Server Room Airflow Management Overview

Objective

To learn about server-room airflow management (AFM) energy saving opportunities

Almost every business has servers for phone and computer equipment.

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Background

- Servers and server-rooms can be found in most buildings
- Data centers and server-rooms can be 5%+ of utility loads
- Many server-rooms, colocation and multi-tenant data centers
- Airflow management has been an accepted practice since 2007
- Airflow management is being done in most large data centers
- Airflow management is NOT being done in most server-rooms, colocation and multi-tenant data centers





Targeting Server Rooms

Space Type	Example
Server Closet	Small business or school
Small Sanvar Boom	Medium sized business
Small Server Room	with less than 400 staff
Medium Server	Large business, hospital
Room	or university
	Corporate data center, or
Large Server Room	medium sized colocation
	facility
Entorpriso Class	Internet company server
Data Contor	farm, state data center or
Data Center	large colocation facility





What is a Server Room?

Server-rooms are typically:

- Located in a commercial building;
- Are between 200 and 5,000 square feet;
- Have between 4 and 250 servers;
- Need between 10 and 250 tons of cooling capacity;
- Use between 150,000 and 3,750,000 kWh annually.

Server Rooms

- Server rooms found in most medium/ large commercial buildings
- **VERY** Energy intensive
- Can't manage building energy use without managing the server room

Facility Type	% of Data Center in Building	% of Building Electric used by Data Center
Municipal Office Bldg.	0.8%	23.1%
Regional Office Bldg. Software Co.	3.0%	26.7%
Corporate Office Travel Company	1.8%	29.5%
School District Administration Bldg.	1.5%	32.7%

Efficiency Perception



Reality –lots of opportunity



Server Room HVAC Systems

- Computer room air conditioners (CRACs): splitsystem DX air conditioning units
- Computer room air handlers (CRAHs): air handling units which use cold water from a central chiller plant
- Other: Some small closets use the general building cooling system.

What is Airflow Management?

Airflow Management reduces HVAC energy use, while maintaining server cooling

Common strategies include:

- Optimizing under-floor air flow (UAF) systems,
- Adding rack blanking panels,
- Hot or cold isle containment,
- Raising temperature set points, and
- Adding VSDs and controls to CRACs and CRAHs.

What is Airflow Management?

Cold aisle containment





What is Airflow Management?

Cold aisle containment





Why Airflow Management?

For utilities AFM represents energy savings:

- Server rooms represent 261 aMW of potential in the 7th Power Plan.
- Airflow management can save up to 50% of data center HVAC energy use.

For owners AFM represents cost savings and:

 fewer hot spots, better operational visibility, safer and more reliable operation, lower maintenance and increased capacity.

Server-Room Airflow Management Calculator Overview

This calculator is intended to provide a quick, robust estimate of server-room baseline HVAC energy use, energy use with Airflow Management and energy savings, suitable for potential utility incentives

Hurdles for Utility Incentives

- Airflow efficiency measures are well documented and accepted
- Estimating ROI of AFM implementation can be difficult
 - Lack of data about equipment performance
 - Lack of monitoring in many facilities
 - Lack of understanding about savings associated w/ AFM
 - AFM doesn't produce savings it enables changes that produce savings
- Operators are often not experts in energy consumption
- Customized engineering calculations
 - Time consuming & costly
 - Similar effort for small server rooms and large server rooms
- Utility incentive not always enough for implementation

Why develop an airflow tool?

- Significant opportunity for improved efficiency
- Similar measures and HVAC equipment involved
- Custom calculation approach for each project is too expensive and cumbersome to gain traction
- No standardized method available for utilities or trade allies to offer incentives for airflow management

Tool objectives

- Cost-effective method to calculate energy savings for small data centers
- Address common improvements to airflows and cooling system operations in smaller data centers – Supply fans, chillers, Dx CRAC units
- Estimate energy savings for potential utility incentive funding
- Document methodology and assumptions for utility program evaluators

Calculator Applicability

- Data centers with 50-750 kW of IT equipment
- Racks with an average power density of 2 5 kW per rack
- Maximum power density of 10 kW per rack







Cooling system types

- DX RTU
- DX CRAC
 - Air-cooled
 - Water-cooled
 - Glycol-cooled
- CHW CRAH





What is the airflow calculator tool?

- A spreadsheet tool that calculates annualized energy and peak demand changes resulting from HVAC system changes enabled by measures to improve airflows in a data center.
- <u>ONLY</u> meant to provide reliable estimates of energy savings for common airflow management improvements
- NOT For:
 - Data center design
 - Thermal management

What it does:

- Tool estimates cooling energy use based on user supplied inputs:
 - Cooling load
 - Operating set points,
 - Inventory of existing cooling equipment
 - TMY3 hourly climate data
- Existing (base line), Proposed, Implemented scenarios compared for potential and actual savings estimates

CALCULATOR

Example



Example use case

- Large admin bldg. server room
 - 4,000 SqFt (5% of Bldg. SqFt)
 - 200 kW IT Equipment
 - >55% of annual bldg. kWh use

- <page-header>
- Processed as a custom incentive
 - 20-30 hrs. spent estimating energy use, savings
- Calculator tool applied to project data
 - 25 minutes spent for data entry
 - Tool results: 3% less than actual kWh savings

Cooling Loads, Facility Details

/er	1.0 11/02/2015									
	Project #	SEACH-Admin Test	Calculator Co	ompleted By:	ТВ				Date:	11/2/2015
	Facility Information			Uninterrup	ptible Powe	er Supply (l	JPS) Power	& Cooling	Load Inp	uts
					UPS kW	UPS Input			Load	
	Company	SEACH			Capacity	kW	UPS Out kW	kW Loss	factor	Efficiency
	Facility Name	Admin Data Center		UPS 1	270	114.7	103	11.7	42.5%	89.8%
	Address	123 Any Ave. NE		UPS 2	270	108.3	96	12.3	40.1%	88.6%
	City, State Zip	Seattle, WA 98115		UPS 3				0	0.0%	0.0%
	Contact	Mickey Mouse		UPS 4				0	0.0%	0.0%
	Title	DC Ops Mgr.		TOTALS	540	223	199	24	41.3%	89.2%
	Phone	206.555.1212								
	email	mickey@mouse.com								
	Utility Cost / Incentive Inputs			Data Cent	er Inputs					
	Avg. kWh Electricity Cost	\$ 0.071		2	03	Critical Coolir	ng Load Inside D)ata Center -	kW	
	Avg. kW Peak Demand Charge	\$ 1.92		3,0	000	Square Feet				
	per kWh Utility Incentive rate	\$ 0.20		5	00	Max. Critical	Load - kW			
	per kW Demand reduction Incentive			8,3	760	Annual Opera	ating Hours			
				I	No	UPS Units in	Data Center?			
	Annual Facility kWh	4,631,289		Seatt	le, WA	Climate City				
				2	%	% Of Misc.H	eat Gain (PDU lo	osses, plug lo	ads)	
				Blade/ Hig	qh Densitγ	🛛 🖛 🖉 🖉 🖉	uipment Type			
				2	24	Primary IT Ec	uipment Delta T	「(°F)		
				1	30	CFM / kW A	inflow required for	or Critical Coo	ling load (Ty	/pical)

