Large Filing Separator Sheet

CASE NUMBER: 09-1089-EL-POR
09-1090-EL-POR

FILE DATE: 11/12/09

SECTION: PART 3 OF 3

NUMBER OF PAGES: 17

DESCRIPTION OF DOCUMENT:

SEPARATELY BOUND EXHIBIT JFW-2 (VOLUMES 1-3) OF JON F. WILLIAMS (TESTIMONY) ON BEHALF OF COLS. SOUTHERN POWER CO. & OHIO POWER CO.

Table 33. Residential Multi-Family Measure Characteristics (net at meter savings) (Continued)

Baseline Description	DSM Measure Description	Effective Useful Life	Energy Savings - kWh			Demand Savings - kWh			Incremental Costs	
			Gas Heating	Electric Heating	Heat Pump Heating	Gas Heating	Electric Heating	Heat Pump Heating	New/ROB	Retrofit
Appliances										
Standard Refrigerator	Refrigerator - Energy Star	11	98	60	77	0.0118	0.0073	0.0093	$122.23	$1,414.99
Standard Freezer	Freezer Energy Star	11	67	41	53	0.0081	0.0050	0.0064	$35.00	$637.03
2 units in use	1 unit in use	5	1165	716	917	0.1405	0.0864	0.1106	$0.00	$0.00
1 unit in use	0 unit in use	4	1042	641	820	0.1257	0.0773	0.0989	$0.00	$0.00
Standard Pool Pump	Variable Speed Drive Pool Pumps	10	1941	1941	1941	0.0006	0.0006	0.0006	$434.41	$707.73
Hot Water										
Standard Efficiency WH Tank	High Efficiency Water Heating Tank	13	251	251	251	0.0276	0.0276	0.0276	$48.68	$508.69
2.5gpm	1gpm	10	171	171	171	0.0188	0.0188	0.0188	$14.86	$43.68
normal aerator (4gpm)	low flow aerator (1.5gpm)	10	81	81	81	0.0090	0.0090	0.0090	$2.78	$12.34
Standard Clothes Washer	Clothes Washer - Tier 1	11	444	432	437	0.0615	0.0599	0.0606	$363.73	$824.57
Electric Dryer	Gas Dryer	11	501	308	394	0.0761	0.0468	0.0599	$226.96	$657.53
Standard Dishwasher	Dishwasher - Energy Star	11	86	63	73	0.0000	0.0000	0.0000	$284.54	$615.85
No heat recovery	DWHR with GFX 60	20	498	498	498	0.0547	0.0547	0.0547	$742.00	$726.86
Standard Clothes Washer	Clothes Washer - Tier 2	11	519	505	511	0.0720	0.0700	0.0709	$492.16	$952.99
Standard Clothes Washer	Clothes Washer - Tier 3	11	594	577	585	0.0824	0.0800	0.0810	$620.58	$1,081.42
No Insulation	R-13 Blanket	7	332	332	332	0.0365	0.0365	0.0365	$77.14	$70.53
No Insulation	R-2.5 Pipe Wrap	12	133	133	133	0.0147	0.0147	0.0147	$5.28	$4.72
Other										
No Sensor	Occupancy Sensor - Plug Loads	8	88	54	69	0.0106	0.0065	0.0083	$85.00	$85.00
Shell and HVAC										
Standard Room A/C	Room A/C - Energy Star	9	46	46	46	0.0550	0.0550	0.0550	$30.00	$300.00
Central A/C - SEER 13	Central A/C - SEER 14 w/TXV	15	29	29	107	0.0435	0.0435	0.0435	$119.21	$1,149.95
13 SEER Air Source Heat Pump	Geothermal Heat Pump - Energy Star	15	N/A	N/A	N/A	N/A	N/A	N/A	$3,755.99	$4,903.37
U-0.65 SHGC 0.62	U-0.35 SHGC 0.55	20	1	5	4	0.0011	0.0011	0.0008	$2.89	$18.97
R-19	R-38	20	0	0	0	0.0000	0.0000	0.0000	$0.82	$1.56
R-4	R-11 added to walls	20	0	1	1	0.0001	0.0001	0.0001	$0.83	$0.78
0.8 ACH	0.5 ACH	11	69	474	377	0.0833	0.0833	0.0833	$115.00	$115.00
0.8 ACH	0.35 ACH	11	109	714	572	0.1667	0.1667	0.0833	$230.00	$230.00
no maintenance	refrigerant charge and air flow corrected	10	97	439	326	0.0578	0.0578	0.0578	$52.56	$50.19
no maintenance	Ducts sealed	18	158	713	529	0.2850	0.1330	0.1330	$497.62	$469.16
78 AFUE Gas Furnace w/13 SEER A/C	14 SEER ASHP	15	-490	N/A	N/A	0.4348	N/A	N/A	$217.49	$1,352.15
Electric Furnace w/13 SEER A/C	14 SEER ASHP	15	N/A	1514	N/A	N/A	0.4348	N/A	$217.49	$1,352.15
13 SEER HP	14 SEER ASHP	15	N/A	N/A	107	N/A	N/A	0.0435	$137.00	$1,352.15
Energy Star Homes										
Single Family New Construction	Lighting and Shell Measures		N/A	N/A	N/A	N/A	N/A	N/A	$1,316.69	N/A
Single Family New Construction	Lighting, Shell and HVAC Measures		N/A	N/A	N/A	N/A	N/A	N/A	$1,727.69	N/A

Table 34. Mobile Home Measure Characteristics (net at meter savings)

