendor Internal TRM - Lighting
	LED Traffic Lights Green 12"	Unit	80	519.8	0.059	41,584.0	4.7	Vendor Internal TRM - Lighting
	LED Traffic Lights Green 8"	Unit	88	226.0	0.026	19,888.0	2.3	Vendor Internal TRM - Lighting
	LED Traffic Lights Red 12"	Unit	80	693.8	0.079	55,504.0	6.3	Vendor Internal TRM - Lighting
	LED Traffic Lights - Red 8"	Unit	88	298.7	0.034	26,285.6	3.0	Vendor Internal TRM - Lighting
	LED Traffic Lights - Walk/Don't Walk 12"	Unit	35	946.1	0.052	33,112.8	1.8	Vendor Internal TRM - Lighting
	Suite ES or DLC LED	Unit	394	13.5	0.002	5,325.2	0.8	Vendor Internal TRM - Lighting
	Suite Screw-in LED	Unit	6,778	37.8	0.008	255,952.6	52.2	Vendor Internal TRM - Lighting
	Suite New T8/T5 Fixture	Unit	64	356.7	0.080	22,830.3	5.1	Vendor Internal TRM - Lighting
	High Efficiency Electric Hot Water Heater	Unit	2	4,703.4	1.030	9,406.8	2.1	Vendor Internal TRM - Miscellaneous
	Chilled Water Pump	Unit	17	21,399.2	4.019	363,785.7	68.3	Vendor Internal TRM - Motors and Drives
	Cooling Tower Fan	Unit	12	11,025.0	3.658	132,299.5	43.9	Vendor Internal TRM - Motors and Drives
	Hot Water Pump	Unit	18	3,396.4	0.010	61,134.8	0.2	Vendor Internal TRM - Motors and Drives
	Process Motor	Unit	64	30,355.4	4.178	1,942,746.8	267.4	Vendor Internal TRM - Motors and Drives
	Supply/Return Fan	Unit	199	6,023.8	1.021	1,198,737.2	203.3	Vendor Internal TRM - Motors and Drives
	NEMA Premium Efficiency Motor	Unit	32	5,831.5	0.698	186,608.0	22.3	Vendor Internal TRM - Motors and Drives
	Pool Pump Motor	Unit	8	17,600.8	0.149	140,806.0	1.2	Vendor Internal TRM - Motors and Drives
	Anti-Sweat Heater Controls	Unit	1,045	528.0	0.060	551,654.4	62.7	Vendor Internal TRM - Refrigeration
	EC Motor for Evaporator Fan Controls	Unit	60	1,351.0	0.154	81,060.0	9.2	Vendor Internal TRM - Refrigeration
	EC Motor for Reach-in Refrigerator cases and Freezer cases	Unit	681	625.0	0.071	425,625.0	48.4	Vendor Internal TRM - Refrigeration
	EC Motor for Walk-in Cooler and Freezer	Unit	25	1,250.0	0.143	31,250.0	3.6	Vendor Internal TRM - Refrigeration
	ENERGY STAR Glass Door Freezer	Unit	6	725.9	0.083	4,355.4	0.5	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Freezer	Unit	29	519.2	0.059	15,056.8	1.7	Vendor Internal TRM - Refrigeration
	ENERGY STAR Glass Door Refrigerator	Unit	24	356.0	0.041	8,544.5	1.0	Vendor Internal TRM - Refrigeration
	ENERGY STAR Solid Door Refrigerator	Unit	45	197.7	0.023	8,896.5	1.0	Vendor Internal TRM - Refrigeration
	LED Refrigeration Case Lighting - Open Cases	Unit	2,785	365.1	0.063	1,016,674.8	174.2	Vendor Internal TRM - Refrigeration
	LED Refrigeration Case Lighting - With Doors	Unit	2,753	413.3	0.067	1,137,744.6	183.4	Vendor Internal TRM - Refrigeration
	New Doors on Medium Temp Open Refrigerated Case	Unit	117	395.6	0.045	46,082.7	5.3	Vendor Internal TRM - Refrigeration
	Oversized Condenser for Refrigeration	Ton	103	120.0	0.120	12,336.0	12.3	Vendor Internal TRM - Refrigeration
	TOTAL					**143,106,154**	**24,683.9**	

APPENDIX A -- Ohio Savings Terms FINAL **12/31/2018**

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
Self Direct	Our largest existing powder compacting press is a hydraulic powered press which is the same type of operation, but is rated at 3500Kn (392 ton). This machine is roughly half the tonnage.	Custom Measure	1	285,946.7	47.660	285,946.7	47.7	All Custom Measures are individually calculated using methodology consistent with the Draft Ohio 2010 Technical Reference Manual.
	Combination Oven	Oven	2	11,502.0	1.059	23,004.0	2.1	Vendor Internal TRM - Food Service
	Air-source Heat Pump - <= 5.4 tons	Unit	3	846.8	0.473	2,540.3	1.4	Vendor Internal TRM - Cooling
	Air-source Heat Pump - 5.4 - 11.24 tons	Unit	1	1,059.0	0.595	1,059.0	0.6	Vendor Internal TRM - Cooling
	Air-source Heat Pump - 11.25 - 19.9 tons	Unit	2	2,493.2	1.402	4,986.4	2.8	Vendor Internal TRM - Cooling
	Cooling Tower Fan	Unit	1	9,009.0	1.689	9,009.0	1.7	Vendor Internal TRM - Motors & Drives
	Supply/Return Fan	Unit	5	12,234.7	3.121	61,173.7	15.6	Vendor Internal TRM - Motors & Drives
	Interior Occupancy Sensor	Watt controlled	672	1.4	0.000	972.6	0.0	Vendor Internal TRM - Lighting
	Exterior Photocell	Watt controlled	736	0.3	0.000	241.9	-	Vendor Internal TRM - Lighting
	Exterior DLC or ES LED	Unit	8	1,268.6	0.000	10,148.7	-	Vendor Internal TRM - Lighting
	Exterior Other LED	Unit	12	1,681.0	0.000	20,172.5	-	Vendor Internal TRM - Lighting
	Exterior LPD	Watt reduced	262	4.2	0.000	1,091.2	-	Vendor Internal TRM - Lighting
	Interior Exit Sign	Sign	39	81.2	0.010	3,167.0	0.4	Vendor Internal TRM - Lighting
	Interior Screw-in LED	Unit	11,612	199.5	0.029	2,316,053.8	341.7	Vendor Internal TRM - Lighting
	Interior ES or DLC LED	Unit	659	316.6	0.071	208,664.0	46.9	Vendor Internal TRM - Lighting
	Interior Other LED	Unit	323	161.0	0.036	52,006.2	11.7	Vendor Internal TRM - Lighting
	Interior LPD	Watt reduced	211,282	3.1	0.001	656,938.4	146.6	Vendor Internal TRM - Lighting
	TOTAL					**3,657,175**	**619.2**	
Express	Occupancy Sensor	Unit	136	273.2	0.000	37,149.8	0.0	New York State TRM - Lighting
	Photocells	Unit	121	107.8	0.000	13,044.1	0.0	New York State TRM - Lighting
	Exterior LED	Unit	3,426	892.6	0.000	3,058,156.3	0.0	New York State TRM - Lighting
	Exterior T8 Fluorescent	Unit	3	263.7	0.000	791.0	0.0	New York State TRM - Lighting
	Garage LED	Unit	1,636	598.2	0.137	978,578.9	224.0	New York State TRM - Lighting
	Garage Exit Signs	Unit	6	332.9	0.038	1,997.3	0.2	New York State TRM - Lighting
	Interior Exit Signs	Unit	813	284.0	0.028	230,882.7	22.4	New York State TRM - Lighting
	Interior LED	Unit	33,372	299.4	0.058	9,991,273.2	1,934.4	New York State TRM - Lighting
	Interior T8 Fluorescent	Unit	45	179.4	0.017	8,071.9	0.8	New York State TRM - Lighting
	Interior Light - Disconnect Only	Unit	144	693.9	0.150	99,923.6	21.6	New York State TRM - Lighting
	Exterior Light - Disconnect Only	Unit	6	674.3	0.000	4,045.9	0.0	New York State TRM - Lighting
	Exterior Exit Signs	Unit	1	332.9	0.000	332.9	0.0	New York State TRM - Lighting
	Anti Sweat Heater Control	Unit	129	8,694.8	0.220	1,121,623.5	28.4	Pennsylvania TRM - Refrigeration
	Compressor and Intelligent Fan Management	Unit	1,009	855.5	0.072	863,181.3	72.8	New York State TRM - Refrigeration
	Refrigeration LED Case Lighting	Unit	151	5,092.1	0.760	768,907.1	114.7	New York State TRM - Refrigeration
	TOTAL					**17,177,959**	**2,419.3**	
Data Center	Computer Room Air Conditioner	Unit	12	111,016.5	13.375	1,332,198.0	160.5	Standard Engineering Calculation
	Computer Room Air Handler	Unit	2	40,989.4	4.680	81,978.7	9.4	Standard Engineering Calculation
	HVAC Equipment Optimization	Unit	2	281,362.0	32.950	562,724.0	65.9	Standard Engineering Calculation
	HVAC/equipment/variable frequency drive	Unit	6	59,907.5	8.667	359,445.0	52.0	Standard Engineering Calculation
	IT/equipment/virtualization	Unit	6	37,694.2	2.783	226,165.0	16.7	Standard Engineering Calculation
	Non Residential Whole Building Model	Unit	3	10,556,994.3	1243.767	31,670,983.0	3,731.3	Individually modeled by Implementer
	Systemic/Equipment/Energy Management System	Unit	1	1,864,564.0	212.800	1,864,564.0	212.8	Standard Engineering Calculation
	TOTAL					**36,098,058**	**4,248.6**	
Continuous Energy Improvement	Multivariate Linear Regression	Project	57	298,198.5	23.454	16,997,313	1,336.9	Individually modeled by Implementer
	TOTAL					**16,997,313**	**1,337**	
Combined Heat & Power	Combined Heat & Power	Project	2	20,343,449.4	2319.108	40,686,899	4,638.2	Measured meter readings
	TOTAL					**40,686,899**	**4,638.2**	

Efficient Products Program

2018 Evaluation Report

AEP OHIO

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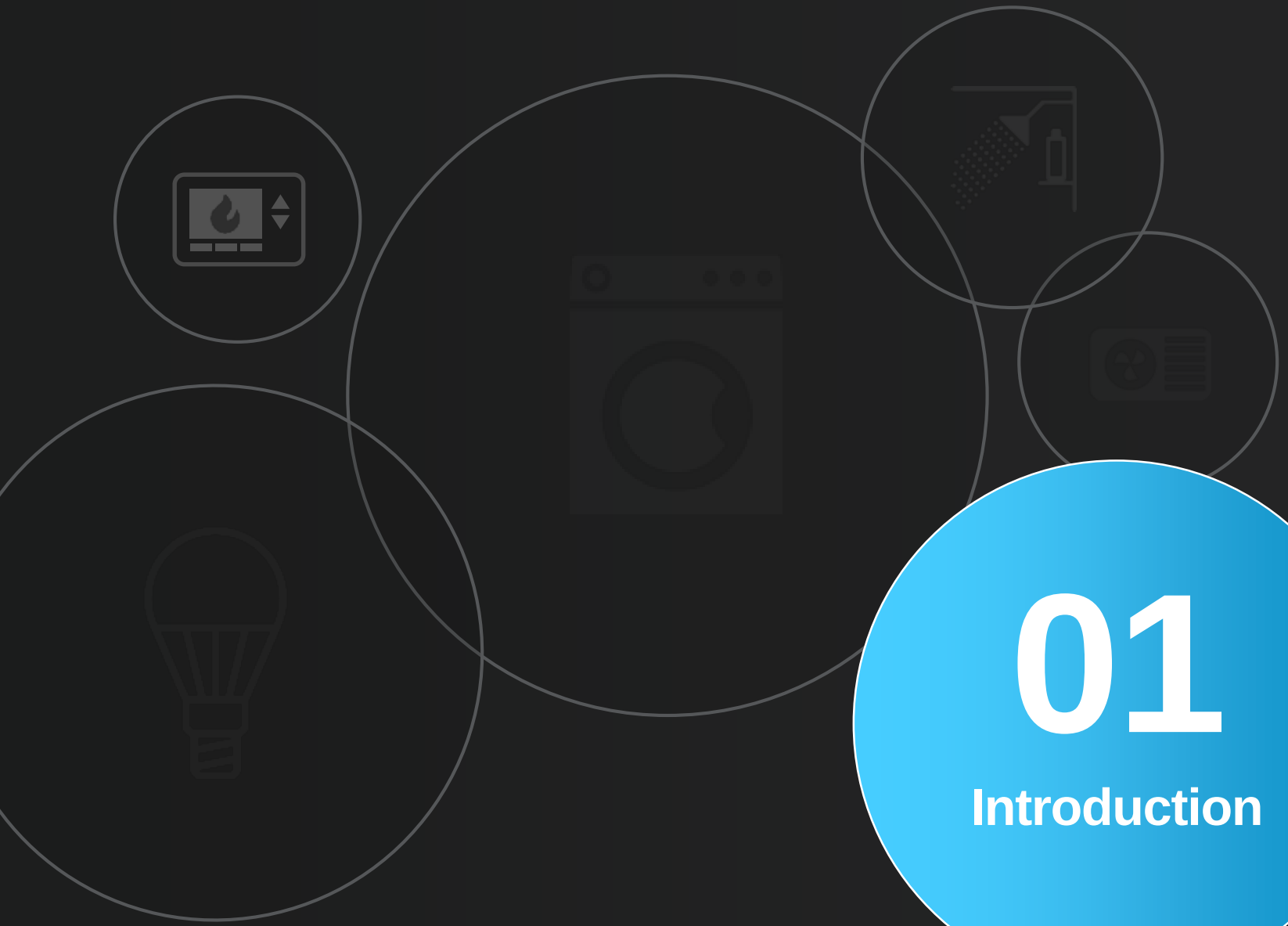


01

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 incentives 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 direct measure installations in multi-family homes
6. Free energy efficiency direct measure installations in select single-family homes through a partnership with Columbia Gas of Ohio

Program Summary

EFFICIENT PRODUCTS PROGRAM COMPONENTS			
Component		**Type**	**Measures**
	Upstream Lighting	Upstream and Coupon	Standard LEDs, Specialty LEDs
	Appliance Rebates[1]	Direct Purchase Through the Online Energy Efficiency Marketplace or Rebate with Online Application[2]	Standard LEDs, Specialty LEDs, Smart Thermostats, Clothes Washers,[3] Refrigerators, Heat Pump Water Heaters, Dehumidifiers, Pool Pumps
	HVAC Equipment	Rebate through Approved Installation Contractor	Central Air Conditioners, 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	Faucet Aerators, Standard LEDs, Nightlights, Showerheads
	Multi-Family Direct Installation	Direct Installation	Faucet Aerators, Standard LEDs, Specialty LEDs, Nightlights, Showerheads, Smart Power Strips
	Single-Family Direct Installation	Direct Installation through Partnership with Columbia Gas of Ohio	Faucet Aerators, Standard LEDs, Specialty LEDs, Nightlights, Showerheads, Smart Power Strips[4]

[1] A few air purifiers incentivized in 2017 were included in 2018 savings, however, air purifiers were not offered in 2018.

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

[3] Clothes washer rebates were only offered beginning in June 2018 due to ENERGY STAR® specification changes.

[4] AEP Ohio also provided a small portion of free smart thermostats through the single-family direct installation component. To simplify reporting, the evaluation team accounted for these smart thermostats as part of the Appliance Rebate component.

Program Summary
(continued)

The Efficient Products Program is AEP Ohio's second largest consumer sector program, accounting for more than one-third of consumer sector portfolio planned savings (34%).

- Energy saving goals decreased by about 5% from 2017, while demand savings goals increased by about 1%.

2018 EFFICIENT PRODUCTS PROGRAM SAVINGS GOALS

Metric	Goal[1,2]	Percent of Consumer Sector Portfolio
Estimated Energy Savings	69,399 MWh	34%
Estimated Demand Savings	7,645 kW	12%

[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 2018. The program achieved 167 percent of the energy savings goal of 69.4 GWh and 280 percent of the demand savings goal of 7.6 MW.

Realization rates were higher than 1 for both energy and demand savings. The realization rates for 2018 were 1.05 for energy savings and 1.05 for demand savings.

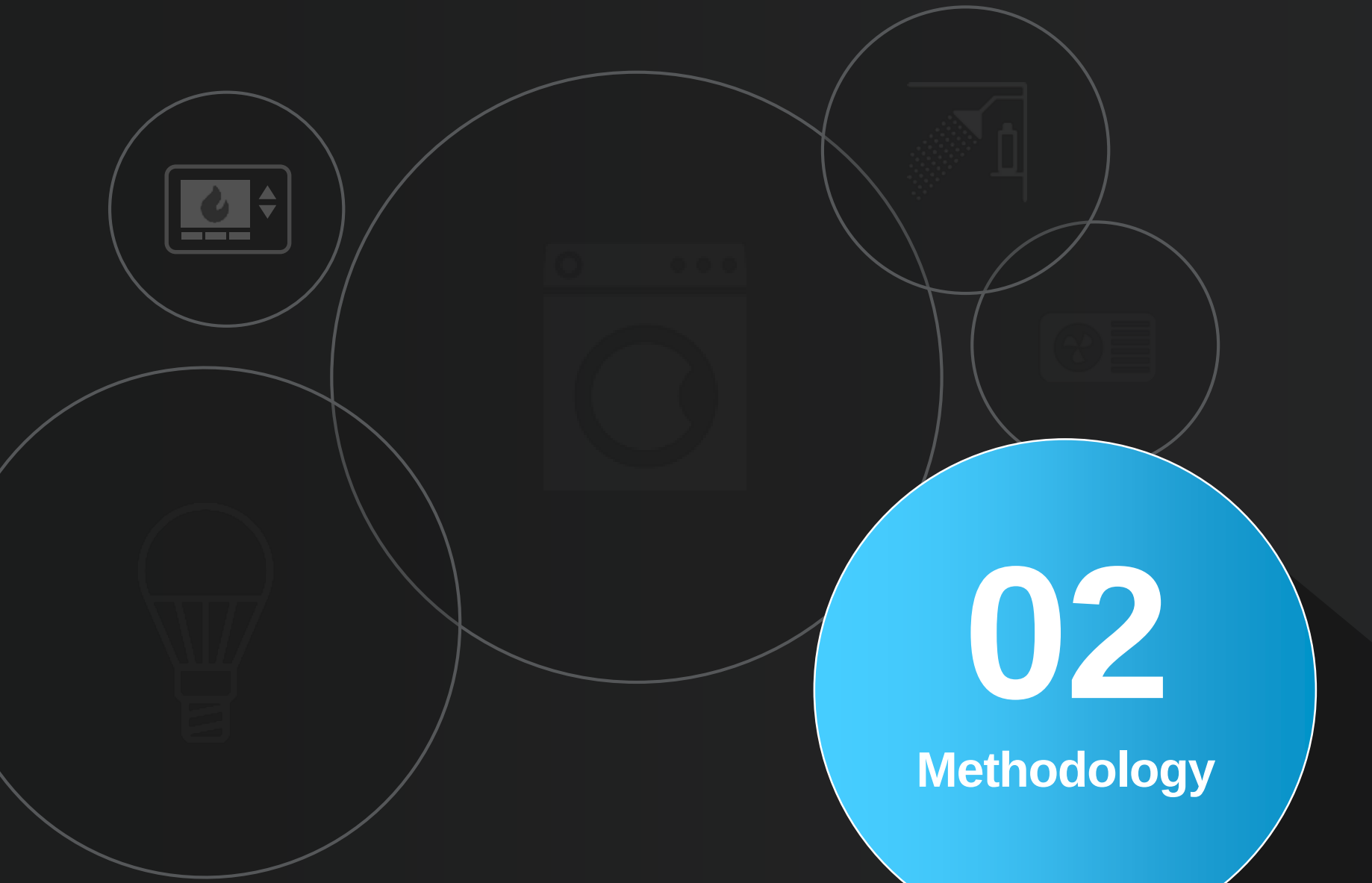
- To estimate the *ex post* savings, the evaluation team applied the methods and assumptions outlined in the Draft 2010 Ohio Technical Reference Manual (TRM).
- For measures that were not included in the TRM, the evaluation team applied methods used by other nearby TRMs (typically the Illinois TRM) and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

PROGRAM EVALUATION SUMMARY RESULTS

	2018 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)	69,399	110,372	115,657	1.05	167%
Demand Savings (MW)	7.65	20.33	21.38	1.05	280%

[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 2018

3 Appliance Rebate Online Survey

Targeted Population
Smart Thermostat and Clothes Washer Rebate Component Participants

Sample Frame
Tracking Database

Sample Size
151 Respondents

Timing
Jan 2019

4 MFDI On-Site Audits

Targeted Population
MFDI Treated Units

Sample Frame
Tracking Database

Sample Size
35 Site Visits

Timing
Dec 2018 – Jan 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

EMI Consulting 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
- Air purifiers[2]
- Refrigerators
- Clothes washers
- Smart thermostats
- Dehumidifiers

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

[2] A few air purifiers incentivized in 2017 were included in 2018 savings, however, air purifiers were not offered in 2018.

03

Evaluation Findings

Program Energy Impacts by Component

The upstream lighting component produced the majority of energy savings (91%). The second-highest energy-saving component, Appliances, produced 3% of energy savings.

Higher Realization Rates

- The upstream lighting component achieved a 1.07 realization rate due to higher ex post baseline bulb equivalencies based on the ENERGY STAR® Qualified Products List (QPL).

Lower Realization Rates

- The energy efficiency kit, single-family direct installation (SFDI), and multi-family direct installation (MFDI) components achieved lower rates due to lower ex post installation rates.
- The appliance rebate component achieved 0.91 due to a lower ex post heating reduction value for smart thermostats.[1]

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	2,857,216	42.94	98,483	105,055	91%	1.07
Appliances	13,383	317.27	4,271	3,883	3%	0.91
Multi-Family Direct Installation	88,298	60.12	3,294	2,818	2%	0.86
Energy Efficiency Kits	77,922	36.78	2,785	2,392	2%	0.86
HVAC Equipment	2,528	397.24	1,004	1,004	1%	1.00
Single-Family Direct Installation	13,385	68.27	534	504	< 1%	0.94
TOTAL OR AVERAGE WEIGHTED VALUE	**3,052,732**		**110,372**	**115,657**	**100%**	**1.05**

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

[1] Based on results from the 2018 Appliance Rebate Survey.

Program Demand Impacts by Component

The upstream lighting component produced the majority of demand savings (88%). The second-most demand-saving component (appliances) produced 6%.

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	2,857,216	7.65	17,552	18,723	88%	1.07
Appliances	13,383	97.98	1,193	1,194	6%	1.00
Multi-Family Direct Installation	88,298	7.37	527	460	2%	0.87
Energy Efficiency Kits	77,922	4.54	409	359	2%	0.88
HVAC Equipment	2,528	224.17	567	567	3%	1.00
Single-Family Direct Installation	13,385	7.97	85	81	< 1%	0.95
TOTAL OR AVERAGE WEIGHTED VALUE	**3,052,732**		**20,333**	**21,383**	**100%**	**1.05**

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

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	69,880	73,832	63.84%	1.06
Specialty LEDs	28,603	31,223	27.00%	1.09
Total Savings for Upstream Lighting	**98,483**	**105,055**	**90.83%**	**1.07**
Standard LEDs	42	43	0.04%	1.03
Specialty LEDs	3	3	< 0.01%	0.97
Smart Thermostats	2,251	1,860	1.61%	0.83
Clothes Washers	481	481	0.42%	1.00
Refrigerators	309	309	0.27%	1.00
Heat Pump Water Heaters	422	422	0.36%	1.00
Dehumidifiers	353	353	0.30%	1.00
Air Purifiers	< 1	< 1	< 0.01%	1.60
Pool Pumps	412	412	0.36%	1.00
Total Savings for Appliances	**4,271**	**3,883**	**3.36%**	**0.91**
Multi-Family DI LEDs	2,551	2,297	1.99%	0.90
Multi-Family DI Nightlights	67	81	0.07%	1.21
Multi-Family DI Smart Power Strips	368	217	0.19%	0.59
Multi-Family DI Showerheads	235	171	0.15%	0.73
Multi-Family DI Faucet Aerators	74	52	0.05%	0.71
Total Savings Multi-Family DI	**3,294**	**2,818**	**2.44%**	**0.86**
Energy Efficiency Kit LEDs	1,627	1,627	1.41%	1.00
Energy Efficiency Kit Nightlights	223	223	0.19%	1.00
Energy Efficiency Kit Showerheads	811	430	0.37%	0.53
Energy Efficiency Kit Faucet Aerators	125	112	0.10%	0.90
Total Savings Energy Efficiency Kits	**2,785**	**2,392**	**2.07%**	**0.86**
Central Air Conditioners	584	584	0.51%	1.00
Air Source Heat Pumps	210	210	0.18%	1.00
Ductless Mini-Splits	144	144	0.12%	1.00
Ground Source Heat Pumps	66	66	0.06%	1.00
Total Savings for HVAC Equipment	**1,004**	**1,004**	**0.87%**	**1.00**
Single-Family DI LEDs	428	414	0.36%	0.97
Single-Family DI Nightlights	17	17	0.02%	1.00
Single-Family DI Smart Power Strips	76	63	0.05%	0.83
Single-Family DI Showerheads	11	9	0.01%	0.76
Single-Family DI Faucet Aerators	1	1	< 0.01%	0.88
Total Savings Single-Family DI	**534**	**504**	**0.44%**	**0.94**

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	12,454	13,159	61.54%	1.06
Specialty LEDs	5,098	5,565	26.02%	1.09
Total Savings for Upstream Lighting	**17,552**	**18,723**	**87.56%**	**1.07**
Standard LEDs	7	8	0.04%	1.03
Specialty LEDs	1	1	< 0.01%	0.97
Smart Thermostats	314	314	1.47%	1.00
Clothes Washers	68	68	0.32%	1.00
Refrigerators	57	57	0.27%	1.00
Heat Pump Water Heaters	57	57	0.27%	1.00
Dehumidifiers	80	80	0.38%	1.00
Air Purifiers	< 1	< 1	< 0.01%	1.60
Pool Pumps	609	609	2.85%	1.00
Total Savings for Appliances	**1,193**	**1,194**	**5.58%**	**1.00**
Multi-Family DI LEDs	455	409	1.91%	0.90
Multi-Family DI Nightlights	-	-	0.00%	-
Multi-Family DI Smart Power Strips	33	19	0.09%	0.59
Multi-Family DI Showerheads	30	22	0.10%	0.73
Multi-Family DI Faucet Aerators	9	9	0.04%	1.00
Total Savings Multi-Family DI	**527**	**460**	**2.15%**	**0.87**
Energy Efficiency Kit LEDs	290	290	1.36%	1.00
Energy Efficiency Kit Nightlights	-	-	0.00%	-
Energy Efficiency Kit Showerheads	104	55	0.26%	0.53
Energy Efficiency Kit Faucet Aerators	16	14	0.07%	0.90
Total Savings Energy Efficiency Kits	**409**	**359**	**1.68%**	**0.88**
Central Air Conditioners	473	473	2.21%	1.00
Air Source Heat Pumps	66	66	0.31%	1.00
Ductless Mini-Splits	16	16	0.07%	1.00
Ground Source Heat Pumps	12	12	0.05%	1.00
Total Savings for HVAC Equipment	**567**	**567**	**2.65%**	**1.00**
Single-Family DI LEDs	76	74	0.35%	0.97
Single-Family DI Nightlights	-	-	0.00%	-
Single-Family DI Smart Power Strips	7	6	0.03%	0.83
Single-Family DI Showerheads	1	1	0.01%	0.76
Single-Family DI Faucet Aerators	< 1	< 1	< 0.01%	0.88
Total Savings Single-Family DI	**85**	**81**	**0.38%**	**0.95**

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 5.8, 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	17
Units	3,052,732
Annual Energy Savings (kWh)	115,656,613
Coincident Peak Savings (kW)	21,383
Third-Party Implementation Costs	$3,422,381
Utility Administration Costs	$1,114,334
Utility Incentive Costs	$7,171,420
Participant Contribution to Incremental Measure Costs	$10,954,317

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

Benefit- Cost Test Results – Efficient Products	Ratio
Total Resource Cost	5.8
Participant Cost Test	8.2
Ratepayer Impact Measure	0.7
Utility Cost Test	7.7

Changes Since 2017 – Appliances

In 2018, AEP Ohio launched the Online Energy Efficiency Marketplace which allowed customers to purchase select incentivized products directly through an online store (standard LEDs, specialty LEDs, and smart thermostats).

- Customers were also able to complete their rebate applications through the Online Energy Efficiency Marketplace.

Changes in 2018

- Program staff added rebates for pool pumps and dehumidifiers.
  - Dehumidifier rebates were instituted once again in 2018 after discontinuing the rebate in 2017.
- Program staff removed rebates for air purifiers early in 2018.

APPLIANCE REBATE AMOUNTS IN 2018

Appliance Type	Rebate Amounts	Purchase Mechanism
Standard LEDs	$1.50	Direct Purchase through Marketplace
Specialty LEDs	$3	
Smart Thermostats – Gas Heated Homes	$25[1]	Direct Purchase through Marketplace or through Contractor or Downstream Rebate for Purchases through Retailer
Smart Thermostats – Electric Heated Homes	100	
Clothes Washers[2]	$50	Through Contractor or Downstream Rebate for Purchases through Retailer
Dehumidifiers	$25	
Refrigerators	$50	
Water Heater – Electric Heat Pump	$500	
Pool Pumps – Variable Speed Drive	$350[3]	

[1] Customers who asked for an exception to receive the 2017 rebate amount ($75) were granted an exception.

[2] Clothes washer rebates were only offered beginning in June 2018 due to ENERGY STAR® specification changes.

[3] Maximum rebate provided was restricted to 50% of the purchase price, up to $350.

Changes Since 2017 – Lighting & HVAC

Lighting

The program adjusted incentives for LED upstream lighting products over the course of the year to meet savings goals.

LIGHTING INCENTIVE AMOUNTS IN 2018			
Type	**Minimum Incentive**	**Average Incentive**	**Maximum Incentive**
Standard LEDs	$0.50	$1.35	$1.50
Specialty LEDs	$1.00	$2.16	$3.50
LEDs Overall	**$0.50**	**$1.53**	**$3.50**

HVAC

In 2018, the program discontinued a second tier of rebates for the early replacement of air conditioners and air source heat pumps. Incentives were consistent throughout the year for HVAC equipment.

HVAC EQUIPMENT REBATE AMOUNTS IN 2018	
Appliance Type	**Rebate Amounts**
Central Air Conditioners	$150
Air Source Heat Pumps	$300
Ductless Mini-Split Heat Pumps	$300
Ground Source Heat Pumps	$1,200

Program Activity

Across all components, specialty LEDs represented 21% of all program-incentivized LEDs. This portion grew from 20% in 2017.

- AEP Ohio increased the number of incentivized specialty LEDs from 2017 to 2018, however the number of program-incentivized standard LEDs also grew from 2017 to 2018.

LEDS ACROSS ALL EFFICIENT PRODUCT PROGRAM COMPONENTS

Product	2017 LED Units	2018 LED Units
Standard LEDs	2,175,687	2,357,644
Specialty LEDs	550,725	638,650
Specialty LEDs as a Percent of All Incentivized LEDs	**20%**	**21%**

Note: Total unit counts do not match those found on pp 13 - 16 as this table represents counts of all LEDs across all program components (not just upstream lighting).