Existing (base line) operations

- HVAC system type
- Current operating conditions

EXISTING C Current Le	OOLING SYSTEM INPUTS vel of Airflow Management Blanking Panels, Dedicated H/C A	isles, Perí tiles o	Fer 1.6 1 Description cold rows on	11/02/2015 	r		Restore Defau	ults			1. RA Te 2. Any c recalcul	mp and Hi hanges to i ated for re	umidity are inputs nee sults to be	required d to be updated		Dema k∨ 83.4	* Total * Energg k∀h 658,242	6	alculate	ŀ
AHU	Type	Economizer	Nominal Tons			Fan Type	,	Coolin Load	9 On łOff	RAT setpoint					Vorst Case Capacity	Pea Dema d	n Annual Energy	Efficiency (annualize d)	X Econ	X Non econ
			Toas Capacity						0+Off; 1+ On	Beturn Air Temp Setpoint	Return Air Relative Humidity	Avg Supply Air Temp	Actual Delta T	Glycol %	Tons	٨V	kWh	kW/ton		
CRAC1	Vater-cooled CRAC with DX cooling	No	20		<u></u>	roll fan witho	# VFD	42	1	73	50%	67	6		15	12.6	96,208	0.91	0%	100%
CRAC 2	Vater-cooled CHAC with EX cooling	No	20	<u> </u>	30	roll in without	2 VFD	46		75	50%	50 61	20		- 10 	12.4	92,564	0.90	0%	100%
CRAC 4	Vater-cooled CRAC with DX cooling	No	20	<u> </u>	Se	roll fan withor	# VED	42	i	78	50%	52	26		- 2	121	92.471	0.88	0%	100%
CRAC5-Lab	Vater-cooled CRAC with DX cooling	No	16		So	roll fan withor	ut VFD	34	1	71	50%	68	3		12	10.4	78,579	0.93	0%	100%
				<u> </u>					-									4		<u> </u>
				<u> </u>					-			<u> </u>								<u> </u>
Totals			96					283	5						74	59.6	454 293			
Fan Inputs																		1 4		Aidler
AHU	Type					Fi					v	FD or ON	OFF Cge	ling	CFM	Dema	n Energy	Demand		CFM
AHU	Туре	нр	Fas Static Pressure (in. H2O)	RPM	Motor Type	Fa Motor Enclosure	Belt Type	Motor	y Efficiency	Bak Efficiency	Speed% or Cycle ON%	VFD Efficiency	Bec. Speed% or ON%	Affinity Lov Exposunt	CFM Estimated	Dema k∨	kWh	Demand k∨		CFM Require CFM
CRAC1	T gpe Water-cooled CRAC with DX cooling	HP 7.5	Fae Static Pressure (in. H20) 197	RPM	Motor Type Premium	Fa Motor Exclosure ODP	Bulk Type Standard V-be	Motor Efficient elt 91%	y Fun Efficiency 56%	Bek Efficiency 95%	Speed% or Cycle ON%	FD or ON VFD Efficiency	Port Cycl Rec. Speed's or ONS	Affinity Lov Exposunt	CFM Estimated	Dema kV 43	kWh	Aug Demand k∨ 4.8		CFM Require CFM 26,387
CRAC1 CRAC2	Type Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling	HP 7.5 7.5	Fas Stutic Pressure (in. H20) 1.97 1.97	RPM 1,800	Motor Type Premium Premium	Motor Exclosure ODP	Belt Type Standard V-bi Standard V-bi	Motor Efficient elt 91% elt 91%	y Fun Efficiency 56%	Bak Efficiency 95%	Speed% or Cycle ON%	VFD Efficiency	POFF Cycl Rec. Speeds or ONS	Affinity Lov Exposed	CFM Estimated 10,200	Dem: k∀ 4.9 4.9	Annual Energy k.Vh 42,82 42,82	Aug Demand k∨ 4.8 4.8		CFM Require CFM 26,387 Availab
CRAC1 CRAC2 CRAC3 CRAC3	T spe Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling	HP 7.5 7.5 7.5 7.5	Fas Static Pressure (in. H20) 1.97 1.97 1.97	RPM 1,800 1,800 1,800	Motor Type Premium Premium Premium	Fi Motor Exclosure ODP ODP ODP	Bulk Type Standard V-bi Standard V-bi Standard V-bi Standard V-bi	Motor Efficient elt 985 elt 9155 elt 9155 elt 9155	y Fan Efficiency 56% 56% 56%	Buk Efficiency 95% 95% 95%	Speed% or Cycle ON%	VFD Efficiency	POFF Cycl Rec. Speeds or ONS	Atfinity Lov Exposed	CFM Estinuted 10,200 10,200 10,200	Dema k∨ 4.9 4.9 4.9	Annual Energy k\Vh 42,162 42,52 42,52 42,52	Aug Demand k∨ 4.8 4.8 4.8 4.8 4.8		CFM Require CFM 26,387 Availab CFM
CRAC1 CRAC2 CRAC3 CRAC3 CRAC4 CRAC5-Lab	Type Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling	HP 7.5 7.5 7.5 7.5 5	Pae Stutic Pressure (in. H20) 197 197 197 197 197	RPM (800 1,800 1,800 1,800 1,800	Motor Type Premium Premium Premium Premium	Fi Motor Exclosure ODP ODP ODP ODP	Belt Type Standard V-br Standard V-br Standard V-br Standard V-br	Motor Efficient elt 985 elt 985 elt 985 elt 985 elt 985	y Efficiency 56% 56% 56% 56%	Bak Efficiency 95% 95% 95% 95%	Speed% or Cycle ON%	FD or ON VFD Ethiciancy	POFF Cycl Rec. Speeds or ONS	Affinity Lov Exposust	CFM Estimated 10,200 10,200 10,200 8,400	Dem: k∨ 43 43 43 43 43 43 43	Ansuar Energy k.Vh 42,162 42,162 42,162 42,162 35,003	Avg Demand k∨ 4.8 4.8 4.8 4.8 4.8 4.8 4.8		CFM Require CFM 26,387 Availab CFM 49,200 Excess