Baseline Description	DSM Measure Description	Effective Useful Life	Energy Savings - kWh			Demand Savings - kWh			Incremental Costs	
			Gas Heating	Electric Heating	Heat Pump Heating	Gas Heating	Electric Heating	Heat Pump Heating	New/ROB	Retrofit
Lighting									Material Only	Labor
40W incandescent	13 Watt Screw-in CFL <=800 lumens	6	24	13	19	0.0038	0.0012	0.0024	$1.94	$2.56
60W incandescent	13 Watt Screw-in CFL > 800 lumens	6	41	23	33	0.0067	0.0021	0.0042	$1.90	$2.56
75W Incandescent	20 Watt Screw-in CFL	6	48	27	38	0.0078	0.0024	0.0049	$1.99	$2.65
100W Incandescent	30 Watt Screw-in CFL	6	61	34	49	0.0099	0.0031	0.0062	$3.35	$4.01
120W Incandescent	40 Watt Screw-in CFL	6	70	39	55	0.0114	0.0035	0.0071	$5.84	$8.24
40W incandescent	13 Watt Pin Based CFL <=800 lumens	6	24	13	19	0.0038	0.0012	0.0024	$12.31	$45.26
60W incandescent	13 Watt Pin Based CFL >800 lumens	6	41	23	33	0.0067	0.0021	0.0042	$11.35	$45.26
75W Incandescent	20 Watt Pin Based CFL	6	48	27	38	0.0078	0.0024	0.0049	$13.61	$48.96
100W Incandescent	30 Watt Pin Based CFL	6	61	34	49	0.0099	0.0031	0.0062	$16.74	$55.43
120W Incandescent	40 Watt Pin Based CFL	6	70	39	55	0.0114	0.0035	0.0071	$27.62	$68.71
200W Incandescent	55 Watt Pin Based CFL	6	127	71	101	0.0206	0.0063	0.0129	$32.22	$75.98
250W Incandescent	65 Watt Pin Based CFL	6	118	66	94	0.0192	0.0059	0.0120	$36.16	$86.96
40W incandescent	13 Watt Screw-in CFL - Outdoor <=800 lumens	8	31	31	31	0.0000	0.0000	0.0000	$3.32	$3.94
60W incandescent	13 Watt Screw-in CFL - Outdoor > 800 lumens	8	53	53	53	0.0000	0.0000	0.0000	$3.28	$3.94
75W Incandescent	20 Watt Screw-in CFL - Outdoor	8	62	62	62	0.0000	0.0000	0.0000	$3.37	$4.03
100W Incandescent	30 Watt Screw-in CFL - Outdoor	8	79	79	79	0.0000	0.0000	0.0000	$5.43	$6.09
120W Incandescent	40 Watt Screw-in CFL - Outdoor	8	124	124	124	0.0000	0.0000	0.0000	$10.12	$12.52
40W incandescent	13 Watt Pin Based CFL - Outdoor <=800 lumens	8	31	31	31	0.0000	0.0000	0.0000	$1.94	$34.89
60W incandescent	13 Watt Pin Based CFL - Outdoor >800 lumens	8	53	53	53	0.0000	0.0000	0.0000	$0.98	$34.89
75W Incandescent	20 Watt Pin Based CFL - Outdoor	8	62	62	62	0.0000	0.0000	0.0000	$2.20	$37.55
100W Incandescent	30 Watt Pin Based CFL - Outdoor	8	79	79	79	0.0000	0.0000	0.0000	$3.11	$41.80
120W Incandescent	40 Watt Pin Based CFL - Outdoor	8	91	91	91	0.0000	0.0000	0.0000	$9.45	$50.54
200W Incandescent	55 Watt Pin Based CFL - Outdoor	8	164	164	164	0.0000	0.0000	0.0000	$11.56	$55.32
250W Incandescent	65 Watt Pin Based CFL - Outdoor	8	209	209	209	0.0000	0.0000	0.0000	$11.74	$62.54
200 W Inc	55 W CFL	8	153	85	121	0.0247	0.0137	0.0196	$5.09	$62.92
300 W Inc (halogen)	55 W CFL	8	258	143	204	0.0418	0.0232	0.0330	$1.57	$59.40
75 W Inc	20 W CFL	8	48	27	38	0.0078	0.0024	0.0049	-$4.48	$54.23
100 W Inc	25 W CFL	8	66	36	52	0.0107	0.0033	0.0067	$12.61	$64.61
120 W Inc	30 W CFL	8	79	44	62	0.0128	0.0039	0.0080	$5.24	$66.62
200 W Inc	55 W CFL	8	127	71	101	0.0206	0.0063	0.0129	$10.03	$124.58
Occupancy Sesor for Common Area	No sensor	8	226	125	178	0.0111	0.0062	0.0088	$88.53	$83.90
Lighting Photocell controls for Common Area	No sensor	8	500	277	395	0.0000	0.0000	0.0000	$172.50	$172.50
LED Exit Signs for Multi-family	Incandescent Exit Sign	16	333	184	263	0.0380	0.0210	0.0300	$22.00	$101.50
7W Incandescent Light	1 W LED light	16	18	10	15	0.0000	0.0000	0.0000	$3.00	$3.00
300 x 0.48 W Incandescent Lights	300 x 0.08 W LED Lights	16	18	18	18	0.0000	0.0000	0.0000	$10.00	$10.00

Table 35: Mobile Home Measure Characteristics (net at meter savings) (Continued)

