DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Product: Computer Efficiency

Description:

Manufacturer incentives will be offered for desktop computers that are either Energy Star or 80 Plus labeled. Incentives are administered via Ecos Plug Load Solutions PLS. Prescriptive rebates offered for end-use customers for installing VDI (Virtual Desktop Infrastructure) devices, also known as "Thin Client" systems instead of new PCs. PC Power Management is a prescriptive measure for an office-type occupancy which will provide customers with rebates for installing centralized PC power management software. Commercial customer incentives for installing servers with power supplies rated higher than Silver. At the moment, Silver efficiency power supplies are most commonplace in the market and will serve as the baseline. Gold, Platinum, and Titanium power supplies are eligible for incentive. All eligible servers are required to have redundant power supplies.

Algorithms:

General:

Gross Coincident kW Saved at Customer per Unit (kW)	= Customer kW x CF

Upstream Manufacturer Incentives:

Gross kW Saved at Customer per Unit (kW)	= (Baseline Computer kW - Efficient PS Computer kW) * Cooling kW factor * Quantity
Gross Annual kWh Saved at Customer per Unit (kWh/yr)	= (Baseline Computer kWh - Efficient PS Computer kWh) * Cooling kWh factor * Quantity
UMI Energy O&M Savings	= Customer kWh * Heating Penalty Factor * Gas Cost * Quantity

Desktop PC Virtualization:

Gross kW Saved at Customer per Unit (kW)	= (Baseline Computer kW - Virtualized kW) * Cooling kW factor * Quantity
Gross Annual kWh Saved at Customer per Unit (kWh/yr)	= (Baseline Computer kWh - Virtualized kWh) * Cooling kWh factor * Quantity
VDI Energy O&M Savings	= (Customer kWh * Heating Penalty Factor * Gas Cost * Quantity) + (Quantity * (O&M - Hours Savings + O&M - License Cost))

Network PC Power Management:

Gross kW Saved at Customer per Unit (kW)	= (kW_Base - kW_EE) x Cooling kW factor * Quantity
Gross Annual kWh Saved at Customer per Unit (kWh/yr)	= (kW_Base - kW_EE) x Hours x Cooling kWh factor * Quantity
VDI Energy O&M Savings	= (Customer kWh * Heating Penalty Factor * Gas Cost * Quantity) + (Quantity * O&M - License Cost)

High Efficiency Power Supply Server:

Power Supply reduction kW	= Baseline Power Supply kW - Proposed Power Supply kW
Power Supply Output Wattage	= input wattage * number of power supplies * load factor
Baseline Power Supply kW	= Power Supply Output Wattage / (1000 * Silver Efficiency)
Baseline Power Supply kWh	= Baseline kW * hours of operation
Proposed Power Supply kW	= Power Supply Output Wattage / (1000 * Proposed Efficiency)
Proposed Power Supply kWh	= Proposed kW * hours of operation
Cooling Interaction kW	= PS Cooling Load (tons) * Cooling System kW/ton [per temperature bin]
Cooling Interaction kWh	= Cooling Interaction kW * Cooling System Hours [per temperature bin]
PS Cooling Load (tons)	= Power Supply Reduction (kW) * 3413 / 12000
Gross kW Saved at Customer per Unit (kW)	= Power Supply Reduction + Cooling Interaction kW
Gross Coincident kW Saved at Customer per Unit (kW)	= Gross kW Saved at Customer per Unit * Coincidence Factor
Gross Annual kWh Saved at Customer per Unit (kWh/yr)	= (Power Supply Reduction * Hours of Operation) + Cooling Interaction kWh

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Variables:

General:

Customer kW	Calculated	Per measure kW savings value.
CF	Table 8	Probability that the calculated 'customer kW' will coincide with the period of generator peak operation
Cooling kW factor	Table 7	Average annual demand of cooling system necessary to cool the heat gain from the equipment (Ref. 13).
Cooling kWh factor	Table 7	= Average annual energy of cooling system necessary to cool the heat gain from the equipment (Ref. 13).
Heating Penalty Factor (Dth/kWh)	Table 7	= Average annual energy of heating system necessary to compensate for the negative heat gain associated with the more efficient equipment (Reference 13).
Gas Cost	$6.46	=Average Forecast Utility Cost ($/Dth) of Commercial Gas

Upstream Manufacturer Incentives:

Baseline Computer kW	Table 3	Average baseline computer energy demand (= Baseline Computer kWh / 8760 *Quantity)
Baseline Computer kWh	Table 3	Average baseline computer energy usage ('= UEC * PC Frequency * Quantity)
PC Frequency	Table 2	PC Frequency of Operating Patterns = Assumed % of the population that enables power management software in one of four available configurations (power management enabled, computer turned off; power management not enabled, computer turned off; power management enabled, computer left on; power management not enabled, computer left on (Reference 4); this is used to estimate average kWh usage over the entire population.
UEC	Table 3	Unit Energy Consumption = Sum of the products of the wattages and the annual hours in the four states of operation (active, idle, sleep, off) = (Active Wattage *Active Annual Hours of Operation)+(Idle Wattage * Idle Annual Hours of Operation)+(Sleep Wattage * Sleep Annual Hours of Operation)+(Off Wattage*Off Annual Hours of Operation) = Wattages are shown in Table 1 and Hours in each state are shown in Table 2.
Efficient PS Computer kW	Table 3	Average wattage demand of High Efficiency Power Supply
Efficient PS Computer kWh	Table 3	Average energy usage of High Efficiency Power Supply
Quantity		# of computers with a more efficient power supply
Measure Life	5 years	Average life of desktop computers (Reference 1)
Incremental Cost	Table 1	Cost of high efficiency model over baseline model
Net-to-Gross	88%	Reference 21

Desktop PC Virtualization:

Baseline Computer kW	Table 5	Societal aggregate baseline computer energy demand (= Baseline Computer kWh / 8760 *Quantity)
Baseline Computer kWh	Table 5	Societal aggregate of baseline computer energy usage * Quantity
Incremental Server kW	0.00401	Average energy usage per virtualized server = 273W (per Server) / 68 Virtual Machines (per Server) - Ref.9
Hours	8760	Average 'on' hours for a virtualized server
Quantity		# of VDI (thin client) devices installed instead of a desktop PC computer
VDI kW		kW of VDI product (provided by the customer)
Measure Life	10 years	Average life of desktop computers (Reference 1)
Incremental Cost	$117.00	Cost of high efficiency model over baseline model (Reference 6)
Net-to-Gross	88%	Calculated by applying a market penetration % of the efficient computer power supplies to the wattage and kilowatt-hour savings amount at five baseline levels. If our program was not in place, some of the customers that bought VDI boxes would have bought desktop computers at ESTAR 5 or higher.
O&M - Hours Savings	1/2	Hours Per Year per desktop @ $85/hr
O&M - Licence Cost	$12.00	Software License Fee per year per desktop

Network PC Power Management:

kW_Base	Table 5	Average weighted computer kW WITHOUT centralized power management.
kWh_Base	Table 5	Average weighted computer kWh WITHOUT centralized power management.
kW_EE	Table 5	Average weighted computer kW WITH centralized power management.
kWh_EE	Table 5	Average weighted computer kWh WITH centralized power management.
Hours	Table 6	Average PC hours broken out by operational state
Quantity		# of computers to be equipped with network power management control
Measure Life	6 Years	Length of time software will be utilized (Reference 19)
Baseline Cost	$0.00	Cost of the baseline technology. (The baseline is to continue to operate the existing system.)
Incremental Efficiency Cost	$15.00	Cost of the High Efficiency technology = average of various vendor products(Reference 15)
Net-to-Gross	88%	Aligns with the Computer Efficiency program as a whole
O&M - Licence Cost	$2.74	Software License Fee per year per desktop

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

High Efficiency Power Supply Server:

Proposed Efficiency	See Table 8	Power supply efficiency is dependent on efficiency level and loading
Power Supply input wattage	750	rated wattage of the power supply
HVAC System Type	Chilled Water	HVAC system type serving the data center where the power supplies will be installed. There are five options and the customer must indicate which option best matches their system. The options are shown in Table 10 below.
Load Factor	See Table 9	Power supply load factor
Number of Power Supplies	2	each power supply contains two power supplies for 100% redundancy. Load factors take the redundancy into account.
Hours of operation	8760	Servers operate all hours of the year
Chiller Efficiency (COP)	5.55	Assumed efficiency of data center central centrifugal chiller (ASHRAE 90.1-2001 (150-300 tons, centrif) page 34, Table 6.2.1L). Converted to kW/ton for use in the analysis.
DX Efficiency (EER)	9.5	Assumed efficiency of DX CRAC units (ASHRAE 90.1-2001 (>=240,000 BTU/h and <760,000 BTU/h, air cooled DX) page 27, Table 6.2.1A). Converted to kW/ton for use in the analysis
Glycol-Cooled DX Efficiency (EER)	11	Assumed efficiency of glycol (water) cooled DX CRAC units (ASHRAE 90.1-2001 (>=240,000 BTU/h, water cooled air conditioners) page 27, Table 6.2.1A). Converted to kW/ton for use in the analysis.
Cooling Tower Fan Energy (GPM/HP)	20	ASHRAE maximum cooling tower fan energy requirement (ASHRAE 90.1-2001 Centrif. Cooling Tower Fan Power, page 32, Table 6.2.1G) used to determine the cooling tower fan power/ton, along with the GPM/ton assumption.
Cooling Tower Sizing Factor (GPM/ton)	3	Standard cooling tower sizing rule of thumb (Ref 23,24,25)
Primary Chilled Water Pump Power (HP)	5	Assumed, based on assumed chiller size and typical primary pump size
Primary Chilled Water Pump Load	75%	Assumed, based on rule-of-thumb for pump load factor
Primary Chilled Water Pump Motor Efficiency	89.50%	Assumed, based on NEMA Premium motor efficiency for 5-hp motors
Chiller Size (tons)	150	Assumed, based on minimum chiller size within range used for chiller efficiency determination. This and the primary chilled water pump assumptions only affect the primary pump analysis and are only a very small portion of the total savings for this measure.
Measure Life (Retrofit)	5	Lifetime (in years) of the retrofit measure. This is based on subtracting the average CRAC unit age from the new construction lifetime. Ref 22.
Desired Chilled Water Temperature (F)	45	Chilled water supply temperature. This is a typical value for most chilled water systems.
Cooling Tower Approach (F)	7	Cooling tower approach (difference between outdoor air wet bulb temperature and condensing temperature). Values can range from 4-12 F, but 7 is typical.
Cooling Tower Design Wet Bulb Temperature (F)	69	Assumed design wet bulb temperature for cooling towers installed in the relevant location (69 F used for CO), based on weather data.
Chiller Minimum Efficiency Dry Bulb Temperature (F)	93	Assumed design dry bulb temperature for chiller in the relevant location (93 F used for CO), based on weather data.
Chiller Maximum Efficiency Dry Bulb Temperature (F)	30	Assumed dry bulb temperature below which the chiller's efficiency will not decrease any further.
Dry Cooler Dry Bulb Approach Temperature (F)	15	Dry cooler approach (difference between outdoor air dry bulb temperature and condensing temperature). 15 F is the most common value (Ref 27)
Cooling Equipment Temperature-based Efficiency Improvement (%/F)	0.50%	Assumed efficiency improvement for chiller and DX systems (and, for simplicity, cooling tower fans) based on outdoor dry bulb temperature decrease (due to lower condenser pressure). Standard Xcel Energy assumption for cooling interaction.
Net-to-Gross	88%	To match overall program. Program will be evaluated in 2016.

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Tables:

Table 1: Desktop Computer Wattages

Desktop Computer	Avg Active Watts (W)	Idle (W)	Sleep (W)	Off /Standby (W)	Incremental Cost (reference 5)	Notes
Baseline Aggregate: ES 3.0	97.48	71.20	4.14	2.05		Reference 2
ES 5.0 or 80 Plus Qualified	97.48	46.20	2.45	1.47		Reference 5
ES 5.0 or 80 Plus Bronze Qualified	92.60	43.70	2.45	1.47	$9.00	Reference 5
ES 5.0 or 80 Plus Silver Qualified	89.68	42.32	2.45	1.47	$14.00	Reference 5
ES 5.0 or 80 Plus Gold Qualified	87.73	41.40	2.45	1.47	$16.00	Reference 5
ES 5.0 or 80 Plus Platinum Qualified	85.78	40.48	2.45	1.47	$22.00	Reference 5

Table 2: Annual Hours in each Operational State and Frequency of PC Operation Patterns (PC Frequency)

Computer State	Active (Hrs/year)	Idle (Hrs/year)	Sleep (Hrs/year)	Standby / Off (Hrs/year)	PC Frequency	Notes
Power managed (local), turned off	175	5,011	431	3,143	11.7%	Reference 3
Not power managed (local), turned off	175	5,422	0	3,143	66.3%	Reference 3
Power managed (local), left on	175	5,687	2,898	0	3.3%	Reference 3
Not power managed (local), left on	175	8,585	0	0	18.7%	Reference 3