CRAC1 CRAC2 CRAC3 CRAC4 CRAC5 Lab	Type Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling	HP 7.5 7.5 7.5 7.5 5	Fas Static Pressure (in. H20) 197 197 197 197	RPM 1,800 1,800 1,800 1,800 1,800	Motor Type Premium Premium Premium Premium	Fi Motor Exclosure OOP OOP OOP	Belt Type Standard V-br Standard V-br Standard V-br Standard V-br Standard V-br	Motor Efficient elt 91% elt 91% elt 91% elt 91%	y Fin Efficiency 56% 56% 56% 56%	Balt Efficiency 95% 95% 95% 95%	Speed't or Cycle ON%	FD or ON VFD Efficiency	Port Cycl Rec. Speed& or ONX	Affinity Lov Exposunt	CFM Estimated 10,200 10,200 10,200 10,200 10,200	Dem: kV 43 43 49 43 43 43	Annual Energy k.Vh 42,162 42,162 42,162 42,162 35,000	Avg Demand kV 4.8 4.8 4.8 4.8 4.8 4.8		CFM Require CFM 26,387 Availab CFM Excess CFM
CRAC1 CRAC2 CRAC3 CRAC4 CRAC5-Lab	Type Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling	HP 7.5 7.5 7.5 7.5 5	Fae Static Pressure (in. H20) 197 197 197 197	RPM (000 (800 (800 (800 (800 (800	Motor Type Premium Premium Premium Premium	Fi Motor Exclosure OOP OOP OOP	Belt Type Standard V-bi Standard V-bi Standard V-bi Standard V-bi Standard V-bi	Motor Efficient elt 915; elt 915; elt 915; elt 915;	Faa Efficiency 56% 56% 56% 56%	Bek Efficiency 95% 95% 95% 95%	Speedt or Cycle ONS	FD or ON VFD Efficiency	Bec. Speed or ON2	Affinity Lux Exposent	CFM Estimated 10,200 10,200 10,200 8,400	Dem: kV 43 43 49 43 43 41	n Energy k.Vh 42,82 42,82 42,82 42,82 35,000	Avg Demand k√ 4.8 4.8 4.8 4.8 4.8 4.0		CFM Require CFM 26,307 Availab CFM 49,200 Excess CFM 86%
CRAC1 CRAC2 CRAC3 CRAC4 CRAC5-Lab	Type Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling	HP 7.5 7.5 7.5 7.5 5	Fae Static Pressure (in. H20) 197 197 197 197	RPM (800 (800 (800 (800 (800	Motor Type Premium Premium Premium Premium	Fi Motor Eactorere ODP ODP ODP ODP	Bulk Type Standard V-by Standard V-by Standard V-by Standard V-by Standard V-by	Motor Efficient elt 915; elt 915; elt 915; elt 915;	Fan Efficiency 5653 5653 5653 5653 5654	Bek Efficiency 95% 95% 95% 95% 95%	Speedt or Cycle ONS	FD or ON VFD Efficiency	Bec. Speed or ON2	Affinity Lux Exposent	CFM Eptimated 10,200 10,200 10,200 8,400	Dema k.∨ 439 439 439 431 411	n Energy k.Vh 42,82 42,82 42,82 35,303	Avg Demand k∨ 4.8 4.8 4.8 4.8 4.8 4.8		CFM Require CFM 26,307 Availab CFM 49,200 Excess CFM 86%
CRAC1 CRAC2 CRAC3 CRAC4 CRAC5-Lub	Type Vater-cooled CRAC with DX cooling	HP 7.5 7.5 7.5 5	Fas Static Pressure (in. H2O) 197 197 197 197	RPM (800 (800 (800 (800 (800	Motor Type Premium Premium Premium Premium	Fi Motor Esclosure OOP OOP OOP OOP	Buik Type Standard V-bi Standard V-bi Standard V-bi Standard V-bi	Motor Efficient elt 915; elt 915; elt 915; elt 915;	Fas Efficiency 56% 56% 56% 56%	Bek Efficiency 9550 9550 9550 9550 9550	Speed't or Cycle ON's	FD or ON VFD Efficiency	Rec. Speed& or ONE	Affinity Lov Exposunt	CFM Estinuted 10,200 10,200 10,200 8,400	Dema k.V 439 439 439 439 431 411	n Energy k.Vh 42,82	Avg Demand kV 4.8 4.8 4.8 4.8 4.8 4.0		CFM Require CFM 26,307 Availab CFM Excess CFM 86%
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AHU CRAC1 CRAC2 CRAC3 CRAC4 CRAC5Lab Totals Chiller Inpu Condenser Tspe	Type Vater-cooled CRAC with DX cooling If s Compressor Type	HP 775 775 775 775 5 5 35 235 235	Pas Static Preserve (a. H2O) 137 137 137 137 137 137 137	RPM (300 (300 (300 (300 (300 (300 (300) (30) (3	Motor Type Premium Premium Premium Premium Efficiency (full load) KV/too	Fi Motor Esclorere OOP OOP OOP OOP OOP	Bulk Type Standard V-bi Standard V-bi Standard V-bi Standard V-bi Standard V-bi	Motor Efficient elt 915; elt 915; elt 915; elt 905; Vaterside Economizer?	y Fun Efficiency 56% 56% 56% 56% 56% 56% 56% 56%	Buh Efficiency 95% 95% 95% 95% 95% 95%	V Speeds or Cycle ONS Minimu m allovabl e lift (F)	Design Vetbulb Temp (F)	Design approac (cooling (F)	Design approach h(HX) (F)	CFM Entirexted 10,200 10,20	Dema kV 43 43 43 43 43 43 43 41 41 23.8 23.8 Peal Dema d 4 kV	n Annual Energy k∨h 42,82 42,	Avg Demand k∨ 4.8 4.8 4.8 4.8 4.8 23.3	X Econ	CFM Require CFM 26,387 Availab CFM 49,200 Excess CFM 8622

Proposed operations

- User identified changes to operations
- Modified parameters flagged (orange cell highlight)