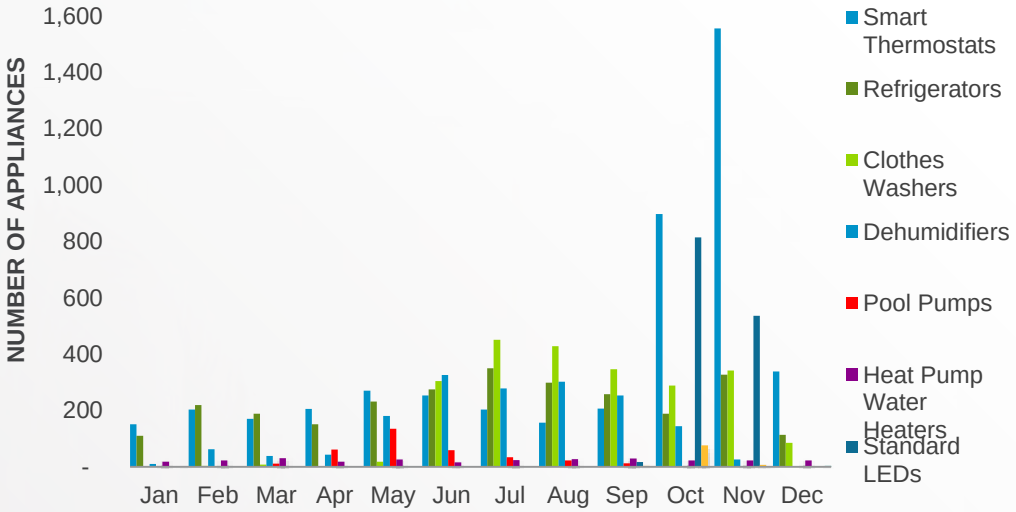
ENERGY STAR® filament LEDs gained popularity in 2018. The number of standard and specialty incentivized ENERGY STAR® filament LEDs increased by 170% from 2017 to 2018 (from 15,584 in 2017 to 42,044 in 2018).

Program Activity

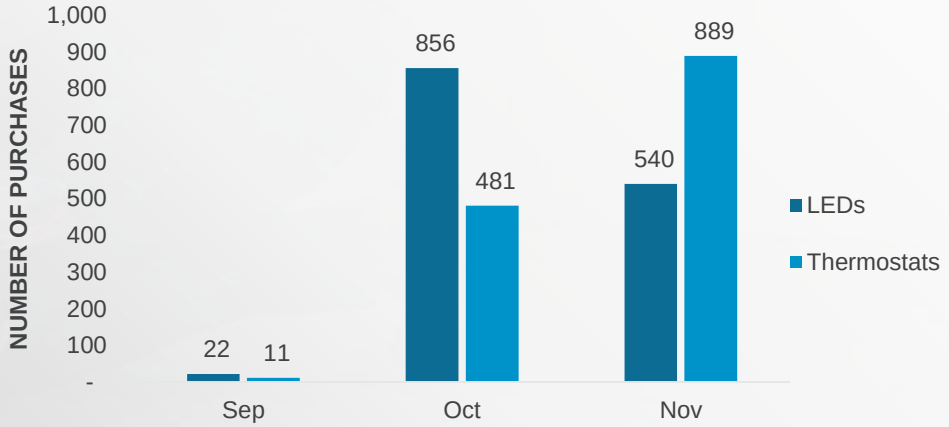
(continued)

- The appliance rebate component incentivized fewer units of equipment in 2018 than in 2017 (down 38% from 21,478 in 2017 to 13,383 in 2018).
- More than one-third of all program-rebated appliances were purchased in October and November (39%).
- Clothes washer rebates began in June due to an anticipated change in ENERGY STAR® specifications.
- Smart thermostat rebates spiked in November (1,555 units).
- Pool pump rebates spiked in April and May (136 units rebated).
- The program also allowed customers to purchase select LEDs and smart thermostats directly through the newly launched Online Energy Efficiency Marketplace starting in August 2018.
  - Though direct purchases through the Marketplace were low initially, participation spiked in October for LEDs (856 units) and November for smart thermostats (889 units).
  - Customers were allowed to purchase 1 smart thermostat and 12 of each LED bulb type.

APPLIANCE SALES BY MONTH[1, 2]



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



[1] Based on "MeasInstallDate" field.

[2] One clothes washer did not have a valid date field for "MeasInstallDate".

[3] Excludes seasonal lighting for which AEP Ohio did not claim savings.

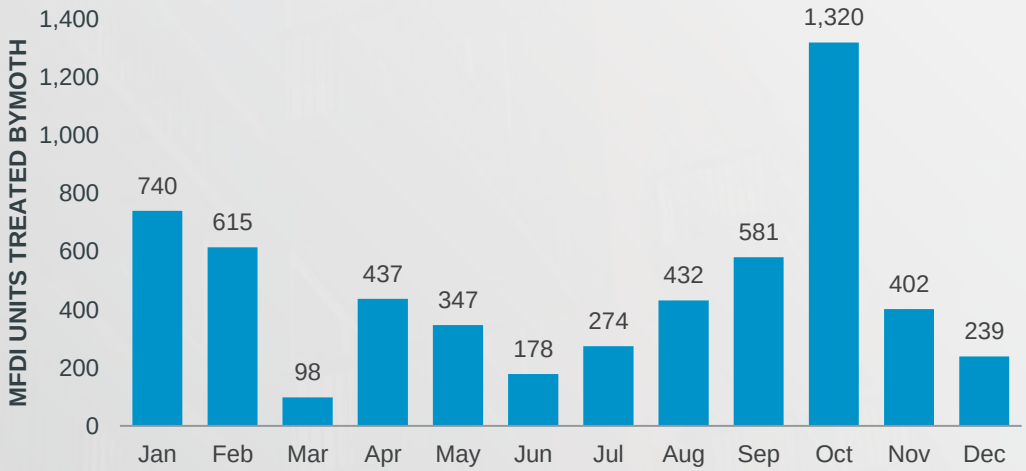
Program Activity

(continued)

Program staff treated 5,663 multi-family units in 2018, visiting 50 different multi-family properties.

- Program staff installed more MFDI measures in 2018 than in 2017 (87,143 in 2017 versus 88,298 in 2018).
- Program staff treated an average of 111.1 units per participating multi-family property.
- Program staff visited almost one-quarter of all sites (23%) in October.

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 appliance rebate component until the Online Energy Efficiency Marketplace was launched.
- Also responsible for most marketing activities for the Efficient Products Program.
- Handled incoming customer phone calls regarding appliance rebate applications until September 2018.

Enervee

Role

Implementer of the Online Energy Efficiency Marketplace.

Responsibilities

- Administered the appliance rebate component once the Marketplace site was set to handle applications in February 2018.
- Processed appliance rebate applications and direct purchases through the marketplace website.
- Handled emailed customer questions regarding appliance rebate applications and contacted customers regarding issues processing their application.
- Handled incoming customer telephone calls regarding appliance rebate applications after September 2018.

EnergySavvy

Role

Implementer of the Online Home Energy Profile.

Responsibilities

- Administered the Online Home Energy Profile.
- Coordinated with subcontractors and CLEAResult to send out energy efficiency kits requested after completion of the Online Home Energy Profile.

Marketing Activities

Program staff also undertook similar activities to 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)
- Social media posts (Facebook and Twitter)
- 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 (launched July 2018)

Challenges Cited by Program Staff

Program staff identified several challenges to the administration of the program:

Issues with Appliance Rebate Models

Initially, the list of model numbers used on the Marketplace website did not include many rebate-eligible models. As a quick solution, Enervee allowed customers to apply for appliance rebates by email without an application form. Therefore:

- Customers submitting applications with missing critical information.
- Customers contacted staff outside of their typical customer relationship management system and customers felt they were not kept informed on their application status.
- Responses to customer application issues were often sent to spam folders.

Response: AEP Ohio switched back to their previous implementer (CLEAResult) for 2019 appliance rebate processing.

Customer Complaints of Slow Rebate Processing

Slow processing was caused by the following:

- CLEAResult managed incoming customer questions through their call center until September.
  - CLEAResult staff had to ask Enervee staff to send along information for each individual customer issue, resulting in multiple interactions for each issue.
- Enervee had difficulty setting up automated connection to AEP Ohio customer databases (API calls).
  - Enervee used a slower, manual process to look up customer eligibility using a copy of the AEP Ohio residential customer database.

Response: issues with program applications were reduced when Enervee launched API calls in September.

Issues Related to Tango Gift Cards

AEP Ohio began offering Tango email gift cards in lieu of mailed rebate checks in 2018. Program staff faced the following issues with those gift cards:

- A portion of customers did not wish to receive an online gift card.
- Emails from Tango were marked as spam and went into a spam folder.
- Customers did not associate their Tango gift card with their participation in the Appliance Rebate program.

Response: AEP Ohio provided physical gift cards for those customers requesting a physical alternative and absorbed the cost of issuing the gift card ($3).

Transition to the Online Energy Efficiency Marketplace in 2018

January

CLEAResult®

Continues to Process Appliance Rebates

February

enervee®

Begins Processing Appliance Rebates through the Marketplace Website

March

CLEAResult®

Stops Processing Appliance Rebates

May

enervee®

Allows Email Appliance Rebate Submissions to Address Model Number Issues on Marketplace Appliance Rebate Applications

April

enervee®

Begins Distributing Physical Gift Cards Upon Customer Request

September

CLEAResult®

Handles Appliance Rebate Customer Calls Through August

enervee®

Launches Customer Call Center, Begins Handling Appliance Rebate Customer Calls in September

enervee®

Fixes Model Number Issue on the Marketplace Rebate Application

enervee®

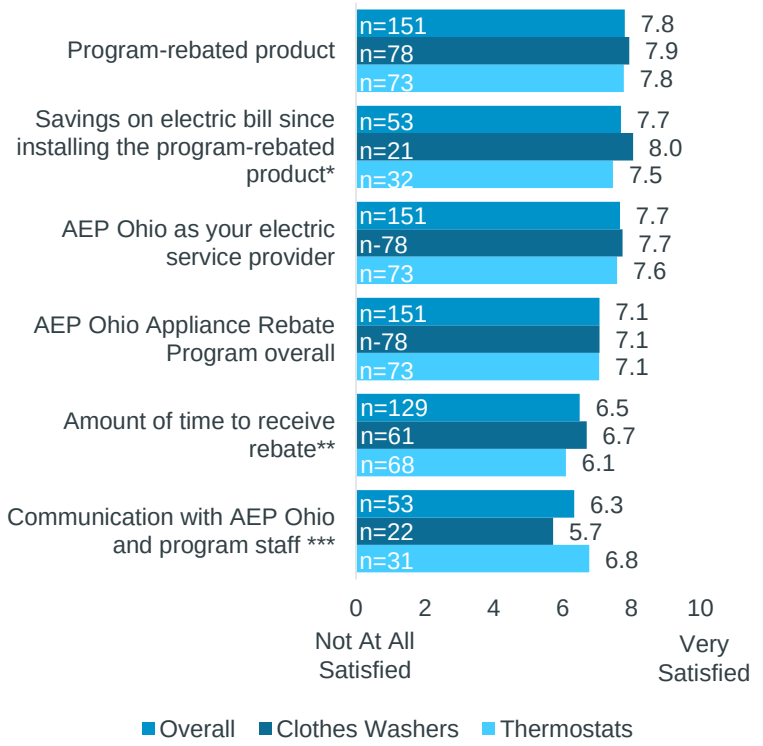
Launches Direct Purchases through the Marketplace

Appliance Rebate Survey

Satisfaction

- All appliance rebate survey satisfaction results were lower in 2018 than in 2017.
- Respondents provided the highest average satisfaction rating for their program-rebated product (mean = 7.8), followed by savings achieved as a result of installing the product (mean = 7.7).
- Respondents provided the lowest satisfaction ratings for communication with AEP Ohio and program staff (mean = 6.3) and the amount of time it took to receive their rebate (mean = 6.5).
  - When asked to explain their rationale, respondents noted poor customer service and confusion regarding the rebate process.
- 58 respondents offered feedback on program improvements, including: more timely rebate processing, requests for more products and equipment eligible for rebates, and simplifying the rebate process.
- Respondents were, on average, satisfied with AEP Ohio as an electric service provider (mean = 7.7, down from 8.2 in 2017).
  - Satisfied customers (rating of 8 to 10) noted AEP Ohio's: reliability, customer service, adaptive technology, and prompt response to outages.
  - Dissatisfied customers (rating of less than 5) noted: high costs of energy, problems with rebate applications, and 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 rebate.*
**** Question asked of participants who contacted AEP Ohio/program staff with questions in the course of participating in the AEP Ohio Appliance Rebate Program.*

Appliance Rebate Survey

(continued)

Rebates and Rebate Processing Time

- Of those customers who received their rebate, about half of respondents (47%) were very satisfied (rated 8 to 10) with the amount of time the rebate process took; however, dissatisfied respondents resulted in a lower mean rating (6.7).
  - 14 respondents rated their satisfaction a 0 for the amount of time the rebate process took.
  - Means were similar for both clothes washer and smart thermostat respondents.

MEAN SATISFACTION WITH TIME TO RECEIVE REBATE		
Overall (n=129)	Clothes Washer (n=61)	Thermostat (n=68)
6.5	6.7	6.1

Of those who recalled receiving their rebate, more than one-third (35%, or 45 respondents) estimated it took four weeks or longer to receive the rebate.

- Seven customers noted that they only received their rebate after multiple phone calls and/or emails to customer service.
- Twenty-one customers reported never receiving their rebate.
- 38% of respondents could not remember how long it took them to receive a rebate.

- Of those flagged as receiving an emailed gift card in the tracking data (99% of respondents) just over half of (52%, or 68 respondents) reported that they would have liked to receive the rebate in another format.
  - More than half (54%, or 37 respondents) preferring another format would prefer a mailed check. The second most popular option (n=15) was a mailed Visa card. Of the 7 open-ended responses, 5 noted they would have preferred a credit to their AEP Ohio bill.
  - More than two-thirds of customers preferring another rebate format (67%, or 46 respondents) gave neutral or satisfied ratings regarding the time it took to receive their rebate, suggesting that customer preferences for other rebate formats are not simply a by-product of issues with rebate delays.

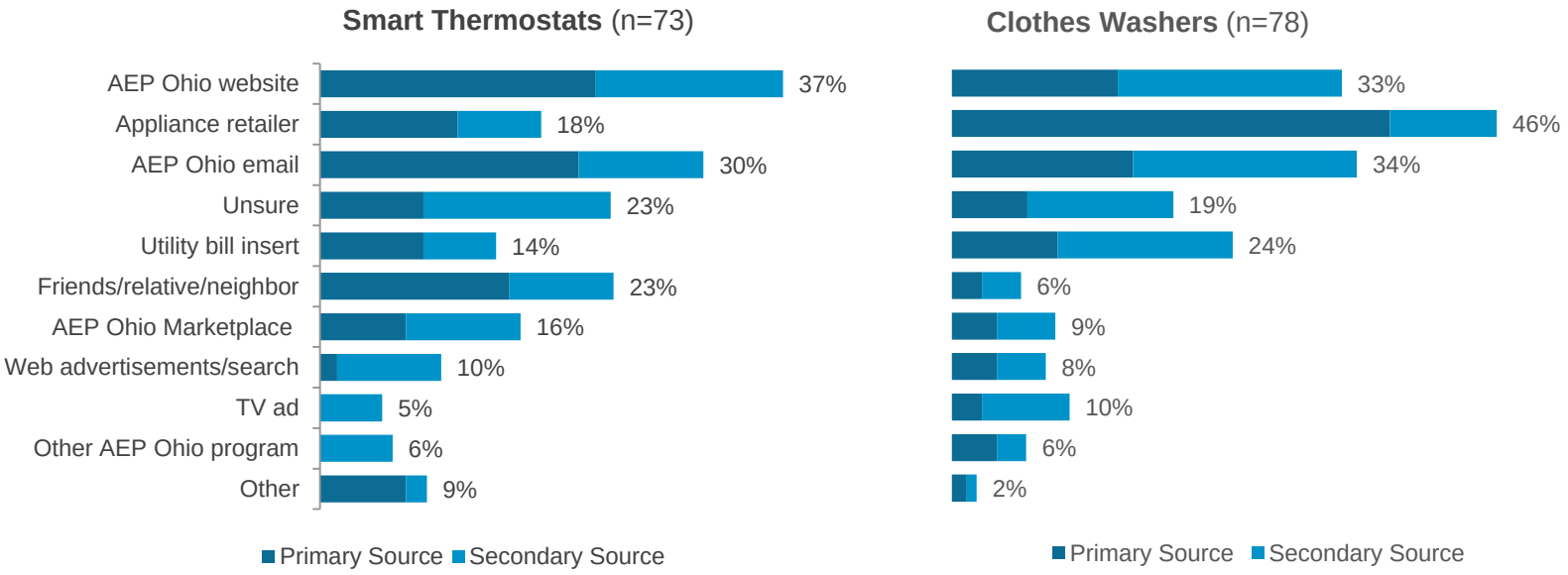
Appliance Rebate Survey

(continued)

Awareness

- Smart thermostat respondents most often reported learning about the program through the AEP Ohio website (37%).
- The top three sources of awareness for clothes washer respondents were: appliance retailers, AEP Ohio emails, and the AEP Ohio website.
  - Clothes washer respondents most often reported learning about the program through their appliance retailer (46%).
- The third most often cited source of awareness overall was AEP Ohio emails (30% for smart thermostats and 34% for clothes washers).

SOURCES FROM WHICH CUSTOMERS LEARNED ABOUT THE APPLIANCE REBATE PROGRAM



Note: Multiple responses allowed. Sources accounting for less that 5% were excluded: social media, newspaper, radio ad, contractor, and community events.

Appliance Rebate Survey

(continued)

Clothes Washers

- 63% of clothes washer respondents reported that they purchased a new clothes dryer within two weeks of purchasing their new clothes washer.
- More respondents purchasing rebated clothes washers report purchasing their equipment through a physical retail store (87%) compared to respondents purchasing rebated smart thermostats (42%).
- Of the people who did purchase their product at a store, 44% remembered seeing AEP Ohio promotional materials at the store. The remainder either reported that they did not see materials (40%) or were unsure whether they did (15%).

PERCENTAGE OF CUSTOMERS WHO PURCHASED REBATED PRODUCT AT A PHYSICAL RETAIL STORE

Overall (n=151)	Thermostat (n=73)	Clothes Washer (n=78)
66%	42%	87%

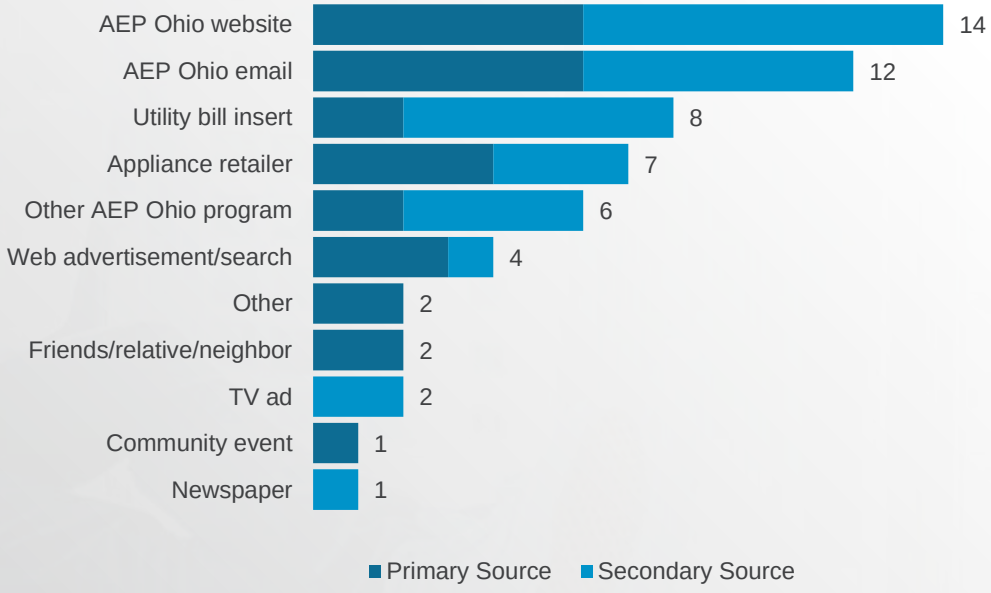
Appliance Rebate Survey

(continued)

Rebates and Rebate Processing Time

- 19% of all respondents used the AEP Ohio Online Energy Efficiency Marketplace to research products (n=28).
- Respondents most commonly learned about the Marketplace through the AEP Ohio website, emails from AEP Ohio, and an appliance retailer.
- When asked why they chose to browse products using the Marketplace instead of using another online source, the most common responses were:
  - Ability to compare energy efficiency scores between products (n=15).
  - Ease of using the fast-track rebate through AEP Ohio (n=13).
  - Convenience of the information listed on the site (n=9).

SOURCES FROM WHICH CUSTOMER LEARNED ABOUT MARKETPLACE



Appliance Rebate Survey

(continued)

Issues with Electronic Gift Cards

- Electronic gift cards were a new addition to the Efficient Products program in 2018.
- Twenty-one appliance survey respondents (14% of 151 respondents) reported that they did not receive their electronic gift card.
- Of those who did recall receiving their incentive, more than one-third (35%, or 45 respondents) reported that it took four weeks or more to receive their electronic gift card.
- After investigating instances of customers not receiving their electronic gift card, AEP Ohio found that electronic gift cards often went to customer email spam folders. When AEP Ohio staff learned of issues with electronic gift cards, program staff contacted customers to rectify the situation, often reissuing electronic gift cards or sending customers physical gift cards.

Energy Efficiency Marketplace

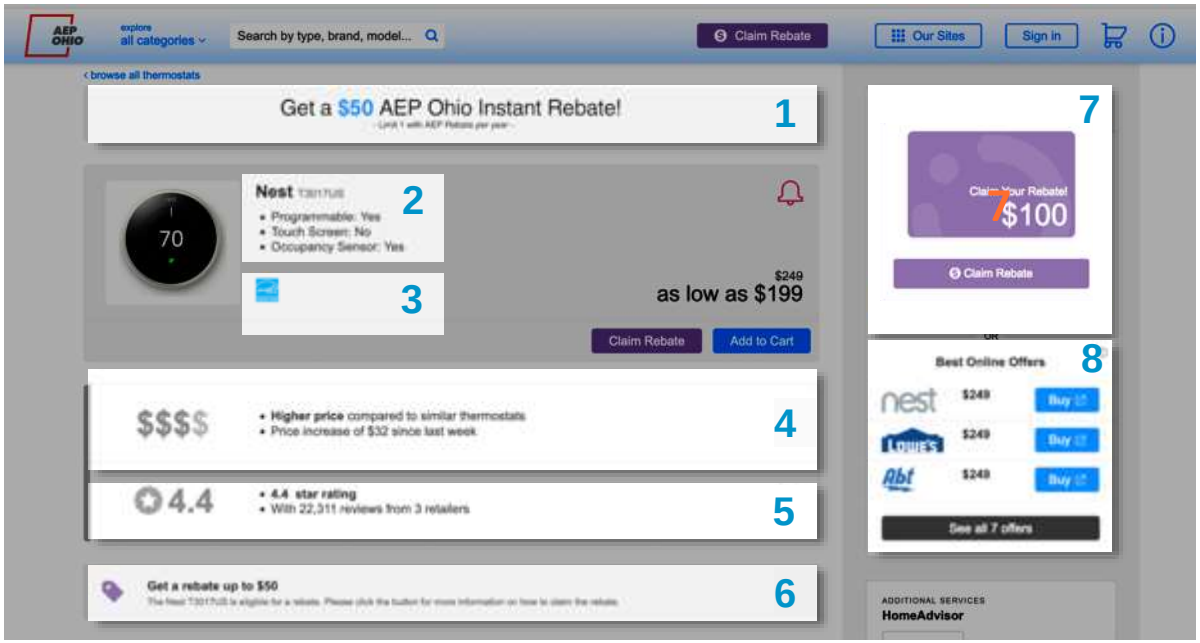
As this survey was the first time evaluating the Energy Efficiency Marketplace, the evaluation team asked respondents to reflect on their experience using the AEP Ohio Energy Efficiency Marketplace website.

- Only 28 respondents (19% of all respondents) reported using the Energy Efficiency Marketplace to research their equipment purchase.
  - The evaluation team therefore conducted a qualitative analysis of results.[1]

These 28 respondents 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 find the element useful?

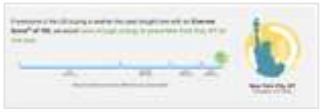
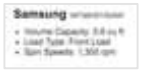
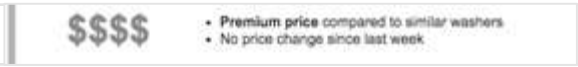
ELEMENTS OF SURVEY FOCUS ON MARKETPLACE WEBSITE



[1] Due to the small respondent pool, responses to questions regarding the Energy Efficiency Marketplace are not generalizable. However, similar to usability testing procedures, a small sample of respondents can be used to provide directional feedback regarding what could be improved with the design of a website.

Energy Efficiency Marketplace: Clothes Washers

RECALL AND USEFULNESS OF MARKETPLACE WEBSITE ELEMENTS: CLOTHES WASHERS (n=12)

Element Description	Number that Recalled Seeing Element	Number that Found Element Useful[1]	Image of Element
Savings potential	9	10	
Discussion of Efficiency rating	9	9	
Efficiency rating	5	7	
Product rating	4	6	
National energy-saving potential	2	5	
Product specs	3	4	
Link to claim rebate	4	3	
Price rating	3	2	
ENERGY STAR® logo	2	2	
Rebate offer	3	1	
Best online offers	1	1	

[1] Respondents who did not recall seeing an element were still asked to note elements they would find useful for researching their purchase. Therefore, the count of that found an element useful may be larger than the count of respondents who recall seeing an element.

Energy Efficiency Marketplace: Smart Thermostats

RECALL AND USEFULNESS OF MARKETPLACE WEBSITE ELEMENTS: SMART THERMOSTATS (n=16)

Element Description	Number that Recalled Seeing Element	Number that Found Element Useful[1]	Image of Element
Product rating	9	9	
Link to claim rebate	9	9	
Best online offers	8	8	
Online offers with price and store links	7	8	
Price drop trends	6	8	
Product specs	10	7	
Rebate offer	4	6	
Price rating	3	6	
Price ranking compared to other thermostats	4	5	
Map of local stores	4	5	
Link to claim rebate	3	3	
ENERGY STAR® logo	0	1	

[1] Respondents who did not recall seeing an element were still asked to note elements they would find useful for researching their purchase. Therefore, the count of that found an element useful may be larger than the count of respondents who recall seeing an element.

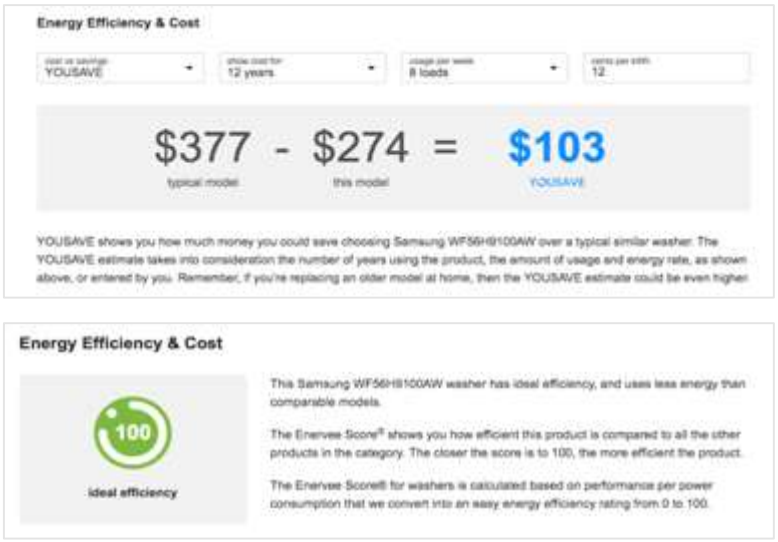
Energy Efficiency Marketplace: Overall Most Useful and Least Useful Element

MOST USEFUL ELEMENT OVERALL	LEAST USEFUL ELEMENT OVERALL
	
6 clothes washer respondents; 9 thermostat respondents found element useful	2 clothes washer respondents; 1 thermostat respondent found element useful[1]

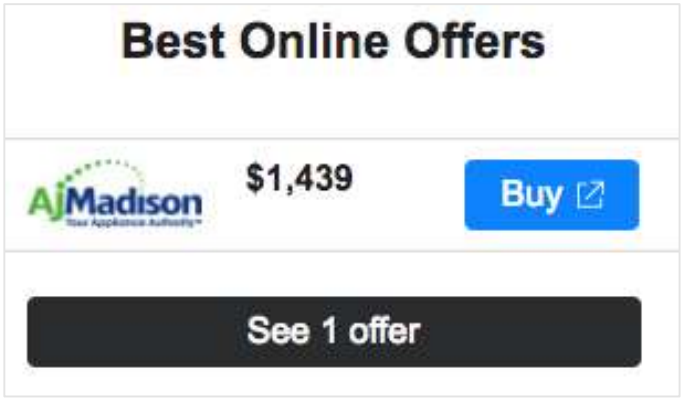
[1] The evaluation team does not advocate removing the ENERGY STAR® logo from the website.
Note: This question was only asked of respondents that used the AEP Ohio Online Energy Efficiency Marketplace to research their equipment.

Energy Efficiency Marketplace: Clothes Washers Most Useful and Least Useful Element

MOST USEFUL ELEMENTS

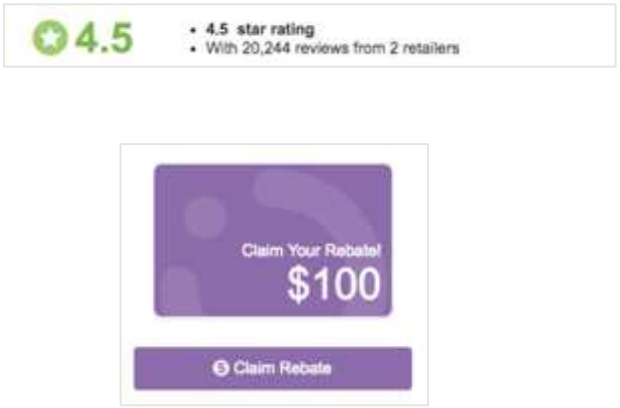
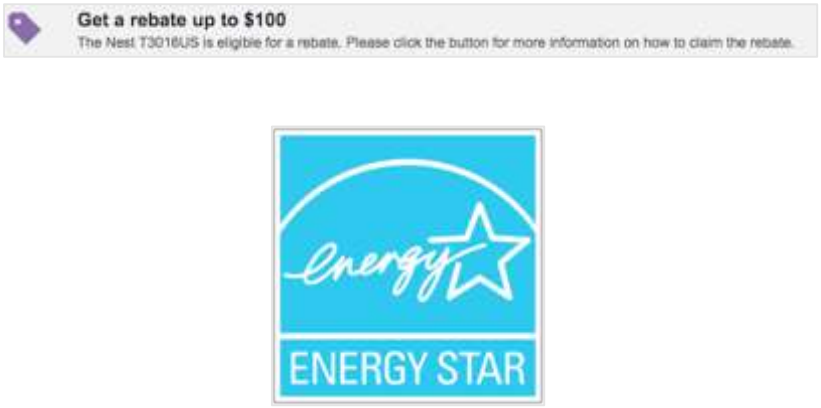


LEAST USEFUL ELEMENTS



Note: This question was only asked of respondents that used the AEP Ohio Online Energy Efficiency Marketplace to research their washer (n=12)

Energy Efficiency Marketplace: Smart Thermostats Most Useful and Least Useful Element

MOST USEFUL ELEMENTS	LEAST USEFUL ELEMENTS[1]
	

[1] The evaluation team does not advocate removing the ENERGY STAR® logo from the website.
Note: This question was only asked of respondents that used the AEP Ohio Online Energy Efficiency Marketplace to research their smart thermostat (n=16).

MFDI Audits

Multi-Family Installations

The evaluation team examined all 2018 multi-family direct installation data to characterize this component of the program.

In 2018, LED lighting constituted more than 85 percent of all multi-family measures.

- The multi-family direct installation audits found program bulbs installed in traditionally low-use sockets such as closets and hallways.
  - CLEAResult instructs their staff not to install program bulbs in low-use sockets.
  - It is unknown if the bulbs were initially installed in low-use sockets, 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.

MFDI Audits

(continued)

In-unit ISRs

To compute the 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 0.90, which was greatly impacted by a single site audit where a large number of bulbs had been installed and subsequently removed.
- On-site audits of multi-family direct installations revealed one tenant had 24 LED bulbs installed in the home and had removed all of these bulbs when they moved out of the unit.
- The results from this single unit (out of the 35 units audited) decreased the overall ISR by 0.05 (the ISR without this home was 0.95). This is similar to 2017 audit results.