Table 3: Energy and Demand Savings (Reference 1-5)

Desktop Computer	UEC	Computer Watts	Computer kWh/yr	Cooling Watts	Cooling Peak kWh	Customer kW Savings	Customer kWh Savings	Heating Dth Penalty
Baseline: ES 3.0	NA	51.3	449.0	16.91	58			
ES 4.0 or 80 Plus Qualified	1223	33.8	296.5	11.17	39	0.0232	172	
ES 5.0 or 80 Plus Bronze Qualified	1163	32.2	281.8	10.62	37	0.0254	189	-0.09
ES 5.0 or 80 Plus Silver Qualified	1127	31.2	273.1	10.29	35	0.0267	199	-0.10
ES 5.0 or 80 Plus Gold Qualified	1102	30.5	267.2	10.07	35	0.0276	205	-0.10
ES 5.0 or 80 Plus Platinum Qualified	1078	29.8	261.4	9.85	34	0.0285	212	-0.10

Table 4: Computer Annual kWh and Average kW (Reference 14, 18)

	No centralized PC Power Management		With centralized PC Power		% of Program
Desktop PC	kWh_Base	kW_Base	kWh_EE	kW_EE	Participation
ENERGY STAR 3.0 Aggregate Desktop PC	449.00	0.0513	155.16	0.0177	8.89%
ENERGY STAR 4.0 Desktop PC	322.07	0.0368	120.59	0.0138	19.11%
ENERGYSTAR 5.0 Desktop PC	297.65	0.0340	106.26	0.0121	72.00%
Aggregate of Society	315.77	0.0360	113.35	0.0129	100.00%

Table 5: Hours of Operation (Reference 14, 16, 17 & Table 2 - for non-network aggregate operation.)

Desktop PC	Active	Idle	Sleep	Off	Total
Not network power managed, left on	175	8,150	435	0	8,760
Not network power managed, turned off	175	5,377	65	3,143	8,760
Network power managed, left on	175	1,631	6,954	0	8,760
Network power managed turned off	175	1,631	431	6,523	8,760

Table 6: Secondary Cooling/Heating Values

Location	kW	kWh	Dth/kWh	Notes
Front Range	1.33	1.13	-0.000504027	Reference 13
Western Slope	1.33	1.137	-0.000504027	Reference 13
Mountain	1.33	1.099	-0.000702273	Reference 13

Table 7: Per Measure Coincidence Factors

Upstream Manufaturer Incentives	100%
Desktop PC Virtualization	100%
PC Power Management	0%

Table 8: Power Supply Efficiency

Loading	Silver	Gold	Platinum	Titanium
5%	75.1%	80.2%	85.6%	90.6%
10%	79.0%	83.4%	87.9%	92.1%
15%	82.9%	86.5%	90.2%	93.5%
20%	86.8%	89.6%	92.5%	94.9%
30%	88.0%	90.6%	93.1%	95.3%
40%	89.2%	91.5%	93.7%	95.8%
50%	90.4%	92.5%	94.3%	96.2%
60%	90.1%	92.2%	94.0%	95.9%
70%	89.8%	92.0%	93.7%	95.6%
80%	89.5%	91.8%	93.4%	95.3%
90%	89.2%	91.5%	93.2%	95.1%
100%	88.9%	91.3%	92.9%	94.8%

Ref 22, 26

Table 9: Power Supply Load Factor

Loading	% operating hours	
	Hi Performance	Bus Computing
5%	5%	10%
10%	10%	55%
15%	55%	30%
20%	30%	5%
30%	0%	0%
40%	0%	0%
50%	0%	0%
60%	0%	0%
70%	0%	0%
80%	0%	0%
90%	0%	0%
100%	0%	0%

Ref 22, 26

Table 10: Cooling System Efficiencies

HVAC System Type	Efficiency	kW/ton	Notes
Chilled Water	5.55 COP	0.634	kW/ton is the rated efficiency
DX	9.5 EER	1.263	kW/ton is the rated efficiency
Glycol-Cooled DX	11 EER	1.091	kW/ton is the rated efficiency
Glycol-Cooled DX with Waterside Economizer	N/A	0.756	kW/ton is calculated from weather data and includes free cooling
Chilled Water with Waterside Economizer	N/A	0.407	kW/ton is calculated from weather data and includes free cooling

Table 11: Cooling Efficiency Table (kW/Ton)