PROPOSED Current Ler 2	COOLING SYSTEM INPUTS vel of Airflow Management Level1, • Part Containment		Ver 1.6 1 Description	W62/2618	r	1	Restore Existing				1. RA Tem (Note: Hun changed fo 2. Any cha recalculate	up and Hum nidity may n on the exist anges to inp ed for resul	idity are re- eed to be up ing sceneric. ruts need to its to be upd	puired deted if RAT is be lated	•	Deman kV 68.2	Total Energy kVh 374,685	0	alculate	,	SAVINGS kV 232	8 POTENTIA k/vh 283,557
AHU	Type	Economizer	Nominal Tons			Fan Type	,	Cooling Load	On /Off						Vorst Case Capacity	Peak Deman đ	Annual Energy	Efficiency (annualize d)	X Econ	X Non- econ	Deman d Saving	Energy Savings
			Tous Cupacity						0=Off; t= Os	Return Air Temp Setpoint	Return Air Relative Humidity	Avg Supply Air Temp	Recom/d Delta T	Glycol %	Tons	k∀	k\/h	kWitton			kΨ	R.Wh
CRAC1	Water-cooled CRAC with DK cooling	Yes	20			icroll Fan with	VFO	42	1	()	35×	66	15		17	10.8	63,476	0.60	63X	37%	1.0	32,732
CRAC 2	Vater-cooled CHAC with DX cooling	Yes	20			scroll Fan with	WFD	42	-	83	35%	66	20		17	10.8	63,476	0.60	63%	37%	1.6	31,088
CRACA	Water-cooled CPU-L with DV cooling	Tes .	20			croll Fan with	170		0	85	30%		17		- e	0.0	63.676				10	36,471
CRACK Lab	Vater cooled CBAC with DX cooling	Ves				COULT AND WRITE	VED	14		81	35%	60			- 17	87	50,976	0.60	600	37%	17	27.641
CRAC 6	Vater-cooled CRAC with DX cooling	Yes	20		š	icroll fan with	WED	42	1	100	35%	66	15		17	10.8	63.476	0.60	63%	37%	-10.8	-63.476
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Fan Inputs																						
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AHU	Type					Fa	in				VI	D or ON	OFF Cycli	ing	CFM	Deman	Annual Energy	Avg Demand		CFM	d	Energy Savings
AHU	Type	нр	Fas Static Process (in: H2O)	RPM	Motor Type	Fa Motor Exclosure	Buk Type	Motor Efficiency	Fu Efficiency	Buk Efficiency	Speedt or Cycle ONS	VFD Discourse	Rec. Speeds or ONS	Affinity Lyw Exposent	CFM Estinuted	Deman k∀	Annual Energy kWh	Avg Demand KV		CFM CFM CFM	d kV	Energy Savings k\/h
CRACI	Type Vater-cooled CRAC with DX cooling	нр 7.5	Fan Static Process (in: H2O) 197	RPM 1,000	Motor Type Premium	Fa Motor Exclosure	Bult Type Standard V-belt	Motor Efficiency 98%	Fue Efficiency 5633	Buk Efficiency 95%	Speedt or Cycle ON4 75%	VFD VFD Efficiency 97%	Port Cycli Rec. Speeds or ONI	Affinity Lvw Exposent 2.4	CFM Estinuted	Deman kV	Annual Energy kVh H,528	Avg Demand kV		CFM Required CFM 26,387	4 6	Energy Savings k\/h 27,834
CRAC1 CRAC2	Type Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling	нр 7.5 7.5	Pan Studic Pressere (in: H2O) 1.97 1.97	RPM 1,000 1,000	Motor Type Premium Premium	Fa Motor Exdocure ODP ODP	Bult Type Standard V-belt Standard V-belt	Motor Efficiency 985	Fue Efficiency 56%	Bult Efficiency 95% 95%	Speedt or Cycle ONt 75% 75%	VFD Discourse 97% 97%	OFF Cycli Bit. Spice& or ONL 60% 60%	Affinity Lvw Exposent 2.4 2.4	CFM Estimated 6,800 6,800	Deman kV 17	Annual Energy kVh 14,528 14,528	Avg Demand KV 1/ 17		Ainflow CFM Required CFM 26,387 Available	4 kV 32 32	Energy Savings k/v/h 27,834 27,634
CRAC1 CRAC2 CRAC3	Type Water-cooled CRAC with DX cooling Water-cooled CRAC with DX cooling Water-cooled CRAC with DX cooling	HP 7.5 7.5 7.5	Fan Studic Prestwie (in: H2O) 1.97 1.97 1.97	RPM 1,000 1,000 1,800	Motor Type Premium Premium Premium	Fa Motor Exdoore ODP ODP	Bek Type Skandard V-bek Skandard V-bek Skandard V-bek	Motor Efficiency Stbs Stbs	Fue Efficiency 56% 56%	Bult Efficiency 95% 95%	Speedt or Cycle ONt 75% 75% 75%	D or ON VFD Dificiency 97% 97% 97%	OFF Cycli Rec. Speeds or ONS 60% 60%	Affinity Lvw Exposed 2.4 2.4 2.4	CFM Estinuted 6,800 6,800	Deman kV 17 17 0.0	Annual Energy k.Vh H,528 H,528	Avg Demand kV 17 17 0.0		Airflov CFM Required CFM 26,387 Available CFM	4 6	Energy Savings k/vh 27,834 27,834 42,82
CRAC1 CRAC2 CRAC3 CRAC4	Type Vater-cooled CFMC with DX cooling	HP 75 75 75 75	Fan Studic Prestwire (in: H2O) 1.97 1.97 1.97 1.97	RPM 1,950 1,900 1,800 1,800 1,900	Motor Type Premium Premium Premium	Fa Motor Exdecure ODP ODP ODP	n Beh Type Skandard V-bek Skandard V-bek Skandard V-bek Skandard V-bek	Motor Efficiency 985 985 985 985	Fue Efficiency 56% 56% 56%	Bulk Efficiency 95% 95% 95%	Speeds or Cycle ONS 75% 75% 75% 75%	*D or ON/ VFD D/ficiuscy 97% 97% 97% 97%	OFF Cycli Rec. Speeds or ONS 60% 60% 60%	Affinity Lvw Exposunt 2.4 2.4 2.4 2.4 2.4 2.4	CFM Estinuted 6,800 6,800 0 6,800	Deman kV 17 17 0.0 17 17	Annual Energy k.Vh H,528 0 H,528 0 H,528	Avg Demand kV 17 17 0.0 17		Airflov CFM Required CFM 26:307 Available CFM 32:600	4 6	Energy Savings k/vh 27,634 27,634 42,82 27,634
CRAC1 CRAC2 CRAC3 CRAC4 CRAC5-Lab	Type Valer-cooled CFIAC with DX cooling Valer-cooled CFIAC with DX cooling Valer-cooled CFIAC with DX cooling Valer-cooled CFIAC with DX cooling Valer-cooled CFIAC with DX cooling	HP 775 775 775 775 5 5	Fan Stufic Pressure (in. H2O) 1.97 1.97 1.97 1.97 1.97	RFM (950 (800 (800 (950 (950	Motor Type Premium Premium Premium Premium Premium	Fa Motor Exdoorn OOP OOP OOP	n Buk Type Standard V-bek Standard V-bek Standard V-bek Standard V-bek	Motor Efficiency 98% 98% 98% 98% 98%	Fus Efficiency 56% 56% 56% 56%	Bulk Efficiency 95% 95% 95% 95%	5peeds or Cycle 04st 7555 7555 7555 7555 7555 7555	D or ON/ V/D E/fiducy 97% 97% 97% 97% 97%	OFF Cycli Pole Spredit or ONA 60% 60% 60%	ing Affaity Lve Exposent 24 24 24 24 24 24 24 24 24	CFM Estimated 6,800 6,800 6,800 5,400	Deman KV 17 17 0.0 17 14	Annual Energy k.Vh H,528 0 H,528 10,730	Avg Demand kV 17 17 13 13		Airflow CFM Pequired CFM 26,387 Available CFM 22,600 Excess Excess	4 KV 32 32 43 32 27 27	Energy Savings k/vh 27,634 42,82 27,634 42,82 27,634 23,573
