Appendix B: Residential Measure Assumptions

This file provides measure-level detail, including measure name, estimates of savings, costs, useful lives. A brief overview of key descriptor columns is provided below:
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Measure #	End-Use	Measure Name	Program	Home Type	Income Type	Replacement Type	Base Annual Electric kWh Usage	% Elec Savings	Per Unit Elec Savings (kWh)	Per Unit Summer kW Savings	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	UCT Score
9038	Water Heating	Thermostatic Restrictor Shower Valve	Residential Emerging Markets Pilot	SF	N/A	NC	2,942	2%	65	0.00	10	$30	80%	80%	TRSV-2	73%	0%	35%	55%	1.2
9039	Water Heating	Thermostatic Restrictor Shower Valve	Residential Emerging Markets Pilot	MF	N/A	Retrofit	3,045	3%	93	0.00	10	$30	100%	80%	TRSV-3	50%	14%	39%	55%	1.8
9040	Water Heating	Thermostatic Restrictor Shower Valve	Residential Emerging Markets Pilot	MF	N/A	NC	3,045	3%	93	0.00	10	$30	100%	80%	TRSV-4	50%	0%	47%	55%	1.8
9041	Water Heating	Water Heater Timer	Residential Emerging Markets Pilot	SF	N/A	Retrofit	2,942	5%	147	0.02	2	$60	80%	80%	WHT-1	38%	35%	35%	55%	0.4
9042	Water Heating	Water Heater Timer	Residential Emerging Markets Pilot	SF	N/A	NC	2,942	5%	147	0.02	2	$60	80%	80%	WHT-2	38%	0%	35%	55%	0.4
9043	Water Heating	Water Heater Timer	Residential Emerging Markets Pilot	MF	N/A	Retrofit	3,045	5%	152	0.02	2	$60	80%	80%	WHT-3	38%	35%	35%	55%	0.4
9044	Water Heating	Water Heater Timer	Residential Emerging Markets Pilot	MF	N/A	NC	3,045	5%	152	0.02	2	$60	80%	80%	WHT-4	38%	0%	35%	55%	0.4
9045	Water Heating	Drain Water Heat Recovery	Residential Emerging Markets Pilot	SF	N/A	Retrofit	2,942	14%	422	0.04	30	$742	80%	80%	DWHR-1	38%	1%	35%	55%	0.9
9046	Water Heating	Drain Water Heat Recovery	Residential Emerging Markets Pilot	SF	N/A	NC	2,942	14%	422	0.04	30	$742	80%	80%	DWHR-2	38%	0%	35%	55%	0.9
9047	Water Heating	Drain Water Heat Recovery	Residential Emerging Markets Pilot	MF	N/A	Retrofit	3,045	14%	437	0.05	30	$742	80%	80%	DWHR-3	38%	1%	35%	55%	1.0
9048	Water Heating	Drain Water Heat Recovery	Residential Emerging Markets Pilot	MF	N/A	NC	3,045	14%	437	0.05	30	$742	80%	80%	DWHR-4	38%	0%	35%	55%	1.0
9049	Water Heating	Shower Timer	Residential Emerging Markets Pilot	SF	N/A	Retrofit	2,942	0%	13	0.00	2	$5	80%	80%	ST-1	73%	5%	32%	55%	0.2
9050	Water Heating	Shower Timer	Residential Emerging Markets Pilot	SF	N/A	NC	2,942	0%	13	0.00	2	$5	80%	80%	ST-2	73%	0%	35%	55%	0.6
9051	Water Heating	Shower Timer	Residential Emerging Markets Pilot	MF	N/A	Retrofit	3,045	0%	13	0.00	2	$5	80%	80%	ST-3	50%	5%	32%	55%	0.6
9052	Water Heating	Shower Timer	Residential Emerging Markets Pilot	MF	N/A	NC	3,045	0%	13	0.00	2	$5	80%	80%	ST-4	50%	0%	35%	55%	0.6
9053	Water Heating	Low Flow Showerhead 1.5 gpm	Residential Instant Rebate	SF	NLI	Retrofit	2,942	11%	321	0.01	10	$1	100%	100%	LFSH-1	73%	61%	87%	93%	116.2
9054	Water Heating	Low Flow Showerhead 1.5 gpm	Residential Instant Rebate	SF	LI	Retrofit	2,942	11%	321	0.01	10	$1	100%	100%	LFSH-2	73%	61%	87%	93%	116.2
9055	Water Heating	Low Flow Showerhead 1.5 gpm	IQW	SF	LI	Retrofit	2,942	10%	293	0.01	10	$1	100%	100%	LFSH-2	73%	61%	87%	93%	107.5
9056	Water Heating	Low Flow Showerhead 1.5 gpm	Residential Instant Rebate	SF	N/A	NC	2,942	11%	321	0.01	10	$1	100%	100%	LFSH-3	73%	0%	96%	93%	116.2
9057	Water Heating	Low Flow Showerhead 1.5 gpm	Residential Instant Rebate	MF	NLI	Retrofit	3,045	11%	321	0.01	10	$1	100%	100%	LFSH-4	50%	51%	90%	93%	116.2
9058	Water Heating	Low Flow Showerhead 1.5 gpm	Residential Instant Rebate	MF	LI	Retrofit	3,045	11%	321	0.01	10	$1	100%	100%	LFSH-5	50%	51%	90%	93%	116.2
9059	Water Heating	Low Flow Showerhead 1.5 gpm	IQW	MF	LI	Retrofit	3,045	10%	293	0.01	10	$1	100%	100%	LFSH-5	50%	51%	90%	93%	107.5
9060	Water Heating	Low Flow Showerhead 1.5 gpm	Residential Instant Rebate	MF	N/A	NC	3,045	11%	321	0.01	10	$1	100%	100%	LFSH-6	50%	0%	96%	93%	116.2
9061	Water Heating	Kitchen Faucet Aerator 1.5 gpm	Residential Marketplace	SF	NLI	Retrofit	2,942	5%	141	0.01	10	$1	100%	100%	KITCH-1	38%	49%	90%	93%	51.6
9062	Water Heating	Kitchen Faucet Aerator 1.5 gpm	Residential Marketplace	SF	LI	Retrofit	2,942	5%	141	0.01	10	$1	100%	100%	KITCH-2	38%	49%	90%	93%	51.6
9063	Water Heating	Kitchen Faucet Aerator 1.5 gpm	IQW	SF	LI	Retrofit	2,942	4%	117	0.01	10	$1	100%	100%	KITCH-2	38%	49%	90%	93%	44.0
9064	Water Heating	Kitchen Faucet Aerator 1.5 gpm	Residential Marketplace	SF	N/A	NC	2,942	5%	141	0.01	10	$1	100%	100%	KITCH-3	38%	0%	96%	93%	51.6
9065	Water Heating	Kitchen Faucet Aerator 1.5 gpm	Residential Marketplace	MF	NLI	Retrofit	3,045	5%	141	0.01	10	$1	100%	100%	KITCH-4	38%	38%	92%	93%	51.6
9066	Water Heating	Kitchen Faucet Aerator 1.5 gpm	Residential Marketplace	MF	LI	Retrofit	3,045	5%	141	0.01	10	$1	100%	100%	KITCH-5	38%	38%	92%	93%	51.6
9067	Water Heating	Kitchen Faucet Aerator 1.5 gpm	IQW	MF	LI	Retrofit	3,045	4%	117	0.01	10	$1	100%	100%	KITCH-5	38%	38%	92%	93%	44.0
9068	Water Heating	Kitchen Faucet Aerator 1.5 gpm	Residential Marketplace	MF	N/A	NC	3,045	5%	141	0.01	10	$1	100%	100%	KITCH-6	38%	0%	96%	93%	51.6
9069	Water Heating	Bathroom Aerator 1.0 gpm	Residential Marketplace	SF	NLI	Retrofit	2,942	1%	35	0.00	10	$1	100%	100%	BATH-1	88%	49%	90%	93%	13.9
9070	Water Heating	Bathroom Aerator 1.0 gpm	Residential Marketplace	SF	LI	Retrofit	2,942	1%	35	0.00	10	$1	100%	100%	BATH-2	88%	49%	90%	93%	13.9
9071	Water Heating	Bathroom Aerator 1.0 gpm	IQW	SF	LI	Retrofit	2,942	1%	27	0.00	10	$1	100%	100%	BATH-2	88%	49%	90%	93%	11.1
9072	Water Heating	Bathroom Aerator 1.0 gpm	Residential Marketplace	SF	N/A	NC	2,942	1%	35	0.00	10	$1	100%	100%	BATH-3	88%	0%	96%	93%	13.9
9073	Water Heating	Bathroom Aerator 1.0 gpm	Residential Marketplace	MF	NLI	Retrofit	3,045	1%	35	0.00	10	$1	100%	100%	BATH-4	54%	38%	92%	93%	13.9
9074	Water Heating	Bathroom Aerator 1.0 gpm	Residential Marketplace	MF	LI	Retrofit	3,045	1%	35	0.00	10	$1	100%	100%	BATH-5	54%	38%	92%	93%	13.9
9075	Water Heating	Bathroom Aerator 1.0 gpm	IQW	MF	LI	Retrofit	3,045	1%	27	0.00	10	$1	100%	100%	BATH-5	54%	38%	92%	93%	11.1
9076	Water Heating	Bathroom Aerator 1.0 gpm	Residential Marketplace	MF	N/A	NC	3,045	1%	35	0.00	10	$1	100%	100%	BATH-6	54%	0%	96%	93%	13.9
9077	Water Heating	Pipe Wrap	Residential Emerging Markets Pilot	SF	NLI	Retrofit	2,942	3%	89	0.01	15	$9	100%	100%	PIPE-1	38%	17%	37%	73%	7.7
9078	Water Heating	Pipe Wrap	IQW	SF	LI	Retrofit	2,942	3%	89	0.01	15	$9	100%	100%	PIPE-2	38%	17%	95%	93%	7.7
9079	Water Heating	Pipe Wrap	Residential Emerging Markets Pilot	MF	NLI	Retrofit	3,045	3%	89	0.01	15	$9	100%	100%	PIPE-3	38%	17%	37%	73%	7.7
9080	Water Heating	Pipe Wrap	IQW	MF	LI	Retrofit	3,045	3%	89	0.01	15	$9	100%	100%	PIPE-4	38%	17%	95%	93%	7.7

Appendix B: Residential Measure Assumptions

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Measure #	End-Use	Measure Name	Program	Home Type	Income Type	Replacement Type	Base Annual Electric kWh Usage	% Elec Savings	Per Unit Elec Savings (kWh)	Per Unit Summer kW Savings	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	UCT Score
9081	Water Heating	Water Heater Temperature Setback	Residential Emerging Markets Pilot	SF	NLI	Retrofit	2,942	3%	82	0.01	2	$10	100%	100%	WHTS-1	38%	54%	39%	73%	1.0
9082	Water Heating	Water Heater Temperature Setback	IQW	SF	LI	Retrofit	2,942	3%	82	0.01	2	$10	100%	100%	WHTS-2	38%	54%	89%	93%	1.0
9083	Water Heating	Water Heater Temperature Setback	Residential Emerging Markets Pilot	MF	NLI	Retrofit	3,045	3%	82	0.01	2	$10	100%	100%	WHTS-3	38%	54%	39%	73%	1.0
9084	Water Heating	Water Heater Temperature Setback	IQW	MF	LI	Retrofit	3,045	3%	82	0.01	2	$10	100%	100%	WHTS-4	38%	54%	89%	93%	1.0

Appendix C. C&I Sector Measure Detail

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
1	CompressedAir	Efficient Air Compressors (VSD)	Biz-Prescriptive	Assembly	ROB	1,583	1,583	21%	329	0.00	13	$127	100%	59%	80%	1	100%	33%	92.7%	76.7%	83.1%	5.5
2	CompressedAir	Efficient Air Nozzles	Biz-Prescriptive	Assembly	Retro	1,480	1,480	50%	740	0.00	15	$50	100%	81%	81%	2	35%	33%	92.7%	91.1%	91.1%	15.8
3	CompressedAir	AODD Pump Controls	Biz-Custom	Assembly	Retro	103,919	103,919	35%	36,372	0.00	10	$1,150	100%	50%	50%	3	10%	33%	92.7%	72.6%	72.6%	38.2
4	CompressedAir	Compressed Air - Custom	Biz-Custom	Assembly	Retro	5	5	20%	1	0.00	10	$0	100%	47%	47%	4	50%	33%	92.7%	64.2%	64.2%	6.0
5	CompressedAir	Retro-commissioning_Compressed Air Optimization	Biz-Custom RCx	Assembly	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	5	50%	33%	92.7%	64.2%	64.2%	3.2
6	Cooking	Commercial Combination Oven (Electric)	Biz-Prescriptive	Assembly	ROB	38,561	38,561	48%	18,432	0.00	12	$16,884	75%	6%	15%	1	18%	53%	77.5%	62.4%	62.4%	14.1
7	Cooking	Commercial Electric Convection Oven	Biz-Prescriptive	Assembly	ROB	12,193	12,193	15%	1,879	0.00	12	$1,706	75%	21%	51%	1	18%	53%	77.6%	62.4%	62.4%	4.4
8	Cooking	Commercial Electric Griddle	Biz-Prescriptive	Assembly	ROB	17,056	17,056	15%	2,596	0.00	12	$3,604	25%	15%	15%	2	14%	17%	41.9%	33.6%	33.6%	2.8
9	Cooking	Commercial Electric Steam Cooker	Biz-Prescriptive	Assembly	ROB	19,549	19,549	67%	13,162	0.00	12	$2,490	100%	24%	55%	3	6%	45%	88.0%	81.1%	83.5%	18.0
10	Cooking	Dishwasher Low Temp Door (Energy Star)	Biz-Prescriptive	Assembly	ROB	39,306	39,306	44%	17,369	0.00	15	$1,000	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	11.7
11	Cooking	Dishwasher High Temp Door (Energy Star)	Biz-Prescriptive	Assembly	ROB	26,901	26,901	32%	8,586	0.00	15	$1,100	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	5.2
12	Cooking	Energy efficient electric fryer	Biz-Prescriptive	Assembly	ROB	18,955	18,955	17%	3,274	0.00	12	$1,500	100%	5%	13%	5	27%	24%	88.0%	57.2%	59.4%	23.2
13	Cooking	Insulated Holding Cabinets (Full Size)	Biz-Prescriptive	Assembly	ROB	13,697	13,697	68%	9,314	0.00	12	$1,200	100%	35%	55%	6	3%	16%	88.0%	83.6%	84.9%	12.7
14	Cooking	Insulated Holding Cabinets (Half-Size)	Biz-Prescriptive	Assembly	ROB	4,383	4,383	60%	2,630	0.00	12	$1,500	100%	10%	25%	6	3%	16%	88.0%	52.6%	57.6%	10.1
15	Cooling	Air Conditioner - 13 IEER (5-20 Tons)	Biz-Prescriptive	Assembly	ROB	1,030	1,030	6%	63	0.00	15	$63	100%	48%	55%	1	20%	20%	92.7%	50.9%	53.4%	4.7
16	Cooling	Air Conditioner - 14 IEER (5-20 Tons)	Biz-Prescriptive	Assembly	ROB	1,030	1,030	13%	132	0.00	15	$127	100%	24%	55%	1	20%	20%	92.7%	43.4%	54.0%	9.7
17	Cooling	Air Conditioner - 17 IEER (5-20 Tons)	Biz-Prescriptive	Assembly	ROB	1,030	1,030	28%	291	0.00	15	$127	100%	24%	55%	1	20%	20%	92.7%	61.3%	73.6%	21.4
18	Cooling	Air Conditioner - 21 IEER (5-20 Tons)	Biz-Prescriptive	Assembly	ROB	1,030	1,030	42%	432	0.00	15	$127	100%	24%	55%	1	20%	20%	92.7%	71.4%	78.7%	31.7
19	Cooling	Air Conditioner - 12.1 IEER (20+ Tons)	Biz-Prescriptive	Assembly	ROB	1,102	1,102	6%	64	0.00	15	$30	100%	100%	100%	2	20%	20%	92.7%	92.7%	92.7%	4.7
20	Cooling	Air Conditioner - 13 IEER (20+ Tons)	Biz-Prescriptive	Assembly	ROB	1,102	1,102	12%	136	0.00	15	$37	100%	81%	81%	2	20%	20%	92.7%	86.3%	86.3%	10.0
21	Cooling	Air Conditioner - 14.3 IEER (20+ Tons)	Biz-Prescriptive	Assembly	ROB	1,102	1,102	20%	224	0.00	15	$37	100%	81%	81%	2	20%	20%	92.7%	88.8%	88.8%	16.4
22	Cooling	Air Conditioner - 21 IEER (20+ Tons)	Biz-Prescriptive	Assembly	ROB	1,102	1,102	46%	504	0.00	15	$37	100%	81%	81%	2	20%	20%	92.7%	91.0%	91.0%	37.0
23	Cooling	Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up)	Biz-Custom	Assembly	Retro	1,047	1,047	7%	73	0.00	3	$5	100%	50%	50%	3	41%	50%	92.7%	70.5%	70.5%	14.6
24	Cooling	Air Side Economizer	Biz-Custom	Assembly	Retro	1,030	1,030	20%	206	0.00	10	$84	75%	25%	25%	4	41%	20%	81.0%	51.0%	51.0%	3.9
25	Cooling	Advanced Rooftop Controls	Biz-Prescriptive	Assembly	Retro	1,047	1,047	8%	85	0.00	10	$100	100%	100%	100%	5	41%	20%	92.7%	92.7%	92.7%	0.3
26	Cooling	HVAC Occupancy Controls	Biz-Custom	Assembly	ROB	2,900	2,900	20%	580	0.00	15	$537	100%	11%	11%	6	41%	20%	92.7%	36.0%	36.0%	12.0
27	Cooling	Air Conditioner - 16 SEER (<5 Tons)	Biz-Prescriptive	Assembly	ROB	897	897	13%	112	0.00	15	$47	100%	64%	80%	7	26%	20%	92.7%	77.3%	82.5%	8.2
28	Cooling	Air Conditioner - 17 SEER (<5 Tons)	Biz-Prescriptive	Assembly	ROB	897	897	18%	158	0.00	15	$206	100%	15%	36%	7	26%	20%	92.7%	36.0%	40.6%	11.6
29	Cooling	Air Conditioner - 18 SEER(<5 Tons)	Biz-Prescriptive	Assembly	ROB	897	897	22%	199	0.00	15	$206	100%	15%	36%	7	26%	20%	92.7%	39.6%	46.0%	14.7
30	Cooling	Air Conditioner - 21 SEER(<5 Tons)	Biz-Prescriptive	Assembly	ROB	897	897	33%	299	0.00	15	$253	100%	12%	30%	7	26%	20%	92.7%	42.9%	48.2%	22.0
31	Cooling	Smart Thermostat	Biz-Prescriptive	Assembly	ROB	897	897	14%	127	0.00	11	$175	57%	57%	57%	8	26%	12%	48.4%	48.4%	48.4%	1.3
32	Cooling	PTAC - <7,000 Btuh - lodging	Biz-Prescriptive	Assembly	ROB	1,056	1,056	8%	89	0.00	8	$84	100%	36%	36%	9	0%	20%	92.7%	47.9%	47.9%	3.6
33	Cooling	PTAC - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Assembly	ROB	1,158	1,158	7%	84	0.00	8	$84	100%	36%	36%	10	0%	20%	92.7%	46.6%	46.6%	3.4
34	Cooling	PTAC - >15,000 Btuh - lodging	Biz-Prescriptive	Assembly	ROB	1,323	1,323	10%	126	0.00	8	$84	100%	36%	55%	11	0%	20%	92.7%	54.1%	64.5%	5.1
35	Cooling	Air Cooled Chiller	Biz-Prescriptive	Assembly	ROB	917	917	6%	51	0.00	23	$126	100%	24%	55%	12	33%	15%	92.7%	32.0%	35.8%	6.5
36	Cooling	Chiller Tune-up	Biz-Prescriptive	Assembly	Retro	1,047	1,047	7%	73	0.00	3	$8	100%	100%	100%	13	33%	50%	92.7%	92.7%	92.7%	4.9
37	Cooling	HVAC/Chiller Custom	Biz-Custom	Assembly	Retro	5	5	20%	1	0.00	20	$1	100%	7%	7%	14	100%	20%	92.7%	36.0%	36.0%	30.3
38	Cooling	Window Film	Biz-Prescriptive	Assembly	Retro	6,000	6,000	4%	264	0.00	10	$154	100%	65%	65%	15	100%	20%	92.7%	73.1%	73.1%	3.2
39	Cooling	Triple Pane Windows	Biz-Custom	Assembly	ROB	6,000	6,000	6%	360	0.00	25	$700	100%	5%	5%	15	100%	20%	92.7%	36.0%	36.0%	24.5
40	Cooling	Energy Recovery Ventilator	Biz-Custom	Assembly	Retro	1,102	1,102	32%	355	0.00	15	$1,500	25%	2%	2%	16	100%	2%	31.4%	21.8%	21.8%	13.2
41	Heating	Heat Pump - 16 SEER (<5 Tons)	Biz-Prescriptive	Assembly	ROB	1,671	1,671	4%	71	0.00	16	$87	100%	46%	46%	1	33%	20%	92.7%	45.8%	45.8%	2.8
42	Heating	Heat Pump - 17 SEER (<5 Tons)	Biz-Prescriptive	Assembly	ROB	1,671	1,671	9%	152	0.00	16	$442	25%	9%	23%	1	33%	20%	44.0%	36.0%	36.0%	5.4
43	Heating	Heat Pump - 18 SEER(<5 Tons)	Biz-Prescriptive	Assembly	ROB	1,671	1,671	13%	217	0.00	16	$507	50%	8%	20%	1	33%	20%	44.0%	36.0%	36.0%	7.7
44	Heating	Heat Pump - 21 SEER(<5 Tons)	Biz-Prescriptive	Assembly	ROB	1,671	1,671	20%	339	0.00	16	$507	75%	8%	20%	1	33%	20%	57.4%	36.0%	36.0%	12.2
45	Heating	Geothermal HP - SEER 20.3 (<5 Tons)	Biz-Prescriptive	Assembly	ROB	1,671	1,671	23%	385	0.00	25	$2,576	25%	2%	2%	1	33%	20%	44.0%	36.0%	36.0%	17.3
46	Heating	Geothermal HP - SEER 21.5 (<5 Tons)	Biz-Prescriptive	Assembly	ROB	1,671	1,671	27%	457	0.00	25	$2,576	25%	2%	4%	1	33%	20%	44.0%	36.0%	36.0%	20.0
47	Heating	Geothermal HP - SEER 23.1 (<5 Tons)	Biz-Prescriptive	Assembly	ROB	1,671	1,671	32%	541	0.00	25	$2,576	25%	2%	4%	1	33%	20%	44.0%	36.0%	36.0%	23.0
48	Heating	Geothermal HP - SEER 29.3 (<5 Tons)	Biz-Prescriptive	Assembly	ROB	1,671	1,671	47%	785	0.00	25	$2,576	25%	2%	4%	1	33%	20%	44.0%	36.0%	36.0%	29.6
49	Heating	Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Assembly	ROB	2,023	2,023	11%	231	0.00	16	$100	100%	40%	55%	2	26%	20%	92.7%	68.3%	73.8%	31.8
50	Heating	Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Assembly	ROB	2,023	2,023	17%	338	0.00	16	$136	100%	30%	55%	2	26%	20%	92.7%	66.1%	74.9%	35.4
51	Heating	Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Assembly	ROB	2,109	2,109	15%	322	0.00	16	$100	100%	40%	55%	2	26%	20%	92.7%	74.4%	78.1%	36.2
52	Heating	Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Assembly	ROB	2,109	2,109	20%	428	0.00	16	$139	100%	29%	55%	2	26%	20%	92.7%	71.0%	77.6%	39.6
53	Heating	Geothermal HP - SEER 20.3 (5-20 Tons)	Biz-Prescriptive	Assembly	ROB	1,841	1,841	30%	556	0.00	25	$2,576	50%	2%	4%	2	26%	20%	44.0%	36.0%	36.0%	36.1
54	Heating	Geothermal HP - SEER 21.5 (5-20 Tons)	Biz-Prescriptive	Assembly	ROB	1,841	1,841	34%	628	0.00	25	$2,576	50%	2%	4%	2	26%	20%	44.0%	36.0%	36.0%	38.8
55	Heating	Geothermal HP - SEER 23.1 (5-20 Tons)	Biz-Prescriptive	Assembly	ROB	1,974	1,974	43%	844	0.00	25	$2,576	50%	2%	4%	2	26%	20%	44.0%	36.0%	36.0%	44.7
56	Heating	Geothermal HP - SEER 29.3 (5-20 Tons)	Biz-Prescriptive	Assembly	ROB	1,974	1,974	55%	1,088	0.00	25	$2,576	75%	2%	4%	2	26%	20%	48.3%	36.0%	36.0%	51.3
57	Heating	Variable Refrigerant Flow Heat Pump	Biz-Custom	Assembly	ROB	1,571	1,571	15%	239	0.00	16	$224	100%	11%	11%	2	26%	2%	92.7%	32.4%	32.4%	17.9
58	Heating	Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr)	Biz-Prescriptive	Assembly	ROB	2,215	2,215	10%	220	0.00	16	$100	100%	40%	55%	3	26%	20%	92.7%	67.1%	73.0%	28.4
59	Heating	Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr)	Biz-Prescriptive	Assembly	ROB	2,215	2,215	16%	354	0.00	16	$175	100%	23%	55%	3	26%	20%	92.7%	56.7%	71.6%	33.2
60	Heating	Geothermal HP - SEER 20.3 (20+ Tons)	Biz-Prescriptive	Assembly	ROB	2,109	2,109	39%	824	0.00	25	$2,576	100%	2%	4%	3	26%	20%	92.7%	36.0%	36.0%	70.2
61	Heating	Geothermal HP - SEER 21.5 (20+ Tons)	Biz-Prescriptive	Assembly	ROB	2,109	2,109	42%	895	0.00	25	$2,576	100%	2%	4%	3	26%	20%	92.7%	36.0%	36.0%	72.9
62	Heating	Geothermal HP - SEER 23.1 (20+ Tons)	Biz-Prescriptive	Assembly	ROB	2,109	2,109	46%	979	0.00	25	$2,576	100%	2%	4%	3	26%	20%	92.7%	36.0%	36.0%	75.9
63	Heating	Geothermal HP - SEER 29.3 (20+ Tons)	Biz-Prescriptive	Assembly	ROB	2,109	2,109	58%	1,223	0.00	25	$2,576	100%	2%	4%	3	26%	20%	92.7%	36.0%	36.0%	82.5
64	Heating	Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD)	Biz-Prescriptive	Assembly	ROB	1,671	1,671	20%	339	0.00	16	$224	100%	18%	45%	4	15%	20%	92.7%	50.1%	58.2%	12.2
65	Heating	PTHP - <7,000 Btuh - lodging	Biz-Custom	Assembly	ROB	1,829	1,829	5%	86	0.00	8	$130	100%	100%	100%	5	0%	10%	92.7%	74.2%	74.2%	0.7
66	Heating	PTHP - >15,000 Btuh - lodging	Biz-Prescriptive	Assembly	ROB	2,245	2,245	18%	410	0.00	8	$130	100%	100%	100%	6	0%	10%	92.7%	92.7%	92.7%	3.6
67	Heating	PTHP - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Assembly	ROB	2,015	2,015	11%	213	0.00	8	$130	100%	100%	100%	7	0%	10%	92.7%	92.7%	92.7%	1.8
68	HotWater	Heat Pump Water Heater	Biz-Prescriptive	Assembly	ROB	3,027	3,027	67%	2,027	0.00	15	$1,115	100%	45%	45%	1	100%	0%	84.0%	60.9%	60.9%	3.4
69	HotWater	Hot Water Pipe Insulation	Biz-Custom	Assembly	Retro	3,027	3,027	2%	61	0.00	20	$60	75%	10%	10%	2	100%	80%	86.0%	84.0%	84.0%	9.8
70	HotWater	Faucet Aerator	Biz-Custom	Assembly	Retro	389	389	32%	126	0.00	10	$8	100%	50%	50%	3	20%	90%	93.0%	92.0%	92.0%	25.8
71	HotWater	Low Flow Pre-Rinse Sprayers	Biz-Prescriptive	Assembly	ROB	18,059	18,059	54%	9,789	0.00	5	$60	100%	17%	42%	4	20%	80%	86.0%	84.0%	84.0%	199.3
72	HotWater	ENERGY STAR Commercial Washing Machines	Biz-Prescriptive	Assembly	ROB	1,552	1,552	43%	671	0.00	7	$250	75%	28%	28%	5	25%	33%	79.3%	64.6%	64.6%	2.9

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
73	InteriorLighting	LED T8 Tube Replacement	Biz-Prescriptive Light	Assembly	Retro	80	80	45%	36	0.00	15	$5	100%	100%	100%	1	56%	40%	94.6%	94.6%	94.6%	7.9
74	InteriorLighting	LED troffer retrofit kit, 2'X2' and 2'X4'	Biz-Prescriptive Light	Assembly	Retro	181	181	50%	91	0.00	15	$70	100%	36%	55%	1	56%	40%	94.6%	52.0%	54.5%	4.0
75	InteriorLighting	LED troffer, 2'X2' and 2'X4'	Biz-Prescriptive Light	Assembly	Retro	181	181	50%	91	0.00	15	$70	100%	36%	55%	1	56%	40%	94.6%	52.0%	54.5%	4.0
76	InteriorLighting	Bi-Level Lighting Fixture – Stairwells, Hallways	Biz-Custom Light	Assembly	Retro	181	181	74%	135	0.00	10	$274	25%	5%	6%	2	1%	40%	58.0%	49.0%	49.0%	5.1
77	InteriorLighting	LED high bay fixture	Biz-Prescriptive Light	Assembly	Retro	1,687	1,687	68%	1,147	0.00	15	$330	100%	35%	55%	3	1%	34%	94.6%	76.4%	82.6%	11.0
78	InteriorLighting	LED Mogul-base HID Lamp Replacing High Bay HID	Biz-Prescriptive Light	Assembly	Retro	1,687	1,687	66%	1,119	0.00	15	$330	100%	35%	55%	3	1%	34%	94.6%	75.9%	82.3%	10.7
79	InteriorLighting	LED low bay fixture	Biz-Prescriptive Light	Assembly	Retro	359	359	61%	218	0.00	15	$44	100%	68%	80%	4	34%	34%	94.6%	89.3%	91.2%	8.0
80	InteriorLighting	LED Mogul-base HID Lamp Replacing Low Bay HID	Biz-Prescriptive Light	Assembly	Retro	359	359	59%	211	0.00	15	$44	100%	68%	80%	4	34%	34%	94.6%	89.1%	91.1%	7.7
81	InteriorLighting	LED Screw-In Lamps (Directional)	Biz-Prescriptive Light	Assembly	ROB	150	150	86%	128	0.00	10	$1	100%	100%	100%	6	0%	43%	94.6%	94.6%	94.6%	113.7
82	InteriorLighting	LED downlight fixture	Biz-Prescriptive Light	Assembly	Retro	124	124	68%	84	0.00	15	$27	100%	19%	46%	6	8%	45%	94.6%	67.3%	78.0%	18.5
83	InteriorLighting	LED Screw-In Lamps (Omnidirectional & Decorative)	Biz-Prescriptive Light	Assembly	ROB	113	113	81%	92	0.00	10	$1	100%	100%	100%	5	1%	20%	94.6%	94.6%	94.6%	81.0
84	InteriorLighting	DeLamp Fluorescent Fixture Average Lamp Wattage 28W	Biz-Prescriptive Light	Assembly	Retro	67	67	100%	67	0.00	11	$4	100%	100%	100%	7	56%	0%	94.6%	94.6%	94.6%	14.1
85	InteriorLighting	Occupancy Sensors	Biz-Prescriptive Light	Assembly	Retro	305	305	30%	91	0.00	10	$65	50%	31%	31%	8	95%	10%	52.9%	42.4%	42.4%	2.3
86	InteriorLighting	Daylighting Controls	Biz-Prescriptive Light	Assembly	Retro	390	390	30%	117	0.00	10	$58	100%	35%	55%	8	95%	10%	94.6%	58.5%	72.7%	6.5
87	InteriorLighting	Dual Occupancy & Daylighting Controls	Biz-Custom Light	Assembly	Retro	174	174	44%	77	0.00	10	$75	75%	40%	50%	8	95%	10%	69.9%	30.4%	34.2%	2.0
88	InteriorLighting	Central Lighting Monitoring & Controls (non-networked)	Biz-Custom Light	Assembly	Retro	41,703	41,703	20%	8,341	0.00	12	$3,700	100%	23%	29%	8	95%	10%	94.6%	44.1%	47.7%	4.6
89	InteriorLighting	Network Lighting Controls - Wireless (WiFi)	Biz-Custom Light	Assembly	Retro	1	1	49%	1	0.00	15	$1	100%	12%	15%	8	95%	10%	94.6%	28.0%	28.0%	10.9
90	InteriorLighting	Luminaire Level Lighting Controls w/ HVAC Control	Biz-Custom Light	Assembly	Retro	174	174	65%	113	0.00	15	$90	100%	13%	16%	8	91%	10%	94.6%	28.0%	28.0%	10.9
91	InteriorLighting	LED Exit Sign - 4 Watt Fixture (2 lamp)	Biz-Prescriptive Light	Assembly	Retro	69	69	43%	29	0.00	5	$33	92%	92%	92%	9	1%	75%	87.4%	87.4%	87.4%	0.3
92	InteriorLighting	Lighting - Custom	Biz-Custom Light	Assembly	Retro	4	4	25%	1	0.00	15	$1	100%	10%	13%	10	100%	0%	94.6%	21.4%	21.7%	10.9
93	ExteriorLighting	LED wallpack (existing W<250)	Biz-Prescriptive Light	Assembly	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	1	12%	46%	94.6%	56.6%	70.8%	5.8
94	ExteriorLighting	LED parking lot fixture (existing W≥250)	Biz-Prescriptive Light	Assembly	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	2	11%	54%	67.8%	63.2%	63.2%	4.4
95	ExteriorLighting	LED parking lot fixture (existing W<250)	Biz-Prescriptive Light	Assembly	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	3	11%	54%	94.6%	63.2%	70.8%	5.8
96	ExteriorLighting	LED outdoor pole decorative fixture (existing W≥250)	Biz-Prescriptive Light	Assembly	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	17%	17%	4	11%	54%	67.8%	63.2%	63.2%	3.4
97	ExteriorLighting	LED parking garage fixture (existing W≥250)	Biz-Prescriptive Light	Assembly	Retro	3,235	3,235	60%	1,953	0.00	6	$756	50%	13%	33%	5	11%	69%	78.3%	75.2%	75.2%	4.7
98	ExteriorLighting	LED parking garage fixture (existing W<250)	Biz-Prescriptive Light	Assembly	Retro	1,742	1,742	66%	1,154	0.00	6	$248	100%	18%	45%	6	11%	69%	94.6%	77.6%	83.9%	6.2
99	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250)	Biz-Prescriptive Light	Assembly	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	7	11%	46%	62.1%	56.6%	56.6%	4.4
100	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250)	Biz-Prescriptive Light	Assembly	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	8	11%	46%	94.6%	56.6%	70.8%	5.8
101	ExteriorLighting	Bi-Level Lighting Fixture – Garages	Biz-Custom Light	Assembly	Retro	181	181	69%	125	0.00	10	$274	5%	5%	6%	9	11%	20%	44.0%	31.9%	31.9%	3.9
102	ExteriorLighting	LED fuel pump canopy fixture (existing W<250)	Biz-Prescriptive Light	Assembly	Retro	0	0	0%	0	0.00	12	$0	0%	0%		10	0%	54%	94.6%	94.6%	94.6%	0.0
103	ExteriorLighting	LED fuel pump canopy fixture (existing W≥250)	Biz-Prescriptive Light	Assembly	Retro	0	0	0%	0	0.00	12	$0	0%	0%		11	0%	54%	94.6%	94.6%	94.6%	0.0
104	Miscellaneous	Vending Machine Controller - Non-Refrigerated	Biz-Prescriptive	Assembly	Retro	385	385	61%	237	0.00	5	$233	11%	11%	11%	1	5%	30%	51.0%	44.0%	44.0%	1.9
105	Miscellaneous	Miscellaneous Custom	Biz-Custom	Assembly	Retro	7	7	2%	0	0.00	10	$0	75%	25%	25%	2	44%	10%	37.0%	23.4%	23.4%	3.3
106	Miscellaneous	Kitchen Exhaust Hood Demand Ventilation Control System	Biz-Prescriptive	Assembly	ROB	9,932	9,932	50%	4,966	0.00	20	$1,180	100%	11%	27%	3	31%	10%	94.6%	73.8%	78.0%	39.7
107	Miscellaneous	High Efficiency Hand Dryers	Biz-Custom	Assembly	Retro	262	262	83%	217	0.00	10	$483	25%	4%	4%	4	5%	10%	37.0%	23.4%	23.4%	10.5
108	Miscellaneous	Ozone Commercial Laundry	Biz-Custom	Assembly	Retro	2,984	2,984	25%	746	0.00	10	$20,310	0%	0%	0%	5	0%	2%	31.4%	16.6%	16.6%	3.9
109	Miscellaneous	ENERGY STAR Uninterrupted Power Supply	Biz-Custom	Assembly	ROB	3,096	3,096	3%	85	0.00	15	$59	100%	14%	14%	6	1%	70%	94.6%	76.0%	76.0%	8.8
110	Motors	Cogged V-Belt	Biz-Custom	Assembly	Retro	17,237	17,237	3%	534	0.00	15	$384	100%	14%	14%	1	50%	10%	83.4%	32.2%	32.2%	9.2
111	Motors	Pump and Fan Variable Frequency Drive Controls (Pumps)	Biz-Custom	Assembly	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	30%	2	100%	10%	83.4%	52.4%	52.4%	11.6
112	Motors	Power Drive Systems	Biz-Custom	Assembly	Retro	4	4	23%	1	0.00	15	$0	100%	37%	37%	2	100%	10%	83.4%	53.4%	53.4%	9.2
113	Motors	Switch Reluctance Motors	Biz-Custom	Assembly	Retro	33,406	33,406	31%	10,222	0.00	15	$528	100%	50%	50%	2	100%	1%	83.4%	64.1%	64.1%	26.3
114	Motors	Escalators Motor Efficiency Controllers	Biz-Custom	Assembly	Retro	7,500	7,500	20%	1,500	0.00	10	$5,000	3%	3%	3%	3	0%	10%	37.0%	26.3%	26.3%	7.3
115	Office_NonPC	Energy Star Printer/Copier/Fax	Biz-Custom	Assembly	ROB	551	551	40%	223	0.00	6	$0	0%			1	30%	90%	94.6%	92.0%	92.0%	0.0
116	Office_NonPC	Smart Power Strip – Commercial Use	Biz-Custom	Assembly	Retro	1,086	1,086	10%	109	0.00	7	$50	50%	22%	22%	2	35%	15%	71.8%	42.0%	42.0%	2.8
117	Office_NonPC	Plug Load Occupancy Sensor	Biz-Custom	Assembly	Retro	1,126	1,126	15%	169	0.00	8	$70	75%	24%	24%	2	35%	15%	85.4%	47.6%	47.6%	3.2
118	Office_PC	Electrically Commutated Plug Fans in data centers	Biz-Custom	Assembly	Retro	86,783	86,783	18%	15,778	0.00	15	$480	100%	50%	50%	1	65%	20%	94.6%	74.6%	74.6%	50.8
119	Office_PC	Energy Star Server	Biz-Custom	Assembly	ROB	1,621	1,621	23%	368	0.00	8	$118	100%	31%	31%	1	65%	25%	94.6%	58.2%	58.2%	4.5
120	Office_PC	Server Virtualization	Biz-Custom	Assembly	Retro	2	2	45%	1	0.00	8	$0	75%	25%	25%	1	65%	25%	85.8%	49.3%	49.3%	3.2
121	Office_PC	High Efficiency CRAC unit	Biz-Custom	Assembly	ROB	541	541	30%	162	0.00	15	$63	100%	26%	26%	2	65%	20%	94.6%	51.1%	51.1%	8.1
122	Office_PC	Computer Room Air Conditioner Economizer	Biz-Custom	Assembly	Retro	764	764	47%	358	0.00	15	$82	100%	44%	44%	2	65%	20%	94.6%	66.1%	66.1%	5.6
123	Office_PC	Data Center Hot/Cold Aisle Configuration	Biz-Custom	Assembly	Retro	4	4	25%	1	0.00	15	$0	100%	25%	25%	3	3%	10%	94.6%	49.3%	49.3%	7.7
124	Office_PC	Energy Star Laptop	Biz-Custom	Assembly	ROB	126	126	33%	41	0.00	4	$0	0%			4	11%	85%	94.6%	88.0%	88.0%	0.0
125	Office_PC	Energy Star Monitor	Biz-Custom	Assembly	ROB	72	72	21%	15	0.00	4	$0	0%			5	25%	85%	94.6%	88.0%	88.0%	0.0
126	Refrigeration	Strip Curtains	Biz-Custom	Assembly	Retro	0	0	0%	0	0.00	4	$0	0%	0%		1	11%	30%	88.0%	70.4%	70.4%	0.0
127	Refrigeration	Bare Suction Line	Biz-Custom	Assembly	Retro	23	23	93%	21	0.00	15	$4	100%	50%	50%	2	0%	50%	88.0%	66.5%	66.5%	8.1
128	Refrigeration	Floating Head Pressure Controls	Biz-Custom	Assembly	Retro	1,112	1,112	25%	278	0.00	15	$431	25%	6%	6%	3	7%	25%	47.5%	40.0%	40.0%	5.6
129	Refrigeration	Saturated Suction Controls	Biz-Custom	Assembly	Retro	831	831	50%	416	0.00	15	$559	100%	7%	7%	4	2%	10%	88.0%	28.0%	28.0%	13.7
130	Refrigeration	Compressor Retrofit	Biz-Custom	Assembly	Retro	813	813	20%	163	0.00	15	$477	25%	3%	3%	5	24%	25%	47.5%	39.4%	39.4%	13.8
131	Refrigeration	Electronically Commutated (EC) Walk-In Evaporator Fan Motor	Biz-Prescriptive	Assembly	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	6	7%	80%	88.0%	84.0%	84.0%	30.7
132	Refrigeration	Evaporator Fan Motor Controls	Biz-Custom	Assembly	Retro	1,912	1,912	25%	478	0.00	13	$162	100%	30%	30%	7	7%	25%	88.0%	61.7%	61.7%	7.0
133	Refrigeration	Variable Speed Condenser Fan	Biz-Custom	Assembly	Retro	2,960	2,960	50%	1,480	0.00	15	$1,170	50%	13%	13%	8	9%	25%	59.5%	40.0%	40.0%	5.6
134	Refrigeration	Refrigeration Economizer	Biz-Custom	Assembly	Retro	7	7	2%	0	0.00	10	$0	100%	50%	50%	9	34%	10%	88.0%	41.1%	41.1%	4.2
135	Refrigeration	Anti-Sweat Heater Controls MT	Biz-Prescriptive	Assembly	Retro	579	579	59%	338	0.00	10	$170	75%	44%	44%	10	12%	25%	81.8%	72.4%	72.4%	2.1
136	Refrigeration	Auto Door Closer, Cooler	Biz-Custom	Assembly	Retro	471,500	471,500	0%	943	0.00	8	$157	100%	50%	50%	11	9%	50%	88.0%	66.9%	66.9%	5.8
137	Refrigeration	Display Case Door Retrofit, Medium Temp	Biz-Custom	Assembly	Retro	1,584	1,584	36%	578	0.00	12	$686	50%	8%	8%	11	3%	25%	47.9%	40.0%	40.0%	7.1
138	Refrigeration	Electronically Commutated (EC) Reach-In Evaporator Fan Motor	Biz-Prescriptive	Assembly	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	12	2%	80%	88.0%	84.0%	84.0%	30.7
139	Refrigeration	Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor	Biz-Custom	Assembly	Retro	1,911	1,911	26%	504	0.00	10	$96	100%	50%	50%	12	2%	2%	88.0%	66.5%	66.5%	5.8
140	Refrigeration	Energy Star Reach-In Refrigerator, Glass Doors	Biz-Prescriptive	Assembly	ROB	2,140	2,140	29%	629	0.00	12	$1,239	25%	6%	14%	13	11%	54%	67.8%	63.2%	63.2%	5.6
141	Refrigeration	Energy Star Reach-In Refrigerator, Solid Doors	Biz-Prescriptive	Assembly	ROB	1,410	1,410	20%	281	0.00	12	$1,211	6%	6%	6%	14	11%	54%	67.8%	63.2%	63.2%	2.5
142	Refrigeration	Anti-Sweat Heater Controls LT	Biz-Prescriptive	Assembly	Retro	2,016	2,016	68%	1,361	0.00	10	$170	100%	44%	55%	15	4%	25%	88.0%	84.3%	85.0%	8.3
143	Refrigeration	Auto Door Closer, Freezer	Biz-Custom	Assembly	Retro	419,455	419,455	1%	2,307	0.00	8	$157	100%	50%	50%	16	4%	50%	88.0%	68.9%	68.9%	13.9
144	Refrigeration	Display Case Door Retrofit, Low Temp	Biz-Custom	Assembly	Retro	2,922	2,922	50%	1,453	0.00	12	$686	100%	21%	21%	16	4%	25%	88.0%	49.7%	49.7%	7.1

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
145	Refrigeration	Energy Star Reach-In Freezer, Glass Doors	Biz-Prescriptive	Assembly	ROB	6,374	6,374	20%	1,275	0.00	12	$1,651	25%	21%	21%	17	4%	54%	67.8%	63.2%	63.2%	2.3
146	Refrigeration	Energy Star Reach-In Freezer, Solid Doors	Biz-Prescriptive	Assembly	ROB	4,522	4,522	7%	305	0.00	12	$1,521	23%	23%	23%	18	4%	54%	67.8%	63.2%	63.2%	0.5
147	Refrigeration	Refrigeration - Custom	Biz-Custom	Assembly	ROB	7	7	2%	0	0.00	10	$0	75%	25%	25%	19	90%	25%	47.5%	39.4%	39.4%	3.3
148	Refrigeration	Retro-commissioning_Refrigerator Optimization	Biz-Custom RCx	Assembly	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	20	90%	25%	88.0%	65.9%	65.9%	3.2
149	Refrigeration	Energy Star Ice Machine	Biz-Prescriptive	Assembly	ROB	6,993	6,993	10%	721	0.00	15	$1,426	25%	18%	18%	21	7%	44%	60.8%	55.2%	55.2%	2.1
150	Refrigeration	Vending Machine Controller - Refrigerated	Biz-Prescriptive	Assembly	Retro	1,586	1,586	34%	537	0.00	5	$245	25%	16%	16%	22	2%	30%	65.5%	61.1%	61.1%	2.7
151	Refrigeration	LED Refrigerated Display Case Lighting Average 6W/LF	Biz-Prescriptive	Assembly	Retro	273	273	89%	243	0.00	9	$11	100%	45%	55%	23	7%	35%	88.0%	86.7%	86.9%	30.9
152	Refrigeration	LED Refrigerated Display Case Lighting Controls	Biz-Prescriptive	Assembly	Retro	522	522	27%	141	0.00	10	$15	100%	100%	100%	24	7%	18%	88.0%	88.0%	88.0%	6.6
153	Ventilation	Demand Controlled Ventilation	Biz-Custom	Assembly	Retro	1,698	1,698	20%	340	0.00	15	$227	100%	15%	15%	1	100%	13%	92.7%	39.4%	39.4%	9.4
154	Ventilation	Pump and Fan Variable Frequency Drive Controls (Fans)	Biz-Prescriptive	Assembly	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	55%	2	100%	13%	92.7%	74.0%	79.4%	11.6
155	WholeBldg_HVAC	HVAC - Energy Management System	Biz-Custom RCx	Assembly	Retro	13	13	8%	1	0.00	15	$0	100%	25%	25%	1	100%	20%	92.7%	51.6%	51.6%	8.8
156	WholeBldg_HVAC	Guest room energy management system	Biz-Custom	Assembly	Retro	0	0	0%	0	0.00	15	$260	0%		0%	2	100%	20%	92.7%	74.2%	74.2%	0.0
157	WholeBldg_HVAC	Retro-commissioning_Bld Optimization	Biz-Custom RCx	Assembly	Retro	10	10	10%	1	0.00	15	$0	100%	25%	25%	3	100%	0%	92.7%	51.6%	51.6%	8.8
158	WholeBuilding	WholeBlg - Com RET	Biz-Custom	Assembly	Retro	7	7	15%	1	0.00	12	$0	100%	25%	25%	1	90%	0%	92.7%	51.6%	51.6%	7.3
159	WholeBuilding	WholeBlg - Custom (Other)	Biz-Custom	Assembly	Retro	5	5	20%	1	0.00	12	$0	100%	25%	25%	2	90%	0%	92.7%	51.6%	51.6%	7.3
160	WholeBuilding	Power Distribution Equipment Upgrades (Transformers)	Biz-Custom	Assembly	Retro	1,150	1,150	1%	6	0.00	30	$8	100%	9%	9%	3	100%	20%	92.7%	36.0%	36.0%	17.1
161	WholeBldg_NC	WholeBlg - Com NC	Biz-Custom	Assembly	NC	4	4	25%	1	0.00	12	$0	100%	50%	50%	1	100%	60%	83.4%	68.0%	68.0%	7.6
162	Behavioral	COM Competitions	Biz-Custom	Assembly	Retro	53	53	2%	1	0.00	2	$0	100%	50%	50%	1	100%	0%	50.0%	50.0%	50.0%	3.9
163	Behavioral	Business Energy Reports	Biz-Custom	Assembly	Retro	0	0	0%	0	0.00	2	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
164	Behavioral	Building Benchmarking	Biz-Custom	Assembly	Retro	0	0	0%	0	0.00	2	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
165	Behavioral	Strategic Energy Management	Biz-Custom SEM	Assembly	Retro	0	0	0%	0	0.00	2	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
166	Behavioral	BEIMS	Biz-Custom	Assembly	Retro	20	20	5%	1	0.00	2	$0	23%	23%	23%	1	100%	2%	50.0%	50.0%	50.0%	0.8
167	Behavioral	Building Operator Certification	Biz-Custom	Assembly	Retro	10	10	3%	0	0.00	3	$0	14%	14%	14%	1	100%	2%	50.0%	50.0%	50.0%	1.7
168	CompressedAir	Efficient Air Compressors (VSD)	Biz-Prescriptive	Education	ROB	1,583	1,583	21%	329	0.00	13	$127	100%	59%	80%	1	100%	33%	92.7%	76.7%	83.1%	5.5
169	CompressedAir	Efficient Air Nozzles	Biz-Prescriptive	Education	Retro	1,480	1,480	50%	740	0.00	15	$50	100%	81%	81%	2	35%	33%	92.7%	91.1%	91.1%	15.8
170	CompressedAir	AODD Pump Controls	Biz-Custom	Education	Retro	103,919	103,919	35%	36,372	0.00	10	$1,150	100%	50%	50%	3	10%	33%	92.7%	72.6%	72.6%	38.2
171	CompressedAir	Compressed Air - Custom	Biz-Custom	Education	Retro	5	5	20%	1	0.00	10	$0	100%	47%	47%	4	50%	33%	92.7%	64.2%	64.2%	6.0
172	CompressedAir	Retro-commissioning_Compressed Air Optimization	Biz-Custom RCx	Education	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	5	50%	33%	92.7%	64.2%	64.2%	3.2
173	Cooking	Commercial Combination Oven (Electric)	Biz-Prescriptive	Education	ROB	38,561	38,561	48%	18,432	0.00	12	$16,884	75%	6%	15%	1	18%	53%	77.5%	62.4%	62.4%	14.1
174	Cooking	Commercial Electric Convection Oven	Biz-Prescriptive	Education	ROB	12,193	12,193	15%	1,879	0.00	12	$1,706	75%	21%	51%	1	18%	53%	77.6%	62.4%	62.4%	4.4
175	Cooking	Commercial Electric Griddle	Biz-Prescriptive	Education	ROB	17,056	17,056	15%	2,596	0.00	12	$3,604	25%	15%	15%	2	14%	17%	41.9%	33.6%	33.6%	2.8
176	Cooking	Commercial Electric Steam Cooker	Biz-Prescriptive	Education	ROB	19,549	19,549	67%	13,162	0.00	12	$2,490	100%	24%	55%	3	6%	45%	88.0%	81.1%	83.5%	18.0
177	Cooking	Dishwasher Low Temp Door (Energy Star)	Biz-Prescriptive	Education	ROB	39,306	39,306	44%	17,369	0.00	15	$1,000	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	11.7
178	Cooking	Dishwasher High Temp Door (Energy Star)	Biz-Prescriptive	Education	ROB	26,901	26,901	32%	8,586	0.00	15	$1,100	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	5.2
179	Cooking	Energy efficient electric fryer	Biz-Prescriptive	Education	ROB	18,955	18,955	17%	3,274	0.00	12	$1,500	100%	5%	13%	5	27%	24%	88.0%	57.2%	59.4%	23.2
180	Cooking	Insulated Holding Cabinets (Full Size)	Biz-Prescriptive	Education	ROB	13,697	13,697	68%	9,314	0.00	12	$1,200	100%	35%	55%	6	3%	16%	88.0%	83.6%	84.9%	12.7
181	Cooking	Insulated Holding Cabinets (Half-Size)	Biz-Prescriptive	Education	ROB	4,383	4,383	60%	2,630	0.00	12	$1,500	100%	10%	25%	6	3%	16%	88.0%	52.6%	57.6%	10.1
182	Cooling	Air Conditioner - 13 IEER (5-20 Tons)	Biz-Prescriptive	Education	ROB	723	723	6%	44	0.00	15	$63	100%	48%	55%	1	23%	20%	92.7%	43.0%	46.7%	4.3
183	Cooling	Air Conditioner - 14 IEER (5-20 Tons)	Biz-Prescriptive	Education	ROB	723	723	13%	93	0.00	15	$127	100%	24%	55%	1	23%	20%	92.7%	36.8%	47.5%	9.0
184	Cooling	Air Conditioner - 17 IEER (5-20 Tons)	Biz-Prescriptive	Education	ROB	723	723	28%	204	0.00	15	$127	100%	24%	55%	1	23%	20%	92.7%	52.5%	66.4%	19.8
185	Cooling	Air Conditioner - 21 IEER (5-20 Tons)	Biz-Prescriptive	Education	ROB	723	723	42%	303	0.00	15	$127	100%	24%	55%	1	23%	20%	92.7%	62.5%	74.3%	29.3
186	Cooling	Air Conditioner - 12.1 IEER (20+ Tons)	Biz-Prescriptive	Education	ROB	773	773	6%	45	0.00	15	$30	100%	100%	100%	2	23%	20%	92.7%	92.7%	92.7%	4.3
187	Cooling	Air Conditioner - 13 IEER (20+ Tons)	Biz-Prescriptive	Education	ROB	773	773	12%	95	0.00	15	$37	100%	81%	81%	2	23%	20%	92.7%	83.5%	83.5%	9.2
188	Cooling	Air Conditioner - 14.3 IEER (20+ Tons)	Biz-Prescriptive	Education	ROB	773	773	20%	157	0.00	15	$37	100%	81%	81%	2	23%	20%	92.7%	87.1%	87.1%	15.2
189	Cooling	Air Conditioner - 21 IEER (20+ Tons)	Biz-Prescriptive	Education	ROB	773	773	46%	354	0.00	15	$37	100%	81%	81%	2	23%	20%	92.7%	90.2%	90.2%	34.3
190	Cooling	Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up)	Biz-Custom	Education	Retro	735	735	7%	51	0.00	3	$5	100%	50%	50%	3	46%	50%	92.7%	69.0%	69.0%	13.6
191	Cooling	Air Side Economizer	Biz-Custom	Education	Retro	723	723	20%	145	0.00	10	$84	50%	17%	17%	4	46%	20%	65.4%	41.8%	41.8%	3.9
192	Cooling	Advanced Rooftop Controls	Biz-Prescriptive	Education	Retro	735	735	14%	107	0.00	10	$100	100%	100%	100%	5	46%	20%	92.7%	92.7%	92.7%	0.4
193	Cooling	HVAC Occupancy Controls	Biz-Custom	Education	ROB	1,113	1,113	20%	223	0.00	15	$537	4%	4%	4%	6	46%	20%	44.0%	36.0%	36.0%	5.6
194	Cooling	Air Conditioner - 16 SEER (<5 Tons)	Biz-Prescriptive	Education	ROB	630	630	13%	79	0.00	15	$47	100%	64%	80%	7	3%	20%	92.7%	72.3%	79.7%	7.6
195	Cooling	Air Conditioner - 17 SEER (<5 Tons)	Biz-Prescriptive	Education	ROB	630	630	18%	111	0.00	15	$206	100%	15%	36%	7	3%	20%	92.7%	36.0%	36.0%	10.8
196	Cooling	Air Conditioner - 18 SEER(<5 Tons)	Biz-Prescriptive	Education	ROB	630	630	22%	140	0.00	15	$206	100%	15%	36%	7	3%	20%	92.7%	36.0%	38.7%	13.6
197	Cooling	Air Conditioner - 21 SEER(<5 Tons)	Biz-Prescriptive	Education	ROB	630	630	33%	210	0.00	15	$253	100%	12%	30%	7	3%	20%	92.7%	36.5%	40.3%	20.3
198	Cooling	Smart Thermostat	Biz-Prescriptive	Education	ROB	630	630	14%	89	0.00	11	$175	57%	57%	57%	8	3%	12%	40.4%	40.4%	40.4%	1.1
199	Cooling	PTAC - <7,000 Btuh - lodging	Biz-Prescriptive	Education	ROB	741	741	8%	63	0.00	8	$84	100%	36%	36%	9	0%	20%	92.7%	40.0%	40.0%	3.3
200	Cooling	PTAC - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Education	ROB	813	813	7%	59	0.00	8	$84	100%	36%	36%	10	0%	20%	92.7%	39.1%	39.1%	3.1
201	Cooling	PTAC - >15,000 Btuh - lodging	Biz-Prescriptive	Education	ROB	928	928	10%	88	0.00	8	$84	100%	36%	55%	11	0%	20%	92.7%	47.7%	54.1%	4.7
202	Cooling	Air Cooled Chiller	Biz-Prescriptive	Education	ROB	644	644	6%	36	0.00	23	$126	100%	24%	55%	12	51%	15%	92.7%	32.0%	32.0%	6.1
203	Cooling	Chiller Tune-up	Biz-Prescriptive	Education	Retro	735	735	7%	51	0.00	3	$8	100%	100%	100%	13	51%	50%	92.7%	92.7%	92.7%	4.5
204	Cooling	HVAC/Chiller Custom	Biz-Custom	Education	Retro	5	5	20%	1	0.00	20	$1	100%	7%	7%	14	100%	20%	92.7%	36.0%	36.0%	30.3
205	Cooling	Window Film	Biz-Prescriptive	Education	Retro	6,000	6,000	4%	264	0.00	10	$154	100%	65%	65%	15	100%	20%	92.7%	73.1%	73.1%	3.2
206	Cooling	Triple Pane Windows	Biz-Custom	Education	ROB	6,000	6,000	6%	360	0.00	25	$700	100%	5%	5%	15	100%	20%	92.7%	36.0%	36.0%	24.5
207	Cooling	Energy Recovery Ventilator	Biz-Custom	Education	Retro	773	773	19%	148	0.00	15	$1,500	25%	1%	1%	16	100%	2%	31.4%	21.8%	21.8%	33.2
208	Heating	Heat Pump - 16 SEER (<5 Tons)	Biz-Prescriptive	Education	ROB	2,196	2,196	3%	72	0.00	16	$87	100%	46%	46%	1	5%	20%	92.7%	46.3%	46.3%	2.8
209	Heating	Heat Pump - 17 SEER (<5 Tons)	Biz-Prescriptive	Education	ROB	2,196	2,196	8%	172	0.00	16	$442	50%	9%	23%	1	5%	20%	44.0%	36.0%	36.0%	5.7
210	Heating	Heat Pump - 18 SEER(<5 Tons)	Biz-Prescriptive	Education	ROB	2,196	2,196	11%	247	0.00	16	$507	50%	8%	20%	1	5%	20%	44.0%	36.0%	36.0%	8.1
211	Heating	Heat Pump - 21 SEER(<5 Tons)	Biz-Prescriptive	Education	ROB	2,196	2,196	16%	361	0.00	16	$507	75%	8%	20%	1	5%	20%	59.6%	36.0%	36.0%	12.5
212	Heating	Geothermal HP - SEER 20.3 (<5 Tons)	Biz-Prescriptive	Education	ROB	2,196	2,196	22%	475	0.00	25	$2,576	25%	2%	4%	1	5%	20%	44.0%	36.0%	36.0%	19.2
213	Heating	Geothermal HP - SEER 21.5 (<5 Tons)	Biz-Prescriptive	Education	ROB	2,196	2,196	26%	571	0.00	25	$2,576	25%	2%	4%	1	5%	20%	44.0%	36.0%	36.0%	22.4
214	Heating	Geothermal HP - SEER 23.1 (<5 Tons)	Biz-Prescriptive	Education	ROB	2,196	2,196	31%	684	0.00	25	$2,576	25%	2%	4%	1	5%	20%	44.0%	36.0%	36.0%	26.0
215	Heating	Geothermal HP - SEER 29.3 (<5 Tons)	Biz-Prescriptive	Education	ROB	2,196	2,196	46%	1,013	0.00	25	$2,576	50%	2%	4%	1	5%	20%	44.0%	36.0%	36.0%	34.5
216	Heating	Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Education	ROB	2,619	2,619	10%	262	0.00	16	$100	100%	40%	55%	2	42%	20%	92.7%	71.1%	75.6%	32.3

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Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
217	Heating	Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Education	ROB	2,619	2,619	15%	395	0.00	16	$136	100%	30%	55%	2	42%	20%	92.7%	70.0%	76.9%	36.2
218	Heating	Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Education	ROB	2,717	2,717	12%	332	0.00	16	$100	100%	40%	55%	2	42%	20%	92.7%	74.9%	78.4%	36.3
219	Heating	Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Education	ROB	2,717	2,717	17%	467	0.00	16	$139	100%	29%	55%	2	42%	20%	92.7%	72.5%	78.6%	40.2
220	Heating	Geothermal HP - SEER 20.3 (5-20 Tons)	Biz-Prescriptive	Education	ROB	2,397	2,397	28%	676	0.00	25	$2,576	50%	2%	4%	2	42%	20%	44.0%	36.0%	36.0%	38.7
221	Heating	Geothermal HP - SEER 21.5 (5-20 Tons)	Biz-Prescriptive	Education	ROB	2,397	2,397	32%	772	0.00	25	$2,576	50%	2%	4%	2	42%	20%	44.0%	36.0%	36.0%	41.9
222	Heating	Geothermal HP - SEER 23.1 (5-20 Tons)	Biz-Prescriptive	Education	ROB	2,490	2,490	39%	977	0.00	25	$2,576	50%	2%	4%	2	42%	20%	44.0%	36.0%	36.0%	47.5
223	Heating	Geothermal HP - SEER 29.3 (5-20 Tons)	Biz-Prescriptive	Education	ROB	2,490	2,490	52%	1,306	0.00	25	$2,576	75%	2%	4%	2	42%	20%	51.8%	36.0%	36.0%	56.0
224	Heating	Variable Refrigerant Flow Heat Pump	Biz-Custom	Education	ROB	2,003	2,003	8%	168	0.00	16	$224	100%	7%	7%	2	42%	2%	92.7%	26.8%	26.8%	23.1
225	Heating	Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr)	Biz-Prescriptive	Education	ROB	2,791	2,791	8%	227	0.00	16	$100	100%	40%	55%	3	42%	20%	92.7%	67.9%	73.5%	28.5
226	Heating	Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr)	Biz-Prescriptive	Education	ROB	2,791	2,791	14%	386	0.00	16	$175	100%	23%	55%	3	42%	20%	92.7%	59.7%	73.1%	33.7
227	Heating	Geothermal HP - SEER 20.3 (20+ Tons)	Biz-Prescriptive	Education	ROB	2,717	2,717	37%	996	0.00	25	$2,576	100%	2%	4%	3	42%	20%	92.7%	36.0%	36.0%	74.0
228	Heating	Geothermal HP - SEER 21.5 (20+ Tons)	Biz-Prescriptive	Education	ROB	2,717	2,717	40%	1,092	0.00	25	$2,576	100%	2%	4%	3	42%	20%	92.7%	36.0%	36.0%	77.2
229	Heating	Geothermal HP - SEER 23.1 (20+ Tons)	Biz-Prescriptive	Education	ROB	2,717	2,717	44%	1,205	0.00	25	$2,576	100%	2%	4%	3	42%	20%	92.7%	36.0%	36.0%	80.8
230	Heating	Geothermal HP - SEER 29.3 (20+ Tons)	Biz-Prescriptive	Education	ROB	2,717	2,717	56%	1,534	0.00	25	$2,576	100%	2%	4%	3	42%	20%	92.7%	36.0%	36.0%	89.2
231	Heating	Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD)	Biz-Prescriptive	Education	ROB	2,196	2,196	16%	361	0.00	16	$224	100%	18%	45%	4	12%	20%	92.7%	51.2%	60.3%	12.5
232	Heating	PTHP - <7,000 Btuh - lodging	Biz-Custom	Education	ROB	2,448	2,448	2%	60	0.00	8	$130	100%	100%	100%	5	0%	10%	92.7%	74.2%	74.2%	0.7
233	Heating	PTHP - >15,000 Btuh - lodging	Biz-Prescriptive	Education	ROB	2,852	2,852	10%	288	0.00	8	$130	100%	100%	100%	6	0%	10%	92.7%	92.7%	92.7%	3.3
234	Heating	PTHP - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Education	ROB	2,651	2,651	6%	149	0.00	8	$130	100%	100%	100%	7	0%	10%	92.7%	92.7%	92.7%	1.7
235	HotWater	Heat Pump Water Heater	Biz-Prescriptive	Education	ROB	5,042	5,042	67%	3,377	0.00	15	$1,115	100%	45%	55%	1	100%	4%	84.0%	72.3%	75.0%	5.6
236	HotWater	Hot Water Pipe Insulation	Biz-Custom	Education	Retro	5,042	5,042	2%	101	0.00	20	$60	100%	17%	17%	2	100%	80%	86.0%	84.0%	84.0%	9.8
237	HotWater	Faucet Aerator	Biz-Custom	Education	Retro	467	467	32%	151	0.00	10	$8	100%	50%	50%	3	20%	90%	93.0%	92.0%	92.0%	33.4
238	HotWater	Low Flow Pre-Rinse Sprayers	Biz-Prescriptive	Education	ROB	18,059	18,059	54%	9,789	0.00	5	$60	100%	17%	42%	4	20%	80%	86.0%	84.0%	84.0%	199.3
239	HotWater	ENERGY STAR Commercial Washing Machines	Biz-Prescriptive	Education	ROB	1,552	1,552	43%	671	0.00	7	$250	75%	28%	28%	5	25%	33%	79.3%	64.6%	64.6%	2.9
240	InteriorLighting	LED T8 Tube Replacement	Biz-Prescriptive Light	Education	Retro	116	116	45%	52	0.00	15	$5	100%	100%	100%	1	84%	40%	94.6%	94.6%	94.6%	11.4
241	InteriorLighting	LED troffer retrofit kit, 2'X2' and 2'X4'	Biz-Prescriptive Light	Education	Retro	262	262	50%	131	0.00	15	$70	100%	36%	55%	1	84%	40%	94.6%	55.2%	70.6%	5.8
242	InteriorLighting	LED troffer, 2'X2' and 2'X4'	Biz-Prescriptive Light	Education	Retro	262	262	50%	131	0.00	15	$70	100%	36%	55%	1	84%	40%	94.6%	55.2%	70.6%	5.8
243	InteriorLighting	Bi-Level Lighting Fixture – Stairwells, Hallways	Biz-Custom Light	Education	Retro	262	262	74%	195	0.00	10	$274	25%	7%	9%	2	1%	40%	58.0%	50.6%	50.7%	4.8
244	InteriorLighting	LED high bay fixture	Biz-Prescriptive Light	Education	Retro	2,440	2,440	68%	1,660	0.00	15	$330	100%	35%	55%	3	5%	34%	94.6%	82.6%	86.9%	15.9
245	InteriorLighting	LED Mogul-base HID Lamp Replacing High Bay HID	Biz-Prescriptive Light	Education	Retro	2,440	2,440	66%	1,619	0.00	15	$330	100%	35%	55%	3	5%	34%	94.6%	82.3%	86.7%	15.5
246	InteriorLighting	LED low bay fixture	Biz-Prescriptive Light	Education	Retro	520	520	61%	316	0.00	15	$44	100%	68%	80%	4	6%	34%	94.6%	90.9%	92.3%	11.6
247	InteriorLighting	LED Mogul-base HID Lamp Replacing Low Bay HID	Biz-Prescriptive Light	Education	Retro	520	520	59%	305	0.00	15	$44	100%	68%	80%	4	6%	34%	94.6%	90.8%	92.2%	11.2
248	InteriorLighting	LED Screw-In Lamps (Directional)	Biz-Prescriptive Light	Education	ROB	229	229	86%	197	0.00	6	$1	100%	100%	100%	6	0%	43%	94.6%	94.6%	94.6%	107.5
249	InteriorLighting	LED downlight fixture	Biz-Prescriptive Light	Education	Retro	180	180	68%	121	0.00	15	$27	100%	19%	46%	6	3%	45%	94.6%	77.1%	83.7%	26.8
250	InteriorLighting	LED Screw-In Lamps (Omnidirectional & Decorative)	Biz-Prescriptive Light	Education	ROB	173	173	81%	140	0.00	6	$1	100%	100%	100%	5	0%	20%	94.6%	94.6%	94.6%	76.6
251	InteriorLighting	DeLamp Fluorescent Fixture Average Lamp Wattage 28W	Biz-Prescriptive Light	Education	Retro	97	97	100%	97	0.00	11	$4	100%	100%	100%	7	84%	0%	94.6%	94.6%	94.6%	20.4
252	InteriorLighting	Occupancy Sensors	Biz-Prescriptive Light	Education	Retro	440	440	30%	132	0.00	10	$65	75%	31%	31%	8	95%	10%	83.2%	55.1%	55.1%	3.2
253	InteriorLighting	Daylighting Controls	Biz-Prescriptive Light	Education	Retro	564	564	30%	169	0.00	10	$58	100%	35%	55%	8	95%	10%	94.6%	72.7%	80.1%	7.9
254	InteriorLighting	Dual Occupancy & Daylighting Controls	Biz-Custom Light	Education	Retro	252	252	44%	111	0.00	10	$75	100%	40%	50%	8	95%	10%	94.6%	37.3%	44.7%	2.9
255	InteriorLighting	Central Lighting Monitoring & Controls (non-networked)	Biz-Custom Light	Education	Retro	41,703	41,703	20%	8,341	0.00	12	$3,700	100%	23%	29%	8	95%	10%	94.6%	44.1%	47.7%	4.6
256	InteriorLighting	Network Lighting Controls - Wireless (WiFi)	Biz-Custom Light	Education	Retro	3	3	49%	1	0.00	15	$0	100%	34%	44%	8	95%	10%	94.6%	60.4%	63.0%	9.6
257	InteriorLighting	Luminaire Level Lighting Controls w/ HVAC Control	Biz-Custom Light	Education	Retro	337	337	65%	219	0.00	15	$90	100%	24%	32%	8	97%	10%	94.6%	48.0%	51.6%	9.6
258	InteriorLighting	LED Exit Sign - 4 Watt Fixture (2 lamp)	Biz-Prescriptive Light	Education	Retro	66	66	43%	28	0.00	5	$33	92%	92%	92%	9	1%	75%	87.0%	87.0%	87.0%	0.3
259	InteriorLighting	Lighting - Custom	Biz-Custom Light	Education	Retro	4	4	25%	1	0.00	15	$1	100%	15%	20%	10	100%	0%	94.6%	32.0%	33.1%	9.6
260	ExteriorLighting	LED wallpack (existing W<250)	Biz-Prescriptive Light	Education	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	1	12%	46%	94.6%	56.6%	70.8%	5.8
261	ExteriorLighting	LED parking lot fixture (existing W≥250)	Biz-Prescriptive Light	Education	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	2	11%	54%	67.8%	63.2%	63.2%	4.4
262	ExteriorLighting	LED parking lot fixture (existing W<250)	Biz-Prescriptive Light	Education	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	3	11%	54%	94.6%	63.2%	70.8%	5.8
263	ExteriorLighting	LED outdoor pole decorative fixture (existing W≥250)	Biz-Prescriptive Light	Education	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	17%	17%	4	11%	54%	67.8%	63.2%	63.2%	3.4
264	ExteriorLighting	LED parking garage fixture (existing W≥250)	Biz-Prescriptive Light	Education	Retro	3,235	3,235	60%	1,953	0.00	6	$756	50%	13%	33%	5	11%	69%	78.3%	75.2%	75.2%	4.7
265	ExteriorLighting	LED parking garage fixture (existing W<250)	Biz-Prescriptive Light	Education	Retro	1,742	1,742	66%	1,154	0.00	6	$248	100%	18%	45%	6	11%	69%	94.6%	77.6%	83.9%	6.2
266	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250)	Biz-Prescriptive Light	Education	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	7	11%	46%	62.1%	56.6%	56.6%	4.4
267	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250)	Biz-Prescriptive Light	Education	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	8	11%	46%	94.6%	56.6%	70.8%	5.8
268	ExteriorLighting	Bi-Level Lighting Fixture – Garages	Biz-Custom Light	Education	Retro	262	262	69%	181	0.00	10	$274	25%	7%	9%	9	11%	20%	44.0%	33.2%	33.5%	3.9
269	ExteriorLighting	LED fuel pump canopy fixture (existing W<250)	Biz-Prescriptive Light	Education	Retro	0	0	0%	0	0.00	12	$0	0%	0%		10	0%	54%	94.6%	94.6%	94.6%	0.0
270	ExteriorLighting	LED fuel pump canopy fixture (existing W≥250)	Biz-Prescriptive Light	Education	Retro	0	0	0%	0	0.00	12	$0	0%	0%		11	0%	54%	94.6%	94.6%	94.6%	0.0
271	Miscellaneous	Vending Machine Controller - Non-Refrigerated	Biz-Prescriptive	Education	Retro	385	385	61%	237	0.00	5	$233	11%	11%	11%	1	5%	30%	51.0%	44.0%	44.0%	1.9
272	Miscellaneous	Miscellaneous Custom	Biz-Custom	Education	Retro	7	7	2%	0	0.00	10	$0	75%	25%	25%	2	0%	10%	37.0%	23.4%	23.4%	3.3
273	Miscellaneous	Kitchen Exhaust Hood Demand Ventilation Control System	Biz-Prescriptive	Education	ROB	9,932	9,932	50%	4,966	0.00	20	$1,180	100%	11%	27%	3	42%	10%	94.6%	73.8%	78.0%	39.7
274	Miscellaneous	High Efficiency Hand Dryers	Biz-Custom	Education	Retro	2,093	2,093	83%	1,737	0.00	10	$483	100%	36%	36%	4	5%	10%	94.6%	61.9%	61.9%	8.2
275	Miscellaneous	Ozone Commercial Laundry	Biz-Custom	Education	Retro	2,984	2,984	25%	746	0.00	10	$20,310	0%	0%	0%	5	0%	2%	31.4%	16.6%	16.6%	3.9
276	Miscellaneous	ENERGY STAR Uninterrupted Power Supply	Biz-Custom	Education	ROB	3,096	3,096	3%	85	0.00	15	$59	100%	14%	14%	6	1%	70%	94.6%	76.0%	76.0%	8.8
277	Motors	Cogged V-Belt	Biz-Custom	Education	Retro	17,237	17,237	3%	534	0.00	15	$384	100%	14%	14%	1	50%	10%	83.4%	32.2%	32.2%	9.2
278	Motors	Pump and Fan Variable Frequency Drive Controls (Pumps)	Biz-Custom	Education	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	30%	2	100%	10%	83.4%	52.4%	52.4%	11.6
279	Motors	Power Drive Systems	Biz-Custom	Education	Retro	4	4	23%	1	0.00	15	$0	100%	37%	37%	2	100%	10%	83.4%	53.4%	53.4%	9.2
280	Motors	Switch Reluctance Motors	Biz-Custom	Education	Retro	33,406	33,406	31%	10,222	0.00	15	$528	100%	50%	50%	2	100%	1%	83.4%	64.1%	64.1%	26.3
281	Motors	Escalators Motor Efficiency Controllers	Biz-Custom	Education	Retro	7,500	7,500	20%	1,500	0.00	10	$5,000	3%	3%	3%	3	0%	10%	37.0%	26.3%	26.3%	7.3
282	Office_NonPC	Energy Star Printer/Copier/Fax	Biz-Custom	Education	ROB	551	551	40%	223	0.00	6	$0	0%			1	30%	90%	94.6%	92.0%	92.0%	0.0
283	Office_NonPC	Smart Power Strip – Commercial Use	Biz-Custom	Education	Retro	1,086	1,086	10%	109	0.00	7	$50	50%	22%	22%	2	35%	15%	71.8%	42.0%	42.0%	2.8
284	Office_NonPC	Plug Load Occupancy Sensor	Biz-Custom	Education	Retro	1,126	1,126	15%	169	0.00	8	$70	75%	24%	24%	2	35%	15%	85.4%	47.6%	47.6%	3.2
285	Office_PC	Electrically Commutated Plug Fans in data centers	Biz-Custom	Education	Retro	86,783	86,783	18%	15,778	0.00	15	$480	100%	50%	50%	1	65%	20%	94.6%	74.6%	74.6%	50.8
286	Office_PC	Energy Star Server	Biz-Custom	Education	ROB	1,621	1,621	23%	368	0.00	8	$118	100%	31%	31%	1	65%	25%	94.6%	58.2%	58.2%	4.5
287	Office_PC	Server Virtualization	Biz-Custom	Education	Retro	2	2	45%	1	0.00	8	$0	75%	25%	25%	1	65%	25%	85.8%	49.3%	49.3%	3.2
288	Office_PC	High Efficiency CRAC unit	Biz-Custom	Education	ROB	541	541	30%	162	0.00	15	$63	100%	26%	26%	2	65%	20%	94.6%	51.1%	51.1%	8.1