MFDI Audits

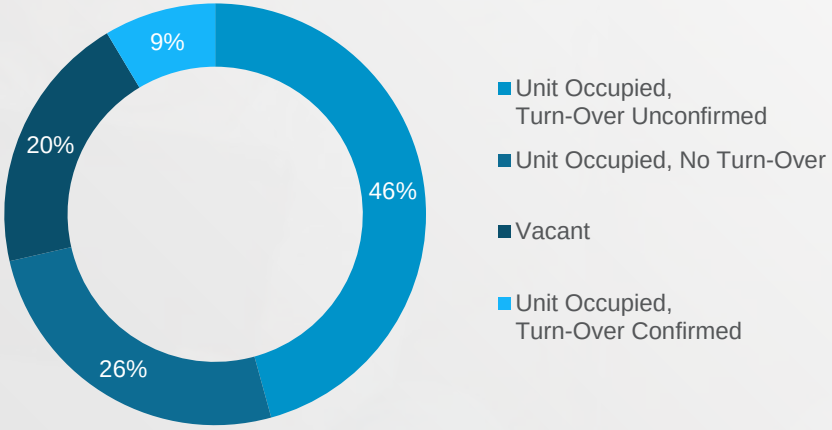
(continued)

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 9 percent of units were currently occupied by a different tenant than when measure installation occurred.
- For another 46 percent of units, the tenant was not present for the audit, and 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 (0.95) compared to vacant units (0.90), and ISRs were even higher for tenants present during the audit for LEDs (0.96) when compared to units with no tenant presence (0.86). However, sample sizes were too small to detect significant differences.



04

Recommendations

Update LED Bulb Baseline Wattage Equivalencies

The evaluation team recommends updating the baseline equivalencies for LED bulbs. In 2018, AEP Ohio applied baseline bulb equivalencies based on the ENERGY STAR® Qualified Products List (QPL) from 2016. LED bulbs have become more efficient over the last two years, and this has shifted the bulb equivalencies. The evaluation team recommends applying the *ex post* baseline equivalencies shown in the tables below in 2019 which are based on the 2018 QPL.

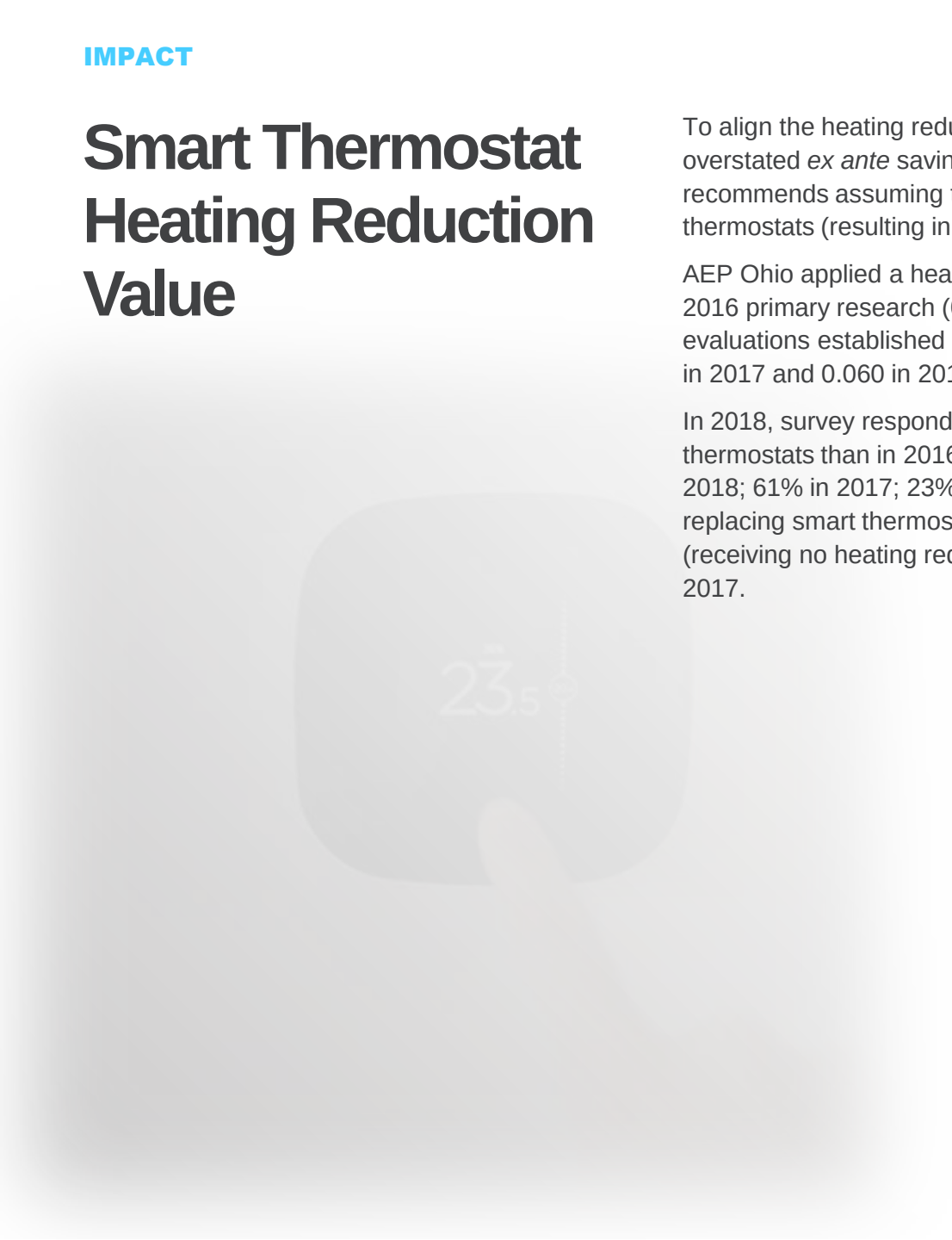
RECOMMENDED STANDARD LED BASELINE WATTAGE, BY PROGRAM MEASURE WATTAGE

Program LED Measure Wattage	*Ex Post* Baseline Wattage for Standard Bulbs
4 – 5	29
6 – 10	43
11 – 13	53
14 – 22	72
23 +	150

RECOMMENDED SPECIALTY LED BASELINE WATTAGE, BY PROGRAM MEASURE WATTAGE

Program LED Measure Wattage	*Ex Post* Baseline Wattage for Specialty Bulbs
2 – 3	25
4 – 5	40
6 – 7	50
8 – 10	65
11 – 15	90
16 – 23	120
24 +	250

Smart Thermostat Heating Reduction Value



To align the heating reduction value with the current trend and to prevent overstated *ex ante* savings for smart thermostats in 2019, the evaluation team recommends assuming that all installed thermostats replace programmable thermostats (resulting in a heating reduction value of 0.056).

AEP Ohio applied a heating reduction value for smart thermostats based on 2016 primary research (0.080). Research conducted for the 2017 and 2018 evaluations established a downward trend in the heating reduction value (0.066 in 2017 and 0.060 in 2018).

In 2018, survey respondents reported a larger portion of programmable thermostats than in 2016, though similar to the portion reported in 2017 (58% in 2018; 61% in 2017; 23% in 2016). 10 percent of 2018 respondents reported replacing smart thermostats with the program-rebated smart thermostats (receiving no heating reduction at all), up from 2 percent of respondents in 2017.

Update ISRs for MFDI, SFDI, and Energy Efficiency Kits

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

The evaluation team recommends updating LED ISRs based on the table below and recommends a review of the ISRs in the TRM.

EX ANTE AND RECOMMENDED ISRS				
Measure	**Component**	**2018 *Ex Ante* ISR**	**Recommended ISR**	**Source of Recommended ISR**
Faucet Aerators	Energy Efficiency Kits	0.48	0.43	2017 Energy Efficiency Kits survey
	MFDI	1.00[1]	0.71	2017 Multi-Family Direct Installation Audits
	SFDI	1.00	0.88	2016 In-Home Evaluation Report
Showerheads	Energy Efficiency Kits	0.48	0.43	2017 Energy Efficiency Kits survey
	MFDI	1.00[1]	0.73	2017 Multi-Family Direct Installation Audits
	SFDI	1.00	0.76	2016 In-Home Evaluation Report
Smart Strips	MFDI	1.00[1]	0.59	2018 Multi-Family Direct Installation Audits
	SFDI	1.00[1]	0.83	2016 In-Home Evaluation Report
LEDs	MFDI	1.00[1]	0.90	2018 Multi-Family Direct Installation Audits
LED Nightlights	MFDI	0.57	0.69	2018 Multi-Family Direct Installation Audits

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

Research and Education for the MFDI Component

The 2018 MFDI audits found that:

- One customer had uninstalled all of the program LEDs when they moved out of the unit. This was also the case in 2017.
- Several customers may have moved LED lights to lower-use sockets after program staff installation.

To remediate these issues, the evaluation team recommends:

1. Performing benchmarking interviews with MFDI program managers at other utilities as part of the 2019 evaluation to better understand how other utilities are managing tenant turnover and bulb persistence issues.
2. Providing a handout to customers educating them on the placement of their LEDs and encouraging them to use LEDs only in high-use sockets.
3. Ensuring that inefficient bulbs removed from sockets are disposed of rather than leaving at the property. This would deter the tenant from installing the inefficient bulbs in other sockets; it would also prevent tenants from re-installing the inefficient bulbs when moving out of the unit.

Ensure Electronic Gift Card Receipt

The evaluation team recommends that AEP Ohio continue taking steps to ensure customers receive their digital incentives.

Electronic gift cards were a new addition to the Efficient Products program in 2018. AEP Ohio has improved the process of electronic gift card distribution in 2019, however, the Appliance Recycling program has issued electronic gift cards for the past two years and Appliance Recycling participants have noted issues with receipt of electronic gift cards in both years.

To ensure receipt of electronic gift cards next year for the Efficient Products program, the evaluation team recommends exploring 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.

Dual Purchase of Clothes Washers and Dryers

The evaluation team found that survey respondents receiving program rebates for clothes washers often purchased a dryer unit within two weeks of their clothes washer purchase.

To capitalize on this dual purchase decision, the evaluation team recommends exploring rebates for energy efficient heat pump clothes dryers upon the purchase of an energy efficient clothes washer (assuming that clothes dryer rebates pass cost-effectiveness testing). There are potential savings associated with heat pump clothes dryers, as indicated in the 2017 to 2019 Peak Demand Reduction Plan.[1] Even small incentives for energy efficient heat pump clothes dryers may sway customers making dual purchasing decisions.

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

Increasing Efficient Products Program Satisfaction in 2019

AEP Ohio attempted to resolve the appliance rebate component challenges and went back to the previous implementer for processing appliance rebates.

The customers who participated in the appliance rebate component, however, may not know these changes occurred and that AEP Ohio acted on customer feedback.

The evaluation team agrees that AEP Ohio has taken proper corrective action to resolve issues in 2018. However, future satisfaction scores may be impacted without further action. To increase customer satisfaction with the Efficient Products program and AEP Ohio overall in 2019, consider:

1. Posting a notice on the Energy Efficiency Marketplace home page acknowledging challenges in 2018 and highlighting program improvements; and
2. Informing residential customers more broadly of changes to the appliance rebate component since 2018 through marketing.

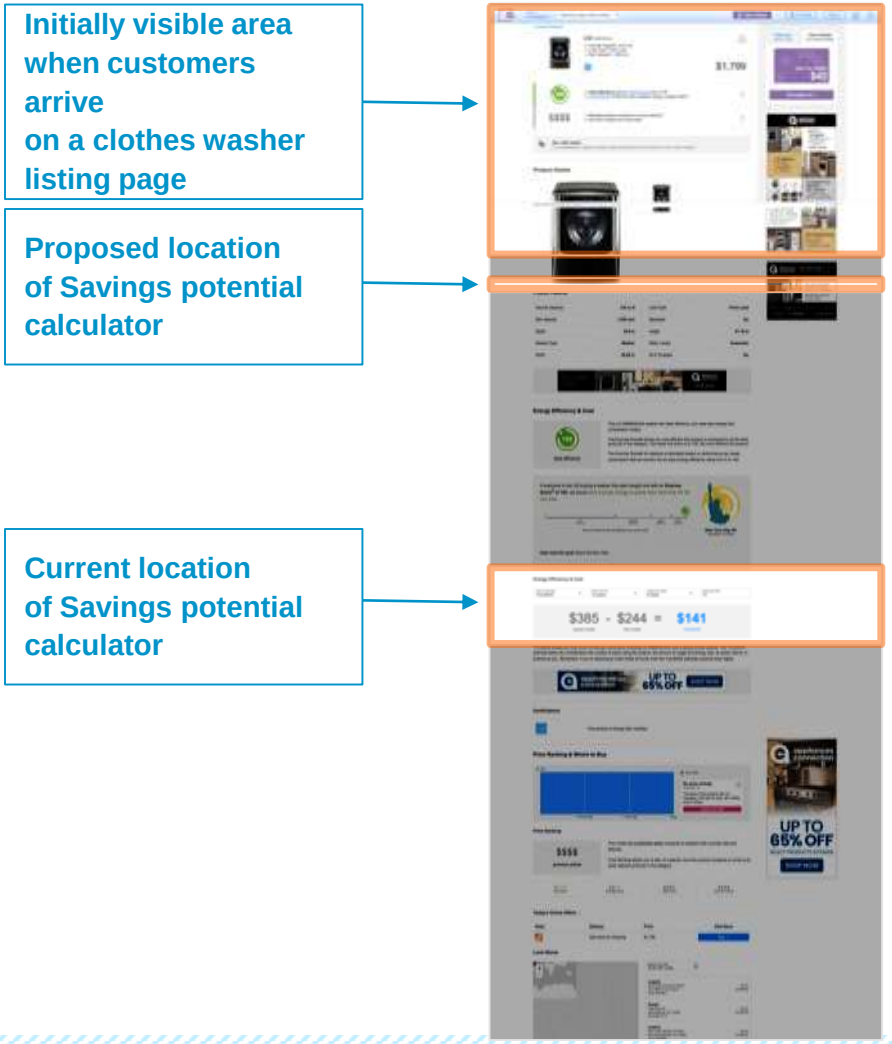
Energy Efficiency Marketplace: Clothes Washer Savings Potential Element

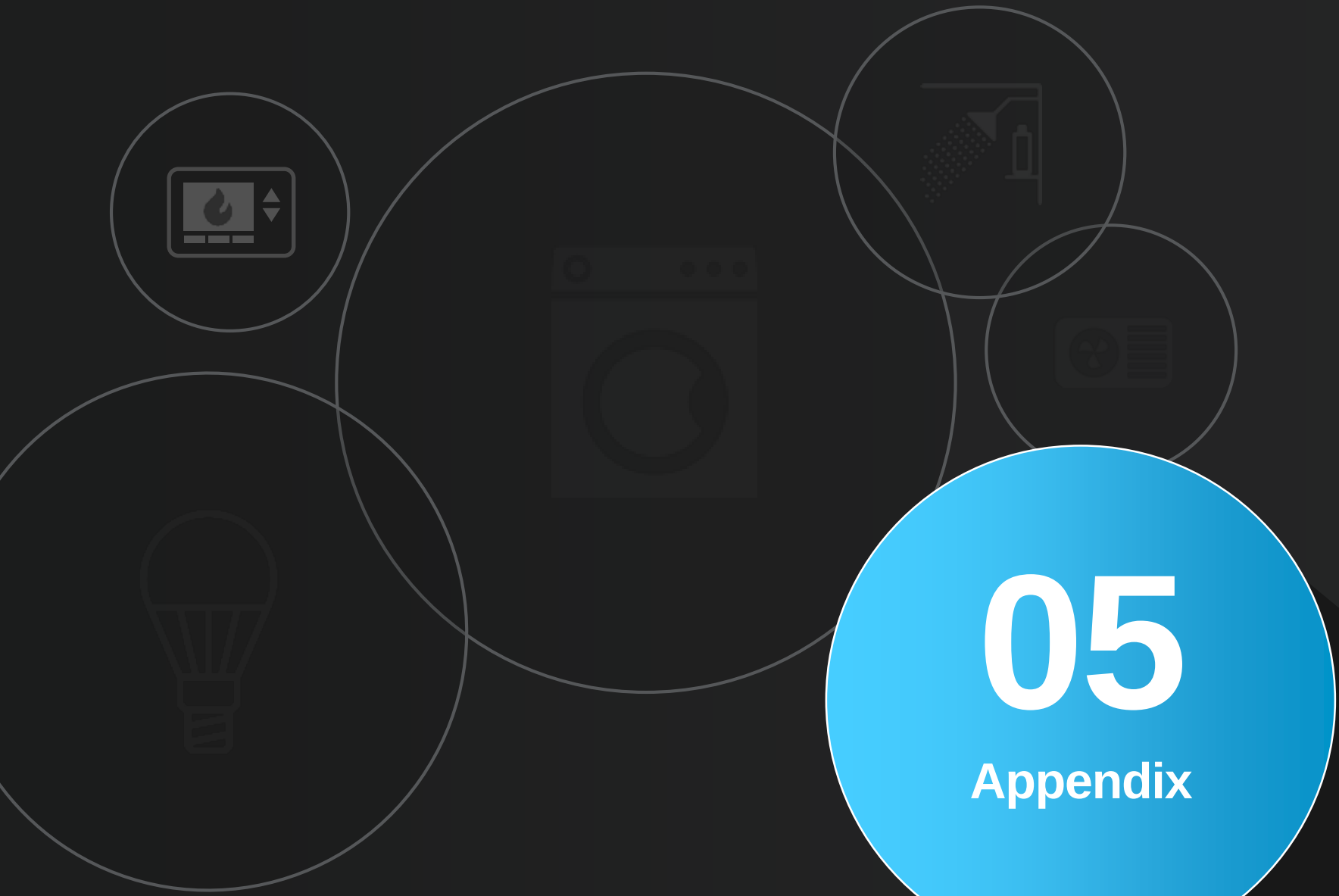
The savings potential calculator is currently posted in the middle of the clothes washer listing page.

The evaluation team asked respondents who used the Energy Efficiency Marketplace to research their clothes washer equipment purchase to identify website elements that they find useful for researching a clothes washer purchase.

Though the sample size of respondents is too small to be generalizable, qualitatively, the savings potential calculator was most often rated as useful compared to other site elements (10 of 12 respondents).

The evaluation team recommends placing the savings potential calculator higher on the page so that customers are more likely to see and use the tool. AEP Ohio may also consider placing elements rated as least useful lower on the 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

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

Equation A-2. *Ex Ante* Demand Savings for LEDs

Summer Coincident Peak kW Savings = (BaselineWatts - 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, ISR equal to 1.00 for all other components
- HOU value of 1,051 hours per year [1]
- CF of 0.13 [2]
- WHFE of 0.93 and 1.34 for WHFD [3]

The table presents the baseline wattages used by AEP Ohio to calculate ex ante savings for each program wattage range. AEP Ohio applied baseline wattage equivalencies used to calculate ex post savings values in 2016.

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

Program LED Measure Wattage	*Ex Ante* Baseline Wattage for Standard Bulbs	*Ex Ante* Baseline Wattage for Specialty Bulbs	Count of Standard LEDs	Count of Specialty LEDs	Overall Count
2 - 3	-	25	-	40,084	40,084
3.1 – 7	29	40	421,085	145,078	566,163
7.1 – 10	43	60	1,767,050	364,840	2,131,890
10.1 – 15	53	75	103,494	80,373	183,867
15.1 – 19	72	100	65,507	7,937	73,444
19.1 +	150	150	508	338	846
TOTAL	–	–	–	–	**2,996,294**

Note. From AEP Ohio program tracking data.
There were no standard 2-3 W LED bulbs incented in 2018.

[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 and Coupon)	0.97 [1]
Online Energy Efficiency Marketplace	0.97 [1]
Energy Efficiency Kits	0.93 [2]
Multi-Family Direct Installation	0.90 [3]
Single-Family Direct Installation	1.00 [4]

[1] Based on a 2014 LED survey of 101 AEP Ohio customers.
[2] Based on 2017 Energy Efficiency Kits Survey
[3] Based on 2018 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)	LEDWatts	10.2	10.2	Tracking Data
Average Standard Wattage (W)	BaselineWatts	64.7	82.3	Evaluation based on 2018 ENERGY STAR® product list, Tracking Data
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 parameters developed for the 2016 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 used in the 2016 *ex post* impact calculations. This value was calculated based on the baseline thermostat technology reported in the 2016 appliance rebate survey and using the IL TRM formula, as shown in Equation A-5. 2016 survey results were used to estimate the percentage of homes with manual thermostats and percentage of homes with programmable thermostats.

Equation A-5. *Ex Ante* Heating Reduction Formula

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

Where:

%ManualThermostats = The percentage of homes replacing manual thermostats (78% in the 2016 appliance rebate survey)

%ProgrammableThermostats = The percentage of homes replacing programmable thermostats (23% in the 2016 appliance rebate survey)

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 2018 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	0.080	0.060	IL TRM and 2018 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	1.00	2016 Appliance Rebate Survey and 2018 Appliance Rebate Survey

Appendix: Impacts Details

(continued)

The *ex post* heating reduction values were calculated based on the baseline thermostat technology reported in the 2018 appliance rebate survey. In 2018, survey respondents reported a larger portion of programmable thermostats than in 2016, though similar to the portion reported in 2017 (58% in 2018; 61% in 2017; 23% in 2016). 10 percent of 2018 respondents reported replacing smart thermostats with the program-rebated smart thermostats (receiving no heating reduction at all), up from 2 percent of respondents in 2017.

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 (32% in the 2018 appliance rebate survey)

%ProgrammableThermostats = The percentage of homes replacing programmable thermostats (58% in the 2018 appliance rebate survey)

%SmartThermostats = The percentage of homes replacing smart thermostats (10% in the 2018 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.

Appendix: Impacts Details

(continued)

Refrigerator Savings Analysis Details

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

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 March 6, 2019. http://www.energystar.gov/productfinder/download/certified-residential-refrigerators/

Appendix: Impacts Details

(continued)

Refrigerator *Ex Post* Savings

The evaluation team verified that AEP Ohio correctly applied the TRM methods. Differences between *ex ante* and *ex post* savings results from the fact that the evaluation team was able to identify most models from ENERGY STAR® Qualified Products List (QPL) dataset.

Although the evaluation team attempted to locate savings estimates for unknown configurations, the team did not discover any savings information and therefore applied the same assumptions as AEP Ohio.

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 applied 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 2018. 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. This calculation may be updated in future evaluation years based on 2016 RASS data or 2019 RASS data.

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

This sub-section describes the analysis methods applied to central air conditioners.

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

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

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

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

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] For the few records (4) missing baseline measure size information ($SEER_{base}$ and EER_{base}), AEP Ohio estimated savings as the average per-unit savings.

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 reviewed the 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 the 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 reviewed the 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.

TABLE A-16. *EX ANTE* ISRS – NIGHTLIGHTS

Component	ISR Adjustment	Source of ISR Adjustment
Energy Efficiency Kits	0.84	2017 Energy Efficiency Kits survey
Single-Family Direct Installation	0.83	2016 In-Home Evaluation Report
Multi-Family Direct Installation	0.57	2017 Multi-Family onsite audits

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.

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

$$\Delta kWh = ISR * (GPMbase - GPMlow) * kWh/GPMreduced$$

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

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

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	0.73	2017 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	0.71	2017 Multi-Family onsite audits[1]

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

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 did not apply an ISR value for smart power strips.

[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 applied the same methodologies as AEP Ohio to calculate *ex post* savings, but in addition applied the ISR values seen in Table A-19.

TABLE A-19. *EX POST* ISR ADJUSTMENTS - SMART POWER STRIPS

Component	ISR Adjustment	Source of ISR Adjustment
Single-Family Direct Installation	0.83	2016 In-Home Evaluation Report
Multi-Family Direct Installation	0.59	2018 Multi-Family onsite audits

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: Appliance Rebate Participant Survey

Methodology:

In January 2019, the evaluation team conducted a survey with 2018 program participants to address multiple process evaluation research questions. The evaluation team targeted customers who rebated either smart thermostats or clothes washers through the program. A link to the online survey was sent to participants via email and implemented using Qualtrics survey software.

2018 PARTICIPANT SURVEY COMPLETIONS AND POPULATION-LEVEL SAMPLING ERROR

Equipment Type	2018 Population Size[1]	Survey Target Completions	Survey Completions	Sampling Error
Smart Thermostats	4,100	67	73	10%
Clothes Washers	2,283	67	78	9%
Total	**6,383**	**134**	**151**	**7%**

[1] Population excludes the customers who received smart thermostats through the single-family direct installation component (95 customers).
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 14, 2018 and January 25, 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:

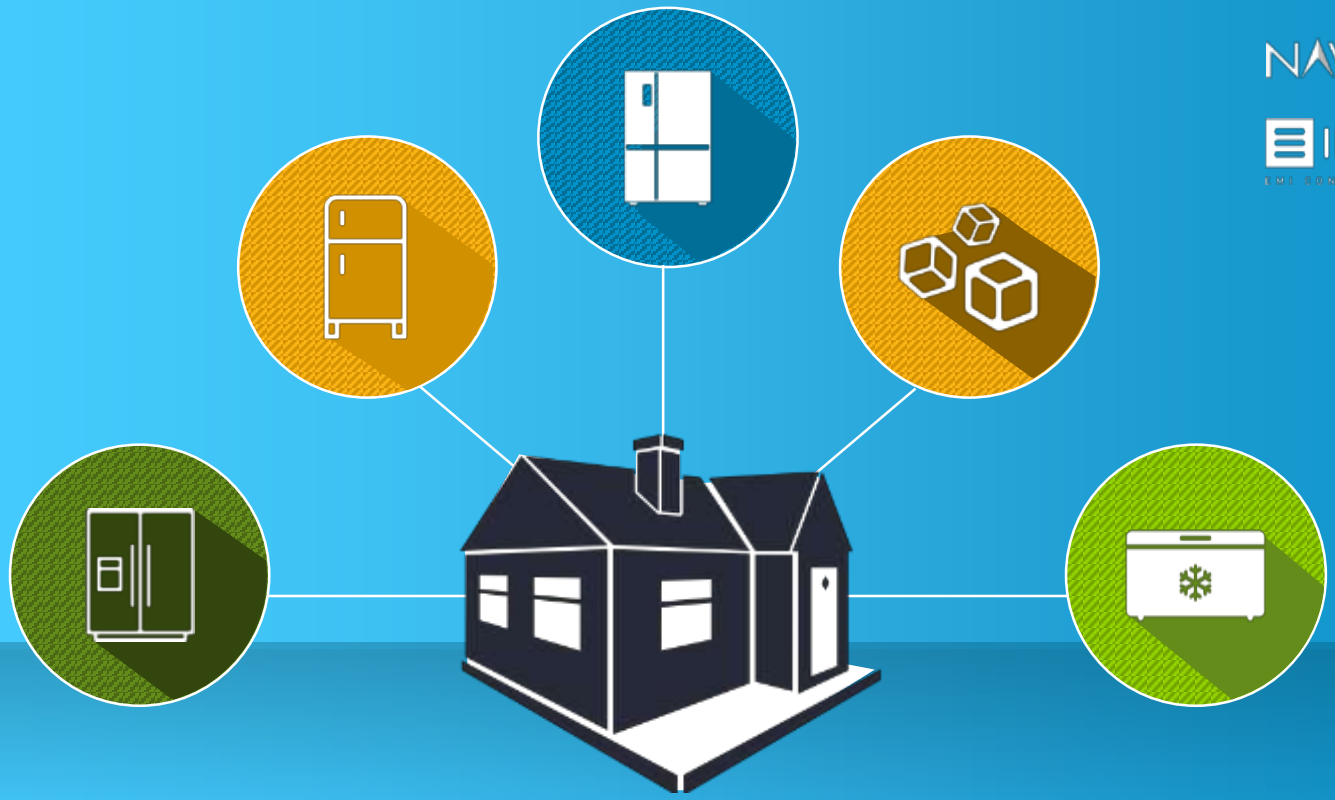
- Whether tenants were present during the installation of program equipment.
- Whether tenants received equipment that was not directly installed.
- Whether tenants uninstalled equipment.
- What types of light bulbs the program LEDs replaced.

The evaluation team performed a census attempt of all multi-family direct installation participants and performed 35 audits to attain 90 percent confidence and +/- 10 percent precision at the component level.