CRAC1 CRAC2 CRAC3 CRAC4 CRAC5-Lab CRAC6	Type Valer-cooled CPIAC with DX cooling Valer-cooled CPIAC with DX cooling Valer-cooled CPIAC with DX cooling Valer-cooled CPIAC with DX cooling Valer-cooled CPIAC with DX cooling	HP 7.5 7.5 7.5 7.5 5 7.5	Fan Stutic Pressure (in. H2O) 1.97 1.97 1.97 1.97 1.97 1.97 1.97	RPM 1,000 1,000 1,000 1,000 1,000 1,000 1,000	Motor Type Premium Premium Premium Premium Premium	Fa Motor COP COP COP COP COP COP	n Belt Type Standard Y-belt Standard Y-belt Standard Y-belt Standard Y-belt Standard Y-belt	Motor Efficiency 98% 98% 98% 98% 98%	Fus Efficiency 56% 56% 56% 56% 56%	Bult Ethiology 95% 95% 95% 95% 95%	V5 Speeds or Cycle ONS 7555 7555 7555 7555 7555	*D or ON/ V/TD E/fiduacy 97% 97% 97% 97% 97% 97%	0FF Cgeli Rec. Speeds or 00% 60% 60% 60% 60% 60% 60%	ing Affaity Lve Exposent 24 24 24 24 24 24 24 24 24	CFM Estimated 6,800 6,800 6,800 5,400 6,800	Deman KV 17 17 00 17 14 17 14 17	Annual Energy k.Vh H.528 0 H.528 H.528 H.730 H.528	Avg Demand KV 17 17 0.0 17 13 13 17		Airflow CFM Pequited CFM 26,087 Available CFM 22,600 Excess CFM 244	4 KV 32 32 43 32 27 47	Energy Savings k.vh 27,634 427,634 422,534 23,573 -34,528
CRAC1 CRAC2 CRAC3 CRAC5-Lab CRAC5-Lab	Type Vater-cooled CPAC with DX cooling Vater-cooled CPAC with DX cooling Vater-cooled CPAC with DX cooling Vater-cooled CPAC with DX cooling Vater-cooled CPAC with DX cooling	HP 75 75 75 75 5 75 5 75	Fas Static Prestate (in. H2O) 197 197 197 197 197 197	RPM 1,000 1,000 1,000 1,000 1,000 1,000 1,000	Motor Type Premium Premium Premium Premium Premium	Fa Motor Exdeeme OOP OOP OOP OOP	n Standard Y-bek Standard Y-bek Standard Y-bek Standard Y-bek Standard Y-bek Standard Y-bek	Motor Efficiency 985 985 985 985 985 985	Fai Efficiency 56% 56% 56% 56% 56%	Bult Efficiency 95% 95% 95% 95% 95%	V5 Speeds or Cycle ONS 7555 7555 7555 7555 7555	P or ON/ VFD Efficiency 97% 97% 97% 97% 97% 97% 97%	POFF Cgeli Poc. \$peeds or ONS 60% 60% 60% 60% 60% 60%	ing Affinity Luw Exposent 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4	CFM Estimated 6,000 6,000 6,000 5,400 6,000	Deman KV 17 17 10 0.0 17 14 17 14	Annual Energy k.Vh H.528 H.528 H.528 H.730 H.528	Avg Demand kV 17 17 17 13 13 17		Airflow CFM Required CFM 35,307 Available CFM 32,500 Elicess CFM 245	4 6 12 32 32 43 32 27 47 47	Energy Savings k.vh 27,634 42,62 23,573 -14,528
CRAC1 CRAC2 CRAC3 CRAC4 CRAC5-Lab CRAC6	Type Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling Vater-cooled CRAC with DX cooling	HP 7.5 7.5 7.5 7.5 5 7.5	Pas Static Produce (in. H2O) 197 197 197 197 197	RFM 1,000 1,000 1,000 1,000 1,000 1,000	Motor Type Premium Premium Premium Premium Premium	Fa Motor Esdeam ODP ODP ODP ODP	n Buk Type Standard V-bek Standard V-bek Standard V-bek Standard V-bek Standard V-bek	Motor Efficiency 91% 91% 91% 91% 91% 91%	Fai Ethiciancy 56% 56% 56% 56% 56%	Balt Efficiency 95% 95% 95% 95% 95%	V5 Speeds of Cycle ON45 7555 7555 7555 7555 7555	*D or ON/ vrD Efficiency 97% 97% 97% 97% 97% 97% 97%	0FF Cgeli Poc. \$pte6% or 0% 60% 60% 60% 60% 60% 60%	Affinity Luw Exposent 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4	CFM Estinated 6,800 6,800 5,400 6,800	Deman kV 1/ 17 0.0 17 14 17	Annual Energy kVh H,528 0 H,528 11,528 11,730 H,528	Avg Demand kV 1/ 17 0.0 17 13 17		Airflow CFM Required CFM 26:307 Available CFM 22:500 Encess CFM 24%	d C	Energy Savings kVh 27,634 42,82 27,634 42,82 27,634 23,573 -44,528
CRAC1 CRAC2 CRAC3 CRAC4 CRAC4 CRAC5 Lab CRAC6	Type Water-cooled CPRAC with DX cooling	HP 75 75 75 75 5 75	Fas Static Products (in: H2C0) 197 197 197 197 197	RPM (300 (300 (300 (300 (300 (300	Motor Type Premium Premium Premium Premium Premium	Fa Motor Existent ODP ODP ODP ODP	n Buk Type Standard V-bek Standard V-bek Standard V-bek Standard V-bek Standard V-bek	Motor Efficiency 305 305 305 305 305	Fea Efficiency 56% 56% 56% 56% 56%	Bak Efficiency 95% 95% 95% 95% 95%	VF Speeds or Cycle ONS 7555 7555 7555 7555 7555 7555	*D or ON/ V/D E/fideacy 97% 97% 97% 97% 97% 97% 97%	POFF Cgeli Rec. \$peeds or ONE 60% 60% 60% 60% 60% 60%	ing Affiaity Lyw Exposunt 24 24 24 24 24 24 24	CFM Estimated 6,800 0 6,800 5,400 6,800	Deman kV 1/ 17 0.0 17 14 17 14 17	Annual Energy k.Vh H.528 0 H.528 H.528 H.720 H.528	Avg Demand kV 17 17 0.0 17 13 13 17		Airflow CFM Required CFM 26,507 Available CFM 22,500 Encess CFM 2455	4 6 8 8 8 12 12 13 12 13 12 17 17 17 17 17 17 17 17 17 17	Energy Savings k/vh 27,634 42,82 27,634 42,92 27,634 42,92 27,634 42,92 27,634 42,92 27,634 42,92 27,634
CRAC1 CRAC2 CRAC3 CRAC4 CRAC5 Lab CRAC6	Type Vater-cooled CPAC with DX cooling	HP 7.5 7.5 7.5 5 7.5 7.5 42.5	Fas Static Presses (in: H2O) 197 197 197 197 197	RPM 1,000 1,000 1,000 1,000 1,000 1,000	Motor Type Premium Premium Premium Premium Premium	Fa Motor Exclosure OOP OOP OOP OOP	n Bek Type Standard V-bek Standard V-bek Standard V-bek Standard V-bek Standard V-bek	Motor Efficiency 300 300 300 300 300 300 300	Fua Exticioney 560X 560X 560X 560X 560X	Bulk Ethiolousy 95% 95% 95% 95%	V5 Speedt or Cycle ONt 75% 75% 75% 75% 75%	*D or ON/ VPD Efficiency 97% 97% 97% 97% 97% 97% 97%	POFF Cgoli Porc \$perefit or ON1 60% 60% 60% 60% 60%	ing AffiakyLuw Exposest 24 24 24 24 24 24 24 24	CFM Estimated 6,000 0 6,000 5,400 5,400 6,800	Deman kV 17 17 16 17 14 17 14 17 14 17 14 17 17 18 19 19 10 17 17 17 17 17 17 17 17 17 17	Annual Energy k.Vh 14,528 0 14,528 14,528 14,528 14,528 14,528	Avg Demand kV 17 17 13 13 17 13		Airflow CFM Pequited CFM 35,007 Available CFM 22,500 Encess CFM 24%	4 6 6 7 7 7 7 7 7 7 7 7 7 7 7 7	Energy Savings k/vh 27,834 42,82 27,834 42,82 27,834 42,82 27,834 23,573 -14,528