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
289	Office_PC	Computer Room Air Conditioner Economizer	Biz-Custom	Education	Retro	764	764	47%	358	0.00	15	$82	100%	44%	44%	2	65%	20%	94.6%	66.1%	66.1%	5.6
290	Office_PC	Data Center Hot/Cold Aisle Configuration	Biz-Custom	Education	Retro	4	4	25%	1	0.00	15	$0	100%	25%	25%	3	3%	10%	94.6%	49.3%	49.3%	7.7
291	Office_PC	Energy Star Laptop	Biz-Custom	Education	ROB	126	126	33%	41	0.00	4	$0	0%			4	11%	85%	94.6%	88.0%	88.0%	0.0
292	Office_PC	Energy Star Monitor	Biz-Custom	Education	ROB	72	72	21%	15	0.00	4	$0	0%			5	25%	85%	94.6%	88.0%	88.0%	0.0
293	Refrigeration	Strip Curtains	Biz-Custom	Education	Retro	0	0	0%	0	0.00	4	$0	0%	0%		1	11%	30%	88.0%	70.4%	70.4%	0.0
294	Refrigeration	Bare Suction Line	Biz-Custom	Education	Retro	23	23	93%	21	0.00	15	$4	100%	50%	50%	2	0%	50%	88.0%	66.5%	66.5%	8.1
295	Refrigeration	Floating Head Pressure Controls	Biz-Custom	Education	Retro	1,112	1,112	25%	278	0.00	15	$431	25%	6%	6%	3	7%	25%	47.5%	40.0%	40.0%	5.6
296	Refrigeration	Saturated Suction Controls	Biz-Custom	Education	Retro	831	831	50%	416	0.00	15	$559	100%	7%	7%	4	2%	10%	88.0%	28.0%	28.0%	13.7
297	Refrigeration	Compressor Retrofit	Biz-Custom	Education	Retro	813	813	20%	163	0.00	15	$477	25%	3%	3%	5	25%	25%	47.5%	39.4%	39.4%	13.8
298	Refrigeration	Electronically Commutated (EC) Walk-In Evaporator Fan Motor	Biz-Prescriptive	Education	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	6	7%	80%	88.0%	84.0%	84.0%	30.7
299	Refrigeration	Evaporator Fan Motor Controls	Biz-Custom	Education	Retro	1,912	1,912	25%	478	0.00	13	$162	100%	30%	30%	7	7%	25%	88.0%	61.7%	61.7%	7.0
300	Refrigeration	Variable Speed Condenser Fan	Biz-Custom	Education	Retro	2,960	2,960	50%	1,480	0.00	15	$1,170	50%	13%	13%	8	9%	25%	59.5%	40.0%	40.0%	5.6
301	Refrigeration	Refrigeration Economizer	Biz-Custom	Education	Retro	7	7	2%	0	0.00	10	$0	100%	50%	50%	9	35%	10%	88.0%	41.1%	41.1%	4.2
302	Refrigeration	Anti-Sweat Heater Controls MT	Biz-Prescriptive	Education	Retro	579	579	59%	338	0.00	10	$170	75%	44%	44%	10	12%	75%	82.5%	80.0%	80.0%	2.1
303	Refrigeration	Auto Door Closer, Cooler	Biz-Custom	Education	Retro	471,500	471,500	0%	943	0.00	8	$157	100%	50%	50%	11	9%	50%	88.0%	66.9%	66.9%	5.8
304	Refrigeration	Display Case Door Retrofit, Medium Temp	Biz-Custom	Education	Retro	1,584	1,584	36%	578	0.00	12	$686	50%	8%	8%	11	3%	25%	47.9%	40.0%	40.0%	7.1
305	Refrigeration	Electronically Commutated (EC) Reach-In Evaporator Fan Motor	Biz-Prescriptive	Education	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	12	2%	80%	88.0%	84.0%	84.0%	30.7
306	Refrigeration	Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor	Biz-Custom	Education	Retro	1,911	1,911	26%	504	0.00	10	$96	100%	50%	50%	12	2%	2%	88.0%	66.5%	66.5%	5.8
307	Refrigeration	Energy Star Reach-In Refrigerator, Glass Doors	Biz-Prescriptive	Education	ROB	2,140	2,140	29%	629	0.00	12	$1,239	25%	6%	14%	13	12%	54%	67.8%	63.2%	63.2%	5.6
308	Refrigeration	Energy Star Reach-In Refrigerator, Solid Doors	Biz-Prescriptive	Education	ROB	1,410	1,410	20%	281	0.00	12	$1,211	6%	6%	6%	14	12%	54%	67.8%	63.2%	63.2%	2.5
309	Refrigeration	Anti-Sweat Heater Controls LT	Biz-Prescriptive	Education	Retro	2,016	2,016	68%	1,361	0.00	10	$170	100%	44%	55%	15	4%	75%	88.0%	84.3%	85.0%	8.3
310	Refrigeration	Auto Door Closer, Freezer	Biz-Custom	Education	Retro	419,455	419,455	1%	2,307	0.00	8	$157	100%	50%	50%	16	4%	50%	88.0%	68.9%	68.9%	13.9
311	Refrigeration	Display Case Door Retrofit, Low Temp	Biz-Custom	Education	Retro	2,922	2,922	50%	1,453	0.00	12	$686	100%	21%	21%	16	4%	25%	88.0%	49.7%	49.7%	7.1
312	Refrigeration	Energy Star Reach-In Freezer, Glass Doors	Biz-Prescriptive	Education	ROB	6,374	6,374	20%	1,275	0.00	12	$1,651	25%	21%	21%	17	4%	54%	67.8%	63.2%	63.2%	2.3
313	Refrigeration	Energy Star Reach-In Freezer, Solid Doors	Biz-Prescriptive	Education	ROB	4,522	4,522	7%	305	0.00	12	$1,521	23%	23%	23%	18	4%	54%	67.8%	63.2%	63.2%	0.5
314	Refrigeration	Refrigeration - Custom	Biz-Custom	Education	ROB	7	7	2%	0	0.00	10	$0	75%	25%	25%	19	90%	25%	47.5%	39.4%	39.4%	3.3
315	Refrigeration	Retro-commissioning_Refrigerator Optimization	Biz-Custom RCx	Education	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	20	90%	25%	88.0%	65.9%	65.9%	3.2
316	Refrigeration	Energy Star Ice Machine	Biz-Prescriptive	Education	ROB	6,993	6,993	10%	721	0.00	15	$1,426	25%	18%	18%	21	4%	44%	60.8%	55.2%	55.2%	2.1
317	Refrigeration	Vending Machine Controller - Refrigerated	Biz-Prescriptive	Education	Retro	1,586	1,586	34%	537	0.00	5	$245	25%	16%	16%	22	3%	30%	65.5%	61.1%	61.1%	2.7
318	Refrigeration	LED Refrigerated Display Case Lighting Average 6W/LF	Biz-Prescriptive	Education	Retro	273	273	89%	243	0.00	9	$11	100%	45%	55%	23	7%	35%	88.0%	86.7%	86.9%	30.9
319	Refrigeration	LED Refrigerated Display Case Lighting Controls	Biz-Prescriptive	Education	Retro	522	522	27%	141	0.00	10	$15	100%	100%	100%	24	7%	18%	88.0%	88.0%	88.0%	6.6
320	Ventilation	Demand Controlled Ventilation	Biz-Custom	Education	Retro	2,223	2,223	20%	445	0.00	15	$227	100%	20%	20%	1	100%	22%	92.7%	43.8%	43.8%	9.0
321	Ventilation	Pump and Fan Variable Frequency Drive Controls (Fans)	Biz-Prescriptive	Education	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	55%	2	100%	22%	92.7%	74.0%	79.4%	11.6
322	WholeBldg_HVAC	HVAC - Energy Management System	Biz-Custom RCx	Education	Retro	13	13	8%	1	0.00	15	$0	100%	25%	25%	1	100%	20%	92.7%	51.6%	51.6%	8.8
323	WholeBldg_HVAC	Guest room energy management system	Biz-Custom	Education	Retro	0	0	0%	0	0.00	15	$260	0%		0%	2	100%	20%	92.7%	74.2%	74.2%	0.0
324	WholeBldg_HVAC	Retro-commissioning_Bld Optimization	Biz-Custom RCx	Education	Retro	10	10	10%	1	0.00	15	$0	100%	25%	25%	3	100%	0%	92.7%	51.6%	51.6%	8.8
325	WholeBuilding	WholeBlg - Com RET	Biz-Custom	Education	Retro	7	7	15%	1	0.00	12	$0	100%	25%	25%	1	90%	0%	92.7%	51.6%	51.6%	7.3
326	WholeBuilding	WholeBlg - Custom (Other)	Biz-Custom	Education	Retro	5	5	20%	1	0.00	12	$0	100%	25%	25%	2	90%	0%	92.7%	51.6%	51.6%	7.3
327	WholeBuilding	Power Distribution Equipment Upgrades (Transformers)	Biz-Custom	Education	Retro	1,150	1,150	1%	6	0.00	30	$8	100%	9%	9%	3	100%	20%	92.7%	36.0%	36.0%	17.1
328	WholeBldg_NC	WholeBlg - Com NC	Biz-Custom	Education	NC	4	4	25%	1	0.00	12	$0	100%	50%	50%	1	100%	60%	83.4%	68.0%	68.0%	7.6
329	Behavioral	COM Competitions	Biz-Custom	Education	Retro	0	0	0%	0	0.00	2	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
330	Behavioral	Business Energy Reports	Biz-Custom	Education	Retro	0	0	0%	0	0.00	2	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
331	Behavioral	Building Benchmarking	Biz-Custom	Education	Retro	83	83	1%	1	0.00	2	$0	45%	45%	45%	1	100%	0%	50.0%	50.0%	50.0%	0.8
332	Behavioral	Strategic Energy Management	Biz-Custom SEM	Education	Retro	33	33	3%	1	0.00	5	$0	75%	37%	37%	1	100%	0%	50.0%	50.0%	50.0%	2.1
333	Behavioral	BEIMS	Biz-Custom	Education	Retro	43	43	2%	1	0.00	2	$0	23%	23%	23%	1	100%	2%	50.0%	50.0%	50.0%	0.8
334	Behavioral	Building Operator Certification	Biz-Custom	Education	Retro	41	41	3%	1	0.00	3	$0	75%	50%	50%	1	100%	2%	50.0%	50.0%	50.0%	2.0
335	CompressedAir	Efficient Air Compressors (VSD)	Biz-Prescriptive	Food Sales	ROB	1,583	1,583	21%	329	0.00	13	$127	100%	59%	80%	1	100%	33%	92.7%	76.7%	83.1%	5.5
336	CompressedAir	Efficient Air Nozzles	Biz-Prescriptive	Food Sales	Retro	1,480	1,480	50%	740	0.00	15	$50	100%	81%	81%	2	35%	33%	92.7%	91.1%	91.1%	15.8
337	CompressedAir	AODD Pump Controls	Biz-Custom	Food Sales	Retro	103,919	103,919	35%	36,372	0.00	10	$1,150	100%	50%	50%	3	10%	33%	92.7%	72.6%	72.6%	38.2
338	CompressedAir	Compressed Air - Custom	Biz-Custom	Food Sales	Retro	5	5	20%	1	0.00	10	$0	100%	47%	47%	4	50%	33%	92.7%	64.2%	64.2%	6.0
339	CompressedAir	Retro-commissioning_Compressed Air Optimization	Biz-Custom RCx	Food Sales	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	5	50%	33%	92.7%	64.2%	64.2%	3.2
340	Cooking	Commercial Combination Oven (Electric)	Biz-Prescriptive	Food Sales	ROB	38,561	38,561	48%	18,432	0.00	12	$16,884	75%	6%	15%	1	18%	53%	77.5%	62.4%	62.4%	14.1
341	Cooking	Commercial Electric Convection Oven	Biz-Prescriptive	Food Sales	ROB	12,193	12,193	15%	1,879	0.00	12	$1,706	75%	21%	51%	1	18%	53%	77.6%	62.4%	62.4%	4.4
342	Cooking	Commercial Electric Griddle	Biz-Prescriptive	Food Sales	ROB	17,056	17,056	15%	2,596	0.00	12	$3,604	25%	15%	15%	2	14%	17%	41.9%	33.6%	33.6%	2.8
343	Cooking	Commercial Electric Steam Cooker	Biz-Prescriptive	Food Sales	ROB	19,549	19,549	67%	13,162	0.00	12	$2,490	100%	24%	55%	3	6%	45%	88.0%	81.1%	83.5%	18.0
344	Cooking	Dishwasher Low Temp Door (Energy Star)	Biz-Prescriptive	Food Sales	ROB	39,306	39,306	44%	17,369	0.00	15	$1,000	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	11.7
345	Cooking	Dishwasher High Temp Door (Energy Star)	Biz-Prescriptive	Food Sales	ROB	26,901	26,901	32%	8,586	0.00	15	$1,100	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	5.2
346	Cooking	Energy efficient electric fryer	Biz-Prescriptive	Food Sales	ROB	18,955	18,955	17%	3,274	0.00	12	$1,500	100%	5%	13%	5	27%	24%	88.0%	57.2%	59.4%	23.2
347	Cooking	Insulated Holding Cabinets (Full Size)	Biz-Prescriptive	Food Sales	ROB	13,697	13,697	68%	9,314	0.00	12	$1,200	100%	35%	55%	6	3%	16%	88.0%	83.6%	84.9%	12.7
348	Cooking	Insulated Holding Cabinets (Half-Size)	Biz-Prescriptive	Food Sales	ROB	4,383	4,383	60%	2,630	0.00	12	$1,500	100%	10%	25%	6	3%	16%	88.0%	52.6%	57.6%	10.1
349	Cooling	Air Conditioner - 13 IEER (5-20 Tons)	Biz-Prescriptive	Food Sales	ROB	1,399	1,399	6%	86	0.00	15	$63	100%	48%	55%	1	19%	20%	92.7%	56.5%	61.7%	5.1
350	Cooling	Air Conditioner - 14 IEER (5-20 Tons)	Biz-Prescriptive	Food Sales	ROB	1,399	1,399	13%	180	0.00	15	$127	100%	24%	55%	1	19%	20%	92.7%	50.2%	62.8%	10.6
351	Cooling	Air Conditioner - 17 IEER (5-20 Tons)	Biz-Prescriptive	Food Sales	ROB	1,399	1,399	28%	395	0.00	15	$127	100%	24%	55%	1	19%	20%	92.7%	69.7%	77.7%	23.3
352	Cooling	Air Conditioner - 21 IEER (5-20 Tons)	Biz-Prescriptive	Food Sales	ROB	1,399	1,399	42%	586	0.00	15	$127	100%	24%	55%	1	19%	20%	92.7%	76.1%	81.4%	34.6
353	Cooling	Air Conditioner - 12.1 IEER (20+ Tons)	Biz-Prescriptive	Food Sales	ROB	1,497	1,497	6%	87	0.00	15	$30	100%	100%	100%	2	19%	20%	92.7%	92.7%	92.7%	5.1
354	Cooling	Air Conditioner - 13 IEER (20+ Tons)	Biz-Prescriptive	Food Sales	ROB	1,497	1,497	12%	184	0.00	15	$37	100%	81%	81%	2	19%	20%	92.7%	88.0%	88.0%	10.9
355	Cooling	Air Conditioner - 14.3 IEER (20+ Tons)	Biz-Prescriptive	Food Sales	ROB	1,497	1,497	20%	304	0.00	15	$37	100%	81%	81%	2	19%	20%	92.7%	89.8%	89.8%	17.9
356	Cooling	Air Conditioner - 21 IEER (20+ Tons)	Biz-Prescriptive	Food Sales	ROB	1,497	1,497	46%	684	0.00	15	$37	100%	81%	81%	2	19%	20%	92.7%	91.4%	91.4%	40.4
357	Cooling	Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up)	Biz-Custom	Food Sales	Retro	1,422	1,422	7%	100	0.00	3	$5	100%	50%	50%	3	38%	50%	92.7%	71.5%	71.5%	15.8
358	Cooling	Air Side Economizer	Biz-Custom	Food Sales	Retro	1,399	1,399	20%	280	0.00	10	$84	100%	33%	33%	4	38%	20%	92.7%	58.7%	58.7%	3.9
359	Cooling	Advanced Rooftop Controls	Biz-Prescriptive	Food Sales	Retro	1,422	1,422	5%	68	0.00	10	$100	100%	100%	100%	5	38%	20%	92.7%	92.7%	92.7%	0.3
360	Cooling	HVAC Occupancy Controls	Biz-Custom	Food Sales	ROB	2,900	2,900	20%	580	0.00	15	$537	100%	11%	11%	6	38%	20%	92.7%	36.0%	36.0%	12.0

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
361	Cooling	Air Conditioner - 16 SEER (<5 Tons)	Biz-Prescriptive	Food Sales	ROB	1,219	1,219	13%	152	0.00	15	$47	100%	64%	80%	7	23%	20%	92.7%	80.4%	85.0%	9.0
362	Cooling	Air Conditioner - 17 SEER (<5 Tons)	Biz-Prescriptive	Food Sales	ROB	1,219	1,219	18%	215	0.00	15	$206	100%	15%	36%	7	23%	20%	92.7%	40.8%	47.7%	12.7
363	Cooling	Air Conditioner - 18 SEER(<5 Tons)	Biz-Prescriptive	Food Sales	ROB	1,219	1,219	22%	271	0.00	15	$206	100%	15%	36%	7	23%	20%	92.7%	46.3%	52.1%	16.0
364	Cooling	Air Conditioner - 21 SEER(<5 Tons)	Biz-Prescriptive	Food Sales	ROB	1,219	1,219	33%	406	0.00	15	$253	100%	12%	30%	7	23%	20%	92.7%	49.9%	53.8%	24.0
365	Cooling	Smart Thermostat	Biz-Prescriptive	Food Sales	ROB	1,219	1,219	14%	173	0.00	11	$175	75%	57%	57%	8	23%	12%	68.9%	53.9%	53.9%	1.5
366	Cooling	PTAC - <7,000 Btuh - lodging	Biz-Prescriptive	Food Sales	ROB	1,434	1,434	8%	121	0.00	8	$84	100%	36%	55%	9	38%	20%	92.7%	53.5%	63.4%	3.9
367	Cooling	PTAC - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Food Sales	ROB	1,573	1,573	7%	114	0.00	8	$84	100%	36%	55%	10	38%	20%	92.7%	52.5%	61.5%	3.7
368	Cooling	PTAC - >15,000 Btuh - lodging	Biz-Prescriptive	Food Sales	ROB	1,796	1,796	10%	171	0.00	8	$84	100%	36%	55%	11	38%	20%	92.7%	63.0%	71.7%	5.5
369	Cooling	Air Cooled Chiller	Biz-Prescriptive	Food Sales	ROB	1,246	1,246	6%	70	0.00	23	$126	100%	24%	55%	12	0%	15%	92.7%	32.0%	40.9%	7.0
370	Cooling	Chiller Tune-up	Biz-Prescriptive	Food Sales	Retro	1,422	1,422	7%	100	0.00	3	$8	100%	100%	100%	13	0%	50%	92.7%	92.7%	92.7%	5.3
371	Cooling	HVAC/Chiller Custom	Biz-Custom	Food Sales	Retro	5	5	20%	1	0.00	20	$1	100%	7%	7%	14	100%	20%	92.7%	36.0%	36.0%	30.3
372	Cooling	Window Film	Biz-Prescriptive	Food Sales	Retro	6,000	6,000	4%	264	0.00	10	$154	100%	65%	65%	15	100%	20%	92.7%	73.1%	73.1%	3.2
373	Cooling	Triple Pane Windows	Biz-Custom	Food Sales	ROB	6,000	6,000	6%	360	0.00	25	$700	100%	5%	5%	15	100%	20%	92.7%	36.0%	36.0%	24.5
374	Cooling	Energy Recovery Ventilator	Biz-Custom	Food Sales	Retro	1,497	1,497	6%	96	0.00	15	$1,500	1%	1%	1%	16	100%	2%	31.4%	21.8%	21.8%	13.3
375	Heating	Heat Pump - 16 SEER (<5 Tons)	Biz-Prescriptive	Food Sales	ROB	1,581	1,581	5%	81	0.00	16	$87	100%	46%	46%	1	31%	20%	92.7%	48.7%	48.7%	2.9
376	Heating	Heat Pump - 17 SEER (<5 Tons)	Biz-Prescriptive	Food Sales	ROB	1,581	1,581	10%	162	0.00	16	$442	50%	9%	23%	1	31%	20%	44.0%	36.0%	36.0%	5.6
377	Heating	Heat Pump - 18 SEER(<5 Tons)	Biz-Prescriptive	Food Sales	ROB	1,581	1,581	15%	231	0.00	16	$507	50%	8%	20%	1	31%	20%	44.0%	36.0%	36.0%	7.9
378	Heating	Heat Pump - 21 SEER(<5 Tons)	Biz-Prescriptive	Food Sales	ROB	1,581	1,581	24%	378	0.00	16	$507	100%	8%	20%	1	31%	20%	92.7%	36.0%	36.2%	12.8
379	Heating	Geothermal HP - SEER 20.3 (<5 Tons)	Biz-Prescriptive	Food Sales	ROB	1,581	1,581	24%	386	0.00	25	$2,576	25%	2%	2%	1	31%	20%	44.0%	36.0%	36.0%	17.3
380	Heating	Geothermal HP - SEER 21.5 (<5 Tons)	Biz-Prescriptive	Food Sales	ROB	1,581	1,581	29%	452	0.00	25	$2,576	25%	2%	4%	1	31%	20%	44.0%	36.0%	36.0%	19.9
381	Heating	Geothermal HP - SEER 23.1 (<5 Tons)	Biz-Prescriptive	Food Sales	ROB	1,581	1,581	34%	531	0.00	25	$2,576	25%	2%	4%	1	31%	20%	44.0%	36.0%	36.0%	22.7
382	Heating	Geothermal HP - SEER 29.3 (<5 Tons)	Biz-Prescriptive	Food Sales	ROB	1,581	1,581	48%	755	0.00	25	$2,576	25%	2%	4%	1	31%	20%	44.0%	36.0%	36.0%	28.9
383	Heating	Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Food Sales	ROB	1,941	1,941	13%	246	0.00	16	$100	100%	40%	55%	2	26%	20%	92.7%	69.9%	74.7%	32.0
384	Heating	Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Food Sales	ROB	1,941	1,941	18%	353	0.00	16	$136	100%	30%	55%	2	26%	20%	92.7%	67.3%	75.5%	35.6
385	Heating	Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Food Sales	ROB	2,032	2,032	18%	366	0.00	16	$100	100%	40%	55%	2	26%	20%	92.7%	76.2%	79.4%	36.8
386	Heating	Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Food Sales	ROB	2,032	2,032	23%	468	0.00	16	$139	100%	29%	55%	2	26%	20%	92.7%	72.6%	78.6%	40.2
387	Heating	Geothermal HP - SEER 20.3 (5-20 Tons)	Biz-Prescriptive	Food Sales	ROB	1,758	1,758	32%	563	0.00	25	$2,576	50%	2%	4%	2	26%	20%	44.0%	36.0%	36.0%	36.3
388	Heating	Geothermal HP - SEER 21.5 (5-20 Tons)	Biz-Prescriptive	Food Sales	ROB	1,758	1,758	36%	630	0.00	25	$2,576	50%	2%	4%	2	26%	20%	44.0%	36.0%	36.0%	38.9
389	Heating	Geothermal HP - SEER 23.1 (5-20 Tons)	Biz-Prescriptive	Food Sales	ROB	1,938	1,938	46%	887	0.00	25	$2,576	50%	2%	4%	2	26%	20%	44.0%	36.0%	36.0%	45.6
390	Heating	Geothermal HP - SEER 29.3 (5-20 Tons)	Biz-Prescriptive	Food Sales	ROB	1,938	1,938	57%	1,112	0.00	25	$2,576	75%	2%	4%	2	26%	20%	48.8%	36.0%	36.0%	51.8
391	Heating	Variable Refrigerant Flow Heat Pump	Biz-Custom	Food Sales	ROB	1,528	1,528	21%	325	0.00	16	$224	100%	15%	15%	2	26%	2%	92.7%	38.8%	38.8%	14.8
392	Heating	Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr)	Biz-Prescriptive	Food Sales	ROB	2,176	2,176	11%	250	0.00	16	$100	100%	40%	55%	3	26%	20%	92.7%	70.2%	75.0%	28.8
393	Heating	Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr)	Biz-Prescriptive	Food Sales	ROB	2,176	2,176	18%	388	0.00	16	$175	100%	23%	55%	3	26%	20%	92.7%	59.9%	73.1%	33.7
394	Heating	Geothermal HP - SEER 20.3 (20+ Tons)	Biz-Prescriptive	Food Sales	ROB	2,032	2,032	41%	837	0.00	25	$2,576	100%	2%	4%	3	26%	20%	92.7%	36.0%	36.0%	70.5
395	Heating	Geothermal HP - SEER 21.5 (20+ Tons)	Biz-Prescriptive	Food Sales	ROB	2,032	2,032	44%	904	0.00	25	$2,576	100%	2%	4%	3	26%	20%	92.7%	36.0%	36.0%	73.1
396	Heating	Geothermal HP - SEER 23.1 (20+ Tons)	Biz-Prescriptive	Food Sales	ROB	2,032	2,032	48%	982	0.00	25	$2,576	100%	2%	4%	3	26%	20%	92.7%	36.0%	36.0%	76.0
397	Heating	Geothermal HP - SEER 29.3 (20+ Tons)	Biz-Prescriptive	Food Sales	ROB	2,032	2,032	59%	1,207	0.00	25	$2,576	100%	2%	4%	3	26%	20%	92.7%	36.0%	36.0%	82.2
398	Heating	Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD)	Biz-Prescriptive	Food Sales	ROB	1,581	1,581	24%	378	0.00	16	$224	100%	18%	45%	4	8%	20%	92.7%	52.1%	61.8%	12.8
399	Heating	PTHP - <7,000 Btuh - lodging	Biz-Custom	Food Sales	ROB	1,701	1,701	7%	117	0.00	8	$130	100%	100%	100%	5	3%	10%	92.7%	74.2%	74.2%	0.8
400	Heating	PTHP - >15,000 Btuh - lodging	Biz-Prescriptive	Food Sales	ROB	2,190	2,190	25%	557	0.00	8	$130	100%	100%	100%	6	3%	10%	92.7%	92.7%	92.7%	3.9
401	Heating	PTHP - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Food Sales	ROB	1,905	1,905	15%	289	0.00	8	$130	100%	100%	100%	7	3%	10%	92.7%	92.7%	92.7%	2.0
402	HotWater	Heat Pump Water Heater	Biz-Prescriptive	Food Sales	ROB	4,687	4,687	67%	3,139	0.00	15	$1,115	100%	45%	55%	1	100%	0%	84.0%	71.2%	74.1%	5.2
403	HotWater	Hot Water Pipe Insulation	Biz-Custom	Food Sales	Retro	4,687	4,687	2%	94	0.00	20	$60	100%	16%	16%	2	100%	80%	86.0%	84.0%	84.0%	9.8
404	HotWater	Faucet Aerator	Biz-Custom	Food Sales	Retro	284	284	32%	92	0.00	10	$8	100%	50%	50%	3	20%	90%	93.0%	92.0%	92.0%	13.5
405	HotWater	Low Flow Pre-Rinse Sprayers	Biz-Prescriptive	Food Sales	ROB	18,059	18,059	54%	9,789	0.00	5	$60	100%	17%	42%	4	20%	80%	86.0%	84.0%	84.0%	199.3
406	HotWater	ENERGY STAR Commercial Washing Machines	Biz-Prescriptive	Food Sales	ROB	1,552	1,552	43%	671	0.00	7	$250	75%	28%	28%	5	25%	33%	79.3%	64.6%	64.6%	2.9
407	InteriorLighting	LED T8 Tube Replacement	Biz-Prescriptive Light	Food Sales	Retro	197	197	45%	88	0.00	9	$5	100%	100%	100%	1	84%	40%	94.6%	94.6%	94.6%	10.2
408	InteriorLighting	LED troffer retrofit kit, 2'X2' and 2'X4'	Biz-Prescriptive Light	Food Sales	Retro	445	445	50%	223	0.00	9	$70	100%	36%	55%	1	84%	40%	94.6%	74.8%	81.4%	5.2
409	InteriorLighting	LED troffer, 2'X2' and 2'X4'	Biz-Prescriptive Light	Food Sales	Retro	445	445	50%	223	0.00	9	$70	100%	36%	55%	1	84%	40%	94.6%	74.8%	81.4%	5.2
410	InteriorLighting	Bi-Level Lighting Fixture – Stairwells, Hallways	Biz-Custom Light	Food Sales	Retro	445	445	74%	331	0.00	10	$274	50%	12%	16%	2	1%	40%	58.0%	52.0%	52.0%	4.3
411	InteriorLighting	LED high bay fixture	Biz-Prescriptive Light	Food Sales	Retro	4,147	4,147	68%	2,821	0.00	9	$330	100%	35%	55%	3	5%	34%	94.6%	88.3%	90.2%	14.2
412	InteriorLighting	LED Mogul-base HID Lamp Replacing High Bay HID	Biz-Prescriptive Light	Food Sales	Retro	4,147	4,147	66%	2,751	0.00	9	$330	100%	35%	55%	3	5%	34%	94.6%	88.1%	90.1%	13.8
413	InteriorLighting	LED low bay fixture	Biz-Prescriptive Light	Food Sales	Retro	883	883	61%	537	0.00	9	$44	100%	68%	80%	4	7%	34%	94.6%	92.4%	93.2%	10.3
414	InteriorLighting	LED Mogul-base HID Lamp Replacing Low Bay HID	Biz-Prescriptive Light	Food Sales	Retro	883	883	59%	519	0.00	9	$44	100%	68%	80%	4	7%	34%	94.6%	92.3%	93.2%	10.0
415	InteriorLighting	LED Screw-In Lamps (Directional)	Biz-Prescriptive Light	Food Sales	ROB	308	308	86%	264	0.00	4	$1	100%	100%	100%	6	0%	43%	94.6%	94.6%	94.6%	86.4
416	InteriorLighting	LED downlight fixture	Biz-Prescriptive Light	Food Sales	Retro	306	306	68%	206	0.00	9	$27	100%	19%	46%	6	3%	45%	94.6%	85.1%	88.8%	23.9
417	InteriorLighting	LED Screw-In Lamps (Omnidirectional & Decorative)	Biz-Prescriptive Light	Food Sales	ROB	233	233	81%	188	0.00	4	$1	100%	100%	100%	5	0%	20%	94.6%	94.6%	94.6%	61.6
418	InteriorLighting	DeLamp Fluorescent Fixture Average Lamp Wattage 28W	Biz-Prescriptive Light	Food Sales	Retro	164	164	100%	164	0.00	11	$4	100%	100%	100%	7	84%	0%	94.6%	94.6%	94.6%	28.0
419	InteriorLighting	Occupancy Sensors	Biz-Prescriptive Light	Food Sales	Retro	749	749	30%	225	0.00	10	$65	100%	31%	55%	8	95%	10%	94.6%	74.8%	82.4%	4.9
420	InteriorLighting	Daylighting Controls	Biz-Prescriptive Light	Food Sales	Retro	959	959	30%	288	0.00	10	$58	100%	35%	55%	8	95%	10%	94.6%	82.5%	86.9%	9.4
421	InteriorLighting	Dual Occupancy & Daylighting Controls	Biz-Custom Light	Food Sales	Retro	428	428	44%	188	0.00	10	$75	100%	40%	50%	8	95%	10%	94.6%	56.6%	60.1%	3.9
422	InteriorLighting	Central Lighting Monitoring & Controls (non-networked)	Biz-Custom Light	Food Sales	Retro	41,703	41,703	20%	8,341	0.00	12	$3,700	100%	23%	29%	8	95%	10%	94.6%	44.1%	47.7%	4.6
423	InteriorLighting	Network Lighting Controls - Wireless (WiFi)	Biz-Custom Light	Food Sales	Retro	4	4	49%	2	0.00	15	$1	100%	29%	38%	8	95%	10%	94.6%	56.0%	58.8%	8.9
424	InteriorLighting	Luminaire Level Lighting Controls w/ HVAC Control	Biz-Custom Light	Food Sales	Retro	428	428	65%	278	0.00	15	$90	100%	31%	40%	8	97%	10%	94.6%	58.0%	60.6%	8.9
425	InteriorLighting	LED Exit Sign - 4 Watt Fixture (2 lamp)	Biz-Prescriptive Light	Food Sales	Retro	64	64	43%	28	0.00	5	$33	92%	92%	92%	9	1%	75%	86.8%	86.8%	86.8%	0.3
426	InteriorLighting	Lighting - Custom	Biz-Custom Light	Food Sales	Retro	4	4	25%	1	0.00	15	$0	100%	21%	28%	10	100%	0%	94.6%	41.2%	44.8%	8.9
427	ExteriorLighting	LED wallpack (existing W<250)	Biz-Prescriptive Light	Food Sales	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	1	12%	46%	94.6%	56.6%	70.8%	5.8
428	ExteriorLighting	LED parking lot fixture (existing W≥250)	Biz-Prescriptive Light	Food Sales	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	2	11%	54%	67.8%	63.2%	63.2%	4.4
429	ExteriorLighting	LED parking lot fixture (existing W<250)	Biz-Prescriptive Light	Food Sales	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	3	11%	54%	94.6%	63.2%	70.8%	5.8
430	ExteriorLighting	LED outdoor pole decorative fixture (existing W≥250)	Biz-Prescriptive Light	Food Sales	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	17%	17%	4	11%	54%	67.8%	63.2%	63.2%	3.4
431	ExteriorLighting	LED parking garage fixture (existing W≥250)	Biz-Prescriptive Light	Food Sales	Retro	3,235	3,235	60%	1,953	0.00	6	$756	50%	13%	33%	5	11%	69%	78.3%	75.2%	75.2%	4.7
432	ExteriorLighting	LED parking garage fixture (existing W<250)	Biz-Prescriptive Light	Food Sales	Retro	1,742	1,742	66%	1,154	0.00	6	$248	100%	18%	45%	6	11%	69%	94.6%	77.6%	83.9%	6.2

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
433	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250)	Biz-Prescriptive Light	Food Sales	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	7	11%	46%	62.1%	56.6%	56.6%	4.4
434	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250)	Biz-Prescriptive Light	Food Sales	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	8	11%	46%	94.6%	56.6%	70.8%	5.8
435	ExteriorLighting	Bi-Level Lighting Fixture – Garages	Biz-Custom Light	Food Sales	Retro	445	445	69%	307	0.00	10	$274	25%	11%	15%	9	11%	20%	44.0%	36.0%	36.0%	3.9
436	ExteriorLighting	LED fuel pump canopy fixture (existing W<250)	Biz-Prescriptive Light	Food Sales	Retro	0	0	0%	0	0.00	12	$0	0%	0%		10	0%	54%	94.6%	94.6%	94.6%	0.0
437	ExteriorLighting	LED fuel pump canopy fixture (existing W≥250)	Biz-Prescriptive Light	Food Sales	Retro	0	0	0%	0	0.00	12	$0	0%	0%		11	0%	54%	94.6%	94.6%	94.6%	0.0
438	Miscellaneous	Vending Machine Controller - Non-Refrigerated	Biz-Prescriptive	Food Sales	Retro	385	385	61%	237	0.00	5	$233	11%	11%	11%	1	5%	30%	51.0%	44.0%	44.0%	1.9
439	Miscellaneous	Miscellaneous Custom	Biz-Custom	Food Sales	Retro	7	7	2%	0	0.00	10	$0	75%	25%	25%	2	37%	10%	37.0%	23.4%	23.4%	3.3
440	Miscellaneous	Kitchen Exhaust Hood Demand Ventilation Control System	Biz-Prescriptive	Food Sales	ROB	9,932	9,932	50%	4,966	0.00	20	$1,180	100%	11%	27%	3	13%	10%	94.6%	73.8%	78.0%	39.7
441	Miscellaneous	High Efficiency Hand Dryers	Biz-Custom	Food Sales	Retro	3,819	3,819	83%	3,170	0.00	10	$483	100%	50%	50%	4	5%	10%	94.6%	70.6%	70.6%	8.4
442	Miscellaneous	Ozone Commercial Laundry	Biz-Custom	Food Sales	Retro	2,984	2,984	25%	746	0.00	10	$20,310	0%	0%	0%	5	0%	2%	31.4%	16.6%	16.6%	3.9
443	Miscellaneous	ENERGY STAR Uninterrupted Power Supply	Biz-Custom	Food Sales	ROB	3,096	3,096	3%	85	0.00	15	$59	100%	14%	14%	6	0%	70%	94.6%	76.0%	76.0%	8.8
444	Motors	Cogged V-Belt	Biz-Custom	Food Sales	Retro	19,471	19,471	3%	604	0.00	15	$384	100%	16%	16%	1	50%	10%	83.4%	34.4%	34.4%	8.8
445	Motors	Pump and Fan Variable Frequency Drive Controls (Pumps)	Biz-Custom	Food Sales	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	30%	2	100%	10%	83.4%	52.4%	52.4%	11.6
446	Motors	Power Drive Systems	Biz-Custom	Food Sales	Retro	4	4	23%	1	0.00	15	$0	100%	37%	37%	2	100%	10%	83.4%	53.4%	53.4%	8.8
447	Motors	Switch Reluctance Motors	Biz-Custom	Food Sales	Retro	37,735	37,735	31%	11,547	0.00	15	$528	100%	50%	50%	2	100%	1%	83.4%	64.4%	64.4%	29.8
448	Motors	Escalators Motor Efficiency Controllers	Biz-Custom	Food Sales	Retro	7,500	7,500	20%	1,500	0.00	10	$5,000	3%	3%	3%	3	0%	10%	37.0%	26.3%	26.3%	7.3
449	Office_NonPC	Energy Star Printer/Copier/Fax	Biz-Custom	Food Sales	ROB	551	551	40%	223	0.00	6	$0	0%			1	30%	90%	94.6%	92.0%	92.0%	0.0
450	Office_NonPC	Smart Power Strip – Commercial Use	Biz-Custom	Food Sales	Retro	1,086	1,086	10%	109	0.00	7	$50	50%	22%	22%	2	35%	15%	71.8%	42.0%	42.0%	2.8
451	Office_NonPC	Plug Load Occupancy Sensor	Biz-Custom	Food Sales	Retro	1,126	1,126	15%	169	0.00	8	$70	75%	24%	24%	2	35%	15%	85.4%	47.6%	47.6%	3.2
452	Office_PC	Electrically Commutated Plug Fans in data centers	Biz-Custom	Food Sales	Retro	86,783	86,783	18%	15,778	0.00	15	$480	100%	50%	50%	1	65%	20%	94.6%	74.6%	74.6%	50.8
453	Office_PC	Energy Star Server	Biz-Custom	Food Sales	ROB	1,621	1,621	23%	368	0.00	8	$118	100%	31%	31%	1	65%	25%	94.6%	58.2%	58.2%	4.5
454	Office_PC	Server Virtualization	Biz-Custom	Food Sales	Retro	2	2	45%	1	0.00	8	$0	75%	25%	25%	1	65%	25%	85.8%	49.3%	49.3%	3.2
455	Office_PC	High Efficiency CRAC unit	Biz-Custom	Food Sales	ROB	541	541	30%	162	0.00	15	$63	100%	26%	26%	2	65%	20%	94.6%	51.1%	51.1%	8.1
456	Office_PC	Computer Room Air Conditioner Economizer	Biz-Custom	Food Sales	Retro	764	764	47%	358	0.00	15	$82	100%	44%	44%	2	65%	20%	94.6%	66.1%	66.1%	5.6
457	Office_PC	Data Center Hot/Cold Aisle Configuration	Biz-Custom	Food Sales	Retro	4	4	25%	1	0.00	15	$0	100%	25%	25%	3	3%	10%	94.6%	49.3%	49.3%	7.7
458	Office_PC	Energy Star Laptop	Biz-Custom	Food Sales	ROB	126	126	33%	41	0.00	4	$0	0%			4	11%	85%	94.6%	88.0%	88.0%	0.0
459	Office_PC	Energy Star Monitor	Biz-Custom	Food Sales	ROB	72	72	21%	15	0.00	4	$0	0%			5	25%	85%	94.6%	88.0%	88.0%	0.0
460	Refrigeration	Strip Curtains	Biz-Custom	Food Sales	Retro	412	412	50%	206	0.00	4	$10	100%	50%	50%	1	16%	30%	88.0%	69.3%	69.3%	9.4
461	Refrigeration	Bare Suction Line	Biz-Custom	Food Sales	Retro	23	23	93%	21	0.00	15	$4	100%	50%	50%	2	1%	50%	88.0%	66.5%	66.5%	8.1
462	Refrigeration	Floating Head Pressure Controls	Biz-Custom	Food Sales	Retro	1,112	1,112	25%	278	0.00	15	$431	25%	6%	6%	3	11%	25%	47.5%	40.0%	40.0%	5.6
463	Refrigeration	Saturated Suction Controls	Biz-Custom	Food Sales	Retro	831	831	50%	416	0.00	15	$559	100%	7%	7%	4	2%	10%	88.0%	28.0%	28.0%	13.7
464	Refrigeration	Compressor Retrofit	Biz-Custom	Food Sales	Retro	813	813	20%	163	0.00	15	$477	25%	3%	3%	5	37%	25%	47.5%	39.4%	39.4%	13.8
465	Refrigeration	Electronically Commutated (EC) Walk-In Evaporator Fan Motor	Biz-Prescriptive	Food Sales	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	6	10%	80%	88.0%	84.0%	84.0%	30.7
466	Refrigeration	Evaporator Fan Motor Controls	Biz-Custom	Food Sales	Retro	1,912	1,912	25%	478	0.00	13	$162	100%	30%	30%	7	10%	25%	88.0%	61.7%	61.7%	7.0
467	Refrigeration	Variable Speed Condenser Fan	Biz-Custom	Food Sales	Retro	2,960	2,960	50%	1,480	0.00	15	$1,170	50%	13%	13%	8	14%	25%	59.5%	40.0%	40.0%	5.6
468	Refrigeration	Refrigeration Economizer	Biz-Custom	Food Sales	Retro	7	7	2%	0	0.00	10	$0	100%	50%	50%	9	52%	10%	88.0%	41.1%	41.1%	4.2
469	Refrigeration	Anti-Sweat Heater Controls MT	Biz-Prescriptive	Food Sales	Retro	579	579	59%	338	0.00	10	$170	75%	44%	44%	10	8%	75%	82.5%	80.0%	80.0%	2.1
470	Refrigeration	Auto Door Closer, Cooler	Biz-Custom	Food Sales	Retro	471,500	471,500	0%	943	0.00	8	$157	100%	50%	50%	11	6%	50%	88.0%	66.9%	66.9%	5.8
471	Refrigeration	Display Case Door Retrofit, Medium Temp	Biz-Custom	Food Sales	Retro	1,584	1,584	36%	578	0.00	12	$686	50%	8%	8%	11	2%	25%	47.9%	40.0%	40.0%	7.1
472	Refrigeration	Electronically Commutated (EC) Reach-In Evaporator Fan Motor	Biz-Prescriptive	Food Sales	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	12	1%	80%	88.0%	84.0%	84.0%	30.7
473	Refrigeration	Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor	Biz-Custom	Food Sales	Retro	1,911	1,911	26%	504	0.00	10	$96	100%	50%	50%	12	1%	2%	88.0%	66.5%	66.5%	5.8
474	Refrigeration	Energy Star Reach-In Refrigerator, Glass Doors	Biz-Prescriptive	Food Sales	ROB	2,140	2,140	29%	629	0.00	12	$1,239	25%	6%	14%	13	8%	54%	67.8%	63.2%	63.2%	5.6
475	Refrigeration	Energy Star Reach-In Refrigerator, Solid Doors	Biz-Prescriptive	Food Sales	ROB	1,410	1,410	20%	281	0.00	12	$1,211	6%	6%	6%	14	8%	54%	67.8%	63.2%	63.2%	2.5
476	Refrigeration	Anti-Sweat Heater Controls LT	Biz-Prescriptive	Food Sales	Retro	2,016	2,016	68%	1,361	0.00	10	$170	100%	44%	55%	15	3%	75%	88.0%	84.3%	85.0%	8.3
477	Refrigeration	Auto Door Closer, Freezer	Biz-Custom	Food Sales	Retro	419,455	419,455	1%	2,307	0.00	8	$157	100%	50%	50%	16	3%	50%	88.0%	68.9%	68.9%	13.9
478	Refrigeration	Display Case Door Retrofit, Low Temp	Biz-Custom	Food Sales	Retro	2,922	2,922	50%	1,453	0.00	12	$686	100%	21%	21%	16	3%	25%	88.0%	49.7%	49.7%	7.1
479	Refrigeration	Energy Star Reach-In Freezer, Glass Doors	Biz-Prescriptive	Food Sales	ROB	6,374	6,374	20%	1,275	0.00	12	$1,651	25%	21%	21%	17	3%	54%	67.8%	63.2%	63.2%	2.3
480	Refrigeration	Energy Star Reach-In Freezer, Solid Doors	Biz-Prescriptive	Food Sales	ROB	4,522	4,522	7%	305	0.00	12	$1,521	23%	23%	23%	18	3%	54%	67.8%	63.2%	63.2%	0.5
481	Refrigeration	Refrigeration - Custom	Biz-Custom	Food Sales	ROB	7	7	2%	0	0.00	10	$0	75%	25%	25%	19	90%	25%	47.5%	39.4%	39.4%	3.3
482	Refrigeration	Retro-commissioning_Refrigerator Optimization	Biz-Custom RCx	Food Sales	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	20	90%	25%	88.0%	65.9%	65.9%	3.2
483	Refrigeration	Energy Star Ice Machine	Biz-Prescriptive	Food Sales	ROB	6,993	6,993	10%	721	0.00	15	$1,426	25%	18%	18%	21	0%	44%	60.8%	55.2%	55.2%	2.1
484	Refrigeration	Vending Machine Controller - Refrigerated	Biz-Prescriptive	Food Sales	Retro	1,586	1,586	34%	537	0.00	5	$245	25%	16%	16%	22	0%	30%	65.5%	61.1%	61.1%	2.7
485	Refrigeration	LED Refrigerated Display Case Lighting Average 6W/LF	Biz-Prescriptive	Food Sales	Retro	273	273	89%	243	0.00	9	$11	100%	45%	55%	23	5%	35%	88.0%	86.7%	86.9%	30.9
486	Refrigeration	LED Refrigerated Display Case Lighting Controls	Biz-Prescriptive	Food Sales	Retro	522	522	27%	141	0.00	10	$15	100%	100%	100%	24	5%	18%	88.0%	88.0%	88.0%	6.6
487	Ventilation	Demand Controlled Ventilation	Biz-Custom	Food Sales	Retro	2,658	2,658	20%	532	0.00	15	$227	100%	23%	23%	1	100%	14%	92.7%	49.6%	49.6%	12.3
488	Ventilation	Pump and Fan Variable Frequency Drive Controls (Fans)	Biz-Prescriptive	Food Sales	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	55%	2	100%	14%	92.7%	74.0%	79.4%	11.6
489	WholeBldg_HVAC	HVAC - Energy Management System	Biz-Custom RCx	Food Sales	Retro	13	13	8%	1	0.00	15	$0	100%	25%	25%	1	100%	20%	92.7%	51.6%	51.6%	8.8
490	WholeBldg_HVAC	Guest room energy management system	Biz-Custom	Food Sales	Retro	0	0	0%	0	0.00	15	$260	0%		0%	2	100%	20%	92.7%	74.2%	74.2%	0.0
491	WholeBldg_HVAC	Retro-commissioning_Bld Optimization	Biz-Custom RCx	Food Sales	Retro	10	10	10%	1	0.00	15	$0	100%	25%	25%	3	100%	0%	92.7%	51.6%	51.6%	8.8
492	WholeBuilding	WholeBlg - Com RET	Biz-Custom	Food Sales	Retro	7	7	15%	1	0.00	12	$0	100%	25%	25%	1	90%	0%	92.7%	51.6%	51.6%	7.3
493	WholeBuilding	WholeBlg - Custom (Other)	Biz-Custom	Food Sales	Retro	5	5	20%	1	0.00	12	$0	100%	25%	25%	2	90%	0%	92.7%	51.6%	51.6%	7.3
494	WholeBuilding	Power Distribution Equipment Upgrades (Transformers)	Biz-Custom	Food Sales	Retro	1,150	1,150	1%	6	0.00	30	$8	100%	9%	9%	3	100%	20%	92.7%	36.0%	36.0%	17.1
495	WholeBldg_NC	WholeBlg - Com NC	Biz-Custom	Food Sales	NC	4	4	25%	1	0.00	12	$0	100%	50%	50%	1	100%	60%	83.4%	68.0%	68.0%	7.6
496	Behavioral	COM Competitions	Biz-Custom	Food Sales	Retro	0	0	0%	0	0.00	2	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
497	Behavioral	Business Energy Reports	Biz-Custom	Food Sales	Retro	0	0	0%	0	0.00	2	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
498	Behavioral	Building Benchmarking	Biz-Custom	Food Sales	Retro	0	0	0%	0	0.00	2	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
499	Behavioral	Strategic Energy Management	Biz-Custom SEM	Food Sales	Retro	0	0	0%	0	0.00	5	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
500	Behavioral	BEIMS	Biz-Custom	Food Sales	Retro	20	20	5%	1	0.00	2	$0	23%	23%	23%	1	100%	2%	50.0%	50.0%	50.0%	0.8
501	Behavioral	Building Operator Certification	Biz-Custom	Food Sales	Retro	10	10	2%	0	0.00	3	$0	14%	14%	14%	1	100%	2%	50.0%	50.0%	50.0%	1.7
502	CompressedAir	Efficient Air Compressors (VSD)	Biz-Prescriptive	Food Service	ROB	1,583	1,583	21%	329	0.00	13	$127	100%	59%	80%	1	100%	33%	92.7%	76.7%	83.1%	5.5
503	CompressedAir	Efficient Air Nozzles	Biz-Prescriptive	Food Service	Retro	1,480	1,480	50%	740	0.00	15	$50	100%	81%	81%	2	35%	33%	92.7%	91.1%	91.1%	15.8
504	CompressedAir	AODD Pump Controls	Biz-Custom	Food Service	Retro	103,919	103,919	35%	36,372	0.00	10	$1,150	100%	50%	50%	3	10%	33%	92.7%	72.6%	72.6%	38.2

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
505	CompressedAir	Compressed Air - Custom	Biz-Custom	Food Service	Retro	5	5	20%	1	0.00	10	$0	100%	47%	47%	4	50%	33%	92.7%	64.2%	64.2%	6.0
506	CompressedAir	Retro-commissioning_Compressed Air Optimization	Biz-Custom RCx	Food Service	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	5	50%	33%	92.7%	64.2%	64.2%	3.2
507	Cooking	Commercial Combination Oven (Electric)	Biz-Prescriptive	Food Service	ROB	38,561	38,561	48%	18,432	0.00	12	$16,884	75%	6%	15%	1	18%	53%	77.5%	62.4%	62.4%	14.1
508	Cooking	Commercial Electric Convection Oven	Biz-Prescriptive	Food Service	ROB	12,193	12,193	15%	1,879	0.00	12	$1,706	75%	21%	51%	1	18%	53%	77.6%	62.4%	62.4%	4.4
509	Cooking	Commercial Electric Griddle	Biz-Prescriptive	Food Service	ROB	17,056	17,056	15%	2,596	0.00	12	$3,604	25%	15%	15%	2	14%	17%	41.9%	33.6%	33.6%	2.8
510	Cooking	Commercial Electric Steam Cooker	Biz-Prescriptive	Food Service	ROB	19,549	19,549	67%	13,162	0.00	12	$2,490	100%	24%	55%	3	6%	45%	88.0%	81.1%	83.5%	18.0
511	Cooking	Dishwasher Low Temp Door (Energy Star)	Biz-Prescriptive	Food Service	ROB	39,306	39,306	44%	17,369	0.00	15	$1,000	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	11.7
512	Cooking	Dishwasher High Temp Door (Energy Star)	Biz-Prescriptive	Food Service	ROB	26,901	26,901	32%	8,586	0.00	15	$1,100	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	5.2
513	Cooking	Energy efficient electric fryer	Biz-Prescriptive	Food Service	ROB	18,955	18,955	17%	3,274	0.00	12	$1,500	100%	5%	13%	5	27%	24%	88.0%	57.2%	59.4%	23.2
514	Cooking	Insulated Holding Cabinets (Full Size)	Biz-Prescriptive	Food Service	ROB	13,697	13,697	68%	9,314	0.00	12	$1,200	100%	35%	55%	6	3%	16%	88.0%	83.6%	84.9%	12.7
515	Cooking	Insulated Holding Cabinets (Half-Size)	Biz-Prescriptive	Food Service	ROB	4,383	4,383	60%	2,630	0.00	12	$1,500	100%	10%	25%	6	3%	16%	88.0%	52.6%	57.6%	10.1
516	Cooling	Air Conditioner - 13 IEER (5-20 Tons)	Biz-Prescriptive	Food Service	ROB	1,000	1,000	6%	62	0.00	15	$63	100%	48%	55%	1	18%	20%	92.7%	50.3%	53.0%	4.6
517	Cooling	Air Conditioner - 14 IEER (5-20 Tons)	Biz-Prescriptive	Food Service	ROB	1,000	1,000	13%	129	0.00	15	$127	100%	24%	55%	1	18%	20%	92.7%	42.6%	53.5%	9.7
518	Cooling	Air Conditioner - 17 IEER (5-20 Tons)	Biz-Prescriptive	Food Service	ROB	1,000	1,000	28%	282	0.00	15	$127	100%	24%	55%	1	18%	20%	92.7%	60.3%	73.2%	21.2
519	Cooling	Air Conditioner - 21 IEER (5-20 Tons)	Biz-Prescriptive	Food Service	ROB	1,000	1,000	42%	419	0.00	15	$127	100%	24%	55%	1	18%	20%	92.7%	70.9%	78.3%	31.5
520	Cooling	Air Conditioner - 12.1 IEER (20+ Tons)	Biz-Prescriptive	Food Service	ROB	1,070	1,070	6%	62	0.00	15	$30	100%	100%	100%	2	18%	20%	92.7%	92.7%	92.7%	4.7
521	Cooling	Air Conditioner - 13 IEER (20+ Tons)	Biz-Prescriptive	Food Service	ROB	1,070	1,070	12%	132	0.00	15	$37	100%	81%	81%	2	18%	20%	92.7%	86.1%	86.1%	9.9
522	Cooling	Air Conditioner - 14.3 IEER (20+ Tons)	Biz-Prescriptive	Food Service	ROB	1,070	1,070	20%	217	0.00	15	$37	100%	81%	81%	2	18%	20%	92.7%	88.7%	88.7%	16.3
523	Cooling	Air Conditioner - 21 IEER (20+ Tons)	Biz-Prescriptive	Food Service	ROB	1,070	1,070	46%	489	0.00	15	$37	100%	81%	81%	2	18%	20%	92.7%	90.9%	90.9%	36.8
524	Cooling	Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up)	Biz-Custom	Food Service	Retro	1,017	1,017	7%	71	0.00	3	$5	100%	50%	50%	3	36%	50%	92.7%	70.4%	70.4%	14.5
525	Cooling	Air Side Economizer	Biz-Custom	Food Service	Retro	1,000	1,000	20%	200	0.00	10	$84	75%	24%	24%	4	36%	20%	80.8%	50.0%	50.0%	3.9
526	Cooling	Advanced Rooftop Controls	Biz-Prescriptive	Food Service	Retro	1,017	1,017	3%	26	0.00	10	$100	100%	100%	100%	5	36%	20%	92.7%	92.7%	92.7%	0.1
527	Cooling	HVAC Occupancy Controls	Biz-Custom	Food Service	ROB	2,900	2,900	20%	580	0.00	15	$537	100%	11%	11%	6	36%	20%	92.7%	36.0%	36.0%	12.0
528	Cooling	Air Conditioner - 16 SEER (<5 Tons)	Biz-Prescriptive	Food Service	ROB	871	871	13%	109	0.00	15	$47	100%	64%	80%	7	27%	20%	92.7%	76.9%	82.3%	8.2
529	Cooling	Air Conditioner - 17 SEER (<5 Tons)	Biz-Prescriptive	Food Service	ROB	871	871	18%	154	0.00	15	$206	100%	15%	36%	7	27%	20%	92.7%	36.0%	40.2%	11.6
530	Cooling	Air Conditioner - 18 SEER(<5 Tons)	Biz-Prescriptive	Food Service	ROB	871	871	22%	194	0.00	15	$206	100%	15%	36%	7	27%	20%	92.7%	39.2%	45.3%	14.6
531	Cooling	Air Conditioner - 21 SEER(<5 Tons)	Biz-Prescriptive	Food Service	ROB	871	871	33%	290	0.00	15	$253	100%	12%	30%	7	27%	20%	92.7%	42.1%	47.6%	21.8
532	Cooling	Smart Thermostat	Biz-Prescriptive	Food Service	ROB	871	871	14%	123	0.00	11	$175	57%	57%	57%	8	27%	12%	47.8%	47.8%	47.8%	1.3
533	Cooling	PTAC - <7,000 Btuh - lodging	Biz-Prescriptive	Food Service	ROB	1,025	1,025	8%	87	0.00	8	$84	100%	36%	36%	9	36%	20%	92.7%	47.3%	47.3%	3.6
534	Cooling	PTAC - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Food Service	ROB	1,124	1,124	7%	82	0.00	8	$84	100%	36%	36%	10	36%	20%	92.7%	45.9%	45.9%	3.4
535	Cooling	PTAC - >15,000 Btuh - lodging	Biz-Prescriptive	Food Service	ROB	1,284	1,284	10%	122	0.00	8	$84	100%	36%	55%	11	36%	20%	92.7%	53.6%	63.6%	5.0
536	Cooling	Air Cooled Chiller	Biz-Prescriptive	Food Service	ROB	890	890	6%	50	0.00	23	$126	100%	24%	55%	12	0%	15%	92.7%	32.0%	35.2%	6.5
537	Cooling	Chiller Tune-up	Biz-Prescriptive	Food Service	Retro	1,017	1,017	7%	71	0.00	3	$8	100%	100%	100%	13	0%	50%	92.7%	92.7%	92.7%	4.8
538	Cooling	HVAC/Chiller Custom	Biz-Custom	Food Service	Retro	5	5	20%	1	0.00	20	$1	100%	7%	7%	14	100%	20%	92.7%	36.0%	36.0%	30.3
539	Cooling	Window Film	Biz-Prescriptive	Food Service	Retro	6,000	6,000	4%	264	0.00	10	$154	100%	65%	65%	15	100%	20%	92.7%	73.1%	73.1%	3.2
540	Cooling	Triple Pane Windows	Biz-Custom	Food Service	ROB	6,000	6,000	6%	360	0.00	25	$700	100%	5%	5%	15	100%	20%	92.7%	36.0%	36.0%	24.5
541	Cooling	Energy Recovery Ventilator	Biz-Custom	Food Service	Retro	1,070	1,070	0%	0	0.00	15	$1,500	0%		0%	16	100%	2%	92.7%	74.2%	74.2%	0.0
542	Heating	Heat Pump - 16 SEER (<5 Tons)	Biz-Prescriptive	Food Service	ROB	1,899	1,899	4%	75	0.00	16	$87	100%	46%	46%	1	36%	20%	92.7%	47.1%	47.1%	2.8
543	Heating	Heat Pump - 17 SEER (<5 Tons)	Biz-Prescriptive	Food Service	ROB	1,899	1,899	9%	165	0.00	16	$442	50%	9%	23%	1	36%	20%	44.0%	36.0%	36.0%	5.6
544	Heating	Heat Pump - 18 SEER(<5 Tons)	Biz-Prescriptive	Food Service	ROB	1,899	1,899	12%	236	0.00	16	$507	50%	8%	20%	1	36%	20%	44.0%	36.0%	36.0%	7.9
545	Heating	Heat Pump - 21 SEER(<5 Tons)	Biz-Prescriptive	Food Service	ROB	1,899	1,899	19%	363	0.00	16	$507	75%	8%	20%	1	36%	20%	59.7%	36.0%	36.0%	12.6
546	Heating	Geothermal HP - SEER 20.3 (<5 Tons)	Biz-Prescriptive	Food Service	ROB	1,899	1,899	23%	429	0.00	25	$2,576	25%	2%	4%	1	36%	20%	44.0%	36.0%	36.0%	18.2
547	Heating	Geothermal HP - SEER 21.5 (<5 Tons)	Biz-Prescriptive	Food Service	ROB	1,899	1,899	27%	511	0.00	25	$2,576	25%	2%	4%	1	36%	20%	44.0%	36.0%	36.0%	21.1
548	Heating	Geothermal HP - SEER 23.1 (<5 Tons)	Biz-Prescriptive	Food Service	ROB	1,899	1,899	32%	608	0.00	25	$2,576	25%	2%	4%	1	36%	20%	44.0%	36.0%	36.0%	24.4
549	Heating	Geothermal HP - SEER 29.3 (<5 Tons)	Biz-Prescriptive	Food Service	ROB	1,899	1,899	47%	887	0.00	25	$2,576	25%	2%	4%	1	36%	20%	44.0%	36.0%	36.0%	31.7
550	Heating	Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Food Service	ROB	2,289	2,289	11%	251	0.00	16	$100	100%	40%	55%	2	24%	20%	92.7%	70.3%	75.0%	32.1
551	Heating	Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Food Service	ROB	2,289	2,289	16%	371	0.00	16	$136	100%	30%	55%	2	24%	20%	92.7%	68.5%	76.1%	35.9
552	Heating	Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Food Service	ROB	2,382	2,382	14%	341	0.00	16	$100	100%	40%	55%	2	24%	20%	92.7%	75.3%	78.7%	36.4
553	Heating	Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Food Service	ROB	2,382	2,382	19%	460	0.00	16	$139	100%	29%	55%	2	24%	20%	92.7%	72.3%	78.4%	40.1
554	Heating	Geothermal HP - SEER 20.3 (5-20 Tons)	Biz-Prescriptive	Food Service	ROB	2,086	2,086	30%	617	0.00	25	$2,576	50%	2%	4%	2	24%	20%	44.0%	36.0%	36.0%	37.5
555	Heating	Geothermal HP - SEER 21.5 (5-20 Tons)	Biz-Prescriptive	Food Service	ROB	2,086	2,086	34%	699	0.00	25	$2,576	50%	2%	4%	2	24%	20%	44.0%	36.0%	36.0%	40.4
556	Heating	Geothermal HP - SEER 23.1 (5-20 Tons)	Biz-Prescriptive	Food Service	ROB	2,215	2,215	42%	924	0.00	25	$2,576	50%	2%	4%	2	24%	20%	44.0%	36.0%	36.0%	46.4
557	Heating	Geothermal HP - SEER 29.3 (5-20 Tons)	Biz-Prescriptive	Food Service	ROB	2,215	2,215	54%	1,203	0.00	25	$2,576	75%	2%	4%	2	24%	20%	50.3%	36.0%	36.0%	53.8
558	Heating	Variable Refrigerant Flow Heat Pump	Biz-Custom	Food Service	ROB	1,768	1,768	13%	232	0.00	16	$224	100%	10%	10%	2	24%	2%	92.7%	32.0%	32.0%	18.3
559	Heating	Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr)	Biz-Prescriptive	Food Service	ROB	2,485	2,485	9%	234	0.00	16	$100	100%	40%	55%	3	24%	20%	92.7%	68.6%	73.9%	28.6
560	Heating	Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr)	Biz-Prescriptive	Food Service	ROB	2,485	2,485	15%	380	0.00	16	$175	100%	23%	55%	3	24%	20%	92.7%	59.3%	72.8%	33.6
561	Heating	Geothermal HP - SEER 20.3 (20+ Tons)	Biz-Prescriptive	Food Service	ROB	2,382	2,382	38%	913	0.00	25	$2,576	100%	2%	4%	3	24%	20%	92.7%	36.0%	36.0%	72.2
562	Heating	Geothermal HP - SEER 21.5 (20+ Tons)	Biz-Prescriptive	Food Service	ROB	2,382	2,382	42%	995	0.00	25	$2,576	100%	2%	4%	3	24%	20%	92.7%	36.0%	36.0%	75.1
563	Heating	Geothermal HP - SEER 23.1 (20+ Tons)	Biz-Prescriptive	Food Service	ROB	2,382	2,382	46%	1,091	0.00	25	$2,576	100%	2%	4%	3	24%	20%	92.7%	36.0%	36.0%	78.3
564	Heating	Geothermal HP - SEER 29.3 (20+ Tons)	Biz-Prescriptive	Food Service	ROB	2,382	2,382	58%	1,370	0.00	25	$2,576	100%	2%	4%	3	24%	20%	92.7%	36.0%	36.0%	85.7
565	Heating	Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD)	Biz-Prescriptive	Food Service	ROB	1,899	1,899	19%	363	0.00	16	$224	100%	18%	45%	4	17%	20%	92.7%	51.3%	60.5%	12.6
566	Heating	PTHP - <7,000 Btuh - lodging	Biz-Custom	Food Service	ROB	2,091	2,091	4%	84	0.00	8	$130	100%	100%	100%	5	0%	10%	92.7%	74.2%	74.2%	0.7
567	Heating	PTHP - >15,000 Btuh - lodging	Biz-Prescriptive	Food Service	ROB	2,525	2,525	16%	398	0.00	8	$130	100%	100%	100%	6	0%	10%	92.7%	92.7%	92.7%	3.5
568	Heating	PTHP - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Food Service	ROB	2,291	2,291	9%	207	0.00	8	$130	100%	100%	100%	7	0%	10%	92.7%	92.7%	92.7%	1.8
569	HotWater	Heat Pump Water Heater	Biz-Prescriptive	Food Service	ROB	5,521	5,521	67%	3,698	0.00	15	$1,115	100%	45%	55%	1	100%	4%	84.0%	73.6%	76.0%	6.1
570	HotWater	Hot Water Pipe Insulation	Biz-Custom	Food Service	Retro	5,521	5,521	2%	110	0.00	20	$60	100%	18%	18%	2	100%	80%	86.0%	84.0%	84.0%	9.8
571	HotWater	Faucet Aerator	Biz-Custom	Food Service	Retro	973	973	32%	315	0.00	10	$8	100%	50%	50%	3	20%	90%	93.0%	92.0%	92.0%	44.5
572	HotWater	Low Flow Pre-Rinse Sprayers	Biz-Prescriptive	Food Service	ROB	18,059	18,059	54%	9,789	0.00	5	$60	100%	17%	42%	4	20%	80%	86.0%	84.0%	84.0%	199.3
573	HotWater	ENERGY STAR Commercial Washing Machines	Biz-Prescriptive	Food Service	ROB	1,552	1,552	43%	671	0.00	7	$250	75%	28%	28%	5	25%	33%	79.3%	64.6%	64.6%	2.9
574	InteriorLighting	LED T8 Tube Replacement	Biz-Prescriptive Light	Food Service	Retro	206	206	45%	92	0.00	9	$5	100%	100%	100%	1	57%	40%	94.6%	94.6%	94.6%	10.9
575	InteriorLighting	LED troffer retrofit kit, 2'X2' and 2'X4'	Biz-Prescriptive Light	Food Service	Retro	467	467	50%	234	0.00	9	$70	100%	36%	55%	1	57%	40%	94.6%	75.8%	82.0%	5.5
576	InteriorLighting	LED troffer, 2'X2' and 2'X4'	Biz-Prescriptive Light	Food Service	Retro	467	467	50%	234	0.00	9	$70	100%	36%	55%	1	57%	40%	94.6%	75.8%	82.0%	5.5

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
577	InteriorLighting	Bi-Level Lighting Fixture – Stairwells, Hallways	Biz-Custom Light	Food Service	Retro	467	467	74%	347	0.00	10	$274	50%	13%	16%	2	1%	40%	58.0%	52.0%	52.0%	4.3
578	InteriorLighting	LED high bay fixture	Biz-Prescriptive Light	Food Service	Retro	4,346	4,346	68%	2,957	0.00	9	$330	100%	35%	55%	3	9%	34%	94.6%	88.6%	90.4%	15.1
579	InteriorLighting	LED Mogul-base HID Lamp Replacing High Bay HID	Biz-Prescriptive Light	Food Service	Retro	4,346	4,346	66%	2,883	0.00	9	$330	100%	35%	55%	3	9%	34%	94.6%	88.4%	90.3%	14.8
580	InteriorLighting	LED low bay fixture	Biz-Prescriptive Light	Food Service	Retro	926	926	61%	563	0.00	9	$44	100%	68%	80%	4	25%	34%	94.6%	92.5%	93.3%	11.0
581	InteriorLighting	LED Mogul-base HID Lamp Replacing Low Bay HID	Biz-Prescriptive Light	Food Service	Retro	926	926	59%	543	0.00	9	$44	100%	68%	80%	4	25%	34%	94.6%	92.4%	93.2%	10.7
582	InteriorLighting	LED Screw-In Lamps (Directional)	Biz-Prescriptive Light	Food Service	ROB	415	415	86%	356	0.00	4	$1	100%	100%	100%	6	0%	43%	94.6%	94.6%	94.6%	105.7
583	InteriorLighting	LED downlight fixture	Biz-Prescriptive Light	Food Service	Retro	320	320	68%	216	0.00	9	$27	100%	19%	46%	6	8%	45%	94.6%	85.6%	89.0%	25.5
584	InteriorLighting	LED Screw-In Lamps (Omnidirectional & Decorative)	Biz-Prescriptive Light	Food Service	ROB	314	314	81%	254	0.00	4	$1	100%	100%	100%	5	1%	20%	94.6%	94.6%	94.6%	75.4
585	InteriorLighting	DeLamp Fluorescent Fixture Average Lamp Wattage 28W	Biz-Prescriptive Light	Food Service	Retro	172	172	100%	172	0.00	11	$4	100%	100%	100%	7	57%	0%	94.6%	94.6%	94.6%	29.9
586	InteriorLighting	Occupancy Sensors	Biz-Prescriptive Light	Food Service	Retro	785	785	30%	235	0.00	10	$65	100%	31%	55%	8	95%	10%	94.6%	75.8%	83.1%	5.0
587	InteriorLighting	Daylighting Controls	Biz-Prescriptive Light	Food Service	Retro	1,005	1,005	30%	301	0.00	10	$58	100%	35%	55%	8	95%	10%	94.6%	83.2%	87.3%	9.3
588	InteriorLighting	Dual Occupancy & Daylighting Controls	Biz-Custom Light	Food Service	Retro	448	448	44%	197	0.00	10	$75	100%	40%	50%	8	95%	10%	94.6%	57.6%	60.9%	4.2
589	InteriorLighting	Central Lighting Monitoring & Controls (non-networked)	Biz-Custom Light	Food Service	Retro	41,703	41,703	20%	8,341	0.00	12	$3,700	100%	23%	29%	8	95%	10%	94.6%	44.1%	47.7%	4.6
590	InteriorLighting	Network Lighting Controls - Wireless (WiFi)	Biz-Custom Light	Food Service	Retro	4	4	49%	2	0.00	15	$1	100%	30%	40%	8	95%	10%	94.6%	57.6%	60.2%	9.0
591	InteriorLighting	Luminaire Level Lighting Controls w/ HVAC Control	Biz-Custom Light	Food Service	Retro	448	448	65%	291	0.00	15	$90	100%	32%	42%	8	92%	10%	94.6%	59.2%	61.8%	9.0
592	InteriorLighting	LED Exit Sign - 4 Watt Fixture (2 lamp)	Biz-Prescriptive Light	Food Service	Retro	66	66	43%	28	0.00	5	$33	92%	92%	92%	9	1%	75%	87.1%	87.1%	87.1%	0.3
593	InteriorLighting	Lighting - Custom	Biz-Custom Light	Food Service	Retro	4	4	25%	1	0.00	15	$0	100%	22%	29%	10	100%	0%	94.6%	43.3%	46.9%	9.0
594	ExteriorLighting	LED wallpack (existing W<250)	Biz-Prescriptive Light	Food Service	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	1	12%	46%	94.6%	56.6%	70.8%	5.8
595	ExteriorLighting	LED parking lot fixture (existing W≥250)	Biz-Prescriptive Light	Food Service	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	2	11%	54%	67.8%	63.2%	63.2%	4.4
596	ExteriorLighting	LED parking lot fixture (existing W<250)	Biz-Prescriptive Light	Food Service	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	3	11%	54%	94.6%	63.2%	70.8%	5.8
597	ExteriorLighting	LED outdoor pole decorative fixture (existing W≥250)	Biz-Prescriptive Light	Food Service	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	17%	17%	4	11%	54%	67.8%	63.2%	63.2%	3.4
598	ExteriorLighting	LED parking garage fixture (existing W≥250)	Biz-Prescriptive Light	Food Service	Retro	3,235	3,235	60%	1,953	0.00	6	$756	50%	13%	33%	5	11%	69%	78.3%	75.2%	75.2%	4.7
599	ExteriorLighting	LED parking garage fixture (existing W<250)	Biz-Prescriptive Light	Food Service	Retro	1,742	1,742	66%	1,154	0.00	6	$248	100%	18%	45%	6	11%	69%	94.6%	77.6%	83.9%	6.2
600	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250)	Biz-Prescriptive Light	Food Service	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	7	11%	46%	62.1%	56.6%	56.6%	4.4
601	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250)	Biz-Prescriptive Light	Food Service	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	8	11%	46%	94.6%	56.6%	70.8%	5.8
602	ExteriorLighting	Bi-Level Lighting Fixture – Garages	Biz-Custom Light	Food Service	Retro	467	467	69%	322	0.00	10	$274	25%	12%	15%	9	11%	20%	44.0%	36.0%	36.0%	3.9
603	ExteriorLighting	LED fuel pump canopy fixture (existing W<250)	Biz-Prescriptive Light	Food Service	Retro	0	0	0%	0	0.00	12	$0	0%	0%		10	0%	54%	94.6%	94.6%	94.6%	0.0
604	ExteriorLighting	LED fuel pump canopy fixture (existing W≥250)	Biz-Prescriptive Light	Food Service	Retro	0	0	0%	0	0.00	12	$0	0%	0%		11	0%	54%	94.6%	94.6%	94.6%	0.0
605	Miscellaneous	Vending Machine Controller - Non-Refrigerated	Biz-Prescriptive	Food Service	Retro	385	385	61%	237	0.00	5	$233	11%	11%	11%	1	5%	30%	51.0%	44.0%	44.0%	1.9
606	Miscellaneous	Miscellaneous Custom	Biz-Custom	Food Service	Retro	7	7	2%	0	0.00	10	$0	75%	25%	25%	2	30%	10%	37.0%	23.4%	23.4%	3.3
607	Miscellaneous	Kitchen Exhaust Hood Demand Ventilation Control System	Biz-Prescriptive	Food Service	ROB	9,932	9,932	50%	4,966	0.00	20	$1,180	100%	11%	27%	3	18%	10%	94.6%	73.8%	78.0%	39.7
608	Miscellaneous	High Efficiency Hand Dryers	Biz-Custom	Food Service	Retro	1,909	1,909	83%	1,585	0.00	10	$483	100%	33%	33%	4	5%	10%	94.6%	59.6%	59.6%	6.4
609	Miscellaneous	Ozone Commercial Laundry	Biz-Custom	Food Service	Retro	2,984	2,984	25%	746	0.00	10	$20,310	0%	0%	0%	5	0%	2%	31.4%	16.6%	16.6%	3.9
610	Miscellaneous	ENERGY STAR Uninterrupted Power Supply	Biz-Custom	Food Service	ROB	3,096	3,096	3%	85	0.00	15	$59	100%	14%	14%	6	0%	70%	94.6%	76.0%	76.0%	8.8
611	Motors	Cogged V-Belt	Biz-Custom	Food Service	Retro	17,237	17,237	3%	534	0.00	15	$384	100%	14%	14%	1	50%	10%	83.4%	32.2%	32.2%	9.2
612	Motors	Pump and Fan Variable Frequency Drive Controls (Pumps)	Biz-Custom	Food Service	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	30%	2	100%	10%	83.4%	52.4%	52.4%	11.6
613	Motors	Power Drive Systems	Biz-Custom	Food Service	Retro	4	4	23%	1	0.00	15	$0	100%	37%	37%	2	100%	10%	83.4%	53.4%	53.4%	9.2
614	Motors	Switch Reluctance Motors	Biz-Custom	Food Service	Retro	33,406	33,406	31%	10,222	0.00	15	$528	100%	50%	50%	2	100%	1%	83.4%	64.1%	64.1%	26.3
615	Motors	Escalators Motor Efficiency Controllers	Biz-Custom	Food Service	Retro	7,500	7,500	20%	1,500	0.00	10	$5,000	3%	3%	3%	3	0%	10%	37.0%	26.3%	26.3%	7.3
616	Office_NonPC	Energy Star Printer/Copier/Fax	Biz-Custom	Food Service	ROB	551	551	40%	223	0.00	6	$0	0%			1	30%	90%	94.6%	92.0%	92.0%	0.0
617	Office_NonPC	Smart Power Strip – Commercial Use	Biz-Custom	Food Service	Retro	1,086	1,086	10%	109	0.00	7	$50	50%	22%	22%	2	35%	15%	71.8%	42.0%	42.0%	2.8
618	Office_NonPC	Plug Load Occupancy Sensor	Biz-Custom	Food Service	Retro	1,126	1,126	15%	169	0.00	8	$70	75%	24%	24%	2	35%	15%	85.4%	47.6%	47.6%	3.2
619	Office_PC	Electrically Commutated Plug Fans in data centers	Biz-Custom	Food Service	Retro	86,783	86,783	18%	15,778	0.00	15	$480	100%	50%	50%	1	65%	20%	94.6%	74.6%	74.6%	50.8
620	Office_PC	Energy Star Server	Biz-Custom	Food Service	ROB	1,621	1,621	23%	368	0.00	8	$118	100%	31%	31%	1	65%	25%	94.6%	58.2%	58.2%	4.5
621	Office_PC	Server Virtualization	Biz-Custom	Food Service	Retro	2	2	45%	1	0.00	8	$0	75%	25%	25%	1	65%	25%	85.8%	49.3%	49.3%	3.2
622	Office_PC	High Efficiency CRAC unit	Biz-Custom	Food Service	ROB	541	541	30%	162	0.00	15	$63	100%	26%	26%	2	65%	20%	94.6%	51.1%	51.1%	8.1
623	Office_PC	Computer Room Air Conditioner Economizer	Biz-Custom	Food Service	Retro	764	764	47%	358	0.00	15	$82	100%	44%	44%	2	65%	20%	94.6%	66.1%	66.1%	5.6
624	Office_PC	Data Center Hot/Cold Aisle Configuration	Biz-Custom	Food Service	Retro	4	4	25%	1	0.00	15	$0	100%	25%	25%	3	3%	10%	94.6%	49.3%	49.3%	7.7
625	Office_PC	Energy Star Laptop	Biz-Custom	Food Service	ROB	126	126	33%	41	0.00	4	$0	0%			4	11%	85%	94.6%	88.0%	88.0%	0.0
626	Office_PC	Energy Star Monitor	Biz-Custom	Food Service	ROB	72	72	21%	15	0.00	4	$0	0%			5	25%	85%	94.6%	88.0%	88.0%	0.0
627	Refrigeration	Strip Curtains	Biz-Custom	Food Service	Retro	88	88	50%	44	0.00	4	$10	100%	43%	43%	1	17%	30%	88.0%	65.2%	65.2%	2.3
628	Refrigeration	Bare Suction Line	Biz-Custom	Food Service	Retro	23	23	93%	21	0.00	15	$4	100%	50%	50%	2	1%	50%	88.0%	66.5%	66.5%	8.1
629	Refrigeration	Floating Head Pressure Controls	Biz-Custom	Food Service	Retro	1,112	1,112	25%	278	0.00	15	$431	25%	6%	6%	3	11%	25%	47.5%	40.0%	40.0%	5.6
630	Refrigeration	Saturated Suction Controls	Biz-Custom	Food Service	Retro	831	831	50%	416	0.00	15	$559	100%	7%	7%	4	2%	10%	88.0%	28.0%	28.0%	13.7
631	Refrigeration	Compressor Retrofit	Biz-Custom	Food Service	Retro	813	813	20%	163	0.00	15	$477	25%	3%	3%	5	38%	25%	47.5%	39.4%	39.4%	13.8
632	Refrigeration	Electronically Commutated (EC) Walk-In Evaporator Fan Motor	Biz-Prescriptive	Food Service	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	6	11%	80%	88.0%	84.0%	84.0%	30.7
633	Refrigeration	Evaporator Fan Motor Controls	Biz-Custom	Food Service	Retro	1,912	1,912	25%	478	0.00	13	$162	100%	30%	30%	7	11%	25%	88.0%	61.7%	61.7%	7.0
634	Refrigeration	Variable Speed Condenser Fan	Biz-Custom	Food Service	Retro	2,960	2,960	50%	1,480	0.00	15	$1,170	50%	13%	13%	8	14%	25%	59.5%	40.0%	40.0%	5.6
635	Refrigeration	Refrigeration Economizer	Biz-Custom	Food Service	Retro	7	7	2%	0	0.00	10	$0	100%	50%	50%	9	53%	10%	88.0%	41.1%	41.1%	4.2
636	Refrigeration	Anti-Sweat Heater Controls MT	Biz-Prescriptive	Food Service	Retro	579	579	59%	338	0.00	10	$170	75%	44%	44%	10	6%	75%	82.5%	80.0%	80.0%	2.1
637	Refrigeration	Auto Door Closer, Cooler	Biz-Custom	Food Service	Retro	471,500	471,500	0%	943	0.00	8	$157	100%	50%	50%	11	4%	50%	88.0%	66.9%	66.9%	5.8
638	Refrigeration	Display Case Door Retrofit, Medium Temp	Biz-Custom	Food Service	Retro	1,584	1,584	36%	578	0.00	12	$686	50%	8%	8%	11	2%	25%	47.9%	40.0%	40.0%	7.1
639	Refrigeration	Electronically Commutated (EC) Reach-In Evaporator Fan Motor	Biz-Prescriptive	Food Service	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	12	1%	80%	88.0%	84.0%	84.0%	30.7
640	Refrigeration	Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor	Biz-Custom	Food Service	Retro	1,911	1,911	26%	504	0.00	10	$96	100%	50%	50%	12	1%	2%	88.0%	66.5%	66.5%	5.8
641	Refrigeration	Energy Star Reach-In Refrigerator, Glass Doors	Biz-Prescriptive	Food Service	ROB	2,140	2,140	29%	629	0.00	12	$1,239	25%	6%	14%	13	6%	54%	67.8%	63.2%	63.2%	5.6
642	Refrigeration	Energy Star Reach-In Refrigerator, Solid Doors	Biz-Prescriptive	Food Service	ROB	1,410	1,410	20%	281	0.00	12	$1,211	6%	6%	6%	14	6%	54%	67.8%	63.2%	63.2%	2.5
643	Refrigeration	Anti-Sweat Heater Controls LT	Biz-Prescriptive	Food Service	Retro	2,016	2,016	68%	1,361	0.00	10	$170	100%	44%	55%	15	2%	75%	88.0%	84.3%	85.0%	8.3
644	Refrigeration	Auto Door Closer, Freezer	Biz-Custom	Food Service	Retro	419,455	419,455	1%	2,307	0.00	8	$157	100%	50%	50%	16	2%	50%	88.0%	68.9%	68.9%	13.9
645	Refrigeration	Display Case Door Retrofit, Low Temp	Biz-Custom	Food Service	Retro	2,922	2,922	50%	1,453	0.00	12	$686	100%	21%	21%	16	2%	25%	88.0%	49.7%	49.7%	7.1
646	Refrigeration	Energy Star Reach-In Freezer, Glass Doors	Biz-Prescriptive	Food Service	ROB	6,374	6,374	20%	1,275	0.00	12	$1,651	25%	21%	21%	17	2%	54%	67.8%	63.2%	63.2%	2.3
647	Refrigeration	Energy Star Reach-In Freezer, Solid Doors	Biz-Prescriptive	Food Service	ROB	4,522	4,522	7%	305	0.00	12	$1,521	23%	23%	23%	18	2%	54%	67.8%	63.2%	63.2%	0.5
648	Refrigeration	Refrigeration - Custom	Biz-Custom	Food Service	ROB	7	7	2%	0	0.00	10	$0	75%	25%	25%	19	90%	25%	47.5%	39.4%	39.4%	3.3