SUMMARY OF COMPLETED MULTI-FAMILY DIRECT INSTALLATION AUDITS

	2018 Population Size	Survey Target Completes	Survey Completes	Sampling Error
Multi-Family Direct Installation Participants	5,663	35	35	13.9%[1]

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



Appliance Recycling Program

2018 Evaluation Report

AEP OHIO

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APRIL 3, 2019

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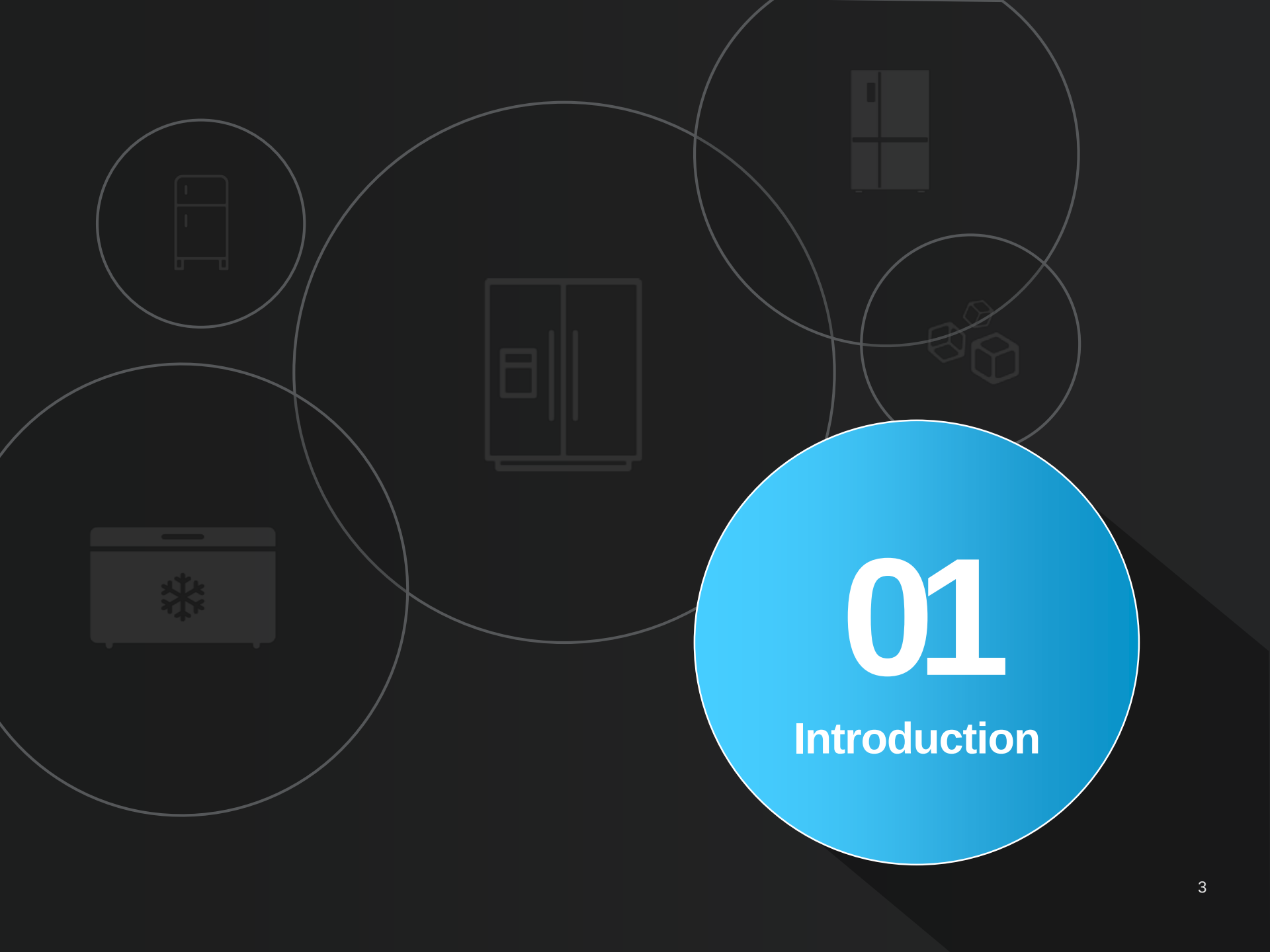


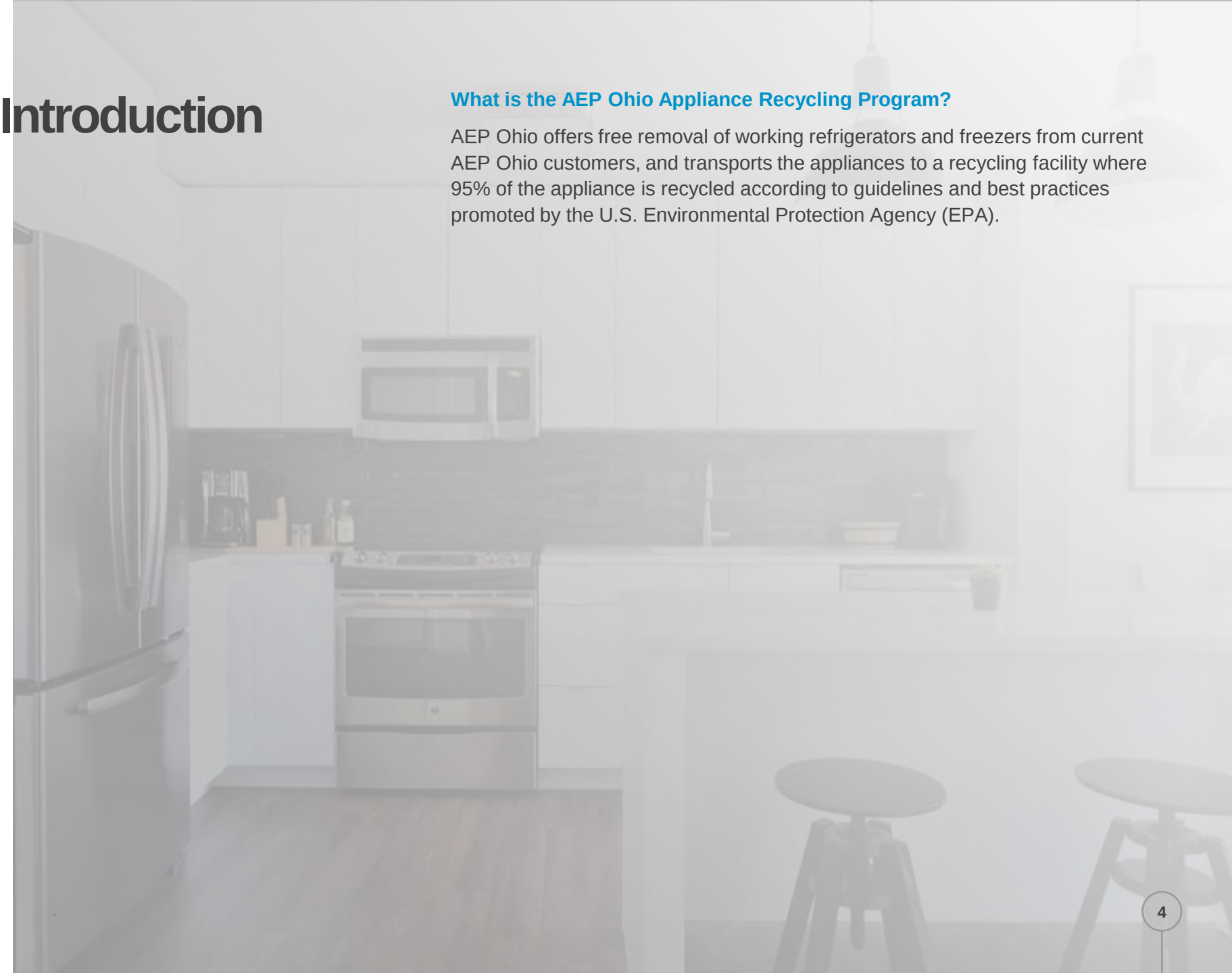
01

Introduction

Introduction

What is the AEP Ohio Appliance Recycling Program?

AEP Ohio offers free removal of working refrigerators and freezers from current AEP Ohio customers, and transports the appliances to a recycling facility where 95% of the appliance is recycled according to guidelines and best practices promoted by the U.S. Environmental Protection Agency (EPA).



Program Summary

The objective of the Appliance Recycling program is to:

To achieve these objectives, AEP Ohio provides:

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

Recycle 95% 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.

Free 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.

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

Program Summary

(continued)

Program Additions in 2018:

01 The program incentive was $50 throughout 2018.

02 Television and radio ads were discontinued as marketing channels in 2018.

03 The program began collecting appliances replaced through AEP Ohio's Community Assistance Program (CAP) and recycling them as part of the Appliance Recycling Program. This portion of the program is known as Community Assistance Appliance Recycling (CAAR).

04 CAAR officially started offering appliance recycling on April 1st, with the first pick-ups taking place on May 1st.

05 CAAR participants who recycled an appliance through the program did not receive an incentive, as their old appliance was replaced with a new, ENERGY STAR appliance through the CAP program.

Program Summary

(continued)

PROGRAM EVALUATION SUMMARY RESULTS

Measure	2018 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)	11,927	**25,455**	**25,455**	100%	213%
Demand Savings (kW)	1,820	**4,073**	**4,073**	100%	224%

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

02

Methodology

Evaluation Objectives

The 2018 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

Tracking Data Analysis

Targeted Populations
Appliance Recycling Participants

CAAR Participants

Sample Frame
Tracking Database

Full Population
18,810

CAAR Population
2,170 (12% of total)

Timing
Jan-19

1

In-Depth Telephone Interviews

Targeted Population
Program Staff

Sample Frame
Contacts from AEP Ohio

Sample Size
2

Timing
Nov-18

2

Participant Online Survey

Targeted Populations
Appliance Recycling Participants

CAAR Participants*

Sample Frame
Tracking Database

Sample Size
118 Traditional Program Respondents

54 CAAR Program Participants

Timing
Jan – Feb 2019

3

*The evaluation team also conducted a shortened form of the program survey with CAAR 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.

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 2018
- Program marketing materials
- AEP Ohio Appliance Recycling Program website

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

03

Evaluation Findings

Evaluation Savings Results

The program surpassed the savings goals for 2018. The program achieved 213 percent of the energy savings goal of 11.9 GWh and 224 percent of the demand savings goal of 1.8 MW.

***Ex post* savings were identical to the program ex ante values, resulting in realization rates of 1.00.** AEP Ohio appropriately calculated the Draft Ohio TRM annual energy (kWh) and summer peak demand (kW) impacts for the program. The evaluation team verified the energy savings by multiplying the verified appliance counts in the tracking data by the Draft Ohio TRM deemed per-unit energy savings values.

***Ex Ante* and *Ex Post* Energy Savings and Realization Rates**

Product	Number of Units	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
Refrigerator	15,544	1,376.15	21,391	21,391	84%	1.00
Freezer	3,266	1,244.40	4,064	4,064	16%	1.00
All Products	**18,810**	**N/A**	**25,455**	**25,455**	**100%**	**1.00**

***Ex Ante* and *Ex Post* Demand Savings and Realization Rates**

Product	Number of Units	Per Unit Demand Savings (kW)	Total Ex Ante Demand Savings (kW)	Total Ex Post Demand Savings (kW)	Percent of Ex Post Demand Savings	Realization Rate
Refrigerator	15,544	0.22	3,420	3,420	84%	1.00
Freezer	3,266	0.20	653	653	16%	1.00
All Products	**18,810**	**N/A**	**4,073**	**4,073**	**100%**	**1.00**

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	18,810
Annual Energy Savings (kWh)	25,455,086
Coincident Peak Savings (kW)	4,073
Third Party Implementation Costs	$1,239,004
Utility Administration Costs	$328,012
Utility Incentive Costs	$1,581,258
Participant Contribution to Incremental Measure Costs	$0

Based on these inputs, the TRC ratio is 3.3. 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	3.3
Participant Cost Test	N/A
Ratepayer Impact Measure	0.5
Utility Cost Test	3.3

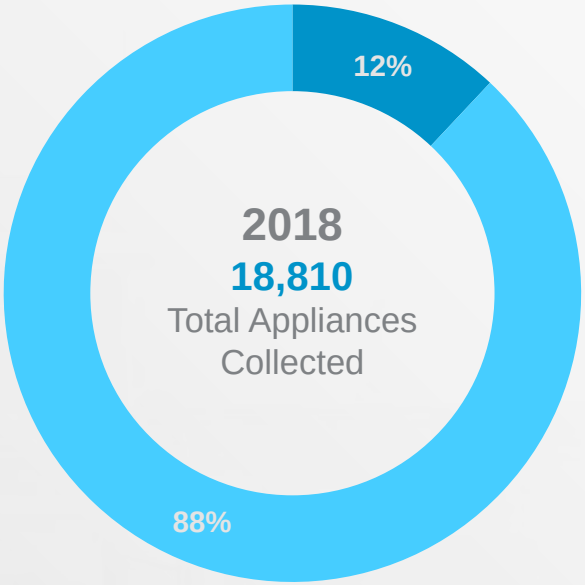
Additional benefits related to the reduction of greenhouse gas emissions have not been quantified in the calculation of the TRC.

Program Activity Review

Number of Appliances Recycled:

The 2018 AEP Ohio Appliance Recycling Program collected a total of 18,810 appliances. These units were collected through 17,821 unique orders. Of these 18,810 recycled appliances, 2,170 (12%) were collected through the CAAR program. 3,266 (16%) of appliances collected were freezers, and 15,544 (84%) were refrigerators.

This is an overall increase from 13,608 appliances collected in 2017.



Traditional | CAAR

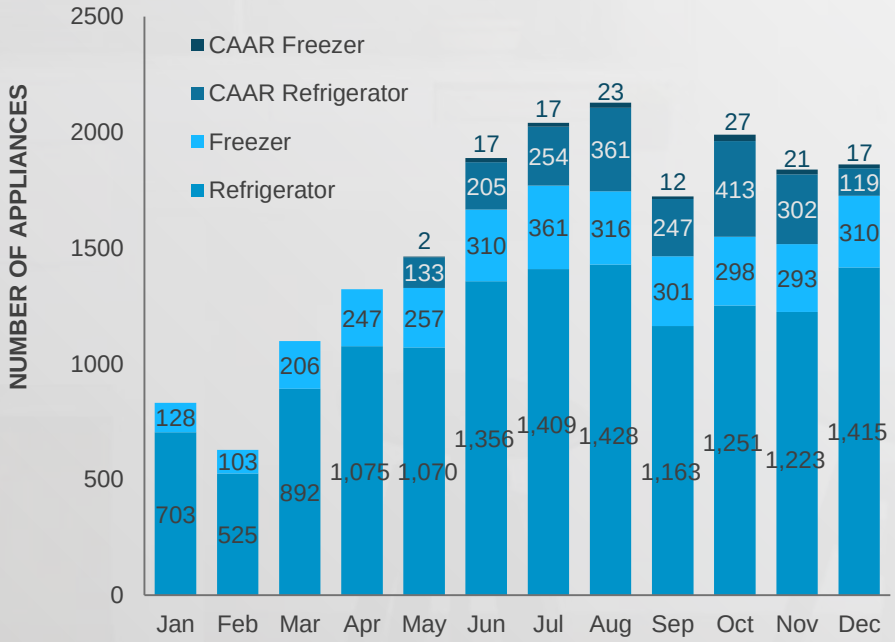
Program Activity Review

(continued)

August 2018 was the month with the highest number of appliances recycled, with 1,789 refrigerators and 339 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.
- The higher volume during the summer months of 2018 could be attributed to the program's marketing cycle. According to marketing materials, the majority of marketing channels were not fully active until March 2018.
- New refrigerator models are released in the summer, which could also influence the higher volume of pick-ups during these months.[1]

PROGRAM APPLIANCES RECYCLED BY MONTH



[1] https://www.moneycrashers.com/best-time-of-year-buy-large-appliances/

Program Activity Review

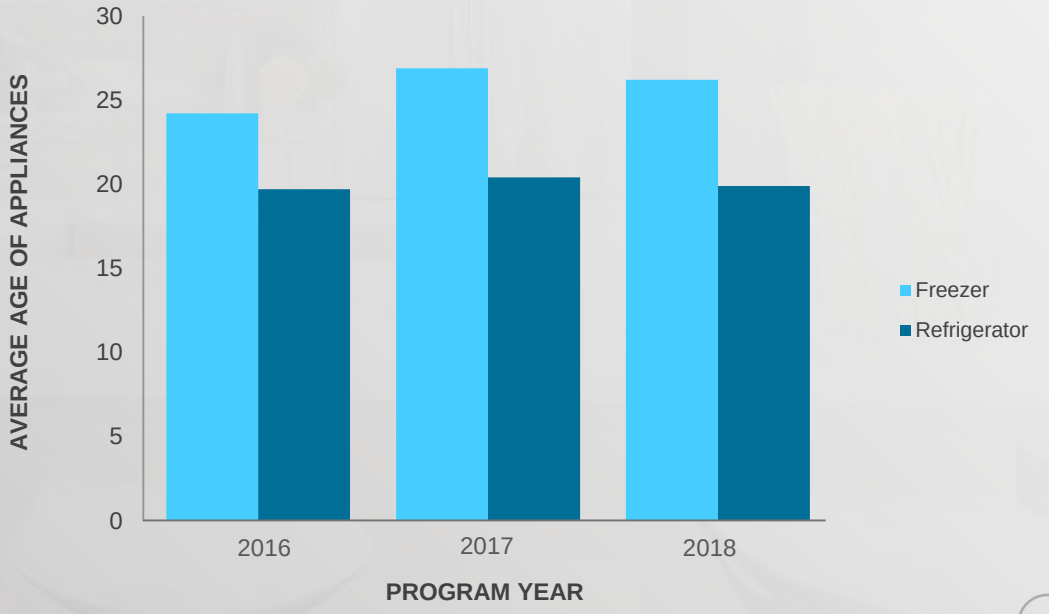
(continued)

Appliance Characteristics (Age):

The average age of recycled appliances was 19.7 years for refrigerators and 26.2 years for freezers.

- This is very similar to the average age of units in 2017 (20.4 years for refrigerators and 26.9 years for freezers) and 2016 (19.7 years for refrigerators and 24.2 years for freezers), although freezers have generally gotten somewhat older.
- The middle 50 percent of appliances were between 26 and 34 years old.
- The oldest appliances in the tracking data were a 79-year-old refrigerator and a 70-year-old freezer.

AVERAGE APPLIANCE AGE OVER TIME



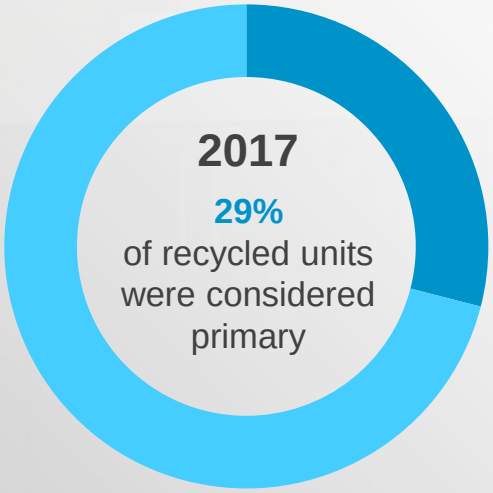
Program Activity Review

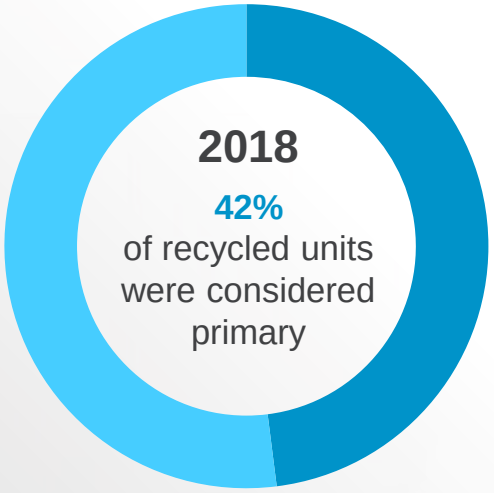
(continued)

Appliance Characteristics (Primary vs. Secondary):

Most refrigerators (57%) were secondary units, according to the program tracking data.

- This is a considerable decrease from 2017, in which 71% of refrigerators were considered secondary units.
- This decrease is exacerbated by the addition of CAAR appliances, as the tracking data indicated that most CAP participants (96%) were recycling their primary refrigerator.
- The increase in primary units recycled was reflected in the traditional program participant survey, where 61% of recycled appliances were considered primary by survey respondents and 38% were considered secondary. In the separate survey conducted with CAAR participants, 100% of respondents reported recycling their primary appliance.





Program Operation Evaluation Results

This section provides a summary of process findings for the 2018 Appliance Recycling Program. Data collection activities informing the process evaluation include:

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

- Key drivers of overall survey respondent satisfaction with the program include the ease of participation, the environmental benefits of recycling an appliance through the program, and the cash incentive.
- Ratings of individual program components were highest for the collection team and the enrollment experience.
- Only a few respondents (n=4) were consistently dissatisfied with the program, reporting they had not yet received their incentive at the time of the survey. These respondents gave negative satisfaction scores throughout the survey.

Marketing and Program Awareness

Marketing Changes in 2018:

The program was not marketed through TV or radio ads.

- Program marketing instead focused on utility channels, digital, and print campaigns.
- This change was made to help accommodate the increased incentive.

AEP Ohio also developed a more customer-centric marketing plan designed to feature ads specific to AEP Ohio.

- A photo-shoot was conducted in September for these new advertisements, and these new ads were used for email blasts and other direct mail and banner ads in December of 2018.
- This was done to differentiate AEP Ohio from other appliance recycling programs conducted by utilities across the state.

AEP Ohio conducted analyses to determine particular demographic segments that are more likely to participate in the Appliance Recycling Program.

- AEP Ohio sent these identified customers direct mail promotional materials in August and December of 2018.

Marketing and Program Awareness

(continued)

MARKETING CHANNELS IN 2018					
 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

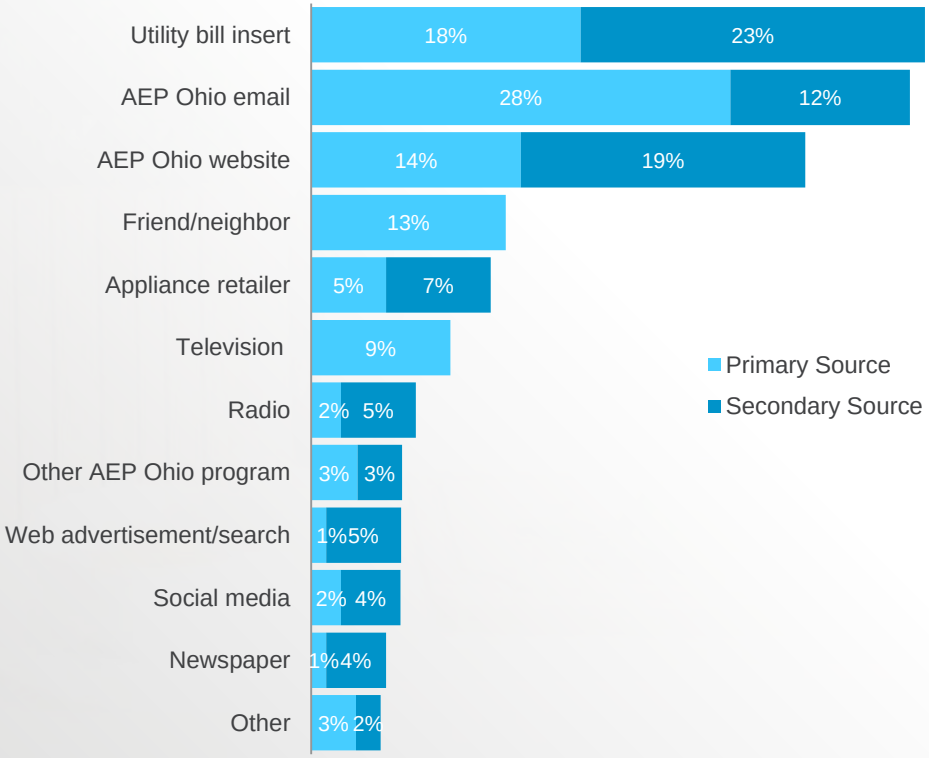
(continued)

Source of Awareness (Participant Survey):

Survey respondents were asked how they initially became aware of the program, as well as whether they heard of the program through any other sources.

- The most common source was utility bill inserts.

PRIMARY AND SECONDARY SOURCES OF AWARENESS



Note: Although there was no television or radio marketing in 2018, customers may have become aware of the program through these channels in previous years. Although AEP Ohio has not used newspaper advertisements, it is possible customers saw a newspaper ad from another utility, or they may have confused newspaper ads with the newsletter.

Marketing and Program Awareness

(continued)

Motivations for Program Participation:

Survey respondents were asked to identify the most important reason for recycling their appliance. These included:

- The cash incentive (35%)
- The appliance was recycled in a way that was good for the environment (31%)
- The convenience of the home pick-up (19%)
- The free pick-up (14%)

Program Effectiveness and Satisfaction

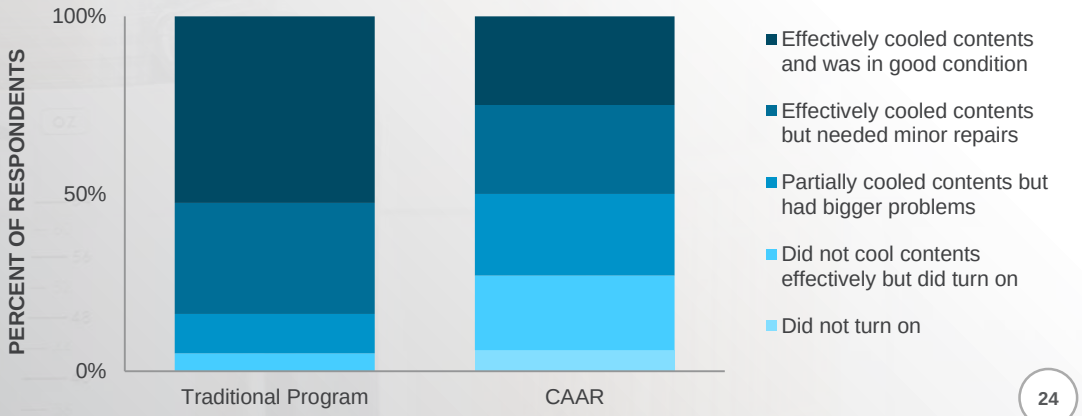
Condition of the Appliance Prior to Recycling:

The 5% of traditional program survey respondents indicating their appliance did not cool its contents effectively is a decrease from 11% in 2017 and 8% in 2015. (There was no participant survey in 2016.)

- 21% of CAAR respondents indicated the appliance did not cool its contents effectively, although it did turn on.
- Across both CAAR and the traditional program, two-thirds (67%) reported that they still used their appliance even though it did not cool its contents effectively, while one-third were not using the appliance.
- These results suggest that a customer is still likely to use their appliance, even if the appliance is not in good working condition – meaning recycling these appliances prevents them from continuing to be used.

Of CAAR respondents, 6% reported their appliance did not turn on at all.

- All-in-all, thirteen percent of surveyed CAAR customers reported that their appliance did not turn on or that they were not using it prior to pick-up. While the CAAR sample size was relatively low (n = 54), these results suggest some CAAR appliances are not working prior to pick-up.



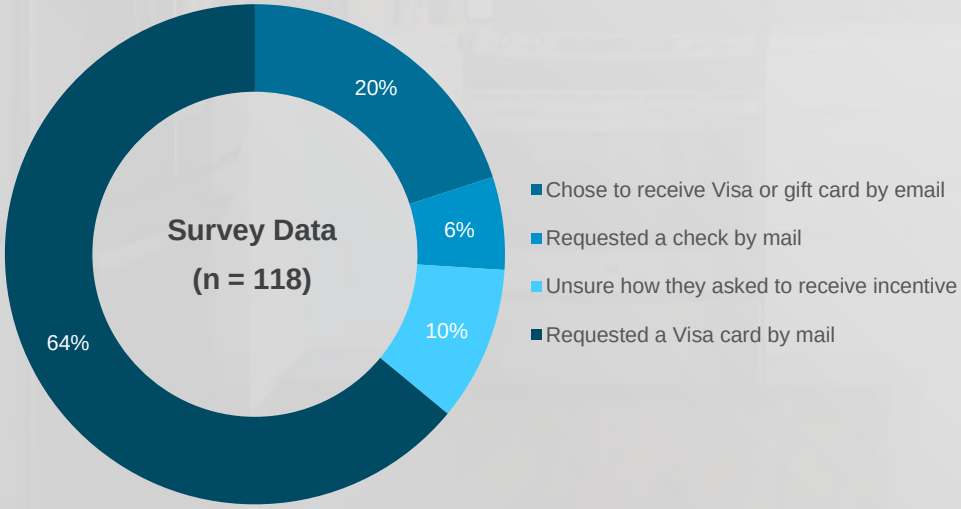
Program Effectiveness and Satisfaction

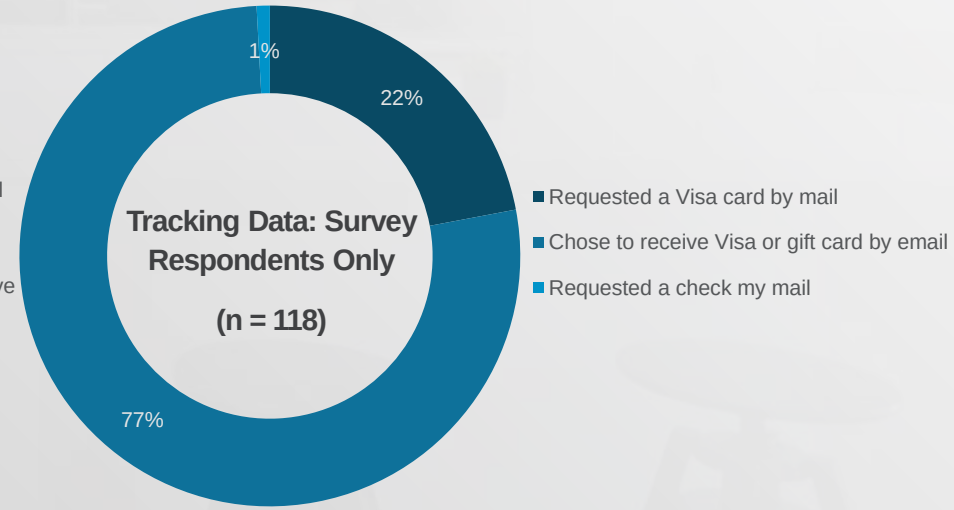
(continued)

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 by mail was the most popular form of chosen payment in the participant survey (64%).
- This differed from survey respondent's recorded payment method in the tracking data, which showed only 22% selected a Visa card by mail.
- This suggests program participants may not correctly remember their chosen incentive type, or may be confused by the differences between the mailed prepaid Visa card and the emailed prepaid Visa card or gift card.





[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

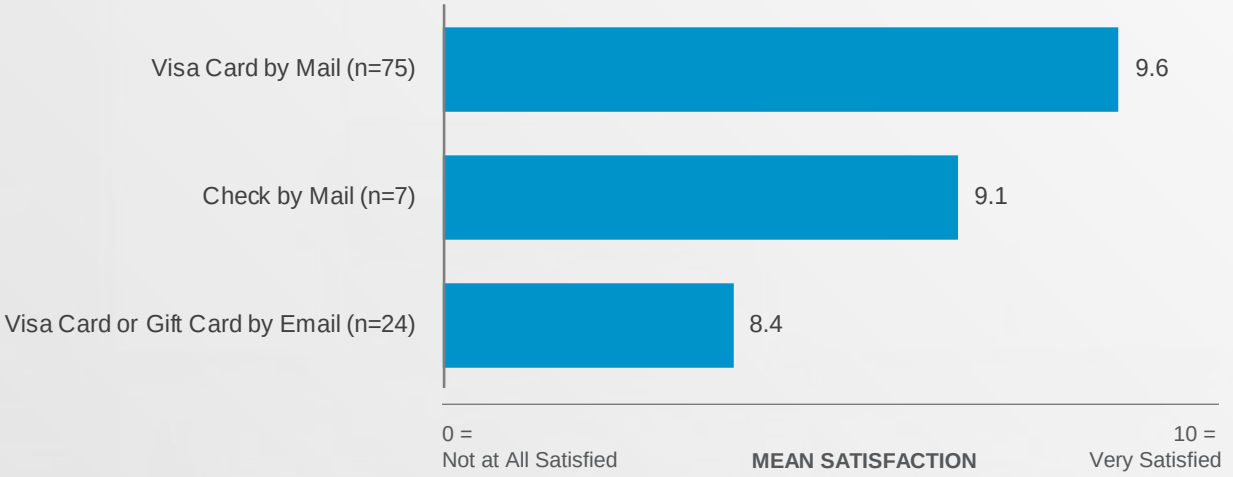
(continued)

Satisfaction with Payment Type:

Overall satisfaction with the incentive type according to survey respondents was high, at 9.0.

- On average, survey respondents were most satisfied with the Visa card by mail.

Although satisfaction with the incentive type was fairly high at 9.0, respondents were somewhat less satisfied with the emailed Visa card or gift card when compared to the other incentive types. While sample sizes were small, results suggest a small percentage of customers are dissatisfied with this payment type.



Note: Several respondents (n=4) reported throughout the survey that they were dissatisfied with the digital and pre-paid Visa gift cards. Specific reasons provided by these dissatisfied respondents include that it was difficult to keep track of balances or that certain retailers would not accept them. These respondents also consistently gave negative satisfaction scores across the survey.

Program Effectiveness and Satisfaction

(continued)

Perceived Energy Savings:

A third of respondents noticed energy savings associated with recycling their appliance.

- Just over a third (35%) of respondents reported noticing energy savings on their bill.
- Compared to those who recycled refrigerators (32%), a greater percentage of those who recycled freezers (44%) noticed energy 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 (80%). No respondents ranked their satisfaction lower than a five.

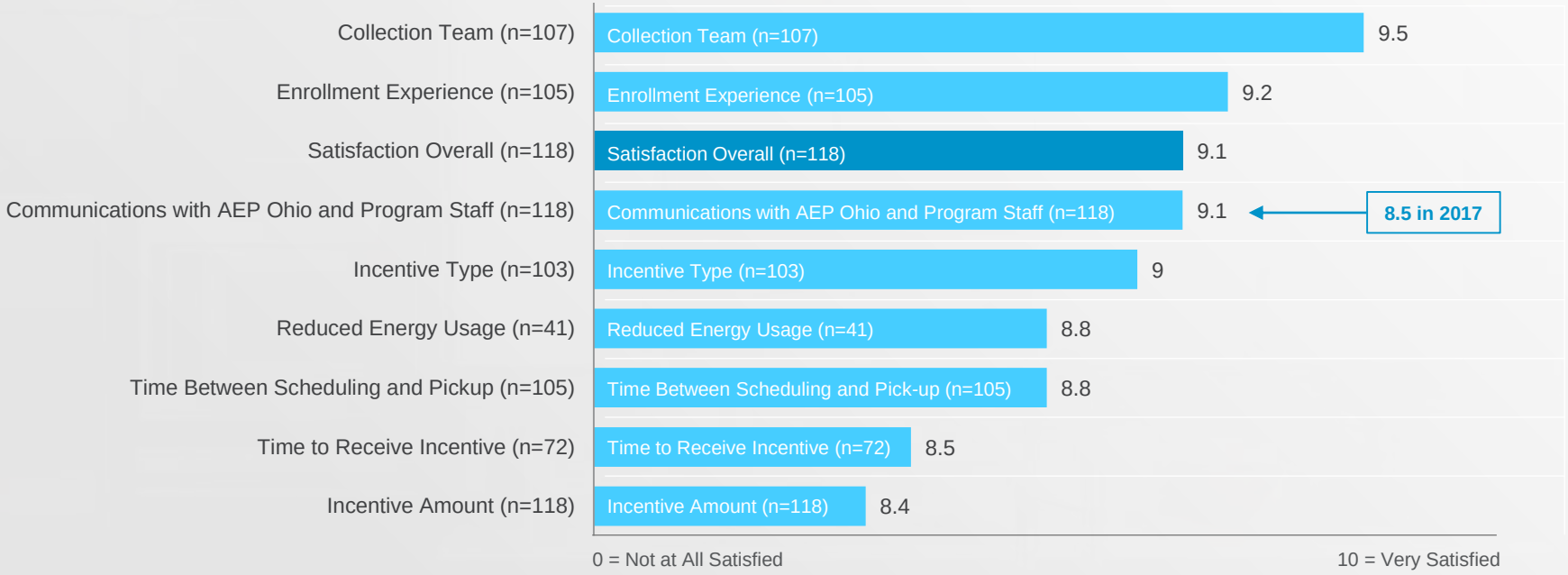
Program Effectiveness and Satisfaction

(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, and communications with AEP Ohio staff.
- Respondents were, on average, least satisfied with the incentive amount, although satisfaction was still high at 8.4.
- This is fairly consistent with previous years, with the exception of communications with AEP Ohio staff, which was rated somewhat higher in 2018 compared to 2017, when it was an 8.5 on a 0-to-10 scale.