Baseline Description	DSM Measure Description	Effective Useful Life	Energy Savings - kWh			Demand Savings - kWh			Incremental Costs	
			Gas Heating	Electric Heating	Heat Pump Heating	Gas Heating	Electric Heating	Heat Pump Heating	New/ROB	Retrofit
Appliances										
Standard Refrigerator	Refrigerator - Energy Star	11	99	55	78	0.0119	0.0066	0.0094	$122.23	$1,414.99
Standard Freezer	Freezer Energy Star	11	68	38	54	0.0082	0.0045	0.0065	$35.00	$637.03
2 units in use	1 unit in use	5	1173	650	927	0.1414	0.0784	0.1118	$0.00	$0.00
1 unit in use	0 unit in use	4	1049	582	829	0.1265	0.0701	0.1000	$0.00	$0.00
Standard Pool Pump	Variable Speed Drive Pool Pumps	10	1941	1941	1941	0.0006	0.0006	0.0006	$434.41	$707.73
Hot Water										
Standard Efficiency WH Tank	High Efficiency Water Heating Tank	13	228	228	228	0.0251	0.0251	0.0251	$48.58	$506.69
2.5gpm	1gpm	10	194	194	194	0.0214	0.0214	0.0214	$14.86	$43.68
normal aerator (4gpm)	low flow aerator (1.5gpm)	10	77	77	77	0.0085	0.0085	0.0085	$2.78	$12.34
Standard Clothes Washer	Clothes Washer - Tier 1	11	403	391	398	0.0560	0.0542	0.0552	$363.73	$824.57
Electric Dryer	Gas Dryer	11	458	254	362	0.0696	0.0386	0.0550	$226.96	$657.53
Standard Dishwasher	Dishwasher - Energy Star	11	78	55	67	0.0000	0.0000	0.0000	$284.54	$615.85
No heat recovery	DWHR with GFX 60	20	441	441	441	0.0485	0.0485	0.0485	$742.00	$726.86
Standard Clothes Washer	Clothes Washer - Tier 2	11	472	457	465	0.0656	0.0633	0.0645	$492.16	$952.99
Standard Clothes Washer	Clothes Washer - Tier 3	11	540	522	532	0.0750	0.0724	0.0738	$620.58	$1,081.42
No Insulation	R-13 Blanket	7	332	332	332	0.0365	0.0365	0.0365	$77.14	$70.53
No Insulation	R-2.5 Pipe Wrap	12	121	121	121	0.0133	0.0133	0.0133	$5.26	$4.72
Other										
No Sensor	Occupancy Sensor - Plug Loads	8	89	49	70	0.0107	0.0059	0.0084	$85.00	$85.00
Shell and HVAC										
Standard Room A/C	Room A/C - Energy Star	9	46	46	46	0.0550	0.0550	0.0550	$30.00	$300.00
Central A/C - SEER 13	Central A/C - SEER 14 w/TXV	15	45	45	188	0.0400	0.0400	0.0400	$119.21	$1,149.95
13 SEER Air Source Heat Pump	Geothermal Heat Pump - Energy Star	15	N/A	N/A	N/A	N/A	N/A	N/A	$3,755.99	$4,903.37
U-0.65 SHGC 0.62	U-0.35 SHGC 0.55	20	1	6	4	0.0006	0.0006	0.0006	$2.89	$18.97
R-19	R-38	20	0	1	0	0.0000	0.0000	0.0000	$0.82	$1.56
R-4	R-11 added to walls	20	0	2	1	0.0002	0.0002	0.0002	$0.83	$0.78
0.8 ACH	0.5 ACH	11	87	594	425	0.0909	0.0909	0.0909	$115.00	$115.00
0.8 ACH	0.35 ACH	11	135	896	636	0.1818	0.1818	0.1818	$230.00	$230.00
no maintenance	refrigerant charge and air flow corrected	10	86	700	435	0.0504	0.0504	0.0504	$52.56	$50.19
no maintenance	Ducts sealed	18	152	1235	768	0.2700	0.1260	0.1260	$497.62	$469.16
78 AFUE Gas Furnace w/13 SEER A/C	14 SEER ASHP	15	-1471	N/A	N/A	0.2400	N/A	N/A	$217.49	$1,352.15
Electric Furnace w/13 SEER A/C	14 SEER ASHP	15	N/A	2138	N/A	N/A	0.2400	N/A	$217.49	$1,352.15
13 SEER HP	14 SEER ASHP	15	N/A	N/A	188	N/A	N/A	0.0800	$137.00	$1,352.15
Energy Star Homes										
Single Family New Construction	Lighting and Shell Measures		N/A	N/A	N/A	N/A	N/A	N/A	$1,316.69	N/A
Single Family New Construction	Lighting, Shell and HVAC Measures		N/A	N/A	N/A	N/A	N/A	N/A	$1,727.69	N/A

D.3 Non-Residential DSM Measure Characterizations

D.3.1 Sources used for the analysis

1. eQUEST (DOE-2.2 engine) simulations based on the market profiles described in the previous section. [illegible].
2. Advance Transformer 1 catalog [illegible], 2008.
3. California Database for Energy Efficient Resources (DEER), 2004-2005 version 2.01. [illegible] cost and savings estimates.
4. California Database for Energy Efficient Resources (DEER), 2008 update. Unpublished data. Cost and savings estimates.
5. Minnesota Deemed Savings Database, unpublished data.
6. Michigan Deemed Savings Database, unpublished data.
7. RS Means *Mechanical Cost Data*, 2005.
8. 2007 ASHRAE Fundamentals Handbook, *HVAC applications*.
9. Xcel Energy – MN, *Conservation Improvement Plan 2007-2009*, July 2006.

This section describes the non-residential energy efficiency measures analyzed for this study and the methods used to estimate savings. The section is organized by major end-uses such as lighting, heating, ventilation and air-conditioning ("HVAC"), and refrigeration. This section focuses on prescriptive measures, which are generally straight-forward measures that have largely uniform energy and peak demand savings on a per unit basis from application to application. However, even prescriptive measures' savings will have some variability, depending on the specific application and baseline equipment replaced.

Summit Blue chose to represent the commercial sector with three segments, office buildings, retail and restaurants. These three segments include a significant portion of the commercial floor area and consumption (see Market Profile in Volume 2) and diverse energy end-uses.

Savings estimates are based on secondary resources such as evaluations and deemed savings estimates from other jurisdictions (CA, MN, and MI), and engineering calculations for climate *in*dependent measures. For measures that are climate *dependent* Summit Blue used hourly simulations executed with DOE2-2 simulation software. For indoor lighting measures a combination of the techniques is used. Engineering calculations estimate direct energy savings from lighting measures and simulations are used to estimate the indirect savings from interaction with HVAC equipment. Each service territory was modeled with appropriate weather sites and the baseline models were calibrated against the Market Profiles developed earlier in the project.

In the industrial sector the measure focus is on lighting, compressed air, drivepower and HVAC measures. All other measures are aggregated into the custom line item. There are no HVAC interactive effects assumed for industrial indoor lighting. Custom Measures have more variable energy and peak demand savings on a per unit basis from application to application and might involve any qualifying technology. *Ex Post* results from a large Midwestern utility company's Custom Program calibrate the custom measure

savings estimates. Custom measures might include, process or control improvements and holistic renovations of systems.