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
649	Refrigeration	Retro-commissioning_Refrigerator Optimization	Biz-Custom RCx	Food Service	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	20	90%	25%	88.0%	65.9%	65.9%	3.2
650	Refrigeration	Energy Star Ice Machine	Biz-Prescriptive	Food Service	ROB	6,993	6,993	10%	721	0.00	15	$1,426	25%	18%	18%	21	5%	44%	60.8%	55.2%	55.2%	2.1
651	Refrigeration	Vending Machine Controller - Refrigerated	Biz-Prescriptive	Food Service	Retro	1,586	1,586	34%	537	0.00	5	$245	25%	16%	16%	22	0%	30%	65.5%	61.1%	61.1%	2.7
652	Refrigeration	LED Refrigerated Display Case Lighting Average 6W/LF	Biz-Prescriptive	Food Service	Retro	273	273	89%	243	0.00	9	$11	100%	45%	55%	23	4%	35%	88.0%	86.7%	86.9%	30.9
653	Refrigeration	LED Refrigerated Display Case Lighting Controls	Biz-Prescriptive	Food Service	Retro	522	522	27%	141	0.00	10	$15	100%	100%	100%	24	4%	18%	88.0%	88.0%	88.0%	6.6
654	Ventilation	Demand Controlled Ventilation	Biz-Custom	Food Service	Retro	2,669	2,669	20%	534	0.00	15	$227	100%	24%	24%	1	100%	15%	92.7%	49.7%	49.7%	7.7
655	Ventilation	Pump and Fan Variable Frequency Drive Controls (Fans)	Biz-Prescriptive	Food Service	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	55%	2	100%	15%	92.7%	74.0%	79.4%	11.6
656	WholeBldg_HVAC	HVAC - Energy Management System	Biz-Custom RCx	Food Service	Retro	13	13	8%	1	0.00	15	$0	100%	25%	25%	1	100%	20%	92.7%	51.6%	51.6%	8.8
657	WholeBldg_HVAC	Guest room energy management system	Biz-Custom	Food Service	Retro	0	0	0%	0	0.00	15	$260	0%		0%	2	100%	20%	92.7%	74.2%	74.2%	0.0
658	WholeBldg_HVAC	Retro-commissioning_Bld Optimization	Biz-Custom RCx	Food Service	Retro	10	10	10%	1	0.00	15	$0	100%	25%	25%	3	100%	0%	92.7%	51.6%	51.6%	8.8
659	WholeBuilding	WholeBlg - Com RET	Biz-Custom	Food Service	Retro	7	7	15%	1	0.00	12	$0	100%	25%	25%	1	90%	0%	92.7%	51.6%	51.6%	7.3
660	WholeBuilding	WholeBlg - Custom (Other)	Biz-Custom	Food Service	Retro	5	5	20%	1	0.00	12	$0	100%	25%	25%	2	90%	0%	92.7%	51.6%	51.6%	7.3
661	WholeBuilding	Power Distribution Equipment Upgrades (Transformers)	Biz-Custom	Food Service	Retro	1,150	1,150	1%	6	0.00	30	$8	100%	9%	9%	3	100%	20%	92.7%	36.0%	36.0%	17.1
662	WholeBldg_NC	WholeBlg - Com NC	Biz-Custom	Food Service	NC	4	4	25%	1	0.00	12	$0	100%	50%	50%	1	100%	60%	83.4%	68.0%	68.0%	7.6
663	Behavioral	COM Competitions	Biz-Custom	Food Service	Retro	53	53	2%	1	0.00	2	$0	100%	50%	50%	1	100%	0%	50.0%	50.0%	50.0%	3.9
664	Behavioral	Business Energy Reports	Biz-Custom	Food Service	Retro	0	0	0%	0	0.00	2	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
665	Behavioral	Building Benchmarking	Biz-Custom	Food Service	Retro	0	0	0%	0	0.00	2	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
666	Behavioral	Strategic Energy Management	Biz-Custom SEM	Food Service	Retro	0	0	0%	0	0.00	5	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
667	Behavioral	BEIMS	Biz-Custom	Food Service	Retro	20	20	5%	1	0.00	2	$0	23%	23%	23%	1	100%	2%	50.0%	50.0%	50.0%	0.8
668	Behavioral	Building Operator Certification	Biz-Custom	Food Service	Retro	40	40	3%	1	0.00	3	$0	75%	50%	50%	1	100%	2%	50.0%	50.0%	50.0%	2.0
669	CompressedAir	Efficient Air Compressors (VSD)	Biz-Prescriptive	Health	ROB	1,583	1,583	21%	329	0.00	13	$127	100%	59%	80%	1	100%	33%	92.7%	76.7%	83.1%	5.5
670	CompressedAir	Efficient Air Nozzles	Biz-Prescriptive	Health	Retro	1,480	1,480	50%	740	0.00	15	$50	100%	81%	81%	2	35%	33%	92.7%	91.1%	91.1%	15.8
671	CompressedAir	AODD Pump Controls	Biz-Custom	Health	Retro	103,919	103,919	35%	36,372	0.00	10	$1,150	100%	50%	50%	3	10%	33%	92.7%	72.6%	72.6%	38.2
672	CompressedAir	Compressed Air - Custom	Biz-Custom	Health	Retro	5	5	20%	1	0.00	10	$0	100%	47%	47%	4	50%	33%	92.7%	64.2%	64.2%	6.0
673	CompressedAir	Retro-commissioning_Compressed Air Optimization	Biz-Custom RCx	Health	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	5	50%	33%	92.7%	64.2%	64.2%	3.2
674	Cooking	Commercial Combination Oven (Electric)	Biz-Prescriptive	Health	ROB	38,561	38,561	48%	18,432	0.00	12	$16,884	75%	6%	15%	1	18%	53%	77.5%	62.4%	62.4%	14.1
675	Cooking	Commercial Electric Convection Oven	Biz-Prescriptive	Health	ROB	12,193	12,193	15%	1,879	0.00	12	$1,706	75%	21%	51%	1	18%	53%	77.6%	62.4%	62.4%	4.4
676	Cooking	Commercial Electric Griddle	Biz-Prescriptive	Health	ROB	17,056	17,056	15%	2,596	0.00	12	$3,604	25%	15%	15%	2	14%	17%	41.9%	33.6%	33.6%	2.8
677	Cooking	Commercial Electric Steam Cooker	Biz-Prescriptive	Health	ROB	19,549	19,549	67%	13,162	0.00	12	$2,490	100%	24%	55%	3	6%	45%	88.0%	81.1%	83.5%	18.0
678	Cooking	Dishwasher Low Temp Door (Energy Star)	Biz-Prescriptive	Health	ROB	39,306	39,306	44%	17,369	0.00	15	$1,000	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	11.7
679	Cooking	Dishwasher High Temp Door (Energy Star)	Biz-Prescriptive	Health	ROB	26,901	26,901	32%	8,586	0.00	15	$1,100	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	5.2
680	Cooking	Energy efficient electric fryer	Biz-Prescriptive	Health	ROB	18,955	18,955	17%	3,274	0.00	12	$1,500	100%	5%	13%	5	27%	24%	88.0%	57.2%	59.4%	23.2
681	Cooking	Insulated Holding Cabinets (Full Size)	Biz-Prescriptive	Health	ROB	13,697	13,697	68%	9,314	0.00	12	$1,200	100%	35%	55%	6	3%	16%	88.0%	83.6%	84.9%	12.7
682	Cooking	Insulated Holding Cabinets (Half-Size)	Biz-Prescriptive	Health	ROB	4,383	4,383	60%	2,630	0.00	12	$1,500	100%	10%	25%	6	3%	16%	88.0%	52.6%	57.6%	10.1
683	Cooling	Air Conditioner - 13 IEER (5-20 Tons)	Biz-Prescriptive	Health	ROB	2,159	2,159	6%	133	0.00	15	$63	100%	48%	55%	1	24%	20%	92.7%	69.4%	72.3%	6.0
684	Cooling	Air Conditioner - 14 IEER (5-20 Tons)	Biz-Prescriptive	Health	ROB	2,159	2,159	13%	278	0.00	15	$127	100%	24%	55%	1	24%	20%	92.7%	59.7%	72.9%	12.4
685	Cooling	Air Conditioner - 17 IEER (5-20 Tons)	Biz-Prescriptive	Health	ROB	2,159	2,159	28%	610	0.00	15	$127	100%	24%	55%	1	24%	20%	92.7%	76.6%	81.7%	27.3
686	Cooling	Air Conditioner - 21 IEER (5-20 Tons)	Biz-Prescriptive	Health	ROB	2,159	2,159	42%	905	0.00	15	$127	100%	24%	55%	1	24%	20%	92.7%	80.6%	84.8%	40.5
687	Cooling	Air Conditioner - 12.1 IEER (20+ Tons)	Biz-Prescriptive	Health	ROB	2,311	2,311	6%	134	0.00	15	$30	100%	100%	100%	2	24%	20%	92.7%	92.7%	92.7%	6.0
688	Cooling	Air Conditioner - 13 IEER (20+ Tons)	Biz-Prescriptive	Health	ROB	2,311	2,311	12%	284	0.00	15	$37	100%	81%	81%	2	24%	20%	92.7%	89.6%	89.6%	12.7
689	Cooling	Air Conditioner - 14.3 IEER (20+ Tons)	Biz-Prescriptive	Health	ROB	2,311	2,311	20%	469	0.00	15	$37	100%	81%	81%	2	24%	20%	92.7%	90.9%	90.9%	21.0
690	Cooling	Air Conditioner - 21 IEER (20+ Tons)	Biz-Prescriptive	Health	ROB	2,311	2,311	46%	1,056	0.00	15	$37	100%	81%	81%	2	24%	20%	92.7%	91.9%	91.9%	47.3
691	Cooling	Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up)	Biz-Custom	Health	Retro	2,195	2,195	7%	154	0.00	3	$5	100%	50%	50%	3	48%	50%	92.7%	72.4%	72.4%	18.3
692	Cooling	Air Side Economizer	Biz-Custom	Health	Retro	2,159	2,159	20%	432	0.00	10	$84	100%	50%	50%	4	48%	20%	92.7%	65.1%	65.1%	4.0
693	Cooling	Advanced Rooftop Controls	Biz-Prescriptive	Health	Retro	2,195	2,195	0%	0	0.00	10	$100	0%		100%	5	48%	20%	92.7%	92.7%	92.7%	0.0
694	Cooling	HVAC Occupancy Controls	Biz-Custom	Health	ROB	1,150	1,150	20%	230	0.00	15	$537	100%	4%	4%	6	48%	20%	92.7%	36.0%	36.0%	25.5
695	Cooling	Air Conditioner - 16 SEER (<5 Tons)	Biz-Prescriptive	Health	ROB	1,882	1,882	13%	235	0.00	15	$47	100%	64%	80%	7	0%	20%	92.7%	83.8%	87.7%	10.5
696	Cooling	Air Conditioner - 17 SEER (<5 Tons)	Biz-Prescriptive	Health	ROB	1,882	1,882	18%	332	0.00	15	$206	100%	15%	36%	7	0%	20%	92.7%	50.5%	55.3%	14.9
697	Cooling	Air Conditioner - 18 SEER(<5 Tons)	Biz-Prescriptive	Health	ROB	1,882	1,882	22%	418	0.00	15	$206	100%	15%	36%	7	0%	20%	92.7%	54.3%	63.1%	18.7
698	Cooling	Air Conditioner - 21 SEER(<5 Tons)	Biz-Prescriptive	Health	ROB	1,882	1,882	33%	627	0.00	15	$253	100%	12%	30%	7	0%	20%	92.7%	59.2%	66.0%	28.1
699	Cooling	Smart Thermostat	Biz-Prescriptive	Health	ROB	1,882	1,882	14%	266	0.00	11	$175	100%	57%	57%	8	0%	12%	92.7%	66.2%	66.2%	1.9
700	Cooling	PTAC - <7,000 Btuh - lodging	Biz-Prescriptive	Health	ROB	2,214	2,214	8%	187	0.00	8	$84	100%	36%	55%	9	0%	20%	92.7%	65.6%	73.2%	4.6
701	Cooling	PTAC - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Health	ROB	2,428	2,428	7%	176	0.00	8	$84	100%	36%	55%	10	0%	20%	92.7%	63.9%	72.3%	4.4
702	Cooling	PTAC - >15,000 Btuh - lodging	Biz-Prescriptive	Health	ROB	2,773	2,773	10%	264	0.00	8	$84	100%	36%	55%	11	0%	20%	92.7%	73.0%	77.8%	6.5
703	Cooling	Air Cooled Chiller	Biz-Prescriptive	Health	ROB	1,923	1,923	6%	108	0.00	23	$126	100%	24%	55%	12	52%	15%	92.7%	39.5%	50.7%	8.0
704	Cooling	Chiller Tune-up	Biz-Prescriptive	Health	Retro	2,195	2,195	7%	154	0.00	3	$8	100%	100%	100%	13	52%	50%	92.7%	92.7%	92.7%	6.1
705	Cooling	HVAC/Chiller Custom	Biz-Custom	Health	Retro	5	5	20%	1	0.00	20	$1	100%	7%	7%	14	100%	20%	92.7%	36.0%	36.0%	30.3
706	Cooling	Window Film	Biz-Prescriptive	Health	Retro	6,000	6,000	4%	264	0.00	10	$154	100%	65%	65%	15	100%	20%	92.7%	73.1%	73.1%	3.2
707	Cooling	Triple Pane Windows	Biz-Custom	Health	ROB	6,000	6,000	6%	360	0.00	25	$700	100%	5%	5%	15	100%	20%	92.7%	36.0%	36.0%	24.5
708	Cooling	Energy Recovery Ventilator	Biz-Custom	Health	Retro	2,311	2,311	43%	1,003	0.00	15	$1,500	100%	7%	7%	16	100%	2%	92.7%	24.5%	24.5%	21.3
709	Heating	Heat Pump - 16 SEER (<5 Tons)	Biz-Prescriptive	Health	ROB	3,186	3,186	4%	142	0.00	16	$87	100%	46%	55%	1	0%	20%	92.7%	61.4%	66.7%	3.8
710	Heating	Heat Pump - 17 SEER (<5 Tons)	Biz-Prescriptive	Health	ROB	3,186	3,186	9%	298	0.00	16	$442	50%	9%	23%	1	0%	20%	44.0%	36.0%	36.0%	7.6
711	Heating	Heat Pump - 18 SEER(<5 Tons)	Biz-Prescriptive	Health	ROB	3,186	3,186	13%	425	0.00	16	$507	75%	8%	20%	1	0%	20%	64.7%	36.0%	38.4%	10.7
712	Heating	Heat Pump - 21 SEER(<5 Tons)	Biz-Prescriptive	Health	ROB	3,186	3,186	21%	673	0.00	16	$507	100%	8%	20%	1	0%	20%	92.7%	44.8%	47.9%	17.1
713	Heating	Geothermal HP - SEER 20.3 (<5 Tons)	Biz-Prescriptive	Health	ROB	3,186	3,186	23%	744	0.00	25	$2,576	25%	2%	4%	1	0%	20%	44.0%	36.0%	36.0%	25.0
714	Heating	Geothermal HP - SEER 21.5 (<5 Tons)	Biz-Prescriptive	Health	ROB	3,186	3,186	28%	881	0.00	25	$2,576	25%	2%	4%	1	0%	20%	44.0%	36.0%	36.0%	29.1
715	Heating	Geothermal HP - SEER 23.1 (<5 Tons)	Biz-Prescriptive	Health	ROB	3,186	3,186	33%	1,040	0.00	25	$2,576	50%	2%	4%	1	0%	20%	44.0%	36.0%	36.0%	33.7
716	Heating	Geothermal HP - SEER 29.3 (<5 Tons)	Biz-Prescriptive	Health	ROB	3,186	3,186	47%	1,502	0.00	25	$2,576	50%	2%	4%	1	0%	20%	44.0%	36.0%	36.0%	45.0
717	Heating	Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Health	ROB	3,871	3,871	12%	453	0.00	16	$100	100%	40%	55%	2	25%	20%	92.7%	78.7%	81.2%	35.1
718	Heating	Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Health	ROB	3,871	3,871	17%	659	0.00	16	$136	100%	30%	55%	2	25%	20%	92.7%	77.7%	81.8%	40.1
719	Heating	Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Health	ROB	4,038	4,038	16%	642	0.00	16	$100	100%	40%	55%	2	25%	20%	92.7%	81.7%	84.0%	40.9
720	Heating	Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Health	ROB	4,038	4,038	21%	845	0.00	16	$139	100%	29%	55%	2	25%	20%	92.7%	79.9%	83.5%	45.7

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
721	Heating	Geothermal HP - SEER 20.3 (5-20 Tons)	Biz-Prescriptive	Health	ROB	3,518	3,518	31%	1,077	0.00	25	$2,576	50%	2%	4%	2	25%	20%	44.0%	36.0%	36.0%	47.3
722	Heating	Geothermal HP - SEER 21.5 (5-20 Tons)	Biz-Prescriptive	Health	ROB	3,518	3,518	34%	1,213	0.00	25	$2,576	75%	2%	4%	2	25%	20%	50.5%	36.0%	36.0%	51.4
723	Heating	Geothermal HP - SEER 23.1 (5-20 Tons)	Biz-Prescriptive	Health	ROB	3,796	3,796	43%	1,650	0.00	25	$2,576	75%	2%	4%	2	25%	20%	55.8%	36.0%	36.0%	62.0
724	Heating	Geothermal HP - SEER 29.3 (5-20 Tons)	Biz-Prescriptive	Health	ROB	3,796	3,796	56%	2,112	0.00	25	$2,576	100%	2%	4%	2	25%	20%	92.7%	36.0%	36.0%	73.3
725	Heating	Variable Refrigerant Flow Heat Pump	Biz-Custom	Health	ROB	3,014	3,014	17%	502	0.00	16	$224	100%	22%	22%	2	25%	2%	92.7%	48.0%	48.0%	11.6
726	Heating	Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr)	Biz-Prescriptive	Health	ROB	4,261	4,261	10%	439	0.00	16	$100	100%	40%	55%	3	25%	20%	92.7%	78.3%	81.0%	31.6
727	Heating	Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr)	Biz-Prescriptive	Health	ROB	4,261	4,261	16%	699	0.00	16	$175	100%	23%	55%	3	25%	20%	92.7%	73.9%	80.2%	38.3
728	Heating	Geothermal HP - SEER 20.3 (20+ Tons)	Biz-Prescriptive	Health	ROB	4,038	4,038	40%	1,597	0.00	25	$2,576	100%	2%	4%	3	25%	20%	92.7%	36.0%	36.0%	86.9
729	Heating	Geothermal HP - SEER 21.5 (20+ Tons)	Biz-Prescriptive	Health	ROB	4,038	4,038	43%	1,733	0.00	25	$2,576	100%	2%	4%	3	25%	20%	92.7%	36.0%	36.0%	90.9
730	Heating	Geothermal HP - SEER 23.1 (20+ Tons)	Biz-Prescriptive	Health	ROB	4,038	4,038	47%	1,893	0.00	25	$2,576	100%	2%	4%	3	25%	20%	92.7%	36.0%	36.0%	95.6
731	Heating	Geothermal HP - SEER 29.3 (20+ Tons)	Biz-Prescriptive	Health	ROB	4,038	4,038	58%	2,355	0.00	25	$2,576	100%	2%	4%	3	25%	20%	92.7%	36.2%	36.7%	106.9
732	Heating	Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD)	Biz-Prescriptive	Health	ROB	3,186	3,186	21%	673	0.00	16	$224	100%	18%	45%	4	50%	20%	92.7%	67.0%	74.6%	17.1
733	Heating	PTHP - <7,000 Btuh - lodging	Biz-Custom	Health	ROB	3,474	3,474	5%	180	0.00	8	$130	100%	100%	100%	5	0%	10%	92.7%	74.2%	74.2%	1.0
734	Heating	PTHP - >15,000 Btuh - lodging	Biz-Prescriptive	Health	ROB	4,311	4,311	20%	860	0.00	8	$130	100%	100%	100%	6	0%	10%	92.7%	92.7%	92.7%	4.7
735	Heating	PTHP - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Health	ROB	3,842	3,842	12%	446	0.00	8	$130	100%	100%	100%	7	0%	10%	92.7%	92.7%	92.7%	2.4
736	HotWater	Heat Pump Water Heater	Biz-Prescriptive	Health	ROB	6,995	6,995	67%	4,684	0.00	15	$1,115	100%	45%	55%	1	100%	14%	84.0%	76.3%	78.2%	7.8
737	HotWater	Hot Water Pipe Insulation	Biz-Custom	Health	Retro	6,995	6,995	2%	140	0.00	20	$60	100%	23%	23%	2	100%	80%	86.0%	84.0%	84.0%	9.8
738	HotWater	Faucet Aerator	Biz-Custom	Health	Retro	2,017	2,017	33%	657	0.00	10	$14	100%	50%	50%	3	20%	90%	93.0%	92.0%	92.0%	50.4
739	HotWater	Low Flow Pre-Rinse Sprayers	Biz-Prescriptive	Health	ROB	18,059	18,059	54%	9,789	0.00	5	$60	100%	17%	42%	4	20%	80%	86.0%	84.0%	84.0%	199.3
740	HotWater	ENERGY STAR Commercial Washing Machines	Biz-Prescriptive	Health	ROB	1,552	1,552	43%	671	0.00	7	$250	75%	28%	28%	5	25%	33%	79.3%	64.6%	64.6%	2.9
741	InteriorLighting	LED T8 Tube Replacement	Biz-Prescriptive Light	Health	Retro	225	225	45%	101	0.00	9	$5	100%	100%	100%	1	78%	40%	94.6%	94.6%	94.6%	10.1
742	InteriorLighting	LED troffer retrofit kit, 2'X2' and 2'X4'	Biz-Prescriptive Light	Health	Retro	509	509	50%	255	0.00	9	$70	100%	36%	55%	1	78%	40%	94.6%	77.5%	83.2%	5.1
743	InteriorLighting	LED troffer, 2'X2' and 2'X4'	Biz-Prescriptive Light	Health	Retro	509	509	50%	255	0.00	9	$70	100%	36%	55%	1	78%	40%	94.6%	77.5%	83.2%	5.1
744	InteriorLighting	Bi-Level Lighting Fixture – Stairwells, Hallways	Biz-Custom Light	Health	Retro	509	509	74%	378	0.00	10	$274	50%	14%	18%	2	1%	40%	58.0%	52.0%	52.0%	4.3
745	InteriorLighting	LED high bay fixture	Biz-Prescriptive Light	Health	Retro	4,737	4,737	68%	3,223	0.00	9	$330	100%	35%	55%	3	5%	34%	94.6%	89.1%	90.8%	14.1
746	InteriorLighting	LED Mogul-base HID Lamp Replacing High Bay HID	Biz-Prescriptive Light	Health	Retro	4,737	4,737	66%	3,143	0.00	9	$330	100%	35%	55%	3	5%	34%	94.6%	88.9%	90.7%	13.7
747	InteriorLighting	LED low bay fixture	Biz-Prescriptive Light	Health	Retro	1,009	1,009	61%	613	0.00	9	$44	100%	68%	80%	4	12%	34%	94.6%	92.7%	93.4%	10.3
748	InteriorLighting	LED Mogul-base HID Lamp Replacing Low Bay HID	Biz-Prescriptive Light	Health	Retro	1,009	1,009	59%	592	0.00	9	$44	100%	68%	80%	4	12%	34%	94.6%	92.6%	93.3%	9.9
749	InteriorLighting	LED Screw-In Lamps (Directional)	Biz-Prescriptive Light	Health	ROB	385	385	86%	331	0.00	3	$1	100%	100%	100%	6	0%	43%	94.6%	94.6%	94.6%	65.4
750	InteriorLighting	LED downlight fixture	Biz-Prescriptive Light	Health	Retro	349	349	68%	236	0.00	9	$27	100%	19%	46%	6	4%	45%	94.6%	86.5%	89.5%	23.7
751	InteriorLighting	LED Screw-In Lamps (Omnidirectional & Decorative)	Biz-Prescriptive Light	Health	ROB	291	291	81%	236	0.00	3	$1	100%	100%	100%	5	1%	20%	94.6%	94.6%	94.6%	46.6
752	InteriorLighting	DeLamp Fluorescent Fixture Average Lamp Wattage 28W	Biz-Prescriptive Light	Health	Retro	187	187	100%	187	0.00	11	$4	100%	100%	100%	7	78%	0%	94.6%	94.6%	94.6%	27.9
753	InteriorLighting	Occupancy Sensors	Biz-Prescriptive Light	Health	Retro	855	855	30%	257	0.00	10	$65	100%	31%	55%	8	95%	10%	94.6%	77.5%	84.2%	5.5
754	InteriorLighting	Daylighting Controls	Biz-Prescriptive Light	Health	Retro	1,095	1,095	30%	329	0.00	10	$58	100%	35%	55%	8	95%	10%	94.6%	84.3%	88.1%	10.2
755	InteriorLighting	Dual Occupancy & Daylighting Controls	Biz-Custom Light	Health	Retro	489	489	44%	215	0.00	10	$75	100%	40%	50%	8	95%	10%	94.6%	59.2%	62.2%	3.9
756	InteriorLighting	Central Lighting Monitoring & Controls (non-networked)	Biz-Custom Light	Health	Retro	41,703	41,703	20%	8,341	0.00	12	$3,700	100%	23%	29%	8	95%	10%	94.6%	44.1%	47.7%	4.6
757	InteriorLighting	Network Lighting Controls - Wireless (WiFi)	Biz-Custom Light	Health	Retro	4	4	49%	2	0.00	15	$0	100%	49%	50%	8	95%	10%	94.6%	68.3%	68.5%	7.8
758	InteriorLighting	Luminaire Level Lighting Controls w/ HVAC Control	Biz-Custom Light	Health	Retro	489	489	65%	318	0.00	15	$90	100%	35%	46%	8	96%	10%	94.6%	61.4%	64.0%	7.8
759	InteriorLighting	LED Exit Sign - 4 Watt Fixture (2 lamp)	Biz-Prescriptive Light	Health	Retro	70	70	43%	30	0.00	5	$33	92%	92%	92%	9	1%	75%	87.6%	87.6%	87.6%	0.3
760	InteriorLighting	Lighting - Custom	Biz-Custom Light	Health	Retro	4	4	25%	1	0.00	15	$0	100%	25%	32%	10	100%	0%	94.6%	49.2%	52.8%	7.8
761	ExteriorLighting	LED wallpack (existing W<250)	Biz-Prescriptive Light	Health	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	1	12%	46%	94.6%	56.6%	70.8%	5.8
762	ExteriorLighting	LED parking lot fixture (existing W≥250)	Biz-Prescriptive Light	Health	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	2	11%	54%	67.8%	63.2%	63.2%	4.4
763	ExteriorLighting	LED parking lot fixture (existing W<250)	Biz-Prescriptive Light	Health	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	3	11%	54%	94.6%	63.2%	70.8%	5.8
764	ExteriorLighting	LED outdoor pole decorative fixture (existing W≥250)	Biz-Prescriptive Light	Health	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	17%	17%	4	11%	54%	67.8%	63.2%	63.2%	3.4
765	ExteriorLighting	LED parking garage fixture (existing W≥250)	Biz-Prescriptive Light	Health	Retro	3,235	3,235	60%	1,953	0.00	6	$756	50%	13%	33%	5	11%	69%	78.3%	75.2%	75.2%	4.7
766	ExteriorLighting	LED parking garage fixture (existing W<250)	Biz-Prescriptive Light	Health	Retro	1,742	1,742	66%	1,154	0.00	6	$248	100%	18%	45%	6	11%	69%	94.6%	77.6%	83.9%	6.2
767	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250)	Biz-Prescriptive Light	Health	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	7	11%	46%	62.1%	56.6%	56.6%	4.4
768	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250)	Biz-Prescriptive Light	Health	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	8	11%	46%	94.6%	56.6%	70.8%	5.8
769	ExteriorLighting	Bi-Level Lighting Fixture – Garages	Biz-Custom Light	Health	Retro	509	509	69%	351	0.00	10	$274	25%	13%	17%	9	11%	20%	44.0%	36.0%	36.0%	3.9
770	ExteriorLighting	LED fuel pump canopy fixture (existing W<250)	Biz-Prescriptive Light	Health	Retro	0	0	0%	0	0.00	12	$0	0%	0%		10	0%	54%	94.6%	94.6%	94.6%	0.0
771	ExteriorLighting	LED fuel pump canopy fixture (existing W≥250)	Biz-Prescriptive Light	Health	Retro	0	0	0%	0	0.00	12	$0	0%	0%		11	0%	54%	94.6%	94.6%	94.6%	0.0
772	Miscellaneous	Vending Machine Controller - Non-Refrigerated	Biz-Prescriptive	Health	Retro	385	385	61%	237	0.00	5	$233	11%	11%	11%	1	5%	30%	51.0%	44.0%	44.0%	1.9
773	Miscellaneous	Miscellaneous Custom	Biz-Custom	Health	Retro	7	7	2%	0	0.00	10	$0	75%	25%	25%	2	0%	10%	37.0%	23.4%	23.4%	3.3
774	Miscellaneous	Kitchen Exhaust Hood Demand Ventilation Control System	Biz-Prescriptive	Health	ROB	9,932	9,932	50%	4,966	0.00	20	$1,180	100%	11%	27%	3	28%	10%	94.6%	73.8%	78.0%	39.7
775	Miscellaneous	High Efficiency Hand Dryers	Biz-Custom	Health	Retro	1,909	1,909	83%	1,585	0.00	10	$483	100%	33%	33%	4	5%	10%	94.6%	59.6%	59.6%	6.3
776	Miscellaneous	Ozone Commercial Laundry	Biz-Custom	Health	Retro	2,984	2,984	25%	746	0.00	10	$20,310	0%	0%	0%	5	2%	2%	31.4%	16.6%	16.6%	3.9
777	Miscellaneous	ENERGY STAR Uninterrupted Power Supply	Biz-Custom	Health	ROB	3,096	3,096	3%	85	0.00	15	$59	100%	14%	14%	6	0%	70%	94.6%	76.0%	76.0%	8.8
778	Motors	Cogged V-Belt	Biz-Custom	Health	Retro	17,237	17,237	3%	534	0.00	15	$384	100%	14%	14%	1	50%	10%	83.4%	32.2%	32.2%	9.2
779	Motors	Pump and Fan Variable Frequency Drive Controls (Pumps)	Biz-Custom	Health	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	30%	2	100%	10%	83.4%	52.4%	52.4%	11.6
780	Motors	Power Drive Systems	Biz-Custom	Health	Retro	4	4	23%	1	0.00	15	$0	100%	37%	37%	2	100%	10%	83.4%	53.4%	53.4%	9.2
781	Motors	Switch Reluctance Motors	Biz-Custom	Health	Retro	33,406	33,406	31%	10,222	0.00	15	$528	100%	50%	50%	2	100%	1%	83.4%	64.1%	64.1%	26.3
782	Motors	Escalators Motor Efficiency Controllers	Biz-Custom	Health	Retro	7,500	7,500	20%	1,500	0.00	10	$5,000	3%	3%	3%	3	0%	10%	37.0%	26.3%	26.3%	7.3
783	Office_NonPC	Energy Star Printer/Copier/Fax	Biz-Custom	Health	ROB	551	551	40%	223	0.00	6	$0	0%			1	5%	90%	94.6%	92.0%	92.0%	0.0
784	Office_NonPC	Smart Power Strip – Commercial Use	Biz-Custom	Health	Retro	1,086	1,086	10%	109	0.00	7	$50	50%	22%	22%	2	35%	15%	71.8%	42.0%	42.0%	2.8
785	Office_NonPC	Plug Load Occupancy Sensor	Biz-Custom	Health	Retro	1,126	1,126	15%	169	0.00	8	$70	75%	24%	24%	2	35%	15%	85.4%	47.6%	47.6%	3.2
786	Office_PC	Electrically Commutated Plug Fans in data centers	Biz-Custom	Health	Retro	86,783	86,783	18%	15,778	0.00	15	$480	100%	50%	50%	1	65%	20%	94.6%	74.6%	74.6%	50.8
787	Office_PC	Energy Star Server	Biz-Custom	Health	ROB	1,621	1,621	23%	368	0.00	8	$118	100%	31%	31%	1	65%	25%	94.6%	58.2%	58.2%	4.5
788	Office_PC	Server Virtualization	Biz-Custom	Health	Retro	2	2	45%	1	0.00	8	$0	75%	25%	25%	1	65%	25%	85.8%	49.3%	49.3%	3.2
789	Office_PC	High Efficiency CRAC unit	Biz-Custom	Health	ROB	541	541	30%	162	0.00	15	$63	100%	26%	26%	2	65%	20%	94.6%	51.1%	51.1%	8.1
790	Office_PC	Computer Room Air Conditioner Economizer	Biz-Custom	Health	Retro	764	764	47%	358	0.00	15	$82	100%	44%	44%	2	65%	20%	94.6%	66.1%	66.1%	5.6
791	Office_PC	Data Center Hot/Cold Aisle Configuration	Biz-Custom	Health	Retro	4	4	25%	1	0.00	15	$0	100%	25%	25%	3	3%	10%	94.6%	49.3%	49.3%	7.7
792	Office_PC	Energy Star Laptop	Biz-Custom	Health	ROB	126	126	33%	41	0.00	4	$0	0%			4	11%	85%	94.6%	88.0%	88.0%	0.0

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
793	Office_PC	Energy Star Monitor	Biz-Custom	Health	ROB	72	72	21%	15	0.00	4	$0	0%			5	25%	85%	94.6%	88.0%	88.0%	0.0
794	Refrigeration	Strip Curtains	Biz-Custom	Health	Retro	0	0	0%	0	0.00	4	$0	0%	0%		1	5%	30%	88.0%	70.4%	70.4%	0.0
795	Refrigeration	Bare Suction Line	Biz-Custom	Health	Retro	23	23	93%	21	0.00	15	$4	100%	50%	50%	2	0%	50%	88.0%	66.5%	66.5%	8.1
796	Refrigeration	Floating Head Pressure Controls	Biz-Custom	Health	Retro	1,112	1,112	25%	278	0.00	15	$431	25%	6%	6%	3	4%	25%	47.5%	40.0%	40.0%	5.6
797	Refrigeration	Saturated Suction Controls	Biz-Custom	Health	Retro	831	831	50%	416	0.00	15	$559	100%	7%	7%	4	2%	10%	88.0%	28.0%	28.0%	13.7
798	Refrigeration	Compressor Retrofit	Biz-Custom	Health	Retro	813	813	20%	163	0.00	15	$477	25%	3%	3%	5	12%	25%	47.5%	39.4%	39.4%	13.8
799	Refrigeration	Electronically Commutated (EC) Walk-In Evaporator Fan Motor	Biz-Prescriptive	Health	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	6	3%	80%	88.0%	84.0%	84.0%	30.7
800	Refrigeration	Evaporator Fan Motor Controls	Biz-Custom	Health	Retro	1,912	1,912	25%	478	0.00	13	$162	100%	30%	30%	7	3%	25%	88.0%	61.7%	61.7%	7.0
801	Refrigeration	Variable Speed Condenser Fan	Biz-Custom	Health	Retro	2,960	2,960	50%	1,480	0.00	15	$1,170	50%	13%	13%	8	5%	25%	59.5%	40.0%	40.0%	5.6
802	Refrigeration	Refrigeration Economizer	Biz-Custom	Health	Retro	7	7	2%	0	0.00	10	$0	100%	50%	50%	9	17%	10%	88.0%	41.1%	41.1%	4.2
803	Refrigeration	Anti-Sweat Heater Controls MT	Biz-Prescriptive	Health	Retro	579	579	59%	338	0.00	10	$170	75%	44%	44%	10	17%	25%	81.8%	72.4%	72.4%	2.1
804	Refrigeration	Auto Door Closer, Cooler	Biz-Custom	Health	Retro	471,500	471,500	0%	943	0.00	8	$157	100%	50%	50%	11	13%	50%	88.0%	66.9%	66.9%	5.8
805	Refrigeration	Display Case Door Retrofit, Medium Temp	Biz-Custom	Health	Retro	1,584	1,584	36%	578	0.00	12	$686	50%	8%	8%	11	5%	25%	47.9%	40.0%	40.0%	7.1
806	Refrigeration	Electronically Commutated (EC) Reach-In Evaporator Fan Motor	Biz-Prescriptive	Health	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	12	3%	80%	88.0%	84.0%	84.0%	30.7
807	Refrigeration	Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor	Biz-Custom	Health	Retro	1,911	1,911	26%	504	0.00	10	$96	100%	50%	50%	12	3%	2%	88.0%	66.5%	66.5%	5.8
808	Refrigeration	Energy Star Reach-In Refrigerator, Glass Doors	Biz-Prescriptive	Health	ROB	2,140	2,140	29%	629	0.00	12	$1,239	25%	6%	14%	13	17%	54%	67.8%	63.2%	63.2%	5.6
809	Refrigeration	Energy Star Reach-In Refrigerator, Solid Doors	Biz-Prescriptive	Health	ROB	1,410	1,410	20%	281	0.00	12	$1,211	6%	6%	6%	14	17%	54%	67.8%	63.2%	63.2%	2.5
810	Refrigeration	Anti-Sweat Heater Controls LT	Biz-Prescriptive	Health	Retro	2,016	2,016	68%	1,361	0.00	10	$170	100%	44%	55%	15	6%	25%	88.0%	84.3%	85.0%	8.3
811	Refrigeration	Auto Door Closer, Freezer	Biz-Custom	Health	Retro	419,455	419,455	1%	2,307	0.00	8	$157	100%	50%	50%	16	6%	50%	88.0%	68.9%	68.9%	13.9
812	Refrigeration	Display Case Door Retrofit, Low Temp	Biz-Custom	Health	Retro	2,922	2,922	50%	1,453	0.00	12	$686	100%	21%	21%	16	6%	25%	88.0%	49.7%	49.7%	7.1
813	Refrigeration	Energy Star Reach-In Freezer, Glass Doors	Biz-Prescriptive	Health	ROB	6,374	6,374	20%	1,275	0.00	12	$1,651	25%	21%	21%	17	6%	54%	67.8%	63.2%	63.2%	2.3
814	Refrigeration	Energy Star Reach-In Freezer, Solid Doors	Biz-Prescriptive	Health	ROB	4,522	4,522	7%	305	0.00	12	$1,521	23%	23%	23%	18	6%	54%	67.8%	63.2%	63.2%	0.5
815	Refrigeration	Refrigeration - Custom	Biz-Custom	Health	ROB	7	7	2%	0	0.00	10	$0	75%	25%	25%	19	90%	25%	47.5%	39.4%	39.4%	3.3
816	Refrigeration	Retro-commissioning_Refrigerator Optimization	Biz-Custom RCx	Health	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	20	90%	25%	88.0%	65.9%	65.9%	3.2
817	Refrigeration	Energy Star Ice Machine	Biz-Prescriptive	Health	ROB	6,993	6,993	10%	721	0.00	15	$1,426	25%	18%	18%	21	6%	44%	60.8%	55.2%	55.2%	2.1
818	Refrigeration	Vending Machine Controller - Refrigerated	Biz-Prescriptive	Health	Retro	1,586	1,586	34%	537	0.00	5	$245	25%	16%	16%	22	3%	30%	65.5%	61.1%	61.1%	2.7
819	Refrigeration	LED Refrigerated Display Case Lighting Average 6W/LF	Biz-Prescriptive	Health	Retro	273	273	89%	243	0.00	9	$11	100%	45%	55%	23	10%	35%	88.0%	86.7%	86.9%	30.9
820	Refrigeration	LED Refrigerated Display Case Lighting Controls	Biz-Prescriptive	Health	Retro	522	522	27%	141	0.00	10	$15	100%	100%	100%	24	10%	18%	88.0%	88.0%	88.0%	6.6
821	Ventilation	Demand Controlled Ventilation	Biz-Custom	Health	Retro	2,639	2,639	20%	528	0.00	15	$227	100%	23%	23%	1	100%	33%	92.7%	49.3%	49.3%	9.4
822	Ventilation	Pump and Fan Variable Frequency Drive Controls (Fans)	Biz-Prescriptive	Health	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	55%	2	100%	33%	92.7%	74.0%	79.4%	11.6
823	WholeBldg_HVAC	HVAC - Energy Management System	Biz-Custom RCx	Health	Retro	13	13	8%	1	0.00	15	$0	100%	25%	25%	1	100%	20%	92.7%	51.6%	51.6%	8.8
824	WholeBldg_HVAC	Guest room energy management system	Biz-Custom	Health	Retro	0	0	0%	0	0.00	15	$260	0%		0%	2	100%	20%	92.7%	74.2%	74.2%	0.0
825	WholeBldg_HVAC	Retro-commissioning_Bld Optimization	Biz-Custom RCx	Health	Retro	10	10	10%	1	0.00	15	$0	100%	25%	25%	3	100%	0%	92.7%	51.6%	51.6%	8.8
826	WholeBuilding	WholeBlg - Com RET	Biz-Custom	Health	Retro	7	7	15%	1	0.00	12	$0	100%	25%	25%	1	90%	0%	92.7%	51.6%	51.6%	7.3
827	WholeBuilding	WholeBlg - Custom (Other)	Biz-Custom	Health	Retro	5	5	20%	1	0.00	12	$0	100%	25%	25%	2	90%	0%	92.7%	51.6%	51.6%	7.3
828	WholeBuilding	Power Distribution Equipment Upgrades (Transformers)	Biz-Custom	Health	Retro	1,150	1,150	1%	6	0.00	30	$8	100%	9%	9%	3	100%	20%	92.7%	36.0%	36.0%	17.1
829	WholeBldg_NC	WholeBlg - Com NC	Biz-Custom	Health	NC	4	4	25%	1	0.00	12	$0	100%	50%	50%	1	100%	60%	83.4%	68.0%	68.0%	7.6
830	Behavioral	COM Competitions	Biz-Custom	Health	Retro	0	0	0%	0	0.00	2	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
831	Behavioral	Business Energy Reports	Biz-Custom	Health	Retro	0	0	0%	0	0.00	2	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
832	Behavioral	Building Benchmarking	Biz-Custom	Health	Retro	114	114	1%	1	0.00	2	$0	45%	45%	45%	1	100%	0%	50.0%	50.0%	50.0%	0.8
833	Behavioral	Strategic Energy Management	Biz-Custom SEM	Health	Retro	33	33	3%	1	0.00	5	$0	75%	37%	37%	1	100%	0%	50.0%	50.0%	50.0%	2.1
834	Behavioral	BEIMS	Biz-Custom	Health	Retro	20	20	5%	1	0.00	2	$0	23%	23%	23%	1	100%	2%	50.0%	50.0%	50.0%	0.8
835	Behavioral	Building Operator Certification	Biz-Custom	Health	Retro	20	20	3%	0	0.00	3	$0	27%	27%	27%	1	100%	2%	50.0%	50.0%	50.0%	1.7
836	CompressedAir	Efficient Air Compressors (VSD)	Biz-Prescriptive	Lodging	ROB	1,583	1,583	21%	329	0.00	13	$127	100%	59%	80%	1	100%	33%	92.7%	76.7%	83.1%	5.5
837	CompressedAir	Efficient Air Nozzles	Biz-Prescriptive	Lodging	Retro	1,480	1,480	50%	740	0.00	15	$50	100%	81%	81%	2	35%	33%	92.7%	91.1%	91.1%	15.8
838	CompressedAir	AODD Pump Controls	Biz-Custom	Lodging	Retro	103,919	103,919	35%	36,372	0.00	10	$1,150	100%	50%	50%	3	10%	33%	92.7%	72.6%	72.6%	38.2
839	CompressedAir	Compressed Air - Custom	Biz-Custom	Lodging	Retro	5	5	20%	1	0.00	10	$0	100%	47%	47%	4	50%	33%	92.7%	64.2%	64.2%	6.0
840	CompressedAir	Retro-commissioning_Compressed Air Optimization	Biz-Custom RCx	Lodging	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	5	50%	33%	92.7%	64.2%	64.2%	3.2
841	Cooking	Commercial Combination Oven (Electric)	Biz-Prescriptive	Lodging	ROB	38,561	38,561	48%	18,432	0.00	12	$16,884	75%	6%	15%	1	18%	53%	77.5%	62.4%	62.4%	14.1
842	Cooking	Commercial Electric Convection Oven	Biz-Prescriptive	Lodging	ROB	12,193	12,193	15%	1,879	0.00	12	$1,706	75%	21%	51%	1	18%	53%	77.6%	62.4%	62.4%	4.4
843	Cooking	Commercial Electric Griddle	Biz-Prescriptive	Lodging	ROB	17,056	17,056	15%	2,596	0.00	12	$3,604	25%	15%	15%	2	14%	17%	41.9%	33.6%	33.6%	2.8
844	Cooking	Commercial Electric Steam Cooker	Biz-Prescriptive	Lodging	ROB	19,549	19,549	67%	13,162	0.00	12	$2,490	100%	24%	55%	3	6%	45%	88.0%	81.1%	83.5%	18.0
845	Cooking	Dishwasher Low Temp Door (Energy Star)	Biz-Prescriptive	Lodging	ROB	39,306	39,306	44%	17,369	0.00	15	$1,000	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	11.7
846	Cooking	Dishwasher High Temp Door (Energy Star)	Biz-Prescriptive	Lodging	ROB	26,901	26,901	32%	8,586	0.00	15	$1,100	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	5.2
847	Cooking	Energy efficient electric fryer	Biz-Prescriptive	Lodging	ROB	18,955	18,955	17%	3,274	0.00	12	$1,500	100%	5%	13%	5	27%	24%	88.0%	57.2%	59.4%	23.2
848	Cooking	Insulated Holding Cabinets (Full Size)	Biz-Prescriptive	Lodging	ROB	13,697	13,697	68%	9,314	0.00	12	$1,200	100%	35%	55%	6	3%	16%	88.0%	83.6%	84.9%	12.7
849	Cooking	Insulated Holding Cabinets (Half-Size)	Biz-Prescriptive	Lodging	ROB	4,383	4,383	60%	2,630	0.00	12	$1,500	100%	10%	25%	6	3%	16%	88.0%	52.6%	57.6%	10.1
850	Cooling	Air Conditioner - 13 IEER (5-20 Tons)	Biz-Prescriptive	Lodging	ROB	1,391	1,391	6%	86	0.00	15	$63	100%	48%	55%	1	12%	20%	92.7%	56.3%	61.5%	5.1
851	Cooling	Air Conditioner - 14 IEER (5-20 Tons)	Biz-Prescriptive	Lodging	ROB	1,391	1,391	13%	179	0.00	15	$127	100%	24%	55%	1	12%	20%	92.7%	50.1%	62.6%	10.6
852	Cooling	Air Conditioner - 17 IEER (5-20 Tons)	Biz-Prescriptive	Lodging	ROB	1,391	1,391	28%	393	0.00	15	$127	100%	24%	55%	1	12%	20%	92.7%	69.5%	77.6%	23.3
853	Cooling	Air Conditioner - 21 IEER (5-20 Tons)	Biz-Prescriptive	Lodging	ROB	1,391	1,391	42%	583	0.00	15	$127	100%	24%	55%	1	12%	20%	92.7%	76.0%	81.3%	34.5
854	Cooling	Air Conditioner - 12.1 IEER (20+ Tons)	Biz-Prescriptive	Lodging	ROB	1,488	1,488	6%	86	0.00	15	$30	100%	100%	100%	2	12%	20%	92.7%	92.7%	92.7%	5.1
855	Cooling	Air Conditioner - 13 IEER (20+ Tons)	Biz-Prescriptive	Lodging	ROB	1,488	1,488	12%	183	0.00	15	$37	100%	81%	81%	2	12%	20%	92.7%	87.9%	87.9%	10.9
856	Cooling	Air Conditioner - 14.3 IEER (20+ Tons)	Biz-Prescriptive	Lodging	ROB	1,488	1,488	20%	302	0.00	15	$37	100%	81%	81%	2	12%	20%	92.7%	89.8%	89.8%	17.9
857	Cooling	Air Conditioner - 21 IEER (20+ Tons)	Biz-Prescriptive	Lodging	ROB	1,488	1,488	46%	680	0.00	15	$37	100%	81%	81%	2	12%	20%	92.7%	91.4%	91.4%	40.3
858	Cooling	Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up)	Biz-Custom	Lodging	Retro	1,414	1,414	7%	99	0.00	3	$5	100%	50%	50%	3	25%	50%	92.7%	71.5%	71.5%	15.8
859	Cooling	Air Side Economizer	Biz-Custom	Lodging	Retro	1,391	1,391	20%	278	0.00	10	$84	100%	33%	33%	4	25%	20%	92.7%	58.6%	58.6%	3.9
860	Cooling	Advanced Rooftop Controls	Biz-Prescriptive	Lodging	Retro	1,414	1,414	0%	0	0.00	10	$100	0%		100%	5	25%	20%	92.7%	92.7%	92.7%	0.0
861	Cooling	HVAC Occupancy Controls	Biz-Custom	Lodging	ROB	9,967	9,967	20%	1,993	0.00	15	$537	100%	37%	37%	6	25%	20%	92.7%	60.6%	60.6%	10.1
862	Cooling	Air Conditioner - 16 SEER (<5 Tons)	Biz-Prescriptive	Lodging	ROB	1,212	1,212	13%	152	0.00	15	$47	100%	64%	80%	7	0%	20%	92.7%	80.3%	85.0%	9.0
863	Cooling	Air Conditioner - 17 SEER (<5 Tons)	Biz-Prescriptive	Lodging	ROB	1,212	1,212	18%	214	0.00	15	$206	100%	15%	36%	7	0%	20%	92.7%	40.7%	47.6%	12.7
864	Cooling	Air Conditioner - 18 SEER(<5 Tons)	Biz-Prescriptive	Lodging	ROB	1,212	1,212	22%	269	0.00	15	$206	100%	15%	36%	7	0%	20%	92.7%	46.1%	52.0%	16.0

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
865	Cooling	Air Conditioner - 21 SEER(<5 Tons)	Biz-Prescriptive	Lodging	ROB	1,212	1,212	33%	404	0.00	15	$253	100%	12%	30%	7	0%	20%	92.7%	49.8%	53.7%	23.9
866	Cooling	Smart Thermostat	Biz-Prescriptive	Lodging	ROB	1,212	1,212	14%	172	0.00	11	$175	75%	57%	57%	8	0%	12%	68.8%	53.8%	53.8%	1.5
867	Cooling	PTAC - <7,000 Btuh - lodging	Biz-Prescriptive	Lodging	ROB	1,426	1,426	8%	121	0.00	8	$84	100%	36%	55%	9	25%	20%	92.7%	53.4%	63.2%	3.9
868	Cooling	PTAC - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Lodging	ROB	1,564	1,564	7%	114	0.00	8	$84	100%	36%	55%	10	25%	20%	92.7%	52.5%	61.3%	3.7
869	Cooling	PTAC - >15,000 Btuh - lodging	Biz-Prescriptive	Lodging	ROB	1,786	1,786	10%	170	0.00	8	$84	100%	36%	55%	11	25%	20%	92.7%	62.8%	71.6%	5.5
870	Cooling	Air Cooled Chiller	Biz-Prescriptive	Lodging	ROB	1,239	1,239	6%	69	0.00	23	$126	100%	24%	55%	12	50%	15%	92.7%	32.0%	40.8%	7.0
871	Cooling	Chiller Tune-up	Biz-Prescriptive	Lodging	Retro	1,414	1,414	7%	99	0.00	3	$8	100%	100%	100%	13	50%	50%	92.7%	92.7%	92.7%	5.3
872	Cooling	HVAC/Chiller Custom	Biz-Custom	Lodging	Retro	5	5	20%	1	0.00	20	$1	100%	7%	7%	14	100%	20%	92.7%	36.0%	36.0%	30.3
873	Cooling	Window Film	Biz-Prescriptive	Lodging	Retro	6,000	6,000	4%	264	0.00	10	$154	100%	65%	65%	15	100%	20%	92.7%	73.1%	73.1%	3.2
874	Cooling	Triple Pane Windows	Biz-Custom	Lodging	ROB	6,000	6,000	6%	360	0.00	25	$700	100%	5%	5%	15	100%	20%	92.7%	36.0%	36.0%	24.5
875	Cooling	Energy Recovery Ventilator	Biz-Custom	Lodging	Retro	1,488	1,488	0%	0	0.00	15	$1,500	0%		0%	16	100%	2%	92.7%	74.2%	74.2%	0.0
876	Heating	Heat Pump - 16 SEER (<5 Tons)	Biz-Prescriptive	Lodging	ROB	2,641	2,641	4%	104	0.00	16	$87	100%	46%	46%	1	0%	20%	92.7%	53.3%	53.3%	3.3
877	Heating	Heat Pump - 17 SEER (<5 Tons)	Biz-Prescriptive	Lodging	ROB	2,641	2,641	9%	229	0.00	16	$442	50%	9%	23%	1	0%	20%	44.0%	36.0%	36.0%	6.6
878	Heating	Heat Pump - 18 SEER(<5 Tons)	Biz-Prescriptive	Lodging	ROB	2,641	2,641	12%	329	0.00	16	$507	50%	8%	20%	1	0%	20%	44.0%	36.0%	36.0%	9.3
879	Heating	Heat Pump - 21 SEER(<5 Tons)	Biz-Prescriptive	Lodging	ROB	2,641	2,641	19%	504	0.00	16	$507	100%	8%	20%	1	0%	20%	92.7%	38.9%	41.0%	14.6
880	Heating	Geothermal HP - SEER 20.3 (<5 Tons)	Biz-Prescriptive	Lodging	ROB	2,641	2,641	23%	597	0.00	25	$2,576	25%	2%	4%	1	0%	20%	44.0%	36.0%	36.0%	21.8
881	Heating	Geothermal HP - SEER 21.5 (<5 Tons)	Biz-Prescriptive	Lodging	ROB	2,641	2,641	27%	712	0.00	25	$2,576	25%	2%	4%	1	0%	20%	44.0%	36.0%	36.0%	25.4
882	Heating	Geothermal HP - SEER 23.1 (<5 Tons)	Biz-Prescriptive	Lodging	ROB	2,641	2,641	32%	845	0.00	25	$2,576	25%	2%	4%	1	0%	20%	44.0%	36.0%	36.0%	29.5
883	Heating	Geothermal HP - SEER 29.3 (<5 Tons)	Biz-Prescriptive	Lodging	ROB	2,641	2,641	47%	1,234	0.00	25	$2,576	50%	2%	4%	1	0%	20%	44.0%	36.0%	36.0%	39.2
884	Heating	Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Lodging	ROB	3,184	3,184	11%	349	0.00	16	$100	100%	40%	55%	2	29%	20%	92.7%	75.6%	78.9%	33.5
885	Heating	Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Lodging	ROB	3,184	3,184	16%	516	0.00	16	$136	100%	30%	55%	2	29%	20%	92.7%	74.5%	79.8%	38.0
886	Heating	Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Lodging	ROB	3,314	3,314	14%	475	0.00	16	$100	100%	40%	55%	2	29%	20%	92.7%	79.1%	81.6%	38.4
887	Heating	Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Lodging	ROB	3,314	3,314	19%	640	0.00	16	$139	100%	29%	55%	2	29%	20%	92.7%	77.0%	81.4%	42.7
888	Heating	Geothermal HP - SEER 20.3 (5-20 Tons)	Biz-Prescriptive	Lodging	ROB	2,902	2,902	30%	858	0.00	25	$2,576	50%	2%	4%	2	29%	20%	44.0%	36.0%	36.0%	42.6
889	Heating	Geothermal HP - SEER 21.5 (5-20 Tons)	Biz-Prescriptive	Lodging	ROB	2,902	2,902	34%	972	0.00	25	$2,576	50%	2%	4%	2	29%	20%	44.0%	36.0%	36.0%	46.3
890	Heating	Geothermal HP - SEER 23.1 (5-20 Tons)	Biz-Prescriptive	Lodging	ROB	3,081	3,081	42%	1,285	0.00	25	$2,576	75%	2%	4%	2	29%	20%	51.5%	36.0%	36.0%	54.1
891	Heating	Geothermal HP - SEER 29.3 (5-20 Tons)	Biz-Prescriptive	Lodging	ROB	3,081	3,081	54%	1,673	0.00	25	$2,576	75%	2%	4%	2	29%	20%	56.4%	36.0%	36.0%	63.9
892	Heating	Variable Refrigerant Flow Heat Pump	Biz-Custom	Lodging	ROB	2,460	2,460	13%	323	0.00	16	$224	100%	14%	14%	2	29%	2%	92.7%	38.6%	38.6%	14.8
893	Heating	Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr)	Biz-Prescriptive	Lodging	ROB	3,457	3,457	9%	325	0.00	16	$100	100%	40%	55%	3	29%	20%	92.7%	74.6%	78.2%	29.9
894	Heating	Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr)	Biz-Prescriptive	Lodging	ROB	3,457	3,457	15%	529	0.00	16	$175	100%	23%	55%	3	29%	20%	92.7%	68.8%	77.4%	35.8
895	Heating	Geothermal HP - SEER 20.3 (20+ Tons)	Biz-Prescriptive	Lodging	ROB	3,314	3,314	38%	1,270	0.00	25	$2,576	100%	2%	4%	3	29%	20%	92.7%	36.0%	36.0%	79.8
896	Heating	Geothermal HP - SEER 21.5 (20+ Tons)	Biz-Prescriptive	Lodging	ROB	3,314	3,314	42%	1,384	0.00	25	$2,576	100%	2%	4%	3	29%	20%	92.7%	36.0%	36.0%	83.4
897	Heating	Geothermal HP - SEER 23.1 (20+ Tons)	Biz-Prescriptive	Lodging	ROB	3,314	3,314	46%	1,517	0.00	25	$2,576	100%	2%	4%	3	29%	20%	92.7%	36.0%	36.0%	87.5
898	Heating	Geothermal HP - SEER 29.3 (20+ Tons)	Biz-Prescriptive	Lodging	ROB	3,314	3,314	58%	1,906	0.00	25	$2,576	100%	2%	4%	3	29%	20%	92.7%	36.0%	36.0%	97.2
899	Heating	Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD)	Biz-Prescriptive	Lodging	ROB	2,641	2,641	19%	504	0.00	16	$224	100%	18%	45%	4	28%	20%	92.7%	58.3%	69.7%	14.6
900	Heating	PTHP - <7,000 Btuh - lodging	Biz-Custom	Lodging	ROB	2,908	2,908	4%	116	0.00	8	$130	100%	100%	100%	5	5%	10%	92.7%	74.2%	74.2%	0.8
901	Heating	PTHP - >15,000 Btuh - lodging	Biz-Prescriptive	Lodging	ROB	3,512	3,512	16%	554	0.00	8	$130	100%	100%	100%	6	5%	10%	92.7%	92.7%	92.7%	3.9
902	Heating	PTHP - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Lodging	ROB	3,187	3,187	9%	287	0.00	8	$130	100%	100%	100%	7	5%	10%	92.7%	92.7%	92.7%	2.0
903	HotWater	Heat Pump Water Heater	Biz-Prescriptive	Lodging	ROB	6,347	6,347	67%	4,250	0.00	15	$1,115	100%	45%	55%	1	100%	4%	84.0%	75.3%	77.4%	7.0
904	HotWater	Hot Water Pipe Insulation	Biz-Custom	Lodging	Retro	6,347	6,347	2%	127	0.00	20	$60	100%	21%	21%	2	100%	80%	86.0%	84.0%	84.0%	9.8
905	HotWater	Faucet Aerator	Biz-Custom	Lodging	Retro	117	117	32%	38	0.00	10	$8	100%	47%	47%	3	20%	90%	93.0%	92.0%	92.0%	12.1
906	HotWater	Low Flow Pre-Rinse Sprayers	Biz-Prescriptive	Lodging	ROB	18,059	18,059	54%	9,789	0.00	5	$60	100%	17%	42%	4	20%	80%	86.0%	84.0%	84.0%	199.3
907	HotWater	ENERGY STAR Commercial Washing Machines	Biz-Prescriptive	Lodging	ROB	1,552	1,552	43%	671	0.00	7	$250	75%	28%	28%	5	25%	33%	79.3%	64.6%	64.6%	2.9
908	InteriorLighting	LED T8 Tube Replacement	Biz-Prescriptive Light	Lodging	Retro	229	229	45%	103	0.00	8	$5	100%	100%	100%	1	46%	40%	94.6%	94.6%	94.6%	10.4
909	InteriorLighting	LED troffer retrofit kit, 2'X2' and 2'X4'	Biz-Prescriptive Light	Lodging	Retro	519	519	50%	260	0.00	8	$70	100%	36%	55%	1	46%	40%	94.6%	77.9%	83.5%	5.2
910	InteriorLighting	LED troffer, 2'X2' and 2'X4'	Biz-Prescriptive Light	Lodging	Retro	519	519	50%	260	0.00	8	$70	100%	36%	55%	1	46%	40%	94.6%	77.9%	83.5%	5.2
911	InteriorLighting	Bi-Level Lighting Fixture – Stairwells, Hallways	Biz-Custom Light	Lodging	Retro	519	519	74%	386	0.00	10	$274	50%	14%	18%	2	1%	40%	58.0%	52.0%	52.0%	4.3
912	InteriorLighting	LED high bay fixture	Biz-Prescriptive Light	Lodging	Retro	4,832	4,832	68%	3,288	0.00	8	$330	100%	35%	55%	3	6%	34%	94.6%	89.2%	90.8%	14.4
913	InteriorLighting	LED Mogul-base HID Lamp Replacing High Bay HID	Biz-Prescriptive Light	Lodging	Retro	4,832	4,832	66%	3,206	0.00	8	$330	100%	35%	55%	3	6%	34%	94.6%	89.0%	90.7%	14.1
914	InteriorLighting	LED low bay fixture	Biz-Prescriptive Light	Lodging	Retro	1,029	1,029	61%	626	0.00	8	$44	100%	68%	80%	4	5%	34%	94.6%	92.7%	93.4%	10.5
915	InteriorLighting	LED Mogul-base HID Lamp Replacing Low Bay HID	Biz-Prescriptive Light	Lodging	Retro	1,029	1,029	59%	604	0.00	8	$44	100%	68%	80%	4	5%	34%	94.6%	92.6%	93.4%	10.2
916	InteriorLighting	LED Screw-In Lamps (Directional)	Biz-Prescriptive Light	Lodging	ROB	68	68	86%	58	0.00	3	$1	100%	100%	100%	6	0%	43%	94.6%	94.6%	94.6%	42.5
917	InteriorLighting	LED downlight fixture	Biz-Prescriptive Light	Lodging	Retro	356	356	68%	241	0.00	8	$27	100%	19%	46%	6	37%	45%	94.6%	86.7%	89.6%	24.3
918	InteriorLighting	LED Screw-In Lamps (Omnidirectional & Decorative)	Biz-Prescriptive Light	Lodging	ROB	51	51	81%	42	0.00	3	$1	100%	100%	100%	5	6%	20%	94.6%	94.6%	94.6%	30.3
919	InteriorLighting	DeLamp Fluorescent Fixture Average Lamp Wattage 28W	Biz-Prescriptive Light	Lodging	Retro	191	191	100%	191	0.00	11	$4	100%	100%	100%	7	46%	0%	94.6%	94.6%	94.6%	31.6
920	InteriorLighting	Occupancy Sensors	Biz-Prescriptive Light	Lodging	Retro	872	872	30%	262	0.00	10	$65	100%	31%	55%	8	95%	10%	94.6%	77.9%	84.5%	5.6
921	InteriorLighting	Daylighting Controls	Biz-Prescriptive Light	Lodging	Retro	1,117	1,117	30%	335	0.00	10	$58	100%	35%	55%	8	95%	10%	94.6%	84.5%	88.2%	10.4
922	InteriorLighting	Dual Occupancy & Daylighting Controls	Biz-Custom Light	Lodging	Retro	498	498	44%	219	0.00	10	$75	100%	40%	50%	8	95%	10%	94.6%	59.6%	62.5%	4.5
923	InteriorLighting	Central Lighting Monitoring & Controls (non-networked)	Biz-Custom Light	Lodging	Retro	41,703	41,703	20%	8,341	0.00	12	$3,700	100%	23%	29%	8	95%	10%	94.6%	44.1%	47.7%	4.6
924	InteriorLighting	Network Lighting Controls - Wireless (WiFi)	Biz-Custom Light	Lodging	Retro	4	4	49%	2	0.00	15	$1	100%	34%	44%	8	95%	10%	94.6%	60.4%	63.0%	8.6
925	InteriorLighting	Luminaire Level Lighting Controls w/ HVAC Control	Biz-Custom Light	Lodging	Retro	498	498	65%	324	0.00	15	$90	100%	36%	47%	8	57%	10%	94.6%	61.9%	64.5%	8.6
926	InteriorLighting	LED Exit Sign - 4 Watt Fixture (2 lamp)	Biz-Prescriptive Light	Lodging	Retro	67	67	43%	29	0.00	5	$33	92%	92%	92%	9	1%	75%	87.2%	87.2%	87.2%	0.3
927	InteriorLighting	Lighting - Custom	Biz-Custom Light	Lodging	Retro	4	4	25%	1	0.00	15	$0	100%	24%	31%	10	100%	0%	94.6%	47.6%	51.2%	8.6
928	ExteriorLighting	LED wallpack (existing W<250)	Biz-Prescriptive Light	Lodging	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	1	12%	46%	94.6%	56.6%	70.8%	5.8
929	ExteriorLighting	LED parking lot fixture (existing W≥250)	Biz-Prescriptive Light	Lodging	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	2	11%	54%	67.8%	63.2%	63.2%	4.4
930	ExteriorLighting	LED parking lot fixture (existing W<250)	Biz-Prescriptive Light	Lodging	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	3	11%	54%	94.6%	63.2%	70.8%	5.8
931	ExteriorLighting	LED outdoor pole decorative fixture (existing W≥250)	Biz-Prescriptive Light	Lodging	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	17%	17%	4	11%	54%	67.8%	63.2%	63.2%	3.4
932	ExteriorLighting	LED parking garage fixture (existing W≥250)	Biz-Prescriptive Light	Lodging	Retro	3,235	3,235	60%	1,953	0.00	6	$756	50%	13%	33%	5	11%	69%	78.3%	75.2%	75.2%	4.7
933	ExteriorLighting	LED parking garage fixture (existing W<250)	Biz-Prescriptive Light	Lodging	Retro	1,742	1,742	66%	1,154	0.00	6	$248	100%	18%	45%	6	11%	69%	94.6%	77.6%	83.9%	6.2
934	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250)	Biz-Prescriptive Light	Lodging	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	7	11%	46%	62.1%	56.6%	56.6%	4.4
935	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250)	Biz-Prescriptive Light	Lodging	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	8	11%	46%	94.6%	56.6%	70.8%	5.8
936	ExteriorLighting	Bi-Level Lighting Fixture – Garages	Biz-Custom Light	Lodging	Retro	519	519	69%	358	0.00	10	$274	50%	13%	17%	9	11%	20%	49.2%	36.0%	36.0%	3.9

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Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
937	ExteriorLighting	LED fuel pump canopy fixture (existing W<250)	Biz-Prescriptive Light	Lodging	Retro	0	0	0%	0	0.00	12	$0	0%	0%		10	0%	54%	94.6%	94.6%	94.6%	0.0
938	ExteriorLighting	LED fuel pump canopy fixture (existing W≥250)	Biz-Prescriptive Light	Lodging	Retro	0	0	0%	0	0.00	12	$0	0%	0%		11	0%	54%	94.6%	94.6%	94.6%	0.0
939	Miscellaneous	Vending Machine Controller - Non-Refrigerated	Biz-Prescriptive	Lodging	Retro	385	385	61%	237	0.00	5	$233	11%	11%	11%	1	5%	30%	51.0%	44.0%	44.0%	1.9
940	Miscellaneous	Miscellaneous Custom	Biz-Custom	Lodging	Retro	7	7	2%	0	0.00	10	$0	75%	25%	25%	2	41%	10%	37.0%	23.4%	23.4%	3.3
941	Miscellaneous	Kitchen Exhaust Hood Demand Ventilation Control System	Biz-Prescriptive	Lodging	ROB	9,932	9,932	50%	4,966	0.00	20	$1,180	100%	11%	27%	3	25%	10%	94.6%	73.8%	78.0%	39.7
942	Miscellaneous	High Efficiency Hand Dryers	Biz-Custom	Lodging	Retro	262	262	83%	217	0.00	10	$483	25%	4%	4%	4	5%	10%	37.0%	23.4%	23.4%	6.1
943	Miscellaneous	Ozone Commercial Laundry	Biz-Custom	Lodging	Retro	2,984	2,984	25%	746	0.00	10	$20,310	0%	0%	0%	5	2%	2%	31.4%	16.6%	16.6%	3.9
944	Miscellaneous	ENERGY STAR Uninterrupted Power Supply	Biz-Custom	Lodging	ROB	3,096	3,096	3%	85	0.00	15	$59	100%	14%	14%	6	0%	70%	94.6%	76.0%	76.0%	8.8
945	Motors	Cogged V-Belt	Biz-Custom	Lodging	Retro	29,207	29,207	3%	905	0.00	15	$384	100%	24%	24%	1	50%	10%	83.4%	43.5%	43.5%	7.7
946	Motors	Pump and Fan Variable Frequency Drive Controls (Pumps)	Biz-Custom	Lodging	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	30%	2	100%	10%	83.4%	52.4%	52.4%	11.6
947	Motors	Power Drive Systems	Biz-Custom	Lodging	Retro	4	4	23%	1	0.00	15	$0	100%	37%	37%	2	100%	10%	83.4%	53.4%	53.4%	7.7
948	Motors	Switch Reluctance Motors	Biz-Custom	Lodging	Retro	56,602	56,602	31%	17,320	0.00	15	$528	100%	50%	50%	2	100%	1%	83.4%	65.2%	65.2%	44.6
949	Motors	Escalators Motor Efficiency Controllers	Biz-Custom	Lodging	Retro	7,500	7,500	20%	1,500	0.00	10	$5,000	3%	3%	3%	3	0%	10%	37.0%	26.3%	26.3%	7.3
950	Office_NonPC	Energy Star Printer/Copier/Fax	Biz-Custom	Lodging	ROB	551	551	40%	223	0.00	6	$0	0%			1	5%	90%	94.6%	92.0%	92.0%	0.0
951	Office_NonPC	Smart Power Strip – Commercial Use	Biz-Custom	Lodging	Retro	1,086	1,086	10%	109	0.00	7	$50	50%	22%	22%	2	35%	15%	71.8%	42.0%	42.0%	2.8
952	Office_NonPC	Plug Load Occupancy Sensor	Biz-Custom	Lodging	Retro	1,126	1,126	15%	169	0.00	8	$70	75%	24%	24%	2	35%	15%	85.4%	47.6%	47.6%	3.2
953	Office_PC	Electrically Commutated Plug Fans in data centers	Biz-Custom	Lodging	Retro	86,783	86,783	18%	15,778	0.00	15	$480	100%	50%	50%	1	65%	20%	94.6%	74.6%	74.6%	50.8
954	Office_PC	Energy Star Server	Biz-Custom	Lodging	ROB	1,621	1,621	23%	368	0.00	8	$118	100%	31%	31%	1	65%	25%	94.6%	58.2%	58.2%	4.5
955	Office_PC	Server Virtualization	Biz-Custom	Lodging	Retro	2	2	45%	1	0.00	8	$0	75%	25%	25%	1	65%	25%	85.8%	49.3%	49.3%	3.2
956	Office_PC	High Efficiency CRAC unit	Biz-Custom	Lodging	ROB	541	541	30%	162	0.00	15	$63	100%	26%	26%	2	65%	20%	94.6%	51.1%	51.1%	8.1
957	Office_PC	Computer Room Air Conditioner Economizer	Biz-Custom	Lodging	Retro	764	764	47%	358	0.00	15	$82	100%	44%	44%	2	65%	20%	94.6%	66.1%	66.1%	5.6
958	Office_PC	Data Center Hot/Cold Aisle Configuration	Biz-Custom	Lodging	Retro	4	4	25%	1	0.00	15	$0	100%	25%	25%	3	3%	10%	94.6%	49.3%	49.3%	7.7
959	Office_PC	Energy Star Laptop	Biz-Custom	Lodging	ROB	126	126	33%	41	0.00	4	$0	0%			4	11%	85%	94.6%	88.0%	88.0%	0.0
960	Office_PC	Energy Star Monitor	Biz-Custom	Lodging	ROB	72	72	21%	15	0.00	4	$0	0%			5	25%	85%	94.6%	88.0%	88.0%	0.0
961	Refrigeration	Strip Curtains	Biz-Custom	Lodging	Retro	0	0	0%	0	0.00	4	$0	0%	0%		1	10%	30%	88.0%	70.4%	70.4%	0.0
962	Refrigeration	Bare Suction Line	Biz-Custom	Lodging	Retro	23	23	93%	21	0.00	15	$4	100%	50%	50%	2	0%	50%	88.0%	66.5%	66.5%	8.1
963	Refrigeration	Floating Head Pressure Controls	Biz-Custom	Lodging	Retro	1,112	1,112	25%	278	0.00	15	$431	25%	6%	6%	3	7%	25%	47.5%	40.0%	40.0%	5.6
964	Refrigeration	Saturated Suction Controls	Biz-Custom	Lodging	Retro	831	831	50%	416	0.00	15	$559	100%	7%	7%	4	2%	10%	88.0%	28.0%	28.0%	13.7
965	Refrigeration	Compressor Retrofit	Biz-Custom	Lodging	Retro	813	813	20%	163	0.00	15	$477	25%	3%	3%	5	23%	25%	47.5%	39.4%	39.4%	13.8
966	Refrigeration	Electronically Commutated (EC) Walk-In Evaporator Fan Motor	Biz-Prescriptive	Lodging	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	6	6%	80%	88.0%	84.0%	84.0%	30.7
967	Refrigeration	Evaporator Fan Motor Controls	Biz-Custom	Lodging	Retro	1,912	1,912	25%	478	0.00	13	$162	100%	30%	30%	7	6%	25%	88.0%	61.7%	61.7%	7.0
968	Refrigeration	Variable Speed Condenser Fan	Biz-Custom	Lodging	Retro	2,960	2,960	50%	1,480	0.00	15	$1,170	50%	13%	13%	8	9%	25%	59.5%	40.0%	40.0%	5.6
969	Refrigeration	Refrigeration Economizer	Biz-Custom	Lodging	Retro	7	7	2%	0	0.00	10	$0	100%	50%	50%	9	32%	10%	88.0%	41.1%	41.1%	4.2
970	Refrigeration	Anti-Sweat Heater Controls MT	Biz-Prescriptive	Lodging	Retro	579	579	59%	338	0.00	10	$170	75%	44%	44%	10	11%	25%	81.8%	72.4%	72.4%	2.1
971	Refrigeration	Auto Door Closer, Cooler	Biz-Custom	Lodging	Retro	471,500	471,500	0%	943	0.00	8	$157	100%	50%	50%	11	8%	50%	88.0%	66.9%	66.9%	5.8
972	Refrigeration	Display Case Door Retrofit, Medium Temp	Biz-Custom	Lodging	Retro	1,584	1,584	36%	578	0.00	12	$686	50%	8%	8%	11	3%	25%	47.9%	40.0%	40.0%	7.1
973	Refrigeration	Electronically Commutated (EC) Reach-In Evaporator Fan Motor	Biz-Prescriptive	Lodging	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	12	2%	80%	88.0%	84.0%	84.0%	30.7
974	Refrigeration	Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor	Biz-Custom	Lodging	Retro	1,911	1,911	26%	504	0.00	10	$96	100%	50%	50%	12	2%	2%	88.0%	66.5%	66.5%	5.8
975	Refrigeration	Energy Star Reach-In Refrigerator, Glass Doors	Biz-Prescriptive	Lodging	ROB	2,140	2,140	29%	629	0.00	12	$1,239	25%	6%	14%	13	11%	54%	67.8%	63.2%	63.2%	5.6
976	Refrigeration	Energy Star Reach-In Refrigerator, Solid Doors	Biz-Prescriptive	Lodging	ROB	1,410	1,410	20%	281	0.00	12	$1,211	6%	6%	6%	14	11%	54%	67.8%	63.2%	63.2%	2.5
977	Refrigeration	Anti-Sweat Heater Controls LT	Biz-Prescriptive	Lodging	Retro	2,016	2,016	68%	1,361	0.00	10	$170	100%	44%	55%	15	4%	25%	88.0%	84.3%	85.0%	8.3
978	Refrigeration	Auto Door Closer, Freezer	Biz-Custom	Lodging	Retro	419,455	419,455	1%	2,307	0.00	8	$157	100%	50%	50%	16	4%	50%	88.0%	68.9%	68.9%	13.9
979	Refrigeration	Display Case Door Retrofit, Low Temp	Biz-Custom	Lodging	Retro	2,922	2,922	50%	1,453	0.00	12	$686	100%	21%	21%	16	4%	25%	88.0%	49.7%	49.7%	7.1
980	Refrigeration	Energy Star Reach-In Freezer, Glass Doors	Biz-Prescriptive	Lodging	ROB	6,374	6,374	20%	1,275	0.00	12	$1,651	25%	21%	21%	17	4%	54%	67.8%	63.2%	63.2%	2.3
981	Refrigeration	Energy Star Reach-In Freezer, Solid Doors	Biz-Prescriptive	Lodging	ROB	4,522	4,522	7%	305	0.00	12	$1,521	23%	23%	23%	18	4%	54%	67.8%	63.2%	63.2%	0.5
982	Refrigeration	Refrigeration - Custom	Biz-Custom	Lodging	ROB	7	7	2%	0	0.00	10	$0	75%	25%	25%	19	90%	25%	47.5%	39.4%	39.4%	3.3
983	Refrigeration	Retro-commissioning_Refrigerator Optimization	Biz-Custom RCx	Lodging	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	20	90%	25%	88.0%	65.9%	65.9%	3.2
984	Refrigeration	Energy Star Ice Machine	Biz-Prescriptive	Lodging	ROB	6,993	6,993	10%	721	0.00	15	$1,426	25%	18%	18%	21	10%	44%	60.8%	55.2%	55.2%	2.1
985	Refrigeration	Vending Machine Controller - Refrigerated	Biz-Prescriptive	Lodging	Retro	1,586	1,586	34%	537	0.00	5	$245	25%	16%	16%	22	4%	30%	65.5%	61.1%	61.1%	2.7
986	Refrigeration	LED Refrigerated Display Case Lighting Average 6W/LF	Biz-Prescriptive	Lodging	Retro	273	273	89%	243	0.00	9	$11	100%	45%	55%	23	7%	35%	88.0%	86.7%	86.9%	30.9
987	Refrigeration	LED Refrigerated Display Case Lighting Controls	Biz-Prescriptive	Lodging	Retro	522	522	27%	141	0.00	10	$15	100%	100%	100%	24	7%	18%	88.0%	88.0%	88.0%	6.6
988	Ventilation	Demand Controlled Ventilation	Biz-Custom	Lodging	Retro	2,639	2,639	20%	528	0.00	15	$227	100%	23%	23%	1	100%	22%	92.7%	49.3%	49.3%	9.4
989	Ventilation	Pump and Fan Variable Frequency Drive Controls (Fans)	Biz-Prescriptive	Lodging	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	55%	2	100%	22%	92.7%	74.0%	79.4%	11.6
990	WholeBldg_HVAC	HVAC - Energy Management System	Biz-Custom RCx	Lodging	Retro	13	13	8%	1	0.00	15	$0	100%	25%	25%	1	15%	20%	92.7%	51.6%	51.6%	8.8
991	WholeBldg_HVAC	Guest room energy management system	Biz-Custom	Lodging	Retro	7,167	7,167	19%	1,382	0.00	15	$260	100%	50%	50%	2	85%	20%	92.7%	65.3%	65.3%	5.9
992	WholeBldg_HVAC	Retro-commissioning_Bld Optimization	Biz-Custom RCx	Lodging	Retro	10	10	10%	1	0.00	15	$0	100%	25%	25%	3	100%	0%	92.7%	51.6%	51.6%	8.8
993	WholeBuilding	WholeBlg - Com RET	Biz-Custom	Lodging	Retro	7	7	15%	1	0.00	12	$0	100%	25%	25%	1	90%	0%	92.7%	51.6%	51.6%	7.3
994	WholeBuilding	WholeBlg - Custom (Other)	Biz-Custom	Lodging	Retro	5	5	20%	1	0.00	12	$0	100%	25%	25%	2	90%	0%	92.7%	51.6%	51.6%	7.3
995	WholeBuilding	Power Distribution Equipment Upgrades (Transformers)	Biz-Custom	Lodging	Retro	1,150	1,150	1%	6	0.00	30	$8	100%	9%	9%	3	100%	20%	92.7%	36.0%	36.0%	17.1
996	WholeBldg_NC	WholeBlg - Com NC	Biz-Custom	Lodging	NC	4	4	25%	1	0.00	12	$0	100%	50%	50%	1	100%	60%	83.4%	68.0%	68.0%	7.6
997	Behavioral	COM Competitions	Biz-Custom	Lodging	Retro	53	53	2%	1	0.00	2	$0	100%	50%	50%	1	100%	0%	50.0%	50.0%	50.0%	3.9
998	Behavioral	Business Energy Reports	Biz-Custom	Lodging	Retro	313	313	0%	1	0.00	2	$0	50%	50%	50%	1	100%	0%	50.0%	50.0%	50.0%	0.8
999	Behavioral	Building Benchmarking	Biz-Custom	Lodging	Retro	263	263	0%	1	0.00	2	$0	45%	45%	45%	1	100%	0%	50.0%	50.0%	50.0%	0.8
1000	Behavioral	Strategic Energy Management	Biz-Custom SEM	Lodging	Retro	0	0	0%	0	0.00	5	$0	0%		0%	1	100%	0%	50.0%	50.0%	50.0%	0.0
1001	Behavioral	BEIMS	Biz-Custom	Lodging	Retro	20	20	5%	1	0.00	2	$0	23%	23%	23%	1	100%	2%	50.0%	40.0%	40.0%	0.8
1002	Behavioral	Building Operator Certification	Biz-Custom	Lodging	Retro	12	12	3%	0	0.00	3	$0	25%	17%	17%	1	100%	2%	50.0%	40.0%	40.0%	1.7
1003	CompressedAir	Efficient Air Compressors (VSD)	Biz-Prescriptive	Retail	ROB	1,583	1,583	21%	329	0.00	13	$127	100%	59%	80%	1	100%	33%	92.7%	76.7%	83.1%	5.5
1004	CompressedAir	Efficient Air Nozzles	Biz-Prescriptive	Retail	Retro	1,480	1,480	50%	740	0.00	15	$50	100%	81%	81%	2	35%	33%	92.7%	91.1%	91.1%	15.8
1005	CompressedAir	AODD Pump Controls	Biz-Custom	Retail	Retro	103,919	103,919	35%	36,372	0.00	10	$1,150	100%	50%	50%	3	10%	33%	92.7%	72.6%	72.6%	38.2
1006	CompressedAir	Compressed Air - Custom	Biz-Custom	Retail	Retro	5	5	20%	1	0.00	10	$0	100%	47%	47%	4	50%	33%	92.7%	64.2%	64.2%	6.0
1007	CompressedAir	Retro-commissioning_Compressed Air Optimization	Biz-Custom RCx	Retail	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	5	50%	33%	92.7%	64.2%	64.2%	3.2
1008	Cooking	Commercial Combination Oven (Electric)	Biz-Prescriptive	Retail	ROB	38,561	38,561	48%	18,432	0.00	12	$16,884	75%	6%	15%	1	18%	53%	77.5%	62.4%	62.4%	14.1

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
1009	Cooking	Commercial Electric Convection Oven	Biz-Prescriptive	Retail	ROB	12,193	12,193	15%	1,879	0.00	12	$1,706	75%	21%	51%	1	18%	53%	77.6%	62.4%	62.4%	4.4
1010	Cooking	Commercial Electric Griddle	Biz-Prescriptive	Retail	ROB	17,056	17,056	15%	2,596	0.00	12	$3,604	25%	15%	15%	2	14%	17%	41.9%	33.6%	33.6%	2.8
1011	Cooking	Commercial Electric Steam Cooker	Biz-Prescriptive	Retail	ROB	19,549	19,549	67%	13,162	0.00	12	$2,490	100%	24%	55%	3	6%	45%	88.0%	81.1%	83.5%	18.0
1012	Cooking	Dishwasher Low Temp Door (Energy Star)	Biz-Prescriptive	Retail	ROB	39,306	39,306	44%	17,369	0.00	15	$1,000	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	11.7
1013	Cooking	Dishwasher High Temp Door (Energy Star)	Biz-Prescriptive	Retail	ROB	26,901	26,901	32%	8,586	0.00	15	$1,100	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	5.2
1014	Cooking	Energy efficient electric fryer	Biz-Prescriptive	Retail	ROB	18,955	18,955	17%	3,274	0.00	12	$1,500	100%	5%	13%	5	27%	24%	88.0%	57.2%	59.4%	23.2
1015	Cooking	Insulated Holding Cabinets (Full Size)	Biz-Prescriptive	Retail	ROB	13,697	13,697	68%	9,314	0.00	12	$1,200	100%	35%	55%	6	3%	16%	88.0%	83.6%	84.9%	12.7
1016	Cooking	Insulated Holding Cabinets (Half-Size)	Biz-Prescriptive	Retail	ROB	4,383	4,383	60%	2,630	0.00	12	$1,500	100%	10%	25%	6	3%	16%	88.0%	52.6%	57.6%	10.1
1017	Cooling	Air Conditioner - 13 IEER (5-20 Tons)	Biz-Prescriptive	Retail	ROB	1,273	1,273	6%	78	0.00	15	$63	100%	48%	55%	1	15%	20%	92.7%	54.4%	58.5%	4.9
1018	Cooling	Air Conditioner - 14 IEER (5-20 Tons)	Biz-Prescriptive	Retail	ROB	1,273	1,273	13%	164	0.00	15	$127	100%	24%	55%	1	15%	20%	92.7%	48.3%	59.8%	10.3
1019	Cooling	Air Conditioner - 17 IEER (5-20 Tons)	Biz-Prescriptive	Retail	ROB	1,273	1,273	28%	359	0.00	15	$127	100%	24%	55%	1	15%	20%	92.7%	67.3%	76.6%	22.7
1020	Cooling	Air Conditioner - 21 IEER (5-20 Tons)	Biz-Prescriptive	Retail	ROB	1,273	1,273	42%	533	0.00	15	$127	100%	24%	55%	1	15%	20%	92.7%	74.8%	80.6%	33.6
1021	Cooling	Air Conditioner - 12.1 IEER (20+ Tons)	Biz-Prescriptive	Retail	ROB	1,362	1,362	6%	79	0.00	15	$30	100%	100%	100%	2	15%	20%	92.7%	92.7%	92.7%	5.0
1022	Cooling	Air Conditioner - 13 IEER (20+ Tons)	Biz-Prescriptive	Retail	ROB	1,362	1,362	12%	168	0.00	15	$37	100%	81%	81%	2	15%	20%	92.7%	87.5%	87.5%	10.6
1023	Cooling	Air Conditioner - 14.3 IEER (20+ Tons)	Biz-Prescriptive	Retail	ROB	1,362	1,362	20%	276	0.00	15	$37	100%	81%	81%	2	15%	20%	92.7%	89.6%	89.6%	17.4
1024	Cooling	Air Conditioner - 21 IEER (20+ Tons)	Biz-Prescriptive	Retail	ROB	1,362	1,362	46%	623	0.00	15	$37	100%	81%	81%	2	15%	20%	92.7%	91.3%	91.3%	39.3
1025	Cooling	Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up)	Biz-Custom	Retail	Retro	1,294	1,294	7%	91	0.00	3	$5	100%	50%	50%	3	29%	50%	92.7%	71.2%	71.2%	15.4
1026	Cooling	Air Side Economizer	Biz-Custom	Retail	Retro	1,273	1,273	20%	255	0.00	10	$84	100%	30%	30%	4	29%	20%	92.7%	56.8%	56.8%	3.9
1027	Cooling	Advanced Rooftop Controls	Biz-Prescriptive	Retail	Retro	1,294	1,294	8%	106	0.00	10	$100	100%	100%	100%	5	29%	20%	92.7%	92.7%	92.7%	0.4
1028	Cooling	HVAC Occupancy Controls	Biz-Custom	Retail	ROB	2,900	2,900	20%	580	0.00	15	$537	100%	11%	11%	6	29%	20%	92.7%	36.0%	36.0%	12.0
1029	Cooling	Air Conditioner - 16 SEER (<5 Tons)	Biz-Prescriptive	Retail	ROB	1,109	1,109	13%	139	0.00	15	$47	100%	64%	80%	7	23%	20%	92.7%	79.5%	84.3%	8.7
1030	Cooling	Air Conditioner - 17 SEER (<5 Tons)	Biz-Prescriptive	Retail	ROB	1,109	1,109	18%	196	0.00	15	$206	100%	15%	36%	7	23%	20%	92.7%	39.3%	45.5%	12.3
1031	Cooling	Air Conditioner - 18 SEER(<5 Tons)	Biz-Prescriptive	Retail	ROB	1,109	1,109	22%	246	0.00	15	$206	100%	15%	36%	7	23%	20%	92.7%	44.0%	50.4%	15.5
1032	Cooling	Air Conditioner - 21 SEER(<5 Tons)	Biz-Prescriptive	Retail	ROB	1,109	1,109	33%	370	0.00	15	$253	100%	12%	30%	7	23%	20%	92.7%	47.9%	52.2%	23.3
1033	Cooling	Smart Thermostat	Biz-Prescriptive	Retail	ROB	1,109	1,109	14%	157	0.00	11	$175	75%	57%	57%	8	23%	12%	66.5%	52.4%	52.4%	1.4
1034	Cooling	PTAC - <7,000 Btuh - lodging	Biz-Prescriptive	Retail	ROB	1,305	1,305	8%	110	0.00	8	$84	100%	36%	55%	9	15%	20%	92.7%	52.0%	60.4%	3.8
1035	Cooling	PTAC - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Retail	ROB	1,431	1,431	7%	104	0.00	8	$84	100%	36%	36%	10	15%	20%	92.7%	50.9%	50.9%	3.6
1036	Cooling	PTAC - >15,000 Btuh - lodging	Biz-Prescriptive	Retail	ROB	1,635	1,635	10%	156	0.00	8	$84	100%	36%	55%	11	15%	20%	92.7%	60.0%	69.9%	5.4
1037	Cooling	Air Cooled Chiller	Biz-Prescriptive	Retail	ROB	1,133	1,133	6%	64	0.00	23	$126	100%	24%	55%	12	32%	15%	92.7%	32.0%	39.5%	6.8
1038	Cooling	Chiller Tune-up	Biz-Prescriptive	Retail	Retro	1,294	1,294	7%	91	0.00	3	$8	100%	100%	100%	13	32%	50%	92.7%	92.7%	92.7%	5.1
1039	Cooling	HVAC/Chiller Custom	Biz-Custom	Retail	Retro	5	5	20%	1	0.00	20	$1	100%	7%	7%	14	100%	20%	92.7%	36.0%	36.0%	30.3
1040	Cooling	Window Film	Biz-Prescriptive	Retail	Retro	6,000	6,000	4%	264	0.00	10	$154	100%	65%	65%	15	100%	20%	92.7%	73.1%	73.1%	3.2
1041	Cooling	Triple Pane Windows	Biz-Custom	Retail	ROB	6,000	6,000	6%	360	0.00	25	$700	100%	5%	5%	15	100%	20%	92.7%	36.0%	36.0%	24.5
1042	Cooling	Energy Recovery Ventilator	Biz-Custom	Retail	Retro	1,362	1,362	11%	156	0.00	15	$1,500	1%	1%	1%	16	100%	2%	31.4%	21.8%	21.8%	6.7
1043	Heating	Heat Pump - 16 SEER (<5 Tons)	Biz-Prescriptive	Retail	ROB	1,841	1,841	4%	83	0.00	16	$87	100%	46%	46%	1	35%	20%	92.7%	49.2%	49.2%	2.9
1044	Heating	Heat Pump - 17 SEER (<5 Tons)	Biz-Prescriptive	Retail	ROB	1,841	1,841	9%	173	0.00	16	$442	50%	9%	23%	1	35%	20%	44.0%	36.0%	36.0%	5.7
1045	Heating	Heat Pump - 18 SEER(<5 Tons)	Biz-Prescriptive	Retail	ROB	1,841	1,841	13%	247	0.00	16	$507	50%	8%	20%	1	35%	20%	44.0%	36.0%	36.0%	8.1
1046	Heating	Heat Pump - 21 SEER(<5 Tons)	Biz-Prescriptive	Retail	ROB	1,841	1,841	21%	392	0.00	16	$507	100%	8%	20%	1	35%	20%	92.7%	36.0%	36.9%	13.0
1047	Heating	Geothermal HP - SEER 20.3 (<5 Tons)	Biz-Prescriptive	Retail	ROB	1,841	1,841	23%	431	0.00	25	$2,576	25%	2%	4%	1	35%	20%	44.0%	36.0%	36.0%	18.3
1048	Heating	Geothermal HP - SEER 21.5 (<5 Tons)	Biz-Prescriptive	Retail	ROB	1,841	1,841	28%	510	0.00	25	$2,576	25%	2%	4%	1	35%	20%	44.0%	36.0%	36.0%	21.1
1049	Heating	Geothermal HP - SEER 23.1 (<5 Tons)	Biz-Prescriptive	Retail	ROB	1,841	1,841	33%	602	0.00	25	$2,576	25%	2%	4%	1	35%	20%	44.0%	36.0%	36.0%	24.3
1050	Heating	Geothermal HP - SEER 29.3 (<5 Tons)	Biz-Prescriptive	Retail	ROB	1,841	1,841	47%	869	0.00	25	$2,576	25%	2%	4%	1	35%	20%	44.0%	36.0%	36.0%	31.4
1051	Heating	Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Retail	ROB	2,239	2,239	12%	264	0.00	16	$100	100%	40%	55%	2	22%	20%	92.7%	71.2%	75.7%	32.3
1052	Heating	Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Retail	ROB	2,239	2,239	17%	383	0.00	16	$136	100%	30%	55%	2	22%	20%	92.7%	69.3%	76.6%	36.1
1053	Heating	Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Retail	ROB	2,336	2,336	16%	375	0.00	16	$100	100%	40%	55%	2	22%	20%	92.7%	76.5%	79.6%	36.9
1054	Heating	Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Retail	ROB	2,336	2,336	21%	492	0.00	16	$139	100%	29%	55%	2	22%	20%	92.7%	73.4%	79.1%	40.5
1055	Heating	Geothermal HP - SEER 20.3 (5-20 Tons)	Biz-Prescriptive	Retail	ROB	2,034	2,034	31%	625	0.00	25	$2,576	50%	2%	4%	2	22%	20%	44.0%	36.0%	36.0%	37.6
1056	Heating	Geothermal HP - SEER 21.5 (5-20 Tons)	Biz-Prescriptive	Retail	ROB	2,034	2,034	35%	703	0.00	25	$2,576	50%	2%	4%	2	22%	20%	44.0%	36.0%	36.0%	40.5
1057	Heating	Geothermal HP - SEER 23.1 (5-20 Tons)	Biz-Prescriptive	Retail	ROB	2,198	2,198	44%	959	0.00	25	$2,576	50%	2%	4%	2	22%	20%	44.0%	36.0%	36.0%	47.1
1058	Heating	Geothermal HP - SEER 29.3 (5-20 Tons)	Biz-Prescriptive	Retail	ROB	2,198	2,198	56%	1,226	0.00	25	$2,576	75%	2%	4%	2	22%	20%	50.7%	36.0%	36.0%	54.2
1059	Heating	Variable Refrigerant Flow Heat Pump	Biz-Custom	Retail	ROB	1,744	1,744	17%	296	0.00	16	$224	100%	13%	13%	2	22%	2%	92.7%	36.8%	36.8%	15.6
1060	Heating	Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr)	Biz-Prescriptive	Retail	ROB	2,467	2,467	10%	256	0.00	16	$100	100%	40%	55%	3	22%	20%	92.7%	70.7%	75.3%	28.9
1061	Heating	Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr)	Biz-Prescriptive	Retail	ROB	2,467	2,467	16%	407	0.00	16	$175	100%	23%	55%	3	22%	20%	92.7%	61.5%	73.9%	34.0
1062	Heating	Geothermal HP - SEER 20.3 (20+ Tons)	Biz-Prescriptive	Retail	ROB	2,336	2,336	40%	927	0.00	25	$2,576	100%	2%	4%	3	22%	20%	92.7%	36.0%	36.0%	72.5
1063	Heating	Geothermal HP - SEER 21.5 (20+ Tons)	Biz-Prescriptive	Retail	ROB	2,336	2,336	43%	1,005	0.00	25	$2,576	100%	2%	4%	3	22%	20%	92.7%	36.0%	36.0%	75.3
1064	Heating	Geothermal HP - SEER 23.1 (20+ Tons)	Biz-Prescriptive	Retail	ROB	2,336	2,336	47%	1,097	0.00	25	$2,576	100%	2%	4%	3	22%	20%	92.7%	36.0%	36.0%	78.5
1065	Heating	Geothermal HP - SEER 29.3 (20+ Tons)	Biz-Prescriptive	Retail	ROB	2,336	2,336	58%	1,364	0.00	25	$2,576	100%	2%	4%	3	22%	20%	92.7%	36.0%	36.0%	85.6
1066	Heating	Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD)	Biz-Prescriptive	Retail	ROB	1,841	1,841	21%	392	0.00	16	$224	100%	18%	45%	4	11%	20%	92.7%	52.7%	62.9%	13.0
1067	Heating	PTHP - <7,000 Btuh - lodging	Biz-Custom	Retail	ROB	2,006	2,006	5%	106	0.00	8	$130	100%	100%	100%	5	3%	10%	92.7%	74.2%	74.2%	0.8
1068	Heating	PTHP - >15,000 Btuh - lodging	Biz-Prescriptive	Retail	ROB	2,495	2,495	20%	507	0.00	8	$130	100%	100%	100%	6	3%	10%	92.7%	92.7%	92.7%	3.8
1069	Heating	PTHP - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Retail	ROB	2,220	2,220	12%	263	0.00	8	$130	100%	100%	100%	7	3%	10%	92.7%	92.7%	92.7%	1.9
1070	HotWater	Heat Pump Water Heater	Biz-Prescriptive	Retail	ROB	4,687	4,687	67%	3,139	0.00	15	$1,115	100%	45%	55%	1	100%	8%	84.0%	71.2%	74.1%	5.2
1071	HotWater	Hot Water Pipe Insulation	Biz-Custom	Retail	Retro	4,687	4,687	2%	94	0.00	20	$60	100%	16%	16%	2	100%	80%	86.0%	84.0%	84.0%	9.8
1072	HotWater	Faucet Aerator	Biz-Custom	Retail	Retro	284	284	32%	92	0.00	10	$8	100%	50%	50%	3	20%	90%	93.0%	92.0%	92.0%	13.5
1073	HotWater	Low Flow Pre-Rinse Sprayers	Biz-Prescriptive	Retail	ROB	18,059	18,059	54%	9,789	0.00	5	$60	100%	17%	42%	4	20%	80%	86.0%	84.0%	84.0%	199.3
1074	HotWater	ENERGY STAR Commercial Washing Machines	Biz-Prescriptive	Retail	ROB	1,552	1,552	43%	671	0.00	7	$250	75%	28%	28%	5	25%	33%	79.3%	64.6%	64.6%	2.9
1075	InteriorLighting	LED T8 Tube Replacement	Biz-Prescriptive Light	Retail	Retro	153	153	45%	68	0.00	12	$5	100%	100%	100%	1	75%	40%	94.6%	94.6%	94.6%	11.1
1076	InteriorLighting	LED troffer retrofit kit, 2'X2' and 2'X4'	Biz-Prescriptive Light	Retail	Retro	346	346	50%	173	0.00	12	$70	100%	36%	55%	1	75%	40%	94.6%	67.7%	77.0%	5.6
1077	InteriorLighting	LED troffer, 2'X2' and 2'X4'	Biz-Prescriptive Light	Retail	Retro	346	346	50%	173	0.00	12	$70	100%	36%	55%	1	75%	40%	94.6%	67.7%	77.0%	5.6
1078	InteriorLighting	Bi-Level Lighting Fixture – Stairwells, Hallways	Biz-Custom Light	Retail	Retro	346	346	74%	257	0.00	10	$274	25%	9%	12%	2	1%	40%	58.0%	52.0%	52.0%	4.4
1079	InteriorLighting	LED high bay fixture	Biz-Prescriptive Light	Retail	Retro	3,225	3,225	68%	2,194	0.00	12	$330	100%	35%	55%	3	3%	34%	94.6%	86.0%	89.0%	15.5
1080	InteriorLighting	LED Mogul-base HID Lamp Replacing High Bay HID	Biz-Prescriptive Light	Retail	Retro	3,225	3,225	66%	2,140	0.00	12	$330	100%	35%	55%	3	3%	34%	94.6%	85.7%	88.8%	15.1

