DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Program: Computer Efficiency

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 occupancy which will provide customers with rebates for installing centralized PC power management software.

Algorithms:

Electrical Energy Savings (Generator kWh)	= Customer kWh / (1-TDLF)
Electrical Demand Savings (Generator kW)	= Customer kW x CF / (1-TDLF)

Upstream Manufacturer Incentives:

Desktop Computer Electrical Demand Savings (Customer kW Savings)	= (Baseline Computer kW - Efficient PS Computer kW) * Cooling kW factor Values listed in Table 3.
Desktop Computer Electrical Energy Savings (Customer kWh Savings)	= (Baseline Computer kWh - Efficient PS Computer kWh) * Cooling kWh factor Values listed in Table 3.

Desktop PC Virtualization:

VDI Electrical Demand Savings (Customer kW)	= Baseline Computer kW - Virtualized kW * Cooling kW factor
VDI Electrical Energy Savings (Customer kWh)	= Baseline Computer kWh - Virtualized kWh * Cooling kWh factor

Network PC Power Management

Electrical Demand Savings (Customer kW)	= (kW_Base - kW_EE) x HVAC_cooling_kWsavings_factor
Electrical Energy Savings (Customer kWh)	= (kW_Base - kW_EE) x Hours x HVAC_cooling_kWhsavings_factor
Peak Coincident kW at the Customer (PC_KW_CUST)	= Customer kW x CF
kW_Base	= kWh_Base / Hours
kW_EE	= kWh_EE / Hours

Variables:

TDLF	Transmission Distribution Loss Factor = 6.50%, the percentage loss of electricity as it flows from the power plant to the customer.
Cooling kW factor	Average annual demand of cooling system necessary to cool the heat gain from the equipment = 33% of baseline and VDI and Network PCPM kW = 1.33 (Reference 13)
Cooling kWh factor	= Average annual energy of cooling system necessary to cool the heat gain from the equipment = 11% of baseline and VDI and Network PCPM kWh = 1.11 (Reference 13)
CF	Coincidence Factor = 100% for Upstream Manufaturer Incentives and VDI, 0% for PC Power Management

PC Frequency	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 (Ref 4); this is used to estimate average kWh usage over the entire population. Values listed in Table 2.
UEC	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. UEC for each computer model is shown in Table 3

Upstream Manufacturer Incentives (Desktops):

Baseline Computer kW	= Baseline Computer kWh/8760 = = 62.0 watts
Baseline Computer kWh	= UEC * PC Frequency = 543
Measure Life	= 4 years for desktop computers (Ref 1)
Hrs	Hours of Operation = Determined by dividing the average kWh by the average kW (Assumption 2)
Incremental Costs	Cost of high efficiency model over baseline model as listed in Table 1.
NTG	Net-to-Gross = Calculated by applying a market penetration % to the wattage and kilowatt-hour savings amount at the four efficiency levels. Values are shown in Table 4 below, we will use 88% for all measures for simplification.
O&M savings	The additional costs associated with the additional heating costs due to the reduced heat generation from the equipment is also treated as O & M penalty (reference 13)

Desktop PC Virtualization:

Baseline Computer kW	= Baseline Computer kWh/8760 = 62.0 watts
Baseline Computer kWh	= UEC * PC Frequency for ENERGY STAR 3.0 Computers = 543
VDI kW	= kW of VDI product (provided by the customer)
Incremental Server kW	Server load per installed VDI device = Total average server Watts (273W) / 68 desktops per server = 4.01 Watts (Ref 9)
Virtualized kW	VDI kW + Incremental Server kW

Virtualized kWh	Virtualized kW x hours
Measure Life	= 10 years (Ref 10)
Hours	Hours of Operation of efficient equipment = VDI equipment assumed to be on 8,760 hours per year
Incremental Costs	Cost of higher efficiency option over baseline option = $117 (Ref 6)
NTG	Net-to-Gross = 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 4 or higher. = 92%
O&M savings	Operation and Maintenance savings are assumed to be 1/2 hour per year per desktop, O/S licenses (specific for virtualization) assumed to be $12/year per desktop. The additional costs associated with the additional heating costs due to the reduced heat generation from the equipment is also treated as O & M penalty (Reference 13)

Network PC Power Management

Hours	Annual Operating Hours = 8,760; Total hours in Active, Idle, Sleep, and Off stages.
kW_Base	Average weighted computer kW WITHOUT centralized power management; See Table 5
kWh_Base	Average weighted computer kWh WITHOUT centralized power management; See Table 5
kW_EE	Average weighted computer kW WITH centralized power management; See Table 5
kWh_EE	Average weighted computer kWh WITH centralized power management; See Table 5
Measure Life	Length of time software will be utilized = 6 years (Reference 19)
Baseline Cost	Cost of the baseline technology. This is $0 since the baseline is to continue to operate the existing system.
Incremental Efficiency Cost	Cost of the High Efficiency technology = average of various vendor products = $12.30 (Reference 15)
NTG	Net-to-gross = 88% to align with the Computer Efficiency program
Incremental operation and maintenance cost	Other annual savings or costs associated with the electrical savings. For PC Power Management, this consists of additional natural gas costs for heating. (Reference 13) There are also annual re-licensing fees associated with the product. Average year 1 set up fee from manufacturer: $1.05 per computer. Average annual O&M fees from manufacturer = $2.35 per PC. (Reference 15).