Cost estimates are largely based on the CA-Database of Energy Efficient Resources (DEER) with costs adjusted with RS Means Mechanical Cost Data factors for Ohio. Measures can either be installed as retrofits or replace on burn-out ("ROB"). In the former the cost includes labor and material costs. In the latter, the measure costs generally exclude labor costs since those would still be incurred in the event of replacement with non-qualifying equipment. Some measures are strictly ROB applications.

D.3.2 Lighting Measures – Non-Residential

The following lighting measures are often part of utilities' prescriptive non-residential lighting energy efficiency programs. The major inputs for the impact estimates are the same for both baseline and efficient technologies: equipment connected Watts, hours of operation and interaction with HVAC equipment for commercial applications.

Measure costs and measure lives are based on the California DEER database. Costs are adjusted to the APCo Retail company area by regional cost factors from *RS Means Cost Data.*

Compact Fluorescent Lamp – Screw-in and Hard-wired Fixtures

Compact fluorescent lamps (CFLs) are the most common alternatives to standard incandescent lamps. CFLs are generally about four times as efficient as incandescent lamps, and last about 10 times as long. CFLs can either be screw-in replacements for incandescent lamps or plug-in lamps in fixtures specifically designed around CFL technology. The measure life for a screw-in CFL is the life of the bulb or two to three years depending on the application. Plug-in lamps in CFL fixtures are assumed to last the life of the fixture, because failed lamps must be replaced with comparable CFLs.

T8 Lamps and Electronic Ballasts - Premium

Premium T8 lamps and electronic ballasts have the same market as regular T8 systems. They gain efficiency over regular T8 systems by the co-development of lamps and ballasts that optimize the efficiency of both when used together. Premium T8 technology is compared versus both a T12 and standard T8 baseline. This measure qualifies under the general lighting category, and indirect heating and cooling impacts are included and are estimated by eQuest simulations.

T5 Lamps and Electronic Ballasts

T5 lamps and electronic ballasts are a newer alternative linear fluorescent lighting system. T5 fluorescent lamps are 5/8 of an inch in diameter, thinner than both T8 lamps and T12 lamps. T5 lighting systems are primarily used in new construction, and are not appropriate for most retrofit situations, as the lamps are only generally available in metric lengths. This measure qualifies under the general lighting category, and indirect heating and cooling impacts for the Commercial sector are included and are estimated by eQuest simulations.

Daylight Sensors

Lighting systems are designed assuming no contribution from ambient daylight. In areas where daylight is available, artificial light may be unnecessary and possibly detrimental to occupant comfort. Daylight sensors measure the contribution of ambient daylight and either turn-off or dim the lamps of the artificial lighting system. Savings were determined by eQuest simulations, assuming that perimeter zone (less than

12 feet from an exterior fenestrated wall) lighting is controlled by daylight sensors to maintain required lighting levels with continuous lighting level control. eQuest input data include location specification for the solar incidence angles and hourly cloud cover to describe available sunlight. Commercial HVAC interactions are included in the estimates.

Occupancy Sensors

Occupancy sensors automatically turn off the lights in a room or an area when the area is unoccupied. Occupancy sensors are an alternative to standard wall mounted on/off lighting switches. Savings were determined with interaction factors from eQuest simulations assuming that 10% of lighting is controlled by occupancy sensors with an average reduction of four hours of use per day.

Delamping

The definition of delamping used for this project is replacing a removing one lamp in a three-lamp, four-foot fluorescent lighting fixture, and re-aligning the lamps in the fixture. This measure is intended for areas that are currently over-lit. Lighting reflectors are often used as part of delamping projects. The measure life for this measure is shorter because the fixture is assumed to have been in place for a period of time already. Savings from Commercial HVAC interactions were determined by eQuest simulation.

LED Exit Signs

LED exit signs are among the most efficient types of exit signs on the market. They generally only draw about two to three watts of power, compared to 15 Watts or more for CFLs, or 25 Watts or more for incandescent exit signs. Weighting of the baseline technologies was based on primary data collected for this project. Savings from Commercial HVAC interactions were determined by eQuest simulation.

High-Bay Fluorescent Lights

High-bay lighting is used in industrial settings for general ambient light. T5 and T8 fluorescent lamps can be used in place of more traditional high-intensity discharge (HID) lamps in specially designed fixtures. The advantages include higher efficacy (lumens/Watt), greater lumen maintenance over the lamp life and better controllability. Savings are determined with engineering calculations, no HVAC interactive effects and 20% fewer operating hours due to control benefits.

Pulse-Start HIDs

Metal Halide pulse-start technology is a slightly more efficient type of HID lighting compared to traditional metal halide and high-pressure sodium HIDs. Special lamps and ballasts generate equivalent illumination in the same light fixture at lower power requirements. Savings are determined with engineering calculations and no HVAC interactive effects.

D.3.3 Non-Residential Motors and Other

The following measures are either common and cut across end-use categories or they are specialized but generally found to be cost effective.

Motor Efficiency

Motor efficiency improvements can be achieved effectively during system specification and installation when new motors are purchased. Premium efficiency motors can be installed in place of motors that only

meet minimum federal efficiency standards detailed in the Energy Policy Act. Since many larger motors (greater than 30 horsepoewr "HP") are rewound after failure rather than replaced, an additional opportunity exists by ensuring rewinds are performed to maintain motor efficiency. Steps like close control of baking temperatures, careful winding removal, and use of high-quality materials will help ensure that efficiency will not diminish during rewinds. Premium motors typically exceed mandated Eenrgy Policy Act ("EPACT") efficiencies by 1-3% depending on the motor size. Motor cost data are based on surveys of motor manufacturers (Baldor, Lesson, Marathon, GE, US Motors, Dayton) prepared for the 2008 update to the California DEER.

VFDs for HVAC Application

VFDs for HVAC applications are listed separately because they take advantage of the fluid affinity laws that show a cube relationship between speed and power. These applications also have a more predictable use pattern than VFDs in industrial processes and conveyance applications. The latter examples would be included with custom measures. The baseline technologies for HVAC VFDs is flow throttling for liquid systems and vortex dampers for air applications.