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
1081	InteriorLighting	LED low bay fixture	Biz-Prescriptive Light	Retail	Retro	687	687	61%	417	0.00	12	$44	100%	68%	80%	4	16%	34%	94.6%	91.8%	92.8%	11.3
1082	InteriorLighting	LED Mogul-base HID Lamp Replacing Low Bay HID	Biz-Prescriptive Light	Retail	Retro	687	687	59%	403	0.00	12	$44	100%	68%	80%	4	16%	34%	94.6%	91.7%	92.8%	10.9
1083	InteriorLighting	LED Screw-In Lamps (Directional)	Biz-Prescriptive Light	Retail	ROB	257	257	86%	221	0.00	5	$1	100%	100%	100%	6	0%	43%	94.6%	94.6%	94.6%	96.3
1084	InteriorLighting	LED downlight fixture	Biz-Prescriptive Light	Retail	Retro	238	238	68%	161	0.00	12	$27	100%	19%	46%	6	4%	45%	94.6%	81.8%	86.8%	26.0
1085	InteriorLighting	LED Screw-In Lamps (Omnidirectional & Decorative)	Biz-Prescriptive Light	Retail	ROB	194	194	81%	157	0.00	5	$1	100%	100%	100%	5	0%	20%	94.6%	94.6%	94.6%	68.7
1086	InteriorLighting	DeLamp Fluorescent Fixture Average Lamp Wattage 28W	Biz-Prescriptive Light	Retail	Retro	128	128	100%	128	0.00	11	$4	100%	100%	100%	7	75%	0%	94.6%	94.6%	94.6%	23.8
1087	InteriorLighting	Occupancy Sensors	Biz-Prescriptive Light	Retail	Retro	582	582	30%	175	0.00	10	$65	100%	31%	55%	8	95%	10%	94.6%	67.6%	78.4%	3.9
1088	InteriorLighting	Daylighting Controls	Biz-Prescriptive Light	Retail	Retro	746	746	30%	224	0.00	10	$58	100%	35%	55%	8	95%	10%	94.6%	78.5%	84.1%	8.0
1089	InteriorLighting	Dual Occupancy & Daylighting Controls	Biz-Custom Light	Retail	Retro	333	333	44%	146	0.00	10	$75	100%	40%	50%	8	95%	10%	94.6%	48.4%	54.6%	3.4
1090	InteriorLighting	Central Lighting Monitoring & Controls (non-networked)	Biz-Custom Light	Retail	Retro	41,703	41,703	20%	8,341	0.00	12	$3,700	100%	23%	29%	8	95%	10%	94.6%	44.1%	47.7%	4.6
1091	InteriorLighting	Network Lighting Controls - Wireless (WiFi)	Biz-Custom Light	Retail	Retro	3	3	49%	1	0.00	15	$1	100%	23%	29%	8	95%	10%	94.6%	44.2%	47.8%	9.7
1092	InteriorLighting	Luminaire Level Lighting Controls w/ HVAC Control	Biz-Custom Light	Retail	Retro	333	333	65%	216	0.00	15	$90	100%	24%	31%	8	95%	10%	94.6%	47.3%	50.9%	9.7
1093	InteriorLighting	LED Exit Sign - 4 Watt Fixture (2 lamp)	Biz-Prescriptive Light	Retail	Retro	67	67	43%	29	0.00	5	$33	92%	92%	92%	9	1%	75%	87.2%	87.2%	87.2%	0.3
1094	InteriorLighting	Lighting - Custom	Biz-Custom Light	Retail	Retro	4	4	25%	1	0.00	15	$1	100%	17%	23%	10	100%	0%	94.6%	34.7%	35.8%	9.7
1095	ExteriorLighting	LED wallpack (existing W<250)	Biz-Prescriptive Light	Retail	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	1	12%	46%	94.6%	56.6%	70.8%	5.8
1096	ExteriorLighting	LED parking lot fixture (existing W≥250)	Biz-Prescriptive Light	Retail	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	2	11%	54%	67.8%	63.2%	63.2%	4.4
1097	ExteriorLighting	LED parking lot fixture (existing W<250)	Biz-Prescriptive Light	Retail	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	3	11%	54%	94.6%	63.2%	70.8%	5.8
1098	ExteriorLighting	LED outdoor pole decorative fixture (existing W≥250)	Biz-Prescriptive Light	Retail	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	17%	17%	4	11%	54%	67.8%	63.2%	63.2%	3.4
1099	ExteriorLighting	LED parking garage fixture (existing W≥250)	Biz-Prescriptive Light	Retail	Retro	3,235	3,235	60%	1,953	0.00	6	$756	50%	13%	33%	5	11%	69%	78.3%	75.2%	75.2%	4.7
1100	ExteriorLighting	LED parking garage fixture (existing W<250)	Biz-Prescriptive Light	Retail	Retro	1,742	1,742	66%	1,154	0.00	6	$248	100%	18%	45%	6	11%	69%	94.6%	77.6%	83.9%	6.2
1101	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250)	Biz-Prescriptive Light	Retail	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	7	11%	46%	62.1%	56.6%	56.6%	4.4
1102	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250)	Biz-Prescriptive Light	Retail	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	8	11%	46%	94.6%	56.6%	70.8%	5.8
1103	ExteriorLighting	Bi-Level Lighting Fixture – Garages	Biz-Custom Light	Retail	Retro	346	346	69%	239	0.00	10	$274	25%	9%	11%	9	11%	20%	44.0%	36.0%	36.0%	3.9
1104	ExteriorLighting	LED fuel pump canopy fixture (existing W<250)	Biz-Prescriptive Light	Retail	Retro	0	0	0%	0	0.00	12	$0	0%	0%		10	0%	54%	94.6%	94.6%	94.6%	0.0
1105	ExteriorLighting	LED fuel pump canopy fixture (existing W≥250)	Biz-Prescriptive Light	Retail	Retro	0	0	0%	0	0.00	12	$0	0%	0%		11	0%	54%	94.6%	94.6%	94.6%	0.0
1106	Miscellaneous	Vending Machine Controller - Non-Refrigerated	Biz-Prescriptive	Retail	Retro	385	385	61%	237	0.00	5	$233	11%	11%	11%	1	5%	30%	51.0%	44.0%	44.0%	1.9
1107	Miscellaneous	Miscellaneous Custom	Biz-Custom	Retail	Retro	7	7	2%	0	0.00	10	$0	75%	25%	25%	2	36%	10%	37.0%	23.4%	23.4%	3.3
1108	Miscellaneous	Kitchen Exhaust Hood Demand Ventilation Control System	Biz-Prescriptive	Retail	ROB	9,932	9,932	50%	4,966	0.00	20	$1,180	100%	11%	27%	3	0%	10%	94.6%	73.8%	78.0%	39.7
1109	Miscellaneous	High Efficiency Hand Dryers	Biz-Custom	Retail	Retro	1,909	1,909	83%	1,585	0.00	10	$483	100%	33%	33%	4	5%	10%	94.6%	59.6%	59.6%	7.2
1110	Miscellaneous	Ozone Commercial Laundry	Biz-Custom	Retail	Retro	2,984	2,984	25%	746	0.00	10	$20,310	0%	0%	0%	5	0%	2%	31.4%	16.6%	16.6%	3.9
1111	Miscellaneous	ENERGY STAR Uninterrupted Power Supply	Biz-Custom	Retail	ROB	3,096	3,096	3%	85	0.00	15	$59	100%	14%	14%	6	5%	70%	94.6%	76.0%	76.0%	8.8
1112	Motors	Cogged V-Belt	Biz-Custom	Retail	Retro	14,670	14,670	3%	455	0.00	15	$384	100%	12%	12%	1	50%	10%	83.4%	28.8%	28.8%	9.9
1113	Motors	Pump and Fan Variable Frequency Drive Controls (Pumps)	Biz-Custom	Retail	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	30%	2	100%	10%	83.4%	52.4%	52.4%	11.6
1114	Motors	Power Drive Systems	Biz-Custom	Retail	Retro	4	4	23%	1	0.00	15	$0	100%	37%	37%	2	100%	10%	83.4%	53.4%	53.4%	9.9
1115	Motors	Switch Reluctance Motors	Biz-Custom	Retail	Retro	28,430	28,430	31%	8,700	0.00	15	$528	100%	50%	50%	2	100%	1%	83.4%	63.7%	63.7%	22.4
1116	Motors	Escalators Motor Efficiency Controllers	Biz-Custom	Retail	Retro	7,500	7,500	20%	1,500	0.00	10	$5,000	3%	3%	3%	3	0%	10%	37.0%	26.3%	26.3%	7.3
1117	Office_NonPC	Energy Star Printer/Copier/Fax	Biz-Custom	Retail	ROB	551	551	40%	223	0.00	6	$0	0%			1	30%	90%	94.6%	92.0%	92.0%	0.0
1118	Office_NonPC	Smart Power Strip – Commercial Use	Biz-Custom	Retail	Retro	1,086	1,086	10%	109	0.00	7	$50	50%	22%	22%	2	35%	15%	71.8%	42.0%	42.0%	2.8
1119	Office_NonPC	Plug Load Occupancy Sensor	Biz-Custom	Retail	Retro	1,126	1,126	15%	169	0.00	8	$70	75%	24%	24%	2	35%	15%	85.4%	47.6%	47.6%	3.2
1120	Office_PC	Electrically Commutated Plug Fans in data centers	Biz-Custom	Retail	Retro	86,783	86,783	18%	15,778	0.00	15	$480	100%	50%	50%	1	65%	20%	94.6%	74.6%	74.6%	50.8
1121	Office_PC	Energy Star Server	Biz-Custom	Retail	ROB	1,621	1,621	23%	368	0.00	8	$118	100%	31%	31%	1	65%	25%	94.6%	58.2%	58.2%	4.5
1122	Office_PC	Server Virtualization	Biz-Custom	Retail	Retro	2	2	45%	1	0.00	8	$0	75%	25%	25%	1	65%	25%	85.8%	49.3%	49.3%	3.2
1123	Office_PC	High Efficiency CRAC unit	Biz-Custom	Retail	ROB	541	541	30%	162	0.00	15	$63	100%	26%	26%	2	65%	20%	94.6%	51.1%	51.1%	8.1
1124	Office_PC	Computer Room Air Conditioner Economizer	Biz-Custom	Retail	Retro	764	764	47%	358	0.00	15	$82	100%	44%	44%	2	65%	20%	94.6%	66.1%	66.1%	5.6
1125	Office_PC	Data Center Hot/Cold Aisle Configuration	Biz-Custom	Retail	Retro	4	4	25%	1	0.00	15	$0	100%	25%	25%	3	3%	10%	94.6%	49.3%	49.3%	7.7
1126	Office_PC	Energy Star Laptop	Biz-Custom	Retail	ROB	126	126	33%	41	0.00	4	$0	0%			4	11%	85%	94.6%	88.0%	88.0%	0.0
1127	Office_PC	Energy Star Monitor	Biz-Custom	Retail	ROB	72	72	21%	15	0.00	4	$0	0%			5	25%	85%	94.6%	88.0%	88.0%	0.0
1128	Refrigeration	Strip Curtains	Biz-Custom	Retail	Retro	0	0	0%	0	0.00	4	$0	0%	0%		1	6%	30%	88.0%	70.4%	70.4%	0.0
1129	Refrigeration	Bare Suction Line	Biz-Custom	Retail	Retro	23	23	93%	21	0.00	15	$4	100%	50%	50%	2	0%	50%	88.0%	66.5%	66.5%	8.1
1130	Refrigeration	Floating Head Pressure Controls	Biz-Custom	Retail	Retro	1,112	1,112	25%	278	0.00	15	$431	25%	6%	6%	3	4%	25%	47.5%	40.0%	40.0%	5.6
1131	Refrigeration	Saturated Suction Controls	Biz-Custom	Retail	Retro	831	831	50%	416	0.00	15	$559	100%	7%	7%	4	2%	10%	88.0%	28.0%	28.0%	13.7
1132	Refrigeration	Compressor Retrofit	Biz-Custom	Retail	Retro	813	813	20%	163	0.00	15	$477	25%	3%	3%	5	13%	25%	47.5%	39.4%	39.4%	13.8
1133	Refrigeration	Electronically Commutated (EC) Walk-In Evaporator Fan Motor	Biz-Prescriptive	Retail	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	6	4%	80%	88.0%	84.0%	84.0%	30.7
1134	Refrigeration	Evaporator Fan Motor Controls	Biz-Custom	Retail	Retro	1,912	1,912	25%	478	0.00	13	$162	100%	30%	30%	7	4%	25%	88.0%	61.7%	61.7%	7.0
1135	Refrigeration	Variable Speed Condenser Fan	Biz-Custom	Retail	Retro	2,960	2,960	50%	1,480	0.00	15	$1,170	50%	13%	13%	8	5%	25%	59.5%	40.0%	40.0%	5.6
1136	Refrigeration	Refrigeration Economizer	Biz-Custom	Retail	Retro	7	7	2%	0	0.00	10	$0	100%	50%	50%	9	18%	10%	88.0%	41.1%	41.1%	4.2
1137	Refrigeration	Anti-Sweat Heater Controls MT	Biz-Prescriptive	Retail	Retro	579	579	59%	338	0.00	10	$170	75%	44%	44%	10	18%	75%	82.5%	80.0%	80.0%	2.1
1138	Refrigeration	Auto Door Closer, Cooler	Biz-Custom	Retail	Retro	471,500	471,500	0%	943	0.00	8	$157	100%	50%	50%	11	13%	50%	88.0%	66.9%	66.9%	5.8
1139	Refrigeration	Display Case Door Retrofit, Medium Temp	Biz-Custom	Retail	Retro	1,584	1,584	36%	578	0.00	12	$686	50%	8%	8%	11	5%	25%	47.9%	40.0%	40.0%	7.1
1140	Refrigeration	Electronically Commutated (EC) Reach-In Evaporator Fan Motor	Biz-Prescriptive	Retail	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	12	3%	80%	88.0%	84.0%	84.0%	30.7
1141	Refrigeration	Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor	Biz-Custom	Retail	Retro	1,911	1,911	26%	504	0.00	10	$96	100%	50%	50%	12	3%	2%	88.0%	66.5%	66.5%	5.8
1142	Refrigeration	Energy Star Reach-In Refrigerator, Glass Doors	Biz-Prescriptive	Retail	ROB	2,140	2,140	29%	629	0.00	12	$1,239	25%	6%	14%	13	17%	54%	67.8%	63.2%	63.2%	5.6
1143	Refrigeration	Energy Star Reach-In Refrigerator, Solid Doors	Biz-Prescriptive	Retail	ROB	1,410	1,410	20%	281	0.00	12	$1,211	6%	6%	6%	14	17%	54%	67.8%	63.2%	63.2%	2.5
1144	Refrigeration	Anti-Sweat Heater Controls LT	Biz-Prescriptive	Retail	Retro	2,016	2,016	68%	1,361	0.00	10	$170	100%	44%	55%	15	6%	75%	88.0%	84.3%	85.0%	8.3
1145	Refrigeration	Auto Door Closer, Freezer	Biz-Custom	Retail	Retro	419,455	419,455	1%	2,307	0.00	8	$157	100%	50%	50%	16	6%	50%	88.0%	68.9%	68.9%	13.9
1146	Refrigeration	Display Case Door Retrofit, Low Temp	Biz-Custom	Retail	Retro	2,922	2,922	50%	1,453	0.00	12	$686	100%	21%	21%	16	6%	25%	88.0%	49.7%	49.7%	7.1
1147	Refrigeration	Energy Star Reach-In Freezer, Glass Doors	Biz-Prescriptive	Retail	ROB	6,374	6,374	20%	1,275	0.00	12	$1,651	25%	21%	21%	17	6%	54%	67.8%	63.2%	63.2%	2.3
1148	Refrigeration	Energy Star Reach-In Freezer, Solid Doors	Biz-Prescriptive	Retail	ROB	4,522	4,522	7%	305	0.00	12	$1,521	23%	23%	23%	18	6%	54%	67.8%	63.2%	63.2%	0.5
1149	Refrigeration	Refrigeration - Custom	Biz-Custom	Retail	ROB	7	7	2%	0	0.00	10	$0	75%	25%	25%	19	90%	25%	47.5%	39.4%	39.4%	3.3
1150	Refrigeration	Retro-commissioning_Refrigerator Optimization	Biz-Custom RCx	Retail	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	20	90%	25%	88.0%	65.9%	65.9%	3.2
1151	Refrigeration	Energy Star Ice Machine	Biz-Prescriptive	Retail	ROB	6,993	6,993	10%	721	0.00	15	$1,426	25%	18%	18%	21	3%	44%	60.8%	55.2%	55.2%	2.1
1152	Refrigeration	Vending Machine Controller - Refrigerated	Biz-Prescriptive	Retail	Retro	1,586	1,586	34%	537	0.00	5	$245	25%	16%	16%	22	3%	30%	65.5%	61.1%	61.1%	2.7

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
1153	Refrigeration	LED Refrigerated Display Case Lighting Average 6W/LF	Biz-Prescriptive	Retail	Retro	273	273	89%	243	0.00	9	$11	100%	45%	55%	23	11%	35%	88.0%	86.7%	86.9%	30.9
1154	Refrigeration	LED Refrigerated Display Case Lighting Controls	Biz-Prescriptive	Retail	Retro	522	522	27%	141	0.00	10	$15	100%	100%	100%	24	11%	18%	88.0%	88.0%	88.0%	6.6
1155	Ventilation	Demand Controlled Ventilation	Biz-Custom	Retail	Retro	2,798	2,798	20%	560	0.00	15	$227	100%	25%	25%	1	100%	18%	92.7%	51.2%	51.2%	10.7
1156	Ventilation	Pump and Fan Variable Frequency Drive Controls (Fans)	Biz-Prescriptive	Retail	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	55%	2	100%	18%	92.7%	74.0%	79.4%	11.6
1157	WholeBldg_HVAC	HVAC - Energy Management System	Biz-Custom RCx	Retail	Retro	13	13	8%	1	0.00	15	$0	100%	25%	25%	1	100%	20%	92.7%	51.6%	51.6%	8.8
1158	WholeBldg_HVAC	Guest room energy management system	Biz-Custom	Retail	Retro	0	0	0%	0	0.00	15	$260	0%		0%	2	100%	20%	92.7%	74.2%	74.2%	0.0
1159	WholeBldg_HVAC	Retro-commissioning_Bld Optimization	Biz-Custom RCx	Retail	Retro	10	10	10%	1	0.00	15	$0	100%	25%	25%	3	100%	0%	92.7%	51.6%	51.6%	8.8
1160	WholeBuilding	WholeBlg - Com RET	Biz-Custom	Retail	Retro	7	7	15%	1	0.00	12	$0	100%	25%	25%	1	90%	0%	92.7%	51.6%	51.6%	7.3
1161	WholeBuilding	WholeBlg - Custom (Other)	Biz-Custom	Retail	Retro	5	5	20%	1	0.00	12	$0	100%	25%	25%	2	90%	0%	92.7%	51.6%	51.6%	7.3
1162	WholeBuilding	Power Distribution Equipment Upgrades (Transformers)	Biz-Custom	Retail	Retro	1,150	1,150	1%	6	0.00	30	$8	100%	9%	9%	3	100%	20%	92.7%	36.0%	36.0%	17.1
1163	WholeBldg_NC	WholeBlg - Com NC	Biz-Custom	Retail	NC	4	4	25%	1	0.00	12	$0	100%	50%	50%	1	100%	60%	83.4%	68.0%	68.0%	7.6
1164	Behavioral	COM Competitions	Biz-Custom	Retail	Retro	53	53	2%	1	0.00	2	$0	100%	50%	50%	1	100%	0%	50.0%	40.0%	40.0%	3.9
1165	Behavioral	Business Energy Reports	Biz-Custom	Retail	Retro	313	313	0%	1	0.00	2	$0	50%	50%	50%	1	100%	0%	50.0%	40.0%	40.0%	0.8
1166	Behavioral	Building Benchmarking	Biz-Custom	Retail	Retro	97	97	1%	1	0.00	2	$0	45%	45%	45%	1	100%	0%	50.0%	40.0%	40.0%	0.8
1167	Behavioral	Strategic Energy Management	Biz-Custom SEM	Retail	Retro	0	0	0%	0	0.00	5	$0	0%		0%	1	100%	0%	50.0%	40.0%	40.0%	0.0
1168	Behavioral	BEIMS	Biz-Custom	Retail	Retro	20	20	5%	1	0.00	2	$0	23%	23%	23%	1	100%	2%	50.0%	40.0%	40.0%	0.8
1169	Behavioral	Building Operator Certification	Biz-Custom	Retail	Retro	14	14	3%	0	0.00	3	$0	25%	20%	20%	1	100%	2%	50.0%	40.0%	40.0%	1.7
1170	CompressedAir	Efficient Air Compressors (VSD)	Biz-Prescriptive	Office	ROB	1,583	1,583	21%	329	0.00	13	$127	100%	59%	80%	1	100%	33%	92.7%	76.7%	83.1%	5.5
1171	CompressedAir	Efficient Air Nozzles	Biz-Prescriptive	Office	Retro	1,480	1,480	50%	740	0.00	15	$50	100%	81%	81%	2	35%	33%	92.7%	91.1%	91.1%	15.8
1172	CompressedAir	AODD Pump Controls	Biz-Custom	Office	Retro	103,919	103,919	35%	36,372	0.00	10	$1,150	100%	50%	50%	3	10%	33%	92.7%	72.6%	72.6%	38.2
1173	CompressedAir	Compressed Air - Custom	Biz-Custom	Office	Retro	5	5	20%	1	0.00	10	$0	100%	47%	47%	4	50%	33%	92.7%	64.2%	64.2%	6.0
1174	CompressedAir	Retro-commissioning_Compressed Air Optimization	Biz-Custom RCx	Office	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	5	50%	33%	92.7%	64.2%	64.2%	3.2
1175	Cooking	Commercial Combination Oven (Electric)	Biz-Prescriptive	Office	ROB	38,561	38,561	48%	18,432	0.00	12	$16,884	75%	6%	15%	1	18%	53%	77.5%	62.4%	62.4%	14.1
1176	Cooking	Commercial Electric Convection Oven	Biz-Prescriptive	Office	ROB	12,193	12,193	15%	1,879	0.00	12	$1,706	75%	21%	51%	1	18%	53%	77.6%	62.4%	62.4%	4.4
1177	Cooking	Commercial Electric Griddle	Biz-Prescriptive	Office	ROB	17,056	17,056	15%	2,596	0.00	12	$3,604	25%	15%	15%	2	14%	17%	41.9%	33.6%	33.6%	2.8
1178	Cooking	Commercial Electric Steam Cooker	Biz-Prescriptive	Office	ROB	19,549	19,549	67%	13,162	0.00	12	$2,490	100%	24%	55%	3	6%	45%	88.0%	81.1%	83.5%	18.0
1179	Cooking	Dishwasher Low Temp Door (Energy Star)	Biz-Prescriptive	Office	ROB	39,306	39,306	44%	17,369	0.00	15	$1,000	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	11.7
1180	Cooking	Dishwasher High Temp Door (Energy Star)	Biz-Prescriptive	Office	ROB	26,901	26,901	32%	8,586	0.00	15	$1,100	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	5.2
1181	Cooking	Energy efficient electric fryer	Biz-Prescriptive	Office	ROB	18,955	18,955	17%	3,274	0.00	12	$1,500	100%	5%	13%	5	27%	24%	88.0%	57.2%	59.4%	23.2
1182	Cooking	Insulated Holding Cabinets (Full Size)	Biz-Prescriptive	Office	ROB	13,697	13,697	68%	9,314	0.00	12	$1,200	100%	35%	55%	6	3%	16%	88.0%	83.6%	84.9%	12.7
1183	Cooking	Insulated Holding Cabinets (Half-Size)	Biz-Prescriptive	Office	ROB	4,383	4,383	60%	2,630	0.00	12	$1,500	100%	10%	25%	6	3%	16%	88.0%	52.6%	57.6%	10.1
1184	Cooling	Air Conditioner - 13 IEER (5-20 Tons)	Biz-Prescriptive	Office	ROB	1,278	1,278	6%	79	0.00	15	$63	100%	48%	55%	1	26%	20%	92.7%	54.4%	58.7%	4.9
1185	Cooling	Air Conditioner - 14 IEER (5-20 Tons)	Biz-Prescriptive	Office	ROB	1,278	1,278	13%	164	0.00	15	$127	100%	24%	55%	1	26%	20%	92.7%	48.4%	59.9%	10.3
1186	Cooling	Air Conditioner - 17 IEER (5-20 Tons)	Biz-Prescriptive	Office	ROB	1,278	1,278	28%	361	0.00	15	$127	100%	24%	55%	1	26%	20%	92.7%	67.4%	76.6%	22.7
1187	Cooling	Air Conditioner - 21 IEER (5-20 Tons)	Biz-Prescriptive	Office	ROB	1,278	1,278	42%	535	0.00	15	$127	100%	24%	55%	1	26%	20%	92.7%	74.8%	80.7%	33.7
1188	Cooling	Air Conditioner - 12.1 IEER (20+ Tons)	Biz-Prescriptive	Office	ROB	1,367	1,367	6%	79	0.00	15	$30	100%	100%	100%	2	26%	20%	92.7%	92.7%	92.7%	5.0
1189	Cooling	Air Conditioner - 13 IEER (20+ Tons)	Biz-Prescriptive	Office	ROB	1,367	1,367	12%	168	0.00	15	$37	100%	81%	81%	2	26%	20%	92.7%	87.5%	87.5%	10.6
1190	Cooling	Air Conditioner - 14.3 IEER (20+ Tons)	Biz-Prescriptive	Office	ROB	1,367	1,367	20%	277	0.00	15	$37	100%	81%	81%	2	26%	20%	92.7%	89.6%	89.6%	17.4
1191	Cooling	Air Conditioner - 21 IEER (20+ Tons)	Biz-Prescriptive	Office	ROB	1,367	1,367	46%	625	0.00	15	$37	100%	81%	81%	2	26%	20%	92.7%	91.3%	91.3%	39.3
1192	Cooling	Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up)	Biz-Custom	Office	Retro	1,299	1,299	7%	91	0.00	3	$5	100%	50%	50%	3	51%	50%	92.7%	71.2%	71.2%	15.4
1193	Cooling	Air Side Economizer	Biz-Custom	Office	Retro	1,278	1,278	20%	256	0.00	10	$84	100%	30%	30%	4	51%	20%	92.7%	56.9%	56.9%	3.9
1194	Cooling	Advanced Rooftop Controls	Biz-Prescriptive	Office	Retro	1,299	1,299	2%	23	0.00	10	$100	100%	100%	100%	5	51%	20%	92.7%	92.7%	92.7%	0.1
1195	Cooling	HVAC Occupancy Controls	Biz-Custom	Office	ROB	2,900	2,900	20%	580	0.00	15	$537	100%	11%	11%	6	51%	20%	92.7%	36.0%	36.0%	12.0
1196	Cooling	Air Conditioner - 16 SEER (<5 Tons)	Biz-Prescriptive	Office	ROB	1,113	1,113	13%	139	0.00	15	$47	100%	64%	80%	7	8%	20%	92.7%	79.6%	84.3%	8.8
1197	Cooling	Air Conditioner - 17 SEER (<5 Tons)	Biz-Prescriptive	Office	ROB	1,113	1,113	18%	196	0.00	15	$206	100%	15%	36%	7	8%	20%	92.7%	39.4%	45.6%	12.4
1198	Cooling	Air Conditioner - 18 SEER(<5 Tons)	Biz-Prescriptive	Office	ROB	1,113	1,113	22%	247	0.00	15	$206	100%	15%	36%	7	8%	20%	92.7%	44.1%	50.5%	15.6
1199	Cooling	Air Conditioner - 21 SEER(<5 Tons)	Biz-Prescriptive	Office	ROB	1,113	1,113	33%	371	0.00	15	$253	100%	12%	30%	7	8%	20%	92.7%	48.0%	52.3%	23.3
1200	Cooling	Smart Thermostat	Biz-Prescriptive	Office	ROB	1,113	1,113	14%	158	0.00	11	$175	75%	57%	57%	8	8%	12%	66.6%	52.4%	52.4%	1.4
1201	Cooling	PTAC - <7,000 Btuh - lodging	Biz-Prescriptive	Office	ROB	1,310	1,310	8%	111	0.00	8	$84	100%	36%	55%	9	7%	20%	92.7%	52.0%	60.5%	3.8
1202	Cooling	PTAC - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Office	ROB	1,437	1,437	7%	104	0.00	8	$84	100%	36%	36%	10	7%	20%	92.7%	51.0%	51.0%	3.6
1203	Cooling	PTAC - >15,000 Btuh - lodging	Biz-Prescriptive	Office	ROB	1,641	1,641	10%	156	0.00	8	$84	100%	36%	55%	11	7%	20%	92.7%	60.1%	70.0%	5.4
1204	Cooling	Air Cooled Chiller	Biz-Prescriptive	Office	ROB	1,138	1,138	6%	64	0.00	23	$126	100%	24%	55%	12	34%	15%	92.7%	32.0%	39.6%	6.8
1205	Cooling	Chiller Tune-up	Biz-Prescriptive	Office	Retro	1,299	1,299	7%	91	0.00	3	$8	100%	100%	100%	13	34%	50%	92.7%	92.7%	92.7%	5.1
1206	Cooling	HVAC/Chiller Custom	Biz-Custom	Office	Retro	5	5	20%	1	0.00	20	$1	100%	7%	7%	14	100%	20%	92.7%	36.0%	36.0%	30.3
1207	Cooling	Window Film	Biz-Prescriptive	Office	Retro	6,000	6,000	4%	264	0.00	10	$154	100%	65%	65%	15	100%	20%	92.7%	73.1%	73.1%	3.2
1208	Cooling	Triple Pane Windows	Biz-Custom	Office	ROB	6,000	6,000	6%	360	0.00	25	$700	100%	5%	5%	15	100%	20%	92.7%	36.0%	36.0%	24.5
1209	Cooling	Energy Recovery Ventilator	Biz-Custom	Office	Retro	1,367	1,367	70%	952	0.00	15	$1,500	100%	6%	6%	16	100%	2%	92.7%	23.3%	23.3%	34.7
1210	Heating	Heat Pump - 16 SEER (<5 Tons)	Biz-Prescriptive	Office	ROB	1,703	1,703	5%	80	0.00	16	$87	100%	46%	46%	1	8%	20%	92.7%	48.4%	48.4%	2.9
1211	Heating	Heat Pump - 17 SEER (<5 Tons)	Biz-Prescriptive	Office	ROB	1,703	1,703	10%	165	0.00	16	$442	50%	9%	23%	1	8%	20%	44.0%	36.0%	36.0%	5.6
1212	Heating	Heat Pump - 18 SEER(<5 Tons)	Biz-Prescriptive	Office	ROB	1,703	1,703	14%	235	0.00	16	$507	50%	8%	20%	1	8%	20%	44.0%	36.0%	36.0%	7.9
1213	Heating	Heat Pump - 21 SEER(<5 Tons)	Biz-Prescriptive	Office	ROB	1,703	1,703	22%	377	0.00	16	$507	100%	8%	20%	1	8%	20%	92.7%	36.0%	36.2%	12.8
1214	Heating	Geothermal HP - SEER 20.3 (<5 Tons)	Biz-Prescriptive	Office	ROB	1,703	1,703	24%	404	0.00	25	$2,576	25%	2%	4%	1	8%	20%	44.0%	36.0%	36.0%	17.7
1215	Heating	Geothermal HP - SEER 21.5 (<5 Tons)	Biz-Prescriptive	Office	ROB	1,703	1,703	28%	477	0.00	25	$2,576	25%	2%	4%	1	8%	20%	44.0%	36.0%	36.0%	20.4
1216	Heating	Geothermal HP - SEER 23.1 (<5 Tons)	Biz-Prescriptive	Office	ROB	1,703	1,703	33%	562	0.00	25	$2,576	25%	2%	4%	1	8%	20%	44.0%	36.0%	36.0%	23.4
1217	Heating	Geothermal HP - SEER 29.3 (<5 Tons)	Biz-Prescriptive	Office	ROB	1,703	1,703	47%	807	0.00	25	$2,576	25%	2%	4%	1	8%	20%	44.0%	36.0%	36.0%	30.0
1218	Heating	Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Office	ROB	2,077	2,077	12%	250	0.00	16	$100	100%	40%	55%	2	26%	20%	92.7%	70.2%	75.0%	32.1
1219	Heating	Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Office	ROB	2,077	2,077	17%	362	0.00	16	$136	100%	30%	55%	2	26%	20%	92.7%	67.9%	75.8%	35.8
1220	Heating	Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Office	ROB	2,170	2,170	17%	361	0.00	16	$100	100%	40%	55%	2	26%	20%	92.7%	76.0%	79.3%	36.7
1221	Heating	Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Office	ROB	2,170	2,170	22%	470	0.00	16	$139	100%	29%	55%	2	26%	20%	92.7%	72.6%	78.6%	40.2
1222	Heating	Geothermal HP - SEER 20.3 (5-20 Tons)	Biz-Prescriptive	Office	ROB	1,886	1,886	31%	587	0.00	25	$2,576	50%	2%	4%	2	26%	20%	44.0%	36.0%	36.0%	36.8
1223	Heating	Geothermal HP - SEER 21.5 (5-20 Tons)	Biz-Prescriptive	Office	ROB	1,886	1,886	35%	659	0.00	25	$2,576	50%	2%	4%	2	26%	20%	44.0%	36.0%	36.0%	39.5
1224	Heating	Geothermal HP - SEER 23.1 (5-20 Tons)	Biz-Prescriptive	Office	ROB	2,050	2,050	44%	908	0.00	25	$2,576	50%	2%	4%	2	26%	20%	44.0%	36.0%	36.0%	46.1

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
1225	Heating	Geothermal HP - SEER 29.3 (5-20 Tons)	Biz-Prescriptive	Office	ROB	2,050	2,050	56%	1,154	0.00	25	$2,576	75%	2%	4%	2	26%	20%	49.5%	36.0%	36.0%	52.7
1226	Heating	Variable Refrigerant Flow Heat Pump	Biz-Custom	Office	ROB	1,624	1,624	18%	297	0.00	16	$224	100%	13%	13%	2	26%	2%	92.7%	36.9%	36.9%	15.6
1227	Heating	Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr)	Biz-Prescriptive	Office	ROB	2,301	2,301	11%	247	0.00	16	$100	100%	40%	55%	3	26%	20%	92.7%	69.9%	74.8%	28.8
1228	Heating	Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr)	Biz-Prescriptive	Office	ROB	2,301	2,301	17%	389	0.00	16	$175	100%	23%	55%	3	26%	20%	92.7%	60.0%	73.2%	33.7
1229	Heating	Geothermal HP - SEER 20.3 (20+ Tons)	Biz-Prescriptive	Office	ROB	2,170	2,170	40%	871	0.00	25	$2,576	100%	2%	4%	3	26%	20%	92.7%	36.0%	36.0%	71.3
1230	Heating	Geothermal HP - SEER 21.5 (20+ Tons)	Biz-Prescriptive	Office	ROB	2,170	2,170	43%	943	0.00	25	$2,576	100%	2%	4%	3	26%	20%	92.7%	36.0%	36.0%	74.0
1231	Heating	Geothermal HP - SEER 23.1 (20+ Tons)	Biz-Prescriptive	Office	ROB	2,170	2,170	47%	1,028	0.00	25	$2,576	100%	2%	4%	3	26%	20%	92.7%	36.0%	36.0%	77.0
1232	Heating	Geothermal HP - SEER 29.3 (20+ Tons)	Biz-Prescriptive	Office	ROB	2,170	2,170	59%	1,274	0.00	25	$2,576	100%	2%	4%	3	26%	20%	92.7%	36.0%	36.0%	83.6
1233	Heating	Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD)	Biz-Prescriptive	Office	ROB	1,703	1,703	22%	377	0.00	16	$224	100%	18%	45%	4	30%	20%	92.7%	52.0%	61.7%	12.8
1234	Heating	PTHP - <7,000 Btuh - lodging	Biz-Custom	Office	ROB	1,849	1,849	6%	107	0.00	8	$130	100%	100%	100%	5	3%	10%	92.7%	74.2%	74.2%	0.8
1235	Heating	PTHP - >15,000 Btuh - lodging	Biz-Prescriptive	Office	ROB	2,324	2,324	22%	509	0.00	8	$130	100%	100%	100%	6	3%	10%	92.7%	92.7%	92.7%	3.8
1236	Heating	PTHP - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Office	ROB	2,054	2,054	13%	264	0.00	8	$130	100%	100%	100%	7	3%	10%	92.7%	92.7%	92.7%	1.9
1237	HotWater	Heat Pump Water Heater	Biz-Prescriptive	Office	ROB	4,536	4,536	67%	3,038	0.00	15	$1,115	100%	45%	55%	1	100%	11%	84.0%	70.7%	73.7%	5.0
1238	HotWater	Hot Water Pipe Insulation	Biz-Custom	Office	Retro	4,536	4,536	2%	91	0.00	20	$60	100%	15%	15%	2	100%	80%	86.0%	84.0%	84.0%	9.8
1239	HotWater	Faucet Aerator	Biz-Custom	Office	Retro	545	545	32%	176	0.00	10	$8	100%	50%	50%	3	20%	90%	93.0%	92.0%	92.0%	35.6
1240	HotWater	Low Flow Pre-Rinse Sprayers	Biz-Prescriptive	Office	ROB	18,059	18,059	54%	9,789	0.00	5	$60	100%	17%	42%	4	20%	80%	86.0%	84.0%	84.0%	199.3
1241	HotWater	ENERGY STAR Commercial Washing Machines	Biz-Prescriptive	Office	ROB	1,552	1,552	43%	671	0.00	7	$250	75%	28%	28%	5	25%	33%	79.3%	64.6%	64.6%	2.9
1242	InteriorLighting	LED T8 Tube Replacement	Biz-Prescriptive Light	Office	Retro	115	115	45%	51	0.00	15	$5	100%	100%	100%	1	78%	40%	94.6%	94.6%	94.6%	10.6
1243	InteriorLighting	LED troffer retrofit kit, 2'X2' and 2'X4'	Biz-Prescriptive Light	Office	Retro	260	260	50%	130	0.00	15	$70	100%	36%	55%	1	78%	40%	94.6%	54.8%	70.4%	5.4
1244	InteriorLighting	LED troffer, 2'X2' and 2'X4'	Biz-Prescriptive Light	Office	Retro	260	260	50%	130	0.00	15	$70	100%	36%	55%	1	78%	40%	94.6%	54.8%	70.4%	5.4
1245	InteriorLighting	Bi-Level Lighting Fixture – Stairwells, Hallways	Biz-Custom Light	Office	Retro	260	260	74%	193	0.00	10	$274	25%	7%	9%	2	1%	40%	58.0%	50.5%	50.7%	4.8
1246	InteriorLighting	LED high bay fixture	Biz-Prescriptive Light	Office	Retro	2,423	2,423	68%	1,649	0.00	15	$330	100%	35%	55%	3	6%	34%	94.6%	82.5%	86.9%	14.7
1247	InteriorLighting	LED Mogul-base HID Lamp Replacing High Bay HID	Biz-Prescriptive Light	Office	Retro	2,423	2,423	66%	1,608	0.00	15	$330	100%	35%	55%	3	6%	34%	94.6%	82.2%	86.6%	14.4
1248	InteriorLighting	LED low bay fixture	Biz-Prescriptive Light	Office	Retro	516	516	61%	314	0.00	15	$44	100%	68%	80%	4	11%	34%	94.6%	90.9%	92.2%	10.7
1249	InteriorLighting	LED Mogul-base HID Lamp Replacing Low Bay HID	Biz-Prescriptive Light	Office	Retro	516	516	59%	303	0.00	15	$44	100%	68%	80%	4	11%	34%	94.6%	90.7%	92.2%	10.4
1250	InteriorLighting	LED Screw-In Lamps (Directional)	Biz-Prescriptive Light	Office	ROB	283	283	86%	243	0.00	7	$1	100%	100%	100%	6	0%	43%	94.6%	94.6%	94.6%	126.7
1251	InteriorLighting	LED downlight fixture	Biz-Prescriptive Light	Office	Retro	179	179	68%	121	0.00	15	$27	100%	19%	46%	6	4%	45%	94.6%	76.9%	83.6%	24.8
1252	InteriorLighting	LED Screw-In Lamps (Omnidirectional & Decorative)	Biz-Prescriptive Light	Office	ROB	214	214	81%	173	0.00	7	$1	100%	100%	100%	5	1%	20%	94.6%	94.6%	94.6%	90.3
1253	InteriorLighting	DeLamp Fluorescent Fixture Average Lamp Wattage 28W	Biz-Prescriptive Light	Office	Retro	96	96	100%	96	0.00	11	$4	100%	100%	100%	7	78%	0%	94.6%	94.6%	94.6%	18.8
1254	InteriorLighting	Occupancy Sensors	Biz-Prescriptive Light	Office	Retro	438	438	30%	131	0.00	10	$65	75%	31%	31%	8	95%	10%	83.1%	54.7%	54.7%	3.1
1255	InteriorLighting	Daylighting Controls	Biz-Prescriptive Light	Office	Retro	560	560	30%	168	0.00	10	$58	100%	35%	55%	8	95%	10%	94.6%	72.5%	80.0%	7.7
1256	InteriorLighting	Dual Occupancy & Daylighting Controls	Biz-Custom Light	Office	Retro	250	250	44%	110	0.00	10	$75	100%	40%	50%	8	95%	10%	94.6%	37.2%	44.4%	2.7
1257	InteriorLighting	Central Lighting Monitoring & Controls (non-networked)	Biz-Custom Light	Office	Retro	41,703	41,703	20%	8,341	0.00	12	$3,700	100%	23%	29%	8	95%	10%	94.6%	44.1%	47.7%	4.6
1258	InteriorLighting	Network Lighting Controls - Wireless (WiFi)	Biz-Custom Light	Office	Retro	5	5	49%	2	0.00	15	$1	100%	40%	50%	8	95%	10%	94.6%	64.4%	66.5%	7.5
1259	InteriorLighting	Luminaire Level Lighting Controls w/ HVAC Control	Biz-Custom Light	Office	Retro	589	589	65%	383	0.00	15	$90	100%	43%	50%	8	96%	10%	94.6%	65.6%	67.1%	7.5
1260	InteriorLighting	LED Exit Sign - 4 Watt Fixture (2 lamp)	Biz-Prescriptive Light	Office	Retro	70	70	43%	30	0.00	5	$33	92%	92%	92%	9	1%	75%	87.6%	87.6%	87.6%	0.3
1261	InteriorLighting	Lighting - Custom	Biz-Custom Light	Office	Retro	4	4	25%	1	0.00	15	$1	100%	17%	21%	10	100%	0%	94.6%	33.6%	34.7%	7.5
1262	ExteriorLighting	LED wallpack (existing W<250)	Biz-Prescriptive Light	Office	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	1	12%	46%	94.6%	56.6%	70.8%	5.8
1263	ExteriorLighting	LED parking lot fixture (existing W≥250)	Biz-Prescriptive Light	Office	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	2	11%	54%	67.8%	63.2%	63.2%	4.4
1264	ExteriorLighting	LED parking lot fixture (existing W<250)	Biz-Prescriptive Light	Office	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	3	11%	54%	94.6%	63.2%	70.8%	5.8
1265	ExteriorLighting	LED outdoor pole decorative fixture (existing W≥250)	Biz-Prescriptive Light	Office	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	17%	17%	4	11%	54%	67.8%	63.2%	63.2%	3.4
1266	ExteriorLighting	LED parking garage fixture (existing W≥250)	Biz-Prescriptive Light	Office	Retro	3,235	3,235	60%	1,953	0.00	6	$756	50%	13%	33%	5	11%	69%	78.3%	75.2%	75.2%	4.7
1267	ExteriorLighting	LED parking garage fixture (existing W<250)	Biz-Prescriptive Light	Office	Retro	1,742	1,742	66%	1,154	0.00	6	$248	100%	18%	45%	6	11%	69%	94.6%	77.6%	83.9%	6.2
1268	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250)	Biz-Prescriptive Light	Office	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	7	11%	46%	62.1%	56.6%	56.6%	4.4
1269	ExteriorLighting	LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250)	Biz-Prescriptive Light	Office	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	8	11%	46%	94.6%	56.6%	70.8%	5.8
1270	ExteriorLighting	Bi-Level Lighting Fixture – Garages	Biz-Custom Light	Office	Retro	260	260	69%	179	0.00	10	$274	25%	7%	9%	9	11%	20%	44.0%	33.2%	33.4%	3.9
1271	ExteriorLighting	LED fuel pump canopy fixture (existing W<250)	Biz-Prescriptive Light	Office	Retro	0	0	0%	0	0.00	12	$0	0%	0%		10	0%	54%	94.6%	94.6%	94.6%	0.0
1272	ExteriorLighting	LED fuel pump canopy fixture (existing W≥250)	Biz-Prescriptive Light	Office	Retro	0	0	0%	0	0.00	12	$0	0%	0%		11	0%	54%	94.6%	94.6%	94.6%	0.0
1273	Miscellaneous	Vending Machine Controller - Non-Refrigerated	Biz-Prescriptive	Office	Retro	385	385	61%	237	0.00	5	$233	11%	11%	11%	1	5%	30%	51.0%	44.0%	44.0%	1.9
1274	Miscellaneous	Miscellaneous Custom	Biz-Custom	Office	Retro	7	7	2%	0	0.00	10	$0	75%	25%	25%	2	31%	10%	37.0%	23.4%	23.4%	3.3
1275	Miscellaneous	Kitchen Exhaust Hood Demand Ventilation Control System	Biz-Prescriptive	Office	ROB	9,932	9,932	50%	4,966	0.00	20	$1,180	100%	11%	27%	3	31%	10%	94.6%	73.8%	78.0%	39.7
1276	Miscellaneous	High Efficiency Hand Dryers	Biz-Custom	Office	Retro	262	262	83%	217	0.00	10	$483	25%	4%	4%	4	5%	10%	37.0%	23.4%	23.4%	8.6
1277	Miscellaneous	Ozone Commercial Laundry	Biz-Custom	Office	Retro	2,984	2,984	25%	746	0.00	10	$20,310	0%	0%	0%	5	3%	2%	31.4%	16.6%	16.6%	3.9
1278	Miscellaneous	ENERGY STAR Uninterrupted Power Supply	Biz-Custom	Office	ROB	3,096	3,096	3%	85	0.00	15	$59	100%	14%	14%	6	1%	70%	94.6%	76.0%	76.0%	8.8
1279	Motors	Cogged V-Belt	Biz-Custom	Office	Retro	9,092	9,092	3%	282	0.00	15	$384	75%	7%	7%	1	50%	10%	52.9%	28.0%	28.0%	12.5
1280	Motors	Pump and Fan Variable Frequency Drive Controls (Pumps)	Biz-Custom	Office	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	30%	2	100%	10%	83.4%	52.4%	52.4%	11.6
1281	Motors	Power Drive Systems	Biz-Custom	Office	Retro	4	4	23%	1	0.00	15	$0	100%	37%	37%	2	100%	10%	83.4%	53.4%	53.4%	12.5
1282	Motors	Switch Reluctance Motors	Biz-Custom	Office	Retro	17,620	17,620	31%	5,392	0.00	15	$528	100%	50%	50%	2	100%	1%	83.4%	61.8%	61.8%	13.9
1283	Motors	Escalators Motor Efficiency Controllers	Biz-Custom	Office	Retro	7,500	7,500	20%	1,500	0.00	10	$5,000	3%	3%	3%	3	0%	10%	37.0%	26.3%	26.3%	7.3
1284	Office_NonPC	Energy Star Printer/Copier/Fax	Biz-Custom	Office	ROB	551	551	40%	223	0.00	6	$0	0%			1	30%	90%	94.6%	92.0%	92.0%	0.0
1285	Office_NonPC	Smart Power Strip – Commercial Use	Biz-Custom	Office	Retro	1,086	1,086	10%	109	0.00	7	$50	50%	22%	22%	2	35%	15%	71.8%	42.0%	42.0%	2.8
1286	Office_NonPC	Plug Load Occupancy Sensor	Biz-Custom	Office	Retro	1,126	1,126	15%	169	0.00	8	$70	75%	24%	24%	2	35%	15%	85.4%	47.6%	47.6%	3.2
1287	Office_PC	Electrically Commutated Plug Fans in data centers	Biz-Custom	Office	Retro	86,783	86,783	18%	15,778	0.00	15	$480	100%	50%	50%	1	65%	20%	94.6%	74.6%	74.6%	50.8
1288	Office_PC	Energy Star Server	Biz-Custom	Office	ROB	1,621	1,621	23%	368	0.00	8	$118	100%	31%	31%	1	65%	25%	94.6%	58.2%	58.2%	4.5
1289	Office_PC	Server Virtualization	Biz-Custom	Office	Retro	2	2	45%	1	0.00	8	$0	75%	25%	25%	1	65%	25%	85.8%	49.3%	49.3%	3.2
1290	Office_PC	High Efficiency CRAC unit	Biz-Custom	Office	ROB	541	541	30%	162	0.00	15	$63	100%	26%	26%	2	65%	20%	94.6%	51.1%	51.1%	8.1
1291	Office_PC	Computer Room Air Conditioner Economizer	Biz-Custom	Office	Retro	764	764	47%	358	0.00	15	$82	100%	44%	44%	2	65%	20%	94.6%	66.1%	66.1%	5.6
1292	Office_PC	Data Center Hot/Cold Aisle Configuration	Biz-Custom	Office	Retro	4	4	25%	1	0.00	15	$0	100%	25%	25%	3	3%	10%	94.6%	49.3%	49.3%	7.7
1293	Office_PC	Energy Star Laptop	Biz-Custom	Office	ROB	126	126	33%	41	0.00	4	$0	0%			4	11%	85%	94.6%	88.0%	88.0%	0.0
1294	Office_PC	Energy Star Monitor	Biz-Custom	Office	ROB	72	72	21%	15	0.00	4	$0	0%			5	25%	85%	94.6%	88.0%	88.0%	0.0
1295	Refrigeration	Strip Curtains	Biz-Custom	Office	Retro	0	0	0%	0	0.00	4	$0	0%	0%		1	1%	30%	88.0%	70.4%	70.4%	0.0
1296	Refrigeration	Bare Suction Line	Biz-Custom	Office	Retro	23	23	93%	21	0.00	15	$4	100%	50%	50%	2	0%	50%	88.0%	66.5%	66.5%	8.1

Appendix C: C&I Measure Assumptions

Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
1297	Refrigeration	Floating Head Pressure Controls	Biz-Custom	Office	Retro	1,112	1,112	25%	278	0.00	15	$431	25%	6%	6%	3	1%	25%	47.5%	40.0%	40.0%	5.6
1298	Refrigeration	Saturated Suction Controls	Biz-Custom	Office	Retro	831	831	50%	416	0.00	15	$559	100%	7%	7%	4	2%	10%	88.0%	28.0%	28.0%	13.7
1299	Refrigeration	Compressor Retrofit	Biz-Custom	Office	Retro	813	813	20%	163	0.00	15	$477	25%	3%	3%	5	2%	25%	47.5%	39.4%	39.4%	13.8
1300	Refrigeration	Electronically Commutated (EC) Walk-In Evaporator Fan Motor	Biz-Prescriptive	Office	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	6	1%	80%	88.0%	84.0%	84.0%	30.7
1301	Refrigeration	Evaporator Fan Motor Controls	Biz-Custom	Office	Retro	1,912	1,912	25%	478	0.00	13	$162	100%	30%	30%	7	1%	25%	88.0%	61.7%	61.7%	7.0
1302	Refrigeration	Variable Speed Condenser Fan	Biz-Custom	Office	Retro	2,960	2,960	50%	1,480	0.00	15	$1,170	50%	13%	13%	8	1%	25%	59.5%	40.0%	40.0%	5.6
1303	Refrigeration	Refrigeration Economizer	Biz-Custom	Office	Retro	7	7	2%	0	0.00	10	$0	100%	50%	50%	9	3%	10%	88.0%	41.1%	41.1%	4.2
1304	Refrigeration	Anti-Sweat Heater Controls MT	Biz-Prescriptive	Office	Retro	579	579	59%	338	0.00	10	$170	75%	44%	44%	10	20%	25%	81.8%	72.4%	72.4%	2.1
1305	Refrigeration	Auto Door Closer, Cooler	Biz-Custom	Office	Retro	471,500	471,500	0%	943	0.00	8	$157	100%	50%	50%	11	15%	50%	88.0%	66.9%	66.9%	5.8
1306	Refrigeration	Display Case Door Retrofit, Medium Temp	Biz-Custom	Office	Retro	1,584	1,584	36%	578	0.00	12	$686	50%	8%	8%	11	6%	25%	47.9%	40.0%	40.0%	7.1
1307	Refrigeration	Electronically Commutated (EC) Reach-In Evaporator Fan Motor	Biz-Prescriptive	Office	Retro	2,440	2,440	65%	1,586	0.00	15	$305	100%	13%	33%	12	3%	80%	88.0%	84.0%	84.0%	30.7
1308	Refrigeration	Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor	Biz-Custom	Office	Retro	1,911	1,911	26%	504	0.00	10	$96	100%	50%	50%	12	3%	2%	88.0%	66.5%	66.5%	5.8
1309	Refrigeration	Energy Star Reach-In Refrigerator, Glass Doors	Biz-Prescriptive	Office	ROB	2,140	2,140	29%	629	0.00	12	$1,239	25%	6%	14%	13	19%	54%	67.8%	63.2%	63.2%	5.6
1310	Refrigeration	Energy Star Reach-In Refrigerator, Solid Doors	Biz-Prescriptive	Office	ROB	1,410	1,410	20%	281	0.00	12	$1,211	6%	6%	6%	14	19%	54%	67.8%	63.2%	63.2%	2.5
1311	Refrigeration	Anti-Sweat Heater Controls LT	Biz-Prescriptive	Office	Retro	2,016	2,016	68%	1,361	0.00	10	$170	100%	44%	55%	15	7%	25%	88.0%	84.3%	85.0%	8.3
1312	Refrigeration	Auto Door Closer, Freezer	Biz-Custom	Office	Retro	419,455	419,455	1%	2,307	0.00	8	$157	100%	50%	50%	16	7%	50%	88.0%	68.9%	68.9%	13.9
1313	Refrigeration	Display Case Door Retrofit, Low Temp	Biz-Custom	Office	Retro	2,922	2,922	50%	1,453	0.00	12	$686	100%	21%	21%	16	7%	25%	88.0%	49.7%	49.7%	7.1
1314	Refrigeration	Energy Star Reach-In Freezer, Glass Doors	Biz-Prescriptive	Office	ROB	6,374	6,374	20%	1,275	0.00	12	$1,651	25%	21%	21%	17	6%	54%	67.8%	63.2%	63.2%	2.3
1315	Refrigeration	Energy Star Reach-In Freezer, Solid Doors	Biz-Prescriptive	Office	ROB	4,522	4,522	7%	305	0.00	12	$1,521	23%	23%	23%	18	6%	54%	67.8%	63.2%	63.2%	0.5
1316	Refrigeration	Refrigeration - Custom	Biz-Custom	Office	ROB	7	7	2%	0	0.00	10	$0	75%	25%	25%	19	90%	25%	47.5%	39.4%	39.4%	3.3
1317	Refrigeration	Retro-commissioning_Refrigerator Optimization	Biz-Custom RCx	Office	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	20	90%	25%	88.0%	65.9%	65.9%	3.2
1318	Refrigeration	Energy Star Ice Machine	Biz-Prescriptive	Office	ROB	6,993	6,993	10%	721	0.00	15	$1,426	25%	18%	18%	21	9%	44%	60.8%	55.2%	55.2%	2.1
1319	Refrigeration	Vending Machine Controller - Refrigerated	Biz-Prescriptive	Office	Retro	1,586	1,586	34%	537	0.00	5	$245	25%	16%	16%	22	9%	30%	65.5%	61.1%	61.1%	2.7
1320	Refrigeration	LED Refrigerated Display Case Lighting Average 6W/LF	Biz-Prescriptive	Office	Retro	273	273	89%	243	0.00	9	$11	100%	45%	55%	23	12%	35%	88.0%	86.7%	86.9%	30.9
1321	Refrigeration	LED Refrigerated Display Case Lighting Controls	Biz-Prescriptive	Office	Retro	522	522	27%	141	0.00	10	$15	100%	100%	100%	24	12%	18%	88.0%	88.0%	88.0%	6.6
1322	Ventilation	Demand Controlled Ventilation	Biz-Custom	Office	Retro	2,644	2,644	20%	529	0.00	15	$227	100%	23%	23%	1	100%	49%	92.7%	59.1%	59.1%	6.5
1323	Ventilation	Pump and Fan Variable Frequency Drive Controls (Fans)	Biz-Prescriptive	Office	Retro	1,902	1,902	38%	731	0.00	15	$200	100%	30%	55%	2	100%	49%	92.7%	74.0%	79.4%	11.6
1324	WholeBldg_HVAC	HVAC - Energy Management System	Biz-Custom RCx	Office	Retro	13	13	8%	1	0.00	15	$0	100%	25%	25%	1	100%	20%	92.7%	51.6%	51.6%	8.8
1325	WholeBldg_HVAC	Guest room energy management system	Biz-Custom	Office	Retro	0	0	0%	0	0.00	15	$260	0%		0%	2	100%	20%	92.7%	74.2%	74.2%	0.0
1326	WholeBldg_HVAC	Retro-commissioning_Bld Optimization	Biz-Custom RCx	Office	Retro	10	10	10%	1	0.00	15	$0	100%	25%	25%	3	100%	0%	92.7%	51.6%	51.6%	8.8
1327	WholeBuilding	WholeBlg - Com RET	Biz-Custom	Office	Retro	7	7	15%	1	0.00	12	$0	100%	25%	25%	1	90%	0%	92.7%	51.6%	51.6%	7.3
1328	WholeBuilding	WholeBlg - Custom (Other)	Biz-Custom	Office	Retro	5	5	20%	1	0.00	12	$0	100%	25%	25%	2	90%	0%	92.7%	51.6%	51.6%	7.3
1329	WholeBuilding	Power Distribution Equipment Upgrades (Transformers)	Biz-Custom	Office	Retro	1,150	1,150	1%	6	0.00	30	$8	100%	9%	9%	3	100%	20%	92.7%	36.0%	36.0%	17.1
1330	WholeBldg_NC	WholeBlg - Com NC	Biz-Custom	Office	NC	4	4	25%	1	0.00	12	$0	100%	50%	50%	1	100%	60%	83.4%	68.0%	68.0%	7.6
1331	Behavioral	COM Competitions	Biz-Custom	Office	Retro	53	53	2%	1	0.00	2	$0	100%	50%	50%	1	100%	0%	50.0%	40.0%	40.0%	3.9
1332	Behavioral	Business Energy Reports	Biz-Custom	Office	Retro	0	0	0%	0	0.00	2	$0	0%		0%	1	100%	0%	50.0%	40.0%	40.0%	0.0
1333	Behavioral	Building Benchmarking	Biz-Custom	Office	Retro	114	114	1%	1	0.00	2	$0	45%	45%	45%	1	100%	0%	50.0%	40.0%	40.0%	0.8
1334	Behavioral	Strategic Energy Management	Biz-Custom SEM	Office	Retro	33	33	3%	1	0.00	5	$0	75%	37%	37%	1	100%	0%	50.0%	40.0%	40.0%	2.1
1335	Behavioral	BEIMS	Biz-Custom	Office	Retro	29	29	4%	1	0.00	2	$0	23%	23%	23%	1	100%	2%	50.0%	40.0%	40.0%	0.8
1336	Behavioral	Building Operator Certification	Biz-Custom	Office	Retro	16	16	3%	0	0.00	3	$0	25%	22%	22%	1	100%	2%	50.0%	40.0%	40.0%	1.7
1337	CompressedAir	Efficient Air Compressors (VSD)	Biz-Prescriptive	Warehouse	ROB	1,583	1,583	21%	329	0.00	13	$127	100%	59%	80%	1	100%	33%	92.7%	76.7%	83.1%	5.5
1338	CompressedAir	Efficient Air Nozzles	Biz-Prescriptive	Warehouse	Retro	1,480	1,480	50%	740	0.00	15	$50	100%	81%	81%	2	35%	33%	92.7%	91.1%	91.1%	15.8
1339	CompressedAir	AODD Pump Controls	Biz-Custom	Warehouse	Retro	103,919	103,919	35%	36,372	0.00	10	$1,150	100%	50%	50%	3	10%	33%	92.7%	72.6%	72.6%	38.2
1340	CompressedAir	Compressed Air - Custom	Biz-Custom	Warehouse	Retro	5	5	20%	1	0.00	10	$0	100%	47%	47%	4	50%	33%	92.7%	64.2%	64.2%	6.0
1341	CompressedAir	Retro-commissioning_Compressed Air Optimization	Biz-Custom RCx	Warehouse	Retro	3	3	30%	1	0.00	5	$0	100%	47%	47%	5	50%	33%	92.7%	64.2%	64.2%	3.2
1342	Cooking	Commercial Combination Oven (Electric)	Biz-Prescriptive	Warehouse	ROB	38,561	38,561	48%	18,432	0.00	12	$16,884	75%	6%	15%	1	18%	53%	77.5%	62.4%	62.4%	14.1
1343	Cooking	Commercial Electric Convection Oven	Biz-Prescriptive	Warehouse	ROB	12,193	12,193	15%	1,879	0.00	12	$1,706	75%	21%	51%	1	18%	53%	77.6%	62.4%	62.4%	4.4
1344	Cooking	Commercial Electric Griddle	Biz-Prescriptive	Warehouse	ROB	17,056	17,056	15%	2,596	0.00	12	$3,604	25%	15%	15%	2	14%	17%	41.9%	33.6%	33.6%	2.8
1345	Cooking	Commercial Electric Steam Cooker	Biz-Prescriptive	Warehouse	ROB	19,549	19,549	67%	13,162	0.00	12	$2,490	100%	24%	55%	3	6%	45%	88.0%	81.1%	83.5%	18.0
1346	Cooking	Dishwasher Low Temp Door (Energy Star)	Biz-Prescriptive	Warehouse	ROB	39,306	39,306	44%	17,369	0.00	15	$1,000	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	11.7
1347	Cooking	Dishwasher High Temp Door (Energy Star)	Biz-Prescriptive	Warehouse	ROB	26,901	26,901	32%	8,586	0.00	15	$1,100	100%	100%	100%	4	26%	61%	88.0%	88.0%	88.0%	5.2
1348	Cooking	Energy efficient electric fryer	Biz-Prescriptive	Warehouse	ROB	18,955	18,955	17%	3,274	0.00	12	$1,500	100%	5%	13%	5	27%	24%	88.0%	57.2%	59.4%	23.2
1349	Cooking	Insulated Holding Cabinets (Full Size)	Biz-Prescriptive	Warehouse	ROB	13,697	13,697	68%	9,314	0.00	12	$1,200	100%	35%	55%	6	3%	16%	88.0%	83.6%	84.9%	12.7
1350	Cooking	Insulated Holding Cabinets (Half-Size)	Biz-Prescriptive	Warehouse	ROB	4,383	4,383	60%	2,630	0.00	12	$1,500	100%	10%	25%	6	3%	16%	88.0%	52.6%	57.6%	10.1
1351	Cooling	Air Conditioner - 13 IEER (5-20 Tons)	Biz-Prescriptive	Warehouse	ROB	828	828	6%	51	0.00	15	$63	100%	48%	55%	1	31%	20%	92.7%	46.4%	49.6%	4.4
1352	Cooling	Air Conditioner - 14 IEER (5-20 Tons)	Biz-Prescriptive	Warehouse	ROB	828	828	13%	106	0.00	15	$127	100%	24%	55%	1	31%	20%	92.7%	39.2%	50.3%	9.3
1353	Cooling	Air Conditioner - 17 IEER (5-20 Tons)	Biz-Prescriptive	Warehouse	ROB	828	828	28%	234	0.00	15	$127	100%	24%	55%	1	31%	20%	92.7%	54.6%	69.8%	20.3
1354	Cooling	Air Conditioner - 21 IEER (5-20 Tons)	Biz-Prescriptive	Warehouse	ROB	828	828	42%	347	0.00	15	$127	100%	24%	55%	1	31%	20%	92.7%	66.4%	76.1%	30.2
1355	Cooling	Air Conditioner - 12.1 IEER (20+ Tons)	Biz-Prescriptive	Warehouse	ROB	886	886	6%	51	0.00	15	$30	100%	100%	100%	2	31%	20%	92.7%	92.7%	92.7%	4.5
1356	Cooling	Air Conditioner - 13 IEER (20+ Tons)	Biz-Prescriptive	Warehouse	ROB	886	886	12%	109	0.00	15	$37	100%	81%	81%	2	31%	20%	92.7%	84.7%	84.7%	9.5
1357	Cooling	Air Conditioner - 14.3 IEER (20+ Tons)	Biz-Prescriptive	Warehouse	ROB	886	886	20%	180	0.00	15	$37	100%	81%	81%	2	31%	20%	92.7%	87.9%	87.9%	15.6
1358	Cooling	Air Conditioner - 21 IEER (20+ Tons)	Biz-Prescriptive	Warehouse	ROB	886	886	46%	405	0.00	15	$37	100%	81%	81%	2	31%	20%	92.7%	90.6%	90.6%	35.2
1359	Cooling	Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up)	Biz-Custom	Warehouse	Retro	842	842	7%	59	0.00	3	$5	100%	50%	50%	3	62%	50%	92.7%	69.7%	69.7%	14.0
1360	Cooling	Air Side Economizer	Biz-Custom	Warehouse	Retro	828	828	20%	166	0.00	10	$84	75%	20%	20%	4	62%	20%	79.1%	43.9%	43.9%	3.9
1361	Cooling	Advanced Rooftop Controls	Biz-Prescriptive	Warehouse	Retro	842	842	1%	6	0.00	10	$100	100%	100%	100%	5	62%	20%	92.7%	92.7%	92.7%	0.0
1362	Cooling	HVAC Occupancy Controls	Biz-Custom	Warehouse	ROB	426	426	20%	85	0.00	15	$537	2%	2%	2%	6	62%	20%	44.0%	36.0%	36.0%	5.6
1363	Cooling	Air Conditioner - 16 SEER (<5 Tons)	Biz-Prescriptive	Warehouse	ROB	722	722	13%	90	0.00	15	$47	100%	64%	80%	7	38%	20%	92.7%	74.4%	80.9%	7.8
1364	Cooling	Air Conditioner - 17 SEER (<5 Tons)	Biz-Prescriptive	Warehouse	ROB	722	722	18%	127	0.00	15	$206	100%	15%	36%	7	38%	20%	92.7%	36.0%	37.0%	11.1
1365	Cooling	Air Conditioner - 18 SEER(<5 Tons)	Biz-Prescriptive	Warehouse	ROB	722	722	22%	160	0.00	15	$206	100%	15%	36%	7	38%	20%	92.7%	36.0%	40.8%	13.9
1366	Cooling	Air Conditioner - 21 SEER(<5 Tons)	Biz-Prescriptive	Warehouse	ROB	722	722	33%	241	0.00	15	$253	100%	12%	30%	7	38%	20%	92.7%	38.9%	43.1%	20.9
1367	Cooling	Smart Thermostat	Biz-Prescriptive	Warehouse	ROB	722	722	14%	102	0.00	11	$175	57%	57%	57%	8	38%	12%	43.3%	43.3%	43.3%	1.2
1368	Cooling	PTAC - <7,000 Btuh - lodging	Biz-Prescriptive	Warehouse	ROB	849	849	8%	72	0.00	8	$84	100%	36%	36%	9	0%	20%	92.7%	42.7%	42.7%	3.4

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Measure #	End-Use	Measure Name	Program	Building Type	Replacement Type	Base (Existing) Annual Electric	Base (Standard) Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer kW	EE EUL	Measure Cost	MAP Incentive (%)	RAP Incentive (%)	PP Incentive (%)	End Use Measure Group	Base Saturation	EE Saturation	MAP Adoption Rate	RAP Adoption Rate	PP Adoption Rate	UCT Score
1369	Cooling	PTAC - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Warehouse	ROB	931	931	7%	68	0.00	8	$84	100%	36%	36%	10	0%	20%	92.7%	41.2%	41.2%	3.2
1370	Cooling	PTAC - >15,000 Btuh - lodging	Biz-Prescriptive	Warehouse	ROB	1,064	1,064	10%	101	0.00	8	$84	100%	36%	55%	11	0%	20%	92.7%	50.4%	57.5%	4.8
1371	Cooling	Air Cooled Chiller	Biz-Prescriptive	Warehouse	ROB	738	738	6%	41	0.00	23	$126	100%	24%	55%	12	0%	15%	92.7%	32.0%	32.0%	6.2
1372	Cooling	Chiller Tune-up	Biz-Prescriptive	Warehouse	Retro	842	842	7%	59	0.00	3	$8	100%	100%	100%	13	0%	50%	92.7%	92.7%	92.7%	4.7
1373	Cooling	HVAC/Chiller Custom	Biz-Custom	Warehouse	Retro	5	5	20%	1	0.00	20	$1	100%	7%	7%	14	100%	20%	92.7%	36.0%	36.0%	30.3
1374	Cooling	Window Film	Biz-Prescriptive	Warehouse	Retro	6,000	6,000	4%	264	0.00	10	$154	100%	65%	65%	15	100%	20%	92.7%	73.1%	73.1%	3.2
1375	Cooling	Triple Pane Windows	Biz-Custom	Warehouse	ROB	6,000	6,000	6%	360	0.00	25	$700	100%	5%	5%	15	100%	20%	92.7%	36.0%	36.0%	24.5
1376	Cooling	Energy Recovery Ventilator	Biz-Custom	Warehouse	Retro	886	886	0%	0	0.00	15	$1,500	0%		0%	16	100%	2%	92.7%	74.2%	74.2%	0.0
1377	Heating	Heat Pump - 16 SEER (<5 Tons)	Biz-Prescriptive	Warehouse	ROB	1,653	1,653	4%	64	0.00	16	$87	100%	46%	46%	1	26%	20%	92.7%	43.3%	43.3%	2.7
1378	Heating	Heat Pump - 17 SEER (<5 Tons)	Biz-Prescriptive	Warehouse	ROB	1,653	1,653	9%	142	0.00	16	$442	25%	9%	23%	1	26%	20%	44.0%	36.0%	36.0%	5.3
1379	Heating	Heat Pump - 18 SEER(<5 Tons)	Biz-Prescriptive	Warehouse	ROB	1,653	1,653	12%	203	0.00	16	$507	50%	8%	20%	1	26%	20%	44.0%	36.0%	36.0%	7.4
1380	Heating	Heat Pump - 21 SEER(<5 Tons)	Biz-Prescriptive	Warehouse	ROB	1,653	1,653	19%	310	0.00	16	$507	75%	8%	20%	1	26%	20%	54.8%	36.0%	36.0%	11.8
1381	Heating	Geothermal HP - SEER 20.3 (<5 Tons)	Biz-Prescriptive	Warehouse	ROB	1,653	1,653	22%	372	0.00	25	$2,576	25%	2%	2%	1	26%	20%	44.0%	36.0%	36.0%	17.0
1382	Heating	Geothermal HP - SEER 21.5 (<5 Tons)	Biz-Prescriptive	Warehouse	ROB	1,653	1,653	27%	443	0.00	25	$2,576	25%	2%	4%	1	26%	20%	44.0%	36.0%	36.0%	19.7
1383	Heating	Geothermal HP - SEER 23.1 (<5 Tons)	Biz-Prescriptive	Warehouse	ROB	1,653	1,653	32%	527	0.00	25	$2,576	25%	2%	4%	1	26%	20%	44.0%	36.0%	36.0%	22.6
1384	Heating	Geothermal HP - SEER 29.3 (<5 Tons)	Biz-Prescriptive	Warehouse	ROB	1,653	1,653	47%	771	0.00	25	$2,576	25%	2%	4%	1	26%	20%	44.0%	36.0%	36.0%	29.3
1385	Heating	Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Warehouse	ROB	1,989	1,989	11%	216	0.00	16	$100	100%	40%	55%	2	21%	20%	92.7%	66.6%	72.7%	31.6
1386	Heating	Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr)	Biz-Prescriptive	Warehouse	ROB	1,989	1,989	16%	319	0.00	16	$136	100%	30%	55%	2	21%	20%	92.7%	64.5%	74.1%	35.1
1387	Heating	Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Warehouse	ROB	2,070	2,070	14%	291	0.00	16	$100	100%	40%	55%	2	21%	20%	92.7%	72.9%	76.9%	35.7
1388	Heating	Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr)	Biz-Prescriptive	Warehouse	ROB	2,070	2,070	19%	394	0.00	16	$139	100%	29%	55%	2	21%	20%	92.7%	69.3%	76.7%	39.1
1389	Heating	Geothermal HP - SEER 20.3 (5-20 Tons)	Biz-Prescriptive	Warehouse	ROB	1,814	1,814	29%	533	0.00	25	$2,576	50%	2%	4%	2	21%	20%	44.0%	36.0%	36.0%	35.7
1390	Heating	Geothermal HP - SEER 21.5 (5-20 Tons)	Biz-Prescriptive	Warehouse	ROB	1,814	1,814	33%	605	0.00	25	$2,576	50%	2%	4%	2	21%	20%	44.0%	36.0%	36.0%	38.4
1391	Heating	Geothermal HP - SEER 23.1 (5-20 Tons)	Biz-Prescriptive	Warehouse	ROB	1,921	1,921	41%	795	0.00	25	$2,576	50%	2%	4%	2	21%	20%	44.0%	36.0%	36.0%	43.6
1392	Heating	Geothermal HP - SEER 29.3 (5-20 Tons)	Biz-Prescriptive	Warehouse	ROB	1,921	1,921	54%	1,039	0.00	25	$2,576	75%	2%	4%	2	21%	20%	47.4%	36.0%	36.0%	50.2
1393	Heating	Variable Refrigerant Flow Heat Pump	Biz-Custom	Warehouse	ROB	1,535	1,535	13%	192	0.00	16	$224	100%	9%	9%	2	21%	2%	92.7%	29.2%	29.2%	20.9
1394	Heating	Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr)	Biz-Prescriptive	Warehouse	ROB	2,155	2,155	9%	199	0.00	16	$100	100%	40%	55%	3	21%	20%	92.7%	64.3%	71.3%	28.1
1395	Heating	Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr)	Biz-Prescriptive	Warehouse	ROB	2,155	2,155	15%	326	0.00	16	$175	100%	23%	55%	3	21%	20%	92.7%	54.6%	70.1%	32.8
1396	Heating	Geothermal HP - SEER 20.3 (20+ Tons)	Biz-Prescriptive	Warehouse	ROB	2,070	2,070	38%	789	0.00	25	$2,576	100%	2%	4%	3	21%	20%	92.7%	36.0%	36.0%	69.5
1397	Heating	Geothermal HP - SEER 21.5 (20+ Tons)	Biz-Prescriptive	Warehouse	ROB	2,070	2,070	42%	860	0.00	25	$2,576	100%	2%	4%	3	21%	20%	92.7%	36.0%	36.0%	72.2
1398	Heating	Geothermal HP - SEER 23.1 (20+ Tons)	Biz-Prescriptive	Warehouse	ROB	2,070	2,070	46%	944	0.00	25	$2,576	100%	2%	4%	3	21%	20%	92.7%	36.0%	36.0%	75.2
1399	Heating	Geothermal HP - SEER 29.3 (20+ Tons)	Biz-Prescriptive	Warehouse	ROB	2,070	2,070	57%	1,188	0.00	25	$2,576	100%	2%	4%	3	21%	20%	92.7%	36.0%	36.0%	81.8
1400	Heating	Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD)	Biz-Prescriptive	Warehouse	ROB	1,653	1,653	19%	310	0.00	16	$224	100%	18%	45%	4	33%	20%	92.7%	48.3%	55.1%	11.8
1401	Heating	PTHP - <7,000 Btuh - lodging	Biz-Custom	Warehouse	ROB	1,823	1,823	4%	69	0.00	8	$130	100%	100%	100%	5	0%	10%	92.7%	74.2%	74.2%	0.7
1402	Heating	PTHP - >15,000 Btuh - lodging	Biz-Prescriptive	Warehouse	ROB	2,191	2,191	15%	330	0.00	8	$130	100%	100%	100%	6	0%	10%	92.7%	92.7%	92.7%	3.4
1403	Heating	PTHP - 7,000 to 15,000 Btuh - lodging	Biz-Prescriptive	Warehouse	ROB	1,994	1,994	9%	171	0.00	8	$130	100%	100%	100%	7	0%	10%	92.7%	92.7%	92.7%	1.7
1404	HotWater	Heat Pump Water Heater	Biz-Prescriptive	Warehouse	ROB	3,027	3,027	67%	2,027	0.00	15	$1,115	100%	45%	45%	1	100%	0%	84.0%	60.9%	60.9%	3.4
1405	HotWater	Hot Water Pipe Insulation	Biz-Custom	Warehouse	Retro	3,027	3,027	2%	61	0.00	20	$60	75%	10%	10%	2	100%	80%	86.0%	84.0%	84.0%	9.8
1406	HotWater	Faucet Aerator	Biz-Custom	Warehouse	Retro	195	195	32%	63	0.00	10	$8	100%	50%	50%	3	20%	90%	93.0%	92.0%	92.0%	13.1
1407	HotWater	Low Flow Pre-Rinse Sprayers	Biz-Prescriptive	Warehouse	ROB	18,059	18,059	54%	9,789	0.00	5	$60	100%	17%	42%	4	20%	80%	86.0%	84.0%	84.0%	199.3
1408	HotWater	ENERGY STAR Commercial Washing Machines	Biz-Prescriptive	Warehouse	ROB	1,552	1,552	43%	671	0.00	7	$250	75%	28%	28%	5	25%	33%	79.3%	64.6%	64.6%	2.9
1409	InteriorLighting	LED T8 Tube Replacement	Biz-Prescriptive Light	Warehouse	Retro	110	110	45%	49	0.00	15	$5	100%	100%	100%	1	64%	40%	94.6%	94.6%	94.6%	11.4
1410	InteriorLighting	LED troffer retrofit kit, 2'X2' and 2'X4'	Biz-Prescriptive Light	Warehouse	Retro	248	248	50%	124	0.00	15	$70	100%	36%	55%	1	64%	40%	94.6%	52.3%	68.6%	5.8
1411	InteriorLighting	LED troffer, 2'X2' and 2'X4'	Biz-Prescriptive Light	Warehouse	Retro	248	248	50%	124	0.00	15	$70	100%	36%	55%	1	64%	40%	94.6%	52.3%	68.6%	5.8
1412	InteriorLighting	Bi-Level Lighting Fixture – Stairwells, Hallways	Biz-Custom Light	Warehouse	Retro	248	248	74%	184	0.00	10	$274	25%	7%	9%	2	1%	40%	58.0%	50.1%	50.3%	4.7
1413	InteriorLighting	LED high bay fixture	Biz-Prescriptive Light	Warehouse	Retro	2,310	2,310	68%	1,571	0.00	15	$330	100%	35%	55%	3	23%	34%	94.6%	81.8%	86.4%	15.8
1414	InteriorLighting	LED Mogul-base HID Lamp Replacing High Bay HID	Biz-Prescriptive Light	Warehouse	Retro	2,310	2,310	66%	1,532	0.00	15	$330	100%	35%	55%	3	23%	34%	94.6%	81.5%	86.1%	15.4
1415	InteriorLighting	LED low bay fixture	Biz-Prescriptive Light	Warehouse	Retro	492	492	61%	299	0.00	15	$44	100%	68%	80%	4	9%	34%	94.6%	90.7%	92.1%	11.5
1416	InteriorLighting	LED Mogul-base HID Lamp Replacing Low Bay HID	Biz-Prescriptive Light	Warehouse	Retro	492	492	59%	289	0.00	15	$44	100%	68%	80%	4	9%	34%	94.6%	90.6%	92.0%	11.1
1417	InteriorLighting	LED Screw-In Lamps (Directional)	Biz-Prescriptive Light	Warehouse	ROB	352	352	86%	302	0.00	6	$1	100%	100%	100%	6	0%	43%	94.6%	94.6%	94.6%	135.5
1418	InteriorLighting	LED downlight fixture	Biz-Prescriptive Light	Warehouse	Retro	170	170	68%	115	0.00	15	$27	100%	19%	46%	6	4%	45%	94.6%	76.0%	83.0%	26.6
1419	InteriorLighting	LED Screw-In Lamps (Omnidirectional & Decorative)	Biz-Prescriptive Light	Warehouse	ROB	266	266	81%	215	0.00	6	$1	100%	100%	100%	5	0%	20%	94.6%	94.6%	94.6%	96.6
1420	InteriorLighting	DeLamp Fluorescent Fixture Average Lamp Wattage 28W	Biz-Prescriptive Light	Warehouse	Retro	91	91	100%	91	0.00	11	$4	100%	100%	100%	7	64%	0%	94.6%	94.6%	94.6%	20.2
1421	InteriorLighting	Occupancy Sensors	Biz-Prescriptive Light	Warehouse	Retro	417	417	30%	125	0.00	10	$65	75%	31%	31%	8	95%	10%	82.5%	52.2%	52.2%	2.9
1422	InteriorLighting	Daylighting Controls	Biz-Prescriptive Light	Warehouse	Retro	534	534	30%	160	0.00	10	$58	100%	35%	55%	8	95%	10%	94.6%	71.3%	79.2%	6.7
1423	InteriorLighting	Dual Occupancy & Daylighting Controls	Biz-Custom Light	Warehouse	Retro	238	238	44%	105	0.00	10	$75	100%	40%	50%	8	95%	10%	94.6%	36.5%	42.4%	2.9
1424	InteriorLighting	Central Lighting Monitoring & Controls (non-networked)	Biz-Custom Light	Warehouse	Retro	41,703	41,703	20%	8,341	0.00	12	$3,700	100%	23%	29%	8	95%	10%	94.6%	44.1%	47.7%	4.6
1425	InteriorLighting	Network Lighting Controls - Wireless (WiFi)	Biz-Custom Light	Warehouse	Retro	3	3	49%	1	0.00	15	$1	100%	23%	30%	8	95%	10%	94.6%	45.2%	48.8%	9.7
1426	InteriorLighting	Luminaire Level Lighting Controls w/ HVAC Control	Biz-Custom Light	Warehouse	Retro	338	338	65%	220	0.00	15	$90	100%	24%	32%	8	96%	10%	94.6%	48.2%	51.8%	9.7
1427	InteriorLighting	LED Exit Sign - 4 Watt Fixture (2 lamp)	Biz-Prescriptive Light	Warehouse	Retro	63	63	43%	27	0.00	5	$33	92%	92%	92%	9	1%	75%	86.5%	86.5%	86.5%	0.3
1428	InteriorLighting	Lighting - Custom	Biz-Custom Light	Warehouse	Retro	4	4	25%	1	0.00	15	$1	100%	14%	19%	10	100%	0%	94.6%	30.0%	31.2%	9.7
1429	ExteriorLighting	LED wallpack (existing W<250)	Biz-Prescriptive Light	Warehouse	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	1	12%	46%	94.6%	56.6%	70.8%	5.8
1430	ExteriorLighting	LED parking lot fixture (existing W≥250)	Biz-Prescriptive Light	Warehouse	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	13%	33%	2	11%	54%	67.8%	63.2%	63.2%	4.4
1431	ExteriorLighting	LED parking lot fixture (existing W<250)	Biz-Prescriptive Light	Warehouse	Retro	856	856	66%	567	0.00	12	$248	100%	18%	45%	3	11%	54%	94.6%	63.2%	70.8%	5.8
1432	ExteriorLighting	LED outdoor pole decorative fixture (existing W≥250)	Biz-Prescriptive Light	Warehouse	Retro	1,589	1,589	60%	959	0.00	12	$756	50%	17%	17%	4	11%	54%	67.8%	63.2%	63.2%	3.4
1433	ExteriorLighting	LED parking garage fixture (existing W≥250)	Biz-Prescriptive Light	Warehouse	Retro	3,235	3,235	60%	1,953	0.00	6	$756	50%	13%	33%	5	11%	69%	78.3%	75.2%	75.2%	4.7

GDS Associates, Inc.
ENGINEERS & CONSULTANTS

prepared for

CENTERPOINT ENERGY

2022 Demand Side Management Market Potential Study

May 22,
2023

FINAL REPORT

prepared by

GDS ASSOCIATES INC

Attachment 6.3 All-Source RFP

1898 & CO SM
PART OF BURNS & MCDONNELL

All-Source Request for Proposals

CenterPoint Energy®

CenterPoint Energy Indiana South

Issued 5/11/2022
NOI, NDA, and Respondent Application Due 5/27/2022
Proposals Due 7/5/2022

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LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
1898 & Co.	1898 & Co., part of Burns & McDonnell
CenterPoint	CenterPoint Energy Indiana South
CNP	CenterPoint
COD	Commercial Operating Date
CSP	Curtailment Service Providers
DA	Definitive Agreement
DIR	Dispatchable Intermittent Resource
DR	Demand Response
EPC	Engineering, Procurement, and Construction
GI	Generation Interconnection
GIA	Generator Interconnection Agreement
ICAP	Installed Capacity
IRP	Integrated Resource Plan
IURC	Indiana Utility Regulatory Commission
LCOE	Levelized Cost of Energy
LMR	Load Modifying Resource
LRZ	Local Resource Zone
MISO	Midcontinent Independent System Operator
MW	Megawatt
MWh	Megawatt-Hour
NCF	Net Capacity Factor
NDA	Non-Disclosure Agreement
NRIS	Network Resource Interconnection Service
OVEC	Ohio Valley Electric Corporation
PPA	Power Purchase Agreement
PRM	Planning Reserve Margin
RFP	Request for Proposal

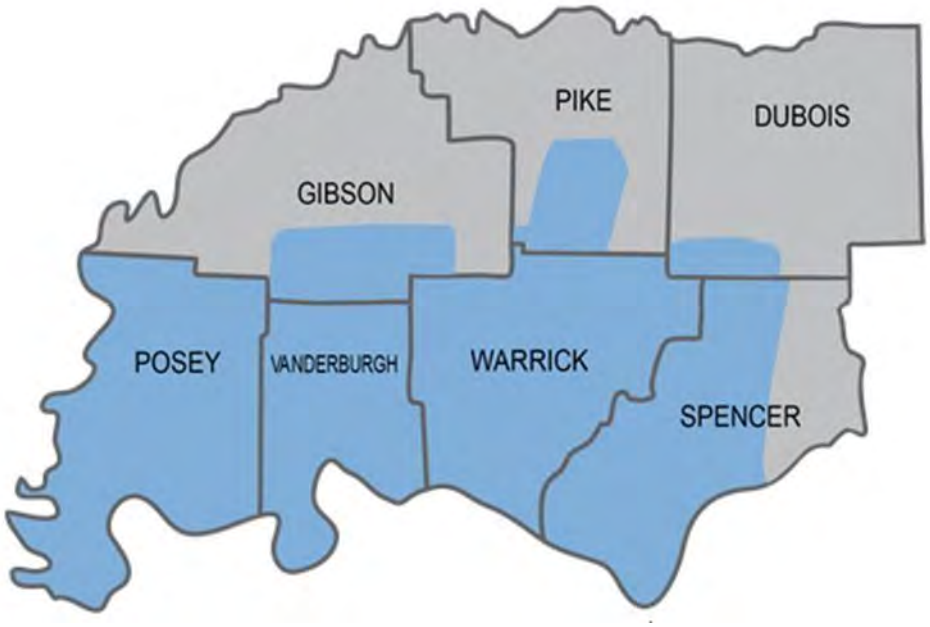
1.0 RFP OVERVIEW

1.1 Introduction

CenterPoint Energy Indiana South (CenterPoint) is a subsidiary of CenterPoint Energy, headquartered in Houston, Texas. CenterPoint provides energy delivery services to 142,000 electric customers located in southwestern Indiana. CenterPoint also owns and operates electric generation to serve its electric customers and optimizes those assets in the wholesale power market.