Temperature	Water-Cooled Chiller	DX	Water-Cooled DX	Water-Cooled DX w/ WS Economizer	Water-Cooled Chiller w/WS Economizer
Determinate Temperature: (dB/wB)	Wet Bulb	Dry Bulb	Dry Bulb	Dry Bulb	Wet Bulb
-3	0.4584	0.8653	0.8316	0.1231	0.0036
-1	0.4584	0.8653	0.8316	0.1231	0.0036
1	0.4584	0.8653	0.8316	0.1231	0.0036
3	0.4584	0.8653	0.8316	0.1231	0.0036
5	0.4584	0.8653	0.8316	0.1231	0.0036
7	0.4584	0.8653	0.8316	0.1231	0.0036
9	0.4584	0.8653	0.8316	0.1231	0.0043
11	0.4584	0.8653	0.8316	0.1231	0.0052
13	0.4584	0.8653	0.8316	0.1231	0.0065
15	0.4584	0.8653	0.8316	0.1231	0.0083
17	0.4584	0.8653	0.8316	0.1231	0.0108
19	0.4591	0.8653	0.8316	0.1231	0.0145
21	0.4601	0.8653	0.8316	0.1231	0.0202
23	0.4613	0.8653	0.8316	0.1231	0.0297
25	0.4645	0.8653	0.8316	0.1231	0.0468
27	0.4766	0.8653	0.8316	0.1231	0.0817
29	0.4903	0.8653	0.8316	0.1231	0.1141
31	0.4993	0.8716	0.8377	0.2252	0.1141
33	0.5202	0.8842	0.8498	0.3307	0.1141
35	0.5468	0.8968	0.8619	0.4397	0.1141
37	0.5924	0.9095	0.8741	0.5522	0.1141
39	0.6314	0.9221	0.8862	0.6682	0.6314
41	0.6385	0.9347	0.8984	0.7876	0.6385
43	0.6492	0.9474	0.9105	0.9105	0.6492
45	0.6514	0.9600	0.9226	0.9226	0.6514
47	0.6587	0.9726	0.9348	0.9348	0.6587
49	0.6735	0.9853	0.9469	0.9469	0.6735
51	0.6808	0.9979	0.9591	0.9591	0.6808
53	0.6871	1.0105	0.9712	0.9712	0.6871
55	0.6971	1.0232	0.9833	0.9833	0.6971
57	0.7086	1.0358	0.9955	0.9955	0.7086
59	0.7167	1.0484	1.0076	1.0076	0.7167
61	0.7172	1.0611	1.0198	1.0198	0.7172
63	0.7284	1.0737	1.0319	1.0319	0.7284
65	0.7303	1.0863	1.0440	1.0440	0.7303
67	0.7302	1.0989	1.0562	1.0562	0.7302
69	0.7512	1.1116	1.0683	1.0683	0.7512
71	N/A	1.1242	1.0805	1.0805	N/A
73	N/A	1.1368	1.0926	1.0926	N/A
75	N/A	1.1495	1.1047	1.1047	N/A
77	N/A	1.1621	1.1169	1.1169	N/A
79	N/A	1.1747	1.1290	1.1290	N/A
81	N/A	1.1874	1.1412	1.1412	N/A
83	N/A	1.2000	1.1533	1.1533	N/A
85	N/A	1.2126	1.1654	1.1654	N/A
87	N/A	1.2253	1.1776	1.1776	N/A
89	N/A	1.2379	1.1897	1.1897	N/A
91	N/A	1.2505	1.2019	1.2019	N/A
93	N/A	1.2632	1.2140	1.2140	N/A
95	N/A	1.2632	1.2140	1.2140	N/A
97	N/A	1.2632	1.2140	1.2140	N/A
99	N/A	1.2632	1.2140	1.2140	N/A
101	N/A	1.2632	1.2140	1.2140	N/A
103	N/A	1.2632	1.2140	1.2140	N/A

Table 12: Power Supply Costs and Market Share

Watts	Silver	Gold	Platinum	Titanium	Market Share
300	$ 30.00	$ 37.50	$ 50.00	$ 67.50	10%
500	$ 40.00	$ 47.50	$ 60.00	$ 77.50	50%
750	$ 50.00	$ 57.50	$ 70.00	$ 87.50	25%
1400	$ 65.00	$ 72.50	$ 85.00	$ 102.50	15%

Ref 22, 27

Table 13: Incremental Cost per Power Supply ($)