CRAC1 CRAC2 CRAC3 CRAC5 Lab CRAC5 Lab CRAC5 Lab CRAC5 Lab	Type Vater-cooled CPAC with DX cooling	HP 75 75 75 75 75 75 75 425	Fas Static Prestate (in 197 197 197 197 197 197	RPM 1,800 1,800 1,800 1,800 1,800	Motor Type Premium Premium Premium Premium Premium	Fa Motor Extense OOP OOP OOP OOP	n Buk Type Standard Y-bek Standard Y-bek Standard Y-bek Standard Y-bek Standard Y-bek	Motor Diriciney 90: 90: 90: 90: 90: 90: 90:	Fus Efficiency 56% 56% 56% 56%	Bulk Efficiency 95% 95% 95% 95%	V5 Speeds of Cycle ONE 7505 7505 7505 7505	D or ON/ D/ficiary 97% 97% 97% 97% 97% 97%	POFF Cgoli For. \$p-red% or ONE 60% 60% 60% 60% 60%	ing Affinity Lve Exposed 2.4 2.4 2.4 2.4 2.4 2.4 2.4	CFM Estimated 6,800 6,800 5,400 6,800 6,800 32,600	Deman kV 17 17 0.0 17 14 17 8.1	Annual Energy k.Vh H.528 H.5388 H.538 H.538 H.538 H.538 H.538 H.538 H.538 H.53	Avg Demand KV 17 17 0.0 17 13 17 13 17 17 8.0		Airflow CFM Required CFM 26,387 Available CFM 32,600 Excess CFM 2455	4 Control kV 32 227 43 322 227 47 47 15.6	Energy Savings k/vh 27,634 27,634 42,82 27,634 23,573 -14,528 134,108
CRAC1 CRAC2 CRAC2 CRAC3 CRAC4 CRAC5 CRAC5 CRAC6 CRAC6 CRAC6 CRAC6	Type Value -cooled CRAC with DX cooling Value -cooled CRAC with DX cooling	HP 75 75 75 75 75 75 425	Fas Stuic Present (a. H2O) 197 197 197 197 197 197	RPM 1800 1800 1800 1800 1800	Motor Type Premium Premium Premium Premium Premium	Fa Monar Erdown OCP OCP OCP	n Buk Type Standard Y-bek Standard Y-bek Standard Y-bek Standard Y-bek Standard Y-bek	Moner Difficiency 30% 30% 30% 30%	Fas Efficiency 56% 56% 56% 56%	Duk Erficiency 95% 95% 95% 95% 95%	¥9 Speedt or Cycle 044 7555 7555 7555 7555	0 or ON/ Efficiency 37% 37% 37% 37% 37% 37%	POFF Cycli Rec. 3peeds or 00% 00% 00% 00% 00% 00%	ng Alfinity Luw Exposent 24 24 24 24 24 24 24	CFM Estimated 6,800 0 6,800 5,400 6,800 6,800 8,800 8,800 8,800 8,800	Deman kV 17 17 00 17 14 17 18 18 18 19 10 10 10 10 10 10 10 10 10 10	Annual Energy k.Vh 14,528 14,5	Avg Demand kV 17 17 17 13 13 17 17 13 17 17 13 17 17 13 13 17 17 17 13 13 17 17 13 13 17 17 18 19 19 19 19 19 19 19 19 19 19 19 19 19		Airflow CFM Required CFM 28,397 Available CFM 22,500 Excess CFM 24%	4 Curles KV 32 32 43 32 27 47 47 15.6	Energy Savings k.Vh 27,534 27,534 42,552 27,534 23,573 -44,528 124,108
CRAC1 CRAC2 CRAC3 CRAC3 CRAC4 CRAC5 CRAC5 CRAC5 CRAC5 CRAC5 CRAC5 CRAC5 CRAC5 CRAC5 CRAC5 CRAC5 CRAC5 CRAC5 CRAC2 CRAC2 CRAC3 CRAC3 CRAC3 CRAC3 CRAC3 CRAC4 CRAC3 CRAC4 CRAC4 CRAC5	Type Vater-cooled CFIAC with DX cooling tater-cooled CFIAC with DX cooling Compressor Type	HP 7.5 7.5 7.5 7.5 7.5 7.5 42.5 Chiller C	Pas Stolic Preform (a. R20) 137 137 137 137 137 137	RPM (1000 (1000 (1000 (1000 (1000 (1000 (1000 (1000 (1000) (100) (1000)	Motor Type Premium Premium Premium Premium Premium Premium Efficience (full load)	Fa Motor Ecdoore OCP OCP OCP OCP OCP OCP	n Buk Type Standard V-bek Standard V-bek Standard V-bek Standard V-bek Standard V-bek	Moner Efficiency 38% 38% 38% 38% 38% 38% 38% Vaterside conomizer?	Fix Efficiency 58% 58% 58% 58% 58% 58%	Duk Efficiency 95% 95% 95% 95% 95% 95%	VI Speeds or Cycle OAS 7555 7555 7555 7555 7555 7555 7555 8 1557 1	D or ON/ VFD Dificiency 97% 97% 97% 97% 97% 97% 97% 97% 97%	POFF Cycli Pric. Sprods or ONS ONS ONS ONS ONS ONS ONS ONS	ng Arfiaky Live Expoont 24 24 24 24 24 24 24 24 24 24 24 24 24	CFM Estimated 6,800 0 6,800 5,400 32,600 BEH. Adj. Factor for VFD Centrif.	Deman 4 kV 17 17 10 17 14 17 17 14 17 17 18 18 19 19 10 10 17 17 17 17 17 17 17 17 17 17	Annual Energy kVh H528 14528 14528 14528 14528 14528 1528 1528 1528 1528 1528 1528 1528 1	Avg Demand kV 1/ 17 13 13 17 13 12 8.0 Efficiency (annualize d)	X Econ	Ainflow CFM Required CFM 20,307 Available CFM 20,007 Extrems CFM 20,00	d d cla kV 32 32 32 27 47 47 47 15.6 Deman d Saving	Energg Savings kVh 27,534 27,5
CRAC1 CRAC2 CRAC3 CRAC4 CRAC5 CRAC4 CRAC4 CRAC4 CRAC4 CRAC5 CRAC4 CRAC5 CRAC4 CRAC5 CRAC4 CRAC5	Type Value-cooled CPIAC with DX cooling tase Compressor Type	HP 7.5 7.5 7.5 7.5 7.5 7.5 42.5 Chiller C.	Pas Drukic Precision (s. H2O) 197 197 197 197 197 197 197	RPM 1,000 1,000 1,000 1,000 1,000 1,000 1,000	Motor Type Premium Premium Premium Premium Premium Premium Premium Premium	Fa Motor Ectorer OGP OGP OCP OCP OCP	n Buk Type Standard V-bek Standard V-bek	Monor Efficiency 980; 980; 980; 900; 900; 900; 900; 900;	Twi Efficiency 56% 56% 56% 56% 56% 56% 56% 56% 56% 56%	Duk Editioncy 955 955 955 955 955 955 955 955 955	V/ Speed 2 of Cycle CM4 7555 7555 7555 7555 7555 8 Minimu m allowabl e lift (F)	D or ON/ VFD Dificiency 97% 97% 97% 97% 97% 97% 97% 97% 97% 97%	POFF Cycli Speed 2 Speed 2 S	ng Affiaby Lsw Erposum 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4	CFM Eptimeted 6,800 6,800 6,800 6,800 6,800 6,800 8,800	Deman kV 17 17 00 17 14 17 17 10 17 14 17 17 10 17 10 17 10 17 10 17 10 17 17 18 17 17 18 17 17 18 18 18 18 18 18 18 18 18 18	Annual Energy kVh H528 0 H528 H528 H528 H528 H528 H528 H528 H528	Avg Demand kV 17 17 13 17 13 17 13 17 17 8.0 8.0 8.0 8.0	X Econ	Ainflow CFM Required CFM 28:307 Available CFM 22:500 Encess CFM 24:50 24	d d d d k 32 32 32 43 32 27 47 47 49 52 27 47 47 58 58 Deman d Saving 5 k k	Energy Savings k/vh 27,634 27,