CenterPoint's electric customers are currently served by a mixed portfolio including 1,000 megawatts (MW) of coalfired generation, up to 160 MW of gas-fired generation and 54 MWs of solar coupled with 1 MW of storage. The portfolio also contains 3 MW from a landfill gas to electric project and purchases from the Ohio Valley Electric Corporation (OVEC) of up to 32 MW, wind purchases of up to 80 MW, and purchases from the Midcontinent Independent System Operator (MISO) power pool as needed to meet CenterPoint's load requirements.

Figure 1: CenterPoint Electric Service Area



1.2 Purpose

CenterPoint has issued this all-source Request for Proposals (RFP) seeking power supply and demand-side Proposals for capacity and unit-contingent energy to meet the needs of its customers. For asset purchases, capacity contracts, and power purchase agreements (PPAs), the capacity is required to be fully accredited prior to March 1st 2027; however, earlier delivery of projects and capacity products is encouraged. CenterPoint intends to submit an updated Integrated Resource Plan (2022/2023 IRP) to the Indiana Utility Regulatory Commission (IURC) in the first half of 2023 which will evaluate existing resources and identify the preferred resource options to meet capacity and energy requirements. Information on CenterPoint IRPs can be found at https://midwest.centerpointenergy.com/irp. Only resources capable of firm deliverability to MISO Local Resource Zone (LRZ) 6 will be considered.

CenterPoint prefers Proposals for resources that are directly interconnected to CenterPoint's system or Proposals that reflect all the costs and characteristics of the resource necessary for energy to be financially settled or delivered to CenterPoint's load node (SIGE.SIGW). All potential agreements are subject to IURC and CenterPoint Board of Director's approval and are not effective until such approval is final.

All Proposals must be submitted via the All-Source Request for Proposal website (http://CenterPoint2022ASRFP.rfpmanager.biz/) no later than the Proposal Submittal Due Date shown in Section 2.3. CenterPoint reserves the right in its sole discretion to modify this schedule for any reason.

In connection with this RFP, CenterPoint has retained the services of an independent third-party consultant, 1898 & Co., a division of Burns & McDonnell, to help manage the RFP process and work with CenterPoint to perform the quantitative and qualitative evaluations of all Proposals. However, CenterPoint will make final decisions (subject to IURC review, as applicable) at its sole discretion.

All Respondents will directly interface with 1898 & Co. for all communications, including questions, RFP clarification issues, and Proposal submission. All questions related to this RFP should be submitted via the RFP Website. If for any reason there are technical issues with bid or question submittal the following email address can be contacted CenterPointRFP@1898andco.com.

CenterPoint has concluded that it is in the best interest of its customers to seek resources that qualify as MISO internal resources (i.e. not pseudo-tied into MISO) with physical deliverability utilizing Network Resource Integration Service (NRIS). However, as described in the RFP requirements below, Proposals for resources located outside of MISO and which can show firm deliverability to MISO LRZ 6 may still qualify for consideration under this RFP. CenterPoint is issuing this all-source RFP for supply-side and demand-side capacity resources to identify viable resources available to CenterPoint in the marketplace to meet the needs of its customers. Dependent upon further evaluation of aging resources and subject to IRP results, the exact capacity need of CenterPoint has not yet been identified. The IRP will evaluate a wide number of potential resource portfolio combinations, and it is likely the 2022/2023 IRP will have scenarios that result in a need for 500 MW or greater. Therefore, Respondents are encouraged to offer multiple projects and/or resource blocks depending on their availability. In addition, CenterPoint wil consider Proposals for up to 350 MW of short-term capacity as described below.

CenterPoint is seeking to provide reliable power supply resources for its customers. This RFP is issued to either acquire or contract for:

- Existing or planned utility-scale solar, wind, and storage (standalone or paired) resources described further in Section 4.0.
- Existing or planned thermal resources described further in Section 5.0
- LMR/DR products described further in Section 6.0.
- Short and long-term capacity only contracts described further in Section 7.0

Accordingly, you are invited to submit a written, binding Proposal in accordance with the requirements described in this RFP and subject to the following dates. See Section 2.3 for additional information about milestone dates.

Table 1: RFP Milestone Dates

Milestone	Date
Issue RFP	Wednesday, May 11, 2022
Notice of Intent with Application Documents Due	Friday, May 27, 2022
Proposals Due	Tuesday, July 5, 2022

2.0 INFORMATION AND SCHEDULE

2.1 Information Provided to Potential Respondents

This RFP and all its Appendices are available on the RFP website (http://CenterPoint2022ASRFP.rfpmanager.biz/). Interested parties are expected to be able to download this RFP with its required forms and complete the forms in Microsoft Word, Microsoft Excel[1], and/or PDF format. Respondents should upload and submit properly completed forms by the specified due date to the RFP website. 1898 & Co. will accept only Proposals that are complete. Proposals that are nonconforming, not complete, mailed, or hand delivered may be deemed ineligible and may not be considered for further evaluation. By submitting a Proposal in response to this RFP, the Respondent certifies that it has not divulged, discussed, or compared any commercial terms of its Proposal with any other party (including any other Respondent and/or prospective Respondent), and has not colluded whatsoever with any other party.

2.2 Information on the RFP Website

The information on the RFP website (http://CenterPoint2022ASRFP.rfpmanager.biz/) contains the following:

- This RFP and associated appendices
- Frequently asked questions and answers about this RFP
- Updates on this RFP process and other relevant information

Phone calls and verbal conversations with Respondents regarding this RFP are not permitted before the Proposal Submittal Due Date. All Respondents will directly interface with 1898 & Co. through the RFP website and email for all communications regarding this resource request. Proposals will be opened in private by 1898 & Co. on a confidential basis, but written questions will not be considered confidential. Individual questions submitted on the website before the submittal due date will be answered and responses will be posted on the website or sent back via email to the Respondent as soon as practical. Responses to select questions may be placed on the RFP website for the benefit of all Respondents, with any identifying information redacted from the question.

Proposals will be reviewed by 1898 & Co. for completeness, and offers that do not include the information requirements of this RFP may be notified by 1898 & Co. and allowed five business days to conform. After Proposals are submitted, 1898 & Co. will review, and both quantitatively and qualitatively evaluate all conforming Proposals. Respondents may be contacted for additional data or clarifications during the evaluation process by 1898 & Co.

[1] Microsoft Excel format is required for the submission of Appendix D.

Any Respondents contacted for further clarifications may or may not be invited to begin further negotiations of terms and details of the offers.

2.3 Schedule

CenterPoint has retained 1898 & Co. to act as an independent third-party consultant to assist with this RFP. All Respondents will directly interface with 1898 & Co. for all communications, including questions, RFP clarification issues, and Proposal submission. All questions should be submitted to the website, and as required, additional correspondence concerning this RFP should be sent via email to CenterPointRFP@1898andco.com.

The schedule below provides the timeline for conducting this resource solicitation. CenterPoint reserves the right to modify this schedule in its sole discretion.

Table 2: RFP Schedule

Step	Date
RFP Issued	Wednesday, May 11, 2022
Notice of Intent, NDA, and Respondent Application Due	5:00 p.m. CDT, Friday, May 27, 2022
Pre-Bid Meeting	3:00 p.m. CDT, Wednesday, June 1, 2022
Proposal Submittal Due Date	5:00 p.m. CDT, Tuesday, July 5, 2022
Initial Proposal Review and Evaluation Period	Wednesday, July 6, 2022 – Thursday, August 11, 2022
Proposal Evaluation Completion Target and Short List to CenterPoint	Friday, August 12, 2022
Due Diligence and Negotiations Period	Q3-Q4 2022

3.0 RFP GENERAL REQUIREMENTS

Proposals must meet the general minimum eligibility requirements described below. 1898 & Co. will screen all Proposals for compliance with these requirements. Proposals that fail to meet one or more of the general minimum eligibility requirements may be disqualified from further consideration as part of this RFP process. Respondents should refer to the Proposal Checklist in Appendix E for high-level guidance on Proposal requirements.

For a Proposal to be eligible under this RFP, it must:

- Offer MISO LRZ 6 zonal resource credits (e.g. NRIS transmission service or other fully deliverable resource).
- Have an existing MISO Generator Interconnection Agreement (GIA), be in the MISO generator interconnection queue, or provide justification how the resource is able to meet CenterPoint's timing needs absent current queue position. CenterPoint will consider Proposals that aim to reuse existing interconnection rights for retiring generation facilities.
- Be in service and operational prior to 3/1/2027.

3.1 General Requirements for Generation Facility Proposals

Respondents should provide sufficient detail to fully evaluate the "all-in" physical, electrical, and economic attributes of any Proposal. In all cases, Respondents shall describe the expected useful life of all facilities included in their Proposals. If a facility does not have black start capability installed but could be made black start capable, Proposals should indicate the estimated costs to construct and operate and include the estimated construction timeline. Respondents shall provide their best estimate of interconnection costs and/or other costs to deliver energy into MISO to a single point of interconnection or other energy settlement node.

3.1.1 Name and Location

Respondents shall state the name of the generating facility, the county where the generating facility is located, the owner of the facility, and the commercial pricing node associated with the facility, if applicable. The facility must be qualified to receive Zonal Resource Credits for Zone 6 consistent with MISO's Module E Planning Resource Auction. Should the facility not be qualified in Zone 6, Respondents shall detail in their Proposals the means by which Zonal Resource Credits will be delivered/fulfilled in Zone 6.

3.1.2 Capacity Characteristics

Respondents shall state the nameplate capacity, net summer operating capacity, net winter operating capacity and, for existing facilities, the awarded unforced capacity (UCAP) of the generation facility for the last five MISO planning years. Respondents shall specifically identify any known derates affecting the facility.

Respondents also should provide the expected UCAP for the first five MISO planning years beginning in the first year after the proposed facility's commercial operation date based on current MISO rules for the applicable generating technology.

3.1.2.1 Interconnection, Capacity Availability and Deliverability

Respondents must identify the specific point(s) of interconnection. CenterPoint has a preference for the type of transmission service to be NRIS, but will consider other Proposals as long as capacity is fully deliverable and accreditable. Proposals for facilities without existing firm deliverability should include cost estimates including transmission and/or interconnection studies associated with securing such deliverability. The GIA or most recent available Definitive Planning Phase (DPP) Study results should be included if applicable.

The Proposal should also include nodal economic analyses (at COD, 2030, and 2035) showing expected unit economic metrics (including congestion impacts on energy production and cost to deliver) for the project at the proposed delivery point(s).

CenterPoint reserves the right to reject any Proposal that does not include the full cost of any known or potential interconnection costs or network upgrades that may be required to provide firm deliverability to MISO LRZ 6 and/or that does not include interconnection, reliability, and/or economic analyses supporting interconnection and transmission requirements. Such materials should include a technical description and estimated costs of network upgrades from studies completed or underway.

CenterPoint will consider Proposals that plan to re-use existing injection rights under an interconnection agreement currently occupied by a retiring generating facility. Qualifying Proposals shall include a discussion of the required MISO studies, project ownership, and timing of commercial operation under the existing interconnection agreement as applicable. Respondents shall include an estimate of the costs required to build gen-tie lines connecting a project to the point of interconnection and shall not assume that existing transmission lines or other utility easements will be available to host the gen-tie circuit.

3.1.3 Technical and Economic Detail

3.1.3.1 Generation Technology

Respondents shall describe the generation technology of the facility, including the make, model, and name of the supplier of all major equipment. All Proposals to sell a generation facility to CenterPoint must utilize an existing, proven technology, with demonstrated reliable generation performance that is capable of sustained, predictable operation.

3.1.3.2 Dispatch, Emissions, and Performance Characteristics

Dispatch, emissions and performance characteristics will vary between different types of generation facilities, but shall be provided by Respondents as applicable including but not limited to load levels, ramp rates, heat rates, fuel consumption, expected energy production based on actual or typical weather, operating limitations, etc. Please refer to Sections 4.0, 5.0, 6.0, and 7.0 of this document for additional resource-specific requirements.

Regarding any major current and/or historical operational limitations, Respondents shall provide a description of the root causes of the limitations (e.g. original equipment manufacturer (OEM) design, material condition of the facility, environmental permits, etc.). To the extent that expected performance deviates from observed performance, the Respondent shall provide the basis for the assumption.

3.1.3.3 Revenues, Operating Costs, and Taxes

Respondents proposing new generation facilities must provide reasonable estimates for all of the following requested details associated with plant revenues and costs, including market revenues, fixed and variable operations costs, expected upgrades and service timing, and taxes.

For existing generation facilities, Respondents shall provide a detailed breakout of the facility's actual annual revenues for each of the past five years. This will include energy, capacity, and ancillary service market revenues, as well as any other revenues the facility earned, including any congestion revenue (positive or negative), as well as uplift revenues. Associated with these revenues, Respondents shall state the estimated annual output in MWh as well as the operation and maintenance costs of the facility on a fixed ($) and variable ($/MWh) basis and provide the actual annual operation and maintenance costs of the facility for each of the past five years in nominal dollars.

Respondents shall provide a detailed breakout of the generation facility's estimated and actual annual fixed costs for the following categories: labor, benefits, materials, and all others for the past five years. Respondents shall provide a breakdown of the number of people employed at the facility, including permanent and contracted employees, and whether those employees are organized under any labor agreement.

If fixed or variable costs for the generation facility are expected to change in the foreseeable future (e.g., following planned upgrades, etc.), the Respondent should provide both the new expected cost(s) and the year(s) in which the costs are expected to change.

Respondents shall also describe any state, local, and property taxes and tax abatements associated with the generation facility.

3.1.4 Operating Considerations

3.1.4.1 Operating Data

Respondents proposing new or planned generating facilities shall include reasonable estimates for all of the following requested operating data points. Proposals shall include the manufacturer or developer quoted expected performance and, if available, historical performance of similar facilities in MISO.

For an existing generation facility, Respondents shall provide historical operating data consisting of:

- The commercial operation date (COD) of the facility
- The annual run-time hours (per unit, if applicable)
- The annual operating cycles per year (per unit, if applicable)
- The annual facility capacity and availability factors
- The equivalent forced outage rate demand (EFORd)

The above annual data may be limited to the most recent five years. The EFORd should correspond to the UCAP amounts awarded for the last five MISO Planning Years. Respondents shall provide a breakdown of EFORd by failure mode or North American Electric Reliability Corporation/Generating Availability Data System category. Respondents

shall provide a description of the major contributors to the generation facility EFORd. If there are particular costs associated with maintaining the EFORd of a generation facility, those must be provided. Generating facilities considered a Dispatchable Intermittent Resource (DIR) in MISO shall provide historical curtailments over the most recent years. New facilities shall put forth a best effort forecast of curtailments by MISO.

For an existing generation facility, Respondents shall provide details on any current generation facility equipment issues and concerns, including any operation outside recommended parameters established by OEM, compromised equipment, etc. Respondents shall provide historical information on such issues and concerns, how they were resolved, and the associated costs for the past 10 years or since the beginning of operation.

Respondents shall provide the following maintenance history for the past 10 years or since the beginning of operation: (i) dates of last full unit inspection and findings based on OEM recommendations; and (ii) outstanding OEM recommendations remaining to be implemented, including the cost and outage duration for any major maintenance requirements expected over the coming ten years. Respondents shall provide the annual reports for major planned and forced outages over the past five years.

3.1.4.2 Operating Plan

Proposals should include a summary of the operating plan for the generation facility. Such plan should include software management system(s) and personnel roles and responsibilities for operating, maintaining, and servicing the facility, including any contractual arrangements. Respondent shall provide an overview of key scheduled outage and maintenance plans, as well as plans for procuring and maintaining key spare parts.

3.1.5 Environmental Considerations

New and existing resources must be in compliance with all applicable environmental rules and regulations. To the extent applicable, all environmental attributes, including emission reduction credits and/or allowances in any form (emissions credits, offsets, financial credits, etc.), related to the power being purchased, should be conveyed to CenterPoint. Respondents shall describe any operating limitations imposed by permitting or environmental compliance that limit plant availability and shall provide a description of any identified environmental liabilities (e.g., potential site remediation requirements, etc.) for the facility.

3.1.6 Permitting

The generation facility must have all relevant environmental, site-use and all other ministerial and discretionary permits necessary for construction and/or operation and maintenance. Existing facilities without such permits may be disqualified from consideration at CenterPoint's sole discretion. Respondents shall provide a description of all permits currently in place for the construction and/or operation and maintenance of the facility and must state whether there are any provisions that would prohibit the assignment of such permits and/or any consents required for the assignment of such permits.

3.1.7 Financial Considerations

3.1.7.1 Acquisition Price / Capital Expenditures

Respondents shall submit an acquisition price with their Proposal, representing their best and final price, consisting of a single fixed payment that is inclusive of all monetary consideration for the generation facility including, but not limited to, costs associated with interconnection, engineering studies, siting, permitting, acquisition, construction, ancillary facilities, working inventory, and contractual arrangements (e.g., for fuel supply and transportation, maintenance, pollution control bonds, etc.). Different transaction structures may warrant a schedule of payments as described below, but the acquisition price should represent the total all-in purchase amount required to close the transaction and achieve complete commercial operation of the generating facility. Respondents must provide details regarding any liabilities that CenterPoint might assume as a buyer of a generation facility.

3.1.7.2 Other Contractual Commitments

Respondents shall provide a description, including detailed cost information, of any other contracts that are necessary to operate the generating facility, including, but not limited to, long-term service agreements, state union labor contracts and/or technical support contracts, agreements related to capacity and/or energy sales from the facility and any capacity offers submitted to any independent system operator/regional transmission organization related to the generation facility that, if accepted, would be binding on CenterPoint as a result of an acquisition. Respondents must also state whether there are any provisions that would prohibit the assignment and/or affect the performance obligations of either party under the respective contract, including transfer or cancellation fees.

3.1.8 Legal Considerations

3.1.8.1 Legal Proceedings, Liabilities & Risks

The Proposal shall include a summary of all material actions, suits, claims or proceedings (threatened or pending) against Respondent, its Guarantor (if applicable) or involving the generation facility or the site as of the Proposal due date, including existing liabilities whether or not publicly disclosed, including but not limited to those related to employment and labor laws, environmental laws, or contractual disputes for the development, construction, maintenance, fueling, or operation of the facility.

3.1.8.2 Material Contingencies

Proposals that have material contingencies, such as for financing, may not be considered.

3.1.9 Other

All Proposals for new generation facilities must have a well-defined and credible development plan for Respondent to complete the development, construction, and commissioning of the facility on their proposed development timeline. Respondents submitting Proposals for new or planned facilities should review the Development Risk evaluation metric and be sure to discuss key development milestones in their Proposal.

Quality Proposals should provide information to assess the following:

- **(Key contractual arrangements)** Roles and responsibilities of the companies involved in the design, development, procurement, and construction of the facility. Information about key contributors including the status of contractual relationship with each key contributor, key contractual assurances, guarantees, warranties or commitments supporting the Proposal, (e.g. executed EPC contract), and any past experience of Respondent working with each key contributor.
- **(EPC)** Description of status of major equipment procurement, as well as processes for engineering, procurement, and construction bids and awards.
- **(Site control)** Description of the facility site and Respondent's rights (i.e., whether owned, leased, under option) to such site. Please indicate whether additional land rights are necessary for the development, construction, and/or operation of the facility.
- **(Schedule)** Discussion of the development schedule and associated risks and risk mitigation plans for that schedule, including whether there are contract commitments from contractors supporting the proposed schedule. The Respondent should be prepared to document and commit to a proposed development schedule, which should include a COD.
- **(Financing)** Discussion of the financing arrangements secured by the Respondent, including an overview of the sources of funds, and level of commitment from debt, equity, or other investors; Respondent's or guarantors' senior unsecured debt and/or corporate issuer ratings documentation from Moody's and Standard & Poor's showing the name of the rating agency, the type of rating, and the rating of the Respondent or guarantor.
- **(Permits and zoning)** Discussion on permitting, including a list of all required permits, permitting status of each, and key risks to securing necessary future permit approvals. Respondents should provide all applicable zoning requirement language for the project location (e.g. county, city, township, etc.) and describe current status of project zoning.
- **(Interconnection)** Description of status in MISO queue process and presentation of documents described in Section 3.1.2.1.

Respondents shall assume for the purposes of Proposal pricing that development schedule, budget, permits and approval risk will be their sole responsibility.

3.2 Eligible Transaction Structures

The following are eligible project transaction structures as part of this RFP. Resource-specific requirements and attributes are provided further down in Sections 4.0 - 7.0 pertaining to specific types of resources. Term sheets containing additional key assumptions for particular contract- and resource-type combinations have been developed and are included in the appendices.

3.2.1 Power Purchase Agreement (PPA)

CenterPoint will consider meeting some or all of its resource requirements through short, medium and/or long-term PPAs. CenterPoint will only consider PPAs that have a term of five years or greater.

3.2.1.1 Price

Respondents shall submit an annual power purchase price ($ and/or $/MWh as applicable) consisting of a payment that is inclusive of all monetary consideration for the capacity, energy, RECs, and, if applicable, ancillary facilities and contractual arrangements related to the generation facility. The contract price shall include all costs of interconnection, including possible MISO and affected system network upgrade costs, and transmission owner interconnection facility and substation upgrade costs. Respondents must provide a flat pricing option (i.e. fixed price for the term of the contract) with each Proposal, and may also include optional escalating pricing options for CenterPoint's consideration.

3.2.1.1.1 Energy Settlement Location

As described further in the evaluation section below, CenterPoint has a preference for Proposals that include all costs to have energy financially settled or directly delivered to CenterPoint's load node (SIGE.SIGW). However, CenterPoint will consider pricing options for Proposals that settle at the facility's point of interconnection (busbar) or Indiana Hub.

3.2.2 Asset Purchase

CenterPoint will accept Proposals for new, planned, or existing generation facilities that are complete and operational in advance of the expected acquisition date. CenterPoint will only consider offers for facilities that have an estimated remaining useful life of five (5) or more years from acquisition date.

3.2.2.1 Location

CenterPoint has a preference for projects located near its load. However, CenterPoint will accept Proposals for new or planned generation facilities that will be complete and operational in advance of the expected acquisition date. A project will be defined as complete and commercially operable if, and only if, it includes all facilities necessary to generate and deliver energy into MISO to at least one single point of interconnection within MISO.

3.2.2.2 Tax Credits

Respondents shall state the qualifications of the project for any applicable tax credits and provide relevant documentation. Respondents should provide a discussion of the method for acquiring tax incentives through safe harbor and attest whether safe harbored equipment is specifically dedicated to the project.

3.2.2.3 Tax Abatements

Respondents shall include a discussion of any tax abatements acquired by the project. Respondents should provide all terms, conditions, and relevant documentation related to tax abatements.

3.2.3 Renewable Project in Development

CenterPoint has a preference for Asset Purchase Proposals as described above in Section 3.2.2. However, CenterPoint will accept Asset Purchase Proposals for Generating Facilities in which ownership transfer of the project occurs prior to project completion; however, such Proposals must provide a definite path to completion. Proposals for Projects in Development must include pricing for completion of the project following transfer of ownership and must otherwise adhere to the Proposal requirements specified in Section 3.2.2 and elsewhere in this document including the Term Sheets provided in Appendices F, G and H. The Term Sheets contemplate asset transfer at completion; however, Proposals with a pre-completion transaction structure shall provide the same protections and commitments contemplated in the Term Sheets. Deviations shall be detailed in the Proposal narrative. Proposals must include discussion of the development schedule and associated risks and risk mitigation plans for that schedule, including commitments from contractors supporting the proposed schedule. The Respondent shall document and commit to a proposed development schedule up to and including commercial operation.

3.2.4 Demand-Side Contracts

CenterPoint will consider LMR and DR resources from one or more MISO customers or curtailment service providers (CSP). LMR suppliers must be located entirely within MISO LRZ 6. Proposals for LMRs/DRs are to be for assets that are eligible to participate in MISO LRZ 6 and can meet the additional performance requirements of CenterPoint as described in Section 6.0 below. Proposals for LMRs/DRs may be combined with another power supply Proposal or may be submitted on a standalone basis. CenterPoint will consider LMR/DR Proposals that have a term of one year or longer, consistent with MISO planning years.

3.2.5 Capacity Only Contracts

CenterPoint is also is seeking to procure MISO Zone 6 Zonal Resource Credits (ZRC) for the 2023/2024 and 2024/2025 MISO Planning Years. As such, the capacity must be physically located or fully delivered to MISO Local Resource Zone (LRZ) 6. Similarly, CenterPoint will consider Proposals for longer-term Market Capacity Products that meet the requirements specified in Section 7.0 below.

3.3 Respondent Pre-Qualification: Notice of Intent and Non-Disclosure Agreement

Respondents to this RFP are required to fill out and sign pre-qualification documents in their present form -- Appendix A: Notice of Intent to Respond, Appendix B: Non-Disclosure Agreement (NDA), and Appendix C: Pre-Qualification Application. Respondents shall submit the signed forms to the RFP website (http://CenterPoint2022ASRFP.rfpmanager.biz/) by 5:00 p.m. CDT on May 27, 2022. Respondents may download the forms from the RFP website.

3.4 Multiple Proposals

Respondents may submit up to three Proposals (Projects) at no cost in response to this RFP. Respondents submitting more than three separate responses will incur a Proposal Evaluation Fee for each additional Proposal (Project) submitted. The non-refundable fee for evaluating each additional Proposal (Project) is $5,000. This sum will serve to defray evaluation costs. Respondents can find instructions for paying fees for their Proposal(s) on the RFP website (http://CenterPoint2022ASRFP.rfpmanager.biz/).

CenterPoint encourages Respondents to offer their Projects in a variety of ways and each Project offered with multiple options will be considered as a single Proposal. For example, Projects that are offered under multiple transaction structures (e.g. PPA or Asset Purchase) will count as one Proposal as it relates to the evaluation fee. Projects that offer various PPA term lengths and/or energy settlement locations (Project busbar, CenterPoint's load node, or Indiana Hub) will also be considered as one Proposal. In addition, Projects that are proposed both as standalone generating assets (e.g. solar) and also paired with storage will be considered as one Proposal as it relates to the fee. CenterPoint and 1898 & Co. will have sole discretion to determine whether a submission is deemed a single Proposal or multiple Proposals.

3.5 Proposal Pricing and Duration

Respondents shall make best efforts to offer Proposals with firm pricing not subject to any revisions during the evaluation, short-list selection and IRP process. As such, **pricing shall reflect the transaction price under current conditions (i.e. steel and other commodities, major equipment costs, tariffs and other duties, shipping costs, labor costs, availability of tax benefits, etc.).** For example, only current, active solar module tariffs in effect at the time of Proposal submission should be included and any potential future tariffs that may be levied should not be included in pricing. Likewise, Proposal pricing shall assume EPC costs such as material and labor as observed today, and shall not make assumptions as to the increase or decrease of costs at some future time.

Respondents shall provide cost assumptions in Appendix D and may provide further detailed justification for cost assumptions in the Proposal narrative. Proposals that base pricing on assumptions out of line with current conditions may be disqualified. All pricing should be provided in Appendix D in terms of US dollars as of the date the term of the contract begins and not subject to a currency exchange rate adjustment. CenterPoint is not obligated to provide an opportunity in the evaluation schedule for Respondents to refresh or update their pricing before the final selection(s) are made (if any).

3.6 Acknowledgment of RFP Terms and Conditions

The submission of a Proposal shall constitute Respondent's acknowledgment and acceptance of all the terms, conditions, and requirements of this RFP.

3.7 RFP Response Summary Information

All Proposals must include a table of contents and provide concise and complete information on the additional topics described below, organized as follows:

3.7.1 Executive Summary

Please provide a one-page executive summary of the Proposal in the form of a cover letter. Include the facility's location, age or development status, MISO generator interconnection project number, ICAP size, the primary contact's name, email, and phone number, and an overview of the major features of the Proposal. The Executive Summary must be signed by an officer of the Respondent who is duly authorized to commit the firm to carry out the proposed transaction should CenterPoint accept the Proposal (this does not have to be the primary contact). A Table of Contents should be the first page and immediately precede the Executive Summary.

3.7.2 Respondent's Information and Experience

Please include information on the Respondent's corporate structure (including identification of any parent companies), the project's financing plan, the Respondent's most recent credit rating, quarterly report containing unaudited consolidated financial statements that is signed and verified by an authorized officer of Respondent attesting to its accuracy, a copy of Respondent's annual report for the prior three years containing audited consolidated financial statements and a summary of Respondent's relevant experience. Please describe any current litigation or environmental fines involving the Respondent within the last five years, including but not limited to, any litigation, settlements of litigation or fines, that could potentially affect the facility or its operation. Please identify all bankruptcy or insolvency proceedings relating to the Respondent in any way. Please describe any litigation the Respondent or its parent company have been a party to in the last six years related to PPAs, asset purchases, capacity contracts or other transactions similar to those solicited in this RFP. All financial statements, annual reports and other large documents may be referenced via a website address.

Generating Facility Proposals shall include a list of projects with a brief description of Respondent's experience in the areas of development, financing, permitting, ownership, construction, and operation of all utility-scale power generation facilities.

4.0 PROPOSALS INCLUDING RENEWABLES & BATTERY STORAGE

4.1 Additional Requirements – Renewable and Storage Resources

Proposals for renewable and storage resources such as wind, solar, standalone storage, or storage paired with solar or other renewable projects (Renewable Resources) will be considered when submitted in response to this RFP. This section of the RFP provides additional requirements applicable to Proposals that include one or more renewable or storage resource(s). In addition, please see applicable Term Sheets (additional key pricing assumptions) in Appendices F, G and H

4.2 Wind Energy Proposals

CenterPoint is seeking Proposals for wind energy projects with an installed capacity (ICAP) of 50 MWac or greater but will consider Proposals for projects of any size. In addition to the general requirements provided in Section 3.0, the following additional requirements apply to any Proposal that includes a wind project:

- Major Component Data: The Proposal shall provide details on major components (such as turbines, blades, transformers, circuit breakers, switchgear, all protection and control systems, etc.) including manufacturer, country-of-origin, individual turbine ratings, rotor diameter and hub height.
- Location: CenterPoint has a preference for wind projects located in MISO Zone 6 as well as MISO Zone 4 and MISO Zone 5 but will also consider Proposals for projects located elsewhere. Proposals for facilities without existing firm deliverability to MISO LRZ 6 shall include cost estimates and transmission studies associated with securing such deliverability.
- Site control and layout: Proposals for wind projects shall include discussion of the project turbine layout and status of land acquisition required to site the layout. Respondents shall include a discussion of any nearby land features or facilities imposing land-use constraints including, but not limited to, wetlands, airports and other FAA facilities, zoning restrictions, etc.
- Permits and zoning: Respondents shall include a discussion of permitting status for the project including zoning status and restrictions such as setbacks, tip height limits, etc.
- Expected performance: Proposals shall include P50 expected annual production in MWh or NCF. Respondents shall provide the wind data or describe the data set used to estimate production.
- Price: Any Asset Purchase Proposal must clearly state all terms and obligations of the parties associated with the proposed transaction, including the disposition of Production Tax Credits. PPA Proposals may also include an option to purchase the assets, and shall clearly state the terms of such purchase option.
    - For purposes of incorporating the effect of tax benefits in Proposal pricing, Respondents shall apply tax law **currently in effect** at the time of Proposal submission and clearly state which tax assumptions are used. Respondents may optionally provide a discussion on the pricing impacts of possible future scenarios; however, a Proposal may be disqualified if it does not at a minimum provide pricing applying only **current laws**.

- To the extent RECs are included in a Proposal they must be registered with North American Renewables Registry.

4.3 Solar Energy Proposals

CenterPoint is seeking Proposals for solar energy projects with an installed capacity (ICAP) of 50 MWac or greater but will consider Proposals for projects of any size. In addition to the general requirements provided in Section 3.0 the following additional requirements will apply to any Proposal that includes a solar energy project:

- Major Component Data: The Proposal shall provide details on major components (such as solar panels, racking, inverters, transformers, circuit breakers, switchgear, all protection and control systems, etc.) including manufacturer, country-of-origin, individual panel ratings, and whether the panels will be fixed or tracking. The Proposal shall also include information on the inverters to be included in the project, including the manufacturer, size of individual inverters, and the type/configuration of the inverter system.
- Location: CenterPoint has a preference for solar projects located in MISO Zone 6 but will also consider Proposals for projects located elsewhere. Proposals for facilities without existing firm deliverability to MISO LRZ 6 shall include cost estimates and transmission studies associated with securing such deliverability.
- Site control and layout: Proposals for solar projects shall include discussion of the project panel/array layout(s) and status of land acquisition required to site the layout. Respondents shall include a discussion of any nearby land features or facilities imposing land-use constraints including, but not limited to, wetlands, zoning restrictions, etc. Respondents shall also include a description of civil work that will be required to prepare the land for solar installation as well as the contiguity of the land parcels used for the project. If possible Proposals should include layout drawings and schematics for the project.
- Permits and zoning: Respondents shall include a discussion of permitting status for the project including zoning status and restrictions such as setbacks, vegetation screening requirements, etc.
- Expected performance: Proposals shall include P50 expected annual production in MWh or NCF. Respondents shall provide the solar data or describe the data set used to estimate production.
- Price: Any Asset Purchase Proposal must clearly state all terms and obligations of the parties associated with the proposed transaction, including the disposition of Investment Tax Credit. PPA Proposals may also include an option to purchase the assets, and shall clearly state the terms of such purchase option.
    - For purposes of incorporating the effect of tax benefits in Proposal pricing, Respondents shall apply tax law **currently in effect** at the time of Proposal submission and clearly state which tax assumptions are used. Respondents may optionally provide a discussion on the pricing impacts of possible future scenarios; however, a Proposal may be disqualified if it does not at a minimum provide pricing applying only **current laws**.
- To the extent RECs are included in a Proposal they must be registered with North American Renewables Registry.

4.4 Energy Storage Proposals

CenterPoint is seeking Proposals for energy storage projects with an installed capacity (ICAP) of 25 MW or greater and a minimum duration of 4 hours; however, Proposals for storage projects of any size and duration will be considered. In addition to the general requirements provided in Section 3.0 the following additional requirements will apply to any Proposal that includes stand-alone storage or storage paired with other renewable technologies (e.g. solar + storage):

- Major Component Data: The Proposal shall provide details on major components (such as cells/modules, inverter, BMS, container system, climate control, fire protection, transformers, circuit breakers, switchgear, and control systems, etc.) including manufacturer, country-of-origin, etc.
- Location: CenterPoint has a preference for storage projects located in MISO Zone 6 but will also consider Proposals for projects located elsewhere. Proposals for facilities without existing firm deliverability to MISO LRZ 6 shall include cost estimates and transmission studies associated with securing such deliverability.
- Expected performance: Proposals shall include the system efficiency (i.e. roundtrip efficiency), overbuild, annual augmentation, maximum/warranty daily and annual cycles, etc. Proposals should include a description of the control strategy and dispatch control ownership.
- Price: Any Asset Purchase Proposal must clearly state all terms and obligations of the parties associated with the proposed transaction, including the disposition of Investment Tax Credit if applicable.
    - For purposes of incorporating the effect of tax benefits in Proposal pricing, Respondents shall apply tax law **currently in effect** at the time of Proposal submission and clearly state which tax assumptions are used. Respondents may optionally provide a discussion on the pricing impacts of possible future scenarios; however, a Proposal may be disqualified if it does not at a minimum provide pricing applying only **current laws**.

4.5 Evaluation Methodology

The following table summarizes the criteria that will be used to evaluate renewable and battery storage resource Proposals. Further definitions of each criteria and how they will be evaluated are outlined in Section 8.0.

Table 3: Renewables and Storage Scoring Criteria Summary

Category	Total points (out of 500)	Allocation
LCOE Evaluation (30%)	150	Proportionately from 0 (awarded to highest LCOE in group) to 150 (lowest LCOE in group)
Energy Settlement Location (20%)	100	• Max points given to energy financially settled or directly delivered to SIGE.SIGW • 90 points to projects located in service territory[2] • 75 points to Zone 6 outside CenterPoint territory • 25 points to projects in MISO that are outside Zone 6 • 0 points otherwise
Interconnection and Development Status (20%)	100	• Points awarded equally to 4 milestones. Max points for completed GIA & cost cap including interconnection agreement re-use • 75 completed Facilities Study (during DPP2-3) & offered cost cap • 50 competed System Impact Study (during DPP1) & offered cost cap • 25 offered cost cap • 0 points otherwise
Project Risk Factor (30%)	150	• Credit and Financial Plan – 30 points awarded proportional to CNP internal score from 0-10 • Development Experience – 30 points awarded proportional to MW in service, max of 1,500 • Site Control – 30 points proportional from 0%-100% of site control verified by provided docs • Permits – 30 points for Proposals showing all permits needed for construction/operation • Zoning – 30 points for Proposals showing completed zoning requirements

[2] For purchase options where delivery to SIGE.SIGW is not applicable, 100 points will be awarded to projects located in CenterPoint's service territory

5.0 PROPOSALS INCLUDING THERMAL RESOURCES

5.1 Additional Requirements – Thermal Resources

Proposals for thermal generating resources such as coal, natural gas, hydrogen or nuclear units will be considered when submitted in response to this RFP. This section of the RFP provides additional requirements applicable to Proposals that include one or more thermal resource(s).

5.2 Dispatch, Emissions, and Performance Characteristics for Thermal Resources

Respondents shall provide the dispatch and emissions characteristics of the generation facility in Appendix D, including, but not limited to:

- Minimum load level
- Maximum load level
- Ramp rates (up and down)
- Number of gas turbines that can be started simultaneously (if applicable)
- Heat rate curve for typical operations, including the minimum load and full load heat rates
    - If applicable, Respondent shall also provide heat rate curves for summer and winter seasons
- Fuel consumption and heat rate during startup, including startup time and the total number of hours annually the facility can be assumed to be in startup mode
- Fuel consumption and heat rate when the facility is being shut down, including how long shutdown takes and the total number of hours annually the facility can be assumed to be in shutdown mode
- An estimation of the total number of hours annually that the facility operates at full load
- Capability reductions as a result of ambient temperature increases
- Supplemental firing capability, including black start capability, and any operating limitations caused by such factors of design
- Emissions rates in units of lb/MWh at relevant dispatch levels (startup, minimum, mid and full loading) and seasons (summer, winter, shoulder) for nitrogen oxides (NO_X), sulfur dioxide (SO_2), carbon dioxide (CO_2), volatile organic compounds (VOC), particulate matter (PM) and carbon monoxide (CO)
- Any other operational limitations that reduce unit availability or reduce a unit's ability to dispatch or regulate

5.3 Operating Considerations

In addition to the instructions provided above in Section 3.0 Respondents shall provide the following data specific to thermal resources.

5.3.1 Operating Data

Respondents shall provide details on any current generation facility equipment issues and concerns, including the potential drivers and recommended mitigation procedures for the issues and/or concerns. These may include, but are not limited to, any operation of the turbine, generator, or boiler outside recommended parameters established by OEM, compromised turbine or compressor blades, etc. Respondents shall provide a list of any redundant equipment that is currently bypassed or out of service, and the related reason. Respondents shall also provide historical information on such issues and concerns that have arisen, how they were resolved, and the associated costs for the last ten years of operation, or for the commercial life of the generation facility, whichever is lesser.

5.3.2 Fuel Supply

Proposals shall describe, to the extent possible, fuel sourcing strategy, including from where their fuel is sourced. Respondents shall provide a description, including detailed cost information, contract duration, and material contract terms (including whether fuel contracts are take or pay, minimum volume requirements, price reopeners, assignability or termination provisions) of all fuel purchase, storage, and transport agreements related to the generation facility Proposal. Cost of fuel commodities shall be provided separately from the cost of fuel transportation. Respondents also must list any provisions or other considerations that would prohibit or impair the assignment and/or affect the performance obligations of either party under the respective contract(s). Respondents shall describe fuel purchase and transport to the generation facility, as well as any existing or known potential operational restrictions or impediments on such fuel purchase and transportation. Respondents also are required to provide a description of the existing fuel supply (and storage) infrastructure serving the generation facility, including the infrastructure for the delivery of secondary fuel for dual-fuel resources. However, CenterPoint, through this RFP, is exploring the potential purchase of generation facilities, and it is CenterPoint's sole discretion whether to assume any contract or contracts associated with the proposed generation facility related to fuel commodities and/or fuel transportation.

Proposals shall describe the generation facility's ability to access a reliable fuel supply that would support operation for any hour throughout the year, including the plant's onsite fuel storage and dual-fuel capabilities, if applicable. Proposals for gas generators shall indicate whether the facility is dual-fuel capable and Proposals should include an indication of the days of onsite fuel storage available. Gas generators without dual fuel capability shall provide information on the costs required to make the facility dual fuel capable to the extent that such cost estimates are available. Natural gas fired facilities shall have firm gas transportation contracts in place for the amount of gas capacity necessary to fulfill the amount of UCAP being bid. Proposals that do not include firm gas supply may be disqualified.

5.4 Environmental Considerations

In addition to the instructions provided above Respondents shall provide the following data specific to thermal resources.

5.4.1 Emissions and Waste Disposal Compliance

To the extent applicable, all environmental attributes, including emission reduction credits and/or allowances, related to the power being purchased should be conveyed to CenterPoint. This includes, but is not limited to, any and all credits in any form (emissions credits, offsets, financial credits, etc.) or baseline emissions associated with both known and unknown pollutants, including but not limited to SO_2, NO_X, Mercury (Hg), and CO_2. Any and all environmental liabilities, including compliance with known and future or unknown regulations or laws will be the sole responsibility of the generation producer or PPA seller.

For Asset Purchase Proposals, the Seller will retain all pre-closing environmental liabilities and obligations as well as all known future environmental liabilities and obligations, in each case associated with the real and personal property transferred with or as part of a Sale of the Plant. This includes both on and off-site liabilities. The Buyer will assume all other post-closing environmental liabilities and obligations. For purposes of facility design, Seller should assume that the unit will be required to meet the proposed New Source Performance Standards for Greenhouse Gases (40 Code of Federal Regulations (CFR) part 60, subpart TTTT).

5.4.2 Water Supply

Respondents shall provide a detailed description of the water supply, including but not limited to, contract term, water usage, and cost of water for the generation facility. Respondents shall also provide the status of the facility's National Pollutant Discharge Elimination System (NPDES) permits, including, but not limited to, permit conditions, permit violations reported over the last five years, the timing of next permit renewal, and any other known concerns.

If applicable, Respondents shall provide a summary of the facility's water chemistry program, including key systems and suppliers, and its performance in the most recent year.

5.4.3 Permits

As stated above, the generation facility must have all relevant environmental and other permits necessary for operation and maintenance. Respondents shall provide a description of all permits currently in place for the operation and maintenance of the facility (e.g., Spill Prevention Containment and Control plans, Title IV and Title V permits of the Clean Air Act, Cap and Trade Permits, NPDES permits, Water Withdrawal, and Pollution Incident Prevention Plan, etc.).

Respondents shall describe any operating limitations imposed by permitting or environmental compliance that limit plant availability.

Respondents shall provide a description of any identified environmental liabilities (e.g., potential site remediation requirements, etc.) for the facility.

5.5 Evaluation Methodology

The following table summarizes the criteria that will be used to evaluate thermal resource Proposals. Further definitions of each criteria and how they will be evaluated are outlined in Section 8.0.

Table 4: Thermal Facility Scoring Criteria Summary

Category	Total points (out of 500)	Allocation
LCOE Evaluation (30%)	150	Proportionately from 0 (awarded to highest LCOE in group) to 150 (lowest LCOE in group)
Energy Settlement Location (20%)	100	• Max points given to energy financially settled or directly delivered to SIGE.SIGW • 90 points to projects located in service territory[3] • 75 points to projects in LRZ 6 outside of CenterPoint's service territory • 25 points to projects that settle in MISO outside of LRZ 6 • 0 points otherwise
Interconnection and Development Status (20%)	100	• Points awarded equally to 4 milestones. Max points for completed GIA & cost cap including interconnection agreement re-use • 75 completed Facilities Study (during DPP2-3) & offered cost cap • 50 competed System Impact Study (during DPP1) & offered cost cap • 25 offered cost cap • 0 points otherwise
Project Risk Factor (30%)	150	• Credit and Financial Plan – 30 points awarded proportional to CNP internal score from 0-10 • Development Experience – 30 points awarded proportional to MW in service, max of 1,500 • Fuel Risk - 15 • Operational Control – 15 • Site Control – 30 points proportional from 0%-100% of site control verified by provided docs • Permits – 15 points for Proposals showing all permits needed for construction/operation • Zoning – 15 points for Proposals showing completed zoning requirements

[3] For purchase options where delivery to SIGE.SIGW is not applicable, 100 points will be awarded to projects located in CenterPoint's service territory

6.0 PROPOSALS INCLUDING LOAD MODIFYING RESOURCES/DEMAND RESOURCES

LMRs/DRs are demand-side resources and behind the meter generation not typically modeled or measured as part of MISO's operations but used during capacity shortages to help meet the energy balance. CenterPoint will consider LMRs/DRs from one or more MISO customers or curtailment service providers (CSP). LMR suppliers must be located entirely within MISO LRZ 6. Proposals for LMRs/DRs are to be for assets that are eligible to participate in MISO LRZ 6 and can meet the additional performance requirements of CenterPoint as described in Sections 6.1 and 6.3. In addition, for LMRs/DRs located within Indiana, Respondent must identify how the Proposal conforms with any requirements of the local utility and state law in order to offer resources for capacity accreditation within the MISO market under Module E Capacity Tracking.

Proposals for LMRs/DRs may be combined with another power supply Proposal or may be submitted on a standalone basis. CenterPoint will consider LMR/DR Proposals that have a term of one year or longer, consistent with MISO planning years.

6.1 Product Definition

To be eligible for participation in this RFP, the LMR/DR offered by a supplier must:

- Meet LMR/DR Requirements for participation in MISO as a demand-side resource, including any future changes to MISO's requirements for LMRs/DRs for the term of the Proposal
- Meet the additional performance requirements described in Section 6.3
- For capacity accreditation, the Proposal must be sourced from locations entirely within MISO LRZ 6
- Use an existing, proven technology that has demonstrated reliable demand reduction, which may include use of Behind the Meter Generation (as defined by MISO)
- Reduce load by a predetermined amount when notified by CenterPoint of a Curtailment Event without further direction or communication by or from CenterPoint.

6.2 Purchase Agreement

If selected, the LMR/DRs supplier and CenterPoint will negotiate a mutually acceptable agreement to govern any commercial relationship established by the parties. With respect to a Proposal from a CSP, CenterPoint will not be responsible for making payments to, communicating with, or managing the relationship or performance of any customer within an aggregation, and the CSP shall be solely responsible for the same in all respects. To mitigate risk, CenterPoint will require the LMR/DR supplier to provide collateral upon execution of a

LMR/DR Proposal. CenterPoint reserves the right to determine the form of that collateral requirement for a winning Proposal.

6.3 Curtailment Events: Notification and Performance Requirements

LMRs/DRs must meet notification and performance requirements applicable to a Curtailment Event, as defined and described herein and comply with MISO current and future testing requirements. A Curtailment Event shall be initiated by either CenterPoint or MISO as described futher in Section 6.3.1.

6.3.1 Notification, Performance, and Test Requirements

Curtailment Events initiated by MISO: For Curtailment Events initiated by MISO, LMR/DR suppliers shall agree to and be capable of meeting, throughout the entire term of the Proposal, all notification and performance requirements applicable to Capacity Performance demand resources. The supplier shall comply with all MISO Module E Capacity Tracking measurement and verification requirements.

Curtailment Events initiated by CenterPoint: Suppliers shall also agree to and be capable of meeting the following additional notification and performance requirements applicable to Curtailment Events initiated solely by CenterPoint:

- Suppliers shall curtail Actual Measured Load to Firm Contract Load within the proposed notification time specified in the Proposal.
- Notification of a Curtailment Event initiated solely by CenterPoint will consist of an electronic message issued by CenterPoint to a device or devices such as telephone, facsimile, or email, selected and provided by the supplier and approved by CenterPoint. Two-way information capability shall be incorporated by CenterPoint and the supplier in order to provide confirmation of receipt of notification messages. CenterPoint will provide the supplier a notification of when Curtailment Events have ended. Operation, maintenance, and functionality of communication devices for receipt of notifications selected by the supplier shall be the sole responsibility of the supplier, and receipt of notifications set out in this paragraph shall be the sole responsibility of the supplier.
- During the entire period of a Curtailment Event initiated by CenterPoint, the supplier's Actual Measured Load must remain at or below its Firm Contract Load. A supplier's Actual Measured Load shall be determined by integrating the megawatts used over every clock hour (hour-ending).

6.3.2 Remedies for Non-Performance

A supplier whose Actual Measured Load exceeds its Firm Contract Load will be subject to performance penalties which may include, but not be limited to, refunding to CenterPoint monthly payments under the agreement.

A supplier shall be responsible for, and shall indemnify CenterPoint for, any non-performance penalties, costs, charges, or other amounts assessed by MISO and incurred by CenterPoint as a result of non-performance attributable to the supplier's LMR/DR, including but not limited to any Capacity Resource Deficiency Charges, Non-Performance Charges, or similar charges or penalties under the MISO agreements. In no event shall the penalties listed above for non-performance during a Curtailment Event be less than the sum of any MISO non-performance penalties, costs, charges, or other amounts incurred by CenterPoint as a result of non-performance attributable to the supplier's LMR/DR and the Curtailment Event charge.

6.4 Proposal Requirements

6.4.1 Acquisition Price

Suppliers shall submit an acquisition price consisting of a single fixed amount denominated in units of dollars per megawatt-day ($/MW-day), which is to apply for the term of the Proposal. If a Proposal is accepted, the supplier will be compensated in an amount equal to the monthly Curtailable Load times the Acquisition Price. The Proposal shall include all monetary consideration for the LMR/DR offered. Suppliers must submit their best and final price with their Proposal.

Should CenterPoint execute an agreement with a Respondent, the contract price between CenterPoint and the Respondent will be the Acquisition Price submitted in its respective Proposal through this RFP process.

6.4.2 Product Description

A Proposal shall include a description of the individual LMR/DR customer(s) and expected load drop values (kW), equipment, and technology that will be deployed and make available any other information required by MISO to meet its registration process, and for CSPs, plans for recruiting, engaging, and maintaining Program Participants.

Proposals should discuss the experience, qualifications, and financial strength of the supplier and other key contributors including the specific number of months the supplier has been providing LMR/DR services in MISO. Responses should indicate whether the supplier has ever been assessed a performance penalty in association with the resource and if so, when any penalties were assessed. For CSPs, Proposals should describe well-defined roles and responsibilities of the supplier and its participants. The supplier should describe successful protocols, if any, they have employed in the MISO LRZ 6 or other MISO zones for dispatching their LMR/DR.

While the product definition requires a load reduction upon notification by CenterPoint or MISO of a Curtailment Event, there is a preference for resources that can provide a more rapid response and/or ramp up or down in response to specific control signals. Respondents are urged to detail the full, demonstrated capability of the proposed resource in accordance with the evaluation criteria included in Section 8.0.

For planned LMRs/DRs, the supplier must fully describe specific plans detailing what equipment or technology it will deploy and/or utilize to support its operations. For CSPs, Proposals must describe supplier's processes for aggregating participants, how the supplier intends to recruit and engage participants, and/or provide lists of participants. The Proposal also must describe curtailment systems and procedures, budgeting for and structure of dispute resolution, and plans for communicating with participants in connection with a curtailment period.

6.4.3 Technical Requirements

CenterPoint shall acquire all rights, titles, and interests in the LMR/DR including all the potential capacity and energy revenues. Suppliers must agree to cooperate with CenterPoint in providing information needed to meet all MISO LMR/DR information requirements.

The supplier will assume all responsibilities and liabilities associated with providing LMRs/DRs. Accordingly, Proposals offering LMRs/DRs must include acknowledgment and agreement that the supplier is responsible for the following non-exhaustive list of activities and obligations:

- Managing load reductions, including all notices, communications, controls, equipment, or other processes required
- If the supplier is a CSP, determining the number of participants, in its aggregation, the number of interruptible hours per customer, and the size of each participant's load reduction
- If the supplier is a CSP, paying any participants according to the CSP's agreement with those participants. Such agreements shall be independent of CenterPoint's agreement with the CSP and must hold CenterPoint harmless for any direct or indirect obligations or liability associated with the program
- Paying penalties assessed due to the non-performance of the LMR/DR

The agreement shall reflect that it will be the supplier's responsibility to reimburse CenterPoint for any penalties, fees, or charges resulting from non-performance of its LMR/DR, including replacement capacity to maintain CenterPoint's Planning Reserve Margin(PRM) requirement, and the supplier's obligation to indemnify and hold CenterPoint harmless against any claim arising from such non-performance. In the case of a supplier who is a CSP, the agreement will additionally set forth CSP's responsibility to reimburse CenterPoint for any penalties, fees, or charges resulting from non-performance of any CSP participant, and CSP's obligation to indemnify and hold CenterPoint harmless against any claim arising from such CSP participants' non-performance.

6.5 Evaluation Methodology

The following evaluation criteria will be used to evaluate Proposals including other LMR/DRs. Since there is a wide range of potential products which could be offered within this category, adjustments may be made on scoring criteria to accurately compare bids within categories to

each other. Further definitions of each criteria and how they will be evaluated are outlined in Section 8.0.

Table 5: Demand-Side Contracts Scoring Criteria Summary

Category	Total points (out of 500)	Allocation
Cost Evaluation (40%)	200	Scaled proportional to the cost of similar Proposals.
Historical Performance (20%)	100	Awarded based on time in-service and absence of a non-performance penalty.
Response Time (20%)	100	Awarded based on response time to specific control signals.
Project Risk Factor (20%)	100	Allocated based on material risk of reduced deliverability.

6.6 Contract Execution

CenterPoint does not, by this RFP, obligate itself to purchase any LMR/DR, or to execute an agreement with any Respondent who submits an offer to sell a LMR/DR to CenterPoint. CenterPoint may, in its discretion, reject any or all Proposals to sell a LMR/DR to CenterPoint, as such are described in this RFP.

Selection of a Proposal as a finalist shall not be construed as a commitment by CenterPoint to execute an agreement. Execution of any agreement is contingent upon CenterPoint receiving all required regulatory approvals and completion of such due diligence as CenterPoint in its sole discretion determines is reasonable to confirm the qualifications and performance of a given LMR/DR. During the period between when 1898 & Co. makes its recommendation(s) to CenterPoint, and the date of execution of the agreement, CenterPoint may conduct additional due diligence on the Proposal.

7.0 CAPACITY OFFERS

7.1 General Requirements – Short Term Capacity Offers

CenterPoint is seeking to procure MISO Zone 6 Zonal Resource Credits (ZRC) for the 2023/2024 and 2024/2025 Planning Years. As such, the capacity must be physically located or fully delivered to MISO Local Resource Zone (LRZ) 6.

Table 6: Short Term Capacity

MISO Planning Year	Planning Year 2023 - 2024 (366 Days)	Planning Year 2024 - 2025 (365 Days)
Product	MISO Zone 6 Zonal Resource Credits	MISO Zone 6 Zonal Resource Credits
Volume	Up to 350 MW	Up to 350 MW

7.2 Long Term Capacity Offers

CenterPoint will also consider longer-term offers for capacity through 2040.

7.3 Terms and Conditions for Capacity Offers

- All bids shall be firm once submitted and shall remain firm through the end of the notification period.
- CenterPoint reserves the right to request clarification of information submitted and to request additional information from any Respondent.
- Capacity (Zonal Resource Credits) must be deliverable and delivered to MISO LRZ 6.
    - Capacity sourced from other MISO Local Resource Zones is acceptable provided the Respondent assumes the risk of any MISO imposed delivery charges and risks associated with MISO Import/Export limits.
- Respondents must be able and commit to transferring capacity to CenterPoint within MISO's Module E Capacity Tracking System ("MECT") tool in accordance with the MISO Tariff and associated business practice manuals for use in meeting Planning Reserve Margin Requirements.
- CenterPoint may require credit support dependent upon the term, overall value, and risks associated with individual Respondents. Such credit support may take the form of;
    - Letter of Credit ("LOC") from a financial institution acceptable to CenterPoint in its sole discretion, or Cash Escrow.

- CenterPoint reserves the right to award all or part of its requirements to one or more Respondents.

7.4 Pricing

Respondents shall provide Proposal pricing in units of $/MW-day for capacity fully delivered to MISO LRZ 6.

7.5 Evaluation Methodology

The following table summarizes the criteria that will be used to evaluate capacity offers. Further definitions of each criteria and how they will be evaluated are outlined in Section 8.0.

Table 7: Capacity Only Scoring Criteria Summary

Category	Total points (out of 500)	Allocation
Cost Evaluation (60%)	300	Scaled proportional to the cost of similar Proposals.
Project Risk Factor (40%)	200	• 200 located in MISO Zone 6 • 150 located in MISO Central Zones • 100 located in MISO North • 50 located outside of MISO North

8.0 PROPOSAL EVALUATION AND CONTRACT NEGOTIATIONS

8.1 Initial Proposal Review

An initial review of the Proposals will be performed by 1898 & Co. Proposals will be reviewed for completeness. Proposals that do not include all of the required information as described herein may be deemed ineligible and may not be considered for further evaluation. If it appears that certain information has inadvertently been omitted from a Proposal, 1898 & Co. may, but is not obligated to, contact the Respondent to obtain the missing information, per Section 2.2. These communications will be initiated via email (CenterPointRFP@1898andco.com).

Each complete Proposal will be evaluated by quantitative and qualitative factors. The evaluation criteria outlined in this section are intended to relatively compare each Proposal to analogous submissions and will be the starting guidelines for the evaluation. If needed, the scoring may be adjusted to provide distinction between Proposals. This evaluation will be used to determine which projects are most capable of providing CenterPoint customers with a safe, reliable, and affordable power supply. Project scoring will be used to narrow the field down to a short list.

8.2 Evaluation Criteria - Generation Facility

1898 & Co. will quantitatively and qualitatively evaluate all conforming generation facility Proposals' ability to meet power supply needs. During this evaluation process, 1898 & Co. may or may not choose to initiate more detailed clarification discussions with one or more Respondents. Discussions with a Respondent shall in no way be construed as commencing contract negotiations.

Table 8: Renewables and Storage Scoring Criteria Summary

Category	Total points (out of 500)	Allocation
LCOE Evaluation (30%)	150	Proportionately from 0 (awarded to highest LCOE in group) to 150 (lowest LCOE in group)
Energy Settlement Location (20%)	100	• Max points given to energy financially settled or directly delivered to SIGE.SIGW • 90 points to projects located in service territory[4] • 75 points to projects in LRZ 6 outside of CenterPoint's service territory • 25 points to projects that settle in MISO outside of LRZ 6 • 0 points otherwise
Interconnection and Development Status (20%)	100	• Points awarded equally to 4 milestones. Max points for completed GIA & cost cap • 75 completed Facilities Study (during DPP2-3) & offered cost cap • 50 competed System Impact Study (during DPP1) & offered cost cap • 25 offered cost cap • 0 points otherwise
Project Risk Factor (30%)	150	• Credit and Financial Plan – 30 points awarded proportional to CNP internal score from 0-10 • Development Experience – 30 points awarded proportional to MW in service, max of 1,500 • Site Control – 30 points proportional from 0%-100% of site control verified by provided docs • Permits – 30 points for Proposals showing all permits needed for construction/operation • Zoning – 30 points for Proposals showing completed zoning requirements

[4] For purchase options where delivery to SIGE.SIGW is not applicable, 100 points will be awarded to projects located in CenterPoint's service territory

Table 9: Thermal Facility Scoring Criteria Summary

Category	Total points (out of 500)	Allocation
LCOE Evaluation (30%)	150	Proportionately from 0 (awarded to highest LCOE in group) to 150 (lowest LCOE in group)
Energy Settlement Location (20%)	100	• Max points given to energy financially settled or directly delivered to SIGE.SIGW • 90 points to projects located in service territory[5] • 75 points to projects in LRZ 6 outside of CenterPoint's service territory • 25 points to projects that settle in MISO outside of LRZ 6 • 0 points otherwise
Interconnection and Development Status (20%)	100	• Points awarded equally to 4 milestones. Max points for completed GIA & cost cap • 75 completed Facilities Study (during DPP2-3) & offered cost cap • 50 competed System Impact Study (during DPP1) & offered cost cap • 25 offered cost cap • 0 points otherwise
Project Risk Factor (30%)	150	• Credit and Financial Plan – 30 points awarded proportional to CNP internal score from 0-10 • Development Experience – 30 points awarded proportional to MW in service, max of 1,500 • Fuel Risk - 15 • Operational Control – 15 • Site Control – 30 points proportional from 0%-100% of site control verified by provided docs • Permits – 15 points for Proposals showing all permits needed for construction/operation • Zoning – 15 points for Proposals showing completed zoning requirements

[5] For purchase options where delivery to SIGE.SIGW is not applicable, 100 points will be awarded to projects located in CenterPoint's service territory

8.2.1 Levelized Cost of Energy - 150 Points

The initial evaluation will be primarily based on a comparison of each Proposal's Levelized Cost of Energy (LCOE). A LCOE allows for Proposals within asset classes, which have different sizes, pricing, operating characteristics, ownership structures, etc. to be evaluated and compared to each other on an equivalent economic basis. The LCOE analysis will incorporate all costs associated with an asset purchase or PPA. These costs will include the applicable purchase or PPA cost, fixed costs, and variable operating expenses across standard technology respective operating parameters. The levelized value of these costs over this time period are then divided by the energy produced by the respective Proposal.

CenterPoint specific assumptions used in this analysis will be in accordance with CenterPoint's 2022/2023 IRP assumptions, including but not limited to

- Discount rate
- Capital recovery factor
- Escalation
- Fixed operations and maintenance expenses
- Variable operations and maintenance expense

The LCOE evaluation is a screening level economic evaluation which will determine the cost of energy provided by each Proposal relative to similar technology types. Proposals within an evaluation class with the lowest LCOE will receive full scoring for this metric. Points awarded to higher cost Proposals will be scaled inversely proportional with the highest cost Proposal receiving 0 points for this metric.

The rules for performing the LCOE analysis will be determined by 1898 & Co. and CenterPoint in advance of the receipt and review of any Proposals. However, as part of the process of evaluating Proposals, cases may arise where, in order to adequately project asset costs or to facilitate a comparison between qualified Proposals, the rules related to the LCOE analysis may require review and/or adjustment. To the extent that any additions or adjustments are required, such additions or adjustments will be made solely by 1898 & Co. In such cases, any and all rules will be applied consistently across all Respondents.

While performing LCOE analyses of Proposals, 1898 & Co. may request additional or clarifying information from a given Respondent regarding resource performance, operating costs, or other factors that influence the LCOE calculation for a given resource. This evaluation may also include grid congestion analysis. Requests for additional information may be required to ensure that all qualified Proposals are fairly and consistently evaluated. Consistent with Section 2.2, in such cases, Respondents will be required to respond within five business days of receipt of such request. 1898 & Co. will not consider unsolicited updates from Respondents related to the cost of any power supply resource.

8.2.2 Energy Settlement Location - 100 points

CenterPoint has a preference for Proposals that include all costs to have energy financially settled or directly delivered to CenterPoint's load node (SIGE.SIGW). Proposals that settle at SIGE.SIGW will receive 100 points. Proposals that settle at a node in CenterPoint electric service territory will receive 90 points. Proposals that settle at Indiana Hub will receive 50 points. Proposals that settle at a different node in LRZ 6, but outside of CenterPoint electric

service territory will receive 25 points. Proposals that settle at a node outside of LRZ 6 will receive 0 points.

8.2.3 Interconnection and Development Status - 100 Points

Existing resources will receive full credit under this evaluation category. Plants that have not achieved commercial operation but that are in the MISO Generation Interconnection (GI) Queue will be awarded points based on the Definitive Planning Phase they are in. Facilities failing to meet critical development milestones may be disqualified from consideration at CenterPoint's sole discretion.

Up to 100 points will be will awarded based on the achievement of certain development milestones towards the facility COD. Four milestones have been selected and 25 points will be awarded for each equally. The selected milestones are as follows:

- Completed a MISO System Impact Study
- Completed a MISO Facilities Study
- Executed a MISO Generator Interconnection Agreement
- A maximum limit on interconnection and network upgrade costs that will be passed through to CenterPoint is included in the Proposal

8.2.4 Project Risk Factors - 150 Points

The Project Risk Factors attempt to identify and score potential risks which may compromise the future performance of the asset. In situations where the level of risk is not accurately represented, scoring may be adjusted. Potential considerations include, but may not be limited to the following:

- Credit and financial plan - Proposals will be evaluated based on a rating 0 through 10 (financial score) that takes into account credit ratings from S&P, Moody's, and D&B, years in business, and provided financial statements. The points will be awarded as percent of the maximum financial score as shown below[6]:

$$Points\ Awarded = \frac{Financial\ Score}{10} \times 30$$

- Development experience - Relevant technology development experience is an important risk factor. Proposals will receive up to 30 points based on the following formula:

$$Points\ Awarded = \frac{Nameplate\ MW\ In\ Service\ (same\ technology\ as\ proposed)}{1{,}500} \times 30$$

- Site Control - Proposals will receive points proportionately based on the amount of verifiable site control. Respondents should be as detailed and thorough as possible

[6] CenterPoint reserves the right to re-evaluate credit rating and exclude Respondents at its sole discretion.

in describing and providing evidence of site control. Proposals will receive up to 30 points based on the following formula:

$$Points\ Awarded = \frac{Percent\ of\ Verifiable\ Site\ Control}{100\%} \times 30$$

- Permits - Proposals that have all permits necessary for construction and operation will receive max points. Partial points may be assigned based on level of documentation provided.
- Zoning - Proposals that have fulfilled zoning requirements will receive max points. Partial points may be assigned based on level of documentation provided.
- Fuel risk - For applicable Proposals, sites with firm and reliable fuel supply will receive max points.
- Operational control - Proposals which offer CenterPoint operational control will receive max points

Any such risks shall be disclosed along with a description of the associated measures taken to mitigate the risk. Failure to disclose a reasonably foreseeable risk or risks may be a basis to disqualify a Proposal.

Proposals with no such risks as determined by 1898 & Co. will receive the full number of points available in this category. Proposals with asset or project-specific risks that are not able to be fully mitigated may receive fewer points depending on 1898 & Co.'s assessment.

8.3 Evaluation Criteria – LM/DR Resources

Burns & McDonnell will quantitatively and qualitatively evaluate all conforming LMR/DR Proposals. During this evaluation process, Burns & McDonnell may or may not choose to initiate more detailed clarification discussions with one or more Respondents. Discussions with a Respondent shall in no way be construed as commencing contract negotiations. A more detailed quantitative evaluation for select bidders will consider production cost models and nodal analysis.

CenterPoint will accept Proposals from LMR and DR providers that meet the requirements as established in this RFP and conform to MISO requirements. These requirements include but are not limited to, the ability to respond to Curtailment Events initiated either by MISO or by CenterPoint.

LMR/DR Proposals will be evaluated across the following criteria:

Table 10: Demand-Side Resources Scoring Criteria Summary

Category	Total points (out of 500)	Allocation
Cost Evaluation (40%)	200	Proportionately from 0 (awarded to highest cost in group) to 200 (lowest cost in group)
Historical Performance (20%)	100	Awarded based on time in-service and absence of a non-performance penalty.
Response Time (20%)	100	Awarded based on response time to specific control signals.
Project Risk Factor (20%)	150	Allocated based on material risk of reduced deliverability.

8.3.1 Cost Evaluation - 200 Points

The cost of each Proposal will be evaluated based on the annual payment per MW for the LMR/DR. The lowest $/MW cost Proposal will receive 200 points for the cost evaluation category. Points awarded to higher cost Proposals will be scaled inversely proportional with the highest cost Proposal receiving 0 points for this metric.

8.3.2 Historical Performance - 100 Points

An end use customer or CSP with a historical performance record of successfully providing demand response services for three or more years without being assessed a non-performance penalty will receive 100 points for this category.

An end use customer or CSP that has provided such services for between one year and three years without being assessed a non-performance penalty will receive 50 points for this category.

An end use customer or CSP that has not provided such services in the past or that has been assessed a non-performance penalty will receive zero points for this category.

8.3.3 Response Time - 100 Points

While the product defines a load reduction response time within a Respondent's Proposal, there is a preference for resources that can provide a more rapid response to specific control signals.

Proposals for LMR/DR that have the ability to follow a real-time signal will be awarded 100 points for the response time category. Proposals for LMR/DR that can achieve the load reduction target within 30 minutes of notification will receive 75 points for this category. Proposals for LMR/DR that can achieve the load reduction target within 60 minutes of notification will receive 50 points for this category. Proposals for LMR/DR that can achieve

the load reduction target within 120 minutes of notification will receive 25 points for this category.

8.3.4 Proposal Risk Factors - 100 Points

The Proposal risk factors category will be used to adjust the overall scoring in cases where there is a material risk identified that may create concerns about the ability of the provider to deliver on their Proposal or that may create a material uncertainty about the cost to CenterPoint or its customers, significant regulatory uncertainty, or other considerations.

8.4 Evaluation Criteria - Capacity Offers

Table 11: Capacity Only Scoring Criteria Summary

Category	Total points (out of 500)	Allocation
Cost Evaluation (60%)	300	Proportionately from 0 (awarded to highest cost in group) to 300 (lowest cost in group)
Project Risk Factor (40%)	200	• 200 points to resources located in MISO Zone 6 • 150 points to resources located in MISO Central Zones • 100 points to resources located in MISO North • 50 points to resources located within MISO but outside of MISO North

8.4.1 Cost Evaluation - 300 Points

The cost of each Proposal will be evaluated based on the annual payment per MW for the Capacity. The lowest $/MW cost Proposal will receive 300 points for the cost evaluation category. Points awarded to higher cost Proposals will be scaled inversely proportional with the highest cost Proposal receiving 0 points for this metric.

8.4.2 Proposal Risk Factors - 200 Points

This category is intended to capture deliverability risk. Points will be awarded according to the proximity of the resource to LRZ 6 with max points awarded to resources located in LRZ 6 and decreasing points allocated to offers located in more remote resource zones.

8.5 Discussion of Proposals During Evaluation Period

CenterPoint may or may not select candidates for further discussions. CenterPoint will contact any selected Respondent in writing to confirm interest in commencing contract negotiations. All negotiations will begin with CenterPoint's standard contract as a starting point. CenterPoint's commencement of and participation in negotiations shall not be construed as a commitment to execute a contract. If a contract is negotiated, it will not be effective unless and until it is fully executed with the receipt of all required regulatory approvals.

8.6 Selection of Highest Scoring Proposal(s)

Proposals will be rank ordered consistent with the RFP evaluation criteria. Resources will be selected consistent with the RFP evaluation, short-term capacity needs, and the IRP determined need. CenterPoint will seek to secure, subject to CenterPoint board approval, resources consistent with the preferred portfolio identified in the 2022/2023 IRP. There is no assurance that the individual, highest-scoring qualified Proposal(s) will be selected.

8.7 Contract Execution

CenterPoint does not, by this RFP, obligate itself to purchase any generation facility or facilities, or to execute an Asset Purchase, PPA, or capacity contract with any Respondent. CenterPoint may, in its discretion, reject any or all Proposals, as such are described in this RFP.

Selection of a winning Proposal shall not be construed as a commitment by CenterPoint to execute an agreement. During the period between 1898 & Co.'s delivery of results to CenterPoint and the date of execution of any agreement, CenterPoint will conduct additional due diligence on the Proposal which may include, but not be limited to, onsite visits, management interviews, legal and regulatory due diligence, and detailed engineering assessments and facility dispatch modeling.

9.0 PROPOSAL SUBMISSION

All Proposal documents must be submitted to the RFP website (http://CenterPoint2022ASRFP.rfpmanager.biz/).

9.1 Format and Documentation

All Proposals submitted in response to this RFP must be received by 1898 & Co. to the website (http://CenterPoint2022ASRFP.rfpmanager.biz/) no later than the Proposal Submittal Due Date shown in Section 2.3. 1898 & Co. and CenterPoint will not evaluate Proposals as part of this RFP process if submitted after this date and time. Multiple Proposals submitted by the same Respondent must be identified and submitted separately. Financial statements, annual reports, technical specification documents, and other large documents can be sent electronically to the RFP email address. Each Respondent must submit the following prior to the Proposal deadline:

1. Appendix A: Notice of Intent to Respond
2. Appendix B: Non-Disclosure Agreement (NDA) in its present form
3. Appendix C: Application
4. Appendix D: Proposal Data in Excel format

9.2 Certification

1. A Respondent's Proposal must certify that: There are no pending legal or civil actions that would impair the Respondent's ability to perform its obligations under the proposed PPA, Asset Purchase Agreement or Capacity Contract.
2. The Respondent has not directly or indirectly induced or solicited any other Respondent to submit a false Proposal.
3. The Respondent has not solicited or induced any other person, firm, or corporation to refrain from submitting a Proposal.
4. The Respondent has not sought by collusion to obtain any advantage over any other Respondent.

10.0 RESERVATION OF RIGHTS

Nothing contained in this RFP shall be construed to require or obligate CenterPoint to select any Proposals or limit the ability of CenterPoint to reject all Proposals in its sole and exclusive discretion. CenterPoint further reserves the right to withdraw and terminate this RFP at any time prior to the Proposal Submittal Due Date, selection of projects or execution of a contract. All final contracts will be contingent on IURC and CenterPoint board approval.

All Proposals submitted to CenterPoint pursuant to this RFP shall become the exclusive property of CenterPoint and may be used for any reasonable purpose by CenterPoint. CenterPoint and 1898 & Co. shall consider materials provided by Respondent in response to this RFP to be confidential only if such materials are clearly designated as Confidential. Respondents should be aware that their Proposal, even if marked Confidential, may be subject to discovery and disclosure in regulatory or judicial proceedings that may or may not be initiated by CenterPoint. Respondents may be required to justify the requested confidential treatment under the provisions of a protective order issued in such proceedings. If required by an order of an agency or court of competent jurisdiction, CenterPoint may produce the material in response to such order without prior consultation with the Respondent.

11.0 CONFIDENTIALITY OF INFORMATION

All Proposals submitted in response to this RFP become the responsibility of 1898 & Co. and CenterPoint upon submittal. Respondents desiring confidential treatment by 1898 & Co. and CenterPoint should clearly identify each page of information considered to be confidential or proprietary. Consistent with the RFP NDA (Appendix B), 1898 & Co. will take reasonable precautions and use reasonable efforts to maintain the confidentiality of all information so identified. CenterPoint reserves the right to release any Proposals, or portions thereof, to agents, attorneys, or consultants for purposes of Proposal evaluation. Regardless of the confidentiality claimed, however, and regardless of the provisions of this RFP, all such information may be subject to review by, and disclosable by CenterPoint, to the appropriate state authority, or any other governmental authority or judicial body with jurisdiction relating to these matters, and may also be subject to discovery by other parties subject to fully executed NDAs/confidentiality agreements. Further, because CenterPoint is conducting this RFP as part of the IRP public advisory process, CenterPoint will disclose the UCAP MW offered, technology/resource type, average price, general location, proposed ownership structure, and Proposal duration of all Proposals unless a given technology has less than three Respondents in order to inform stakeholders of the summary results of the RFP.

12.0 REGULATORY APPROVALS

Pursuant to the terms of the definitive agreement(s), the Respondent will agree to use its reasonable best efforts, including, if necessary, providing data and testimony, to obtain any and all State, Federal, or other regulatory approvals required for the consummation of the transaction.