Program Effectiveness and Satisfaction

(continued)

Satisfaction with AEP Ohio Overall:

Respondents were satisfied with AEP Ohio.

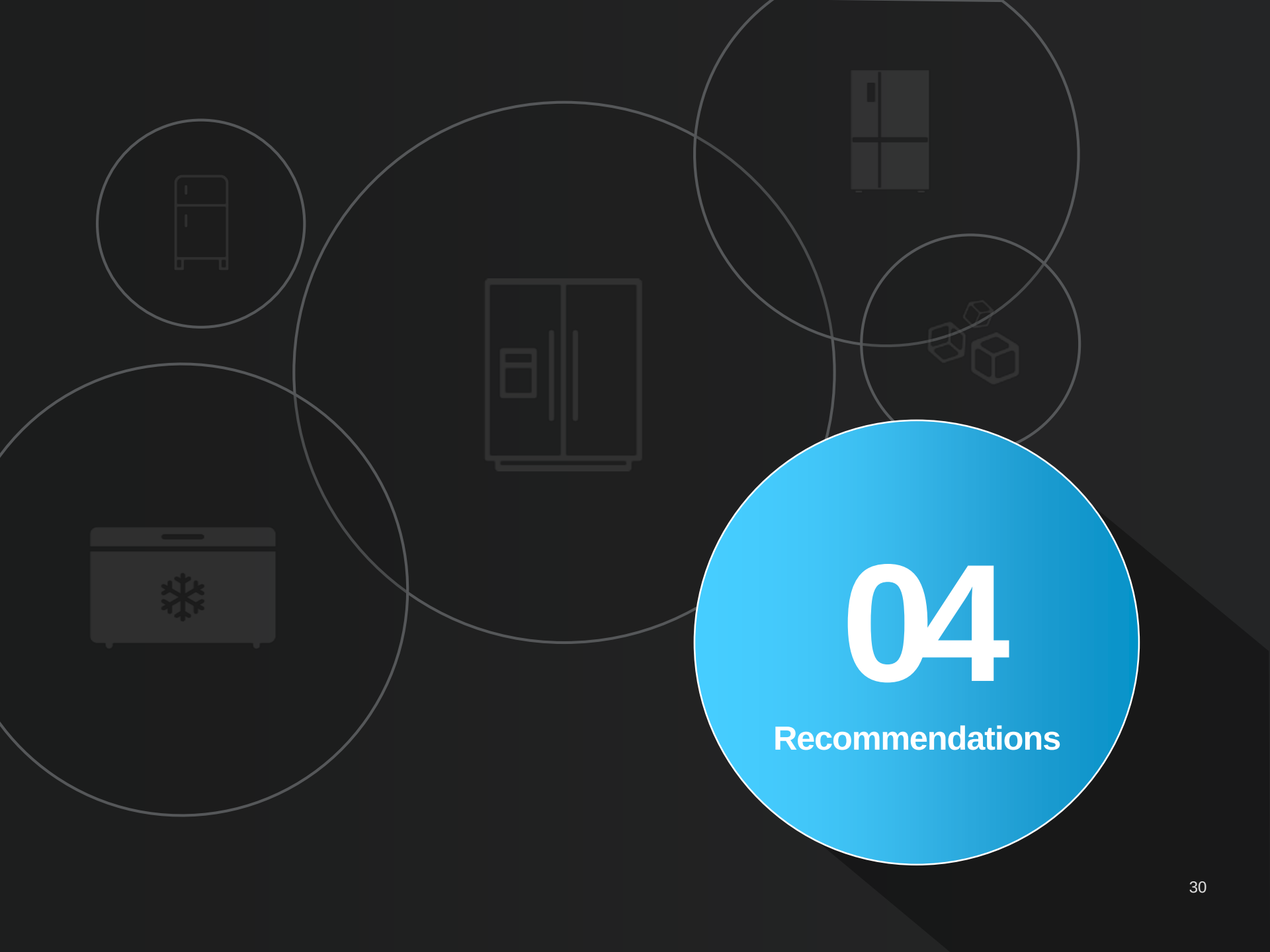
- When asked about their overall level of satisfaction with AEP Ohio as their utility, the majority of respondents (79%) reported satisfaction scores of 8 or higher.
- The average satisfaction score was an 8.3.
- Out of the respondents who reported low satisfaction scores with AEP Ohio (5%), four respondents ranked their satisfaction as a 2 or lower.

61% 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	70	61%
No Different About AEP Ohio	43	38%
Less Favorable About AEP Ohio	1	1%
Total	**114**	**100%**

Note: Analysis does not include 4 participants who responded “Unsure”.



04

Recommendations

Begin Marketing Earlier in the Year

The evaluation team recommends beginning marketing earlier in the year.

Marketing was not fully active until March of 2018, partially due to program changes as a result of the addition of CAAR units to the program. This delay in marketing may have resulted in lower participation rates at the beginning of the year. Once a marketing plan was in place and implemented, participation nearly doubled towards the second half of the year.

This increase in the second half of the year is higher than compared to previous program years where :

- 55% of total program appliances were recycled in the second half of 2014
- 64% of total program appliances were recycled in the second half of 2017
- 72% of total program appliances were recycled in the second half of 2018

The higher volume during the second half of 2018 could be attributed to the program's marketing cycle, and the addition of CAAR appliances in May, although it is worth noting that new refrigerator models are typically rolled out in the summer.

To help avoid these inconsistencies in program participation, the evaluation team recommends an adjusted marketing timeline that will ensure more consistent program participation throughout the next program year.

Continue Fast Incentive Processing

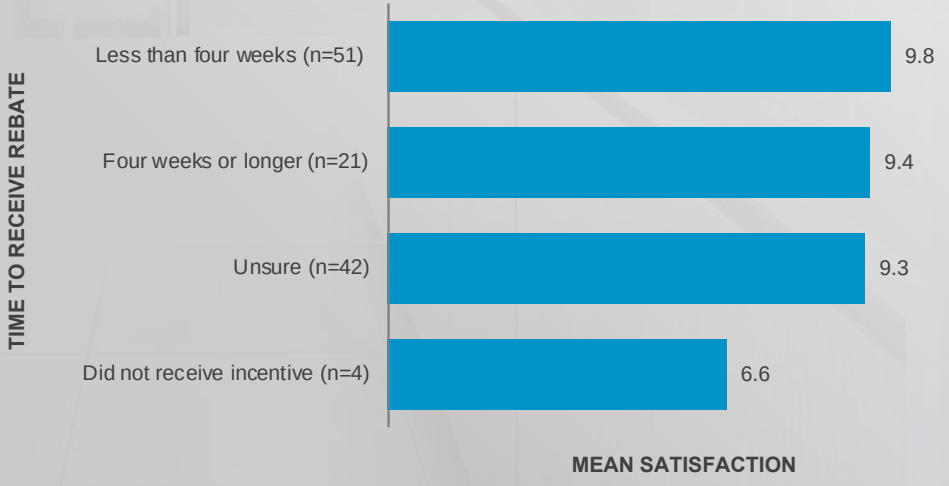
The evaluation team recommends that whenever possible, AEP Ohio aim to send incentives within 4 weeks of appliance pick-up.

Receiving incentives in a timely manner appears to contribute substantially to customers' high overall program satisfaction.

Program tracking data shows that 89% of incentives were sent in one week or less. When broken out by type, 91% of digital choice incentives were sent in one week or less, and 87% of check and prepaid card incentives were sent in one week or less.

43% of survey respondents reported receiving their incentive in less than four weeks, and these customers ranked their overall program satisfaction very high (9.8. on a 0-to-10 scale). The 36% of respondents who were unsure how long they waited for their incentive ranked their overall program satisfaction as a 9.3 on a 0-to-10 scale.

The 18% of survey respondents who reported waiting four weeks or longer to receive an incentive, and the 3% of respondents who believed they had not yet received their incentive at the time of the survey, reported lower levels of satisfaction.



Ensure Incentive Receipt

The evaluation team recommends that AEP Ohio continue taking steps to ensure customers receive their digital incentives.

- AEP Ohio program staff made several changes to address issues with customers not receiving their digital choice incentives. These include: (1) calling the customer the day their incentive is sent to let them know their incentive has been processed, (2) asking the customer specifically for a personal email address, (3) tracking bounce-backs and ensuring a timely follow-up with the customer, and (4) changing the incentive email address to "@aephio.com" to clearly identify the incentive for customers.

Likely as a result of these changes, only 4 customers (3% of survey respondents) reported not receiving their incentive, compared to 10 customers (5% of survey respondents) who reported not receiving an incentive in 2017.

According to the implementation contractor, all four of these respondents were sent their incentive, and one respondent who received a mailed Visa card already spent their incentive in full. While it is unclear why several digital gift card customers did not recall receiving the incentive, AEP Ohio should continue taking steps to correct this perception.

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.

Notification of Incentive Delivery

The evaluation team recommends that AEP Ohio ensure phone calls are made when the digital choice incentives are sent.

In addition to receiving an email letting them know the virtual card was sent, customers are also supposed to receive an auto-call when the card is sent.

No survey participants reported that they received a phone call to alert them that their digital choice incentive had been sent to them. Two-thirds of respondents (67%) stated that the received an email, while one-third (33%) said that they were unsure how they were notified.

It is possible that these unsure respondents received a phone call and did not remember at the time of survey, or the phone call was from a number the respondent did not recognize and chose not to answer their phone, or that the respondent did not have a voicemail system set up.

- We recommend continuing phone calls since not all customers recall receiving the email, or sending an automated text messages to customers who desire this form of communication. When customers enroll in the program and choose their incentive type, they should be informed at that time what they should expect to see on their caller ID when the reminder call is placed or text message is sent (ideally “AEP Ohio” would be displayed). If the customer does not answer the phone, make sure voicemail messages are successfully left with ~~the~~ customers who have voicemail set up (e.g., make sure the voicemail messages do not begin before the customer’s outgoing greeting has finished playing).

Provide Education to Customers about Program Requirements

The evaluation team recommends that AEP Ohio provide information to customers explaining program processes such as cord-cutting and timing of incentives.

Several respondents in the survey identified key barriers to their own participation which might also apply to AEP Ohio customers who chose not to participate in the program. Examples of these responses are shown below. Although these responses are specific to certain participants, similar themes emerged in other participant responses.

> "A little more money would have been nice, and less time between scheduling and pick-up would have been better."

> "I don't understand why the appliance plug has to be cut off. [AEP Ohio] was not clear about directions."

> "Our [other] fridge was too large to qualify for the program."

- Additional information could take different forms. One possibility is to leave behind an FAQ (frequently asked questions) handout that could help explain why the cords are cut, why appliances have to be a certain size, why the pick-ups take time to schedule, and why the digital incentives are not sent the same day. Alternatively, pick-up staff could be trained to provide information on these topics before pick-up of the appliance is completed, explaining to customers why certain steps are being taken. Either way, we recommend communicating not only the program requirements, but also some of the reasons for these requirements.

05

Appendix

Appendix Program Activity Review

Appliance Characteristics (Configuration and Size):

Most refrigerators were top freezer refrigerators (65%). Other types included side-by-side (28%), bottom freezer (5%), and single door (2%) refrigerators. This is similar to 2017.

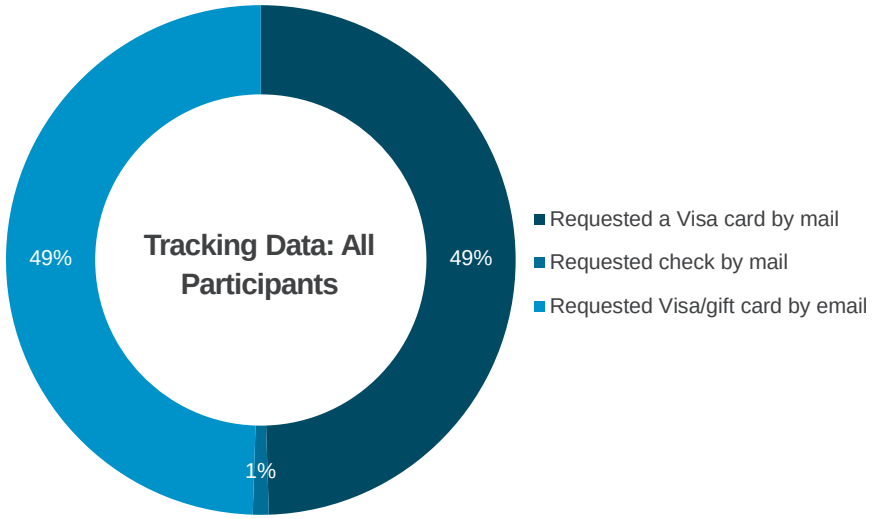
Most freezers were upright freezers (67%). The remaining 33 percent of freezers were chest freezers. This is exactly the same proportion as 2017.

The average size of refrigerators recycled through the program was 19 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 the previous year.

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). Only 1% requested a check by mail.



Appendix Participant Survey

Methodology:

In January 2019, the evaluation team conducted a survey with 2018 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 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.

2018 Participant Survey
Completions and Population-Level Sampling Error

Appliances Collected	2018 Population Size	Survey Target Completions	Survey Completions	Sampling Error
Refrigerators	13,510	80	93	9%
Freezers	3,130	20	25	16%
Total	**16,640**	**100**	**118**	**8%**

Note: Results are not shown for CAP participant survey.

Appendix Participant Survey

(continued)

Program Enrollment Experience:

Preferred program enrollment methods differ across tracking data and participant survey results.

- According to the tracking data, a little less than half (47%) of program participants enrolled online and slightly more than half (53%) of participants enrolled through the call center.
- Most survey respondents reported enrolling online (66%), as shown in Table A-1, and the remaining thirty-four percent of respondents enrolled over the phone.
- The discrepancy between the survey data and the program data is very likely due to the survey sample design; the survey was only sent to participants with a valid email address, which was more likely included in the tracking data if the customer had enrolled online.

Program Enrollment Methods from Tracking Data and Survey

Enrollment Method	Tracking Data Frequency	Tracking Data Percent	Survey Frequency	Survey Percent
Online	7,832	47%	60	66%
Telephone	8,807	53%	31	34%
Total	**16,640**	**100%**	**91**	**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 generally 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 (83%) of respondents stated the time lapse between scheduling the pick-up appointment and actual appliance pick-up was two weeks or less.
- 17% 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	31	38%
More than 1 week to 2 weeks	37	45%
More than 2 weeks to 3 weeks	8	10%
More than 3 weeks to 4 weeks	6	7%
More than 4 weeks	0	0%
Total	**82**	**100%**

Note: Results are not shown for 36 respondents who responded "Don't know" or skipped the question.
Totals may not sum up to 100 percent due to rounding.

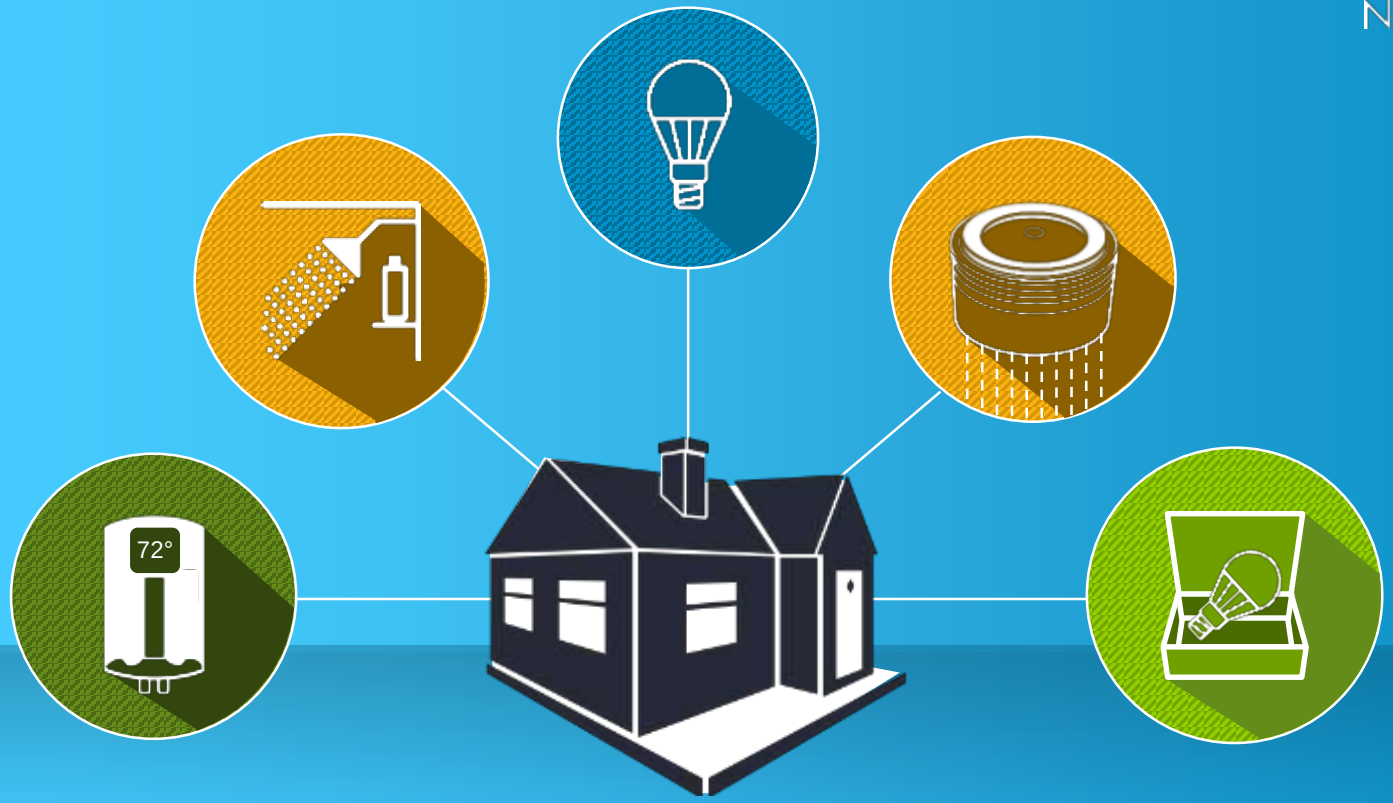
Appendix CAP Participant Survey

Satisfaction with the Appliance Recycling Program:

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

- Ninety-three 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 lower than a 5 (0).
- This respondent did not provide a reason for their dissatisfaction.
- The mean satisfaction ranking was 8.4.

NAVIGANT



e³smart℠ Program

2018 Evaluation Report

AEP OHIO

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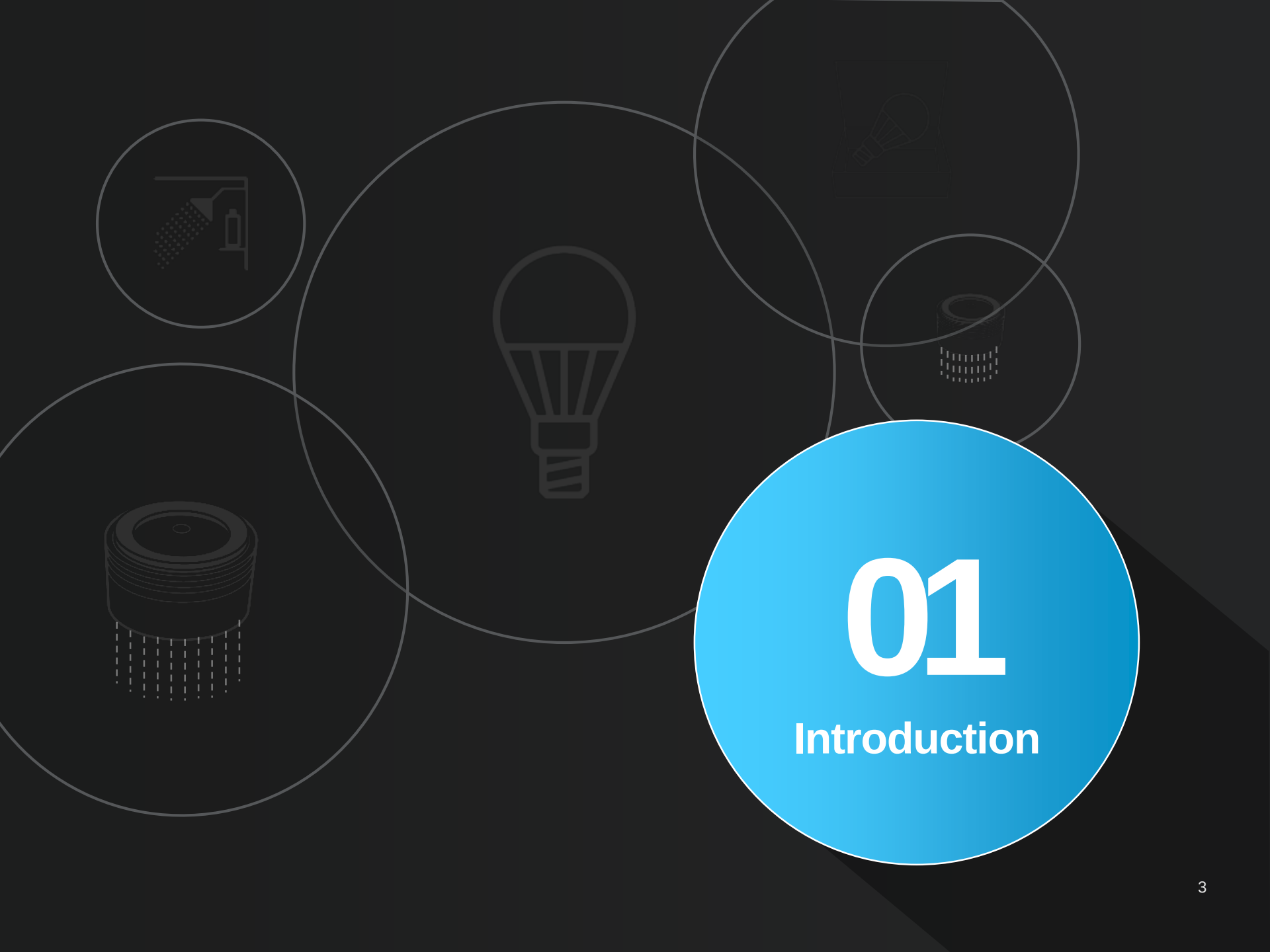
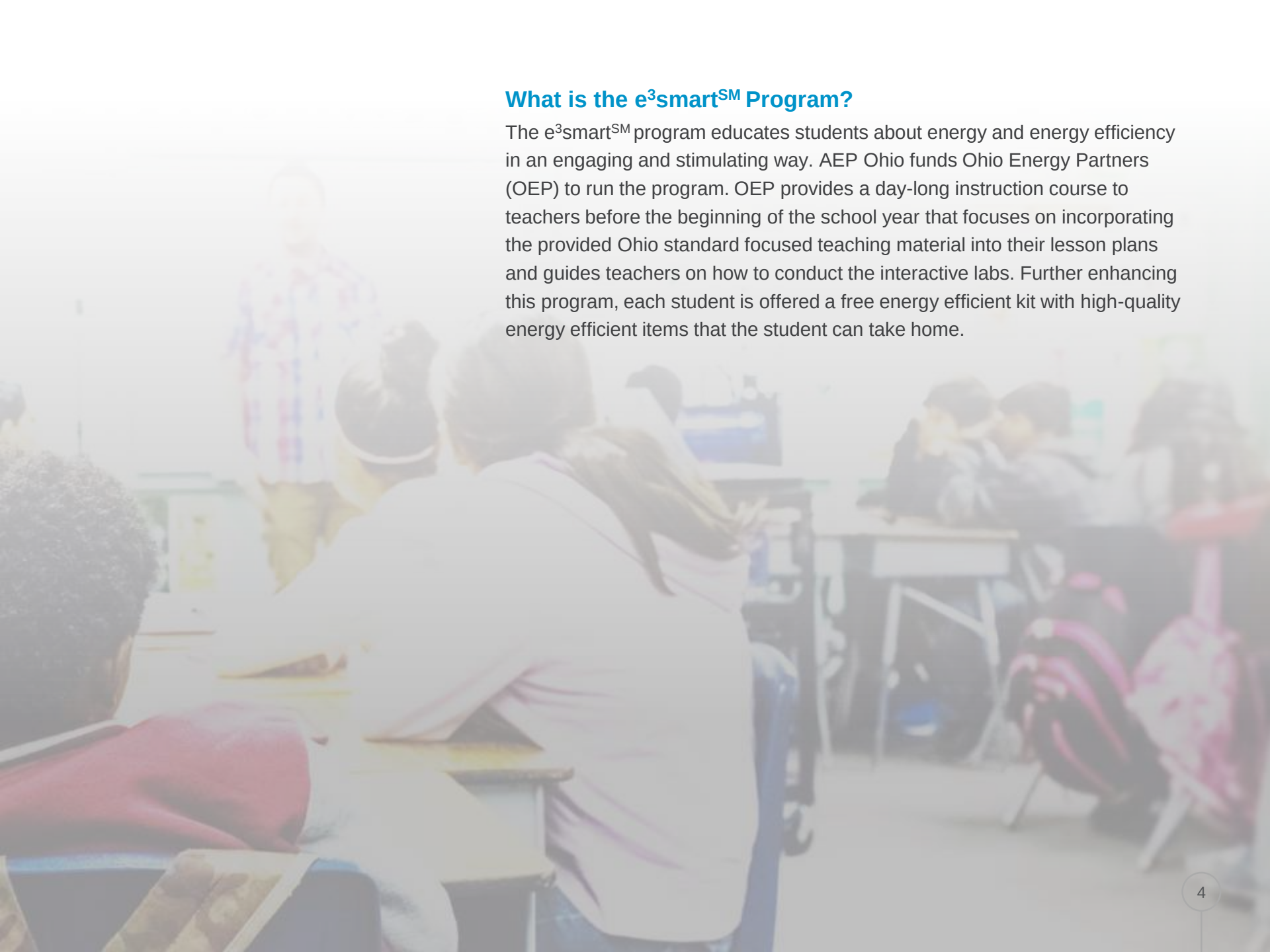


01

Introduction

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

The e^{3}smart^{SM} program educates students about energy and energy efficiency in an engaging and stimulating way. AEP Ohio funds Ohio Energy Partners (OEP) to run the program. OEP provides a day-long instruction course to teachers before the beginning of the school year that focuses on incorporating the provided Ohio standard focused teaching material into their lesson plans and guides teachers on how to conduct the interactive labs. Further enhancing this program, each student is offered a free energy efficient kit with high-quality energy efficient items that the student can take home.



Energy Efficient Items in Kits the Students Take Home

One 11-Watt Light Emitting Diode
(LED)

Two 9-Watt LED

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	2018 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)	6,796	**3,279**	**3,537**	108%	52%
Demand Savings (MW)	0.527	**0.454**	**0.486**	107%	92%

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

02

Methodology

Evaluation Objectives

The 2018 evaluation activities will 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

Tracking Data Analysis
(Participant Online Survey)

Targeted Population
Student/Parent Participants

Sample Frame
Tracking Database

Sample Size
20,624

Timing
Nov-18

1

In-Depth Telephone Interview

Targeted Population
Implementation Contractor

Sample Frame
Contact from Implementation Contractor

Sample Size
1

Timing
Dec-18

2

Teacher Surveys

Targeted Population
All Teacher Participants

Sample Frame
OEP Tracking Data

Sample Size
346

Timing
Jan-19

3

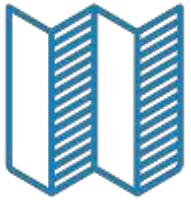
Material Review

Tracking System Review

Navigant conducted a review of program data in the AEP Ohio *e³smart*[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

Navigant 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 algorithms were applied correctly.



Program Material Review

Navigant 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

25,094 energy efficiency kits were distributed to participants during the 2017–2018 school year through 362 teachers participating from 246 schools. Of those kits distributed, 20,624 kit recipients returned information regarding the energy efficiency measures they installed.

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]	10,687	13,003	33.63	33.63	359,418	437,317
9 W LED (2 Bulbs)[2]	24,006	26,608	31.75	31.75	762,292	844,900
Kitchen Aerators (1.5 GPM)	3,123	3,800	55.14	55.14	172,210	209,535
Bathroom Aerators (1.0 GPM)	3,259	3,965	94.40	94.40	307,638	374,314
LED Nightlight	6,117	7,443	20.59	20.59	125,949	153,247
Lower Water Heater Temperature	602	732	81.60	81.60	49,123	59,770
Earth Massage Showerhead (1.25 GPM)	3,946	4,801	280.26	280.26	1,105,906	1,345,598
Weather Stripping	8,319	10,122	11.10	11.10	92,341	112,355
Outboard Non-Response Adjustment[3]	4,470	N/A	67.98	N/A	303,889	N/A
Total	-	-	-	-	**3,278,765**	**3,537,035**

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)

Ex post savings estimates for the e³smart℠ 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 2017-2018 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.

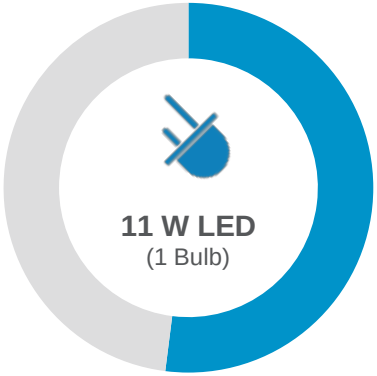
PEAK DEMAND SAVINGS ESTIMATES

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]	10,687	13,003	0.006	0.006	64	77
9 W LED (2 Bulbs)[2]	24,006	26,608	0.006	0.006	134	149
Kitchen Aerators (1.5 GPM)	3,123	3,800	0.007	0.007	21	26
Bathroom Aerators (1.0 GPM)	3,259	3,965	0.012	0.012	38	47
LED Nightlight	0	0	0.000	0.000	0	0
Lower Water Heater Temperature	602	732	0.009	0.009	5	7
Earth Massage Showerhead (1.25 GPM)	3,946	4,801	0.036	0.036	141	172
Weather Stripping[3]	4,808	5,850	0.001	0.001	7	8
Outboard Non-Response Adjustment[4]	4,470	N/A	0	N/A	42	N/A
Total	**-**	**-**			**454**	**486**

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 saving 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.