Compressed Air Controls

Frequently call the fourth utility (after electricity, gas, and water) compressed air systems have many savings opportunities, including: leak repair, efficient motors and compressors and staging, pressure optimization and receiver installation. These measures could be legitimately included in "Custom" due to the site specific nature of savings. We have estimated savings for Compressed air with benchmarks from the Compressed Air Challenge program run by the U.S. Department of Energy, and on a Midwestern utility custom compressed air program results and conservation plan[16]. Savings are listed per system horsepower.

Convection Ovens

These ovens circulate air inside the oven to enhance heat transfer to the food. As a result cooking times are shorter and lower temperatures are needed to cook food.

Spray Nozzles

Pre-wash nozzles remove excess food debris from plates and reduce the use of hot water inside the dish washer.

Hot Water Circulation Pump Control

Small pumps will circulate domestic hot water throughout a facility continuously so that hot water is almost immediately available at the tap. Controls, which turn off the pump at night, save pumping energy and reduce stand by losses in the water distribution system.

D.3.4 Non-Residential HVAC Measures

In the AEP Ohio Commercial and Industrial sectors space heating is split between natural gas and electric heat – primarily heat pumps. Summit Blue analyzed savings with both heating types for the market segments. HVAC Savings can occur through reducing the amount of heating/cooling required with

[16] Xcel Energy – Minnesota Conservation Improvement Plan 2007-2009.

insulation and setting back thermostat settings or by improving the efficiency of the equipment and/or distribution process.

Since HVAC savings are climate dependent, all of the savings for the following measures were determined with eQuest computer energy simulations. The measure baselines are derived from the calibrated models derived with the Market Profile. Savings are the difference between the simulation with the efficient technology and the simulation with the standard or code-compliant technology. Incremental costs are mostly based on the DEER database adjusted with *RS Means Mechanical Cost Data* 'location factors' to reflect Ohio labor and/or equipment costs.[17]

Measure life for these items are base on the American Society of Heating Refrigeration and Air-Conditioning Engineers, Inc. ("ASHRAE") depreciation lives and the California DEER database.

Variable Frequency Drives ("VFDs") for HVAC Application

VFDs for HVAC applications are listed separately because they take advantage of the fluid affinity laws that show a cube relationship between speed and power. These applications also have a more predictable use pattern than VFDs in industrial processes and conveyance applications. The latter examples would be included with custom measures. The baseline technologies for HVAC VFDs are flow throttling for liquid systems and vortex dampers for air applications.

Efficient Packaged Commercial Air Conditioning Systems

Standard efficiency units are specified as units with EER ratings of 10.1. Efficient units are specified as units with EER ratings of 10.4-13.0 depending on the equipment size. Summit Blue characterized a high efficiency unit with an EER of 12.2.

Energy Management Systems (EMS)

EMSs can effectively reduce energy consumption by optimizing equipment operation and/or scheduling equipment use by the time of day and/or time of year. Savings vary based on controlled equipment and the comprehensiveness of the EMS hardware and programming

Economizers

Economizers use outside air for cooling instead of operating the air conditioning compressors on mild days, particularly during the spring and early fall seasons. The analysis assumed an integrated economizer where 100% outdoor air is used up to 65°F ambient temperature. During peak summer conditions economizers produce no peak demand savings.

Programmable Thermostats

Programmable thermostats allow temperatures to be automatically set warmer or colder during unoccupied periods to reduce heating and cooling energy use when facilities are unoccupied. We analyzed 5°F setbacks (set-ups in the summer). Since the impact of set-backs is typically off-peak, these thermostats have minimal peak benefits.

[17] *RS Means Mechanical Cost Databook, 2006.*

Window Film

Polymer films are applied to the interior of glazing to enhance the glazing attributes. Films will have any combination of the following effects: reduced visible and radiant energy from the sun (solar heat gain and shading), lower glazing U-factor and lower emissivity to keep heat in the building in the winter

Cool Roof

Light-colored or white roofs have a lower solar absorptance, thereby reducing the energy gains through the roof. This behavior reduces summer cooling loads, but can increase winter heating requirements.

Efficient Water Chillers

Minimum efficiency standards for water chillers are established by state codes. Primarily through the use of variable speed drives and over-sized heat exchangers, standard equipment can be made more efficient for energy savings.

D.3.5 Refrigeration and Custom Non-Residential Measures

Refrigeration Measures improve the efficiency of the cooling plant and/or reduce the cooling loads that the system must satisfy. Measures that do not fit in the categories listed above are that have savings that are highly project-specific we group in this category. Custom measures is a catch-all category that might include special lighting systems, building controls, exceptional HVAC equipment or process improvements at a factory, for a few examples. Experience of other utilities informs this measure category.

Motor cost data for Custom measures are based on surveys of motor manufacturers (Baldor, Lesson, Marathon, GE, US Motors, Dayton) prepared for the 2008 update to the California DEER.

ECM motors

Electronically commutated motors ("ECM) are DC motors that are more efficient than the permanent split capacitor motors they replace. Since they are used inside refrigeration cases they have the indirect effect of reducing refrigeration loads.

Multi-Line compressors

Instead of one compressor per refrigeration unit, a multi-line system has several compressors that stage optimally to serve many pieces of equipment on the retail floor.

Oversized condensers

Oversized condensers more efficiently reject heat from the refrigeration system and reduce the compressor loads.

High Efficiency Compressors

HE compressors provide gains over standard machines, primarily through the use of VFDs to modulate compressors to match loads.

Evaporator Fan Controllers

Most walk-in cooler evaporator fan motors run continuously. Controllers allow the fans to cycle based on cooling demand.

Strip Curtains, Night Covers and Glass Doors

Strip curtains, night covers and glass doors are used to reduce losses from the refrigerated zones and products to the rest of the retail zones. They are particularly deployed at night when they do not inhibit access to refrigerated products.

Anti-sweat Controls

To keep glass clear of condensation so the merchandise is visible, anti-sweat heaters typically run continuously. Controls cycle heaters based on humidity sensors and or on a timed basis.