Please note in particular that approval by the IURC and MISO may be required before the transaction can be consummated between the selected Respondent and CenterPoint. In addition to disclosure to state authorities or any other governmental authorities or judicial bodies heretofore described, as part of the regulatory process, responses to the RFP may be provided to parties who have executed a NDA/confidentiality agreement, specifically acknowledging that they are neither affiliated with any party responding to the RFP or serving as a conduit for any party responding to the RFP.

13.0 CREDIT QUALIFICATION AND COLLATERAL

CenterPoint will review the creditworthiness of Respondents and the risk associated with any potential transaction to determine what credit requirements may be necessary to protect CenterPoint's ability to serve its customers in a reliable manner. For Proposal pricing purposes, Respondents shall assume that required project collateral shall be in the form of (i) a payment and performance bond, (ii) letter of credit or (iii) a guaranty from a creditworthy parent company ("A" / "A2"). Respondents should also include in their Proposal how they expect to meet these requirements.

For asset purchases, Respondents shall have the obligation to post Definitive Agreement (DA) collateral at the execution of the definitive agreement and will be in force until the transfer of title to CenterPoint.

For PPAs and LM/DR contracts, Respondents may be required to post operating collateral over the term of any agreement consistent with the terms and conditions of final agreements as negotiated between CenterPoint and the supplier.

Respondents shall refer to the Term Sheets in Appendix F, Appendix G, and Appendix H for resource-specific requirements. CenterPoint and 1898 & Co. reserves the right to require a Respondent to post collateral in an amount that exceeds the amounts listed herein as conditions warrant. Unless otherwise specified in the Term Sheets, the following table shall apply:

Table 12: Collateral

Asset	Collateral Amount
Asset Purchase	$75/kW at execution of definitive agreement
Asset Purchase	$150/kW at regulatory approval
Power Purchase Agreement	12-months expected revenues
LM/DR Resource Agreement	12-months expected revenues

14.0 MISCELLANEOUS

14.1 Non-Exclusive Nature of RFP

CenterPoint may procure more or less than the amount of assets solicited in this RFP from one or more Respondent(s). Respondents are advised that any definitive agreement executed by CenterPoint and any selected Respondent may not be an exclusive contract for the provision of assets. In submitting a Proposal(s), Respondent will be deemed to have acknowledged that CenterPoint may contract with others for the same or similar deliverables or may otherwise obtain the same or similar deliverables by other means and on different terms.

14.2 Information Provided in RFP

The information provided in this RFP, or on the RFP website (http://CenterPoint2020RFP.rfpmanager.biz/), has been prepared to assist Respondents in evaluating this RFP. It does not purport to contain all the information that may be relevant to Respondent in satisfying its due diligence efforts. CenterPoint makes no representation or warranty, express or implied, as to the accuracy, reliability or completeness of the information in this RFP, and shall not be liable for any representation, expressed or implied, in this RFP or any omissions from this RFP, or any information provided to a Respondent by any other source.

14.3 Proposal Costs

CenterPoint shall not reimburse Respondent and Respondent is responsible for any cost incurred in the preparation or submission of a Proposal(s), in negotiations for an agreement, and/or any other activity contemplated by the Proposal(s) submitted in connection with this RFP. The information provided in this RFP, or on CenterPoint's RFP website, has been prepared to assist Respondents in evaluating this RFP. It does not purport to contain all the information that may be relevant to Respondent in satisfying its due diligence efforts.

14.4 Indemnity

Supplementing Respondent's assumption of liability pursuant to this RFP, Respondent shall indemnify, hold harmless and defend CenterPoint, its affiliates, and its and their respective officers, employees and agents, from any and all damages, liabilities, claims, expenses (including reasonable attorneys' fees), losses, judgments, proceedings or investigations incurred by, or asserted against, CenterPoint, its affiliates, and its and their respective officers, employees or agents, arising from, or are related to, this RFP, or the execution or performance of one or more definitive agreements.

14.5 Hold Harmless

Respondent shall hold CenterPoint, its affiliates, and its and their respective officers, employees and agents, harmless from all damages and costs, including, but not limited, to legal costs in connection with all claims, expenses, losses, proceedings or investigations that arise as a result of this RFP or the award of a Proposal pursuant to the RFP or the execution or performance of a definitive agreement.

14.6 Further Assurances

By submitting a Proposal, Respondent agrees, at its expense, to enter into additional agreements, and to provide additional information and documents, in either case as requested by 1898 & Co. in order to facilitate: (a) the review of a Proposal, (b) the execution of one or more definitive agreements, or (c) the procurement of regulatory approvals required for the effectiveness of one or more definitive agreements.

14.7 Licenses and Permits

Respondent shall obtain, at its cost and expense, all licenses and permits that may be required by any governmental body or agency necessary to conduct Respondent's business or to perform hereunder. Respondent's subcontractors, employees, agents and representatives of each in performance hereunder shall comply with all applicable governmental laws, ordinances, rules, regulations, orders and all other governmental requirements.

APPENDIX A – NOTICE OF INTENT TO RESPOND

ALL-SOURCE REQUEST FOR PROPOSALS

APPENDIX A - NOTICE OF INTENT TO RESPOND

Contact Information			
Company			
Primary Contact			
Name			
Title			
Telephone			
E-mail			
Mailing Address			
Signature of Respondent		Date	

Project Information			
Count	Technology Type (Solar, Wind, Natural Gas, etc.)	Capacity Offered (MW)	Contract Type (Capacity, Energy, RECs)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Due: 5:00 p.m. CDT, Friday, May 27, 2022

E-mail: CenterPointRFP@1898andco.com

APPENDIX B – NON-DISCLOSURE AGREEMENT

MUTUAL CONFIDENTIALITY AGREEMENT

THIS MUTUAL CONFIDENTIALITY AGREEMENT (this "Agreement") is dated as of this ____ day of _____, 2022 (the "Effective Date"), by and between Southern Indiana Gas and Electric Company d/b/a CenterPoint Energy Indiana South, an Indiana corporation with its principal place of business located at CenterPoint Energy Plaza, 211 NW Riverside Drive, Evansville, Indiana 47708 ("CEI South") and COMPANY NAME, a STATE TYPE OF COMPANY with its principal place of business located at ADDRESS ("Counterparty Short Name") each a "Party" and collectively, the "Parties".

WHEREAS, CEI South and Counterparty Short Name intend to discuss and evaluate proposals regarding possible energy/capacity transactions that could be entered into between CEI South and the Counterparty Short Name (the "Transaction"), which discussions may include sharing of bid proposal information received from Counterparty Short Name during the 2022 competitive request for proposal ("RFP") process (the "2022 RFP Process") administered by 1898 & Co.℠, a division of Burns & McDonnell Engineering Company, Inc. on behalf of CEI South . Through the process of evaluating the 2022 RFP Process and the Transaction, each Party may disclose (and may have in the past disclosed) certain information to the other Party, which the Parties desire to maintain as confidential.

NOW, THEREFORE, in consideration of the disclosure of certain information, and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the Parties hereto mutually agree as follows:

1. Confidentiality Obligations.

(a) The Party receiving Confidential Information (the "Receiving Party") hereby agrees, subject to Sections 3 and 4 below, to treat as strictly confidential and in accordance with this Agreement all Confidential Information of the other Party (the "Disclosing Party"). The term "Confidential Information" shall include (i) any and all proprietary, competitively sensitive, trade secret, financial or other information, data, studies, forecasts, compilations, reports, interpretations, records, statements, documents and notes, as well as product design, drawings, specifications, engineering data, process information, manufacturing information, sales and marketing plans, programs, strategies, methods and means, know-how, samples, materials, and devices, and any technology (whether oral, written or electronic) related to the Disclosing Party (collectively, "Items") and obtained, directly or indirectly (whether in the past or in the future) by the Receiving Party or its officers, directors, employees, independent contractors, professional advisors, agents, affiliates, or representatives ("Representatives"), (ii) any Items based upon Items obtained by the Receiving Party or its Representatives, regardless of who prepared such Items, (iii) the fact that either Party is providing the other Party with Confidential Information, and (iv) the fact that the Parties are negotiating, considering, or engaging in the Transaction and/or relationship between them.

(b) Without limitation to the terms of Section 1(a), each Party further agrees, subject to Sections 3 and 4 below:

(i) to (A) treat all of the Disclosing Party's Confidential Information in accordance with the restrictions of this Agreement; (B) keep all of the Disclosing Party's

Confidential Information strictly confidential, (C) take all precautions with the Disclosing Party's Confidential Information that it takes with its own confidential information, and (D) not use any of the Disclosing Party's Confidential Information, in whole or in part, for any purpose other than in connection with (1) evaluating the 2022 RFP Process, (2) developing and submitting CEI South's 2022/2023 Integrated Resource Plan (the "2022/2023 IRP") to the Indiana Utility Regulatory Commission (the "Commission"), (3) reviewing or submitting CEI South's information required for Regional Transmission Organization ("RTO")/Independent System Operator ("ISO") studies and analysis, (4) negotiating, considering, or engaging in the Transaction, and/or (5) subsequent petitions for approval of a new generation resource arising from the 2022 RFP Process, 2022/2023 IRP, or the Transaction (a "Resource Proceeding"); and

(ii) to (A) not, directly or indirectly, disclose or make available, in whole or in part, any Confidential Information to any other person, except its Representatives who have a need to know the Confidential Information in connection with the Transaction, (B) explain the confidentiality obligations contained herein to any such Representative, (C) use its reasonable best efforts to monitor and ensure that such Representatives comply with the terms of this Agreement, and promptly provide the Disclosing Party with written notice of any violation by such Representative of this Agreement, and (D) be responsible and liable to the Disclosing Party for any violation by such Representatives of the terms of this Agreement; and

(iii) to (A) not file or submit the Confidential Information, or any portions thereof, to the Commission except under seal and pursuant to the terms of a Protective Order protecting such information from public disclosure, (B) take care to protect any and all of the Disclosing Party's Confidential Information in a Resource Proceeding, any other docketed proceeding, resource planning process, or regulatory submission before the Commission from public disclosure through redacted public filings and other similar measures available to Receiving Party to protect Disclosing Party's Confidential Information, (C) treat Confidential Information produced pursuant to this Agreement subject to the terms of any Protective Order issued by the Commission or any other authorized state or federal agency or court with jurisdiction, and (D) advise Disclosing Party as soon as practical of any such use in a Resource Proceeding, other docketed proceeding, resource planning process, or regulatory submission before the Commission and the protections in place for the Confidential Information.

2. Return of Information. If either Party at any time does not intend to continue to actively pursue the Transaction or good faith discussions related thereto, it shall promptly advise the other Party in writing of that fact. The Receiving Party shall return (or destroy if it cannot be returned) all tangible representations of all Confidential Information (whether provided to such Party by the Disclosing Party or its Representatives or whether created by the Receiving Party or a third party), within forty-eight (48) hours of a written request for the return of such items by the Disclosing Party. Notwithstanding the foregoing, the Receiving Party and its Representatives may retain one copy of any Confidential Information to the extent relevant to comply with any legal, regulatory, or documented internal retention obligation. Further, the Receiving Party and its Representatives may retain that portion of Confidential Information that may be found in electronic archives of its computer backup systems. Notwithstanding the return or retention of Confidential Information, in accordance with this Section 2, each Party shall continue to be bound by its other

obligations of confidentiality contained in this Agreement until the later of the eventual destruction of all Confidential Information, or the expiration of the confidentiality obligations set forth in this Agreement.

3. Exclusions. The obligations set forth in this Agreement shall continue in force indefinitely, but shall not apply to a Party with respect to any Confidential Information which:

(a) is or subsequently comes within the public domain, without any fault of or violation of this Agreement by the Receiving Party;

(b) is disclosed independently to the Receiving Party on a non-confidential basis by a third party that is not subject to any duty of confidentiality with respect to such information;

(c) the Receiving Party can demonstrate through written documentation was known by such Party before it was disclosed to such Party by the Disclosing Party; or

(d) the Receiving Party can demonstrate through written documentation was independently developed by such Party, without the use, directly or indirectly, of any of the Disclosing Party's Confidential Information.

4. Obligations of Law. The Receiving Party may disclose Confidential Information of the Disclosing Party to the extent that it is required pursuant to any applicable court order, administrative order, law, statute, regulation, or other official order by any government or agency or department thereof, to disclose such information, provided that the Receiving Party, if reasonably practicable and to the extent legally permissible, first provides the Disclosing Party with written notice of the disclosure within a reasonable period of time prior to the disclosure and allows the Disclosing Party the option, at its cost, of challenging the obligation to disclose the information, and further provided that any such disclosure is limited to that required by law, as determined by the Receiving Party's counsel, and that the Receiving Party uses reasonable efforts to continue to preserve the confidentiality of any information so disclosed. Notwithstanding the foregoing, CEI South may disclose Confidential Information to parties to a Resource Proceeding, other docketed proceeding, resource planning process, or regulatory submission before the Commission requesting such information through lawful discovery provided such parties have executed binding non-disclosure agreements with CEI South and agree to be bound to such non-disclosure agreement and protect the information from public disclosure.

5. No Representations. Except as expressly set forth in a separate writing, (i) neither Party nor any of its Representatives adopts responsibility for or makes any representation, express or implied, with respect to the accuracy or completeness of any information provided to the Receiving Party; (ii) neither Party shall have any obligation to disclose any particular Confidential Information to the other Party, and each Party may, in its sole discretion, withhold and/or refuse to disclose any particular item of Confidential Information to the other Party; and (iii) neither Party nor any of its Representatives shall have any liability resulting from or related to the use of the Disclosing Party's Confidential Information or any inaccuracy or other defect in such Confidential Information.

6. No Obligation. Neither Party is under any obligation as a result of this Agreement to accept any offer or proposal which may be made by or on behalf of the other Party, or to continue negotiations between the Parties. Neither this Agreement nor any disclosure of Confidential

Information hereunder shall be deemed to (a) create any partnership, joint venture, employment, agency or other joint relationship between the Parties, (b) bind either Party to any business transaction, relationship or arrangement between them (without a separate agreement therefor) or (c) constitute a grant of any intellectual property or other right or license in any Confidential Information by the Disclosing Party to the Receiving Party. No contract or agreement providing for any transaction regarding the Transaction shall be deemed to exist, and neither Party shall be under any legal obligation of any kind whatsoever to enter into any such transaction by virtue of this or any written or oral expression with respect to such a transaction by any of its Representatives unless and until a definitive agreement with respect to such transaction has been executed and delivered by each Party thereto. Notwithstanding anything in this Agreement, and subject only to the Receiving Party maintaining the confidentiality of Confidential Information per the requirements of this Agreement, either Party may (i) withdraw from discussions with the other Party at any time and for any reason; (ii) conduct its business operations and activities in the normal course; and (iii) disclose its own confidential information to third parties. For the sake of clarity, this Agreement imposes no exclusive relationship of any kind as between the Parties, and each Party may pursue opportunities of any kind or nature, including competing opportunities.

7. Remedies. Each Party hereby acknowledges that a violation by it of this Agreement would result in irreparable harm to the Disclosing Party and that damages would be an inadequate remedy. Each Party, therefore, agrees that in addition to all remedies at law, the Disclosing Party shall be entitled to equitable relief, including, but not limited to, the right to obtain an injunction to secure the specific performance of this Agreement and/or to prevent a breach or contemplated breach of this Agreement, without any requirement that such Party post a bond as a condition of such relief. In no event shall either Party be liable for consequential, incidental, indirect, special, or punitive damages, by reason of or in connection with a breach of this Agreement.

8. Term. Unless terminated sooner by a Party hereto by sending notice to the other Party, this Agreement shall expire the earlier of (a) two (2) years from the Effective Date, or (b) the date on which the Parties enter into a definitive agreement with respect to the Transaction. The non-disclosure and use restriction obligations for Confidential Information under this Agreement shall survive any termination or expiration of this Agreement and remain in effect for the longer of (a) four (4) years from the Effective Date, or (b) during such period during which Confidential Information retains its status as a trade secret or qualifies as confidential under applicable law.)

9. Choice of Law; Jurisdiction. The terms and conditions of this Agreement shall be governed, construed, interpreted and enforced in accordance with the domestic laws of the State of Indiana, without giving effect to any choice of law or conflict of law provision or rule (whether of the State of Indiana or any other jurisdiction) that would cause the application of the laws of any jurisdiction other than the State of Indiana.

10. Successors and Assigns. This Agreement shall be binding upon and inure to the benefit of the Parties and their respective successors and lawful assigns. Notwithstanding the foregoing, this Agreement may not be assigned by either Party, unless the non-assigning Party consents to such assignment, which consent shall not be unreasonably delayed, conditioned or withheld. Any Confidential Information retained by the assigning Party shall continue to be governed fully by this Agreement.

11. Amendment. This Agreement cannot be amended, altered or modified, and no provision hereof may be waived, unless done so in a writing, signed by a duly authorized

representative of the Party against whom such modification or waiver is sought to be enforced. A waiver by any Party of any breach or failure to comply with any provision of this Agreement by the other Party shall not be construed as or constitute a continuing waiver of such provision or a waiver of any other breach of or failure to comply with any other provision of this Agreement.

12. Severability. The Parties believe that every provision of this Agreement is effective and valid under applicable law, and whenever possible, each provision of this Agreement shall be interpreted in such a manner as to be effective and valid. If any provision of this Agreement is held, in whole or in part, to be invalid, the remainder of such provision and this Agreement shall remain in full force and effect, with the invalid provision or condition being stricken only to the extent necessary to comply with any conflicting law.

13. Entire Agreement. This Agreement constitutes the entire agreement between the Parties with respect to the subject matter of this Agreement.

14. Notices. All notices and demands required or permitted by this Agreement shall be in writing, and shall be deemed properly made: (a) upon personal delivery to the relevant address set forth on the first page of this Agreement or such other relevant address as may be specified in writing by the relevant Party; or (b) upon deposit in the U.S. mail, registered or certified mail, or with a recognized overnight courier, postage prepaid, addressed to the relevant address set forth on the first page of this Agreement or such other relevant address as may be specified in writing by the relevant Party. Proof of sending any notice or demand shall be the responsibility of the sender.

15. Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be considered an original counterpart, and shall become a binding agreement when each Party shall have executed one counterpart and delivered it to the other Party.

IN WITNESS WHEREOF, the Parties have executed this Agreement as of the Effective Date.

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY D/B/A CENTERPOINT ENERGY INDIANA SOUTH

By: _____

Print Name: _____

Position: _____

COUNTERPARTY

By: _____

Print Name: _____

Position: _____

APPENDIX C – APPLICATION

CENTERPOINT ENERGY

ALL-SOURCE REQUEST FOR PROPOSALS

APPENDIX C - PRE-QUALIFICATION APPLICATION

Respondent's Credit-Related Information

Provide the following data to enable CenterPoint to assess the financial viability of the Respondent as well as the entity providing the credit support on behalf of the Respondent (if applicable). Include any additional sheets and materials with this Appendix as necessary. As necessary, please specify whether the information provided is for the Respondent, its parent, or the entity providing the credit support on behalf of the Respondent.

Full Legal Name of the Respondent: _____

Dun & Bradstreet No. of Respondent: _____

Type of Organization: (Corporation, Partnership, etc.) _____

State of Organization: _____

Respondent's Percent Ownership in Proposal: _____

Full Legal Name(s) of Parent Corporation: _____

Entity Providing Credit Support on Behalf of Respondent (if applicable): _____

Dun & Bradstreet No. of Entity Providing Credit Support: _____

Address for each entity referenced (provide additional sheets, if necessary): _____

_____

Type of Relationship: _____

Current Senior Unsecured Debt Rating from each of S&P and Moody's Rating Agencies (specify the entity these ratings are for): ____

_____

OR, if Respondent does not have a current Senior Unsecured Debt Rating, then Tangible Net Worth (total assets minus intangible assets (e.g., goodwill) minus total liabilities):_____

Pending Legal Disputes, if any (describe): _____

_____

General description of Respondent's ability to construct, operate and maintain project, to the extent applicable:

_____

_____

Financial Statements of the Respondent or its Credit Support Provider, where applicable, must include Income Statement, Balance Sheet, Statement of Cash Flows, all notes corresponding to those financial statements and applicable schedules for three most recent fiscal years and financial report for the most recent quarter or year-to-date period. Also, if available, please provide copies of the Annual Reports and/or 10K for the three most recent fiscal years and quarterly report (10Q) for the most recent quarter ended, if available. If such reports are available electronically, please provide link.

_____

APPENDIX D – PROPOSAL DATA

SEE ATTACHMENT: APPENDIX D - PROPOSAL DATA.XLSX

APPENDIX E – PROPOSAL CHECKLIST

CENTERPOINT ENERGY ALL-SOURCE REQUEST FOR PROPOSALS

APPENDIX E - PROPOSAL CHECKLIST

Application Documents:

☐Appendix A – Notice of Intent to Respond

☐Appendix B – Non-Disclosure Agreement

☐Appendix C – Application

☐Appendix D – Proposal Data (multiple in case of Project variations)

☐Proposal Executive Summary & Narrative

Supporting Documents:

☐Generator Interconnection Agreement or DPP Results (if available)

☐Audited or unaudited financial statements including balance sheets, income statements, and cash flow statements for the proposed asset(s) for the past three years (if existing)

Content Requirements:

☐Table of Contents

☐Executive Summary

☐Summary of relevant experience

☐Describe interconnection status and method for firm deliverability to LRZ 6 if not located in the zone

☐Describe annual and/or expected capacity characteristics

☐Provide full description of technical and economic detail and operating characteristics

☐Describe status of meeting all zoning requirements for the project location

☐Describe status of acquiring all permits (Federal, State, local) necessary for construction and operation of the project

☐Describe status of acquiring site control for the project

☐Describe any other contractual commitments of the project that would be binding for CenterPoint upon acquisition

☐Describe any current litigation or environmental fines involving the Respondent within the last five years, including but not limited to, any litigation, settlements of litigation or fines, that could potentially affect the facility or its operation

☐ Describe all bankruptcy or insolvency proceedings relating to the Respondent in any way

☐ Describe any litigation related to PPAs, asset purchases or other offers similar to the transactions solicited in this RFP that the Respondent or its parent company have been a party to in the last six years

☐Describe tax assumptions and status of acquiring all applicable tax credits for the project including safe harbored materials

☐Discussion regarding roles and responsibilities of any 3rd party companies involved in the project's development, construction, or operations

☐Describe status of major equipment procurement for the project

☐Development schedule and associated risks and risk mitigation plans for the project with resource in-service and operational prior to 3/1/2027

☐Discussion of any financing arrangements related to the project

☐"All-in price" including at a minimum 1 flat pricing option for PPAs (if applicable) and incorporating **current** market assumptions

☐ Incorporates pricing assumptions in the term sheets if applicable; explains deviations and pricing impacts if applicable

☐Discussion of resource-specific requirements (Sections 4.0 – 7.0)

☐Certifications. See Section 9.2

APPENDIX F – SOLAR BTA TERM SHEET

SOLAR BUILD TRANSFER AGREEMENT ("BTA") KEY ASSUMPTIONS

The following are key assumptions upon which Respondents should base their proposals. If a proposal deviates from these key assumptions, Respondent shall indicate how it deviates as well as the price impact.

Security	Developer Security: • Five (5) business days after submission for approval to the Indiana Utility Regulatory Commission ("***IURC***"), $[75,000]/MWac of planned nameplate capacity • Five (5) business days after approval by the IURC and through Final Completion, $[150,000]/MWac of planned nameplate capacity • Five (5) business days after after Final Completion, through five years after Final Completion, $[75,000]/MWac of planned nameplate capacity. Form of Developer Security: (i) a payment and performance bond, (ii) letter of credit or (iii) a guaranty from a creditworthy parent company ("A" / "A2") EPC Contractor: at least equal to the contract price set forth in the EPC Agreement as applicable; which is permitted to decrease as the Project progresses
Warranties for Work and Equipment under the EPC Agreement	EPC Contractor: 2 year standard warranty from Closing; will cover serial defect occurrence with respect to any defects occurring in the lesser (x) [10]% or (y) an agreed number of individual units of major equipment (i.e., modules, inverters, raking/trackers) or more of the same or substantially similar component(s) resulting from the same failure mode from the same manufacturer. If a serial defect has occurred, EPC Contractor will provide an additional one (1) years of warranty in addition to the base warranty.
Firm Date Conditions	"***Firm Date Conditions***" shall include (for Buyer and Developer) that Buyer has received approval by the Indiana Utility Regulatory Commission (IURC) for cost recovery through rates for the Project ("***IURC Approval***"). Failure to obtain IURC Approval prior to the Firm Date may result in termination of the agreement without any further obligations by either party.
Indemnification and Limitations of Liability under the BTA and Development Agreements	A. Developer will indemnify Buyer and the other Buyer indemnified parties from and against any and all losses resulting from: • Breach of Developer's reps or warranties (subject to a 100% cap for fundamental reps, 25% cap for all other reps other than tax reps);[1] • Breach by Developer of its covenants, agreements or obligations pursuant to the BTA or ancillary agreements (subject to a 100% cap); • Developer's fraud or willful misconduct; • Loss in value of, or any inability to claim or otherwise take advantage of, the [•]% ITC and accelerated depreciation (MACRS); • Construction costs required to cause the Project to achieve final completion; and • All pre-closing liabilities.
Taxes	Developer will be responsible for all sales, conveyance, transfer, excise, real estate transfer, business and occupation and similar taxes assessed with respect to or imposed on either Party related to Buyer's acquisition of the Project Company (or otherwise) in connection with the Proposed Transaction.
Liquidated Damages	Delay Liquidated Damages: [$200 per MW per day] (based on the Planned Nameplate Capacity) for each day (a) the Project fails to achieve Mechanical Completion on or before the Outside Closing Date (subject to an agreed escalation and long-stop date) or (b) the Project fails to achieve Substantial Completion on or before the Guaranteed Substantial Completion Date.

[1] A pro-sandbagging provision will be included, and Buyer will be able to seek indemnification (and exercise any other remedies, including termination of the BTA) for any updates to disclosure schedules that reflect a breach of Developer's reps and warranties.

APPENDIX G – WIND BTA TERM SHEET

WIND BUILD TRANSFER AGREEMENT ("BTA") KEY ASSUMPTIONS

The following are key assumptions upon which Respondents should base their proposals. If a proposal deviates from these key assumptions, Respondent shall indicate how it deviates as well as the price impact.

Security	Developer Security: • Five (5) business days after submission for approval to the Indiana Utility Regulatory Commission ("***IURC***"), $[75,000]/MWac of planned nameplate capacity • Five (5) business days after approval by the IURC and through two years after Final Completion, $[150,000]/MWac of planned nameplate capacity • Five (5) business days after two years after Final Completion, through five years after Final Completion, $[75,000]/MWac of planned nameplate capacity. Form of Developer Security: (i) a payment and performance bond, (ii) letter of credit or (iii) a guaranty from a creditworthy parent company ("A" / "A2") Turbine Supplier/EPC Contractor: at least equal to the contract price set forth in the TSA/EPC Agreement as applicable; which is permitted to decrease as the Project progresses
Warranties for Work and Equipment under the EPC Agreement and TSA	EPC Contractor: 2 year standard warranty from Closing TSA: 5 year standard warranty from Closing; will cover serial defect occurrence with respect to any defects occurring in the lesser (x) [10]% or (y) an agreed number of individual units of equipment or more of the same or substantially similar component(s) resulting from the same failure mode from the same manufacturer. If a serial defect has occurred, Turbine Supplier will provide an additional three (3) years of warranty in addition to the base warranty.
Firm Date Conditions	"***Firm Date Conditions***" shall include (for Buyer and Developer) that Buyer has received approval by the Indiana Utility Regulatory Commission (IURC) for cost recovery through rates for the Project ("***IURC Approval***"). Failure to obtain IURC Approval prior to the Firm Date may result in termination of the agreement without any further obligations by either party.
Indemnification and Limitations of Liability under the BTA and Development Agreements	A. Developer will indemnify Buyer and the other Buyer indemnified parties from and against any and all losses resulting from: • Breach of Developer's reps or warranties (subject to a 100% cap for fundamental reps, 25% cap for all other reps other than tax reps);[1] • Breach by Developer of its covenants, agreements or obligations pursuant to the BTA or ancillary agreements (subject to a 100% cap); • Developer's fraud or willful misconduct; • Loss in value of, or any inability to claim or otherwise take advantage of, the [•]% PTC and accelerated depreciation (MACRS) ("***PTC and Depreciation Benefits***"); • Construction costs required to cause the Project to achieve final completion; and • All pre-closing liabilities.
Taxes	Developer will be responsible for all sales, conveyance, transfer, excise, real estate transfer, business and occupation and similar taxes assessed with respect to or imposed on either Party related to Buyer's acquisition of the Project Company (or otherwise) in connection with the Proposed Transaction.
Liquidated Damages	Delay Liquidated Damages: [$200 per MW per day] (based on the Planned Nameplate Capacity) for each day the Project fails to achieve Substantial Completion on or before the Outside Closing Date (subject to an agreed escalation and long-stop date).

[1] A pro-sandbagging provision will be included, and Buyer will be able to seek indemnification (and exercise any other remedies, including termination of the BTA) for any updates to disclosure schedules that reflect a breach of Developer's reps and warranties.

APPENDIX H – WIND OR SOLAR PPA TERM SHEET

WIND/SOLAR POWER PURCHASE AGREEMENT (PPA) KEY ASSUMPTIONS

The following are key assumptions upon which Respondents should base their proposals. If a proposal deviates from these key assumptions, Respondent shall indicate how it deviates as well as the price impact.

Energy Delivery Point	SELLER shall be responsible for all costs necessary to deliver energy to the Energy Delivery Point. Proposals should clearly define the Energy Delivery Point, i.e. Point of Interconnection, SIGE.SIGW or other energy settlement node as directed in the RFP.
Product	Product shall include (1) all as-available wind/solar energy generated by the Project and (2) all services and attributes associated with such energy and the Project, including (a) all capacity attributes, (b) all ancillary products, and (c) all renewable energy credits ("RECs"). BUYER shall only be obligated to pay for energy and applicable services and attributes delivered from the Project to the Energy Delivery Point. Throughout the Delivery Term, SELLER shall ensure that the Project qualifies for Green-e certified RECs, and SELLER shall use commercially reasonable efforts to cause the Project to qualify for all applicable attributes and RECs that may become available throughout the Delivery Term, at Seller's cost and expense, subject to a maximum annual compliance cost cap of [•].
Guaranteed Commercial Operation Date	SELLER shall pay the Delay Damage Rate for each day that COD occurs past the Guaranteed Commercial Operation Date. If COD has not occurred by the Outside Commercial Operation Date (without regard to any possible extensions for force majeure), BUYER (a) may terminate the PPA and (b) may draw on the full Development Security. Delay Damage Rate: two-hundred dollars ($200) / MW (AC) of the Planned Nameplate Capacity Rating.
IURC Approval	BUYER will have no obligation to receive, accept or pay for any Products until BUYER has received satisfactory approval, in BUYER'S sole judgement, from the Indiana Utility Regulatory Commission to recover the costs of the PPA through its retail rates.
Performance Guarantee	Greater than ninety percent (90%) of the Expected Contract Quantity over every two consecutive operational year period. If performance is less than this SELLER to pay BUYER liquidated damages equal to "Market Price" over the applicable COD Price, multiplied by the MWhs of output shortfall. BUYER may terminate PPA if Project fails to deliver at least seventy-five percent (75%) of the Expected Contract Quantity for two consecutive operational years.
Capacity Deficit Damages	If the final nameplate capacity rating is less than the planned nameplate capacity rating of [•] MW (AC) (the "Planned Nameplate Capacity Rating"), but not less than ninety-five (95%) of the Planned Nameplate Capacity Rating, SELLER shall make a onetime payment to BUYER in an amount equal to (a) the difference between (i) the final nameplate capacity rating and (ii) the Planned Nameplate Capacity Rating in MWs, (b) multiplied by two-hundred thousand dollars ($200,000) per MW ("Capacity Deficit Damages"). Upon payment of Capacity Deficit Damages, the schedule setting forth the Expected Contract Quantity shall be adjusted by the same ratio.
Project Milestones	Failure to achieve certain "Critical Milestones" during Project development, construction, commissioning and operation to be agreed by the Parties by the agreed dates will require the payment of damages at the Delay Damage Rate and, if not cured within specified timeframes, will permit the early termination of the PPA by BUYER and the BUYER'S retention of certain Development Security.
Seller's Security	Development Security. Prior to COD, equal to seventy-five thousand dollars ($75,000) per MW (AC), posted within five (5) business days after the execution of PPA. Operating Security. Within five (5) business days after COD, equal to one hundred fifty thousand dollars ($150,000) per MW (AC) of the final nameplate capacity of the Project. Development Security and Operating Security shall be in the form of either (a) an irrevocable letter of credit from a qualified institution or (b) a cash deposit.
Seasonal Maintenance	To the extent possible considering prudent industry practices, SELLER shall avoid planned maintenance during the months of peak capacity accreditation (e.g. for Solar PPAs, May, June, July, and August). Any planned maintenance during such months must be approved by BUYER, in its sole discretion.
Right of First Offer	If BUYER terminates PPA (a) prior to COD due to an extended force majeure event or (b) due to a SELLER event of default, BUYER shall have a Right of First Offer for agreements for offtake of Product (or any component of Product) from the Project for twenty four (24) months from the termination date.

1898 & CO℠

PART OF BURNS McDONNELL

9400 Ward Parkway

Kansas City, MO

Attachment 6.5 Conversion Studies (CT conversion, FB Culley Conversion, and Cogen)

CT Conversion Study

Memorandum

Date: September 16, 2022

To: BJ Reynolds
Director of Power Supply Construction
CenterPoint Energy
812.491.5435

Subject: SC-to-CC Conversion Unit Assessment

INTRODUCTION

CenterPoint Energy ("CenterPoint") has retained 1898 & Co., a part of Burns & McDonnell Engineering Company, Inc. ("1898 & Co.") to evaluate a new generation technology option. This option involves converting A.B. Brown simple cycle gas turbine ("SCGT") units #5 and #6 into a 2x1 combined cycle ("CCGT") unit. The intent of this assessment is to provide capital cost, O&M costs, and performance information sufficient to support Integrated Resource Planning ("IRP") efforts.

It is the understanding of 1898 & Co. that this Memo will be used for preliminary information in support of CenterPoint's generation planning process. Any technologies of interest to CenterPoint should be followed by additional detailed studies to further investigate the technology and its direct application within CenterPoint's long-term plans.

Study Basis and Assumptions

The assumptions below govern the overall approach of the Study:

- All estimates are screening-level in nature, do not reflect guaranteed costs, and are not intended for budgetary purposes.
- All information is preliminary and should not be used for construction purposes.
- All capital cost and O&M costs are stated in 2022 US dollars ("USD"). Escalation is excluded.
- Estimates assume an Engineer, Procure, Construct ("EPC") fixed price contract for project execution.
- Ambient conditions are based on the following:
    - Winter Conditions: 5°F
    - Average Ambient Conditions: 59°F
    - Summer Conditions: 90°F

Evaluated Technology

CenterPoint is considering converting existing SCGT's (A.B. Brown #5 & #6) into a CCGT capable of greater capacity and improved efficiency compared to the SCGTs. The basic principle of the CCGT plant is to utilize natural gas to produce power in a gas turbine which can be converted to electric power by a coupled generator, and to also use the hot exhaust gases from the gas turbine to produce steam in a heat recovery steam generator (HRSG). This steam is then used to drive a steam

turbine and generator to produce electric power. The use of both gas and steam turbine cycles (Brayton and Rankine) in a single plant to produce electricity results in high conversion efficiencies and low emissions.

Combined cycle plants are designed for capacity factors consistent with intermediate or base load operation, and therefore it is expected that NOx and CO emissions will need to be controlled. An SCR will be required to reduce NOx emissions to 2 ppmvd at 15 percent O_2. It is expected that an oxidation catalyst will also be required to reduce CO and VOC emissions. This assessment assumes CO emissions will be controlled to 2 ppmvd CO at 15 percent O_2.

Performance Estimates
The CCGT base load performance at ISO conditions is shown in Table 1. Additional performance cases including summer and winter performances are included Appendix A.

Table 1: Estimated CCGT Performance

Base Load @ 59 °F	
Net Plant Output, kW	716,900
Net Plant Heat Rate, Btu/kWh	6,480

Operating and Maintenance Cost Estimates
1898 & Co. developed a screening-level O&M cost estimate including a breakout for fixed operations and maintenance and variable operations and maintenance.

Operating and Maintenance Assumptions
- O&M costs were estimated assuming average ambient conditions and average hot air production.
- Fixed O&M cost estimates include labor, office and administration, training, contract labor, safety, building and ground maintenance, communication, and laboratory expenses.
- Variable O&M costs include routine maintenance, makeup water, water treatment, water disposal, and other consumables.
- O&M costs exclude property taxes and insurance.

Operating and Maintenance Cost Estimates Summary
The total O&M cost is summarized below in Table 2.

Table 2: Operating and Maintenance Cost Estimate

Description	Cost Estimate
Fixed O&M Costs	[redacted]
Variable O&M Costs	
Major Maintenance Cost	

Capital Cost Estimates
1898 & Co. developed a screening-level (Association for the Advancement of Cost Engineering ("AACE") Class V) capital cost estimate including a break-out of anticipated owner's cost.

Cost Estimate Assumptions
A detailed scope assumptions matrix is included in Appendix B. The following assumptions govern the capital cost estimates:

- Capital cost include demolishing the existing SCGT stack.
- No additional demolition is included. No costs are included to address any pre-existing underground tanks, piping, duct bank, cabling, etc..
- The site is assumed to be cleared and graded.
- Electrical scope is assumed to end at the high side of the GSU.

Cost Estimate Exclusions
The following costs are excluded from all estimates:

- Financing fees
- Interest during construction
- Escalation
- Performance and payment bond
- Sales tax
- Property insurance
- Transmission Interconnect / Switchyard
- Water rights

Capital Cost Estimate Summary
The total installed cost of the facility is shown in Table 3. All costs are estimated in 2022 USD. For a further breakdown on the CCGT conversion capital cost estimates, see Appendix A.

Table 3: Capital Cost Estimate (2022$MM)

Description		Cost Estimate
Total Direct Cost		[redacted]
Total Indirect Cost		
Total EPC Project Cost		
Owner's Cost		
Total Project Cost		$495.0 MM

STATEMENT OF LIMITATIONS

Estimates and projections prepared by 1898 & Co. relating to performance, operating and maintenance costs, capital costs are based on experience, qualifications, and judgement as a professional consultant.

Memorandum (*cont'd*)

1898 & Co. has no control over weather, cost and availability of labor, material and equipment, labor productivity, construction contractor's procedures and methods, unavoidable delays, construction contractor's method of determining prices, economic conditions, government regulations and laws (including interpretation thereof), competitive bidding, and market conditions or other factors affecting such estimates or projections. Actual rates, costs, performance ratings, schedules, etc., may vary from the data provided.

CONCLUSIONS AND RECOMMENDATIONS

This study provides capital cost, O&M costs, and performance information to support CenterPoint's consideration of a simple-cycle to combined-cycle conversion. Information provided in this Memo is preliminary in nature and is intended to support screening of generation opportunities. If this opportunity is appealing, CenterPoint should pursue additional studies to define project scope, equipment design, and schedule for the development of the project.

1898 & Co. appreciates the opportunity to support CenterPoint with this evaluation. If you have any questions regarding this memo, please contact Chad Swope at chad.swope@1898andco.com | 816.548.1329.

Sincerely,

Chad Swope, P.E.
Project Manager

Appendix A – CCGT Conversion Technology Assessment Summary Table
Appendix B – CCGT Conversion Scope Assumptions

F.B. Culley Conversion Study

Coal to Gas Conversion Feasibility Study

CenterPoint Energy

FB Culley Generating Station Coal to Gas Conversion
Project No. 148484

Revision 1
August 2022

Coal to Gas Conversion Feasibility Study

prepared for

CenterPoint Energy
FB Culley Generating Station Coal to Gas Conversion
Yankeetown, Indiana

Project No. 148484

Revision 1
August 2022

prepared by

Burns & McDonnell Engineering Co.
Kansas City, MO

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LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
AQCS	Air Quality Control Systems
B&W	Babcock & Wilcox
BMS	Burner Management System
BOP	Balance of Plant
CCR	Coal Combustion Residuals
CO	carbon monoxide
CO_2e	carbon dioxide equivalent
CPE	CenterPoint Energy
DCS	distributed control system
Dth/d	decatherm/day
ELG	Effluent Limitation Guidelines
ESP	Electrostatic Precipitator
FD	forced draft
FGR	flue gas recirculation
ft/min	feet per minute
GE	General Electric
HP	high pressure
I/O	input/output
in	inch
LNB	Low NOx Burner
mcf/h	thousand cubic feet per hour

Abbreviation	Term/Phrase/Name
MFT	master fuel trip
MMBtu/hr	million British thermal unit per hour
MW	megawatts
NDE	non-destructive evaluation
NFPA	National Fire Protection Association
NO_x	nitrogen oxide
NPV	Net Present Value
OEM	original equipment manufacturer
OFA	overfire air
P&IDs	piping and instrumentation diagram
PCU	Process Control Unit
PSD	Prevention of Significant Deterioration
psig	pounds per square inch gauge
SCR	Selective Catalytic Reduction
SO_2	sulfur dioxide
UV	ultraviolet
VOC	volatile organic compounds

1.0 EXECUTIVE SUMMARY

CenterPoint Energy (CPE) is considering a 100% coal to natural gas fuel conversion at the FB Culley power station, Units 2 & 3, located near Yankeetown, Indiana. The conversion would require a new natural gas firing system and a reconfigured DCS for Units 2 and 3. The units presently use natural gas for ignition and burn a variety of local coals.

CPE retained Burns & McDonnell to provide a conceptual engineering design and AACE Class V estimate for converting both units. This report summarizes the conceptual engineering, performance impacts, and cost estimates for CPE to evaluate the feasibility of the 100% fuel conversion.

1.1 Purpose

The purpose of this report is to provide the overall scope, schedule, and capital costs required to procure and construct a 100% coal to gas conversion project based on the assumptions documented herein, and to provide general information to support project feasibility evaluations.

1.2 Project Configuration Summary

FB Culley Power Station Units 2 & 3 both have Babcock & Wilcox (B&W) steam generators in operation. Both units are presently pulverized coal-fired, firing a variety of local bituminous coals. Gross generation is 100 megawatts (MW) for Unit 2, and 287 MW for Unit 3.

Unit 2, commissioned in 1965, has a B&W 1,290 psi/955°F non-reheat steam generator (B&W boiler contract RB-419) that produces steam to power a steam turbine-generator set. The boiler fires bituminous coal in a front wall firing arrangement via three EL-76 ball and race coal pulverizers located on the basement floor on the front of the boiler. Each the three pulverizers feeds pulverized coal to four (4) burners on one of three front wall burner elevations, for a total of twelve (12) burners. Burner (and pulverizer) decks are labeled 2A, 2B and 2C from top elevation to bottom elevation.

The boiler was retrofit with low NO_X burners in 1994. Each burner has its own natural gas igniter sized to be at least 10% of the maximum heat input of the main coal burner. The igniters are used to warm the boiler prior to lighting off a pulverizer. The unit does not have an overfire air system.

Two forced draft (FD) fans force air through a Ljungstrom bi-sector air preheater, and on to the windbox where it is distributed to the twelve burners in an open windbox on the front wall of the unit. The unit was converted to balanced draft with ID Fan-VFDs in the late 1980's. In the mid-1990's connections to a common LS-FGD, with FB Culley #3, were made and over the course of time, the use of the legacy

chimney has been converted to an unfired vent. Unit 2 is presently fitted with a 1980s vintage electrostatic precipitator (ESP) and Unit 3 was fitted with a fabric filter in 2004-2005.

The Unit 2 firing arrangement that will be analyzed for this study will be to continue the routine ability to operate at full load (100 MW) by retaining only the top eight (8) burners and replacing them with natural gas burners. Each burner will have its own safety shut off valve. It is assumed that the existing gas igniters will be reused. A case study for an Overfire air (OFA) system and a case study for a flue gas recirculation (FGR) system will be discussed.

Unit 3, commissioned in 1973, has a B&W 2,000 kpph/1005°F/1005°F steam generator (B&W boiler contract RB-458) that produces steam to power a steam turbine-generator set. The boiler fires bituminous coal in an opposed-firing arrangement via six (6) EL-76 ball and race coal pulverizers located on the ground floor on the front of the boiler. The boiler has been upgraded for additional steam flow from the original design criteria. Each of the six pulverizers feeds pulverized coal to four (4) burners on one of three front wall or three rear wall burner elevations, for a total of twenty-four (24) burners. Burner (and pulverizer) decks are labeled 3C, 3D and 3B from top elevation to bottom elevation on the front wall, and 3A, 3F and 3E from top elevation to bottom elevation on the rear wall.

Each burner has its own natural gas igniter sized to be at least 10% of the maximum heat input of the main coal burner. The igniters are used to warm the boiler prior to lighting off a pulverizer.

Unit 3 boiler has been retrofit with a selective catalytic reduction (SCR) system. The purpose of an SCR system is to reduce the NO_X emissions rate from the boiler. There is a natural gas duct burner as a part of the SCR addition. Modifications were made to bypass the air heater with combustion air.

The Unit 3 firing arrangement that will be analyzed for this study will be to continue the routine ability to operate at full load (287 MW) by retaining only the top sixteen (16) burners and replacing them with natural gas burners. Every two burners will have a safety shut-off valve. It is assumed that the existing gas igniters will be reused. A case study for an OFA system and a case study for a FGR system will be discussed.

1.3 Estimated Performance and Air Emissions Summary

Based on recent relevant results on similar units, the existing boilers are estimated to be capable of firing natural gas without a reduction in steam flow. It may not be possible to reach the full superheat or reheat steam temperature. BMcD estimates that both boilers will be within 50°F of design steam temperatures and can likely make design temperatures at full load conditions. The increased water production from

firing natural gas will decrease the boiler efficiency 4% to 6%. The water content by volume in the flue gas leaving the flue gas economizer with natural gas will be about 18% as compared to 9% with the design fuel. The extra water carries significant heat that is not transferred to the steam. Gas-fired baseline data was not available, so the gross heat rate was estimated.

Table 1-1: Existing Coal Unit Performance Summary

Culley Unit No.	Unit Full Load (Mw)	Estimated NO_X (lb/mmBtu)	Calculated Heat Data	
			Heat Input (mmBtu/hr)	Heat Rate (Btu/kw-hr)
2	100	0.20	1,198	12,000 est.
3	287	0.45	2,870	10,000

Table 1- 2: Estimated Natural Gas Unit Performance Summary Low NOx Burners Only

Culley Unit No.	Unit Full Load (Mw)	Estimated NO_X (lb/mmBtu)	Calculated Heat Data	
			Heat Input (mmBtu/hr)	Heat Rate (Btu/kw-hr)
2	100	0.22	1,246 – 1,270	12,458 – 12,679
3	287	0.22	2,879 -2,935	10,033 – 10,225

Table 1- 3: Estimated Natural Gas Unit Performance Summary with OFA

Culley Unit No.	Unit Full Load (Mw)	Estimated NO_X (lb/mmBtu)	Calculated Heat Data	
			Heat Input (mmBtu/hr)	Heat Rate (Btu/kw-hr)
2	100	0.15	1,246 – 1,270	12,458 – 12,679
3	287	0.15	2,879 -2,935	10,033 – 10,225

Table 1- 4: Estimated Natural Gas Unit Performance Summary with FGR and no SCR

Culley Unit No.	Unit Full Load (Mw)	Estimated NO_X (lb/mmBtu)	Calculated Heat Data	
			Heat Input (mmBtu/hr)	Heat Rate (Btu/kw-hr)
2	100	0.08	1,246 – 1,270	12,458 – 12,679
3	287	0.08	2,879 -2,935	10,033 – 10,225

Table 1- 5: Estimated Natural Gas Unit Performance Summary with SCR

Culley Unit No.	Unit Full Load (Mw)	Estimated NO_X (lb/mmBtu)	Calculated Heat Data	
			Heat Input (mmBtu/hr)	Heat Rate (Btu/kw-hr)
3	287	0.05	2,879 -2,935	10,033 – 10,225

1.4 Contracting Approach

The selected contracting strategy for this feasibility study is the multiple contracts approach with the Owner directly contracting a burner supplier to design the new fuel delivery system, new burners and any potential OFA or FGR modifications and utilizing the Unit 3 SCR. A balance of plant contractor will implement the installation of the equipment. The burner supplier would be responsible for all skids downstream of the emergency shut off valve station and the new burners, igniters, and accessories to make them work. The Owner could buy a BMS and DCS upgrade package separately from the equipment or installation provider. All installation would be provided through a single contractor with an owner's engineer responsible for administrating. The contracting approach assumes an O/E would provide balance of plant design, develop specifications for procurement and construction and contract administration of the project

1.5 Indicative Schedule

A preliminary schedule duration was developed. The durations listed in Table 1-2 below are for both units including an assumed offsite pipeline construction of 12 months after permitting. The schedule assumes that both units will be converted concurrently. If the unit construction is staggered, the estimated durations will increase six months. The critical path for each option will typically run through receipt of gas burner equipment, construction, and continuing through startup and commissioning. This schedule assumes CP Energy will start preliminary engineering and design concurrently with an application for the air permit. An indicative project schedule is shown below in Table 1- 4.

Table 1- 4: Indicative Schedule

Schedule Line Item	100% Natural Gas
Permitting (months)	12
Gas Line to Plant Concurrent (Eng/Pro)	18
Engineering & Procurement (months)	16
Construction (months)	6
Startup (months)	2
Total Project Duration (months)	**30**

*Complete Spring/Fall 2025

1.6 Capital Costs

The capital cost for the gas conversion is presented in Table 1- 5 below. These costs represent a total for the plant which includes both units.

Table 1- 5: Total Plant Capital Costs (2022$)

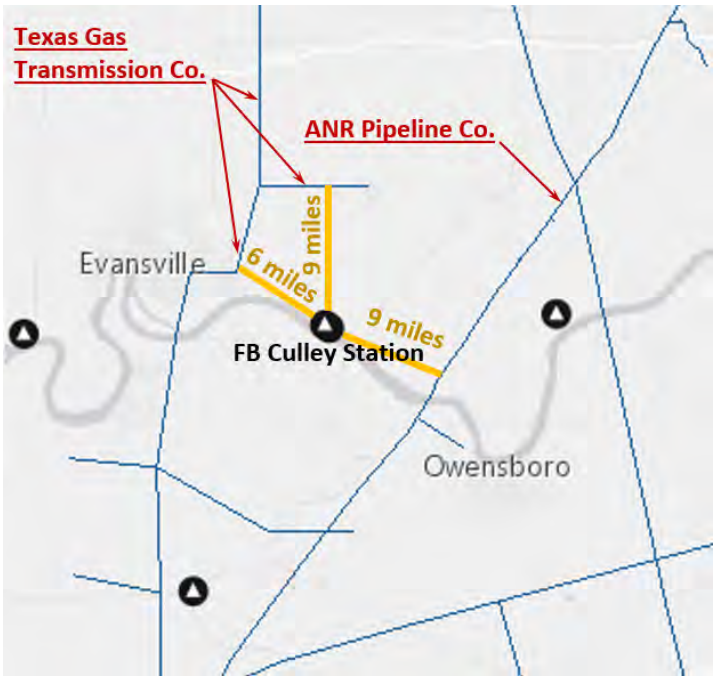
Capital Cost Line Item	Unit 2	Unit 3
Procurement & Construction	[redacted]	
Project Indirects		
Project Costs		
Owner Costs		
Owner Contingency		
Total Onsite Costs – Base Case	**$24,673,642**	**$30,658,448**
Option 1 - OFA	[redacted]	
Option 2 – FGR		

[redacted]

2.0 INTRODUCTION

CenterPoint Energy is investigating the feasibility of a 100% coal to gas conversion at the FB Culley Power Station near Yankeetown, Indiana. Presently Units 2 & 3 both start-up with natural gas and operate with a variety of regional bituminous coals. Potential gas supply pipelines in the area are by Texas Gas Transmission Co. and by ANR Pipeline Co. Texas Gas Transmission Co. has two lines in the area, one about 6 miles to the northwest, and another about 9 miles due north. ANR Pipeline Co. has one line about 9 miles to the southeast (straight down river) Both as indicated in Figure 2- 1, below.

Figure 2- 1 – Pipeline to Coal plant



This study will evaluate the costs to retrofit the units and provide the expected performance from both steam generators. The 100 percent coal to gas conversion will provide a low-cost alternative to continue the use of the units and brings natural gas infrastructure onsite.

CenterPoint Energy retained Burns & McDonnell to provide an estimate similar to an AACE Class V cost estimate for the two units. This report summarizes the conceptual design and presents the project costs to be used by CenterPoint Energy in evaluating the project feasibility.

2.1 Study Scope

The scope of work included preparing the following major conceptual design documents:

1. Identify costs of conversion of the existing burners and burner management system to fire exclusively on natural gas per NFPA 85.
2. Re-use of the existing control room, plant auxiliaries and the cooling cycle equipment.
3. Allowances for boiler, piping, and turbine/generator assessments will be continued.
4. Identify a potential location for the natural gas pressure reducing/metering station on the site and the piping necessary to supply fuel to the boilers from that location.
   - Quantity of natural gas required for full load on both units.
5. Identify cost of boiler modifications, such as furnace refractory or tube modifications necessary for the normal operation of the unit on natural gas
   - Option for OFA and FGR system implementation costs
6. Identify costs for demolition of equipment along the burner front and other areas necessary for the operation on natural gas
   - Cost options for abandon in place versus demolition
7. Identify costs associated with modifications to the existing scrubbers, baghouses, SCR, stack, including fans, to allow for the operation on natural gas.

2.2 Objectives

The objectives of this study were to establish the conceptual design for the two boilers firing systems, provide a predicted performance, provide an overall project schedule, and provide a capital cost estimate to support project feasibility cost evaluations. CenterPoint Energy can use the information from this report to evaluate the natural gas conversion cost against other generation options.

2.3 Limitations and Qualifications

The costs presented within this report are subject to:

- Design changes for enhanced efficiency/operational flexibility.
- Final negotiation of the Terms and Conditions with the contractors and the major equipment suppliers.
- Final geotechnical report findings.
- Final topographical survey.
- Final determination/negotiation of the project schedule.
- Final selection of the equipment.
- Final permit requirements.
- Changes in federal regulations.
- Full evaluation of existing underground interferences.

3.0 PROJECT DEFINITION

The assumptions that formed the basis of the plant conceptual design, predicted performance and cost estimate are summarized in this report. The assumptions were developed through meetings with CP Energy and recent work on other similar coal to gas conversions that are relevant to this application. Some of the key assumptions are as follows:

- The units must be able to routinely operate at the present maximum gross generation, 100 MW for Unit 2 and 287 MW for Unit 3.
- The units will be required to operate over its full operating range.
- The units will cycle from minimum load to maximum load daily, sometimes on and off daily.
- The natural gas supply to the site and the pressure reducing / distribution / metering station will be permitted and built by others.
    - The station should have redundant distribution capabilities to allow for maintenance.
    - All gas piping on site should be above ground.

3.1 Reference Documents

CP Energy provided significant Unit 2 & 3 data for the purposes of developing a conceptual design. The information included:

- Boiler drawings & equipment drawings
- Performance data
- Operation and maintenance manuals for boilers and AQCS systems
- Fan curves & data
- General arrangement drawing
- EPA website CEMS data

3.2 General Design Criteria

The Plant is expected to be operated as a load following facility on 100 percent natural gas. Daily on/off cycling of the plant may be required. Considerations for daily cycling and impacts on existing equipment have not been included in this report. Determining a new low load would require an independent study to identify the existing low load limitation. It should be expected that the units can achieve a low load of 30% when firing gas, assuming the limitation is something other than the firing system.

For purposes of estimating the following design criteria is being used:

- Unit 2: 1,270 mmBtu/hr of natural gas to obtain 100 gross megawatts
- Unit 3: 2,935 mmBtu/hr of natural gas to obtain 287 gross megawatts
- Full plant load capacity would equal 4,204 mmBtu/hr of natural gas not including ignition system. The ignition system is sized for 10% of the firing system.
- Unit 2 airflow requirements of 1,348 kpph at 2% O_2, 15% air heater leakage, and 6% deterioration in boiler efficiency due to gas firing
- Unit 3 airflow requirements of 3,115 kpph at 2% O_2, 15% air heater leakage, and 6% deterioration in boiler efficiency due to gas firing
- We have evaluated 7%, 10%, 12% and 15% air heater leakage from the air to the flue gas side of the air heater.
- Unit 2 total forced draft fan requirement for airflow is 1,348 kpph or 325,496 acfm (163 kacfm per fan) at 105°F.
- Unit 3 total forced draft fan requirement for airflow is 3,115 kpph or 752,305acfm (376 kacfm per fan) at 105°F.
- Each existing Unit 2 forced draft fans test block capacity is unknown at this time.
- Each existing Unit 3 forced draft fan test block capacity is 365 kacfm at 105°F.

The plant will be controlled using the existing control room and distributed control system (DCS). The DCS at FB Culley utilizes an Emerson platform; the control system was upgraded in 1996. The existing BMS IO will be reused to the greatest extend possible. Many other plant systems will be removed from service and additional IO cards can be reused for the BMS as needed.

The existing combustion controls logic will be modified to accommodate the new gas burners, gas supply equipment, and gas interlocks. The existing master fuel trip (MFT) cabinet will be modified to accommodate the new configuration. Fuel firing, air flow, and interlock logic will be reviewed and implemented based on the logic diagrams provided by the burner supplier. Additional modifications to the balance of plant (BOP) logic will be made to remove systems that are out of service and add logic for gas supply skids.

The graphics will also require evaluation and modification with the coal to gas conversion. During detailed design, the Engineer will evaluate the existing graphics compared to the instrument list changes and updated piping configuration provided by the burner supplier to develop graphic update sketches.

An Engineer will be onsite for a portion of the outage to assist with I/O checkout and resolve any logic or graphic issues. Tuning of the air flow, drum level, furnace draft, throttle pressure control, steam temperature control, and other miscellaneous BOP loops will be required by a DCS tuner during startup.

The existing plant operators will need to be trained for natural gas operation. Plant operations personnel can be reduced by as much as 50% as the gas-fired plant will have significantly less equipment operating and require less maintenance, this assumes a full complement to start with. Startup on natural gas ignition system will be easier and reduce costs significantly.

3.2.1 Plant Design Summary

Conceptual design of the new gas conversion system is summarized here. Documents provided were used to produce the conceptual design presented below. Engineer used recent coal to gas conversion experience to estimate total distance for piping and vents. Experience form recent projects was used in determining total number of I/O points to be replaced.

3.2.1.1 Plant Location and Layout

The FB Culley power plant is located near Yankeetown, Indiana on the Ohio River just south of Indiana State Highway 66. The two units are located next to one another but have separate control rooms and turbine decks. The two units share a combined chimney stack is due east of the boilers. The proposed gas yard will be located in the north of the boilers. This keeps the main high pressure (HP) yard a good distance from the existing plant. The new gas pipeline will approach from the north or northeast. From the location of the M&R yard an 800 foot above ground pipe will be routed to the corner of the Unit 3. The pipe will then wye into two emergency shutoff valves. The emergency shutoff valve or NFPA 850 valve will send one pipe to each of the Units.

A single low-pressure skid would control gas to each unit firing equipment and have 100% redundant gas trains for both main gas burners. The burner double block and bleed skids at each burner front will provide the final control for the fuel burning equipment. The regulation station locations shown on the site layout in Appendix A are indicative locations for estimating only. Final regulating station locations will be decided during detailed design.

Figure 3- 1 – Site layout

No modifications to existing roads, switchyard, coal yard, or other plant areas are included. Existing building and structure modifications may not be required.

3.2.1.2 Plant Utilities and Infrastructures

3.2.1.2.1 Water Supply & Discharge

The discontinued use of coal after the 100 percent gas conversion would have an impact to water requirements at the FB Culley plant site. When firing gaseous fuel, ash sluicing won't be necessary for bottom ash or fly ash. Plant wash downs will be decreased as the plant will be cleaner without fly ash concerns.

While water supply and wastewater streams will be decreased, CPE must still comply with any Coal Combustion Residuals (CCR) or Effluent Limitation Guidelines (ELG) regulations. Natural gas conversion does not eliminate all these concerns.

3.2.1.3 Buildings and Enclosure

No changes will be made to the existing boiler house building. The gas yard equipment will not be enclosed. The new fuel gas control valve stations for the conversion will be housed in the existing boiler house with potential minimal structural modifications for valve station locations.

3.2.2 Unit Modifications

BMcD believes that the existing forced draft fans have enough capacity to supply 100% of the air required for complete combustion at a 2.0% O_2 design condition. the primary air fans on both units will no longer be operational.

BMcD has reviewed the information provided by CPE and based on this review the units do not appear to require any internal boiler modifications to fire near 100 percent on natural gas. The units are estimated to reach full load capacity with no modifications to internal heat transfer surface, forced draft fans or induced draft fans.

For the cost estimate to this study all coal pipes will be removed back to a section underneath the lowest burner deck on Unit 2. Coal pipes in the way of the burner front will be removed on unit 2. Some of the coal pipes on the outside will remain in place.

100% Gas Conversion: This will allow 100 percent natural gas single fuel operation. There will not be any coal systems in service. The boiler is estimated to be capable of operating on 100 percent natural gas with the appropriate fuel supply and burners.

Each unit specific fuel control valve skid will supply gas at up to 50 psig to both the main burners and the ignitors using two separate gas trains. The burner regulation stations will drop the pressure further for the final burner pressure.

The burner fuel control skids will be located as close as possible to the burner decks in the boiler house. In addition to the fuel piping, vent pipe will be required per National Fire Protection Association (NFPA) 85. This vent piping will be required on both the front and rear elevations of the boiler for Unit 3 and the front elevations on Unit 2. The vent pipe runs from the skid all the way to the top of the structure.

Burns & McDonnell pipe sizing criteria for fuel gas is as follows:

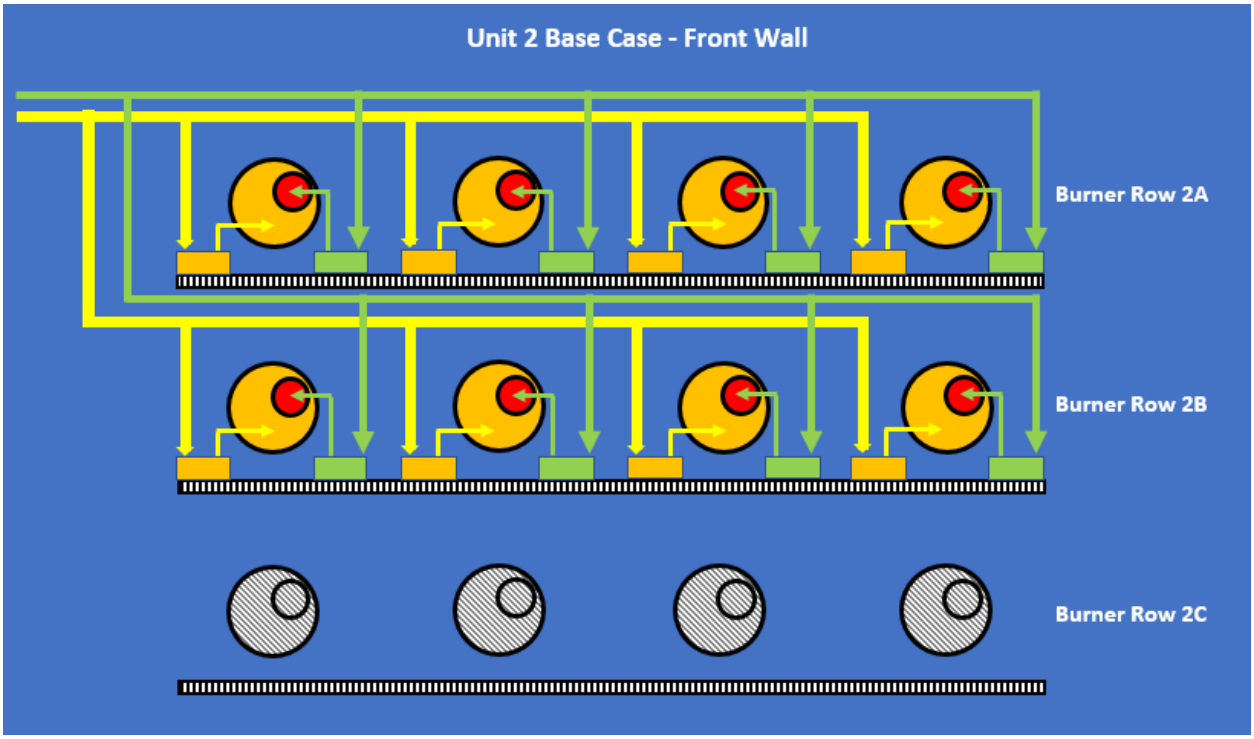
- 10” – 24” Pipe and larger: < 5000 ft/min Line Velocity

This design criteria provides lower velocities, resulting in less potential for noise and pipe vibrations. The velocity increase after the final double block and bleed valving that leads to the burner or ignitor may be as high as 166 fps or 9,960 fpm depending on the designer of the equipment.

Figure 3- 2 – Legend of symbols for Subsequent Figures

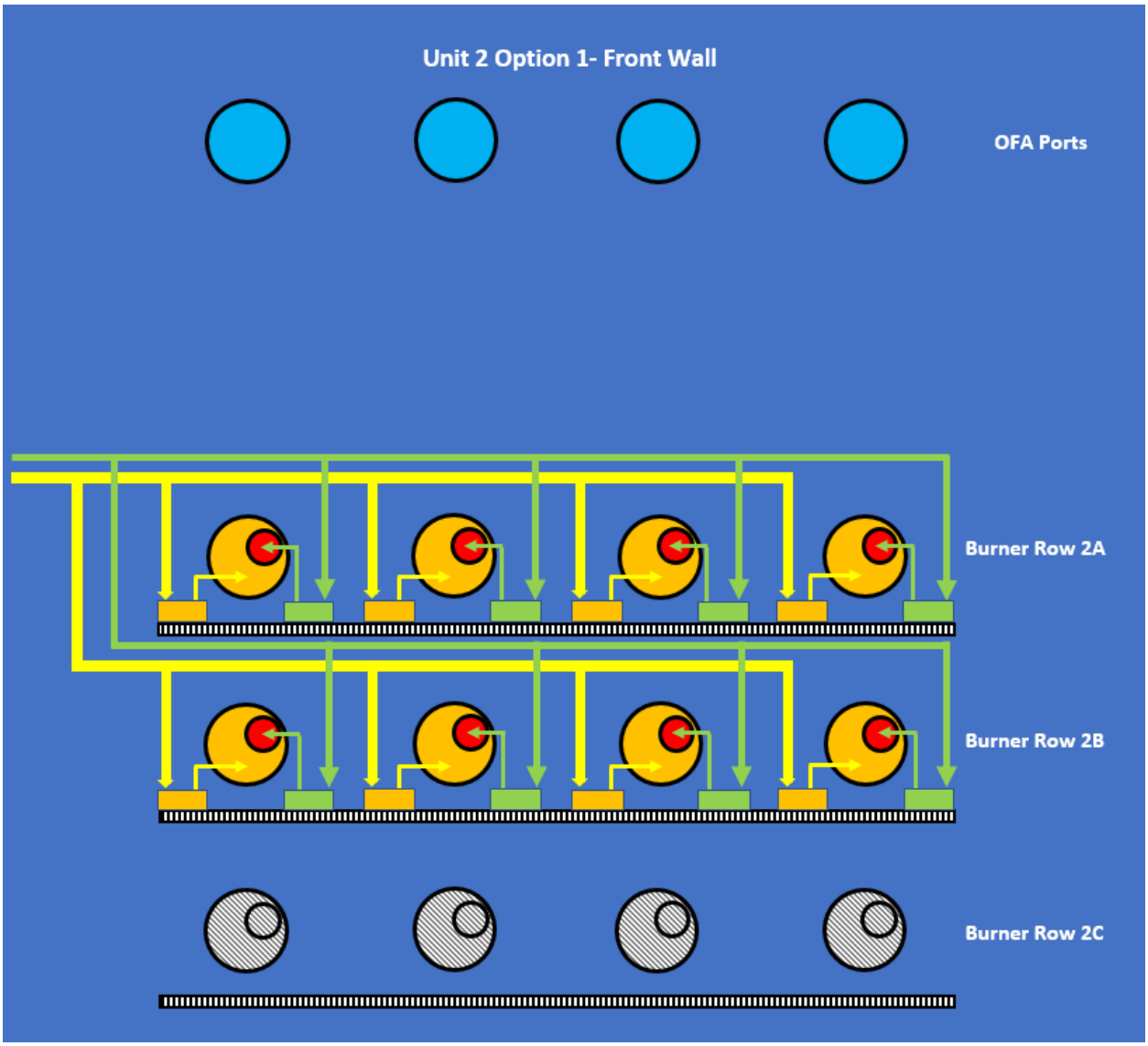
For Unit 2 Base Case: The Base Case is for new gas-fired LNBs, only. Only the upper eight (out of the existing twelve) burners will be retained for service after the fuel conversion. Each of the eight burners will be designed to operate at 160 mmBtu/hr. A detailed study of each system will be required after the procurement of the new firing equipment. The new burners will each have a new flame scanner requiring 15 scfm of cooling air.

Figure 3- 3 – Equipment Arrangement Sketch, Unit 2, Base Case



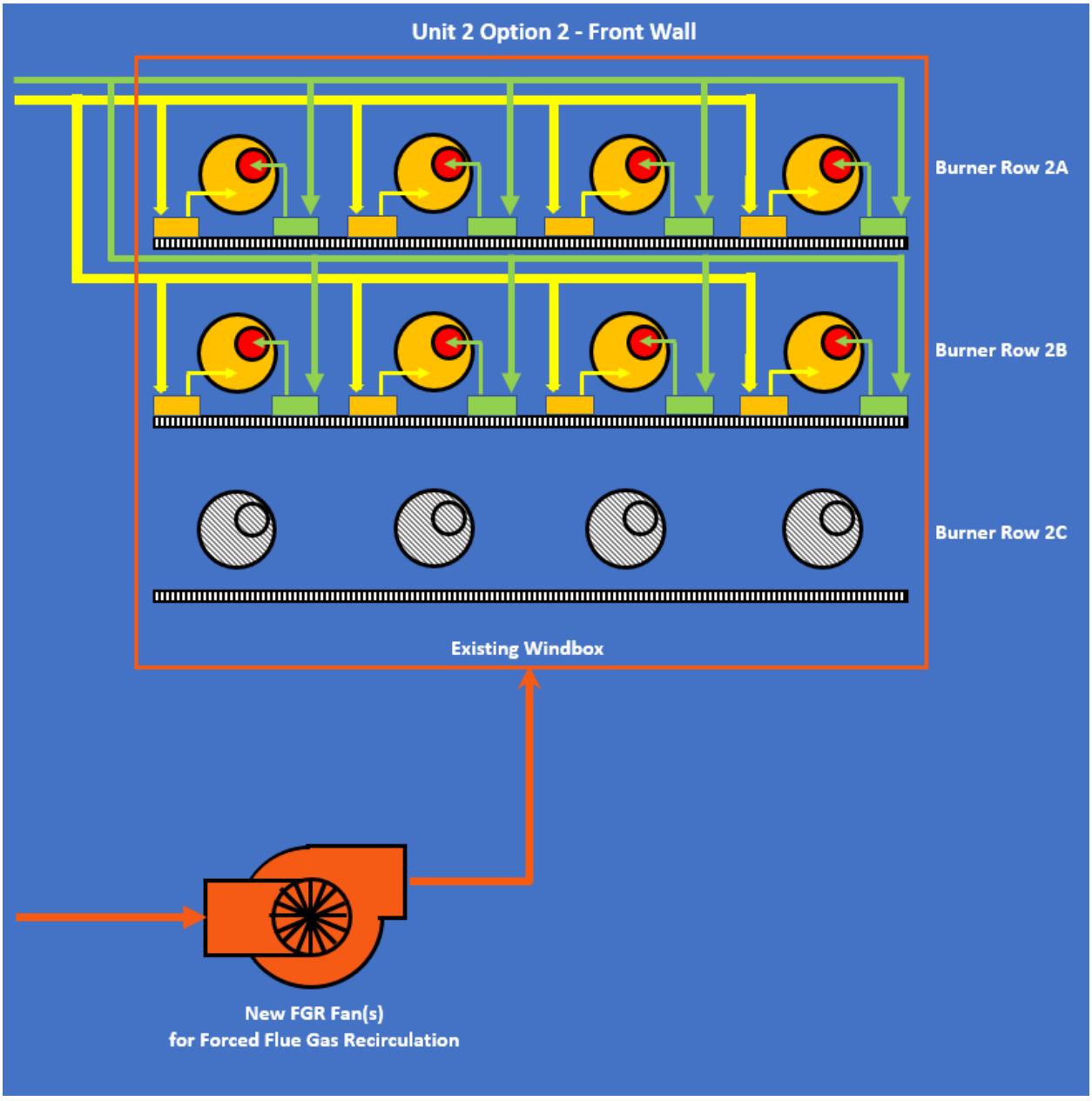
For Unit 2 Option 1: Option 1 is the same as the Base Case, but with an OFA system added. Each of the upper eight burners will be designed to operate at 160 mmBtu/hr. Economizer exit O_2 will not change, and the OFA ports will draw secondary air off the top of the open windbox, thus forcing the burner stoichiometry down to about 0.90 to further reduce NO_X.

Figure 3- 4 – Equipment Arrangement Sketch, Unit 2, Option 1



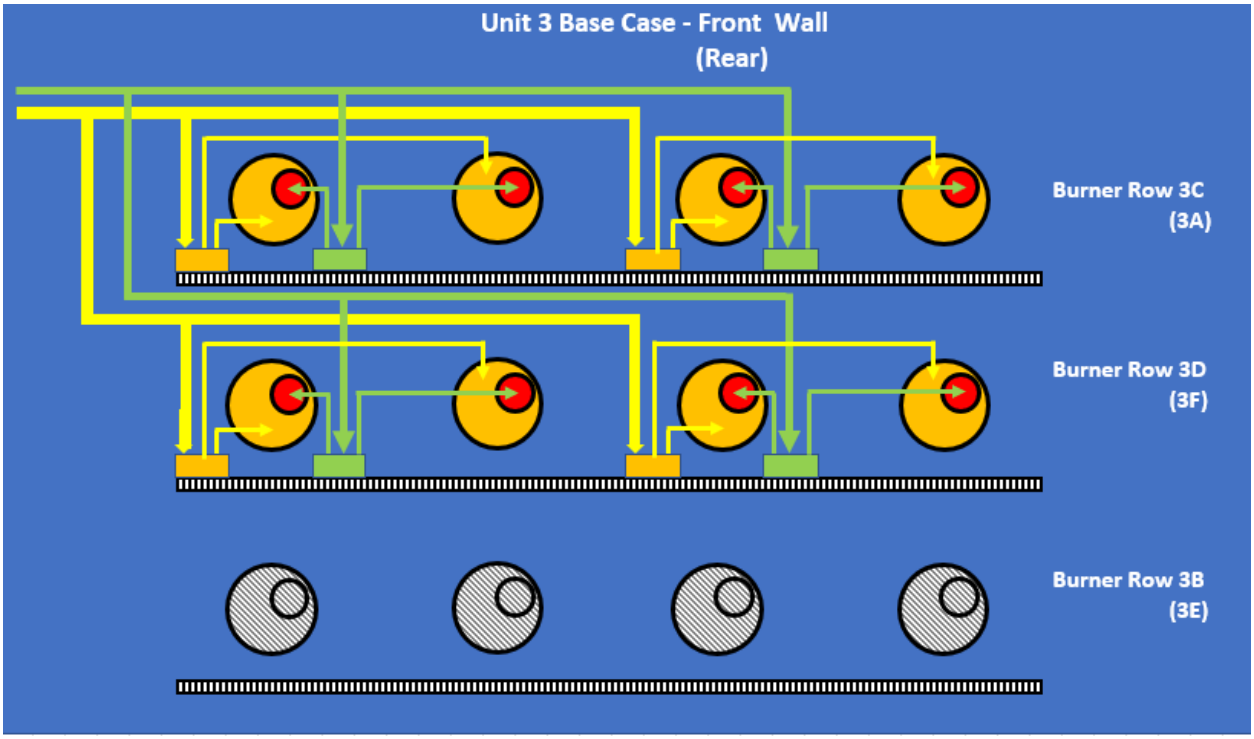
For Unit 2 Option 2: Option 2 is the same as the Base Case, but with a forced Flue Gas Recirculation (FGR) system added (and no OFA). Each of the upper eight burners will be designed to operate at 160 mmBtu/hr. Economizer exit O_2 will not change, and a new forced FGR system will be installed. The forced FGR system pushes flue gas directly back to the windbox rather than into the FD Fan suction, thus avoiding any additional FD Fan duty.

Figure 3- 5 – Equipment Arrangement Sketch, Unit 2, Option 2



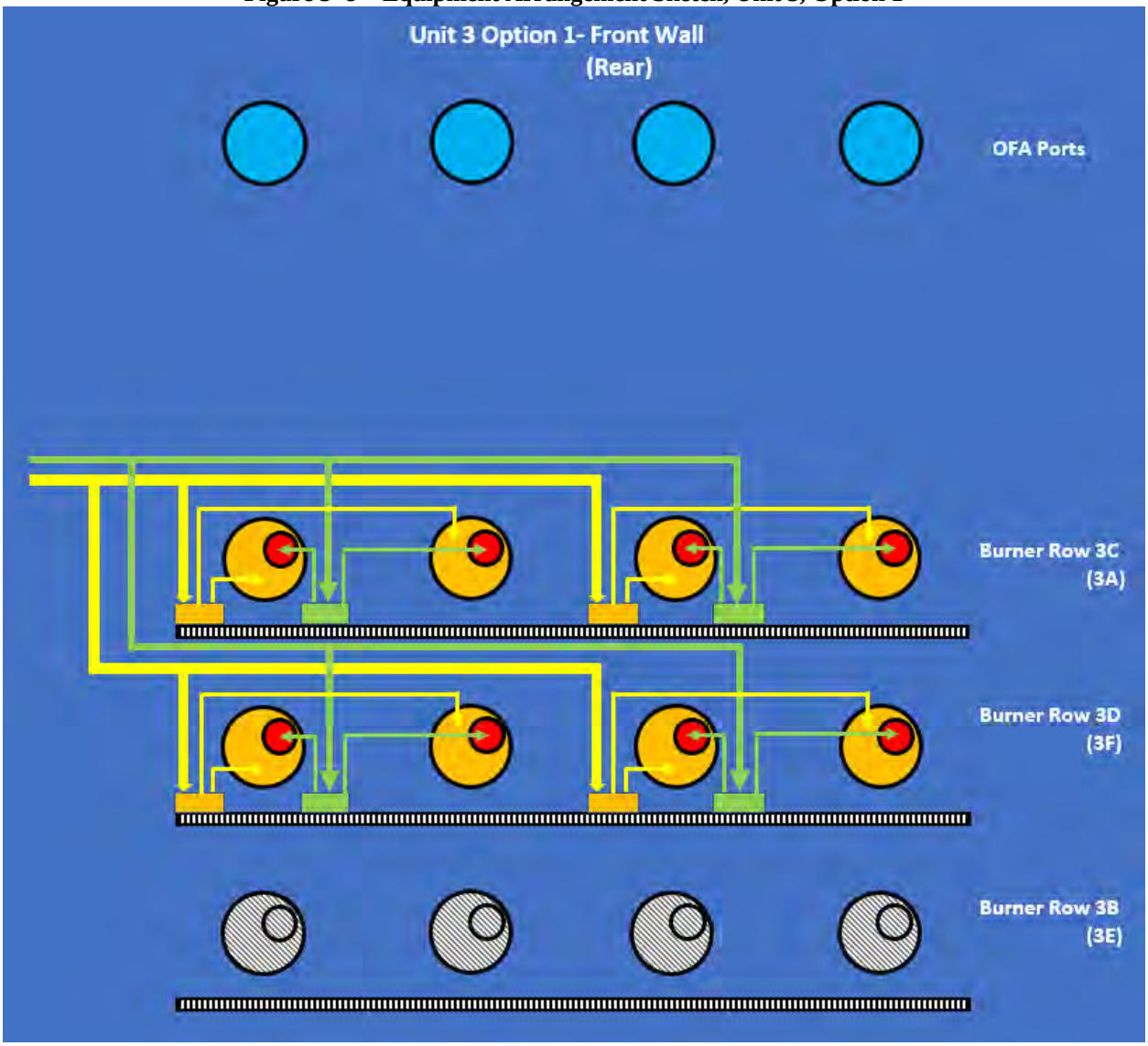
For Unit 3 Base Case: The Base Case is for new gas-fired LNBs, only. Only the upper sixteen (out of the existing twenty-four) burners will be retained for service after the fuel conversion. Each of the sixteen burners will be designed to operate at 185 mmBtu/hr. A detailed study of each system will be required after the procurement of the new firing equipment. The new burners will each have a new flame scanner requiring 15 scfm of cooling air.

Figure 3- 6 – Equipment Arrangement Sketch, Unit 3, Base Case



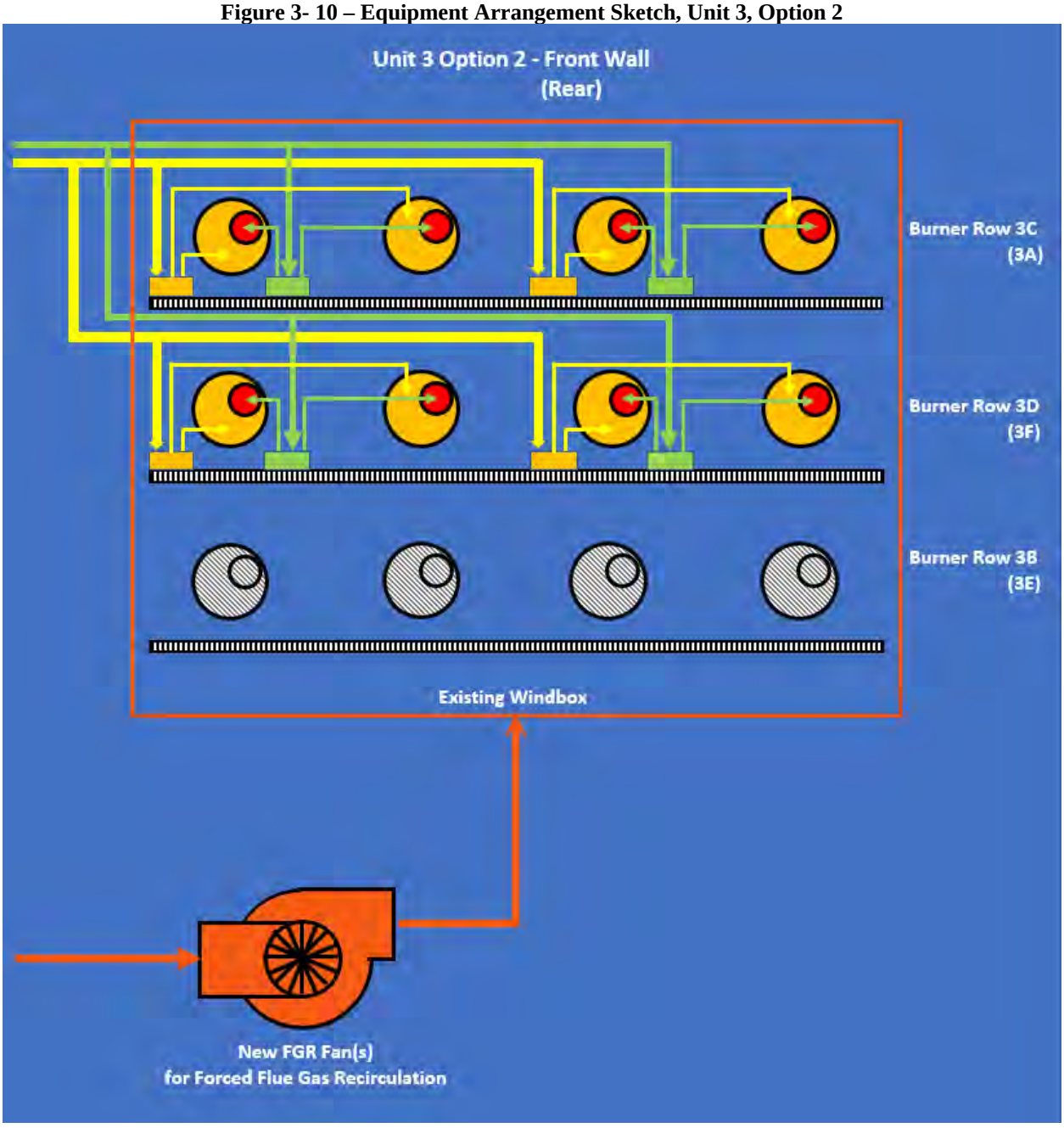
For Unit 3 Option 1: Option 1 is the same as the Base Case, but with an OFA system added. Each of the upper twelve burners will be designed to operate at 185 mmBtu/hr. Economizer exit O_2 will not change, and the OFA ports will draw secondary air off the top of the open windbox, thus forcing the burner stoichiometry down to about 0.90 to further reduce NO_X.