Kit Items In-Service Rates

Installation Rate Based on Returned Surveys



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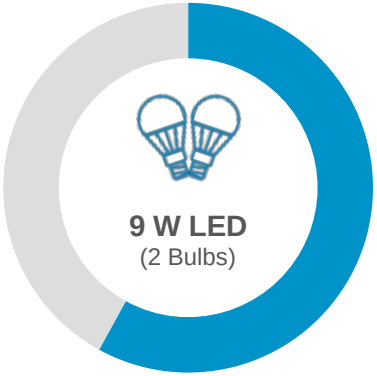

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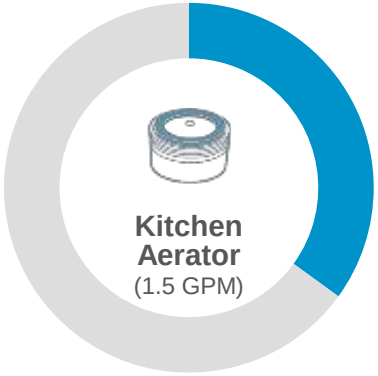

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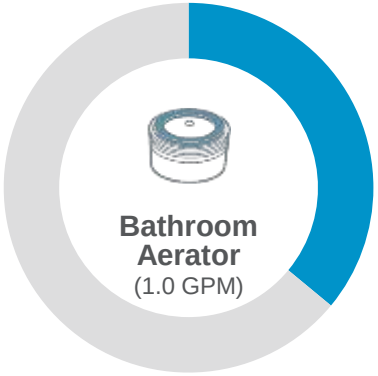

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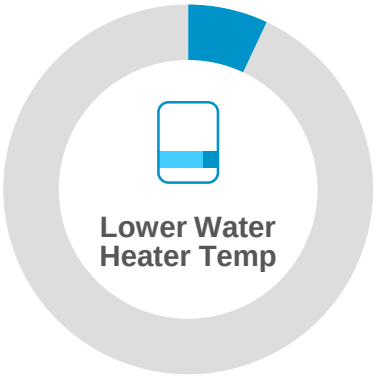
72%



7%

43%

40%

Cost-Effectiveness Review

This section addresses the cost-effectiveness of the e³smart℠ Program. Cost-effectiveness is assessed using the Total Resource Cost (TRC) test.

COST-EFFECTIVENESS MODEL INPUTS	
Item	**Value**
Average Measure Life	15
Kit Recipients	25,094
Annual Energy Savings (kWh)	3,537,035
Coincident Peak Savings (kW)	486
Third Party Implementation Costs	$287,724
Utility Administration Costs	$81,835
Utility Incentive Costs	$532,855
Participant Contribution to Incremental Measure Costs	$0

Based on these inputs, the TRC ratio is 2.1. 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	2.6
Participant Cost Test	N/A
Ratepayer Impact Measure	0.6
Utility Cost Test	2.6

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 2017–2018 e³smart[SM] Program. Data collection activities informing the process evaluation include:

The process evaluation data collection efforts indicate the e³smartSM Program is running exceptionally well. The way the teaching material is incorporated into the teacher's curriculum is the best practice for a utility-sponsored school educational program.

The administration of the program is functioning as expected with continual effort to improve the delivery of the program. At this time there are no problems implementing the program.

The biggest challenge expressed by the teachers has to do with time constraints. The teachers highly valued the lessons and were very disappointed when they did not get the opportunity to teach them due to a lack of time.

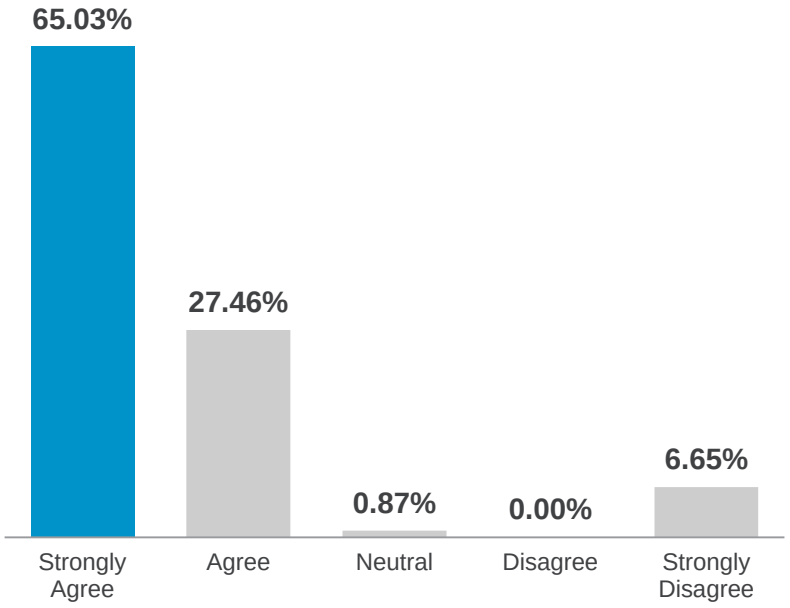
Teacher Input

One of the key components of implementing the e³smart℠ program is teachers who teach the students all the lessons. The following responses tell us how they view the program.

The activities helped my students better understand energy and efficiency.

Percent teacher response

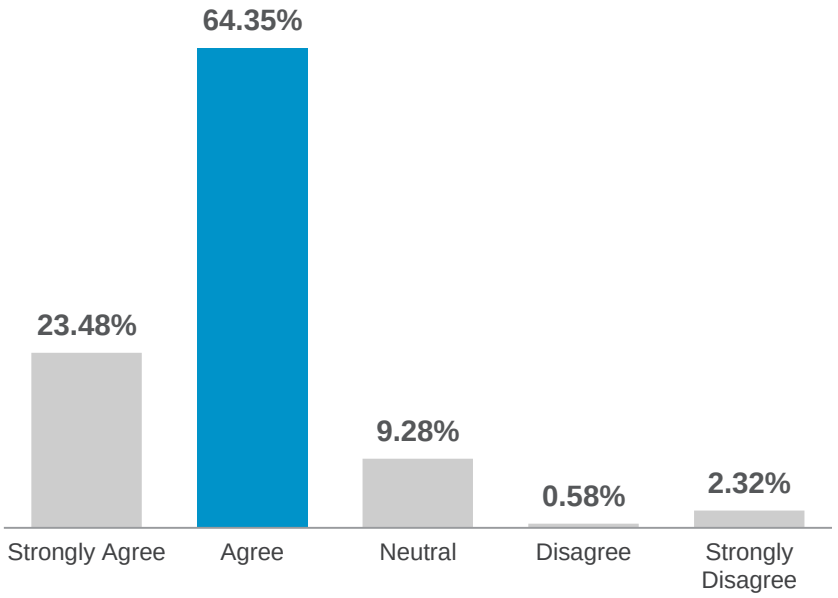
N=346



The program changed student and/or family attitudes or behavior towards energy.

Percent reporting that e³smart℠ changed attitude

N=346



Teacher Input

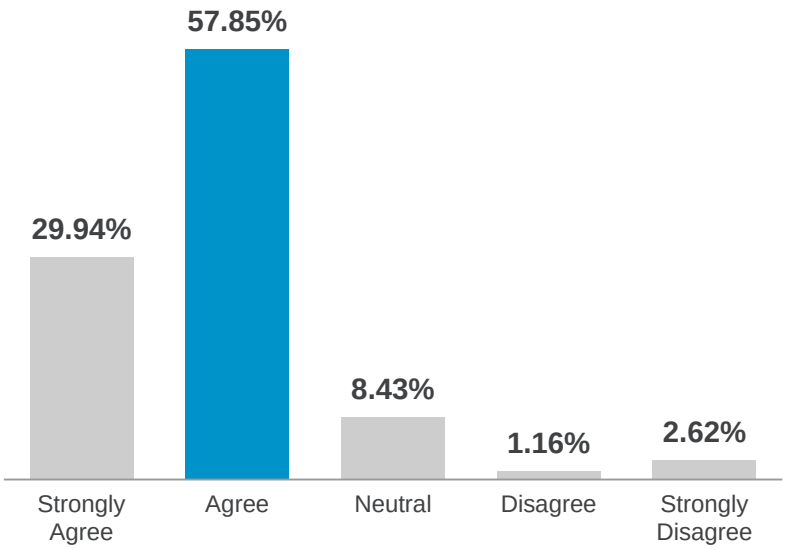
(continued)

One of the key components of implementing the e³smart℠ program is teachers who teach the students all the lessons. The following responses tell us how they view the program.

The activities met my academic content standards.

Percent reporting met academic standards

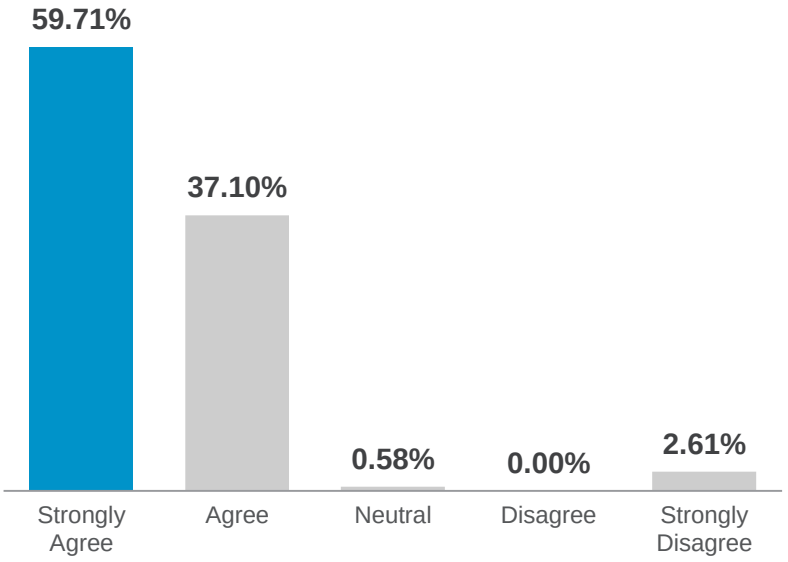
N=346



This program helps me be a more effective teacher when presenting energy content.

Percent reporting that e³smart℠ material helps them present energy material

N=346



Teacher Input

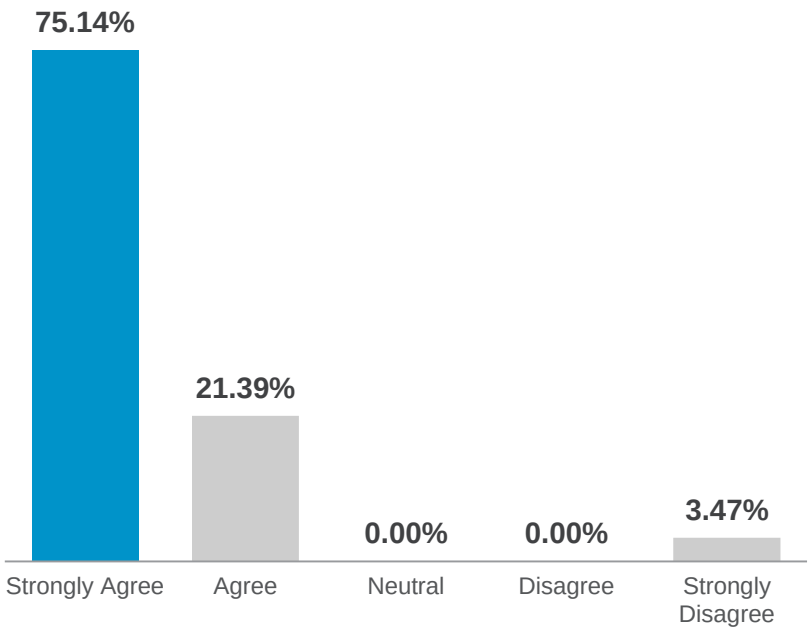
(continued)

One of the key components of implementing the e^{3}smart^{SM} program is teachers who teach the students all the lessons. The following responses tell us how they view the program.

This program promotes real-world application of science concepts.

Percent reporting real world knowledge

N=346



Would you conduct the unit again?

Nearly 100% of respondents said they would do the program again, those who said they wouldn't conduct the unit said it was due to them not teaching in the following year.

Teacher Input

(continued)

"This is a nice easy, all inclusive program that fits right in with the energy standards. It is fun for the kids and teachers too."

"The unit is a great way to connect the students to their families."

"I believe it is a necessary and effective program our students need to be able to make good decisions when it comes to energy usage."

"My students give positive feedback on the program and being high school aged, I feel that they can be vocal advocates for their family and in their own experiences in the near future."

"I would conduct the unit again and again and again! It is the best! The lesson are so hands on and the kids love learning about the content! We get so many amazing resources that allow the lessons to soar!!"

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

Once again, the lack of time to conduct all the lessons and labs was the most common response to the biggest challenge of the program. Increasing teacher's available time is beyond the scope of this program. The implementors take teacher's limited time into consideration and continually update the material so that teachers can seamlessly incorporate it into their lesson plans.

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

Teachers provided detail advice for incoming teachers. Most of the tips focused on preparing for the lessons and labs before introducing them to the class. It might be useful for the implementer to compile a list of preparation suggestions and create a guide on how to best prepare for classroom introduction.

04

Recommendations

In-Service Rates Evaluation

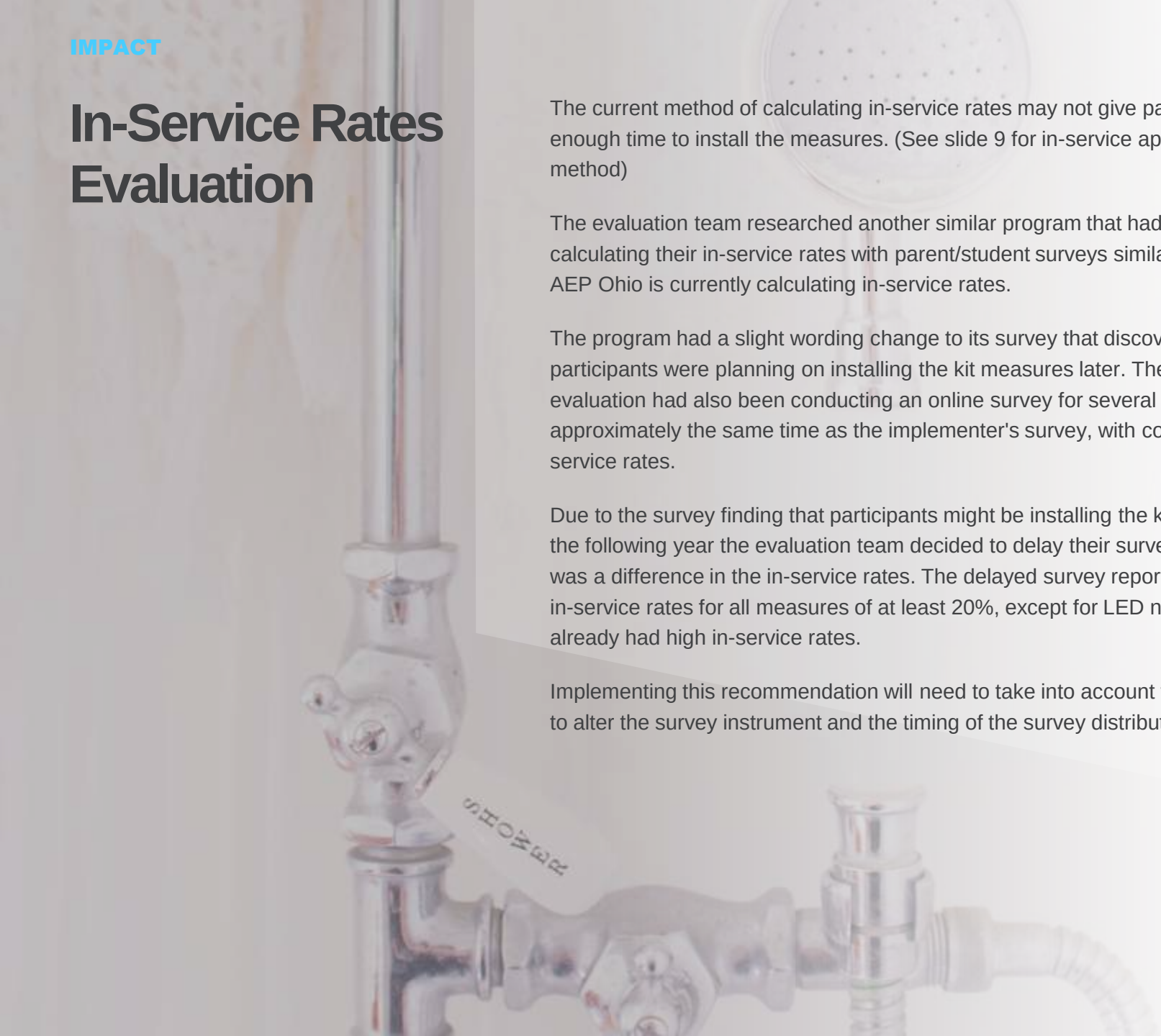
The current method of calculating in-service rates may not give participants enough time to install the measures. (See slide 9 for in-service application method)

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

The program had a slight wording change to its survey that discovered 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 their 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.

Implementing this recommendation will need to take into account the time needed to alter the survey instrument and the timing of the survey distribution.



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

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

Currently, the Draft 2010 Ohio TRM does not account for people per household in its kWh 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 and 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/y) / 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/y = 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 e³smart℠ 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 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 e³smart℠ program targets, gamification could be a useful addition to the e³smart℠ program.

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

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

Gamification options have a wide range; the bullets below show the main types of gamification options.

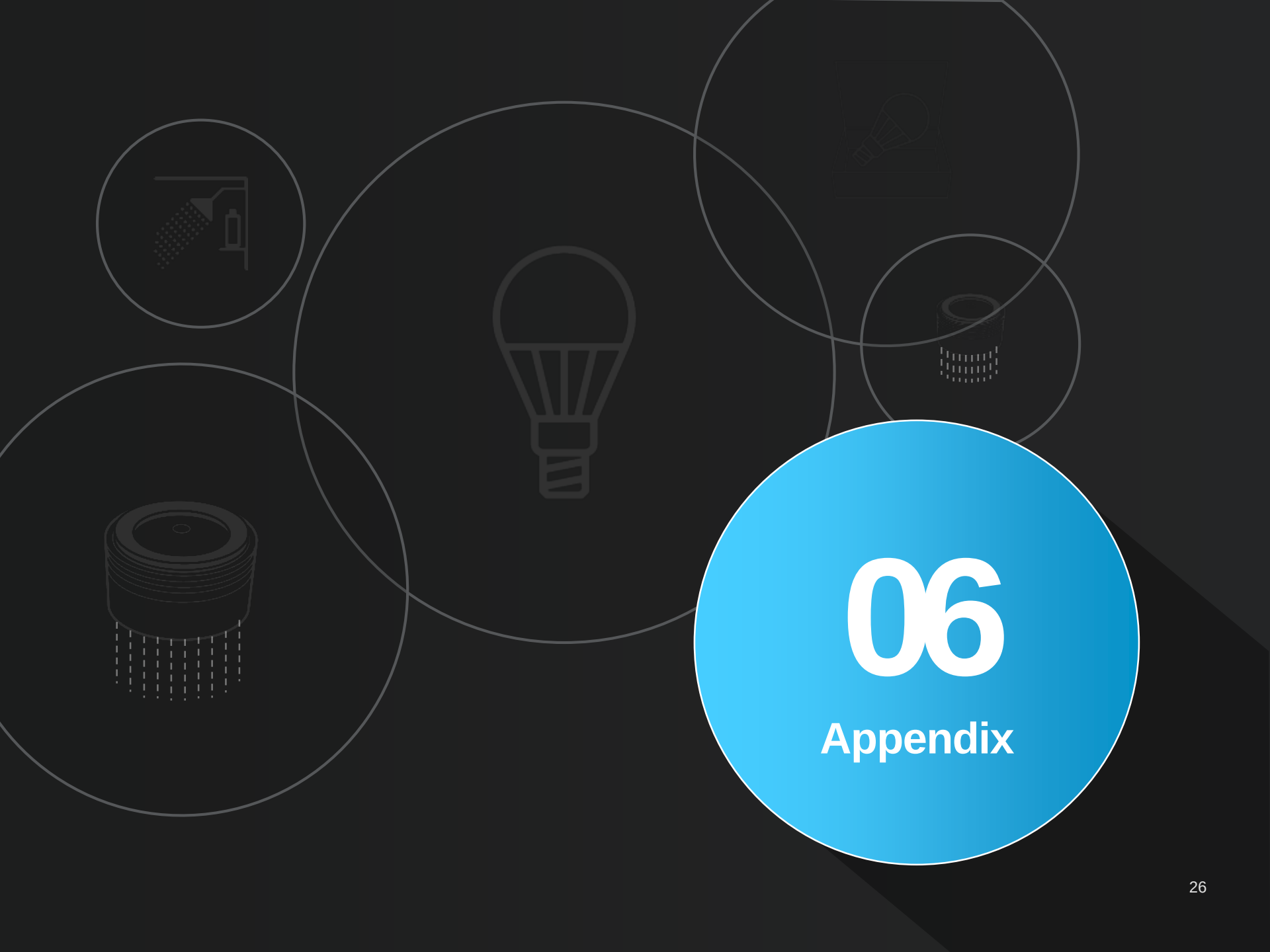
- Give virtual rewards based on answering questions
- Demonstrates home energy usage
- Awards virtual rewards for doing some action
  - kWh savings can be assigned to actions
- Compete with other individuals or groups (classes or schools)
- Use customer utility data to track savings
  - These types of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

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.



06

Appendix

Appendix Measure Algorithms LEDs

Equations

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

*Summer Coincident Peak 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	52%	2017-2018 Participant Survey
Installation Rate 9 W LEDs	IR	58%	2017-2018 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)	33.63	0.006	33.63	0.006	100%	100%
9 W LED (2 Bulbs)	31.75	0.006	31.75	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 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 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	2017 -2018 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)	94.40	94.40	100%
Demand (kW)	0.012	0.012	100%

KITCHEN AERATOR ALGORITHM REVIEW FINDINGS			
Bathroom Aerator (1.5 GPM)	Ex Ante Savings (a)	Ex Post Savings (b)	Realization Rate RR = (b) / (a)
Energy (kWh)	55.14	55.14	100%
Demand (kW)	.007	.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 Navigant 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%	Navigant engineering estimate
Full Load Cooling Hour		503.1	Draft Ohio TRM, average of all locations
Percent Runtime During Peak Period		25%	Navigant 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%	Navigant engineering estimate
Area Covered per Foot of Weather Stripping	12 * Average width of leakage area		-
Average Width of Leakage Area		0.25	Navigant 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

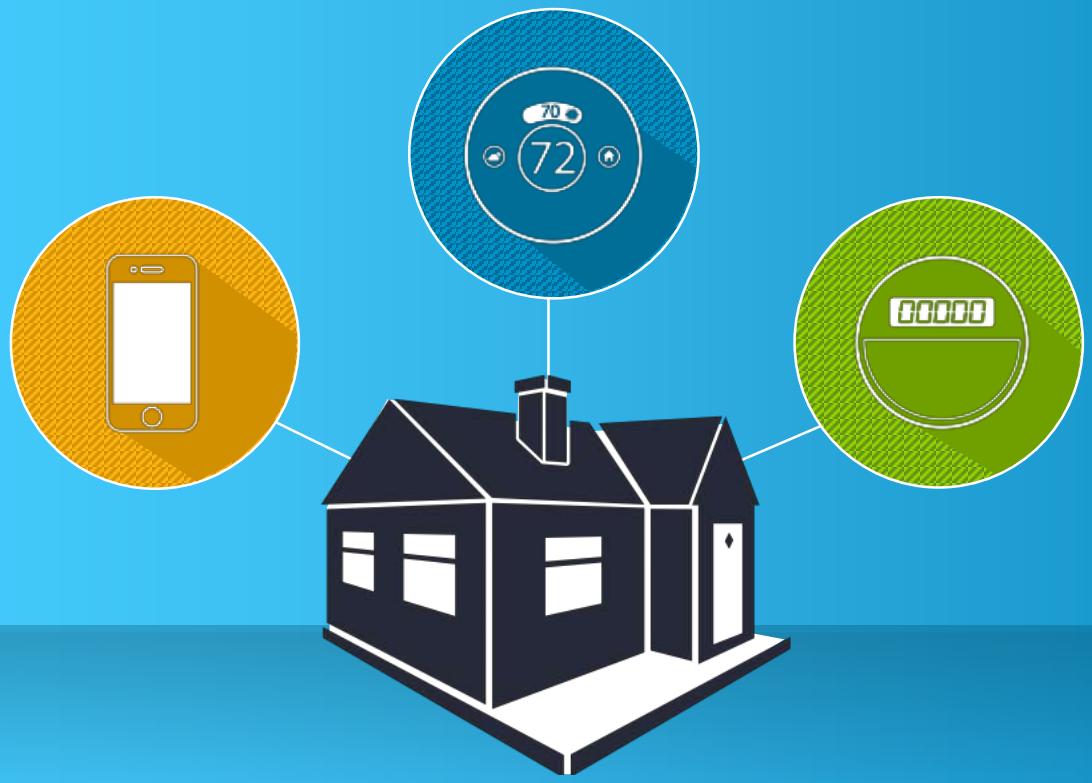
*Annual kWh savings = (UA * (Tpre – Tpost) * Hours) / (3412 * RE_electric)*

*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%

NAVIGANT



Intelligent Home Program

2018 Evaluation Report

AEP OHIO

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MAY 3, 2019

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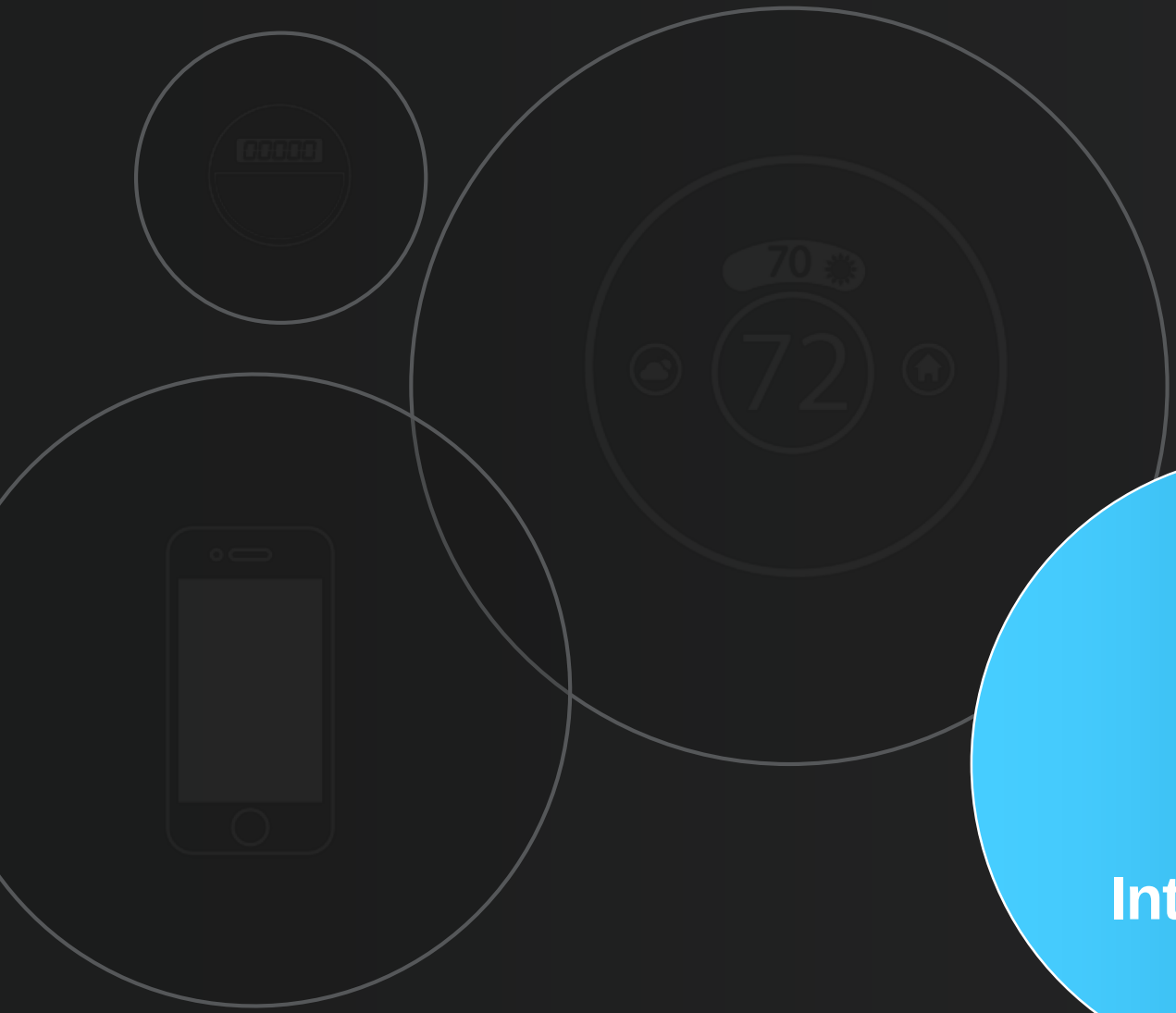


01

Introduction

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.

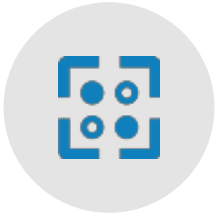
The thermostat will enable DR event participation and offer customizable preferences for automatic and intelligent peak load shed of customers' demand for electricity.

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

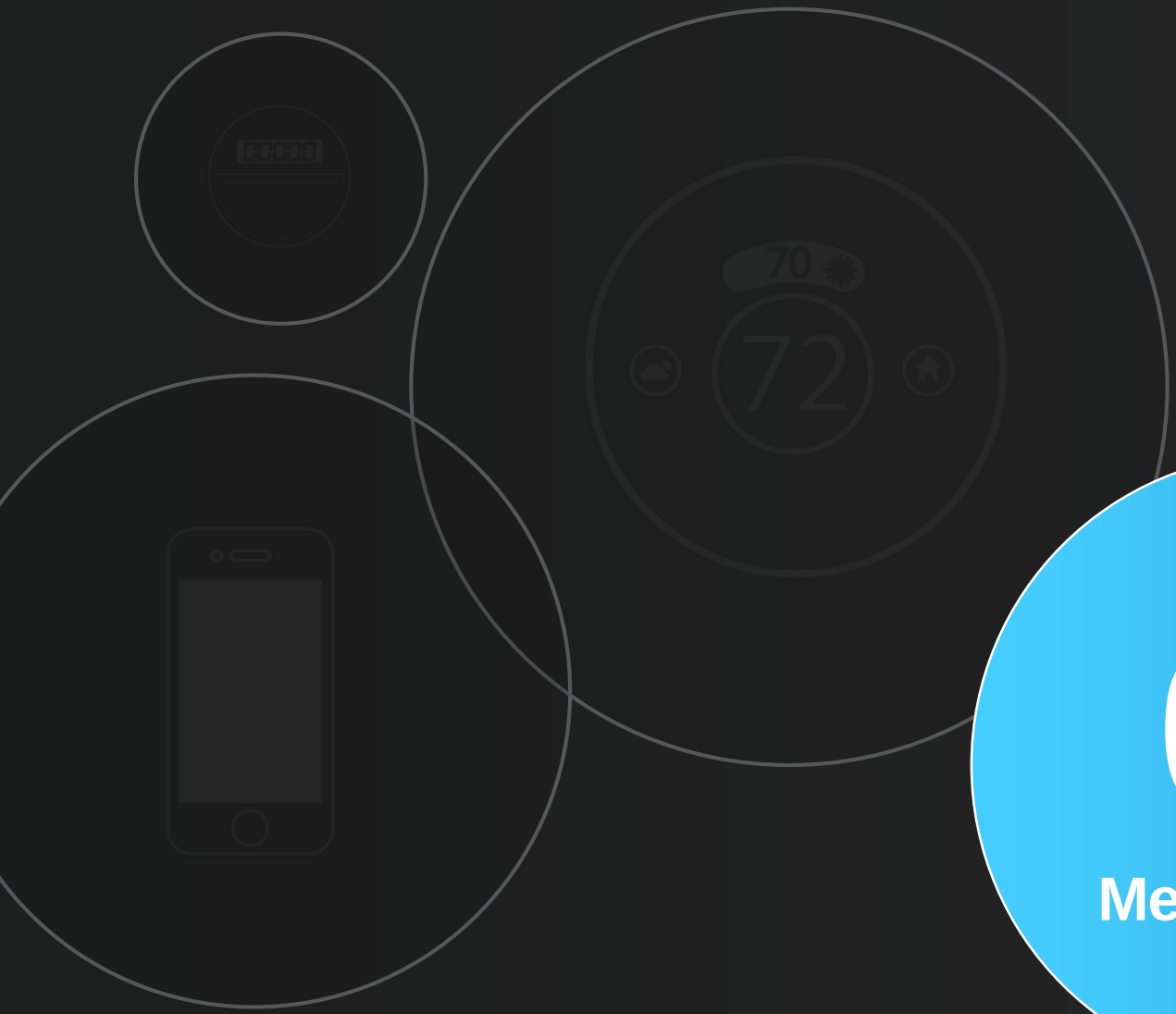
Note: the app also includes pages for Bill Pay, an Outage Map, and the AEP Ohio Energy Efficiency Marketplace.