Floating Head Pressure Controls

When outdoor temperatures are mild, condensed refrigerant can be cooled below default settings to reduce the loads on compressors.

Custom efficiency

"Custom" is a generic name for consumer-specific conservation projects. The magnitude of estimated potential savings is scaled to kW saved and is based on Midwestern utility custom program results and conservation plan[18]. Costs and measure lives are based on the same source.

[18] Xcel Energy – Minnesota Conservation Improvement Plan 2007-2009.

D.3.6 Commercial Measure Characteristics by Program – Ohio Power Company and Columbia Southern Power

Table 36. Commercial Measure Characteristics (at meter savings)

Measure Description	Baseline Measure Description	Office				Retail				Restaurant				EUL	Cost		Coincidence Factors		
		Gas Heat		Elec Heat		Gas Heat		Elec Heat		Gas Heat		Elec Heat			Incremental RET	Incremental - NEW/ROB	Office	Retail	Restaurant
		Sum_kW	kWh	Sum_kW	kWh	Sum_kW	kWh	Sum_kW	kWh	Sum_kW	kWh	Sum_kW	kWh	Years					
Lighting																			
CFL - Screw-in	Incandescent we ghted Watts	0.097	317	0.10	286	0.11	405	0.11	324	0.093	461	0.09	393	3	$4.13	$3.45	0.90	0.90	0.90
CFL - Hard-wired	Incandescent we ghted Watts	0.11	366	0.11	320	0.10	374	0.10	300	0.10	516	0.11	441	12	$15.13	$6.77	0.90	0.90	0.90
Electronic Ballast Dimming	T8 Normal Ballast	0.06	194	0.06	175	0.06	217	0.06	174	0.06	299	0.06	255	8	$151.33	$105.00	0.90	0.90	0.90
LED Exit	Incandescent Exit Sign	0.03	229	0.03	206	0.03	227	0.03	182	0.03	224	0.03	192	18	$82.54	$22.50	1.00	1.00	1.00
T5 w/Electronic Ballast	T8 with electronic Ballast	0.04	133	0.04	120	0.04	140	0.04	112	0.04	193	0.04	165	15	$59.32	$2.14	0.90	0.90	0.90
Super T8 T12 baseline	T12	0.07	225	0.07	203	0.07	237	0.07	190	0.07	327	0.07	279	15	$52.54	$5.17	0.90	0.90	0.90
Super T8 -- T8 baseline	T8	0.01	42	0.01	38	0.01	45	0.01	36	0.01	62	0.01	53	15	$52.54	$1.25	0.90	0.90	0.90
															$0.00	$0.00			
Delamping w/Reflectors (2 lamp)	3 lamp Fixture	0.07	220	0.07	198	0.06	231	0.06	185	0.06	319	0.07	272	15	$52.59	-$3.12	0.90	0.90	0.90
Occupancy Sensor Motion Det.	No sensor	0.23	621	0.23	559	0.16	439	0.16	352	0.12	432	0.12	368	8	$91.27	$91.27	1.00	1.00	1.00
50W MH HID	150W Incandescent	0.13	440	0.13	396	0.13	463	0.13	371	0.13	639	0.13	545	15	$145.39	$124.88	0.90	0.90	0.90
75W MH HID	100W Mercury Vapor	0.04	140	0.04	126	0.04	147	0.04	118	0.04	200	0.04	170	15	$145.39	$104.15	0.90	0.90	0.90
100W MH HID	170W Mercury Vapor	0.11	383	0.11	345	0.11	403	0.11	322	0.11	551	0.11	470	15	$150.55	$70.11	0.90	0.90	0.90
175W PS MH H.D	500W Incandescent	0.47	1549	0.47	1394	0.45	1630	0.45	1305	0.45	2248	0.46	1918	15	$169.81	$64.19	0.90	0.90	0.90
250W PS MH H.D	400W Mercury Vapor	0.27	913	0.27	822	0.26	959	0.26	768	0.26	1312	0.26	1120	15	$182.80	$68.43	0.90	0.90	0.90
50W MH H.D	150W Incandescent	0.05	317	0.05	317	0.05	317	0.05	317	0.05	317	0.05	317	15	$145.39	$124.88	0.00	0.00	0.00
75W MH H.D	100W Mercury Vapor	0.01	101	0.01	101	0.01	101	0.01	101	0.01	101	0.01	101	15	$145.39	$104.15	0.00	0.00	0.00
100W MH HID	170W Mercury Vapor	0.04	277	0.04	277	0.04	277	0.04	277	0.04	277	0.04	277	15	$150.55	$70.11	0.00	0.00	0.00
175W PS MH H.D	500W Incandescent	0.13	1116	0.16	1116	0.16	1116	0.16	1116	0.16	1116	0.16	1116	15	$169.81	$64.19	0.00	0.00	0.00
250W PS MH H.D	400W Mercury Vapor	0.09	660	0.09	660	0.09	660	0.09	660	0.09	660	0.09	660	15	$182.80	$68.43	0.00	0.00	0.00
Outdoor Lighting Controls	No controls	0.00	241	0.00	241	0.00	241	0.00	241	0.00	241	0.00	241	8	$102.78	$102.78	0.00	0.00	0.00
T5 Interior High Bay Fl. Fixt	400W Mercury Vapor	0.34	1279	0.34	1152	0.33	1345	0.33	1076	0.33	1855	0.33	1683	15	$278.20	$126.13	0.90	0.90	0.90
T8 Interior High Bay Fl. Fixt	400W Mercury Vapor	0.25	1012	0.25	911	0.24	1063	0.24	851	0.24	1467	0.24	1252	15	$257.60	$105.53	0.90	0.90	0.90
LED Streetlights	250W HPS or 250W MH	0.00	679	0.00	679	0.00	839	0.00	839	0.20	785	0.20	785	10	$749.47	$415.00	N/A	N/A	N/A
LED Traffic Lights	Incandescent Traffic Light	0.10	417	0.10	417	0.10	417	0.10	417	0.10	417	0.10	417	5	$218.04	$24.62	1.00	1.00	1.00