Summary data

Energy

Savings

kWh

27.634

27,634

42,162 27,634

23,573

-14,528

134,108

Energy

Savings

kWh

Demand

Savings

kW

3.2

3.2

4.9

3.2

2.7

-1.7

15.6

Demand

Savings

kW

Base Line

Total	Total	
Demand	Energy	
kW	kWh	Calculate
83.4	658,242	

Peak Demand	Annual Energy	Efficiency (annualized)	% Econ	% Non- econ
kW	kWh	kW/ton		
12.6	96,208	0.91	0%	100%
12.4	94,564	0.90	0%	100%
12.1	92,471	0.88	0%	100%
12.1	92,471	0.88	0%	100%
10.4	78,579	0.93	0%	100%
59.6	454,293			

Airflow

CFM

Required

CFM

26.387

Available

CFM

49.200

Excess

CFM

86%

Peak

Demand

kW

1.7

1.7

0.0

1.7

1.4

1.7

8.1

Peak

Demand

kW

Annual

Energy

kWh

14.528

14,528

14.528

11,730

14,528

69,841

Annual

Energy

kWh

Peak Demand	Annual Energy	Avg Demand
kW	kWh	kW
4.9	42,162	4.8
4.9	42,162	4.8
4.9	42,162	4.8
4.9	42,162	4.8
4.1	35,303	4.0
23.8	203.949	23.3

Peak Demand	Annual Energy	Efficiency (annualized)	% Econ	% Non- econ
kW	kWh	kW/ton		

Proposed

Total Demand	Total Energy				SAVING	SS POTENT
kW	kWh	l o	alculate	.	kW	kWh
60.2	374,685		arculate	-	23.2	283,557
Peak Demand	Annual Energy	Efficiency (annualized)	% Econ	% Non- econ	Demand Savings	Energy Savings
kW	kWh	kW/ton			kW	kWh
10.8	63,476	0.60	63%	37%	1.8	32,732
10.8	63,476	0.60	63%	37%	1.6	31,088
0.0	0	-	-	-	12.1	92,471
10.8	63,476	0.60	63%	37%	1.3	28,994
8.7	50,938	0.60	63%	37%	1.7	27,641
10.8	63,476	0.60	63%	37%	-10.8	-63,476
52.0	304,844				7.5	149,449