Server Efficiency	min	max	avg
silver to gold	$ 5.00	$ 10.00	$ 7.50
gold to platinum	$ 10.00	$ 15.00	$ 12.50
platinum to titanium	$ 15.00	$ 20.00	$ 17.50

Ref 22, 27

Table 14 Incremental Cost per Server

Server Efficiency	Server Wattage Range			
	<400	400-600	600-1000	>1000
Gold	$ 11.63	$ 13.88	$ 16.13	$ 18.38
Platinum	$ 31.00	$ 37.00	$ 43.00	$ 49.00
Titanium	$ 58.13	$ 69.38	$ 80.63	$ 91.88

Ref 28

Table 15: Assumed Allocation of Cooling Systems (For Forecasting purposes)

Type of Cooling System	% Allocation
Chiller	20%
DX	20%
Water-Cooled DX	20%
Water-Cooled DX with WSE	20%
Chiller with WSE	20%

References:

1. Koomey, J., M. Cramer, M.A. Piette and J. Eto. 1995. "Efficiency Improvements in U.S. Office Equipment: Expected Policy Impacts and Uncertainties." Lawrence Berkeley Laboratory. LBL-37383. December. Table 3.

2. Energy Star Calculator Tool; LBNL 2007 or Energy Star Specification

3. Hours of operation for desktop computers from office desktops/laptops and office monitors from Piette, M. A., M. Cramer, J. Eto and J. Koomey. 1995. "Office Technology Energy Use and Savings Potential in New York." Prepared for the NY State Energy R&D Authority and Con-Ed by LBNL. Lawrence Berkeley Laboratory. LBL-36752. January 1995. p. 4-2

4. LBNL Estimate based on Reference 3
5. Ecos Consulting information from manufacturers
6. Vendor data; see "Ref Cost-PC Virt" worksheet
7. Baseline desktop PC cost assumed at $600; info from the internet indicates a PC with keyboard averages between $300-$1,000 or $650; assumed the keyboard is $50 of that (Ref 6)
8. Costhelper.com
9. Server Wattages from Custom Efficiency program participant; average wattage of 42 models. (Wattages last confirmed in 2014)
10. 10-year life for thin-client and zero-client based on conversation with MN vendor Nowmicro
11. Assumed server utilization rate of 80% of nameplate capacity based on custom efficiency projects in MN and CO 2008-2011
12. ECOVA - May 2013
13. Based upon Rundquist Method Calculation (Matches Colorado Commercial Lighting Program)
14. Ecos Consulting (now Ecova), 2009
15. Various Equipment Vendors
16. Measured Energy Savings and Performance of Power-Managed Personal Computers and Monitors, 1996, Lawrence Berkeley National Laboratory
17. PC and Monitor Night Status: Power Management Enabling and Manual Turn-off, 1998, Lawrence Berkeley National Laboratory
18. ENERGY STAR, 2012
19. Xcel Energy Custom Efficiency projects
20. https://www.efficiencyvermont.com/docs/about_efficiency_vermont/annual_reports/Efficiency-Vermont-2013-Gross-to-Net-Factors.pdf
21. 2014 Michaels Energy (independent 3rd part) NTG review.

References (continued):

22. Ecova, multiple discussions
23. Cooling Plant Optimization (http://academic.udayton.edu/kissock/http/EEB/LecturesAndHomework/23-CoolingPlantOptimization/CoolingPlantOptimization.docx)
24. Georgia Tech Student Thesis (http://www-old.me.gatech.edu/energy/students/liuthesis.pdf)
25. Condenser Water Energy Savings (
http://web.stanford.edu/group/narratives/classes/08-09/CEE215/ReferenceLibrary/Chillers/York%20Engineering%20Updates/Reduced%20condenser-water%20flow%20rate_energy-saving%20miracle%20or%20mirage.pdf)
26. Server Power Supplies Data Points_PMO.XLS supplied by Ecova on 9/1/14
27. 80 Plus Servers Calculator_Xcel14Aug2014.xlsx file provided by Ecova on 9/1/14
28. Inernal adjustment by Xcel energy to distribute power supply cost in a commensurate with wattage served. Values will be reviewed over time as additional information becomes available.

Changes from Previous Filing:

1. Adjusted average societal baseline for PC Power Management and VDI Measures to increase shift to ES 5.0 computers. Refer to Table 5.
2. Revised the NTG to match the findings of the 2014 third-party review.
3. Addition of High Efficiency Power Supply Server Measure