Info needed from Customer/Vendor Administrator for Calculations:

Desktop PC Virtualization:

# of VDI (thin client) devices installed instead of a desktop PC computer

kW of VDI device

Table 1: Desktop Computer Wattages

Desktop Computer	Avg Active Watts (W)	Idle (W)	Sleep (W)	Off /Standby (W)	Incremental Cost (reference 5)	
Baseline: ES 3.0	115	84	6	3		Reference 2
ES 4.0 or 80 Plus Qualified	111	66	3.4	1.7		Reference 5
ES 5.0 or 80 Plus Bronze Qualified	89	46	2	0.9	$9.00	Reference 5
ES 5.0 or 80 Plus Silver Qualified	86	46	2	0.9	$18.00	Reference 5
ES 5.0 or 80 Plus Gold Qualified	84	46	2	0.9	$27.00	Reference 5
ES 5.0 or 80 Plus Platinum Qualified	82	46	2	0.9	$36.00	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
Power managed (local), turned off	586	4,600	431	3,143	11.7%
Not power managed (local), turned off	586	5,031	0	3,143	66.3%
Power managed (local), left on	586	5,276	2,898	0	3.3%
Not power managed (local), left on	586	8,174	0	0	18.7%
Weighted average					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
Baseline: ES 3.0	2245	62.0	543.3	20.47	60		
ES 4.0 or 80 Plus Qualified	1806	50.0	437.8	16.49	48	0.0160	117
ES 5.0 or 80 Plus Bronze Qualified	1283	35.5	311.2	11.72	34	0.0352	258
ES 5.0 or 80 Plus Silver Qualified	1276	35.3	309.4	11.66	34	0.0355	260
ES 5.0 or 80 Plus Gold Qualified	1272	35.2	308.3	11.61	34	0.0357	261
ES 5.0 or 80 Plus Platinum Qualified	1268	35.1	307.1	11.57	34	0.0359	262

Table 4: Net-to-Gross Calculation: Upstream Manufacturer Incentives (Desktops)

Desktop Computer	CO Market Penetration % (ref 12)	Net Customer kW Saved	Net Customer kWh Saved	NTG
ES 4.0 or 80 Plus Qualified	10%			
ES 5.0 or 80 Plus Bronze Qualified	5%	0.0310	227	87.9%
ES 5.0 or80 Plus Silver Qualified	0%	0.0312	228	88.0%
ES 5.0 or 80 Plus Gold Qualified	2.5%	0.0314	230	88.1%
ES 5.0 or 80 Plus Platinum Qualified	0%	0.0316	231	88.1%
Average				88.00%

Table 5: Computer Annual kWh and Average kW (Reference 14, 18)

	No centralized PC		With centralized PC		% of Program
Desktop PC	**kWh_Base**	**kW_Base**	**kWh_EE**	**kW_EE**	**Participation**
ENERGY STAR 3.0 Desktop PC	543.83	0.0620	202.21	0.0231	13.33%
ENERGY STAR 4.0 Desktop PC w/ 80 Plus Bronze power supply	335.98	0.0383	131.25	0.0150	28.67%
ENERGYSTAR 5.0 Desktop PC w/ 80 Plus Bronze power supply	311.49	0.0355	118.59	0.0135	58.00%
Aggregate of Society	349.49	0.0399	133.37	0.0152	100.00%

Table 6: Hours of Operation (Reference 14, 16, 17 & Table 2 - for non-network aggregate operation.)

Desktop PC	**Active**	**Idle**	**Sleep**	**Off**
Not network power managed, left on	586	7,739	435	0
Not network power managed, turned off	586	4,966	65	3,143
Network power managed, left on	586	1,220	6,954	0
Network power managed turned off	586	1,220	431	6,523

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

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. Colorado market penetration initially assumed as 50% of current market penetration in Minnesota because Minnesota is a more mature market; Minnesota data from Ecos Consulting

13. Colorado Commercial Lighting Program (cooling benefit is 33% of equipment kW savings, 11% of equipment kWh savings and heating penalty is 0.00088738 MMBtu/kWh)