Program Summary

PROGRAM EVALUATION SUMMARY RESULTS

Measure	2018 Program Goals[1] (a)	Ex Ante Savings (b)	Ex Post Savings (c)	Realization Rate (c) / (b)	Percent of Goal (c) / (a)
Energy Savings (MWh)	24,050	769	504	0.66	2.1%
Demand Savings (kW)	50,000	1,420	547	0.39	1.1%

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



02

Methodology

Evaluation Objectives

The 2018 evaluation activities will follow the objectives identified in Section 2 including:

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

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

Targeted Population
Census

Sample Frame
Customer Billing Database

Sample Size
Census

Timing
Jan-19

1

Cross-Participation Data

Targeted Population
Census

Sample Frame
EE Program Tracking Database

Sample Size
Census

Timing
Jan-19

2

In-Depth Telephone Interview

Targeted Population
Program Manager and Implementation Contractor

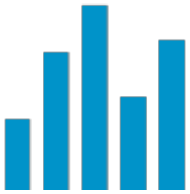
Sample Frame
Contacts for Program Manager and Implementation Contractor

Sample Size
2

Timing
Feb-19

3

Analytical Methods



Econometric Modeling

Navigant estimated the IH app, bridge, and thermostat impacts using an approach called regression with pre-program matching (RPPM). First, IH participants 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 control group and fixed-effects regression model (the thermostat DR component was designed as a randomized control trial (RCT).

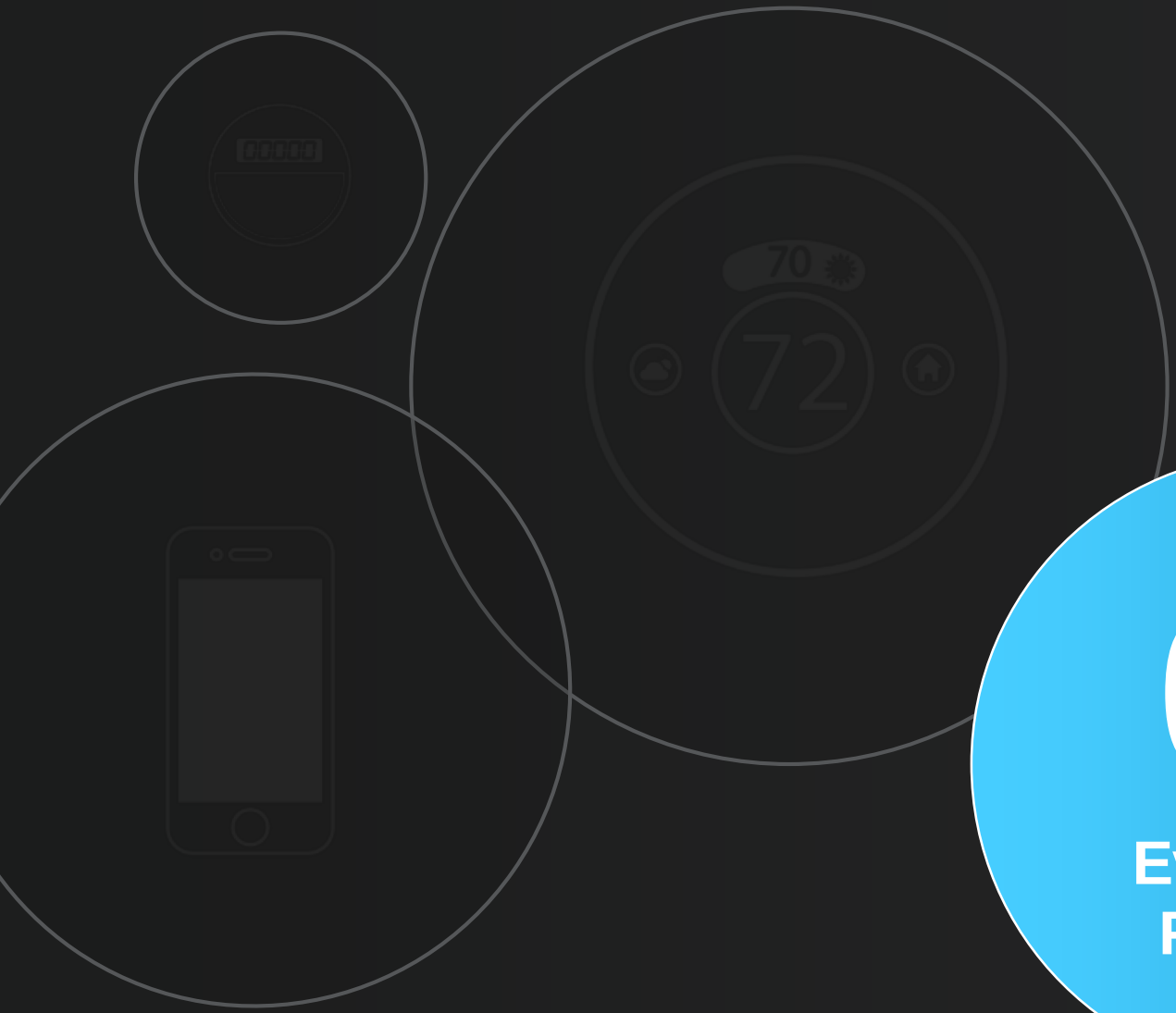
Uplift Analysis

Navigant 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, Navigant compared the difference in the rate of participation between the treatment group and the matched control group in the 2018 program year via the post-only differences (POD) statistic.

In-Depth Staff Interviews

Navigant conducted in-depth interviews in February - March 2019. 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 22,000 customers downloaded the app by the end of 2018, with just under half successfully installing a bridge.

Under a quarter of bridge customers had a program thermostat. In 2018, the app generated no statistically significant savings.

IH SEGMENT SAVINGS ESTIMATES

Group	Number of Participants[1]	Number of Active Participants	Estimated Daily Energy Savings (kWh)	Estimated Percent Savings	Annualized Total (kWh)	Estimated Total Energy Savings (MWh)	Total Peak Demand Savings (kW)[2]
App	21,792	19,040	-0.166	-0.50%	-	-	-
Energy Bridge + App	9,260	8,395	0.230	0.67%	84	332	52
Thermostat + Energy Bridge + App	2,031	2,031	0.568	1.74%	207	237	505
Total	**21,792**	**21,790**	-	-	-	**569**	**557**

[1]AEP Ohio reported 23,471 App participants, 9,816 Energy Bridge + App participants, and 2,153 Thermostat + Energy Bridge + App participants. These numbers accounted for the quantity of devices installed at each household.
[2]Non-DR demand savings are derived from the energy savings estimate using a 1.37 coincidence factor.

TOTAL SAVINGS

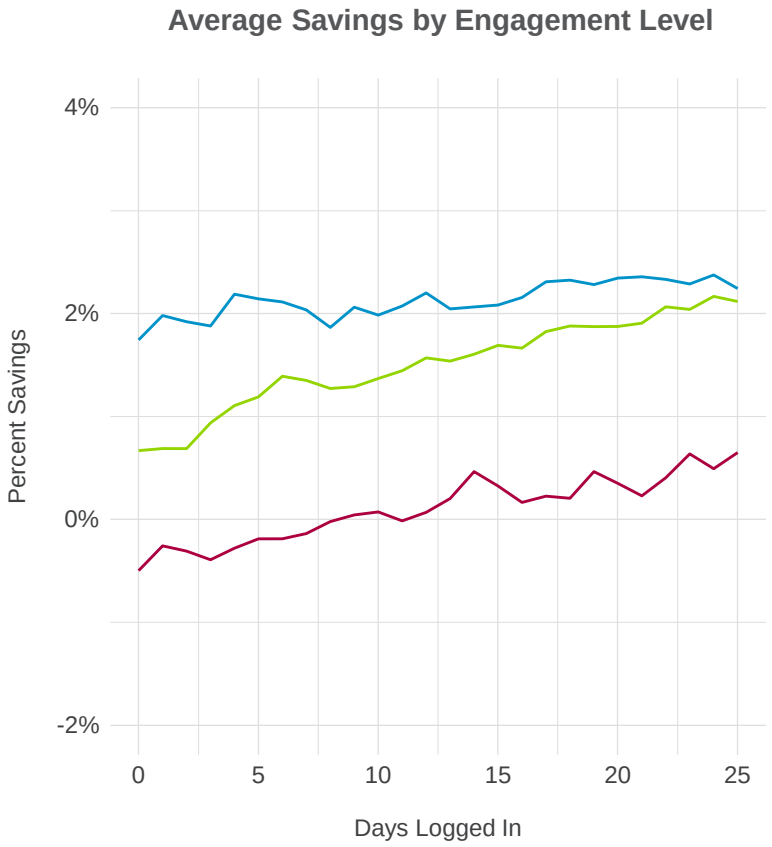
Metric	Total MWh Savings	Total kW Savings[1]
Estimated Total Savings	569	557
Double Counted Savings	64	10
Total	**504**	**547**

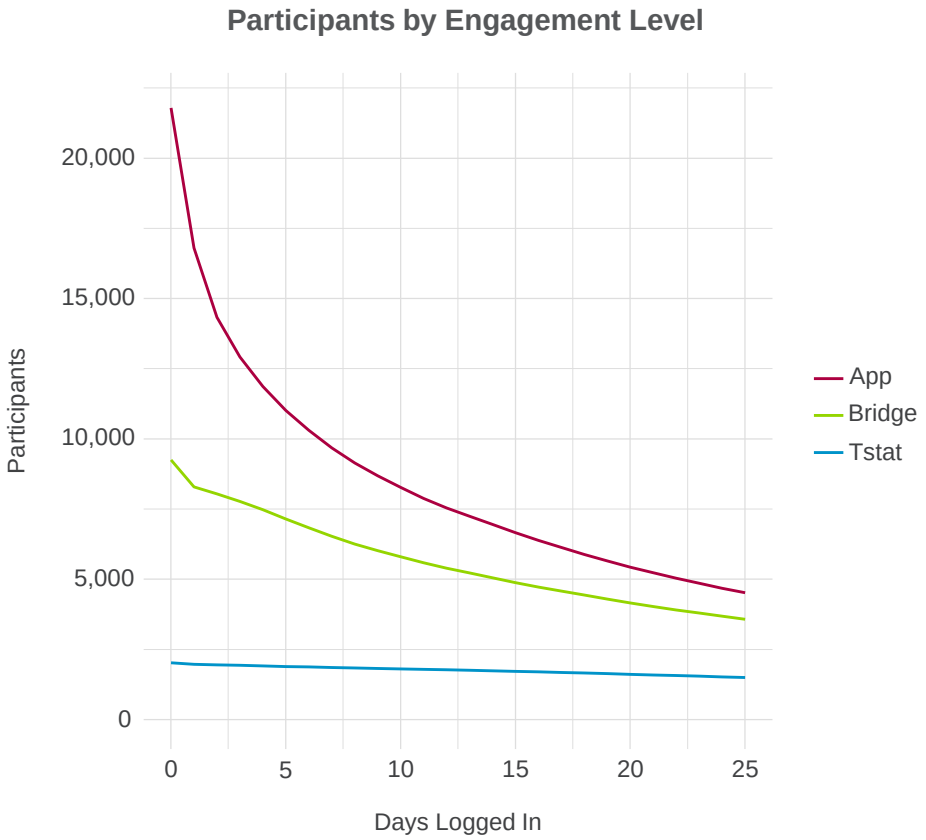
[1]Non-DR demand savings are derived from the energy savings estimate using a 1.37 coincidence factor.

Note: Totals may not sum due to rounding.

Savings by Level of Engagement

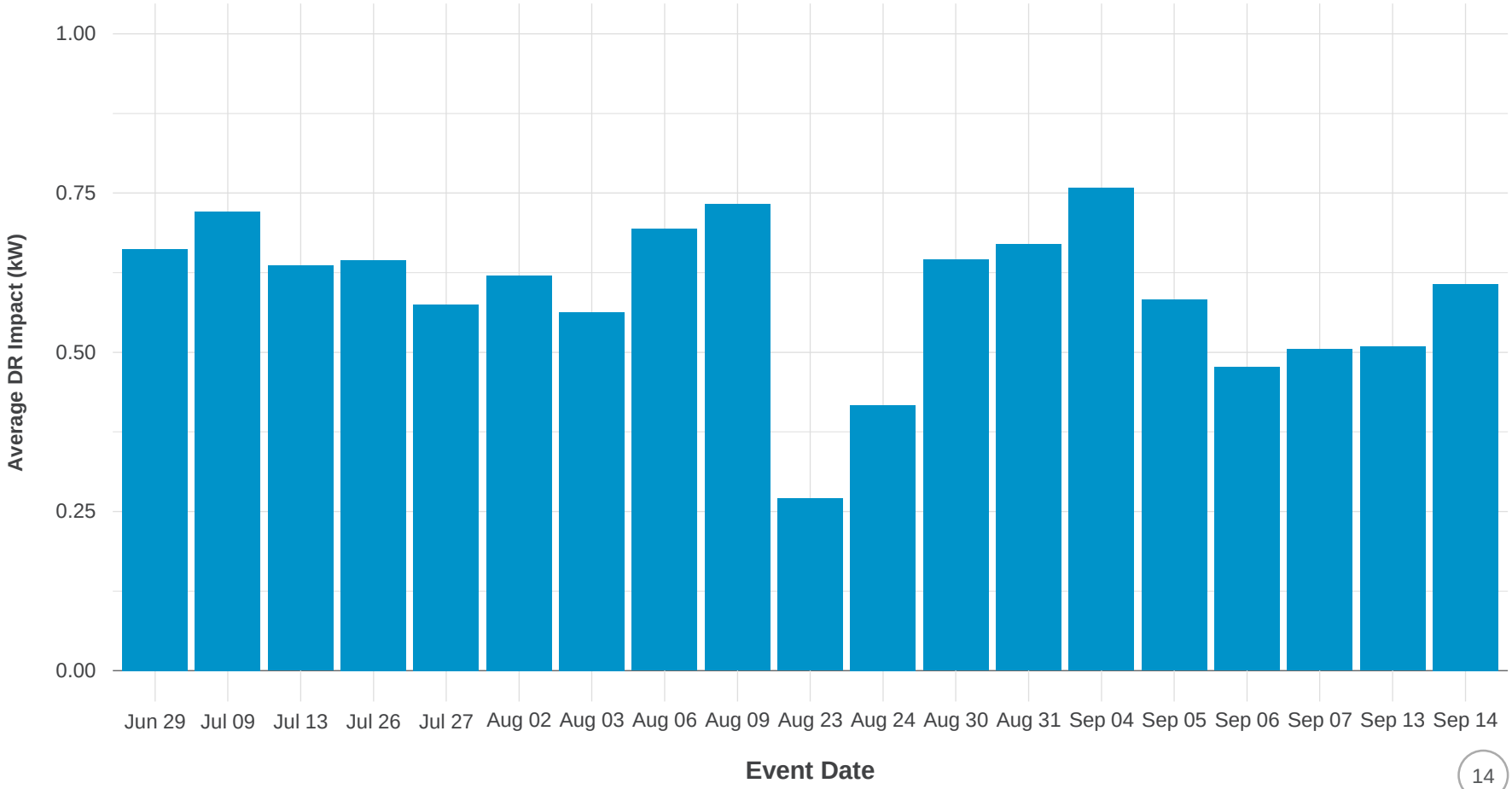
Savings for app and bridge customers trend upward as the engagement threshold is increased. However, the savings increase for thermostat customers is much more gradual. This is likely due to the greater frequency at which thermostat customers use the app. Customers with the thermostat use the app more regularly, so fewer customers are dropped with each threshold increase.





Demand Response Events

The IH program called a total of 19 DR events in the summer of 2018. The DR component of the IH program was designed as an RCT. Customers were randomly sorted into one of three groups (A, B, or C) and only two groups were called for each event. Across all 19 events, average per-customer impacts were 0.59 kW and the average total impact was 468 kW. Individual event impacts ranged from 0.27 kW to 0.79 kW.



Uplift Results

Navigant 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. The Community Assistance Program generated negative uplifted savings, indicating that IH program participants are participating in the program at a lower rate than the comparison group. While negative uplift savings are not usual, the nature of the Community Assistance program has participation constraints that can cause confounding factors to the uplift results.

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	21,270	-2,756	14,026	31,657	64,198

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	21,970
Annual Energy Savings (kWh)	504,401
Coincident Peak Savings (kW)	547
Third Party Implementation Costs	$1,319,012
Utility Administration Costs	$841,470
Utility Incentive Costs	$122,365
Participant Contribution to Incremental Measure Costs	$0

Based on these inputs, the TRC ratio is 0.0. 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	0.0
Participant Cost Test	N/A
Ratepayer Impact Measure	0.0
Utility Cost Test	0.0

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 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.

In early 2018, AEP Ohio and Powerley (the program implementor) went through a major overhaul of the energy bridge bind protocol. Prior to that, the bind failure rate was exceedingly high, resulting in only 37% of bridges being successfully connected and previously bound bridges becoming unbound. AEP Ohio and Powerley worked together to troubleshoot the issues, and now 99% of bridges are successfully bound when attempted, according to the program manager.

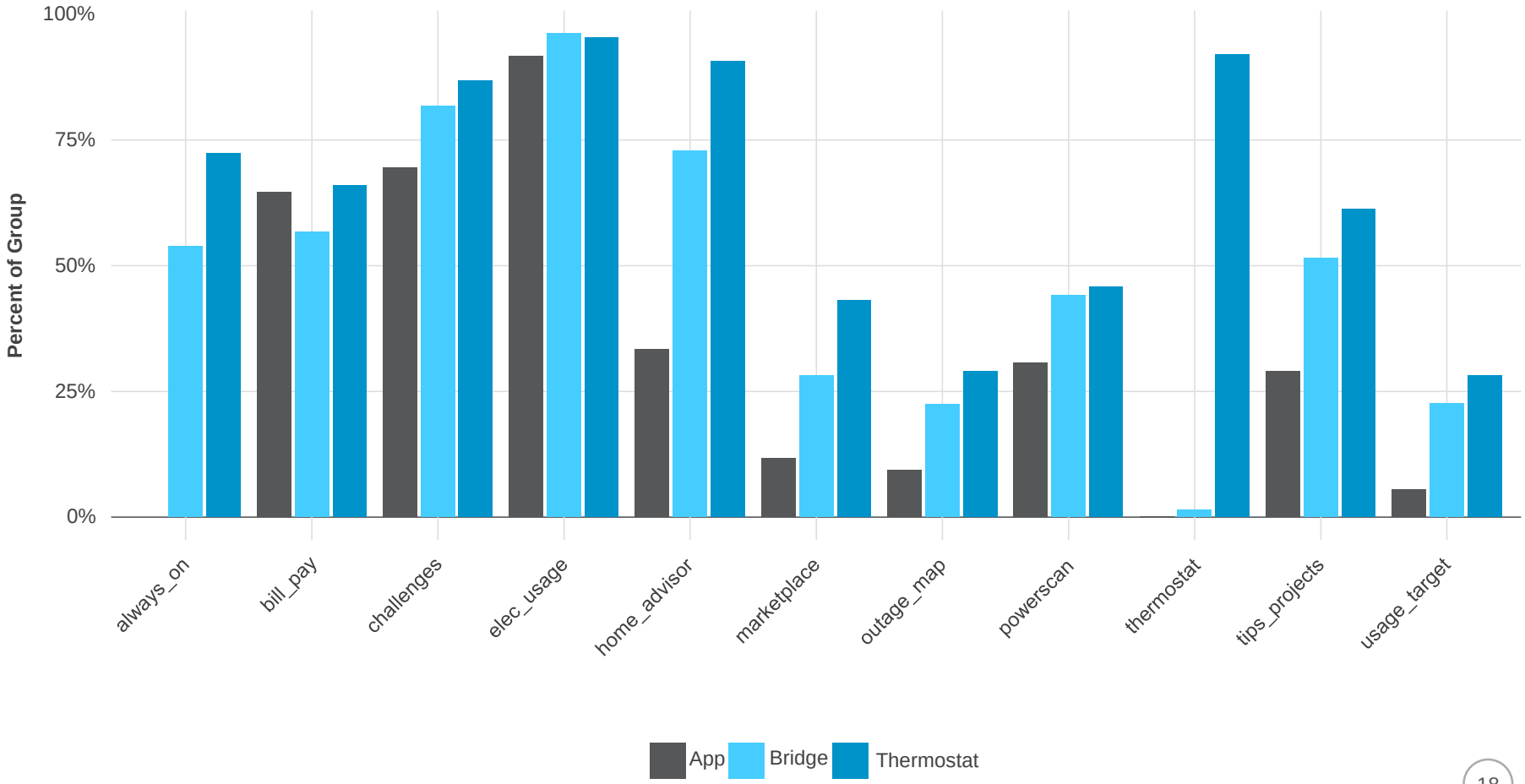
AEP Ohio and Powerley have also worked to increase their communications with customers, particularly those who receive a bridge. Now, every two weeks after bridge delivery, a customer receives an email reminding them to bind their bridge. Additional communication via post card follows several emails, and eventually customers who don’t bind their bridge are sent a return packet. This increase in communication has led to a 70% bound and online rate among deployed bridges, according to the implementation manager.

At this time there are no problems implementing the program.

App Analytics

Page Visits by Customer Type

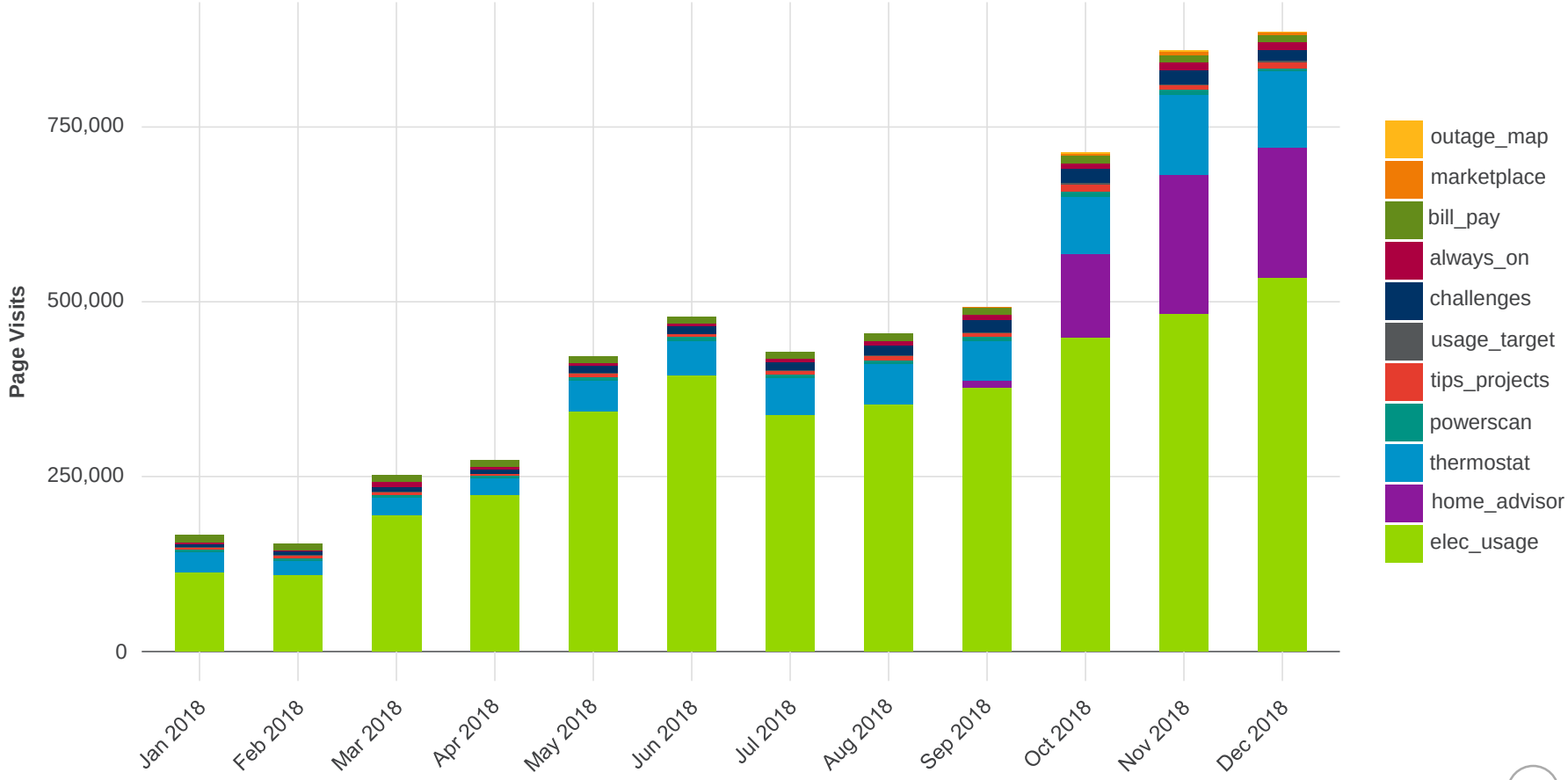
Most app downloaders visit the home page of the app, which shows the hourly or sub-hourly electricity usage. Other pages visited by most downloaders include challenges and bill pay. Home Advisor was visited at least once by Bridge and Thermostat customers, but less than half of App-only customers visited this page.



App Analytics

Page Visits by Month

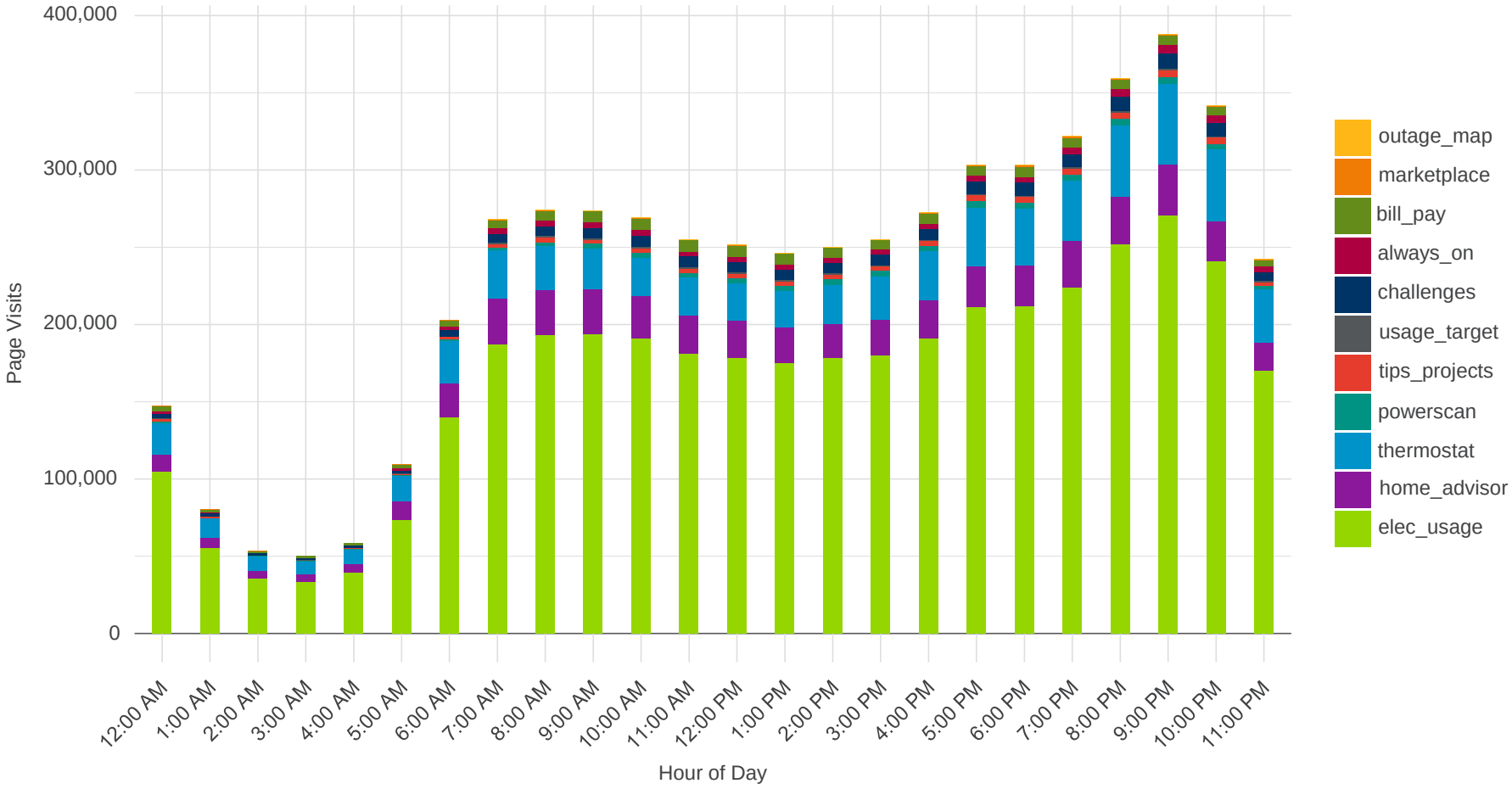
App traffic increased steadily throughout 2018 as more customers downloaded the app. The Home Advisor feature was introduced in late September 2018 and quickly became the second most popular feature after the home page (electricity usage) of the app. The third most popular feature is the thermostat, which allows customers with an IYP thermostat to change the temperature within the app.



App Analytics

Page Visits by Hour of Day

App traffic is 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

App

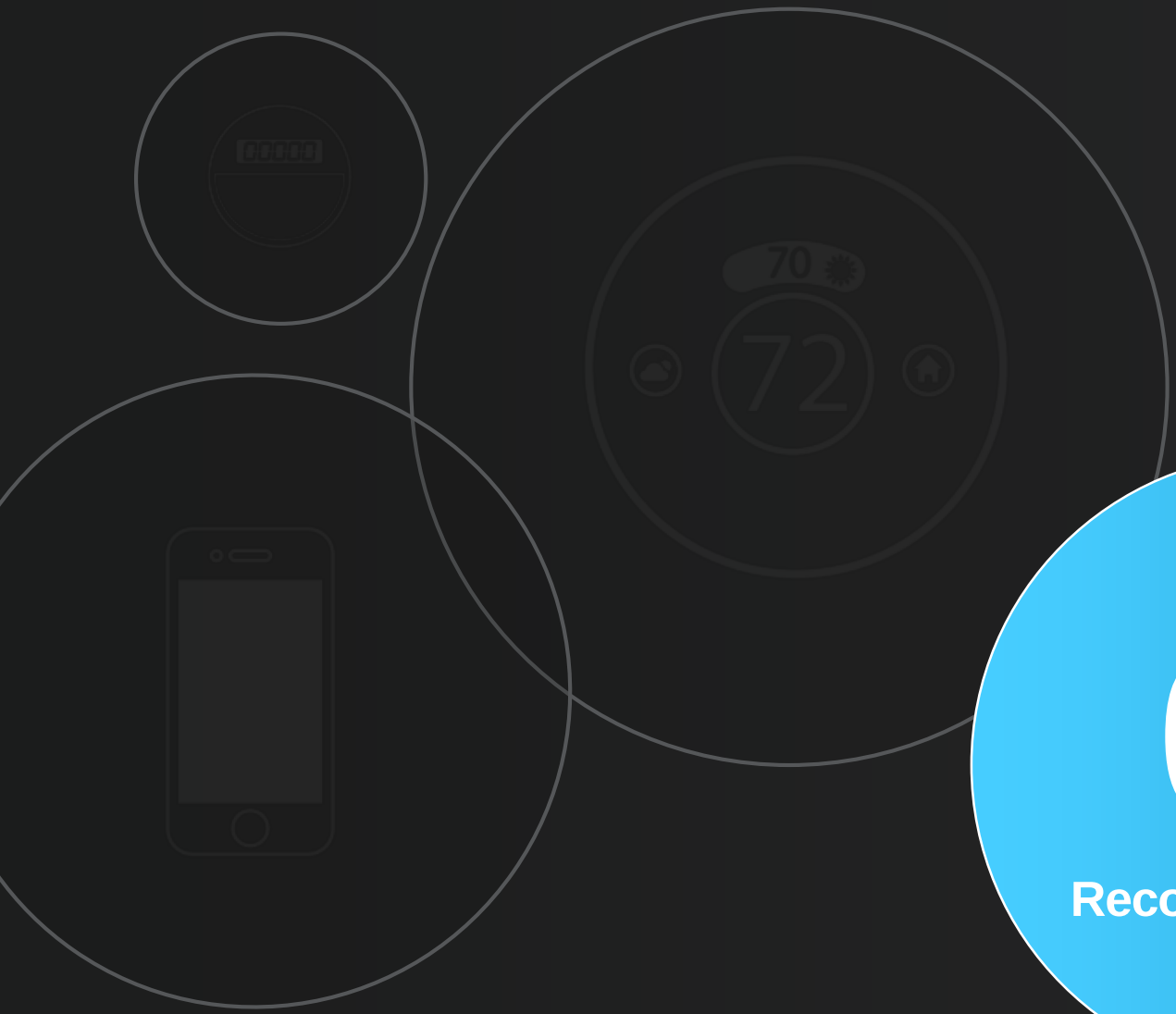
2.82

Bridge

6.04

Thermostat

11.17



04

Recommendations

Recommendations

FINDING 1

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

Customers with an installed energy bridge achieved statistically significant savings, albeit small, likely because having a bridge augments the functionality of the app and provides more insight into household energy usage.