Figure 3- 9 – Equipment Arrangement Sketch, Unit 3, Option 1



For Unit 3 Option 2: Option 2 is the same as the Base Case, but with a forced Flue Gas Recirculation (FGR) system added (and no OFA). Each of the upper twelve burners will be designed to operate at 185 mmBtu/hr. Economizer exit O_2 will not change, and a new forced FGR system will be installed. The forced FGR system pushes flue gas directly back to the windbox rather than into the FD Fan suction, thus avoiding any additional FD Fan duty.

Figure 3- 10 – Equipment Arrangement Sketch, Unit 3, Option 2



The table below shows the total quantities for each of the above cases.

Figure 3- 11 – Quantity of Fuel Burning Equipment per Case

Gas Fuel Burning Equipment Quantities						
Description	**Unit 2**			**Unit 3**		
	Base Case	**Option 1**	**Option 2**	**Base Case**	**Option 1**	**Option 2**
New Burners	8	8	8	16	16	16
New Igniters	0	0	0	0	0	0
New Scanners	16	16	16	32	32	32
Burners DB&V	8	8	8	8	8	8
Igniters DB&V	0	0	0	0	0	0
Total Vents	10	10	10	10	10	10
OFA Ports	0	4	0	0	8	0
FGR Fans	0	0	1	0	0	1

3.2.3 Switchyard

No switchyard modifications will be required.

3.2.4 Flue Gas Desulfurization

When firing natural gas, a flue gas desulfurization system is not necessary since the sulfur content of natural gas is an order of magnitude less than coal fuels. This would dictate that the existing Unit 2 and 3 FGD could be decommissioned. With the FGD out of service, the stack would see air heater outlet temperatures. If mitigating flue gas temperature is required for the stack then spraying some water, using the FGD spraying equipment, into the flue gas can reduce the temperature, if required.

BMcD suggest removing the mist eliminators and any FRP in the system that could potentially be compromised by higher temperatures.

An alternative to using the existing spray machines would be to add a grid of nozzles to the last duct prior to the stack with a redundant system designing specifically for lowering temperature, if required. A price for this system including installation has not yet been developed and is not included in the cost estimates. This system would remove the need for using a sprayer at a low inefficient load.

3.2.5 Selective Catalytic Reduction

Unit 3 has been retrofitted with a selective catalytic reduction (SCR) system for the purposes of reducing NOx emissions from the flue gas generated by burning coal. The NOx emissions are estimated to be 0.45 lb of NOx/mmBtu currently entering the SCR. Typical gas burners without additional NOx reduction technologies can reduce this emissions rate to 0.22 lb/mmBtu. It is estimated that 80% NOx reduction is easily achieved with an SCR while burning gas. BMcD recommend using 0.05 lb/mmBtu for a new NOx emission target on Unit 3.

The economizer surface area has been increased from the original design. At lower loads a natural gas duct burner is required to increase the temperature of the flue gas prior to entering the SCR system. The SCR catalysts require a minimum temperature of the flue gas to be effective.

The SCR system can also be fitted with CO catalysts to lower CO or VOC if required. BMcD is still evaluating the potential need for a layer of CO catalyst. Generally there is not a need for a layer of CO catalyst when converting from coal to 100% gas firing.

3.2.6 Baghouse

Unit 3 has a baghouse. When firing natural gas, a particulate control device is typically not necessary since natural gas is a gaseous fuel and there are no substantial ash particles. Bags are typically rated to operate in temperatures up to 350 F so this shouldn't raise any issues for Unit 3. The baghouse can be decommissioned once the unit has operated for a few months and any ash within the boiler or ductwork has worked its way out. Once the unit has gone through a self-cleaning process, the bags can be removed to lower the pressure drop through the system. Removal of the bags could be done consecutively while the unit is online if the baghouse is fitted with spare compartments to allow online bag changes/removal. If this method is used, the removal of the baghouse bags could be completed by existing staffing, so no capital expenditure is accounted for.

3.2.7 Air Pre-Heater

Unit 2 and 3 have two Ljungstrom bi-sector air preheaters. This is the best arrangement for a coal to gas conversion project. All the air supplied for combustion air both primary and secondary travels through the FD fan. A possible limitation to generating full load is air heater air in-leakage. This air in-leakage

bypasses the boiler and is not available for combustion. Tightening air heater seals in the outage prior to gas only operation maybe warranted. BMcD recommend measuring actual air heater leakage and evaluating the need for significant maintenance. The costs for significant air heater repair are not included in this cost estimate.

3.2.8 Plant Performance Impacts

Burning natural gas will be less efficient than burning coal. The main impact on boiler efficiency is from hydrogen losses due to the higher hydrogen content of the natural gas fuel. The byproduct of combusting hydrogen is water vapor, and additional heat is needed to vaporize this water and heat it to the exiting economizer temperature. This heat is lost in the flue gas rather than absorbed in the boiler's water walls to create steam. We estimate a 4 - 6% loss as compared to the design fuel.

On the other hand, natural gas is more efficient than coal when it comes to dry gas losses due to less combustion air and excess air needed for proper stoichiometries. Approximately 10 percent excess air is needed for proper combustion of natural gas vs. 18 - 20 percent excess air for coal. Less flue gas flow for burning natural gas equates to smaller losses for heating the flue gas. For this study we have assumed an economizer exit O_2 of 2.0% to be conservative while firing gas.

The reduced natural gas-fired boiler efficiency requires an increase in total heat input to reach the same steam generation. Overall, there will be a reduction in auxiliary power requirements for a gas-fired boiler thus increasing the net plant output accordingly. This study assumes a 30 percent savings in auxiliary loads for pulverizers, coal handling, soot blowers, ash handling, baghouse, scrubber, etc. that will not be operated on 100 percent natural gas. The 30 percent savings has been confirmed to be a conservative estimate based on auxiliary load information from other plants.

BMcD review of the existing boilers estimates they are both capable of firing 100% natural gas without a reduction in steam flow and maybe only a slight reduction in steam temperature. The boiler may achieve the same existing coal steam flow conditions natural gas without any modifications to the existing boiler surface area or other boiler modifications. The boiler efficiency will drop by approximately 4% to 6% percentage points on 100 percent natural gas.

3.3 Natural Gas Supply

Burns & McDonnell investigated the flow requirements at CenterPoint Energy for a 100% conversion from coal to natural gas. The total calculated flow requirement is 4,205 mmBtu/hr for both units to meet full load. This does not include any gas to maintain gas heaters in the M&R yard if needed. Costs

regarding bringing gas to the site are outside of the scope of this report. B&McD recommend heated gas to avoid excessive ice and moisture around the burners.

3.4 Project Schedule

The schedule for this project was developed as generic durations to provide an indicative project duration. This schedule assumes CPE will submit the air permit application for approval and concurrently start preliminary engineering and design. It is also assumed the project for 100 percent gas conversion will not trip PSD. The project schedule is shown below in Table 3-1. This schedule shows the durations for one-unit conversion including all onsite work. This includes the offsite pipeline based on other similar jobs. The overall duration depends on how construction and tie-in outages would be staggered. Add six months for the second unit

Table 3- 1: Indicative Schedule

Schedule Line Item	100% Natural Gas
Permitting (months)	12
Gas Line to Plant Concurrent (Eng/Pro)	18
Engineering & Procurement (months)	16
Construction (months)	6
Startup (months)	2
Total Project Duration (months)	**30**

3.4.1 Major Equipment

The natural gas burners and large gas regulators will be the longest lead time for on-site equipment. Vendors have recently quoted lead times of 9-12 months for 100 percent conversion equipment. The schedule may be affected depending on who is selected to provide the burner equipment. It is recommended to perform independent third-party modeling to confirm the best-case combustion equipment required prior to writing a specification to procure fuel burning equipment.

3.4.2 Construction

For onsite work, major construction activities will include the new onsite gas pipeline and fuel yard work, pre-outage pipe hanging, demolition of existing equipment after shutdown, boiler modifications including mechanical during shutdown, and electrical work. Construction, outside the M&R yard, is estimated at six months for complete installation for a 100 percent conversion.

3.4.3 Startup

Startup will be approximately two months. The units will be fired and tuned for optimal performance. Since the steam side will not be affected, no additional steam blows or cleanings will be necessary.

4.0 PROJECT COSTS

The capital cost summary is shown below. The project costs include escalation and are shown as 2022$. A project contingency of [redacted] percent is included to cover the accuracy of the estimate for the scope defined in this report. The costs presented in Table 4- 1 are total for the plant including all three units.

Table 4- 1: Total Plant Capital Costs

Capital Cost Line Item	Unit 2	Case 3
Procurement & Construction	[redacted]	
Project Indirects		
Project Costs		
Owner Costs		
Owner Contingency		
Total Onsite Costs – Base Case	**$24,673,642**	**$30,658,448**
Option 1 - OFA	[redacted]	
Option 2 – FGR		

4.1 Cost Estimate Basis

The purpose of the cost estimate basis is to generally describe the scope of the cost estimate and the methodology for estimating the costs.

4.1.1 Contracting Approach

The cost estimate was assembled using multiple prime contract approach. The Owner is responsible for the purchase of all equipment, while each prime contractor is responsible for their subcontracts, and labor. The associated risk for the Owner of using multiple contractors is accounted for in the total project contingency. Costs to administer the contract, participate in OEM's meetings, and review submittals are included under engineering cost.

4.1.2 Engineered Equipment

An OEM or the burner supplier will provide the majority of the major equipment. The burner supplier scope is described above for the various cases. Budgetary and real pricing for similar equipment were used to build-up the pricing for this study.

Civil scope for this project is very limited. Scope includes excavation and backfill for the onsite natural gas pipeline and finishing work around the gas yard areas. No new roads or grading are required.

4.1.3 Concrete

The gas yard metering and regulation stations are assumed to be field erected and placed on concrete pads. The valve stations and metering in the boiler house will be mounted to the existing floor slab, existing steel, or new steel platforms. Minimal concrete will be required for the conversion. The production rates and material prices were developed from Burns & McDonnell previous project estimates for construction in the project area.

4.1.4 Structural Steel

Miscellaneous steel such as pipe rack, grating, handrail, etc. are included for structure access that is not otherwise provided as part of the equipment contracts. An allowance is also included to cover additional steel platforms for valve stations if existing areas are too tight. Final valve station locations will be decided during detailed design. The production rates and material prices were developed from Burns & McDonnell previous project estimates for construction in the project area.

4.1.5 Piping

The piping scope of work includes above grade gas supply piping from the gas yard to the boiler house, burner supply piping, and vent lines. The piping scope covers purchase of pipe, fittings, flanges, valves, specials, bolt-up kits, supports, and pre-fabricated pipe. The piping scope of work does include applicable non-destructive evaluation (NDE) and pressure testing. The piping scope of work does not include allowances for underground interferences.

The piping estimate was based on a take-off from the similar sized units. Using these quantities, costs for bulk material, valves, and pipe fabrication was based on Burns & McDonnell recent project pricing. The production rates were developed from Burns & McDonnell previous project estimates for construction in the project area.

4.1.6 Electrical

The auxiliary power requirements for burning natural gas are generally lower than that required for burning coal. Abandonment of the pulverizers for a 100 percent conversion will free up considerable load from the auxiliary power system. Power will be required for the new flame scanners, valves, and blowers, but it is assumed that the existing power distribution can accommodate these additional minor loads (for the startup and co-firing cases as well). New control wiring has been included from the burner devices to the existing burner junction boxes. New marshalling control wiring has also been included from the burner junction boxes back to the DCS. It is assumed that the existing cable tray around the boiler has

adequate space to accommodate the new cable. The production rates and material prices were developed from Burns & McDonnell previous project estimates for construction in the project area.

4.1.7 Instrumentation & Controls

The majority of instrumentation for this project is either skid-mounted or included in the burner supplier scope. The skid-mounted regulating skids and valve stations can be specified such that all instrumentation is installed and wired to a junction box. Some instrumentation will be installed separately for the field erected gas yard metering and regulation. This results in negligible BOP instrumentation installation work. As described in the General Design Criteria section, the worst-case scenario was assumed where new DCS I/O modules would be necessary to accommodate the BMS modifications. An internal estimate was developed for this DCS cost that includes both hardware and software modifications.

4.2 Indirects

The following methods were used for indirects:

- Cost for construction management and construction indirects were based on a percentage of the project costs based on similar past projects. Costs include construction management staff expenses including travel and living expenses, temporary buildings and utilities, and site maintenance. Additional construction management provided by the contractors is included in the wage rates used in this estimate.
- Cost for engineering was based on a percentage of the project costs based on similar past projects. The engineering estimate includes costs for office and field engineering as well as all per diems, expenses, and general overhead and administrative costs. The engineering estimate also includes costs to review submittals from major equipment OEMs and contract administration tasks such as attending progress meeting, expediting drawing submittals, and reviewing progress report.
- Cost for startup was based on a percentage of the project costs based on similar past projects.

4.2.1 Taxes

All taxes are excluded from the estimate.

4.2.2 Construction Labor Basis

The estimate was developed on the basis that there will be a sufficient labor pool to draw from the Yankeetown area to support the project. The productivity factors were developed based on Burns & McDonnell project history for labor in the regional area.

4.2.2.1 Labor Wage Rates & Expenses

Wage rates were taken from the 2022 RSMeans Construction Labor Rates for the Yankeetown area. The wage rates include wages, fringes, general liability and workers compensation insurance, overtime, per diem, incentives and contractor indirects.

4.2.2.2 Work Hours

The estimate assumes a 5-day, 50-hour week to incentivize labor. The shifts are based on a 50-hour work week with 25 percent of hours of overtime per day at one and a half times base wage rate for overtime pay.

4.2.2.3 Labor Per Diem

Craft per diem included in the craft wage rates.

4.2.3 Escalation

Escalation was not included with the project costs.

4.2.4 Contingency

A project contingency was included to cover typical final accuracy of pricing, commodity estimates, and accuracy of the defined project scope. Typically the level of contingency is set by the amount of scope definition provided, the amount of engineering and estimating conducted by the owner's engineer and CPE prior to providing cost certainty on the project price, and the amount of risk born by the prime contractors (performance, schedule, scope, payment, etc.). This contingency is NOT intended to cover changes in the general project scope (i.e. addition of buildings, addition of redundant equipment, addition of systems, etc.) NOR major shifts in market conditions that could result in significant increases in contractor margins, major shortages of qualified labor, significant increases in escalation, or major changes in the cost of money (interest rate on loans). A 25 percent contingency was included as a typical allowance for this indirect cost.

4.2.5 Owner Costs

5.0 CONCLUSIONS

Both Unit 2 and Unit 3 would result in a coal to 100% gas conversion that would be at or near the existing capacity when operating for full load.

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Co-gen Unit Study

Memorandum

Date: September 16, 2022

To: BJ Reynolds
Director of Power Supply Construction
CenterPoint Energy
812.491.5435

Subject: Co-gen Unit Assessment

INTRODUCTION

CenterPoint Energy ("CenterPoint") has retained 1898 & Co., a part of Burns & McDonnell Engineering Company, Inc. ("1898 & Co.") to evaluate a new cogeneration technology option. This option involves utilizing excess steam from an adjacent industrial facility to produce electricity via a steam turbine. The intent of this assessment is to provide capital cost, O&M costs, and performance information sufficient to support Integrated Resource Planning ("IRP") efforts.

It is the understanding of 1898 & Co. that this Memo will be used for preliminary information in support of CenterPoint's generation planning process. Any technologies of interest to CenterPoint should be followed by additional detailed studies to further investigate the technology and its direct application within CenterPoint's long-term plans.

Study Basis and Assumptions

The assumptions below govern the overall approach of the Study:

- All estimates are screening-level in nature, do not reflect guaranteed costs, and are not intended for budgetary purposes.
- All information is preliminary and should not be used for construction purposes.
- All capital cost and O&M costs are stated in 2022 US dollars ("USD"). Escalation is excluded.
- Estimates assume an Engineer, Procure, Construct ("EPC") fixed price contract for project execution.
- Ambient conditions are based on the following:
    - Winter Conditions: 5°F
    - Average Ambient Conditions: 59°F
    - Summer Conditions: 90°F

TECHNOLOGY EVALUATION

A large new industrial customer is requesting to partner with CenterPoint on a cogeneration facility. The industrial facility has sufficient waste heat in the form of steam to produce approximately 22 MW of electricity. 1898 & Co. performed a screening-level evaluation of a cogeneration technology to

assist CenterPoint with understanding the likelihood of further development.

Evaluated Technology
The proposed co-gen facility utilizes the industrial customer's waste heat in the form of steam by using it to drive a steam turbine and generator to produce electric power. The steam turbine is a multistage condensing steam turbine with a four-pole generator with gearbox. The exhaust steam is condensed in a surface condenser. Cooling water is supplied by a 2-cell mechanical draft cooling tower via 2x50% circulating water pumps. The condensate is then returned to the industrial facility through 2x100% condensate pumps.

Since the co-gen will utilize steam from the industrial facility waste heat to produce electricity, there are no additional air emissions. No emissions controls technology is required.

Performance Estimates
The steam is assumed to come directly from the industrial customer and at the steam conditions shown in Table 1. The estimated co-gen performance is shown in Table 2.

Table 1: Steam Conditions

Description	Value
Steam Pressure, psig	650
Steam Temperature, °F	740
Steam Flow, kpph	165

Table 2: Co-Gen Performance

Description	Value
Gross Plant Output, MW	23.2
Auxiliary Load, kW	900
Net Plant Output, MW	22.3

Operating and Maintenance Cost Estimates
1898 & Co. developed a screening-level O&M cost estimate including a breakout for fixed operations and maintenance and variable operations and maintenance.

Operating and Maintenance Assumptions
- O&M costs were estimated assuming average annual conditions.
- Fixed O&M cost estimates include labor, office and administration, training, contract labor, safety, building and ground maintenance, communication, and laboratory expenses.
- Variable O&M costs include routine maintenance, makeup water, water treatment, water disposal, and other consumables.
- Variable O&M costs are assuming the facility is operating at full load capacity.
- O&M costs exclude property taxes and insurance.

Operating and Maintenance Cost Estimates Summary
The total O&M cost is summarized below in Table 3.

Table 3: Operating and Maintenance Cost Estimate

Description	Cost Estimate
Fixed O&M Costs	
Variable O&M Costs	

Capital Cost Estimates
1898 & Co. developed a screening-level, Association for the Advancement of Cost Engineering ("AACE") Class V capital cost estimate including a break-out of anticipated owner's cost.

Cost Estimate Assumptions
A detailed scope assumptions matrix is included in Appendix B. The following assumptions govern the capital cost estimates:

- The interface point for all piping is assumed to be at the facility property boundary.
- Steam quality is assumed to meet steam turbine OEM requirements.
- All water treatment is assumed to be performed by the industrial customer and is not included in the scope.
- Spare steam turbine bladed rotor is included to support shorter maintenance outages.
- Electrical scope is assumed to end at the generator terminals. The STG will generate electricity at 13.8 kV and is assumed to tie directly into the industrial customer's system.

Cost Estimate Exclusions
The following costs are excluded from all estimates:

- Financing fees
- Interest during construction
- Escalation
- Performance and payment bond
- Sales tax
- Property insurance
- Transmission Interconnect / Switchyard
- Water rights

Capital Cost Estimate Summary
The total installed cost of the facility is shown in Table 4. All costs are estimated in 2022 USD. For a further breakdown on the Cogeneration capital cost estimates, see Appendix A.

Table 4: Capital Cost Estimate (2022$MM)

Description	Cost Estimate
Total Direct Cost	[redacted]
Total Indirect Cost	
EPC Project Cost	
Owner's Cost	
Total Project Cost	$63.0 MM

STATEMENT OF LIMITATIONS

Estimates and projections prepared by 1898 & Co. relating to performance, operating and maintenance costs, capital costs are based on experience, qualifications, and judgement as a professional consultant. 1898 & Co. has no control over weather, cost and availability of labor, material and equipment, labor productivity, construction contractor's procedures and methods, unavoidable delays, construction contractor's method of determining prices, economic conditions, government regulations and laws (including interpretation thereof), competitive bidding, and market conditions or other factors affecting such estimates or projections. Actual rates, costs, performance ratings, schedules, etc., may vary from the data provided.

CONCLUSIONS AND RECOMMENDATIONS

This study provides capital cost, O&M costs, and performance information to support CenterPoint's consideration of a cogeneration opportunity with an industrial facility. Information provided in this Memo is preliminary in nature and is intended to support screening of generation opportunities. If this opportunity is appealing, CenterPoint should pursue additional studies to define project scope, equipment design, and schedule for the development of the project.

1898 & Co. appreciates the opportunity to support CenterPoint with this evaluation. If you have any questions regarding this memo, please contact Chad Swope at chad.swope@1898andco.com | 816.548.1329.

Sincerely,

Chad Swope, P.E.
Project Manager

Appendix A – Cogeneration Technology Assessment Summary Table
Appendix B – Cogeneration Scope Assumptions

Attachment 6.6 ACE Rule Heat Rate Study

FINAL

EPA ACE HEAT RATE STUDY

B&V PROJECT NO. 402338
B&V FILE NO. 40.0004

PREPARED FOR

VECTREN
A CenterPoint Energy Company

Vectren

16 JANUARY 2020

BLACK & VEATCH

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Executive Summary

The Affordable Clean Energy (ACE) rule, finalized by the United States Environmental Protection Agency (EPA) on June 19, 2019, establishes new standards for reducing greenhouse gas (GHG) emissions for coal-fired electric utility generating units (EGUs) based on the "best system of emission reduction" (BSER). First proposed in August 2018, the rule, Docket ID No. EPA-HQ-OAR-2017-0355: FRL-9995-70-OAR, "Repeal of the Clean Power Plan; Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units; Revisions to Emission Guidelines Implementing Regulations," focuses on measures that can be implemented within the fence line of existing EGU facilities. As such, the EPA concluded that BSER be limited to heat rate improvements (efficiency improvements) for existing coal-fired EGUs. Within ACE, the EPA identified a list of candidate technologies and measures to achieve heat rate improvements (HRI).

In anticipation of the final rule, Vectren requested that Black & Veatch assess these candidate technologies for improvements at four coal fired plants (A.B. Brown Unit 1, A.B. Brown Unit 2, Culley Unit 2, and Culley Unit 3) to meet the goals of the ACE rule. Black & Veatch reviewed the characteristic of the four plants and examined each plant according to several BSER alternatives:

- Steam turbine blade path upgrades.
- Redesign or replacement of the economizer.
- Air heater and duct leakage control.
- Variable frequency drive (VFD) deployment.
- Neural networks.
- Intelligent sootblowing (ISB).
- Various improved operations and maintenance (O&M) practices.

Several factors influenced the recommendations for upgrades at the four plants; these factors are discussed in detail in Section 3.0. A summary of Black & Veatch's assessment and recommendations is as follows:

- The existing steam turbines at A.B. Brown Units 1 and 2 have been upgraded to full dense pack and no significant improvement in heat rate would result in additional upgrades; a turbine blade path upgrade would improve heat rate at F.B. Culley Unit 3 (1.4 to 1.6 percent). Steam turbine blade path upgrades options for F.B. Culley Unit 2 would improve heat rate by 1.3 to 1.5 percent, at a cost of $10.4 million.
- Economizer upgrades are not recommended for A.B. Brown Units 1 and 2 or F.B. Culley Unit 3 at this time; upgrades at F.B. Culley Unit 2 would require significant investment and require further study. A boiler modeling study of the potential benefits of reducing economizer surface area at A.B. Brown Units 1 and 2 or F.B. Culley Unit 3 found that although there was a potential reduction in natural gas use for the gas burners, the net impact upon the units was negative.
- Recommendations were provided for improving unit air heaters at all four units.

- Estimated costs are provided for VFD improvements for the FD and ID Fans at A.B. Brown Units 1 and 2. VFD improvements were studied for the FD fans at F.B. Culley Units 2 and 3 as both units ID fans have already been upgraded with VFDs.
- The deployment of VFDs for circulating water pumps was studied at all four units, but in no instance was it found to be a cost-effective HRI option.
- Estimated costs are provided for neural network deployment at all four units.
- F.B. Culley Unit 2 is the only unit that could benefit from ISB; the other units already use this technology.
- Improved O&M practices include heat rate improvement training, on-site heat rate appraisals, and improved condenser cleanliness strategies; these techniques may result in improvements at all four units.

Overall, many opportunities exist for heat rate improvement at the A.B. Brown and F.B. Culley units in compliance with the EPA-ACE rule. The decision of which heat rate improvements should be pursued must be based upon the long-term plans for the continued operation of the units, and the specific cost/benefit factors for each improvement found in Appendix B.

Recommendations

The following recommendations have been made for the units, based upon their past performance and current operations, as well as the expected future payback potential.

- For the A.B. Brown 1, A.B. Brown 2, and F.B. Culley 3 units upgrades to the air heaters and repair and remediation of ductwork and air quality control systems leakage appears to have a high value to the plants. In the case of air heater upgrades the improvement in heat transfer will improve the boiler efficiency, and the reduction in air heater leakage will reduce station service by reducing the air and gas main fan flow requirements. Reductions in duct leakage and leakage in air quality control equipment leakage will significantly improve induced draft fan performance and will reduce station service. There will also be the ancillary benefit of improved operations and efficiency of the air quality control equipment for emissions reduction.

  F.B. Culley Unit 2 was found to have a poor cost/benefit ratio for these upgrades due to its very low capacity factor and net generation, as well as its relatively short remaining useful life. F.B. Culley Unit 3 on the other hand was found to have the best potential benefit from air heater and duct leakage improvements from the standpoint of improvement per capital dollar spent.

- Steam turbine and blade path upgrades were analyzed for F.B. Culley Units 2 and 3 (A.B. Brown Units 1 and 2 were judged not to benefit from them sufficiently to

warrant further upgrades, due to their relatively recent dense pack refurbishments) but only upgrades respective to F.B. Culley Unit 3 were found to be technically feasible and cost-effective at this time. However, as the New Source Review (NSR) exemption portion of EPA-ACE has been deferred and will be proposed in a separate action at a later date, pursuing steam turbine upgrades at this time should be done under the consideration of the potential for triggering NSR.

- Variable frequency drive deployment was found to be only advantageous for the induced draft fans on A.B. Brown Units 1 and 2. For all other systems and the F.B. Culley units, either VFDs had already been deployed to critical systems, or there was no acceptable cost/benefit to further deployment.
- Deploying a neural network or other boiler optimization system was found to be beneficial for all units except F.B. Culley Unit 2, which again was excluded due to its low capacity factor and output. Even modest improvements in optimization could result in significant improvements to heat rate and overall unit control and emissions.
- Heat rate awareness training was found to be a very good cost/benefit for all the units and could yield significant improvements in operations practices and responses to controllable losses at both plants. Targeted heat rate assessment, while difficult to quantify exactly, is expected based upon Black & Veatch experience to have a very high return on investment, and numerous examples have been provided in the text from past projects.
- The addition of more circulating water temperature measurements leaving the condenser would also improve accuracy of results by better capturing temperature stratification in the return piping.

Summary of Costs

The following table provides a summary of costs associated with the recommended ACE technologies for each unit. Additional detailed cost estimates for each unit can be found in Appendix B.

Table ES-1 A.B. Brown Unit 1 Summary of ACE Technology Costs

Project Description	Est Capital Cost ($000)	Heat Rate Reduction (%)	Heat Rate Reduction (Btu/kWh)
Air Heater Basket, Seal, and Sector Plate Replacement	850	0.50	57.88
Air Heater (Steam Coil) System Repairs	350	0.10	11.6

Project Description	Est Capital Cost ($000)	Heat Rate Reduction (%)	Heat Rate Reduction (Btu/kWh)
Circulating Water Pumps	2,100	N/A	N/A
Induced Draft Fans VFD Deployment	2,900	2.39	276.5
Forced Draft Fans VFD Deployment	2,000	0.43	50.3
Deployment of A Neural Network for Combustion Control and Boiler Excess Air Reduction. (0.25% to 0.75% Reduction in Excess O_2)	500	0.23 to 0.60	26.6 to 69.5
Heat Rate Improvement Training	15	0.30	34.7
On-Site Heat Rate Appraisals	Variable	Variable	N/A
Improved Condenser Cleaning Strategies	N/A	0.15	17.4

Table ES-2 A.B. Brown Unit 2 Summary of ACE Technology Costs

Project Description	Est Capital Cost ($000)	Heat Rate Reduction (%)	Heat Rate Reduction (Btu/kWh)
Air Heater Basket, Seal, and Sector Plate Replacement	850	0.50	55.0
Air Heater (Steam Coil) System Repairs	350	0.10	11.0
Circulating Water Pumps	2,100	N/A	N/A
Induced Draft Fans VFD Deployment	2,900	1.33	146.3
Forced Draft Fans VFD Deployment	2,000	0.26	28.6
Deployment of A Neural Network for Combustion Control and Boiler Excess Air Reduction. (0.25% to 0.75% Reduction in Excess O_2)	500	0.30 to 0.60	25.3 to 66.0
Heat Rate Improvement Training	15	0.30	33.0
On-Site Heat Rate Appraisals	Variable	Variable	N/A
Improved Condenser Cleaning Strategies	N/A	Negligible	Negligible

Table ES-3 F.B. Culley Unit 2 Summary of ACE Technology Costs

Project Description	Est Capital Cost ($000)	Heat Rate Reduction (%)	Heat Rate Reduction (Btu/kWh)
Air Heater Basket, Seal, and Sector Plate Replacement	476	0.50	63.2
Circulating Water Pumps	900	N/A	N/A
Forced Draft Fans VFD Deployment	2,000	0.48	60.9
Deployment of A Neural Network for Combustion Control and Boiler Excess Air Reduction. (0.25% to 0.75% Reduction in Excess O_2)	500	0.26 to 0.62	32.9 to 78.4
Boiler Feed Pump VFD Deployment	600	0.6	75.8
Synchronized Controlled Sootblowing System Designed to Alleviate Excessive Use of Steam, Air or Water That Have A Negative Effect on Heat Rate.	350	0.10	12.64
Heat Rate Improvement Training	15	0.30	37.9
On-Site Heat Rate Appraisals	Variable	Variable	N/A
Improved Condenser Cleaning Strategies	N/A	0.42	53.1

Table ES-4 F.B. Culley Unit 3 Summary of ACE Technology Costs

Project Description	Est Capital Cost ($000)	Heat Rate Reduction (%)	Heat Rate Reduction (Btu/kWh)
HP/IP Upgrades	19,900	1.5	158.3
Air Heater Basket, Seal, and Sector Plate Replacement	750	0.50	52.8
Air Heater (Steam Coil) System Repairs	350	0.10	10.6
Circulating Water Pumps	2,100	N/A	N/A
Forced Draft Fans VFD Deployment	2,000	0.51	54.3
Deployment of A Neural Network for Combustion Control and Boiler Excess Air Reduction. (0.25% to 0.75% Reduction in Excess O_2)	500	0.25 to 0.62	26.4 to 65.4
Heat Rate Improvement Training	15	0.30	31.7
On-Site Heat Rate Appraisals	Variable	Variable	N/A
Improved Condenser Cleaning Strategies	N/A	0.44	46.4

1.0 Introduction

Vectren requested that Black & Veatch support its efforts to analyze a potential response to the United States Environmental Protection Agency (EPA) Docket ID No. EPA-HQ-OAR-2017-0355: FRL-9995-70-OAR, "Repeal of the Clean Power Plan; Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units; Revisions to Emission Guidelines Implementing Regulations;" known as the Affordable Clean Energy (ACE) rule. Vectren operates the A.B. Brown Unit 1, A.B. Brown Unit 2, F.B. Culley Unit 2, and F.B. Culley Unit 3 coal-fired electric generating units (EGUs) and specifically requested that Black & Veatch develop a high-level assessment report identifying opportunities to improve plant efficiency to meet ACE rule goals.

To meet these goals, Black & Veatch prepared a high-level description of four primary heat rate improvement (HRI) projects that have been proposed by the EPA as the best system of emission reduction (BSER). Estimates of HRI, annual carbon dioxide (CO_2) reduction, and a rough order-of-magnitude capital cost estimate were developed for each alternative.

Black & Veatch performed a high-level assessment to consider the technical and economic feasibility of items that have been seen as beneficial in previous ACE studies. Financial benefits would be confirmed by integrated resource plan (IRP) modeling; specific modifications would then be reviewed in a detailed effort to confirm the performance and financial benefits.

1.1 AN OVERVIEW OF EPA-ACE

On June 19, 2019, EPA issued the ACE rule, a replacement to the previous presidential administration's Clean Power Plan (CPP) to regulate CO_2 emissions from existing coal-fired power plants. ACE regulates EGUs based on the BSER. Unlike the CPP, ACE focuses on only those measures which can be implemented within the fence line of existing EGU facilities. As such, EPA has determined BSER to be limited to heat rate improvement (HRI) measures (efficiency improvements) for existing coal-fired EGUs at the individual unit level. The lower a unit's heat rate, the more efficiently it will convert heat input to electrical output, consuming less fuel per kilowatt-hour (kWh) and emitting lower amounts of CO_2. To aid operators and state agencies in determining which measures should be considered when determining BSER, EPA developed a list of 7 HRI candidate technologies. According to EPA, these technologies have been shown to be reliable, efficient, cost-effective, and broadly achievable for a source category across the country. The technologies include:

- Steam turbine blade path upgrades.
- Redesign or replacement of the economizer.
- Air heater and duct leakage control.
- Variable frequency drive (VFD) deployment.
- Neural networks/Intelligent sootblowing (ISB).
- Boiler feed pump upgrade/overhaul
- Various improved operations and maintenance (O&M) practices.

The EPA has responsibility under the CAA to provide a range of reductions and costs associated with each of the candidate technologies. The ranges of expected reductions for each technology are to be used as guidance, but the states will be expected to evaluate each affected unit individually. For reference, EPA's summary of HRI measures and the range of their HRI potential (%) by EGU size is included in Table 1-1. These ranges represent the degree of emission reduction achievable for each technology, however the EPA acknowledges that a specific unit may have the potential for more or less emission reduction based on the unit's specific characteristics. According to the preamble to the final rule, HRI potential will be determined by source-specific factors including, but not limited to, the EGU's past and projected utilization rate, maintenance history, and remaining useful life[1].

Table 1-1 EPA's Summary of HRI Measures and Range of HRI Potential (%) by EGU Size

HRI MEASURE	<200 MW		200-500 MW		>500 MW	
	MIN	MAX	MIN	MAX	MIN	MAX
Neural Network/Intelligent Sootblowers	0.5	1.4	0.3	1.0	0.3	0.9
Boiler Feed Pumps	0.2	0.5	0.2	0.5	0.2	0.5
Air Heater & Duct Leakage Control	0.1	0.4	0.1	0.4	0.1	0.4
Variable Frequency Drives	0.2	0.9	0.2	1.0	0.2	1.0
Blade Path Upgrade (Steam Turbine)	0.9	2.7	1.0	2.9	1.0	2.9
Redesign/Replace Economizer	0.5	0.9	0.5	1.0	0.5	1.0
Improved Operating and Maintenance (O&M) Practices	Can range from 0 to >2.0% depending on the unit's historical O&M practices.					

Ultimately, it is the EPA's role to determine the possible BSERs and the degree of emission control achievable for each technology, and it is the states' role to create plans establishing unit-specific standards (in a lbm CO_2/MWh format) that reflect the application of the BSER. Each state will be required to submit plans (or a State Implementation Plan [SIP]) to the EPA explaining how the state applied the BSER to each source and what other factors were considered when developing the unit-specific standards. In addition to the performance standards, states will also propose compliance deadlines for each EGU, as well as monitoring, recordkeeping and reporting requirements in their plans. These plans will be due to the EPA in three years (July 2022). Upon submittal, the EPA will have 12 months to determine whether or not to approve the plan.

[1] This could have the most significant implications for F.B. Culley Unit 2.

The emission limits and requirements for Vectren's affected EGUs will ultimately be established by IDEM. States are afforded considerable flexibility in determining emission standards for each unit as each state is more familiar with the existing sources within their jurisdictions. States are to use the guidelines EPA provided to evaluate each applicable EGU within its jurisdiction with regards to the utilization of each of the candidate technologies, equipment upgrades, and best O&M practices in establishing a standard of performance for that source. Physical and cost considerations will limit or prevent full implementation of the listed technologies and each state will consider these factors when establishing the standards of performance required. The remaining useful life of the source and other source-specific factors will also be considered by the states when establishing the standards of performance for each unit.

It will be the states' responsibilities to determine how these factors will be taken into consideration when establishing the standards. One approach that states may use is a top-down analysis that examines technical feasibility and cost effectiveness when determining an appropriate standard. Black & Veatch notes that variations of this type of analysis have been used by EPA in multiple regulatory programs to determine appropriate controls (e.g., BACT, RACT, BART, etc.). Such an analysis of the candidate BSER technologies could entail the following steps:

1. Identify all technologies (This step has already been done by the rule);
2. Eliminate technically infeasible options;
3. Rank remaining technologies by effectiveness;
4. Evaluate the most effective controls – entails energy, environmental, and economic impacts – cost effectiveness could entail a consideration of remaining useful life to ultimately determine the cost of a technology on the basis of dollars per lbm CO_2/MWh improvement.
5. Select the appropriate technology and set a standard of performance in terms of a lbm CO_2/MWh emission rate.

Black & Veatch notes that such an approach could provide state agencies such as IDEM with the defensible approach that they seek to avoid potential legal vulnerabilities while at the same time allowing Vectren to implement the most cost-effective option. Given the lack of specificity in the Rule, IDEM and their stakeholders have been afforded a great deal of latitude in designing the SIP. Therefore, early engagement with IDEM is encouraged in order to influence and assist in their determinations of the appropriate performance standard to include in the SIP for Vectren's affected units.

Numerous lawsuits have already been filed against the ACE rule, however, no stay (delay in rule administration) has been requested to this point. As with many environmental rules, industry sentiment is that the Rule's fate could be determined by the 2020 presidential election. In the meantime, however, Black & Veatch would expect that states will begin to gather information in order to begin designing their SIPs.

1.2 EPA'S INTEGRATED PLANNING MODEL

To assess the potential costs and benefits associated with the ACE rule, the EPA used the Integrated Planning Model (IPM) in support of final rulemaking. According to EPA documentation on the latest version of the model (EPA Platform v6, November 2018), "IPM is a multi-regional […] model of the U.S. electric power sector" that provides "[…] forecasts of least cost capacity expansion, electricity dispatch, and emission control strategies while meeting energy demand, environmental, transmission, dispatch, and reliability constraints." Historically, EPA has used the IPM to forecast power sector behavior and examine the impact of potential air pollution control policies. The EPA has used this model for over two decades to evaluate the economic and emission impacts of potential environmental regulations. Specifically, EPA has used v6 to develop regulatory impact analyses in support of the Cross-State Air Pollution Rule (CSAPR), the greenhouse gas New Source Performance Standard (NSPS) for new, modified, and reconstructed electric utility generating units (NSPS Subpart TTTT), the Mercury and Air Toxics Rule (MATS), the Regional Haze Rule, 316b, and ELG/CCR regulations.

The EPA IPM is quite complex and utilizes numerous inputs to characterize the power sector including:

- Power System Operation
- Generation Resources
- Emission Control Technologies
- CO_2 Capture, Transport, and Storage
- Coal Characteristics (i.e., Supply Curves and Transportation Matrix)
- Natural Gas Market Characteristics
- Other Fuel Assumptions
- Financial Assumptions

These inputs are processed in the model in order to arrive at outputs quantifying sector-wide emissions, costs, capacity expansion, retrofit decisions, fuel consumption and prices, and electricity generation and prices. Finally, these outputs can be fed into a post-processor in order to forecast individual boiler-level data, retail electricity price projections, and outputs needed to assess the impacts on air quality via air quality modeling. According to the model documentation, "The model has been tailored to meet the unique environmental considerations important to EPA, while also fully capturing the detailed and complex economic and electric dispatch dynamics of power plants across the country."

The IPM model was not designed to evaluate the technological or economic feasibility of the various BSER technologies for a single ACE-affected unit, but, rather, is intended to be used to holistically evaluate the impacts of EPA rulemakings on the entire power sector. Additionally, the model appears overly complex, such that it could be time-consuming and provide a false sense of accuracy when used to evaluate the technologies as part of an ACE study. As such, it is unlikely that the IPM would/should ever be utilized to evaluate the BSER technologies as a part of a state ACE compliance plan.

1.3 POTENTIAL NEW SOURCE REVIEW CHANGES

To accommodate and facilitate the HRI projects associated with the ACE rulemaking, EPA has proposed changes to the New Source Review (NSR) permitting program. Under the current regulations, modifications to stationary sources, such as EGUs, that increase annual emissions of regulated pollutants at or above certain regulatory thresholds are subject to NSR permitting requirements. EPA is now proposing to incorporate a comparison of hourly emissions into the NSR applicability assessment for EGUs. Under this approach, the maximum actual emissions values measured on an hourly basis before the project and the projected hourly emission rate that will occur after the proposed modification would be compared to determine if an emission increase would result. If no *hourly* emissions increase will occur, NSR would not be applicable.

However, if hourly emissions were determined to increase, the emissions analysis must continue per the traditional methodology where an assessment of both project-specific overall emissions increases, and plant-wide net emissions increases on an annual basis would need to be calculated to determine if NSR permitting requirements would apply. Black & Veatch notes that this proposed rule-making is considered particularly vulnerable to legal challenges. Therefore, an evaluation of the potential applicability of NSR to each of the BSER options examined in this report may be prudent in order to provide Vectren a full picture of the costs project timeline associated with the various options. Additionally, EPA has noted in the final rule, that costs associated with permitting NSR applicable projects can be included in the economic evaluation of the various ACE technologies.

2.0 Existing Plant Characteristics

This section briefly describes the baseline characteristics of each unit. The average and summary annual performance data for each unit that were used to calculate the potential heat rate benefits of applicable technologies can be found in Section 4.0.

A.B. Brown Units 1 and 2 are "sister units" in that they share many common characteristics. Each unit is a nominal 265-megawatt (MW) gross and 245 MW net unit, featuring a subcritical pulverized coal furnace with reheat steam and designed for bituminous coal from the Illinois Basin. A.B. Brown Unit 1 was commissioned in 1979, and A.B. Brown Unit 2 in 1986. Each unit employs low-nitrogen oxide (NO_X) burners and a selective catalytic reduction system (SCR) for NO_X control, and a scrubber for sulfur dioxide (SO_2) control. Unit 1 uses a pulse-jet fabric filter baghouse, and Unit 2 uses a cold-side electrostatic precipitator for particulate removal. Heat rejection is provided by mechanical draft cooling towers.

F.B. Culley Unit 2 is a nominal 100 MW gross and 90 MW net unit, featuring a non-reheat subcritical pulverized coal furnace designed for bituminous coal from the Illinois Basin. F.B. Culley Unit 2 was commissioned in 1966. The unit employs low-NO_X burners for NO_X control and a scrubber for SO_2 control. The unit uses a cold-side electrostatic precipitator for particulate removal. Cooling water is provided by the Ohio River.

F.B. Culley Unit 3 is a nominal 287 MW gross and 270 MW net unit, featuring a subcritical pulverized coal furnace with reheat steam and designed for bituminous coal from the Illinois Basin. F.B. Culley Unit 3 was commissioned in 1973. The unit employs low-NO_X burners and an SCR system for NO_X control and a scrubber for SO_2 control. The unit uses a pulse-jet fabric filter (PJFF) baghouse for particulate removal. Cooling water is provided by the Ohio River.

3.1 Description of Heat Rate Improvement Alternatives

This preliminary heat rate project screening was based on a high-level analysis of A.B. Brown Unit 1 and on Black & Veatch's experience with similar projects. The projects depicted herein were selected from HRI projects detailed by the EPA in its ACE rule as BSER projects. A detailed table summarizing the benefits and costs is included in Appendix B.

3.2 UNIT STEAM TURBINE BLADE PATH UPGRADES

Black & Veatch reviewed the steam turbine blade path upgrade option for each of the existing plants. The specific steam turbine upgrades are described for each individual plant in the following subsections.

3.2.1 A.B. Brown Unit 1 Steam Turbine Blade Path Upgrades

Black & Veatch reviewed steam turbine blade path upgrade. The A.B. Brown Unit 1 steam turbine had a full dense pack upgrade installed in 2012. In 2016, extensive high-pressure/ intermediate-pressure (HP/IP) repairs were made because of a main stop valve bypass failure. Black & Veatch estimates that there would not be any significant improvement with a steam turbine upgrade now, considering the relatively shorter duration since the last steam path upgrade and the potential cost associated with it.

3.2.2 A.B. Brown Unit 2 Steam Turbine Blade Path Upgrades

Black & Veatch reviewed the steam turbine blade path upgrade. The A.B. Brown Unit 2 steam turbine had a full dense pack upgrade installed in 2013. Black & Veatch estimates that there would not be any significant improvement with a steam turbine upgrade now, considering the relatively shorter duration since the last steam path upgrade and the potential cost associated with it.

3.2.3 F.B. Culley Unit 2 Steam Turbine Blade Path Upgrades

The Culley Unit 2 steam turbine is a GE non-reheat steam turbine with a two-flow low-pressure turbine with 20 inch last stage blades. Black & Veatch performed a review of the steam turbine blade path upgrade. As a result of this investigation, two heat balance model of the Culley Unit 2 steam turbine were developed:

- Base: Best match of the Culley Unit 2 Thermal Kit heat balance 328 HB 706 rating flow (guarantee) +5%. (Valve-Wide-Open, Normal Pressure (VWO-NP) case).
- Upgrade Scenario: The entire steam path HP/LP (High-Pressure and Low-Pressure turbines) are upgraded.

This analysis is based on the incremental improvement in steam turbine efficiency, and the differential performance is more important than the absolute performance. The performance improvements and pricing estimates are based on in house data and past project experience. However, steam turbine manufacturers should be contacted to confirm performance and pricing.

3.1.3.1 Base Case

The Base case model is matched to the original thermal kit heat balance 328 HB 706, which is the rating flow (guarantee) +5%. The condenser pressure was set to 1.5 in HgA to keep the basis consistent across the models for comparison against various upgrade options. This Base model was then used to run four cases: Rating flow + 5%, guarantee load (rated pressure and rated flow, corresponding to thermal kit heat balance 332 HB 827), 80% of guarantee load (rated pressure and reduced flow, corresponding to thermal kit heat balance 332 HB 829), and 60% of guarantee load (rated pressure and reduced flow, corresponding to thermal kit heat balance 332 HB 831).

3.1.3.2 Upgrade Scenario: HP/LP Steam Path Upgrades

In this model, the HP and LP sectional efficiencies were increased from approximately 86.9% and 69.9%, to approximately 87.9% and 71.9% respectively. The advanced age of the Culley Unit 2 steam turbine makes it difficult to estimate exactly how much efficiency could be gained in each section and further analysis should be completed by a steam turbine manufacturer. This model was then used to run four cases: Rating flow + 5%, guarantee load, 80% of guarantee load, and 60% of guarantee load. In each of the cases the boiler steam generation was reduced such that the steam turbine power output matches the value found in the corresponding cases in the original design (STG OEM Thermal Kit).

Tables 3-1 through 3-4 show the results of the turbine modeling conducted by Black & Veatch for this study. For comparison purposes, it was assumed that a boiler efficiency of 88.3% (HHV basis) applies regardless of the magnitude and type of boiler upgrades that may be required. This boiler efficiency is provided by the Vectren data in the Culley Unit 3 snapshot data and was assumed to be the same for Culley Unit 2 for the purposes of this modeling to allow for a comparison between the units.

Table 3-1 Culley Unit 2 Steam Turbine Modeling Results – Rating Flow + 5%

		ORIGINAL HEAT BALANCE	UPGRADE HP/LP
Boiler Efficiency (HHV)*	%	88.3	88.3
STG Gross Output	kW	99,765	99,766
Gross Turbine Heat Rate	Btu/kWh	9,012	8,881
Gross Turbine Heat Rate Change	Btu/kWh	N/A	-131
Turbine Heat Rate Improvement	%	N/A	1.5%
Boiler Heat Input (HHV)	MBtu/h	1,018.4	1,003.6
Boiler Heat Input (HHV) Change	MBtu/h	N/A	-14.8
Boiler Heat Input (HHV) Improvement	%	N/A	1.5%
Gross Plant Heat Rate (HHV)	Btu/kWh	10,208	10,060
Gross Plant Heat Rate (HHV) Change	Btu/kWh	N/A	-136
Gross Plant Heat Rate (HHV) Improvement	%	N/A	1.5%
*See the explanation above regarding the choice of the boiler efficiency value.			

Table 3-2 Culley Unit 2 Steam Turbine Modeling Results – Guarantee Load

		ORIGINAL HEAT BALANCE	UPGRADE HP/LP
Boiler Efficiency (HHV)*	%	88.3	88.3
STG Gross Output	kW	95,500	95,501
Gross Turbine Heat Rate	Btu/kWh	9,002	8,870
Gross Turbine Heat Rate Change	Btu/kWh	N/A	-131
Turbine Heat Rate Improvement	%	N/A	1.5%
Boiler Heat Input (HHV)	MBtu/h	973.8	959.6
Boiler Heat Input (HHV) Change	MBtu/h	N/A	-14.2
Boiler Heat Input (HHV) Improvement	%	N/A	1.5%
Gross Plant Heat Rate (HHV)	Btu/kWh	10,197	10,048
Gross Plant Heat Rate (HHV) Change	Btu/kWh	N/A	-136
Gross Plant Heat Rate (HHV) Improvement	%	N/A	1.5%
* See the explanation above regarding the choice of the boiler efficiency value.			

Table 3-3 Culley Unit 2 Steam Turbine Modeling Results – 80% of Guarantee Load

		ORIGINAL HEAT BALANCE	UPGRADE HP/LP
Boiler Efficiency (HHV)*	%	88.3	88.3
STG Gross Output	kW	76,239	76,239
Gross Turbine Heat Rate	Btu/kWh	8,977	8,856
Gross Turbine Heat Rate Change	Btu/kWh	N/A	-121
Turbine Heat Rate Improvement	%	N/A	1.4%
Boiler Heat Input (HHV)	MBtu/h	775.3	764.8
Boiler Heat Input (HHV) Change	MBtu/h	N/A	-10.5
Boiler Heat Input (HHV) Improvement	%	N/A	1.4%
Gross Plant Heat Rate (HHV)	Btu/kWh	10,169	10,032
Gross Plant Heat Rate (HHV) Change	Btu/kWh	N/A	-138
Gross Plant Heat Rate (HHV) Improvement	%	N/A	1.4%
* See the explanation above regarding the choice of the boiler efficiency value.			

Table 3-4 Culley Unit 2 Steam Turbine Modeling Results – 60% of Guarantee Load

		ORIGINAL HEAT BALANCE	UPGRADE HP/LP
Boiler Efficiency (HHV)*	%	88.3	88.3
Gross STG Gross Output	kW	56,672	56,672
Gross Turbine Heat Rate	Btu/kWh	9,133	9,020
Turbine Heat Rate Change	Btu/kWh	N/A	-113
Turbine Heat Rate Improvement	%	N/A	1.2%
Boiler Heat Input (HHV)	MBtu/h	586.3	579.0
Boiler Heat Input (HHV) Change	MBtu/h	N/A	-7.3
Boiler Heat Input (HHV) Improvement	%	N/A	1.2%
Gross Plant Heat Rate (HHV)	Btu/kWh	10,346	10,217
Gross Plant Heat Rate (HHV) Change	Btu/kWh	N/A	-129
Gross Plant Heat Rate (HHV) Improvement	%	N/A	1.2%
* See the explanation above regarding the choice of the boiler efficiency value.			

The estimate capital cost and HRI for the turbine upgrade option is as follows:

Full Steam Path Upgrade

Total Installed Capital Cost:	$10.4 million
Heat Rate (efficiency) Improvement:	1.3-1.5%

3.1.4 F.B. Culley Unit 3 Steam Turbine Blade Path Upgrades

The F.B. Culley Unit 3 steam turbine is a GE reheat steam turbine with a two-flow LP turbine and 26-inch last stage blade length for the LP end. Black & Veatch reviewed the steam turbine blade path upgrade. As a result of this investigation, heat balance cases were developed for the F.B. Culley Unit 3 steam turbine:[2]

- Base Case: Best match of the F.B. Culley Unit 3 thermal kit heat balance 534 HB 894 (guarantee).
- Upgrade Scenario: The entire HP/IP/LP steam path is upgraded.

This analysis is based on the incremental improvement in steam turbine efficiency, and the differential performance is more important than the absolute performance. The performance improvements and pricing estimates are based on in-house data and past project experience and are believed to be achievable. However, steam turbine manufacturers should be contacted to confirm performance and pricing.

3.1.4.1 Base Case

The Base Case model is matched to the thermal kit heat balance 534 HB 894, which is the guarantee case. The condenser pressure was set to 3.5 in. HgA to keep the basis consistent across the models for comparison against various upgrade options. This Base Case model was then used to run three cases: Guarantee load (rated pressure and rated flow, corresponding to thermal kit heat balance 534 HB 894); 80 percent of guarantee load (rated pressure and reduced flow, corresponding to thermal kit heat balance 170X450-21); and 60 percent of guarantee load (rated pressure and reduced flow, corresponding to thermal kit heat balance 170X450-22).

3.1.4.2 Upgrade Scenario: HP/IP/LP Steam Path Upgrades

In this model, the HP, IP, and LP sectional efficiencies were increased from approximately 86.7 percent, 88.2 percent, and 89.3 percent to approximately 90 percent, 90 percent, and 92 percent, respectively[3]. This model was then used to run three cases: Guarantee load; 80 percent of guarantee load; and 60 percent of guarantee load. In each of the cases, the boiler steam generation was reduced so that the steam turbine power output matched the values found in the corresponding cases in the original design (STG OEM thermal kit).

[2] Additional cases could be evaluated which look at the difference between current performance if the blades and turbine are newly overhauled, versus a new upgrade. Another possibility is developing a map of turbine performance over an expected life between major turbine outages and maintenance activities. Those require more detailed studies which mandate input from the STG OEM with a reference upgrade design, which is beyond the scope of this EPA-ACE analysis.

[3] Based upon OEM data.

Tables 3-5 through 3-7 show the results of the turbine modeling conducted by Black & Veatch for this study. For comparison purposes, it was assumed that a boiler efficiency of 88.3 percent (HHV basis) applies regardless of the magnitude and type of boiler upgrades that may be required.

Table 3-5 F.B. Culley Unit 3 Steam Turbine Modeling Results – Guarantee Load

		ORIGINAL HEAT BALANCE	UPGRADE HP/IP/LP
Boiler Efficiency (HHV)*	%	88.3	88.3
STG Gross Output	kW	288,360	288,367
Gross Turbine Heat Rate	Btu/kWh	8,219	8,085
Gross Turbine Heat Rate Change	Btu/kWh	N/A	-134
Turbine Heat Rate Improvement	%	N/A	1.6%
Boiler Heat Input (HHV)	MBtu/h	2,684.7	2,640.9
Boiler Heat Input (HHV) Change	MBtu/h	N/A	-43.8
Boiler Heat Input (HHV) Improvement	%	N/A	1.6%
Gross Plant Heat Rate (HHV)	Btu/kWh	9,310	9,158
Gross Plant Heat Rate (HHV) Change	Btu/kWh	N/A	-152
Gross Plant Heat Rate (HHV) Improvement	%	N/A	1.6%
*This boiler efficiency takes its basis from the F.B. Culley Unit 3 data snapshot, collected on May 27, 2019.			

Table 3-6 F.B. Culley Unit 3 Steam Turbine Modeling Results – 80% of Guarantee Load

		ORIGINAL HEAT BALANCE	UPGRADE HP/IP/LP
Boiler Efficiency (HHV)*	%	88.3	88.3
STG Gross Output	kW	236,806	236,817
Gross Turbine Heat Rate	Btu/kWh	8,254	8,129
Gross Turbine Heat Rate Change	Btu/kWh	N/A	-125
Turbine Heat Rate Improvement	%	N/A	1.5%
Boiler Heat Input (HHV)	MBtu/h	2,214.1	2,180.7
Boiler Heat Input (HHV) Change	MBtu/h	N/A	-33.4
Boiler Heat Input (HHV) Improvement	%	N/A	1.5%
Gross Plant Heat Rate (HHV)	Btu/kWh	9,350	9,208
Gross Plant Heat Rate (HHV) Change	Btu/kWh	N/A	-142
Gross Plant Heat Rate (HHV) Improvement	%	N/A	1.5%

*This boiler efficiency takes its basis from the F.B. Culley Unit 3 data snapshot, collected on May 27, 2019.

Table 3-7 F.B. Culley Unit 3 Steam Turbine Modeling Results – 60% of Guarantee Load

		ORIGINAL HEAT BALANCE	UPGRADE HP/IP/LP
Boiler Efficiency (HHV)*	%	88.3	88.3
STG Gross Output	kW	178,684	178,683
Gross Turbine Heat Rate	Btu/kWh	8,451	8,333
Gross Turbine Heat Rate Change	Btu/kWh	N/A	-118
Turbine Heat Rate Improvement	%	N/A	1.4%
Boiler Heat Input (HHV)	MBtu/h	1,710.6	1,686.7
Boiler Heat Input (HHV) Change	MBtu/h	N/A	-23.9
Boiler Heat Input (HHV) Improvement	%	N/A	1.4%
Gross Plant Heat Rate (HHV)	Btu/kWh	9,573	9,440
Gross Plant Heat Rate (HHV) Change	Btu/kWh	N/A	-134
Gross Plant Heat Rate (HHV) Improvement	%	N/A	1.4%

*This boiler efficiency takes its basis from the F.B. Culley Unit 3 data snapshot, collected on May 27, 2019.

The estimate capital cost and HRI for the turbine upgrade options is as follows:

Full Steam Path Upgrade

Total Installed capital cost: $19.9 million

Heat Rate (efficiency) improvement: 1.4-1.6%

3.2 UNIT ECONOMIZER REDESIGN OR UPGRADES

3.2.1 Economizer Upgrades Under EPA ACE

One of the primary BSER under the EPA ACE is the prospect of upgrades to, or even complete replacement of, the economizer. The overarching goal in economizer upgrades or replacement is to improve heat transfer from the flue gas to add heat to the boiler water/steam circuit and, thus, improve boiler efficiency. According to the performance estimates included in the EPA ACE proposal, redesign or replacement of the economizer should yield a heat rate improvement from 0.5 percent to 0.9 percent for units under 200 MW, and from 0.5 percent to 1.1 percent for units ranging from 200 MW to 500 MW. The EPA specifically states that economizer replacements are often avoided because of concerns over triggering New Source Review (NSR); for this reason, the EPA ACE is intended to provide power plants with the flexibility to make these changes.

However, there are many risks associated with redesign or replacement of the economizer:

- Most commonly, projects that consider increasing economizer tube surface area are ones which consider adding tube passes to either the upstream or the downstream portion of the economizer(s). This is because most economizers have a dense tube packing that disallows addition of tube assemblies across the furnace width. However, in the boiler backpass region, space constraints often limit the ability to add more than 2 or 3 tube passes. Thus, making significant changes to the economizer may not be possible at many units.
- Even the addition of a single pass of tubes requires an extended boiler outage; significant construction preparation and welding/tie-in work are required to add tubes to the economizer. The replacement power cost and lost opportunity/contract cost of this outage can be significant if it is not combined with a previously planned outage (such as, for steam turbine upgrades).
- Replacement of entire economizers is not generally done within the industry because of the large expense involved. When it has been undertaken in recent years, the most common reasons are either to replace a badly eroded economizer, or to replace an economizer with spiral-finned tubes with one with bare tubes to reduce tube fouling (especially after conversions to Powder River Basin coals).
- Changing tube surface area will often change the balance of heat transfer between the radiative and connective sections, as well as the main steam and reheat steam circuitry. This is especially true in the case of units that employ a split backpass design with gas biasing reheat control. Prediction of the complex interactions between the water, main steam, and reheat steam circuits in both the radiative and convective sections typically requires detailed boiler modeling.
- Adding tube surface to an economizer will reduce the flue gas temperature exiting the economizer, which could reduce operations flexibility if an SCR is positioned downstream of the economizer. Reduced flue gas temperatures will increase the minimum load possible with the SCR in service and could require a system such as an economizer gas bypass or in-duct burners to allow for SCR operation with these reduced temperatures. Both of these reparative measures will worsen the plant heat rate, thus negating the benefit of the upgraded economizer.
- Reduced flue gas temperatures entering the air heater will help improve the overall boiler efficiency but can also lead to operations problems should the cold-end average temperature be reduced below the recommended point for the type of fuel that is being burned and its sulfur content. In addition, ammonium bisulfate deposition can be increased in some cases where the flue gas inlet temperature at the air heaters is reduced from normal.
- In some cases, flue gas temperatures could be reduced to the point where other downstream air quality control equipment (such as an electrostatic precipitator or fabric filter baghouse) could be at risk for corrosion damage.

- While it is possible to add an economizer downstream of the SCR system to reduce the impact on the flue gas temperature entering the SCR, such installations are unusual and often require variable water bypass circuitry to maintain good temperature control.

Assessment of the ability of a unit to accommodate changes in the economizer tube surface area typically requires plant modeling of some sort, whether utilizing a combined first-principles and empirical model (such as the Electric Power Research Institute's [EPRI's] Vista program), or even a highly detailed (and expensive) computation fluid dynamics model of the entire boiler circuit and downstream affected equipment. The following section is a high-level overview of economizer upgrades, while the further sections provide more detail through the use of Vista modelling software.

Cost estimation for economizer upgrades is highly variable and depends on the amount of work conducted, the site spacing and access, other boiler or plant modifications that are required, etc. The EPA ACE rule advises in Table 2 that the cost to redesign or replace an economizer can be up to $3.74 million for a 200 MW unit or up to $6.35 million for a 500 MW unit.

3.2.2 A.B. Brown Units 1 and 2 Economizer Redesign or Upgrades

Plant personnel report that because of low SCR inlet temperatures, A.B. Brown Units 1 and 2 require natural gas duct burners to be operated to maintain temperatures over the minimum SCR inlet temperature of 625° F. An example of the gas duct burner operation as a function of gross output is shown for Unit 1 on Figure 3-1.

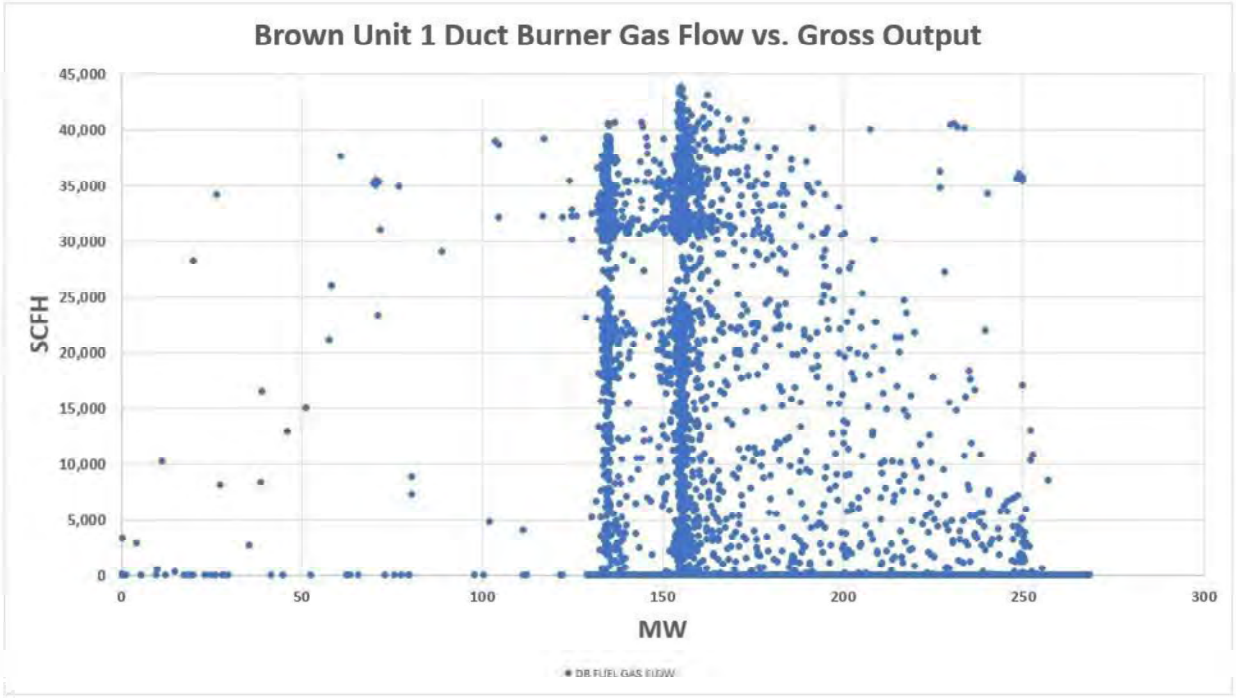

Figure 3-1 A.B. Brown Unit 1 Economizer Gas Flow vs. Gas Outlet

Plant personnel stated that the high gas use of the duct burners is a concern from a heat rate standpoint, although, unlike the case of F.B. Culley Unit 3, there was no estimate on the overall annual heat rate impact. Given this situation at A.B. Brown Units 1 and 2, adding economizer tube surface area is not recommended at this time. It is possible that reducing the economizer tube surface area could improve the plant heat rate by reducing the natural gas usage, and a next-phase study could easily determine this by employing coordinated plant modeling with a boiler-SCR-air heater model across the typical operating load ranges of the units.

3.2.3 F.B. Culley Unit 2 Economizer Redesign or Upgrades

F.B. Culley Unit 2 has maintained its original economizer design, and as it does not have an SCR system, it does not suffer from the constraint of reduced flue gas temperatures limiting operation. As a result, it is possible that economizer modifications could result in a significant heat rate benefit to the unit, especially as the F.B. Culley Unit 2 economizer gas outlet temperature appears to be high at higher loads (over 700° F at times). Refer to Figure 3-2.

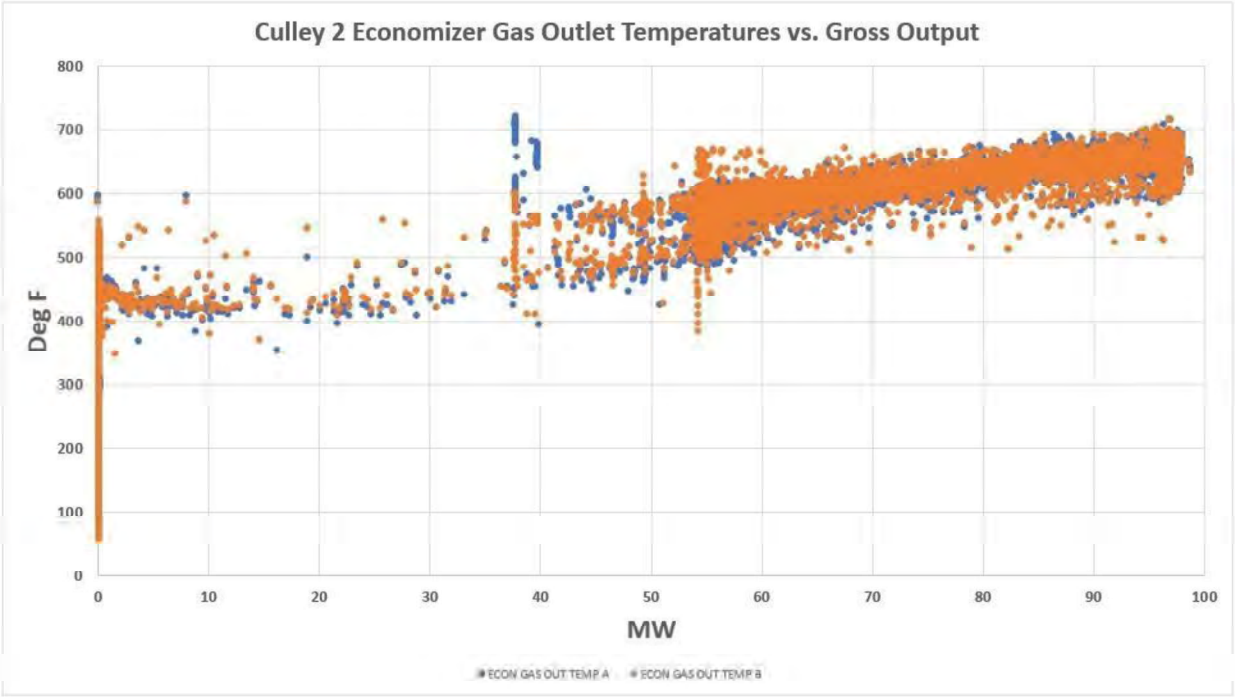

Figure 3-2 F.B. Culley Unit 2 Economizer Gas Outlet Temperature Versus Gross Output

The estimated costs and logistics of such a change to the economizers requires significant investigation as a next-phase effort. Assuming no header relocation is needed, and neglecting the loss of contract availability, such a cost is estimated at about $40,000 to 50,000 per British thermal unit per kilowatt-hour (Btu/kWh) for the improvement, or between $2 million to $4 million. For a small, non-reheat unit such as F.B. Culley Unit 2, such an investment may not be warranted at this juncture unless the unit was expected to operate for a significant length of time so that a sufficient payback period could be realized. When the expected future load factor and remaining plant life are taken into account, it is nearly impossible to justify an investment in this area of the plant.

3.2.4 F.B. Culley Unit 3 Economizer Redesign or Upgrades

According to plant personnel, the F.B. Culley Unit 3 economizer was replaced in 1994 with a tube configuration that had additional tube surface area relative to the original design. The goal of this upgrade was to reduce flue gas exit temperatures and improve cycle efficiency, and in that respect, it was successful. However, when the SCR system was added in 2003, the lower flue gas temperatures exiting the economizer resulted in the need for natural gas duct burners to maintain the minimum SCR flue gas inlet temperature of 625° F. The economizer was replaced again in 2008 but was not changed to the original design because of concerns about triggering NSR. Refer to Figure 3-3.

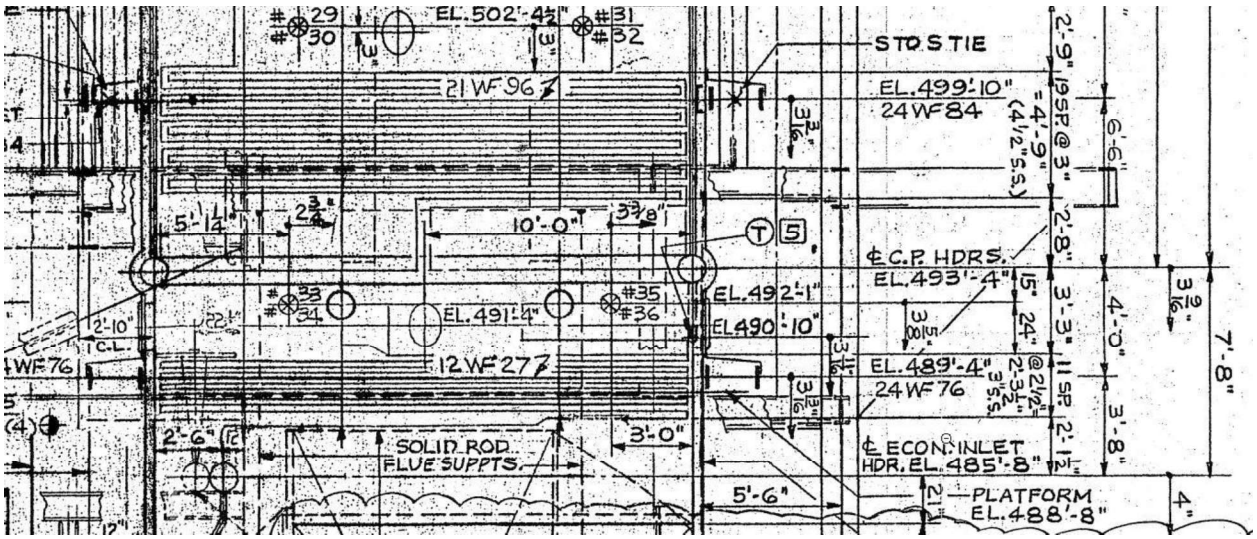

Figure 3-3 F.B. Culley Unit 3 Original Economizer Design

F.B. Culley Unit 3 is required to utilize significant amounts of natural gas via in-duct burners upstream of the SCR system to maintain SCR operating temperatures at anything less than 75 to 80 percent of full load. A plot of operational data, comparing the natural gas burner fuel flow rate versus the unit gross output, is shown by Figure 3-4.

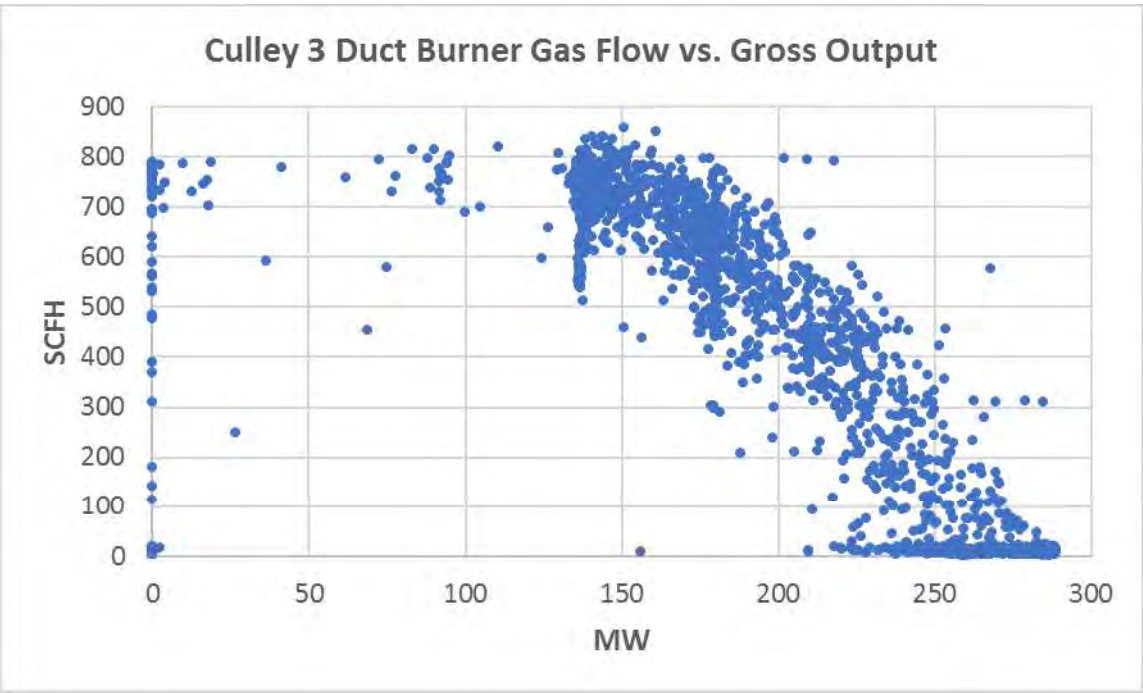

Figure 3-4 F.B. Culley Unit 3 Duct Burner Gas Flow Versus Gross Output

Given this situation at F.B. Culley Unit 3, adding economizer tube surface area is not recommended at this time. It is possible that reducing the economizer tube surface area could improve the plant heat rate by reducing the natural gas usage, and a next-phase study could easily determine this by employing coordinated plant modeling with a boiler-SCR-air heater model across the typical operating load ranges of the units. Plant personnel report that natural gas heat input to the duct burners comprised nearly 2 percent of the total heat input to the unit for 2018 and 2019 to date.

3.2.5 Economizer Analysis using Vista

Based on the analysis and discussion in the above sections, an analysis of the benefit of reducing natural gas flow to the duct burners by reducing the size of the economizer section was performed for A.B. Brown 1 and F.B. Culley 3. To assess the economizer, Black &Veatch created a base case and then investigated three options: removing 1, 2, and 3 tube passes.

Using data provided by Vectren engineering personnel, an EPRI Vista fuel quality impact model was created for A.B. Brown 1 and F.B. Culley 3. The Vista program contains a detailed linear heat transfer model that has the power to conduct "what if" analyses upon tube banks surface area configurations, and this model was utilized successfully for this study. Several simulations of tube

configurations that would decrease the heat transfer area of the economizer were analyzed, and these are detailed in this section. A schematic of the current economizer for A.B. Brown 1 is depicted below (F.B. Culley 3 is depicted in Figure 3-3):

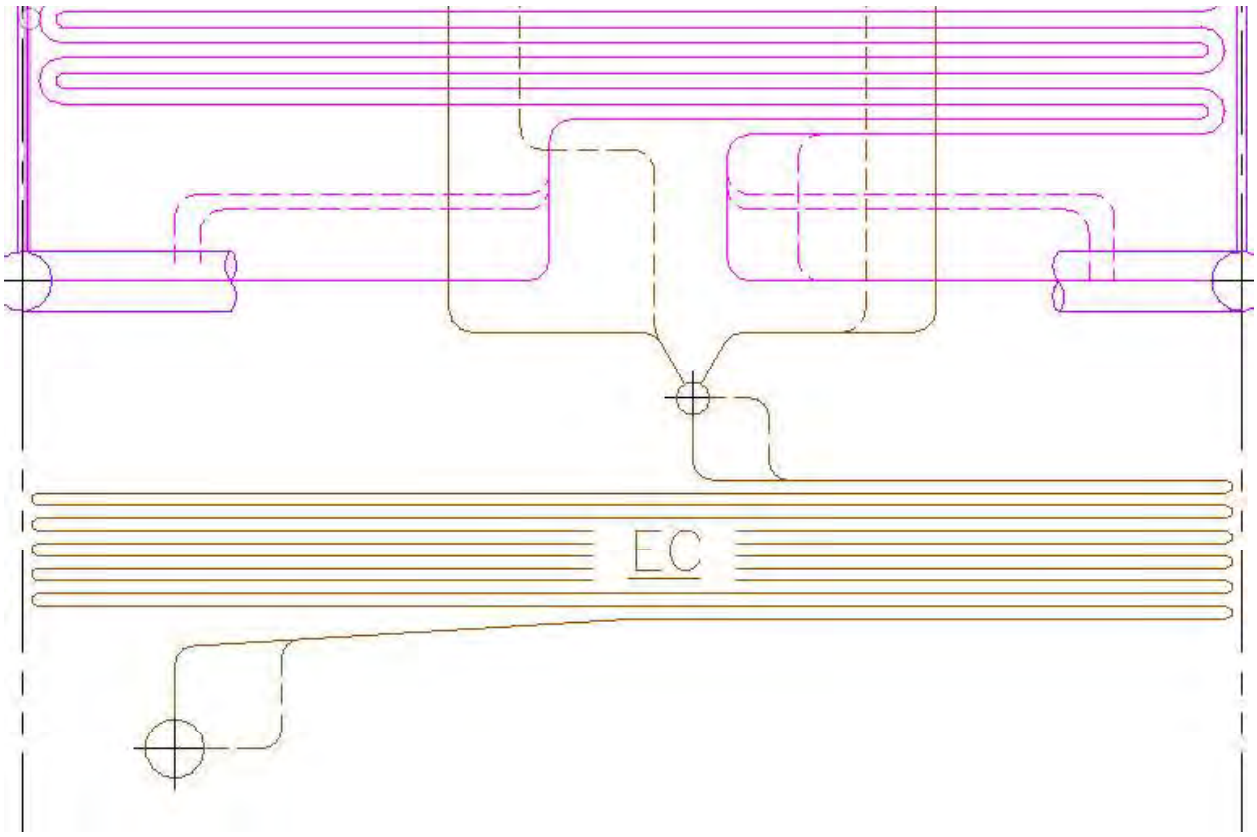

Figure 3-5 A.B. Brown 1 Economizer

3.2.5.1 A.B. Brown Units 1 and 2 Economizer Analysis Results

After calibrating the Vista model of A.B. Brown 1 to 264 MW gross from data collected on August 9, 2018, the following scenarios were run, with the following results.

- Baseline case – SCR inlet temperature = 651 °F.
- Removing 1 pass to the lower economizer – SCR inlet temperature = 662 °F.
- Removing 2 pass to the lower economizer – SCR inlet temperature = 675 °F.
- Removing 3 passes to the lower economizer – SCR inlet temperature = 690 °F.

The results above were from running the model at full load. The graph below shows the unit load vs. the duct burner natural gas flow.

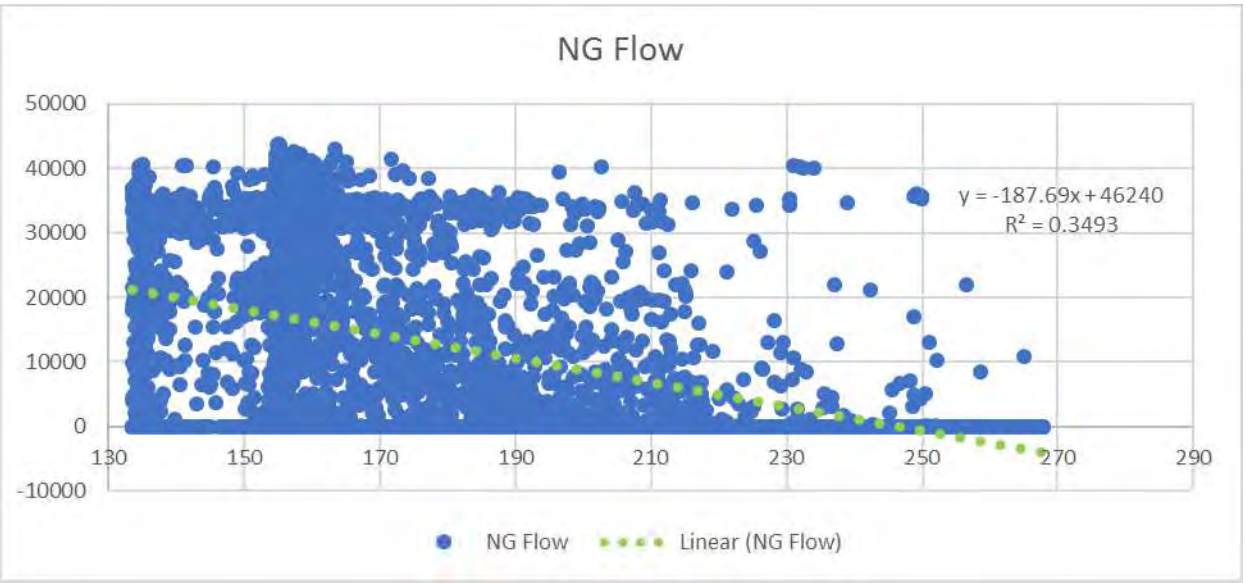

Figure 3-6 Load vs. Temperature and Flow

Linear regression was used to determine the natural gas flow; however, the correlation between natural gas flow and load was poor (R^2 of 0.35). This may warrant further investigation into the measurement or control methodology of the natural gas flow for the duct burners. Also, A.B. Brown 1 does not have an online measurement for the economizer flue gas outlet temperature. If this temperature was measured and tracked in the data historian, it would significantly improve the analysis of the data.

This reduction in economizer surface area comes at a cost in heat rate. From the analysis a reduction in the economizer surface area produces the following heat rate impacts on an overall basis:

- Baseline case – 0% difference.
- Removing 1 pass to the lower economizer – 0.17 % worsening.
- Removing 2 passes to the lower economizer – 0.36 % worsening.
- Removing 3 passes to the lower economizer – 0.61 % worsening.

This heat rate impact had the following effects on fuel burn rate at full load:

- Removing 1 pass to the lower economizer – 4.23 MMBtu/hr increase.
- Removing 2 passes to the lower economizer – 8.91 MMBtu/hr increase.
- Removing 3 passes to the lower economizer – 15.06 MMBtu/hr increase.

Should a change be made to the economizer tube surface area, the estimated costs and logistics of such a change to the economizers, assuming no header relocation is needed and neglecting the loss of contract availability, are expected to range from $750,000 to $1,400,000 depending upon the amount of modification. Complete replacement of the economizer was not estimated during this effort, nor was any addition to hot reheat surface or any other modifications.

3.2.5.2 F.B. Culley Unit 3 Economizer Analysis Results

After calibrating the Vista model of F.B. Culley 3 to 286 MW gross from data collected on May 27, 2019, the following scenarios were run, with the following results.

- Baseline case – SCR inlet temperature = 649 °F.
- Removing 1 pass to the lower economizer – SCR inlet temperature = 656 °F.
- Removing 2 pass to the lower economizer – SCR inlet temperature = 663 °F.
- Removing 3 passes to the lower economizer – SCR inlet temperature = 670 °F.

The results above were from running the model at full load. The graph below shows unit load vs. SCR inlet temperature, economizer gas outlet temperature, and duct burner natural gas flow. The delta-temperature below the minimum acceptable SCR inlet temperature of 625 °F was also plotted.