Table 37. Commercial Measure Characteristics (at meter savings) (Continued)

Measure Description	Baseline Measure Description	Office				Retail				Restaurant				EUL	Cost		Coincidence Factors		
		Gas Heat		Elec Heat		Gas Heat		Elec Heat		Gas Heat		Elec Heat			Incremental RET	Incremental - NEW/ROB	Office	Retail	Restaurant
		Sum_kW	kWh	Sum_kW	kWh	Sum_kW	kWh	Sum_kW	kWh	Sum_kW	kWh	Sum_kW	kWh	Years					
Motors & Other																			
Prem Motor < = 10 HP	EPACT <= 10 HP	0.02	77	0.02	77	0.02	77	0.02	77	0.02	77	0.02	77	15	$214.60	$39.65	0.75	0.75	0.75
Prem Motor > 10HP	EPACT > 10 HP	0.01	34	0.01	34	0.01	34	0.01	34	0.01	34	0.01	34	15	$66.79	$10.67	0.75	0.75	0.75
Adjustable Speed Drives for Fans & Pumps	No ASD	0.00	920	0.00	920	0.00	948	0.00	948	0.00	950	0.00	950	15	$224.50	$212.55	0.38	0.38	0.38
Compressed Air Controls	No control	0.00	222	0.00	222	0.00	222	0.00	222	0.00	222	0.00	222	15	$1,005.00	$216.00	N/A	N/A	N/A
Convection Oven	Standard Oven	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.41	1821	0.41	1821	10	$4,604.00	$554.50	0.20	0.20	0.20
Spray Nozzles for Food Service	No spray nozzle	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.31	3723	0.31	3723	5	$147.54	$147.54	N/A	N/A	N/A
Hot Water Circulation Pump Time Clock	No time clock	0.00	997	0.00	997	0.00	1154	0.00	1154	0.00	1109	0.00	1109	15	$346.19	$346.19	N/A	N/A	N/A
Retrocommissioning	No retrocommissioning	0.11	1367	0.14	2019	0.10	1190	0.10	1961	0.10	1843	0.10	2112	10	$1,500.00	$1,500.00	1.00	1.00	1.00
HVAC & Shell																			
Packaged Rooftop A/C 12 EER	Packaged A/C 10.1 EER	0.17	205	0.17	207	0.16	152	0.17	154	0.15	203	0.15	203	15	$1,340.05	$207.00	0.56	0.72	0.75
EMS System	No EMS	0.00	2017	0.00	2792	0.00	928	0.00	2654	0.00	971	0.00	1180	15	$507.58	$507.58	N/A	N/A	N/A
Programable Thermostat	Standard Thermostat	-0.06	1046	-0.06	1815	0.00	512	0.00	2233	-0.06	520	-0.06	1538	11	$144.50	$82.00	N/A	N/A	N/A
Economizer	No Economizer	0.00	583	0.00	585	0.00	159	0.00	162	0.00	245	0.00	256	10	$155.28	$155.28	0.56	0.72	0.75
Reflective Window Film	No Film	0.27	692	0.27	592	0.11	257	0.11	38	0.01	26	0.02	1	10	$16.12	$16.12	0.56	0.72	0.75
Cool Roof	Standard Roof	0.04	104	0.04	130	0.00	10	0.00	4	0.01	13	0.01	15	15	$3.22	$0.85	0.56	0.72	0.75
Efficient Centrifugal Chiller	ASHRAE01Chiller - 0.59 kW/ton	0.12	177	0.12	177	0.12	118	0.12	118	NA	NA	NA	NA	20	$673.21	$169.04	0.56	0.72	0.75
Efficient Screw Chiller	ASHRAE01Chiller - 0.63 kW/ton	0.10	155	0.10	155	0.10	104	0.10	104	NA	NA	NA	NA		$673.21	$169.04	0.56	0.72	0.75
Efficient AirCooled Chiller	ASHRAE01Chiller - 1.15 kW/ton	0.19	285	0.19	285	0.19	190	0.19	190	NA	NA	NA	NA		$673.21	$169.04	0.56	0.72	0.75
Tune-up/Advanced Diagnostics	None	0.06	94	0.06	94	0.06	62	0.06	62	0.06	83	0.06	83	7	$138.75	$138.75	0.56	0.72	0.75
Refrigeration																			
Motor Upgrade for Fans & Compressors	Shaded pole motors	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.36	1573	0.36	1573	15	N/A	$37.23	N/A	N/A	0.40
Single Line to Multiplex Compressor	Single line compresser	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.03	563	0.03	563	12	N/A	$3,012.78	N/A	N/A	0.40
Multiplex system with oversized condenser	Multiplex system with standard condenser	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.01	68	0.01	68	12	$424.38	N/A	N/A	N/A	0.40
High efficiency, low temperature compresser	Low temperature compresser - EER 4.86	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.18	1106	0.18	1106	12	N/A	$893.52	N/A	N/A	0.40
Evap Fan Controller for Med. Temp Walk-in	No controller for cycling	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.46	2487	0.46	2487	10	$161.75	N/A	N/A	N/A	0.40
Strip Curtains	No strip curtains	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.03	271	0.03	271	4	$7.50	N/A	N/A	N/A	1.00
Night Covers	No night covers	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.07	15	0.07	15	5	$37.63	N/A	N/A	N/A	N/A
Anti-sweat Heater Controls	No controls	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.02	144	0.02	144	12	$968.23	N/A	N/A	N/A	0.40
Floating Head Pressure Controls	No controls	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00	1389	0.00	1389	12	$44.15	N/A	N/A	N/A	0.40
Glass Doors on Low and Med. Temperature	No doors	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.02	161	0.02	161	12	$906.28	N/A	N/A	N/A	0.40

D.3.7 Industrial Measure Characteristics by Program – Ohio Power Company and *Columbia Southern Power*

Table 38. Industrial Measure Characteristics (at meter savings)