RECOMMENDATION 1

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

If AEP Ohio can encourage customers to return to and use the app, higher savings may be achieved. 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.

Recommendations

FINDING 3

The DR program generated demand savings during all events, contributing significantly to the IH program's verified demand savings.

RECOMMENDATION 3

A limitation to the DR program is that participation is restricted to customers with the program thermostat, which was under a quarter of bridge participants in 2018.

If the IH program becomes cost effective in the future. AEP Ohio should consider expanding the DR program to include other smart thermostats. This would allow customers with existing smart thermostats to enroll in the program, increasing the achievable demand savings.

FINDING 4

The IH program is not cost-effective in its current form.

RECOMMENDATION 4

AEP Ohio should consider combining the IH program with its other residential behavior program: Home Energy Reports (HER). Both programs have similar goals: to achieve energy efficiency through behavior change. Many HER treatment customers already use the It's Your Power app, but further cross-participation could be achieve by combining program efforts.

Additionally, combining programs would improve the cost-effectiveness of the IH program components by pooling program marketing and incentive costs of both programs.

NAVIGANT

Community Assistance Program

2018 Evaluation Report

AEP OHIO

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APRIL 19, 2019

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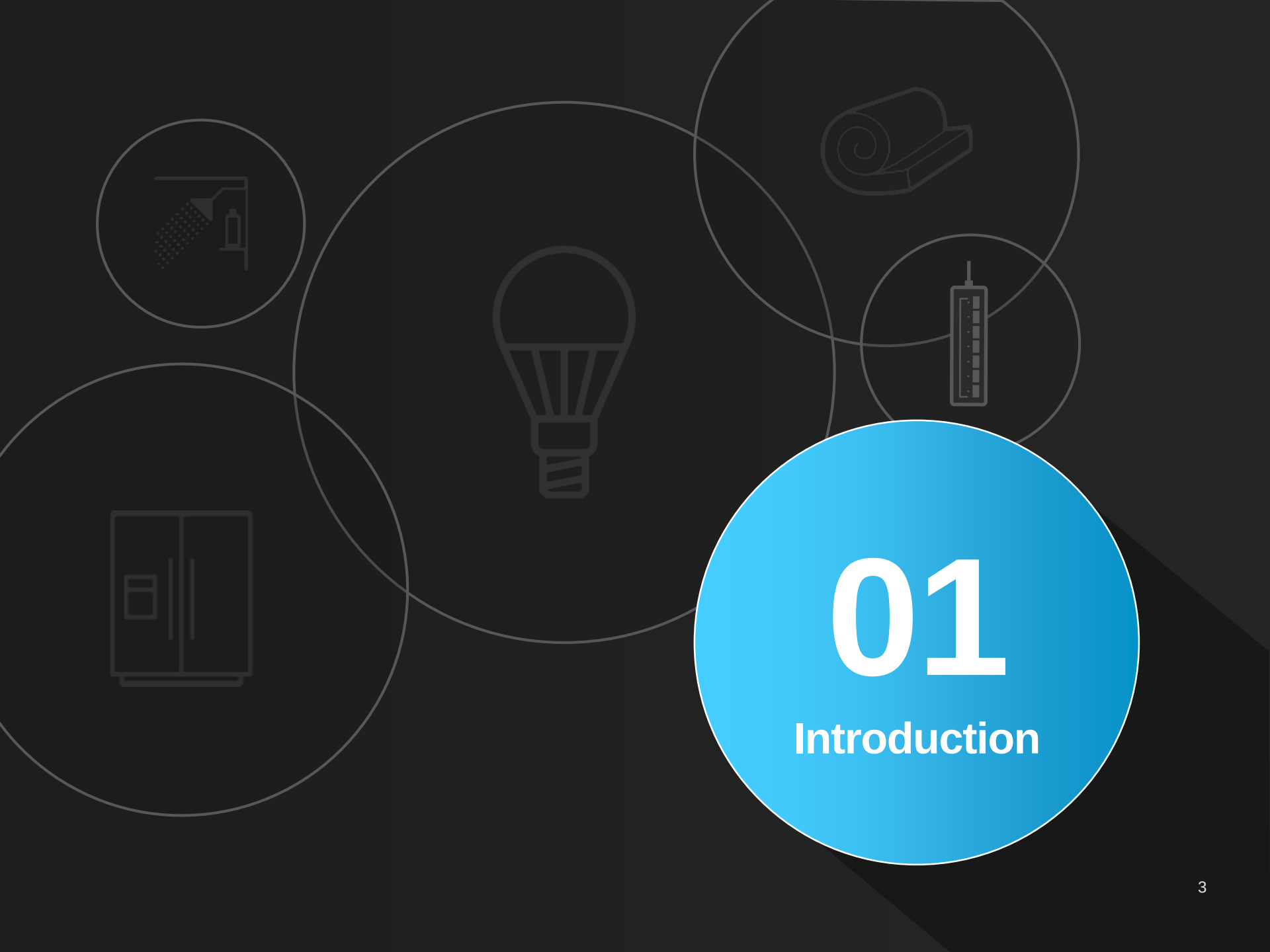


01

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 2018, CAP was administered by AEP Ohio through the implementer, and agencies.

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 2018 were 0.95 for energy savings and 1.01 for demand savings. The program achieved 4,336 MWh and 666 kW in energy and demand savings, respectively.

PROGRAM EVALUATION SUMMARY RESULTS

	2018 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	**4,560**	**4,336**	0.95	51%
Demand Savings (kW)	774	**661**	**666**	1.01	87%

[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

Navigant 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 **4,927**	Sample Size **1**	Sample Size **4,927**	Sample Size **257 valid email addresses**	Sample Size **33**
Completes **Census**	Completes **2 separate interviews**	Completes **79**	Completes **68**	Completes **5**
Timing **October 2018 – February 2019**	Timing **October 2018 – February 2019**	Timing **December 2018 – January 2019**	Timing **January – February 2019**	Timing **November – January 2019**

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.

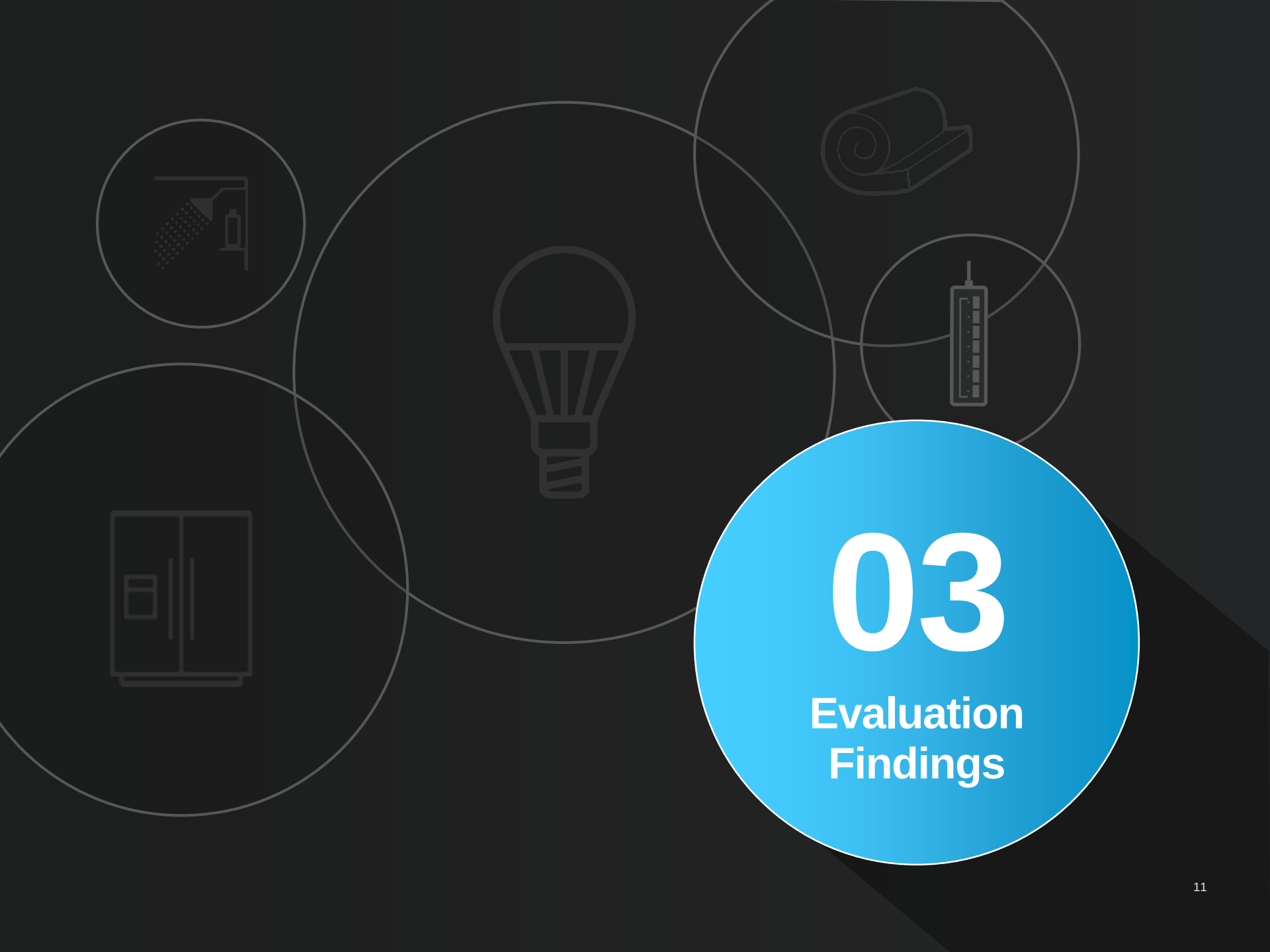
Ex Post Savings Evaluation Methods

Program savings were assessed using the program tracking data and the Draft 2010 Ohio TRM. Navigant 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 2018 and conducted a review of best practices for implementing residential low-income programs. A summary list of program materials reviewed for this report includes:

- Implementation plans
- Operation manuals



03

Evaluation Findings

Measure Saving Results

294,628 measures were installed to 4,927 participants during the 2018 year as a part of the program.

The verified energy savings are 4,335,680 kWh. Navigant found a realization rate of 0.95.

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	52,165	49,014	1,988,082	1,868,797	0.94
Refrigerator	3,445	3,445	1,504,140	1,504,140	1.00
Freezer	444	444	271,969	271,969	1.00
Smart Strip	3,668	3,298	300,448	262,654	0.87
A-R-C Insulation	129,937	129,417	238,972	186,183	0.78
Pipe Insulation	654	612	104,787	99,266	0.95
Other	80,837	28,908	28,927	28,927	1.00.
Showerhead	598	371	31,440	24,596	0.78
Air Sealing	20,751	20,664	35,384	33,782	0.95
Faucet Aerator	831	789	20,335	19,318	0.95
Heat Pump	24	24	15,036	15,083	1.00
WH Replacement	29	29	11,940	11,940	1.00
Duct Sealing	1,197	1,197	4,145	4,145	1.00
HW Tank Wrap	47	46	3,634	3,634	1.00
Freezer Retire	1	1	1,244	1,244	1.00
TOTAL	**294,628**	**238,259**	**4,560,483**	**4,335,680**	**0.95**

[1] Ex Post numbers are different ex ante numbers due to the removal of measures with zero savings values and the ISR.

* Note: totals may not sum due to rounding.

Measure Saving Results continued

The following table shows the demand savings per measure. Navigant verified a total of 666.231 kW in peak demand savings. Navigant found a realization rate of 1.01.

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	52,165	49,014	341.911	321.396	0.94
Refrigerator	3,445	3,445	244.836	244.836	1.00
Freezer	444	444	41.730	41.732	1.00
Smart Strip	3,668	3,298	0.000	30.173	NA
A-R-C Insulation	129,937	129,417	5.076	3.754	0.74
Pipe Insulation	654	612	11.962	11.332	0.95
Other	80,837	28,908	2.134	2.134	1.00
Showerhead	598	371	3.594	2.755	0.77
Air Sealing	20,751	20,664	1.949	0.225	0.12
Faucet Aerator	831	789	2.542	2.415	0.95
Heat Pump	24	24	3.090	3.641	1.24
WH Replacement	29	29	0.669	0.669	1.00
Duct Sealing	1,197	1,197	0.557	0.557	1.00
HW Tank Wrap	47	46	0.414	0.414	1.00
Freezer Retire	1	1	0.200	0.200	1.00
TOTAL	**294,628**	**238,259**	**660.661**	**666.231**	**1.01**

[1] Ex Post numbers are different ex ante numbers due to the removal of measures with zero savings values and the ISR.
* Note: totals may not sum due to rounding.

In-Service Rates

The evaluation team conducted 79 onsite visits to 2018 participant's homes to verify if measures were installed as described in the tracking database.

The evaluation team applied the 2018 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 2018 ISR = (b) / (a)	In-Service Rate 2017
LEDs	973	914	**94%**	94%
Low-Flow Showerhead	21	13	**62%**	94%
Faucet Aerator	22	21	**95%**	100%
Refrigerators	61	61	**100%**	100%
Freezer	8	8	**100%**	100%
Smart Strips	68	61	**90%**	91%

Tracking System Evaluation

The tracking system accurately gathers data on installed measures reported by the agencies.

Some of the variables entered by the agencies are values that are outside the range of values that can be considered valid. The agencies either entered the information in the wrong field or misunderstood which value should be entered into the field.

Compared to previous years the number of reasonable variable entries has increased.

AEP Ohio and the evaluation team attempted to use the tracking data measure variables when reasonable to provide the most accurate saving estimates.

When the variables could not be considered reasonable, AEP Ohio and the evaluation team used deemed variable values from the Draft 2010 Ohio TRM.

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

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.

A-R-C insulation

The realization rate for energy is 78 and 74 percent for demand savings.

Navigant used a combination of the equations specified in the Draft 2010 Ohio TRM 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.

Navigant compared these measures separately. The measure savings are rolled up to present category level summary realization rates.

Pipe Insulation

The realization rate was 95 percent for energy and demand savings.

This is due to Navigant using the tracking data weighted averages for the calculation inputs.

Measure Calculation Methods continued

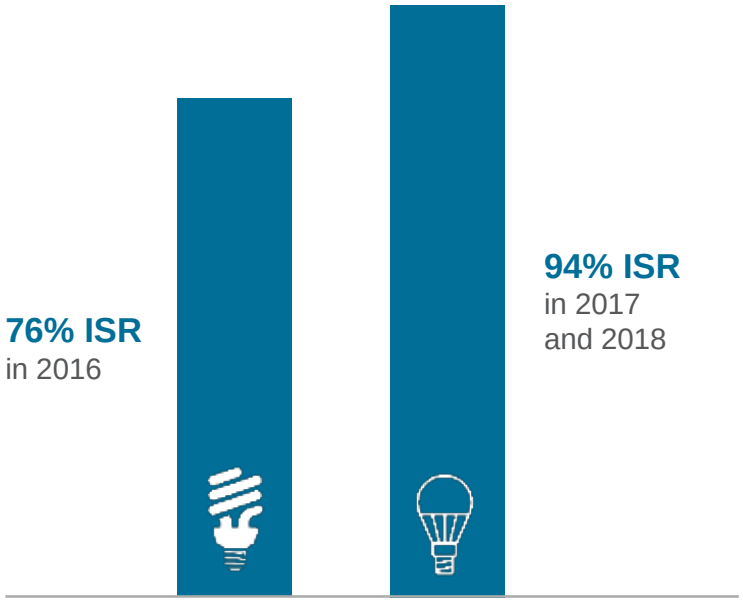
Air Sealing

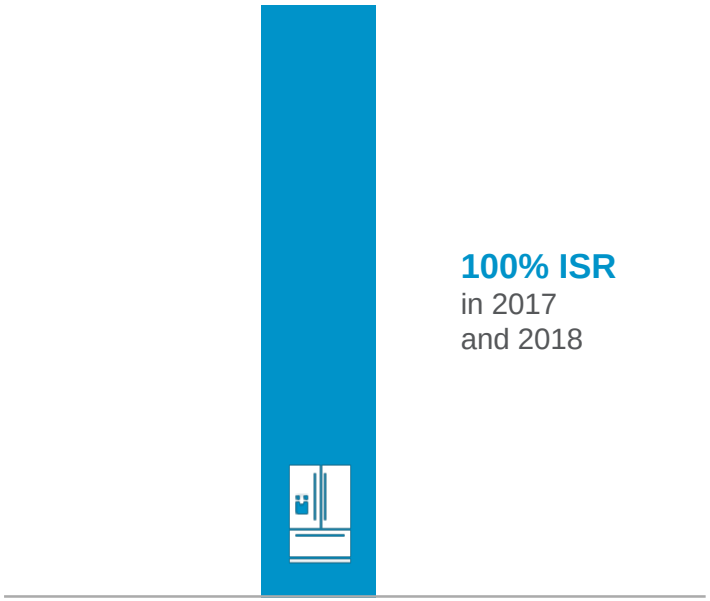
Realization rate was 95 percent for energy savings and 12 percent for demand savings.

The discrepancy in the realization rate for energy is due to Navigant using tracking data variables when reasonable, rather than deemed values.

The discrepancy for demand savings is due to a decimal placement error that caused the values to be off by a factor of ten.

Onsite Verification





This is the second year that LEDs have been installed as part of CAP.

The ISR for LEDs in 2018 was 94 percent, the same as 2017.

This continued high ISR is excellent compared to the 2016 CFL ISR of 76 percent.

All 61 refrigerators that were in the tracking system were visually verified by the on-site evaluation team.

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	16
Residences	4,927
Annual Energy Savings (kWh)	4,335,680
Coincident Peak Savings (kW)	666
Third Party Implementation Costs	$876,237
Utility Administration Costs	$479,946
Utility Incentive Costs	$4,399,414
Participant Contribution to Incremental Measure Costs	$0

Based on these inputs, the TRC ratio is 0.5. 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	0.5
Participant Cost Test	1.7
Ratepayer Impact Measure	0.3
Utility Cost Test	0.5

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.

Navigant's Online Survey

AEP Ohio's Appliance Recycling Program implementation contractor, Recleim is performing well according to Navigant's online survey. The online surveys were conducted with customers who had their old refrigerators picked up and their new refrigerators delivered by Recleim. The online survey only represents customers who participated in CAP after April of 2018 and who had a refrigerator or freezer replaced. 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 68 people but not all respondents answered every question.

SURVEY QUESTION

Did you receive a notice in advance to confirm the delivery and pick-up appointment or to let you know the delivery and pick-up team was coming?

Question Response n = 58

100% said they received a confirmation call for the delivery and pick up

SURVEY QUESTION

Did the collection team arrive during the scheduled appointment window?

Question Response n = 57

100% of respondents said that the collection team arrived on time.

SURVEY QUESTION

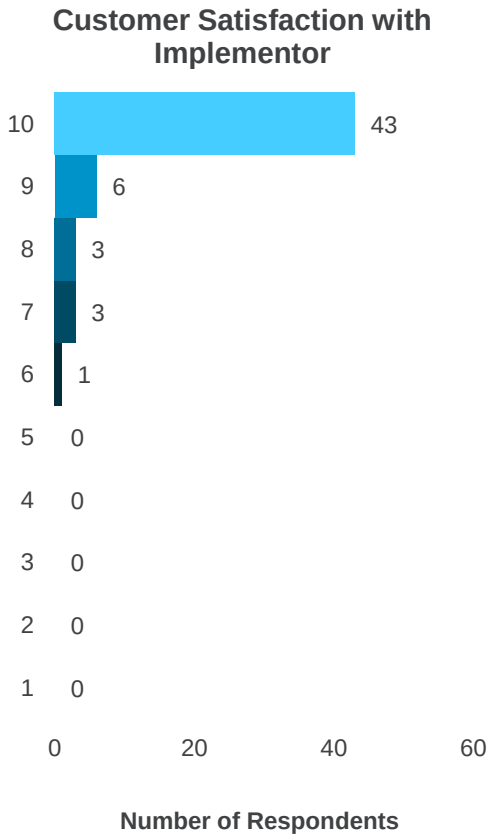
Were the people who performed the services accommodating to your needs when scheduling the services?

Question Response n = 56

55 out of 56 respondents who answer this question said the people who performed the services were accommodating to their scheduling needs. 1 respondent said the team was not accommodating.

Navigant's Online Survey

Continued



SURVEY QUESTION

How satisfied were you with the collection team who delivered and picked up your refrigerator?

Question Response n = 56

On a scale of 0 to 10 the average rating for the pick up and delivery team was 9.55.

The lowest score was 6. This customer said the cord to their old refrigerator was cut before they realized the replacement refrigerator did not fit and they were left with no refrigerator for two days. While this is likely a unique situation it should be emphasized that before the cord is cut to the old refrigerator the new refrigerator should be installed and verified that it is working.

SURVEY QUESTION

Were the people who performed the services courteous?

Question Response n = 54

Yes	53
No	1

SURVEY QUESTION

Would you suggest that others who are offered these services participate in the program?

Question Response n = 55

Yes	54
No	1

Customer Comments

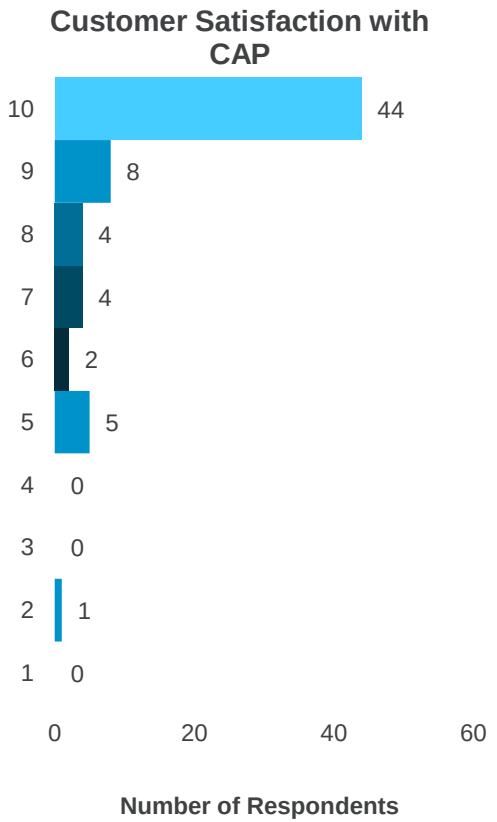
"I could not have asked for more polite and very hard workers doing their job very well! I also much appreciate the help I got with a new refrigerator for my son and myself!"

"I was very happy to get a new refrigerator since I couldn't afford to get a new one myself. I was so excited to see that the new one had a bigger freezer compartment. I love the size; I love everything about it. Thank you!"

"Thank you; I don't know what we would have done without this program."

Navigant's Online Survey

Continued



In previous years it has been uncertain if customers realized AEP Ohio is the sponsor of CAP.

The following survey question identifies that most customers realize AEP Ohio is the CAP sponsor.

SURVEY QUESTION

Was it clear that AEP Ohio funded the CAP program?

Question Response n = 67

Yes	57
Don't Know	6
No	4

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 = 68

The average rating for the program was 8.99

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 and the evaluation onsite field visits.

The key 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.

The majority of questions were open-ended to facilitate an open discussion of the topics.

Each interviewed agency mentioned the 2018 change of Recleim providing refrigerators as the most impactful change in the program for their organizations.

There were mixed reactions to the change.

- *There were concerns (from larger agencies who had the purchasing power to buy refrigerators at a reduced price) that Recleim buying the refrigerator would hurt the agencies operating margins.*
- *Smaller agencies who were making very little on refrigerators were pleased with the audit fee that AEP Ohio added as part of the new refrigerator replacement policy.*

Other takeaways from the interviews:

- *Communication with AEP Ohio is convenient and effective.*
- *Agencies have become more accustomed to adding pre and post data into the tracking system.*
- *Agencies are trying to find new ways to incorporate envelope measures into their standard practices.*

Interviews

AEP Ohio Project Manger Interview

The evaluation team completed two in-depth interviews with the program manager.

The first interview was held at the beginning of the program year to understand the current year's program goals and changes from the previous year.

The evaluation team completed the second interview after the evaluation team received feedback from the on-site visits and the community-based agency interviews.

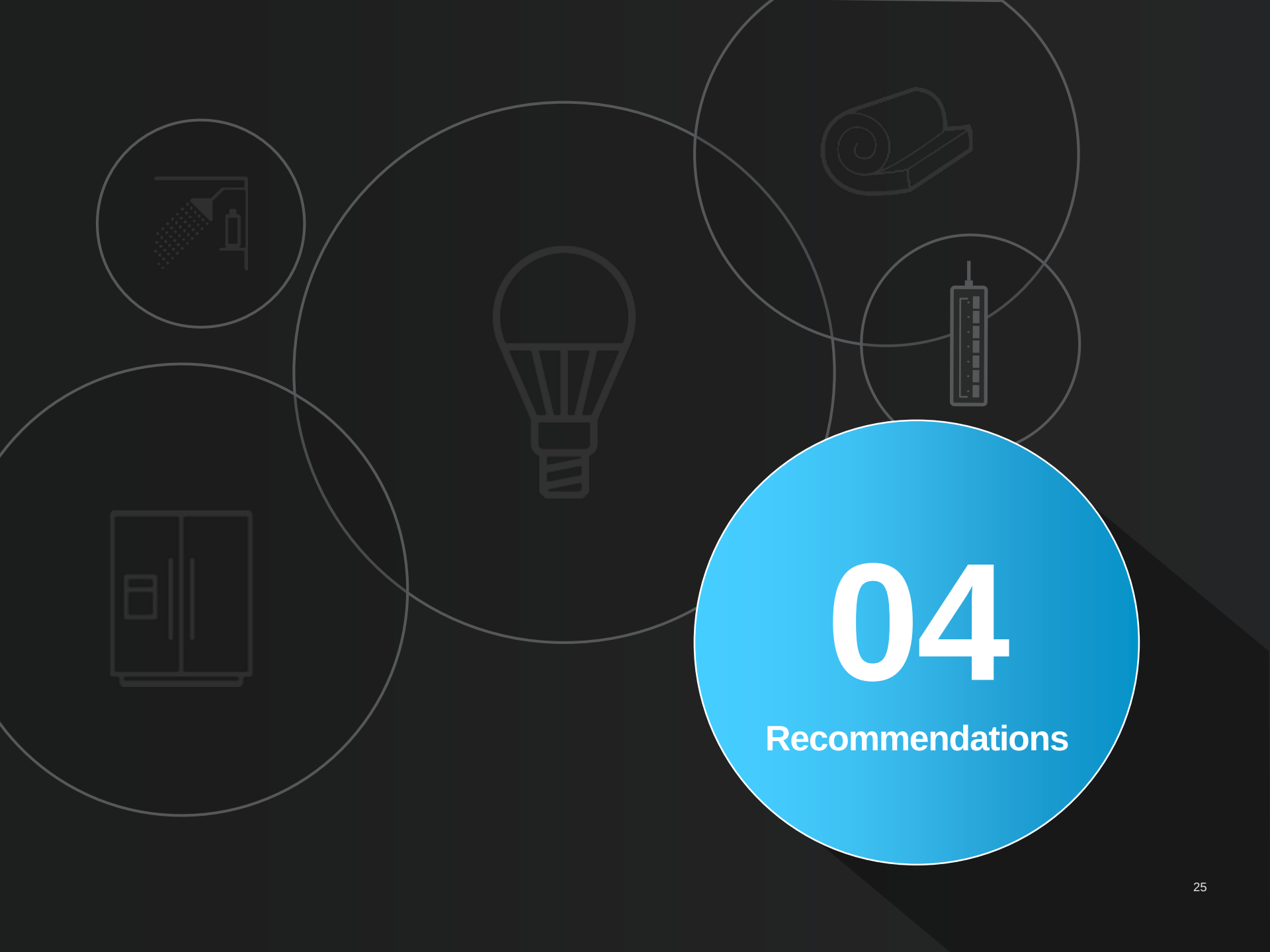
The second interview discussed how the program year went and solicited feedback on the evaluation findings.

Key interview responses to the evaluation findings:

- *The new method of Recleim purchasing all the refrigerators for CAP allows reduced pricing due to bulk purchases, allowing AEP Ohio CAP to reach more income-eligible customers with no budget increase.*
- *CAP now provides the agencies with an audit fee which provides a more equitable distribution of CAP funds to the agencies.*

Having all the refrigerators come from one entity has made it easier for CAP to ensure that:

- *Customers are getting a quality product*
- *Service, installation, and recycling are consistent*
- *Agencies follow the TRM "Like-Kind" protocol, unless an exception approval is provided by AEP Ohio*
- *All refrigerators and freezers are recycled properly*
- *Refrigerators come with a 3-year warranty*



04

Recommendations

Topic	Recommendation
Smart Strip	To calculate demand savings use the deemed savings outlined in the Draft 2010 Ohio TRM. Gather data indicating if the smart strip is a 5-plug or 7-plug to provide more accurate savings.
Tracking Database Measure Variables Accuracy	For better saving estimate accuracy the tracking system should be designed to collect accurate variable data. The tracking system should only accept variable values that are in a reasonable range. The tracking system should not allow variable entries to be left blank.
	Confirm that agency staff are properly trained to enter accurate variable data into the tracking system. Compared to last year, more variable information is being entered into the tracking system. AEP Ohio should continue its efforts to ensure accurate variable information is being entered into the tracking system.

Refrigerator Pick Up and Replacement Policy: Ensure that the implementor's pick up and replacement procedure verifies that the new refrigerator is in working condition and meets the needs of the customer before the cord to the old refrigerator is cut.

AEP Ohio has implemented a procedure that the customer electronically sign-off that that new appliance is acceptable before cutting the cord. Continue to monitor that the procedure is being followed.

Monitor the Agencies Use of the New Tracking System: Each year the agencies become more proficient in entering the pre and post measure data, which results in more accurate savings estimates.

The new tracking system should be monitored to ensure that agencies continue to enter all the needed information.

Monitor the new refrigerator policy: Recleim took over the CAP refrigerator replacement and recycling mid-year.

Monitor a full year's worth of data and Recleim's interactions with; agencies, customers, and AEP Ohio.

05

Appendix

Appendix

Energy and Demand Savings Calculations for LEDs

Navigant 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}	0.937	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

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

Navigant determined a realization rate of 1.00 for energy and demand.

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 Refrigerator
*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

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

Navigant 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 90% 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	Varies	Measure Description (Actual or deemed when input value is considered incorrect by being outside reasonable boundaries)
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

Navigant 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.

Navigant 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: ΔkWh = ((1/Rexist – 1/Rnew) * CDH * DUA * Area) / 1000 / ηCool*

*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

*ΔkW = ΔkWh / 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

Navigant 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*

Navigant 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

Navigant 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

*ΔkW = ΔkWh * 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

*ΔkW = ΔkWh / 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).

Summary: Report - Annual Portfolio Status Report Appendix A-F submitted by Ohio Power Company (Part 2 of 4) electronically filed by Mr. Steven T Nourse on behalf of Ohio Power Company