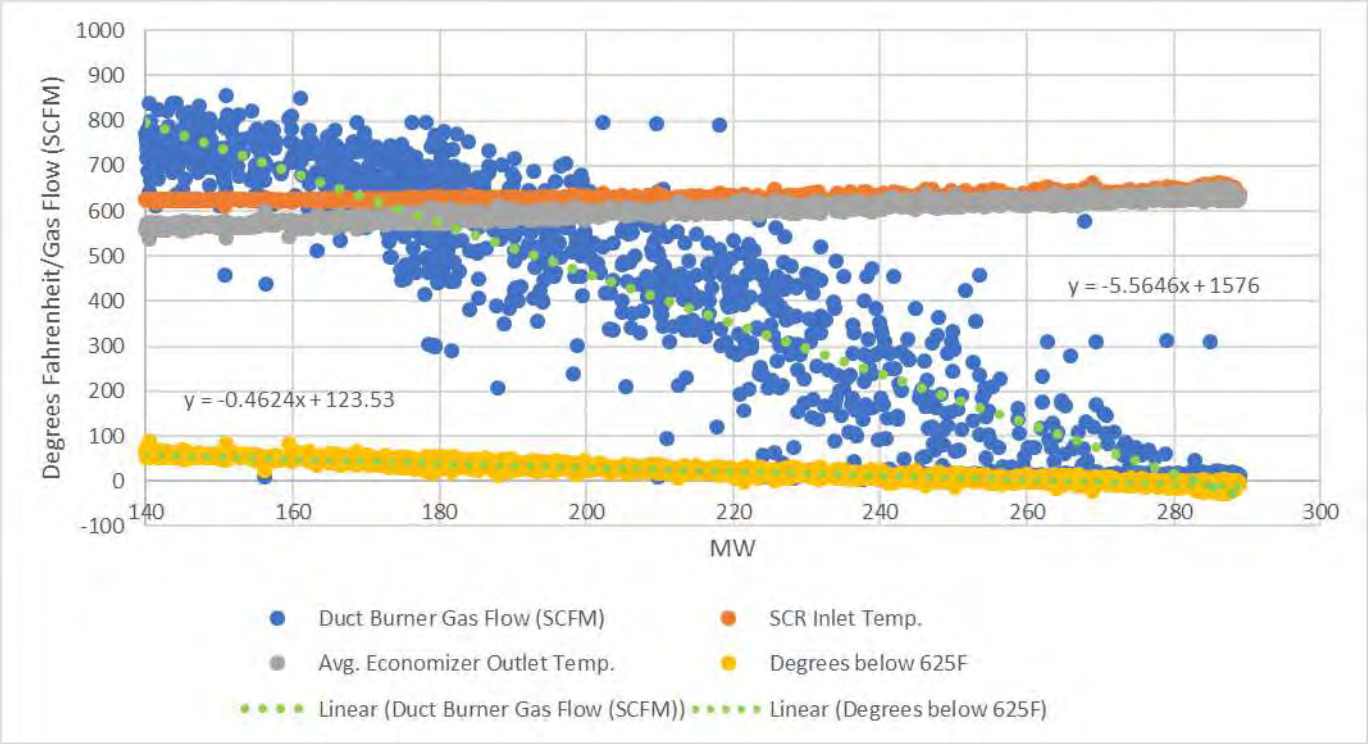

Figure 3-7 Load vs. Temperature and Flow

Using linear regression, the temperature difference calculated from Vista was used to determine new loads without using the duct burner and the gas flow savings for each economizer pass reduction"

- Removing 1 pass to the lower economizer – New load without duct burner use - 252MW, Gas Flow savings - 174 SCFM (10.6 MMBtu).

- Removing 2 passes to the lower economizer – New load without duct burner use- 237MW, Gas Flow savings - 257 SCFM (15.7 MMBtu).
- Removing 3 passes to the lower economizer – New load without duct burner use- 222MW, Gas Flow savings - 341 SCFM, (20.8 MMBtu).

This reduction does come at a cost in heat rate. From the analysis a reduction in the economizer surface area produces the following heat rate impacts on an overall basis:

- Baseline case – 0% difference.
- Removing 1 pass to the lower economizer - 0.14% worsening.
- Removing 2 passes to the lower economizer – 0.28% worsening.
- Removing 3 passes to the lower economizer – 0.43% worsening.

This heat rate impact had the following effects on fuel burn rate at full load:

- Removing 1 pass to the lower economizer – 3.22 MMBtu/hr increase.
- Removing 2 passes to the lower economizer – 6.6 MMBtu/hr increase.
- Removing 3 passes to the lower economizer – 10.16 MMBtu/hr increase.

From examining the results listed above, removing a portion of the economizer would results in an energy savings. Given the cost differential of $3.00 per MMBtu for natural gas compared to Vectren's $2.22 per MMBtu for coal, the savings in natural gas flow at full load would be approximately $5.76 per hour for the 1 pass case and $8.30 per hour for the 3-pass case. Assuming that savings would be realized over 70% of the year (8760 hours). This would result in $151k in savings for the first year for the base case and $244k in savings for the first year for the alternate case.

Should a change be made to the economizer tube surface area, the estimated costs and logistics of such a change to the economizers, assuming no header relocation is needed and neglecting the loss of contract availability are expected to range from $750,000 to $1,400,000 depending upon the amount of modification. Complete replacement of the economizer was not estimated during this effort, nor was any addition to hot reheat surface or any other modifications.

3.3 AIR HEATER AND LEAKAGE CONTROL UPGRADES

A core opportunity for net plant heat rate (NPHR) improvement is solidifying the operational reliability and process integrity of the combustion air draft system and flue gas draft system. The gas-to-air regenerative air heaters are a critical nexus between these two subsystems. Similarly, balanced draft units are susceptible to the effects of air in-leakage in the flue gas draft system because of the negative (internal) operating pressure of the flue gas ductwork. The following sections outline the NPHR improvement initiatives targeting the existing regenerative air heaters and mitigating the detrimental effects of flue gas draft system duct air in-leakage. The A.B.

Brown Unit 1, A.B. Brown Unit 2, F.B. Culley Unit 2, and F.B. Culley Unit 3 considerations are addressed in the following sections.

3.3.1 A.B. Brown Unit 1 Air Heater and Leakage Control Upgrades

The main NPHR benefit of air heater and flue gas ductwork leakage control repairs/upgrades is due to reducing the duty of the unit's combustion air and flue gas induced draft fans, thus reducing the unit's overall auxiliary load.

Excessive air heater and flue gas duct leakage presents additional issues beyond degradation in NPHR, however. Air in-leakage can also result in tempering of flue gas and causing corrosive flue gas acid gasses to condense on air heater cold end baskets and ductwork components. Reduction in air heater and flue gas duct leakage can improve overall equipment life, reduce capital investment for repair and reduce operation and maintenance (O&M) costs caused by flue gas acid gas corrosion. Additionally, the following are some other characteristics of air in-leakage that can negatively impact draft system and air quality control equipment performance:

- Higher velocities from additional mass flow, potentially reducing the life expectancy of pulse jet fabric filter (PJFF) bags.
- Higher pressure drops through combustion air and flue gas draft system equipment.
- Reduced air heater gas outlet temperatures (due to additional leak of cold combustion air mixing with hot flue gas out of air heater), causing flue gas to be closer to acid dew point and increasing the potential for equipment corrosion throughout the flue gas draft system.

The following subsections provide further discussion of air heater and leakage control upgrades. The discussions are based on Black & Veatch prior experience in heat rate assessments and implementation of HRI projects. The typical information and results provided for such projects can be used to assess and further screen the potential benefits. Future efforts would be required to assess the in-service condition of the air heaters and ductwork to determine the definitive benefits of potential improvement projects.

3.3.1.1 Air Heater

As previously noted, air heater leakage rates have the effect of increasing the duty of the combustion air fans and flue gas induced draft fans. Higher pressure combustion air passing through the air heater will leak past air heater seals to the flue gas side (on the cold-side of the air heater for the most part), reduce the temperature of the flue gas, and increase the mass and volumetric flow of the flue gas, which results in a higher flue gas-induced draft fan duty. The combustion air leakage within the air heater also increases the duty of the combustion air fans since additional combustion air needs to be supplied at the outlet of the combustion air fan to account for the combustion air lost across the air heater.

The two air heaters of A.B. Brown Unit 1 are regenerative Ljungström type air heaters with rotating baskets. Radial, axial, and circumferential seals provide sealing between the combustion air and flue gas paths across and around the air heater baskets as they rotate within the air heater

casing. Deterioration of seals from typical usage, corrosion, many large temperature swings such as unit trips, or damage of seals that are misaligned or out of adjustment will result in increased air heater leakage rates. The A.B. Brown Unit 1 air heaters are regularly inspected by the OEM, including an assessment of the air heater seals and replacement if required during all planned outages. Prior to the SCR installation, the original design air leakage for the A.B. Brown Unit 1 air heaters was approximately 7 percent to 8 percent. The installation of the SCR units has resulted in a corresponding increase of the full load air-to-gas side differential pressure by several inches of water column (when combustion air and flue gas pressures are compared). Additionally, the hot end sector plates have been replaced for A.B. Brown Unit 1, and the OEM recommendation is to replace the cold-end sectors plates. Air heater leakage is closely monitored for A.B. Brown Unit 1 because of the detrimental effect of oxygen on the dual alkali scrubbers within the air quality control system (AQCS).

According to feedback from Vectren operations personnel, positive contact seals have been attempted for the A.B. Brown Unit 1 air heaters in the past but were removed from service because of failures during operation. The air heaters now utilize the original seal types. More frequent in situ monitoring or installation of permanent probes measuring flue gas oxygen content at the induced draft (ID) fan inlet would allow for more accurate trending of the air in-leakage over time. This information would assist with planned outage maintenance and would provide ancillary benefits such as reducing ID fan power consumption and improved heat rate due to dry gas loss reduction.

In addition to improving air heater leakage, replacing worn air heater baskets with new ones can improve draft system losses and air heater effectiveness. The replacement of the existing air heater baskets with new ones that are more thermally efficient could be beneficial because the average flue gas temperature leaving the unit could be decreased with minimal, if any, impact to pressure drop. As a rule, for every 40° F decrease in air heater gas outlet temperature, a 1.0 percent increase in boiler efficiency can be expected. The reduction in leakage previously discussed is expected to increase the measured average air heater gas outlet temperature. This increase would not be expected to negatively impact boiler efficiency as the air heater no-leak gas outlet temperature would remain the same. Black & Veatch expects that air heater upgrades that could lower the no-leak temperature by 20° F are attainable without an in-depth analysis of the air preheat system and acid gas dew points. This would increase boiler efficiency by about 0.5 percent.

However, if additional efficiency gains are desired, additional analyses of the air preheat system and acid gas dew points with the air heater performance would be required to ensure the average gas temperature does not encroach upon the acid gas dew point at all loads. It is expected that the air heater gas outlet temperature could be lowered by another 10 to 15° F, improving boiler efficiency by another 0.25 percent. To achieve this, upgrades to the air preheat system and air-side and/or gas-side air heater bypasses would likely be required to maintain air heater gas outlet temperatures above the acid dew point at lower loads and during colder times of the year.

It should be noted that internal air heater condition should also be assessed to help in the decision-making process for upgrading or refurbishing air heater components to improve unit NPHR.

An additional area of opportunity for NPHR improvement related to the A.B. Brown Unit 1 air heaters is the potential reduction of the air heater cold-end setpoint temperature for A.B. Brown Unit 1.

According to unit operating data provided by Vectren, A.B. Brown Unit 1 maintains a consistent air heater cold-end temperature near 325 to 330° F (measured at the ID fan inlet for A.B. Brown Unit 1). This temperature target is considered above the recommended setpoint, given the potential acid gas dew point temperature, which is likely below 300° F. The gradual reduction of the air heater cold-end setpoint (e.g., reduction by 5 degrees every few months) would be a zero-cost (i.e., can be implemented via changes to setpoints within the existing control system) means of improving NPHR and not negatively impacting beneficial reuse of the fly ash. Changes to the condition of the draft system could be monitored during the regularly scheduled maintenance outages. While plant personnel report that generally speaking dew point temperatures have not been a problem at the unit, they nonetheless would be concerned about any significant reduction in air heater gas outlet temperature which takes the unit into an unfamiliar operating regime.

Air heater bypasses have been installed on the A.B. Brown Unit 1 draft system. This system provides a backup for the existing air preheating steam coil systems for cold-end temperature control for periods of extreme cold weather or a coil being taken out of service. Upgrades to the steam coil system would allow for fewer uses of the air heater (air-side) bypass during the year and fewer instances of the associated heat rate penalty during the intermittent use of the bypass.

3.3.1.2 Ductwork

The ductwork system can be divided between the combustion air and the boiler flue gas ductwork systems. Excessive leakages in either ductwork system will negatively impact the overall NPHR of the unit and long-term equipment health.

The combustion air ductwork system operates at a pressure greater than atmosphere and will experience combustion air leakages to atmosphere. Excessive combustion air duct leakages will increase the duty of the combustion air fans and result in an increase in the combustion air fan auxiliary load, thus negatively impacting the unit's NPHR.

The flue gas ductwork system will operate at a pressure slightly below atmosphere and will experience air in-leakage. For balanced draft units, the differential in flue gas ductwork internal pressure compared to ambient increases (i.e., becomes more negative) as the flue gas progresses from the furnace, through the draft system, and to the inlet of the ID fans. Excessive air in-leakage to the flue gas ductwork will increase the duty of the flue gas ID fans and result in an increase in the flue gas ID fan auxiliary load, thus negatively impacting the unit's NPHR.

Air in-leakage to the flue gas duct work will also have the result of tempering the flue gas. A reduction in flue gas temperature (overall or localized) below that of the dew point of acid gases of the flue gas will result in acid gasses condensing on ductwork components. Condensed acid gasses

will result in corrosion and degradation of ductwork components. Reducing air in-leakage of the ductwork system will also provide a capital and O&M expense benefit by improving equipment life and mitigating O&M issues resulting from ductwork corrosion.

The ductwork inspection activities and the air heater upgrades discussed in the previous section would be expected to be incorporated during the regularly scheduled O&M outages. The A.B. Brown Unit 1 forecast for scheduled maintenance outages is outlined in Table 3-8.

Table 3-8 A.B. Brown Unit 1 O&M Scheduled Outage Intervals (2020-2039)

YEAR	A.B. BROWN UNIT 1 O&M - SCHEDULED OUTAGE
2020	--
2021	3 weeks
2022	Major
2023	--
2024	3 weeks
2025	3 weeks
2026	--
2027	3 weeks
2028	3 weeks
2029	--
2030	3 weeks
2031	Major
2032	--
2033	3 weeks
2034	3 weeks
2035	--
2036	3 weeks
2037	3 weeks
2038	--
2039	3 weeks

To determine the overall cost associated with improving the ductwork leakage rates, field examinations and tests must be carried out to pinpoint ductwork leakage locations. Utilization of a smoke generator (or similar system) to locate and catalog the leaks would be required. Leakage

quantities should then be estimated for each leakage source to quantify an impact to fan duty and associated auxiliary load increase. The initial field examination should focus on high impact areas where the differential between the inside duct pressure and atmosphere is greater (i.e., areas closer to the discharge of the combustion air forced draft/primary air [FD/PA]) fans or areas closer to the inlet of the flue gas induced draft fans). In addition, the initial review should focus on expansion joints, expansion joint health, expansion joint sealing gaskets, duct door gaskets, duct gaskets, or potentially failing duct jointing seal welds.

Draft system leakage testing data for A.B. Brown Unit 1 were not available for review or incorporation into this analysis. Therefore, Black & Veatch has not assessed any NPHR impacts regarding reducing flue gas draft system leakage other than that discussed for the air heaters. The following activities can be implemented to improve the existing air heater units and find draft system leakage points. With the availability of additional data, the following estimates could be further refined, and the following heat rate benefits would likely increase.

Air Heater Basket, Seal, and Sector Plate Replacement

Total Installed Capital Cost:	$850,000
Heat Rate (efficiency) Improvement:	0.5% (assumes 20 °F air heater gas outlet temperature improvement)

Air Preheater (Steam Coil) System Repairs

Total Installed Capital Cost:	$350,000
Heat Rate (efficiency) Improvement:	0.1% (applicable to intermittent periods when steam coils would be used)

3.3.2 A.B. Brown Unit 2 Air Heater and Leakage Control Upgrades

The main NPHR benefit of air heater and flue gas ductwork leakage control repairs/upgrades results from reducing the duty of the unit's combustion air and flue gas induced draft fans, thus reducing the unit's overall auxiliary load demand.

Excessive air heater and flue gas duct leakage presents additional issues beyond degradation in NPHR, however. Air in-leakage can also result in tempering of flue gas and causing corrosive flue gas acid gasses to condense on air heater cold end baskets and ductwork components, resulting in degradation of equipment materials. Reduction in air heater and flue gas duct leakage can improve overall equipment life, reduce capital investment for repair, and reduce O&M costs caused by flue gas acid gas corrosion. Additionally, the following are some other characteristics of air in-leakage that can negatively impact draft system and air quality control equipment performance:

- Higher velocities from additional mass flow reducing the ability of an electrostatic precipitator to capture ash.
- Higher pressure drops through combustion air and flue gas draft system equipment.
- Reduced air heater gas outlet temperatures (due to additional leak of cold combustion air mixing with hot flue gas out of air heater), causing flue gas to be

closer to acid dew point increasing the potential for equipment corrosion throughout flue gas draft system.

The following subsections provide further discussion of air heater and leakage control upgrades. The discussions are based on Black & Veatch prior experience in heat rate assessments and implementation of heat rate improvement projects. The typical information and results provided for such projects can be used to assess and further screen the potential benefit. Future efforts would be required to assess the in-service condition of the air heaters and ductwork to determine the definitive benefits of potential improvement projects.

3.3.2.1 Air Heater

As previously noted, air heater leakage rates have the effect of increasing the duty of the combustion air fans and flue gas ID fans. Higher pressure combustion air passing through the air heater will leak past air heater seals to the flue gas side (on the cold-side of the air heater for the most part), reducing the temperature of the flue gas, and increasing the mass and volumetric flow of the flue gas, resulting in a higher flue gas ID fan duty. The combustion air leakage within the air heater also increases the duty of the combustion air fans since additional combustion air needs to be supplied at the outlet of the combustion air fan to account for the combustion air lost across the air heater.

The two air heaters of A.B. Brown Unit 2 are regenerative Ljungström type air heaters with rotating baskets. Radial, axial, and circumferential seals provide sealing between the combustion air and flue gas paths across and around the air heater baskets as they rotate within the air heater casing. Deterioration of seals from typical usage, corrosion, many large temperature swings such as unit trips, or damage of seals that are misaligned or out of adjustment will result in increased air heater leakage rates. The A.B. Brown Unit 2 air heaters are regularly inspected by the OEM, including an assessment of the air heater seals and replacement if required during all planned outages. Prior to the SCR installation, the original design air leakage for the A.B. Brown Unit 2 air heaters was approximately 7 to 8 percent. The installation of the SCR units has resulted in a corresponding increase of the full load air-to-gas side differential pressure by several inches of water column (when combustion air and flue gas pressures are compared). Additionally, the hot end sector plates have been replaced for A.B. Brown Unit 2, and the OEM recommendation is to replace the cold-end sectors plates. Air heater leakage is closely monitored for A.B. Brown Unit 2 because of the detrimental effect of oxygen on the dual alkali scrubbers within the AQCS.

According to feedback from Vectren operations personnel, positive contact seals have been attempted for the A.B. Brown Unit 2 air heaters in the past but were removed from service because of failures during operation. The air heaters now utilize the original seal types. More frequent in-situ monitoring or installation of permanent probes measuring flue gas oxygen content at the ID fan inlet would allow for more accurate trending of the air in-leakage trends over time. This information would assist with planned outage maintenance and would provide ancillary benefits such as reducing ID fan power consumption and improved heat rate due to dry gas loss reduction.

In addition to improving air heater leakage, replacing worn air heater baskets with new ones can improve draft system losses and air heater effectiveness. The replacement of the existing air heater baskets with new ones that are more thermally efficient could be beneficial because the average flue gas temperature leaving the unit could be decreased with minimal, if any, impact to pressure drop. As a rule, for every 40° F decrease in air heater gas outlet temperature, a 1.0 percent increase in boiler efficiency can be expected. The reduction in leakage previously discussed is expected to increase the measured average air heater gas outlet temperature. This increase would not be expected to negatively impact boiler efficiency as the air heater no-leak gas outlet temperature would remain the same. Black & Veatch expects that air heater upgrades that could lower the no-leak temperature by 20° F are attainable without an in-depth analysis of the air preheat system and acid gas dew points. This would increase boiler efficiency by about 0.5 percent.

However, if additional efficiency gains are desired, additional analyses of the air preheat system and acid gas dew points with the air heater performance would be required to ensure the average gas temperature does not encroach upon the acid gas dew point at all loads. It is expected that the air heater gas outlet temperature could be lowered by another 10 to 15° F, improving boiler efficiency by another 0.25 percent. Upgrades to the air preheat system and air-side and/or gas-side air heater bypasses are expected to be likely, however, to maintain air heater gas outlet temperatures above the acid dew point at lower loads and during colder times of the year.

It should be noted that internal air heater condition should also be assessed to help in the decision-making process for upgrading or refurbishing air heater components to improve unit NPHR.

An additional area of opportunity for NPHR improvement related to the A.B. Brown Unit 2 air heaters is the potential reduction of the air heater cold-end setpoint temperature for A.B. Brown Unit 2.

According to unit operating data provided by Vectren, A.B. Brown Unit 2 maintains a consistent air heater cold-end temperature near 325 to 330° F (measured at the ID fan inlet for A.B. Brown Unit 2). This temperature target is considered above the recommended setpoint, given the potential acid gas dew point temperature, which is likely below 300° F. The gradual reduction of the air heater cold-end setpoint (e.g., reduction by 5 degrees every few months) would be a zero-cost (i.e., can be implemented via changes to setpoints within the existing control system) means of improving NPHR and not negatively impacting beneficial reuse of the fly ash. Changes to the condition of the draft system could be monitored during the regularly scheduled maintenance outages.

Air heater bypasses have been installed on the A.B. Brown Unit 2 draft system. This system provides a backup for the existing air preheating steam coil systems for cold-end temperature control for periods of extreme cold weather or a coil being taken out of service. Upgrades to the steam coil system would allow for fewer uses of the air heater (air-side) bypass during the year and fewer instances of the associated heat rate penalty during the intermittent use of the bypass.

3.3.2.2 Ductwork

The ductwork system can be divided between the combustion air and the boiler flue gas ductwork systems. Excessive leakages in either ductwork system will negatively impact the overall NPHR of the unit and long-term equipment health.

The combustion air ductwork system operates at a pressure greater than atmosphere and will experience combustion air leakages to atmosphere. Excessive combustion air duct leakages will increase the duty of the combustion air fans and result in an increase in the combustion air fan auxiliary load, thus negatively impacting the unit's NPHR.

The flue gas ductwork system will operate at a pressure slightly below atmosphere and will experience air in-leakage. For balanced draft units, the differential in flue gas ductwork internal pressure compared to ambient increases (i.e., becomes more negative) as the flue gas progresses from the furnace, through the draft system and to the inlet of the ID fans. Excessive air in-leakage to the flue gas ductwork will increase the duty of the flue gas ID fans and result in an increase in the flue gas ID fan auxiliary load, thus negatively impacting the unit's NPHR.

Air in-leakage to the flue gas duct work will also have the result of tempering the flue gas. A reduction in flue gas temperature (overall or localized) below that of the dew point of acid gases of the flue gas will result in acid gasses condensing on ductwork components. Condensed acid gasses will result in corrosion and degradation of ductwork components. Reducing air in-leakage of the ductwork system will also provide a capital and O&M expense benefit by improving equipment life and mitigating O&M issues resulting from ductwork corrosion.

Ductwork inspection activities and the air heater upgrades discussed in the previous section would be expected to be incorporated during the regularly scheduled O&M outages. The A.B. Brown Unit 2 forecast for scheduled maintenance outages is outlined in Table 3-9.

Table 3-9 A.B. Brown Unit 2 O&M Scheduled Outage Intervals (2020-2039)

YEAR	A.B. BROWN UNIT 2 O&M - SCHEDULED OUTAGE
2020	3 weeks
2021	3 weeks
2022	--
2023	Major
2024	3 weeks
2025	--
2026	3 weeks
2027	3 weeks
2028	--
2029	3 weeks
2030	3 weeks
2031	--
2032	3 weeks
2033	Major
2034	--
2035	3 weeks
2036	Major
2037	--
2038	3 weeks
2039	Major

To determine the overall cost associated with improving the ductwork leakage rates field examinations and tests must be carried out to pinpoint ductwork leakage locations. Utilization of a smoke generator (or similar system) to locate and catalog the leaks would be required. Leakage quantities should then be estimated for each leakage source to quantify an impact to fan duty and associated auxiliary load increase. The initial field examination should focus on high impact areas where the differential between the inside duct pressure and atmosphere is greater (i.e., areas closer to the discharge of the combustion air fans or areas closer to the inlet of the flue gas ID fans). In addition, the initial review should focus on expansion joints, expansion joint health, expansion joint sealing gaskets, duct door gaskets, duct gaskets, or potentially failing duct jointing seal welds.

Draft system leakage testing data for A.B. Brown Unit 2 were not available for review/incorporation into this analysis. Therefore, Black & Veatch has not assessed any NPHR impacts regarding reducing flue gas draft system leakage other than that discussed for the air

heaters. The following activities can be implemented to improve the existing air heater units and find draft system leakage points. With the availability of additional data, the following estimates could be further refined, and the following heat rate benefits could likely increase.

Air Heater Basket, Seal, and Sector Plate Replacement

Total Installed Capital Cost:	$850,000
Heat Rate (efficiency) Improvement:	0.5% (assumes 20° F air heater gas outlet temperature improvement)

Air Preheater (Steam Coil) System Repairs

Total Installed Capital Cost:	$350,000
Heat Rate (efficiency) Improvement:	0.1% (applicable to intermittent periods when steam coils would be used)

3.3.3 F.B. Culley Unit 2 Air Heater and Leakage Control Upgrades

The main NPHR benefit of air heater and flue gas ductwork leakage control repairs/upgrades is a result of reducing the duty of the unit's combustion air and flue gas induced draft fans, thus reducing the unit's overall auxiliary load demand.

Excessive air heater and flue gas duct leakage presents additional issues beyond degradation in NPHR, however. Air in-leakage can also result in tempering of flue gas, causing corrosive flue gas acid gases to condense on air heater cold end baskets and ductwork components. Reduction in air heater and flue gas duct leakage can improve overall equipment life, reduce capital investment for repair, and reduce O&M costs caused by flue gas acid gas corrosion. Additionally, the following are some other characteristics of air in-leakage that can negatively impact draft system and air quality control equipment performance:

- Higher velocities from additional mass flow, potentially reducing the life expectancy of PJFF bags.
- Higher pressure drops through combustion air and flue gas draft system equipment.
- Reduced air heater gas outlet temperatures (due to additional leak by of cold combustion air mixing with hot flue gas out of air heater), causing flue gas to be closer to acid dew point and increasing the potential for equipment corrosion throughout flue the gas draft system.

The following subsections provide further discussion of air heater and leakage control upgrades. The discussions are based on Black & Veatch prior experience in heat rate assessments and implementation of heat rate improvement projects. The typical information and results provided for such projects can be used to assess and further screen the potential benefit. Future efforts would be required to assess the in-service condition of the air heaters and ductwork to determine the definitive benefits of potential improvement projects.

3.3.3.1 Air Heater

As previously noted, air heater leakage rates have the effect of increasing the duty of the combustion air fans and flue gas ID fans. Higher pressure combustion air passing through the air heater will leak past air heater seals to the flue gas side (on the cold-side of the air heater for the most part), reducing the temperature of the flue gas, and increasing the mass and volumetric flow of the flue gas, resulting in a higher flue gas ID fan duty. The combustion air leakage within the air heater also increases the duty of the combustion air fans since additional combustion air needs to be supplied at the outlet of the combustion air fan to account for the combustion air lost across the air heater.

The F.B. Culley Unit 2 air heater is a regenerative Ljungström type air heater with rotating baskets. Radial, axial, and circumferential seals provide sealing between the combustion air and flue gas paths across and around the air heater baskets as they rotate within the air heater casing. Deterioration of seals from typical usage, corrosion, many large temperature swings such as unit trips, or damage of seals that are misaligned or out of adjustment will result in increased air heater leakage rates. The F.B. Culley Unit 2 air heaters are regularly inspected by the OEM, including an assessment of the air heater seals and replacement if required during all planned outages. More frequent in situ monitoring or installation of permanent probes measuring flue gas oxygen content at the ID fan inlet would allow for more accurate trending of the air in-leakage over time. This information would assist with planned outage maintenance and would provide ancillary benefits such as reducing ID fan power consumption and improved heat rate from a dry gas loss reduction.

In addition to improving air heater leakage, replacing worn air heater baskets with new ones can improve draft system losses and air heater effectiveness. The replacement of the existing air heater baskets with new ones that are more thermally efficient could be beneficial because the average flue gas temperature leaving the unit could be decreased with minimal, if any, impact to pressure drop. As a rule, for every 40° F decrease in air heater gas outlet temperature, a 1.0 percent increase in boiler efficiency can be expected. The reduction in leakage previously discussed is expected to increase the measured average air heater gas outlet temperature. This increase would not be expected to negatively impact boiler efficiency because the air heater no-leak gas outlet temperature would remain the same. Black & Veatch expects that air heater upgrades that could lower the no-leak temperature by 20° F are attainable without an in-depth analysis of the air preheat system and acid gas dew points. This would increase boiler efficiency by about 0.5 percent.

However, if additional efficiency gains are desired, additional analyses of the air preheat system and acid gas dew points with the air heater performance would be required to ensure the average gas temperature does not encroach upon the acid gas dew point at all loads. It is expected that the air heater gas outlet temperature could be lowered by another 10 to 15° F, improving boiler efficiency by another 0.25 percent.

The F.B. Culley Unit 2 air preheater (steam coil) units are reportedly in good condition and operate reliably; because of this, there were no recommendations or perceived improvements to unit performance as a result of additional capital budget spending for the air preheater units.

It should be noted that an internal air heater conditional assessment should also be made to help in the decision-making process for upgrading or refurbishing air heater components to improve unit NPHR.

An additional area of opportunity for NPHR improvement related to the F.B. Culley Unit 2 air heaters is the potential reduction of the air heater cold-end setpoint temperature for F.B. Culley Unit 2.

According to unit operating data provided by Vectren, F.B. Culley Unit 2 maintains a consistent air heater cold-end temperature near 325 to 330°F (measured at the ID fan inlet for F.B. Culley Unit 2). This temperature target is considered above the recommended setpoint, given the potential acid gas dew point temperature, which is likely below 300° F. The gradual reduction of the air heater cold-end setpoint (e.g., reduction by 5 degrees every few months) would be a zero-cost (i.e., can be implemented via changes to setpoints within the existing control system) means of improving NPHR and not negatively impacting beneficial reuse of the fly ash. Changes to the condition of the draft system could be monitored during the regularly scheduled maintenance outages.

3.3.3.2 Ductwork

The ductwork system can be divided between the combustion air and the boiler flue gas ductwork systems. Excessive leakages in either ductwork system will negatively impact the overall NPHR of the unit and long-term equipment health.

The combustion air ductwork system operates at a pressure greater than atmosphere and will experience combustion air leakages to atmosphere. Excessive combustion air duct leakages will increase the duty of the combustion air fans and result in an increase in the combustion air fan auxiliary load, thus negatively impacting the unit's NPHR.

The flue gas ductwork system will operate at a pressure slightly below atmosphere and will experience air in-leakage. For balanced draft units, the differential in flue gas ductwork internal pressure compared to ambient increases (i.e., becomes more negative) as the flue gas progresses from the furnace, through the draft system, and to the inlet of the ID fans. Excessive air in-leakage to the flue gas ductwork will increase the duty of the flue gas ID fans and result in an increase in the flue gas induced draft fan auxiliary load, thus negatively impacting the units NPHR.

Air in-leakage to the flue gas duct work will also have the result of tempering the flue gas. A reduction in flue gas temperature (overall or localized) below that of the dew point of acid gases of the flue gas will result in acid gasses condensing on ductwork components. Condensed acid gasses will result in corrosion and degradation of ductwork components. Reducing air in-leakage of the ductwork system will also provide a capital and O&M expense benefit by improving equipment life and mitigating O&M issues resulting from ductwork corrosion.

Ductwork inspection activities and the air heater upgrades discussed in the previous section would be expected to be incorporated during the regularly scheduled O&M outages. The F.B. Culley Unit 2 forecast for scheduled maintenance outages is outlined in Table 3-10.

Table 3-10 F.B. Culley Unit 2 O&M Scheduled Outage Intervals (2020-2039)

YEAR	F.B. CULLEY UNIT 2 O&M - SCHEDULED OUTAGE
2020	3 weeks
2021	--
2022	3 weeks
2023	--
2024	Major
2025	--
2026	3 weeks
2027	--
2028	3 weeks
2029	--
2030	3 weeks
2031	--
2032	3 weeks
2033	--
2034	Major
2035	--
2036	3 weeks
2037	--
2038	3 weeks
2039	--

To determine the overall cost associated with improving the ductwork leakage rates field examinations and tests must be carried out to pinpoint ductwork leakage locations. Utilization of a smoke generator (or similar system) to locate and catalog the leaks would be required. Leakage quantities should then be estimated for each leakage source to quantify an impact to fan duty and associated auxiliary load increase. The initial field examination should focus on high impact areas where the differential between the inside duct pressure and atmosphere is greater (i.e., areas closer to the discharge of the combustion air fans or areas closer to the inlet of the flue gas ID fans). In addition, the initial review should focus on expansion joints, expansion joint health, expansion joint sealing gaskets, duct door gaskets, duct gaskets, or potentially failing duct jointing seal welds.

Draft system leakage testing data for F.B. Culley Unit 2 were not available for review or incorporation into this analysis. Therefore, Black & Veatch has not assessed any NPHR impacts regarding reducing flue gas draft system leakage other than that discussed for the air heaters. The following activities can be implemented to improve the existing air heater units and find draft system leakage points. With the availability of additional data, the following estimates could be further refined, and the following heat rate benefits would likely increase.

Air Heater Basket, Seal, and Sector Plate Replacement

Total Installed Capital Cost:	$476,000
Heat Rate (efficiency) Improvement:	0.5% (assumes 20° F air heater gas outlet temperature improvement)

3.3.4 F.B. Culley Unit 3 Air Heater and Leakage Control Upgrades

The main NPHR benefit of air heater and flue gas ductwork leakage control repairs/upgrades is as a result of reducing the duty of the unit's combustion air and flue gas induced draft fans thus reducing the units overall auxiliary load demand.

Excessive air heater and flue gas duct leakage presents additional issues beyond degradation in NPHR, however. Air in-leakage can also result in tempering of flue gas, causing corrosive flue gas acid gases to condense on air heater cold end baskets and ductwork components. Reduction in air heater and flue gas duct leakage can improve overall equipment life, reduce capital investment for repair, and reduce O&M costs caused by flue gas acid gas corrosion. Additionally, the following are some other characteristics of air in-leakage that can negatively impact draft system and air quality control equipment performance:

- Higher velocities from additional mass flow, potentially reducing the life expectancy of PJFF bags.
- Higher pressure drops through combustion air and flue gas draft system equipment.
- Reduced air heater gas outlet temperatures (due to additional leak-by of cold combustion air mixing with hot flue gas out of air heater), causing flue gas to be closer to acid dew point and increasing the potential for equipment corrosion throughout the flue gas draft system.

The following subsections provide further discussion of air heater and leakage control upgrades. The discussions are based on Black & Veatch prior experience in heat rate assessments and implementation of heat rate improvement projects. The typical information and results provided for such projects can be used to assess and further screen the potential benefit. Future efforts would be required to assess the in-service condition of the air heaters and ductwork to determine the definitive benefits of potential improvement projects.

3.3.4.1 Air Heater

As previously noted, air heater leakage rates have the effect of increasing the duty of the combustion air fans and flue gas ID fans. Higher pressure combustion air passing through the air

heater will leak past air heater seals to the flue gas side (on the cold-side of the air heater for the most part), reducing the temperature of the flue gas, and increasing the mass and volumetric flow of the flue gas, resulting in a higher flue gas ID fan duty. The combustion air leakage within the air heater also increases the duty of the combustion air fans since additional combustion air needs to be supplied at the outlet of the combustion air fan to account for the combustion air lost across the air heater.

The two air heaters of F.B. Culley Unit 3 are regenerative Ljungström type air heaters with rotating baskets. Radial, axial, and circumferential seals provide sealing between the combustion air and flue gas paths across and around the air heater baskets as they rotate within the air heater casing. Deterioration of seals from typical usage, corrosion, many large temperature swings such as unit trips, or damage of seals that are misaligned or out of adjustment will result in increased air heater leakage rates. The F.B. Culley Unit 3 air heaters are regularly inspected by the OEM, including an assessment of the air heater seals and replacement if required during all planned outages. Prior to the SCR installation, the original design air leakage for the F.B. Culley Unit 3 air heaters was approximately 7 to 8 percent. The installation of the SCR units has resulted in a corresponding increase of the full load air-to-gas side differential pressure by several inches of water column (when combustion air and flue gas pressures are compared).

Air in-leakage testing (measuring the oxygen content rise in discrete sections of the F.B. Culley Unit 3 draft system) was performed in 2017. This testing indicated a 16 to 17 percent leakage across each of the F.B. Culley Unit 3 air heaters (with the unit at full load). The leakage data across the PJFF and SCR units indicated no significant air infiltration. These data are outlined in Table 3-11 and Figure 3-8.

Table 3-11 F.B. Culley Unit 3 Draft System and Air Heater Air In-Leakage Test Data (July 2017)

TESTING LOCATION	DESCRIPTION	F.B. CULLEY UNIT 3 DRAFT SYSTEM – WEST SIDE	F.B. CULLEY UNIT 3 DRAFT SYSTEM – EAST SIDE
SCR Inlet	SCR inlet after duct burner; duct burner out of service at during full load test	4.0	3.5
SCR Outlet	SCR outlet/AH inlet duct section	4.0	3.7
AH Outlet	AH outlet/PJFF inlet duct section	6.4	6.3
FF Outlet	PJFF outlet/ID fan inlet(s) duct section	6.5	6.2
Calculated AH Leakage (%)	Calculated from "SCR Out" and "AH Out" data provided above	16.9	17.8

AH - air heater

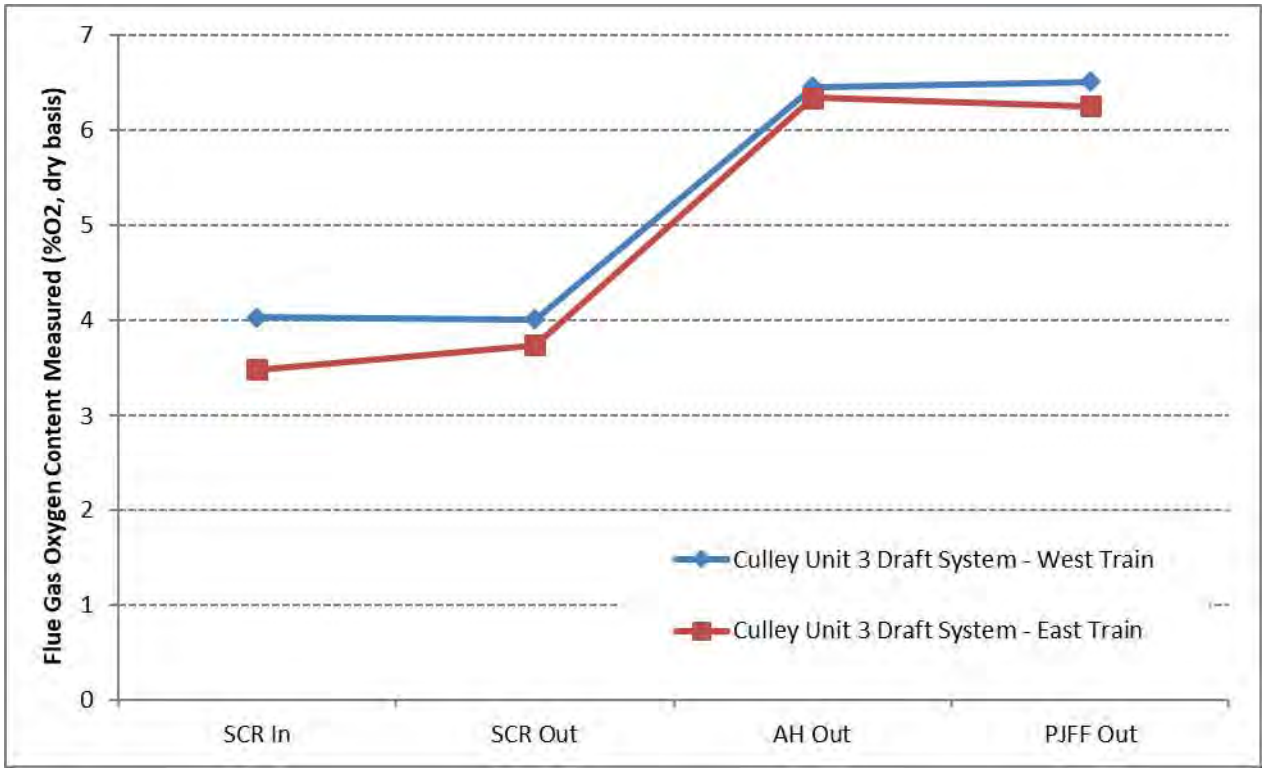

Figure 3-8 F.B. Culley Unit 3 Draft System Air Leakage Test Data (July 2017)

As a result of the air heater leakage test data, all sector plates and seals were replaced at the recommendation of the OEM during the recently completed 2019 planned outage for F.B. Culley Unit 3.

More frequent in situ monitoring or installation of permanent probes measuring flue gas oxygen content at the ID fan inlet would allow for more accurate trending of the air in-leakage over time. This information would assist with planned outage maintenance and would provide ancillary benefits such as reducing ID fan power consumption and improved heat rate due to dry gas loss reduction.

In addition to improving air heater leakage, replacing worn air heater baskets with new ones can improve draft system losses and air heater effectiveness. The replacement of the existing air heater baskets with new ones that are more thermally efficient could be beneficial because the average flue gas temperature leaving the unit could be decreased with minimal, if any, impact to pressure drop. As a rule, for every 40° F decrease in air heater gas outlet temperature, a 1.0 percent increase in boiler efficiency can be expected. The reduction in leakage previously discussed is expected to increase the measured average air heater gas outlet temperature. This increase would not be expected to negatively impact boiler efficiency as the air heater no-leak gas outlet temperature would remain the same. Black & Veatch expects that air heater upgrades that could lower the no-leak temperature by 20° F are attainable without an in-depth analysis of the air preheat system and acid gas dew points. This would increase boiler efficiency by about 0.5 percent.

However, if additional efficiency gains are desired, additional analyses of the air preheat system and acid gas dew points with the air heater performance would be required to ensure the average gas temperature does not encroach upon the acid gas dew point at all loads. It is expected that the air heater gas outlet temperature could be lowered by another 10 to 15° F, improving boiler efficiency by another 0.25 percent. The F.B. Culley Unit 3 air preheater (steam coils) are located in the FD fan room to maintain a minimum air inlet temperature setpoint, controlled by the FD fan outlet temperature. To achieve this, upgrades to the air preheat system and air-side and/or gas-side air heater bypasses would likely be required to maintain air heater gas outlet temperatures above the acid dew point at lower loads and during colder times of the year.

It should be noted that internal air heater condition should also be assessed to help in the decision-making process for upgrading or refurbishing air heater components to improve unit NPHR.

An additional area of opportunity for NPHR improvement related to the F.B. Culley Unit 3 air heaters is the potential reduction of the air heater cold-end setpoint temperature.

According to unit operating data provided by Vectren, F.B. Culley Unit 3 maintains a consistent air heater cold-end temperature near 325 to 330° F (measured at the ID fan inlet for F.B. Culley Unit 3). This temperature target is considered above the recommended setpoint, given the potential acid gas dew point temperature which is likely below 300° F. The gradual reduction of the air heater cold-end setpoint (e.g., reduction by 5 degrees every few months) would be a zero-cost (i.e., can be implemented via changes to set points within the existing control system) means of improving NPHR and not negatively impacting beneficial reuse of the fly ash. Changes to the condition of the draft system could be monitored during the regularly scheduled maintenance outages.

Air heater bypasses have been installed on the F.B. Culley Unit 3 draft system. This system provides a backup for the existing air preheating steam coil systems for cold-end temperature control for periods of extreme cold weather or a coil being taken out of service. Upgrades to the steam coil system would allow for fewer uses of the air heater (air-side) bypass during the year and fewer instances of the associated heat rate penalty during the intermittent use of the bypass.

In October 2018, Ljungström (F.B. Culley Unit 3 air heater OEM, a division of Arvos Group) provided information regarding a proposed air heater upgrade to improve heat rate as part of Vectren's ongoing heat rate improvement initiatives. According to a preliminary review of Ljungström's proposed air heater upgrade options, a 0.4 percent heat rate improvement was estimated. Black & Veatch recommends additional review of the proposed upgrades and potential balance-of-plant impacts (ID fan, ductwork, etc.). The basis of this improvement is relocating the DSI system upstream of the air heater, which would also need to be considered in the project costs.

3.3.4.2 Ductwork

The ductwork system can be divided between the combustion air and the boiler flue gas ductwork systems. Excessive leakages in either ductwork system will negatively impact the overall NPHR of the unit and long-term equipment health.

The combustion air ductwork system operates at a pressure greater than atmosphere and will experience combustion air leakages to atmosphere. Excessive combustion air duct leakages will increase the duty of the combustion air fans and result in an increase in the combustion air fan auxiliary load, thus negatively impacting the unit's NPHR.

The flue gas ductwork system will operate at a pressure slightly below atmosphere and will experience air in-leakage. For balanced draft units, the differential in flue gas ductwork internal pressure compared to ambient increases (i.e., becomes more negative) as the flue gas progresses from the furnace, through the draft system, and to the inlet of the ID fans. Excessive air in-leakage to the flue gas ductwork will increase the duty of the flue gas ID fans and result in an increase in the flue gas induced draft fan auxiliary load, thus negatively impacting the unit's NPHR.

Air in-leakage to the flue gas duct work will also have the result of tempering the flue gas. A reduction in flue gas temperature (overall or localized) below that of the dew point of acid gases of the flue gas will result in acid gasses condensing on ductwork components. Condensed acid gasses will result in corrosion and degradation of ductwork components. Reducing air in-leakage of the ductwork system will also provide a capital and O&M expense benefit by improving equipment life and mitigating O&M issues resulting from ductwork corrosion. Information provided to assess the flue gas duct work leakage is provided in Table 3-11 and Figure 3-8 above.

Ductwork inspection activities and the air heater upgrades discussed in the previous section would be expected to be incorporated during the regularly scheduled O&M outages. The F.B. Culley Unit 3 forecast for scheduled maintenance outages is outlined in Table 3-12.

Table 3-12 F.B. Culley Unit 3 O&M Scheduled Outage Intervals (2020-2039)

YEAR	F.B. CULLEY UNIT 3 O&M - SCHEDULED OUTAGE
2020	3 weeks
2021	--
2022	3 weeks
2023	3 weeks
2024	--
2025	3 weeks
2026	Major
2027	--
2028	3 weeks
2029	3 weeks
2030	--
2031	3 weeks
2032	3 weeks
2033	--
2034	3 weeks
2035	Major
2036	--
2037	3 weeks
2038	3 weeks
2039	--

To determine the overall cost associated with improving the ductwork leakage rates, field examinations and tests must be carried out to pinpoint ductwork leakage locations. Utilization of a smoke generator (or similar system) to locate and catalog the leaks would be required. Leakage quantities should then be estimated for each leakage source to quantify an impact to fan duty and associated auxiliary load increase. The initial field examination should focus on high impact areas where the differential between the inside duct pressure and atmosphere is greater (i.e., areas closer to the discharge of the combustion air fans or areas closer to the inlet of the flue gas ID fans). In addition, the initial review should focus on expansion joints, expansion joint health, expansion joint sealing gaskets, duct door gaskets, duct gaskets, or potentially failing duct jointing seal welds.

Because the age of the previous leakage testing data and the subsequent air heater maintenance performed by Vectren, Black & Veatch has not assessed any NPHR impacts regarding reducing flue gas draft system leakage other than that discussed for the air heaters. The following activities described in this section can be implemented to continue to find draft system leakage points. With the availability of additional data, the following estimates could be further refined, and the following heat rate benefits would likely increase.

Air Heater Basket, Seal, and Sector Plate Replacement

Total Installed Capital Cost:	$750,000
Heat Rate (efficiency) Improvement:	0.5% (assumes 20° F air heater gas outlet temperature improvement)

Air Preheater (Steam Coil) System Repairs

Total Installed Capital Cost:	$350,000
Heat Rate (efficiency) Improvement:	0.1% (applicable to intermittent periods when steam coils would be used)

3.4 UNIT VARIABLE FREQUENCY DRIVE UPGRADES

Variable-frequency drives (VFDs) function by controlling electric motor speed by converting incoming constant frequency power to variable frequency, using pulse width modulation. VFD upgrades for main plant electric motors provide many co-benefits, the largest one of which is improved part-load efficiency and performance. The benefit is greatest at low load. The more part load and unit cycling that is done, the greater the benefit.

In addition to the reduced auxiliary power consumption, other benefits that are gained from the installation of VFDs on rotating equipment are as follows:

- Reduced noise levels around the equipment.
- Lower in-rush current during startups.
- Decreased wear on existing auxiliary power equipment.

Disadvantages of the installation of VFDs include the high capital cost plus a minimal amount of increased electrical equipment maintenance associated with the VFD system.

Output power signal quality and reliability of VFD equipment has increased significantly in the last 10 to 15 years. Part of this increased reliability comes from the development of technology to allow the VFD equipment to remain in operation if one or multiple insulated-gate bipolar transistor (IGBT) power cells fail by automatically bypassing the bad cell, or cells, until an outage when repairs can be made. Additionally, output power signals meet Institute of Electrical and Electronics Engineers (IEEE) 519 1992 requirements, eliminating the need for harmonic filters.

VFD installation typically requires about 2 months of total pre-outage work, with a 1-week outage (per device) for the final tie-in. To support installation of the VFDs, the following changes are necessary:

- Replacement of existing rotating equipment coupling with resilient elastomeric block shaft couplings to accommodate the shaft misalignment and absorb the high torque loads during rapid load changes. This means the existing equipment must be de-coupled from the motor and then realigned with the new coupling.
- Upgrades to lube oil system as necessary.
- New VFD enclosure foundations.
- New VFD enclosures and heat exchangers.
- Replace the power supply cables from existing switchgear to the new VFD cabinet. Install new cables from the VFD cabinet to the motor.
- For smaller units, the VFD control enclosure and cabinets will also be smaller with reduced pre-outage time requirements.

A high-level assessment of the technical and economic feasibility of VFD modifications that have been seen as beneficial in previous ACE studies were considered as part of this study. With financial benefits confirmed by integrated resource plan (IRP) modeling, specific modifications can then be reviewed in a detailed effort to confirm the performance and financial benefits of VFD modifications.

3.4.1 A.B. Brown Unit 1 Variable Frequency Drive Upgrades

The A.B. Brown Unit 1 rotating equipment evaluated for the possible addition of VFD systems in this study include the boiler feed pumps, circulating water pumps, cooling tower fans, and the large draft fans for handling combustion air and flue gas.

After discussion with Vectren personnel, the best potential application for further VFD upgrades appears to be the ID fans.

3.4.1.1 Boiler Feed Pumps

The A.B. Brown Unit 1 boiler feed pump is a turbine driven feed pump that already provides high efficiency variable speed capability. The installation of a VFD system on the boiler feed pump will therefore not be evaluated further.

3.4.1.2 Circulating Water Pumps

The circulating water system includes two 50 percent capacity vertical turbine circulating water pumps driven by 1,750 horsepower motors. The impellers on the circulating water pumps were replaced with new impellers in 2008. According to the A.B. Brown Unit 1 operating data provided by Vectren, during the period of January 2017 through September of 2018, the unit was off-line at times and operated as high as 100 percent load. Excluding any hours when the unit was off-line or appeared to be ramping up to load, the operating data indicates that the unit operated between 40 percent load and 60 percent load for approximately 52 percent of the time, a significant

period where Unit 1 was operating at a relatively significant part load. The operating data also indicate that the unit operated between 60 percent load and 80 percent load for approximately 15 percent of the time and between 80 percent load and 100 percent load for approximately 33 percent of the time. The addition of VFDs on the circulating water pumps would allow variation in pump operating speed and circulating water flow over the operating load ranges experienced during normal operation of the unit. However, variations in pump speed and circulating water flow can have a significant impact on condenser pressure.

Past studies performed by Black & Veatch on similar coal fired plants have shown that condenser pressure has a higher impact on plant heat rate than changes in auxiliary power associated with the circulating water system (i.e., circulating water pumps and cooling tower fans). These studies have shown that, for the majority of time, it is more advantageous to operate the circulating water pumps and cooling tower fans at full capacity to maintain the lowest temperature circulating water to the condenser with the resulting lowest condenser pressure possible. This operating scenario typically provides a better plant heat rate than lowering the auxiliary power requirements with a resulting increase in condenser back pressure.

As an example, for every 0.1 in. Hg increase in condenser pressure for A.B. Brown Unit 1, the turbine generator output is expected to decrease by about 0.3 to 0.8 MW, according to past experience. Decreasing circulating water flow by 5 percent will decrease the circulating water pump auxiliary load by about 0.3 to 0.4 MW, and the condenser pressure is expected to increase by more than 0.2 in. Hg for the vast majority of operating scenarios and unit loads, especially during the warmer months, creating a significant loss in turbine generator output, more so than the gains that would be seen in modulating circulating water pump flow.

For reference, the impact on the circulating water pump power consumption at lower pump speeds and flow rates can be estimated utilizing the pump affinity laws. Table 3-13 summarizes the rated circulating water pump design conditions, as provided in the A.B. Brown Unit 1 documentation, and the reduced operating pump brake horsepower at a 1 percent and a 5 percent reduction in circulating water flow rate per pump. Estimations of pump speed have also been provided if these pumps were to be equipped with VFD systems.

Table 3-13 Predicted Circulating Water Pump Operating Conditions at Reduced Flows

	RATED OPERATING CONDITIONS	1% REDUCED FLOW OPERATING CONDITIONS	5% REDUCED FLOW OPERATING CONDITIONS
Flow, gpm	65,000	64,350	61,750
Total head, ft	84	82.3	75.8
Pump brake horsepower, hp	1,558	1,512	1,336
Pump speed, rpm	514	509	488

gpm – gallons per minute; ft – feet; hp – horsepower; rpm – revolutions per minute
Note: The above operating data is for one of two (2x50%) circulating water pumps.

This is not strictly true for systems with a high static head, and the savings could be somewhat less when the pump speed differences are fully accounted for. Detailed pump modeling should be conducted to improve the accuracy of these predictions as part of a next-phase effort.

The only scenarios that Black & Veatch has assessed where the installation of VFD systems on circulating water pumps has been beneficial is with once-through circulating water systems that use river or lake water that cools during winter months and there is no concern of freezing. Since the heat rejection system on A.B. Brown Unit 1 involves the use of a cooling tower, the installation of VFD systems on the circulating water pumps does not appear to be cost effective.

Lastly, the costs of adding VFDs to large motors is significant. The estimated costs for adding VFDs to the two Unit 1 circulating water pumps is $2,100,000.

3.4.1.3 Cooling Tower Fans

Cycle heat rejection is via a seven-cell mechanical draft cross-flow cooling tower with seven mechanical draft cooling tower fans. Each cooling tower fan is driven by a 200 hp motor equipped with a VFD system to control both de-icing and to control condenser backpressure. As the cooling tower fans are already equipped with VFDs, the fans will not be investigated further.

3.4.1.4 Large Draft Fans

According to available information and operating data, the A.B. Brown Unit 1 ID fan auxiliary power consumption benefit is estimated to be a total of 3.3 MW for both fans at full load and 4.1 MW for both fans at low load on the basis of the density of the inlet air to the fans of 0.0473 pounds per cubic foot (lbm/ft^3) at 322° F.

The estimated furnish and erect price for a VFD system for the A.B. Brown Unit 1 ID fans includes the VFD, VFD enclosure, enclosure foundations, fan coupling, new power cabling and any new raceway required, engineering, installation, and contingency. If there is limited available space immediately around the rotating equipment, the installation of VFD systems would not be affected because the VFD equipment can be placed virtually anywhere on the plant site and still provide adequate, clean power to the equipment.

The evaluated impacts of this project are as follows:

VFD Deployment for ID Fans

Total Installed Capital Cost:	$2,900,000 for both fans
Auxiliary Power Reduction:	Full load: 3.3 MW
	Low Load: 4.1 MW
Heat Rate (efficiency) improvement:	Full Load: 1.4%
	Low Load: 3.0%

Estimated Additional Annual O&M Cost: $2,000 per unit

The A.B. Brown Unit 1 FD fan auxiliary power consumption benefit is estimated to be a total of 0.85 MW for both fans at full load and 0.7 MW for both fans at low load on the basis of the density of the inlet air to the fans of 0.0726 pounds per cubic foot (lbm/ft^3) at 74° F.

The estimated furnish and erect price for a VFD system for the A.B. Brown Unit 1 FD fans includes VFD, VFD enclosure, enclosure foundations, fan coupling, new power cabling and any new raceway required, engineering, installation, and contingency. If there is limited available space immediately around the rotating equipment, the installation of VFD systems would not be affected because the VFD equipment can be placed virtually anywhere on the plant site and still provide adequate, clean power to the equipment.

The evaluated impacts of this project are as follows:

VFD Deployment for FD Fans

Total Installed Capital Cost:	$2,000,000 for both fans
Auxiliary Power Reduction:	Full load: 0.85 MW
	Part load: 0.7 MW
Heat Rate (efficiency) Improvement:	Full Load: 0.37%
	Low Load: 0.54%

Estimated Additional Annual O&M Cost: $2,000 per unit

3.4.2 A.B. Brown Unit 2 Variable Frequency Drive Upgrades

The A.B. Brown Unit 2 rotating equipment evaluated for the possible addition of VFD systems in this study include the boiler feed pumps, circulating water pumps, cooling tower fans, and the large draft fans for handling combustion air and flue gas.

After discussion with Vectren personnel, the best potential application for further VFD upgrades appears to be the ID fans.

3.4.2.1 Boiler Feed Pumps

The A.B. Brown Unit 2 boiler feed pump is a turbine driven feed pump that already provides high efficiency variable speed capability. The installation of a VFD system on the boiler feed pump will therefore not be evaluated further.

3.4.2.2 Circulating Water Pumps

The circulating water system includes two 50 percent capacity vertical turbine circulating water pumps driven by 1,750 hp motors. The impellers on the circulating water pumps were replaced with new impellers in 2008. According to A.B. Brown Unit 2 operating data provided by Vectren, during the period of January 2017 through September of 2018, the unit was off-line at times and operated as high as 100 percent load. Excluding any hours when the unit was off-line or appeared to be ramping up to load, the operating data indicate that the unit operated between 40 percent load and 60 percent load for approximately 44 percent of the time, a significant period where Unit 2 was operating at a relatively significant part load. The operating data also indicate that the unit operated between 60 percent load and 80 percent load for approximately 19 percent of the time and between 80 percent load and 100 percent load for approximately 37 percent of the time. The addition of VFDs on the circulating water pumps would allow variation in pump operating speed and circulating water flow over the operating load ranges experienced during normal operation of the unit. However, variations in pump speed and circulating water flow can have a significant impact on condenser back pressure.

Past studies performed by Black & Veatch on similar coal fired plants have shown that condenser pressure has a higher impact on plant heat rate than changes in auxiliary power associated with the circulating water system (i.e., circulating water pumps and cooling tower fans). These studies have shown that, for the majority of time, it is more advantageous to operate the circulating water pumps and cooling tower fans at full capacity to maintain the lowest temperature circulating water to the condenser with the resulting lowest condenser pressure possible. This operating scenario by and large provides a better plant heat rate than lowering the auxiliary power requirements with a resulting increase in condenser back pressure.

As an example, for every 0.1 in. Hg increase in condenser pressure for A.B. Brown Unit 2, the turbine generator output is expected to decrease by about 0.3 to 0.8 MW, according to past experience. Decreasing circulating water flow by 5 percent will decrease the circulating water pump auxiliary load by about 0.3 to 0.4 MW, and the condenser pressure is expected to increase by more than 0.2 in. Hg for the vast majority of operating scenarios and unit loads, especially during the warmer months, creating a significant loss in turbine generator output, more so than the gains that would be seen in modulating circulating water pump flow.

For reference, the impact on the circulating water pump power consumption at lower pump speeds and flow rates can be estimated utilizing the pump affinity laws. Table 3-14 summarizes the rated circulating water pump design conditions, as provided in the A.B. Brown Unit 2 documentation, and the reduced operating pump brake horsepower at a 1 percent and a 5 percent

reduction in circulating water flow rate per pump. Estimations of pump speed have also been provided if these pumps were to be equipped with VFD systems.

Table 3-14 Predicted Circulating Water Pump Operating Conditions at Reduced Flows

	RATED OPERATING CONDITIONS	1% REDUCED FLOW OPERATING CONDITIONS	5% REDUCED FLOW OPERATING CONDITIONS
Flow, gpm	65,000	64,350	61,750
Total head, ft	84	82.3	75.8
Pump brake horsepower, hp	1,558	1,512	1,336
Pump speed, rpm	514	509	488
Note: The above operating data is for one of two (2x50%) circulating water pumps.			

This is not strictly true for systems with a high static head, and the savings could be somewhat less when the pump speed differences are fully accounted for. Detailed pump modeling should be conducted to improve the accuracy of these predictions as part of a next-phase effort.

The only scenarios that Black & Veatch has assessed where the installation of VFD systems on circulating water pumps has been beneficial is with once-through circulating water systems that use river or lake water that cools during winter months and there is no concern of freezing. Since the heat rejection system on A.B. Brown Unit 2 involves the use of a cooling tower, the installation of VFD systems on the circulating water pumps does not appear to be cost effective.

Lastly, the costs of adding VFDs to large motors is significant. The estimated costs for adding VFDs to the two Unit 2 circulating water pumps is $2,100,000.

3.4.2.3 Cooling Tower Fans

Cycle heat rejection is via a seven-cell mechanical draft cross-flow cooling tower with seven mechanical draft cooling tower fans. Each cooling tower fan is driven by a 200 hp motor equipped with a VFD system. As the cooling tower fans are already equipped with VFDs, the fans will not be investigated further.

3.4.2.4 Large Draft Fans

According to available information and operating data, the A.B. Brown Unit 2 ID fan auxiliary power consumption benefit is estimated to be a total of 1.7 MW for both fans at full load and 2.3 MW on the basis of the density of the inlet air to the fans of 0.048 lbm/ft^3 at 321° F.

The evaluated impacts of this project are as follows:

VFD Deployment for ID Fans

Total Installed Capital Cost:	$2,900,000 for both fans
Auxiliary Power Reduction:	Full load: 1.7 MW
	Part Load: 2.3 MW
Heat Rate (efficiency) improvement	Full Load: 0.73%
	Low Load: 1.7%

Estimated Additional Annual O&M Cost: $2,000 per unit

The estimated furnish and erect price for a variable frequency drive system for the A.B. Brown Unit 2 ID fans includes VFD, VFD enclosure, enclosure foundations, fan coupling, new power cabling and any new raceway required, engineering, installation, and contingency. If there is limited available space immediately around the rotating equipment, the installation of VFD systems would not be affected because the VFD equipment can be placed virtually anywhere on the plant site and still provide adequate, clean power to the equipment.

The Brown Unit 2 FD fan auxiliary power consumption benefit is estimated to be a total of 0.3 MW for both fans at full load and 0.45 MW for both fans at low load on the basis of the density of the inlet air to the fans of 0.0726 pounds per cubic foot (lbm/ft^3) at 74° F.

The estimated furnish and erect price for a VFD system for the Brown Unit 2 FD fans includes VFD, VFD enclosure, enclosure foundations, fan coupling, new power cabling and any new raceway required, engineering, installation, and contingency. If there is limited available space immediately around the rotating equipment, the installation of VFD systems would not be affected because the VFD equipment can be placed virtually anywhere on the plant site and still provide adequate, clean power to the equipment.

The evaluated impacts of this project are as follows:

VFD Deployment for FD Fans

Total Installed Capital Cost:	$2,000,000 for both fans
Auxiliary Power Reduction:	Full load: 0.3 MW
	Part load: 0.45 MW
Heat Rate (efficiency) improvement	Full Load: 0.13%
	Low Load: 0.34%

Estimated Additional Annual O&M Cost: $2,000 per unit

3.4.3 F.B. Culley Unit 2 Variable Frequency Drive Upgrades

The F.B. Culley Unit 2 rotating equipment evaluated for the possible addition of VFD systems in this study include the boiler feed pumps, circulating water pumps, and the large draft fans for handling combustion air and flue gas.

After discussion with Vectren personnel, the best potential application for further VFD upgrades appears to be the circulating water pumps.

3.4.3.1 Boiler Feed Pumps

F.B. Culley Unit 2 includes one 100 percent capacity motor driven boiler feed pumps. The pump is driven by a 2,500 hp single-speed electric motor, which indicates that this system is amenable to a VFD deployment. The boiler feed pump has a design capacity of 1,980 gpm. Feedwater flow at full load is 1,550 gpm and 960 gpm at low load.

Table 3-15 Boiler Feed Water Pump Operating Conditions

	RATED OPERATING CONDITIONS	FULL LOAD	LOW LOAD	FULL LOAD WITH VFD	LOW LOAD WITH VFD
Flow, gpm	1,980	1,550	960	1,550	960
Total head, ft	3,980	4,375	4,550	3,700	3,307
Pump brake horsepower, hp	2,388	2,146	1,690	1,771	1,133
Pump speed, rpm	3,750	3,750	3,750	3,310	3,050

The evaluated impacts of this project are as follows:

VFD Deployment for Boiler Feed Pump

Total Installed Capital Cost: $600,000

Auxiliary Power Reduction: Full load: 0.3 MW
Part load: 0.4 MW

Heat Rate (efficiency) improvement 0.6%

Estimated Additional Annual O&M Cost: $2,000 per unit

3.4.3.2 Circulating Water Pumps

Unit cooling is provided via a once-through circulating water system utilizing river water as the cooling water supply. Circulating water pump installation is two 50 percent capacity vertical turbine wet pit circulating water pumps. The pumps are driven by 450 hp motors. The circulating water pumps take suction directly from the Ohio River. According to F.B. Culley Unit 2 operating data provided by Vectren, during the period of January 2017 through January of 2019, the unit was

off-line at times and operated as high as 100 percent load. Excluding any hours when the unit was off-line or appeared to be ramping up to load, the operating data indicate that the unit operated between 40 percent load and 60 percent load for approximately 45 percent of the time, a significant period where Unit 2 was operating at a relatively significant part load. The operating data also indicate that the unit operated between 60 percent load and 80 percent load for approximately 23 percent of the time and between 80 percent load and 100 percent load for approximately 32 percent of the time. The addition of VFDs on the circulating water pumps would allow variation in pump operating speed and circulating water flow over the operating load ranges experienced during normal operation of the unit. However, variations in pump speed and circulating water flow can have a significant impact on condenser back pressure.

Past studies performed by Black & Veatch on similar coal fired plants have shown that condenser back pressure has a higher impact on plant heat rate than changes in auxiliary power associated with the circulating water system (i.e., circulating water pumps and cooling tower fans). However, Black & Veatch has assessed some coal fired plants where the installation of VFD systems on circulating water pumps has been beneficial when unit cooling was provided by once-through circulating water systems using river or lake water. The impact is particularly beneficial during winter months when the water supply is cold and there is no concern of freezing.

For reference, the impact on the circulating water pump power consumption at lower pump speeds and flow rates can be estimated utilizing the pump affinity laws. Table 3-16 summarizes the rated circulating water pump design conditions, as provided in the F.B. Culley Unit 2 documentation, and the reduced operating pump brake horsepower at a 1 percent and a 5 percent reduction in circulating water flow rate per pump. Estimations of pump speed have also been provided if these pumps were to be equipped with VFD systems.

Table 3-16 Predicted Circulating Water Pump Operating Conditions at Reduced Flows

	RATED OPERATING CONDITIONS	1% REDUCED FLOW OPERATING CONDITIONS	5% REDUCED FLOW OPERATING CONDITIONS
Flow, gpm	34,920	33,947	32,576
Total head, ft	43.7	42.8	39.4
Pump brake horsepower, hp	443	430	380
Pump speed, rpm	505	500	480
Note: The above operating data is for one of two (2x50%) circulating water pumps.			

This is not strictly true for systems with a high static head, and the savings could be somewhat less when the pump speed differences are fully accounted for. Detailed pump modeling should be conducted to improve the accuracy of these predictions as part of a next-phase effort.

Variations in pump speed and circulating water flow can have a significant impact on condenser pressure, particularly when the reduced speed and corresponding decrease in flow

result in an increased circulating water temperature to the unit. As an example, for every 0.1 in. Hg increase in condenser pressure for F.B. Culley Unit 2, the turbine generator output is expected to decrease by about 0.1 to 0.5 MW, according to past experience. Decreasing circulating water flow by 5 percent will decrease the circulating water pump auxiliary load by about 0.09 to 0.1 MW, and the condenser pressure is expected to increase by more than 0.2 in. Hg for the vast majority of operating scenarios and unit loads, especially during the warmer months, creating a significant loss in turbine generator output, more so than the gains that would be seen in modulating circulating water pump flow.

However, when unit cooling is provided by once-through circulating water systems using river water, such as the F.B. Culley Unit 2, the water supply can be provided with little day-to-day variation in temperature. This is particularly beneficial during the winter months when the water supply is very cold and any reduction in circulating water pump speed, with the corresponding decrease in flow, can have little effect on the condenser pressure.

Evaluating the impact to condenser pressure and auxiliary load by the addition of VFDs to circulating water pumps on units with once-through cooling is an involved assessment. It is necessary to determine a temperature profile of the river water over at least one annual operating period since the cooling water temperature directly impacts condenser back pressure. Additionally, the circulating water flow rate impacts heat transfer, which also directly impacts condenser back pressure. The assessment basically requires creating condenser back pressure curves as a function of the two different variables but must also consider the river water temperature profile as a function of time. The assessment would then identify the auxiliary power savings on the basis of the operating profile of the VFD speed controlled circulating water pumps. Still another concern is that low water flow velocities can cause silting and drop-out of suspended particles in piping.

The costs of adding VFDs to large motors is significant, but in the case of once-through cooling water systems, the investment can prove beneficial. The estimated costs for adding VFDs to the two Unit 2 circulating water pumps is $900,000.

3.4.3.3 Large Draft Fans

Vectren personnel informed Black & Veatch that F.B. Culley Unit 2 has already installed VFDs on the ID fans, which are typically the motors that can gain the most HRI benefit.

The Culley Unit 2 FD fan auxiliary power consumption benefit is estimated to be a total of 0.3 MW for both fans at full load and 0.3 MW for both fans at low load on the basis of the density of the inlet air to the fans of 0.0727 pounds per cubic foot (lbm/ft^3) at 74° F.

The estimated furnish and erect price for a VFD system for the Culley Unit 2 FD fans includes VFD, VFD enclosure, enclosure foundations, fan coupling, new power cabling and any new raceway required, engineering, installation, and contingency. If there is limited available space immediately around the rotating equipment, the installation of VFD systems would not be affected because the VFD equipment can be placed virtually anywhere on the plant site and still provide adequate, clean power to the equipment.

The evaluated impacts of this project are as follows:

VFD Deployment for FD Fans

Total Installed Capital Cost:	$2,000,000 for both fans
Auxiliary Power Reduction:	Full load: 0.3 MW
	Low load: 0.3 MW
Heat Rate (efficiency) improvement:	Full Load: 0.34%
	Low Load: 0.57%

Estimated Additional Annual O&M Cost: $2,000 per unit

3.4.4 F.B. Culley Unit 3 Variable Frequency Drive Upgrades

The F.B. Culley Unit 3 rotating equipment evaluated for the possible addition of VFD systems in this study include the boiler feed pumps, circulating water pumps, and the large draft fans for handling combustion air and flue gas.

After discussion with Vectren personnel, the best potential application for further VFD upgrades appears to be the circulating water pumps.

3.4.4.1 Boiler Feed Pumps

The F.B. Culley Unit 3 boiler feed pump is a turbine driven feed pump that already provides high efficiency variable speed capability. The installation of a VFD system on the boiler feed pump will therefore not be evaluated further.

3.4.4.2 Circulating Water Pumps

Unit cooling is provided via a once-through circulating water system utilizing river water as the cooling water supply. The circulating water system includes two 50 percent capacity vertical turbine circulating water pumps driven by electric motors. The circulating water pumps take suction directly from the Ohio River. According to F.B. Culley Unit 3 operating data provided by Vectren, during the period of January 2017 through June of 2018, the unit was off-line at times and operated as high as 100 percent load. Excluding any hours when the unit was off-line or appeared to be ramping up to load, the operating data indicate that the unit operated between 60 percent load and 80 percent load for approximately 14 percent of the time and between 80 percent load and 100 percent load for approximately 60 percent of the time. The operating data also indicate that the unit operated at less than 60 percent load for approximately 26 percent of the time. The addition of VFDs on the circulating water pumps would allow variation in pump operating speed and circulating water flow over the operating load ranges experienced during normal operation of the unit. However, variations in pump speed and circulating water flow can have a significant impact on condenser back pressure.

Past studies performed by Black & Veatch on similar coal fired plants have shown that condenser back pressure has a higher impact on plant heat rate than changes in auxiliary power associated with the circulating water system (i.e., circulating water pumps and cooling tower fans). However, Black & Veatch has assessed some coal fired plants where the installation of VFD systems

on circulating water pumps has been beneficial when unit cooling was provided by once-through circulating water systems using river or lake water. The impact is particularly beneficial during winter months when the water supply is cold and there is no concern of freezing.

For reference, the impact on the circulating water pump power consumption at lower pump speeds and flow rates can be estimated utilizing the pump affinity laws. Table 3-17 summarizes the rated circulating water pump design conditions, as provided in the Culley Unit 3 documentation, and the reduced operating pump brake horsepower at a 1 percent and a 5 percent reduction in circulating water flow rate per pump. Estimations of pump speed have also been provided if these pumps were to be equipped with VFD systems.

Table 3-17 Predicted Circulating Water Pump Operating Conditions at Reduced Flows

	RATED OPERATING CONDITIONS	1% REDUCED FLOW OPERATING CONDITIONS	5% REDUCED FLOW OPERATING CONDITIONS
Flow, gpm	69,000	68,310	65,550
Total head, ft	57	55.9	51.4
Pump brake horsepower, hp	1170	1135	1,003
Pump speed, rpm	300	297	285

Note: The above operating data is for one of two (2x50%) circulating water pumps.

Variations in pump speed and circulating water flow can have a significant impact on condenser pressure, particularly when the reduced speed and corresponding decrease in flow result in an increased circulating water temperature to the unit. As an example, for every 0.1 in. Hg increase in condenser pressure for F.B. Culley Unit 3, the turbine generator output is expected to decrease by about 0.4 to 0.9 MW, according to past experience. Decreasing circulating water flow by 5 percent will decrease the circulating water pump auxiliary load by about 0.25 MW, and the condenser pressure is expected to increase by more than 0.2 in Hg for the vast majority of operating scenarios and unit loads, especially during the warmer months. This creates a significant loss in turbine generator output, more so than the gains that would be seen in modulating circulating water pump flow.

However, when unit cooling is provided by once-through circulating water systems using river water, such as the F.B. Culley Unit 3, the water supply can be provided with little day-to-day variation in temperature. This is particularly beneficial during the winter months when the water supply is very cold and any reduction in circulating water pump speed, with the corresponding decrease in flow, can have little effect on the condenser pressure.

Evaluating the impact to condenser pressure and auxiliary load by the addition of VFDs to circulating water pumps on units with once-through cooling is an involved assessment. It is necessary to determine a temperature profile of the river water over at least one annual operating period since the cooling water temperature directly impacts condenser back pressure. Additionally,

the circulating water flow rate impacts heat transfer, which also directly impacts condenser back pressure. The assessment basically requires creating condenser back pressure curves as a function of the two different variables but must also consider the river water temperature profile as a function time. The assessment would then identify the auxiliary power savings on the basis of the operating profile of the VFD speed controlled circulating water pumps. Moreover, plant personnel have expressed concerns about silting problems due to low water velocity, which is already a known issue at the plant, where, extended periods of operation at low flows have led to silting in the condenser tubes and associated corrosion.

The costs of adding VFDs to large motors is significant, but in the case of once-through cooling water systems, the investment can prove beneficial. The estimated costs for adding VFDs to the two Unit 3 circulating water pumps is $2,100,000.

3.4.4.3 Large Draft Fans

Vectren personnel informed Black & Veatch that F.B. Culley Unit 3 has already installed VFDs on the ID fans, which are typically the motors that can gain the most HRI benefit at a coal fired power plant.

The only other large rotating equipment identified for this F.B. Culley Unit 3 study that has the potential for significant HRI benefits from a VFD retrofit are the FD fans. The F.B. Culley Unit 3 FD fan auxiliary power consumption benefit is estimated to be a total of 0.6 MW for both fans at full load and 0.9 MW for both fans at low load on the basis of the density of the inlet air to the fans of 0.0727 pounds per cubic foot (lbm/ft^3) at 74° F.

The estimated furnish and erect price for a VFD system for the Culley Unit 3 FD fans includes VFD, VFD enclosure, enclosure foundations, fan coupling, new power cabling and any new raceway required, engineering, installation, and contingency. If there is limited available space immediately around the rotating equipment, the installation of VFD systems would not be affected because the VFD equipment can be placed virtually anywhere on the plant site and still provide adequate, clean power to the equipment.

The evaluated impacts of this project are as follows:

VFD Deployment for FD Fans

Total Installed Capital Cost:	$2,000,000 for both fans
Auxiliary Power Reduction:	Full load: 0.6 MW
	Low load: 0.9 MW
Heat Rate (efficiency) improvement:	Full load: 0.23%
	Low Load: 0.69%

Estimated Additional Annual O&M Cost: $2,000 per unit

3.5 BOILER FEED PUMP UPGRADES, REBUILDING, OR REPLACEMENT

The purpose of this project would be to reduce the energy consumed by the boiler feed pumps by exploring whether upgrades or repairs to the pump internal components, or replacement

in kind with a new boiler feed pump would be warranted. As steam-driven boiler feed pumps are inherently much more efficient than any electric-driven boiler feed pumps, no analysis of a conversion to VFD use will be assessed on A.B. Brown Units 1 and 2, or Culley Unit 3.

3.5.1 A.B. Brown Unit 1 Boiler Feed Pumps

A.B. Brown 1 has one Pacific, 5 stage, Type BFIDS, Size 12" RHBK pump. The pump has a rated capacity of 4,400 gpm at 5,470 feet of head, 5,400 rpm, for 367 °F water. With the current data available, there is no indication that any significant improvement could be made to the overall unit heat rate by upgrading this pump. Discussions with one boiler feed pump retrofit vendor indicated that at best a 1-1.5% drive turbine efficiency could be realized, which would only translate to a very small efficiency improvement on a unit basis.

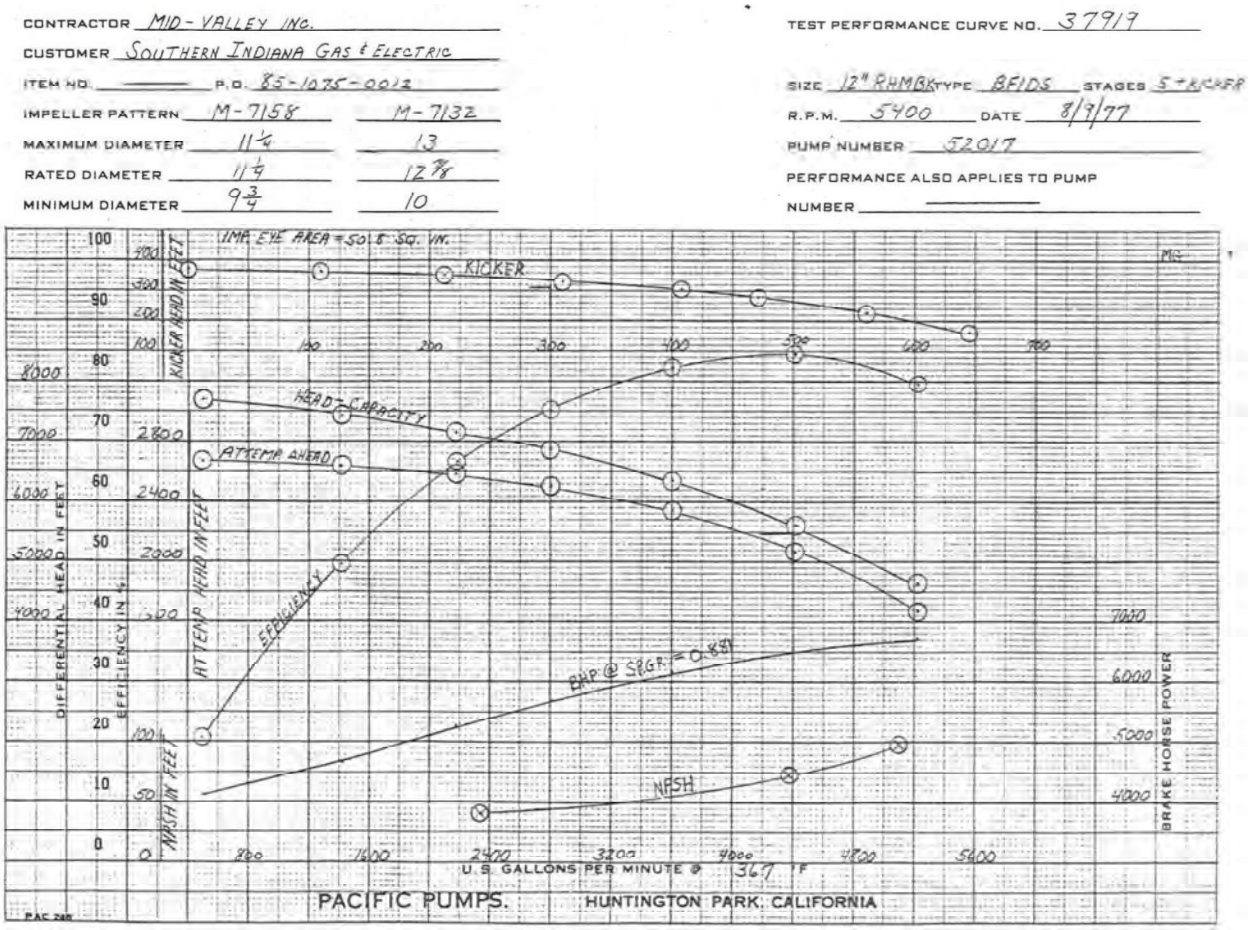

Figure 3-9 Brown 1, Brown 2, and Culley 3 Boiler Feed Pump Performance Curve

3.5.2 A.B. Brown Unit 2 Boiler Feed Pumps

A.B. Brown 2 has one Pacific, 5 stage, Type BFIDS, Size 12" RHBK pump. The pump has a rated capacity of 4,400 gpm at 5,470 feet of head, 5,400 rpm, for 367 °F water. As in the case of Unit 1, with the current data available, there is no indication that any significant improvement could be

made to the overall unit heat rate by upgrading this pump. Discussions with one boiler feed pump retrofit vendor indicated that at best a 1-1.5% drive turbine efficiency could be realized, which would only translate to a very small efficiency improvement on a unit basis.

3.5.3 F.B. Culley Unit 2 Boiler Feed Pumps

F.B. Culley 2 has one Byron Jackson, double volute, 7 stage multiplex, Type DVMX, Size 6x8x11B pump. The pump has a rated capacity of 1,980 gpm at 3,980 feet of head, 3,750 rpm, and 220 °F water. The full load operating data set Black & Veatch was provided has the BFP operating with a discharge flow rate of 1,550 gpm and a total developed head of 3,980 ft. The pump curve shows that the pump should have a TDH of 4,380 ft. The actual developed head of the BFP is 9.2% less than that of the design curve. The pump no longer lies on the initial operating curve which suggest that degradation has occurred. Please see the section on VFD deployment for further information on upgrades that are possible for F.B. Culley Unit 2's boiler feed pump.

3.5.4 F.B. Culley Unit 3 Boiler Feed Pumps

F.B. Culley 3 has one Pacific, 5 stage, Type BFIDS, Size 12" RHBK pump. The pump has a rated capacity of 4,400 gpm at 5,470 feet of head, 5,400 rpm, for 367 °F water. With the current data available, there is no indication that any significant improvement could be made to the overall unit heat rate by upgrading this pump. Discussions with one boiler feed pump retrofit vendor indicated that at best a 1-1.5% drive turbine efficiency could be realized, which would only translate to a very small efficiency improvement on a unit basis.

3.6 UNIT NEURAL NETWORK DEPLOYMENT

The purpose of this project would be to tune the system to allow for the reduction of boiler outlet oxygen concentration without increasing NO_X or carbon monoxide (CO) emissions. Adaptive neural net systems have the greatest effect when controlling air flow and fuel mixtures down to a fine level. The full benefits are realized only if the plant has adequate feedback signals to allow the neural net to sense changes made to the available controls. For instance, individual fuel and air controls at each burner provide tremendous levers for a neural net system; however, the effect of the levers is reduced if the neural net does not receive feedback about the air/fuel mixture through a grid of CO measurements.

3.6.1 A.B. Brown Unit 1 Neural Network Deployment

The unit has the ability to bias individual mills as well as compartmented windboxes. Each burner row has an independent windbox with a damper for air control on each end, but there is only manual secondary air adjustment at each individual burner. CO measurement is located at the outlet of the reheat section, but this requires regular maintenance for reliable operation.

Reducing excess oxygen levels in the boiler increases the boiler efficiency by reducing sensible heat losses, although in some cases, unburned carbon losses can be increased (but almost never more than the sensible heat losses are reduced). In addition, reducing excess oxygen levels