DSM Measure	Baseline Measure	Industrial		EUL	Costs		Coincidence
					Incremental RET	Incremental - NEW/ROB	Industrial
		Sum_kW	kWh	Years			
Lighting							
LED Exit	Incandescent Exit Sign	0.02	166	16	$80.99	$22.91	1
T8/T5 w/Electronic Ballast	T12	0.02	88	15	$54.02	$2.18	0.9
50W MH HID	150W Incandescent	0.08	415	15	$144.99	$127.18	0.9
75W MH HID	100W Mercury Vapor	0.03	130	15	$144.99	$106.06	0.9
100W MH HID	170W Mercury Vapor	0.07	359	15	$150.25	$71.40	0.9
175W PS MH HID	500W Incandescent	0.29	1460	15	$167.07	$65.37	0.9
250W PS MH HID	400W Mercury Vapor	0.17	855	15	$180.30	$69.69	0.9
50W MH HID	150W Incandescent	0.04	147	15	$144.99	$127.18	0
75W MH HID	100W Mercury Vapor	0.01	47	15	$144.99	$106.06	0
100W MH HID	170W Mercury Vapor	0.04	128	15	$150.25	$71.40	0
175W PS MH HID	500W Incandescent	0.15	517	15	$167.07	$65.37	0
250W PS MH HID	400W Mercury Vapor	0.08	306	15	$180.30	$69.69	0
Outdoor Lighting Controls	No controls	0.00	121	8	$101.78	$101.78	0
T5 Interior High Bay Flourescent Fixture	400W Mercury Vapor	0.22	1124	15	$271.04	$128.45	0.9
T5 Interior High Bay Flourescent Fixture	400W MH or HPS	0.11	564	15	$321.45	$178.86	0.9
Motors & Other							
Prem Motor < =10 HP	EPACT <= 10 HP	0.02	88	15	$206.11	$39.53	0.75
Prem Motor > 10HP	EPACT > 10 HP	0.01	40	15	$65.34	$10.64	0.75
Adjustable Speed Drives for Fans & Pumps	No ASD	0.17	851	15	$215.97	$206.02	0.38
Compressed Air Optiization	status quo	0.03	336	15	$205.46	$205.46	N/A
Custom							
Custom Measure	Old technology	39.00	405286	15	$253,000.00	$253,000.00	0.95
HVAC & Shell							
Hi Efficiency Roof Top Units (Cooling Only)	9.7-10.1 EER	0.20	275	15	$1,311.06	$206.38	0.95

APPENDIX E. REFERENCES

AEP Ohio. 2006 AEP Ohio Residential Appliance Saturation Survey, January 10 – February 24, 2006.

Arizona Public Service. (2008, September 15). *Semiannual report summaries, June 2008.* From personal correspondence with Roger Krouse at Arizona Public Service.

Efficiency Maine. (2007, December 15). *2007 Annual report.* From http://www.efficiencymaine.com/documents_reports.htm

Efficiency Vermont. (2008, October 15). *Year 2007 annual report and annual energy savings claim.* From http://www.efficiencyvermont.com/pages/Common/AboutUs/AnnualReport/

Energy Information Administration, Department of Energy. (2007, November). *Form EIA-861 data file – final – YR 2007.* From http://www.eia.doe.gov/cneaf/electricity/page/eia861.html

Energy Information Administration, Department of Energy. (2007, November). *Form EIA-861 data file – final – YR 2006.* From http://www.eia.doe.gov/cneaf/electricity/page/eia861.html

Interstate Power and Light Company, Iowa. (2008, May 1). *Energy efficiency plan annual report for program year 2007.* Docket No. EEP-02-38. From personal correspondence with Alliant Energy.

Interstate Power and Light Company, Minnesota. (2008, April 1). *2006-2007 Minnesota electric and gas conservation improvement plan (CIP).* Docket No. E,G001/CIP-05-581. From https://www.edockets.state.mn.us/EFiling/home.jsp

Komor, P. (2006, November). Best practices in residential direct load control programs. *E Source,* 12-17.

Maine Public Utilities Commission. (2007, March 9). *Inquiry into new conservation programs and developing a plan for using increases in the conservation fund.* Docket 2006-446. From http://www.efficiencymaine.com/documents_reports.htm

MidAmerican Energy Company, Iowa. (2008, May 1). *Energy-efficiency plan 2007 annual report.* EEP-03-1. From personal correspondence with Iowa Utilities Board.

Minnesota Power. (2008, March 31). *2007 Conservation improvement program consolidated filing.* Docket No. E 015/M-08-349. From https://www.edockets.state.mn.us/EFiling/home.jsp

National Grid. (2008, August 1). *2007 Energy efficiency annual report.* From http://db.state.ma.us/dpu/qorders/frmDocketFind.asp

NSTAR. (2008, August 29). *2007 Energy efficiency report.* Docket 08-46. From http://db.state.ma.us/dpu/qorders/frmDocketFind.asp

Otter Tail Power Company. (2008, April 1). *2007 CIP status report.* Docket No. E-017/CIP-05-1125.03. From https://www.edockets.state.mn.us/EFiling/home.jsp

Southwestern Electric Power Company. (2008, May 1). *2008 Energy efficiency plan and report – project No. 35440.* From http://interchange.puc.state.tx.us/WebApp/Interchange/application/dbapps/filings/pgSearch.asp

Violette, D., & Sedano, R. (2006, January 30). *Demand-side management: Determining appropriate spending levels and cost-effectiveness testing Appendix A: Summaries by jurisdiction.* Prepared for the Canadian Association of Members of Public Utility Tribunals (CAMPUT).

Wisconsin Focus on Energy. (2007, November 1). *Focus on energy evaluation semiannual report* (FY 07, year-end). From http://www.focusonenergy.com/EvaluationReports/General_Reports.aspx.

Xcel Energy (CO). (2008, September 16). *DSM programs monitoring and evaluation report for activity in 2007.* From personal correspondence with Rachel Sours-Page at Xcel Energy (CO).

Xcel Energy (MN). (2008, April 1) *2007 Status report and associated compliance filings, Minnesota natural gas and electric conservation improvement program.* Docket No. E,G002/CIP-06-80. From https://www.edockets.state.mn.us/EFiling/home.jsp