Avg

Demand

kW

1.7

0.0

1.7

8.0

Efficiency

-) kW/ton

(annualized % Econ

Airflow

CFM

Required

CFM

26,387

Available

CFM

32,600

Excess

CFM

24%

% Non-

econ

Implemented

10131	Total				:	
Demand	Energy				SAVINGS	ACHIEVE
kW	kWh] Ca	lculate		kW	kWh
60.9	376.552		inculate	·	22.5	281 690
Doak	Annual	Efficiency		% Non	Demand	Energy
Demand	Energy	(annualized)	% Econ	econ	Savings	Savings
kW	kWh	kW/ton			kW	kWh
44.0	04.055	0.04	0.00/	400/	47	24.054
11.0	64,355	0.61	60%	40%	1.7	31,854
11.1	05,162	0.62	00%	40%	1.3	29,402
0.0	0	-	-	-	12.1	92,471
11.3	67,109	0.64	45%	55%	8.0	25,362
9.5	56,720	0.67	45%	55%	0.8	21,859
11.2	65,861	0.63	63%	37%	-11.2	-65,861
54.2	340 206				5.4	435.006
04.2	519,200				0.4	155,060
Peak Demand	Annual Energy	Avg Demand		Airflow CFM	Demand Savings	Energy Savings
ĸW	kWh	kW		Required CFM	kW	kWh
1.6	13,860	1.6		26,387	3.3	28,301
1.5	12,591	1.4		Available	3.4	29,571
0.0	0	0.0		CEM	4.9	42,162
1.6	13,860	1.6		30,600	3.3	28,301
07	6 190	0.7		Excess	34	29 113
12	10.844	12		CEM	-13	-10.844
1.5	10,044	1.2		160/	-1.5	-10,044
				10%	: 	
6.7	57,346	6.5			17.1	146,604
	Δηριμαί	Efficiency	% Econ	% Non-	Demand	Energy
Peak Demand	Energy	(annualized)	/ LCOII	econ	Savings	Savings

Calculator summary metrics

Data Center Airflow/ Efficiency Project Summary Ver 1.0

ļ	
Company	SEACH
Facility Name	Admin Data Center
Address	123 Any Ave. NE
City, State Zip	Seattle, WA 98115
Contact	Mickey Mouse
Title	DC Ops Mgr.
Phone	206.555.1212
email	mickev@mouse.com

Ver 1.0 11/02/2015

Date: 11/2/2015

\$ 0.071	Avg. kWh Electricity Cost
\$ 1.92	Avg. kW Peak Demand Charge
\$ 0.20	per kWh Utility Incentive rate
\$ -	per kW Demand reduction Incentive
4,631,289	Annual Facility kWh
6%	Implemented Saving % of Facility

	Energy Savings (kWh/yr)	Demand Savings (kW)	Utility Cost Savings (\$)	Estimated Project Cost (\$)	Estimated Incentive* (\$)	Simple Payback After Incentive
Project Total - Proposed	291,185	24.0	\$ 20,720.22	\$ 89,178.00	\$ 58,237.07	1.5
Project Total - Implemented	281,690	22.5	\$ 20,043.19	\$ 94,229.00	\$ 56,337.97	1.9

The Incentive Estimate contained in this calculator is for informational purposes only. It is NOT a formal offer of utility incentive funding

203.0 kW Total Cooling Load

ling Load Proposed Project Implementation Date

11/2/2015

Project Verification Date

11/3/2015

EXISTING CONDITION				
Cooling Capacity				
Nominal Cap Ton	96			
% of Norminal Cap	60.1%			
Worst-case Ton	74			
%Worst-case Cap	77.7%			
Airflow Efficiency	,			
CFM/kW	242			
Excess CFM %	86%			
·				
Cooling Efficiency				
Annualized kW/ton	0.90			
Economizing %	0%			
Economizing Hours	0			

PROPUSED				
Cooling Capacity				
Nominal Ton	96			
% of Norminal Cap	60.1%			
Worst-case Ton	81			
%Worst-case Cap	70.9%			

Airflow Efficience	9
CFM7kW	154
Excess CFM %	18%

Cooling Efficiency		
Annualized kW/ton	0.61	
Economizing %	70%	
Economizing Hours	6,167	

IMPLEMENTED				
Cooling Capacity	I			
Nominal Ton	96			
% of Norminal Cap	60.12%			
Worst-case Ton	78			
%Worst-case Cap	73.9%			
Airflow Efficiency	l			
CFM/kW	151			
Excess CFM ½	16%			
Cooling Efficiency				
Annualized kW/ton	0.63			
Economizing %	55%			
Economizing Hours	4,818			

Calculator summary metrics

Environmental Co	onditions
62.1	Avg. Server Inlet Temp., 'F (Estimated)
75	Avg. AHU Return Air Temp., 'F
61	Avg. AHU Supply Air Temp., 'F
Airflows	
49,200	Estimated CFM
130	Required CFM / kW
5	CRAC Units "On"
100%	Avg, CRAC Fan Speed
Cooling Energy C	onsumption
203,949	Yrly, AHU Fan kWh
454,293	Yrly.Mechanical Cooling kWh
658,242	Total Cooling kWh
Energy Use Brea	kdown
Existing Condition	kW
HVAC	
Fan	23.3
Compressor	51.9
IT	203.0
UPSLoss	24.0
PUE (Partial)	1.49
UF5 2	Fen, 23.3 4.0 51.9

vironmental Conditions		
66.8	Target Server Inlet Temp., 'F	
83	Avg. AHU Return Air Temp., 'F	
66	Avg. AHU Supply Air Temp., F	

Airflows

32,600	Proposed CFM
34%	Planned Airflow Reduction
5	CRAC Units "On"
75%	Avg, CRAC Fan Speed

Cooling Energy Consumption

43%	Reduction
283,557	Est. Annual kWh Savings
374,685	Total Cooling kWh
304,844	Yrly.Mechanical Cooling kWh
69,841	Yrly. AHU Fan kWh

Energy Use Breakdown

Proposed	kW
HVAC	
Fan	8.0
Compressor	34.8
IT	203.0
UPSLoss	24.0
Savings	23.2
PUE (Partial)	1.33



Environmental Conditions	
62.0	Avg. Server Inlet Temp., 'F
81	Avg. AHU Return Air Temp., F
61	Ava. AHU Supply Air Temp 'F
Airflows	
30,600	
38-/	A-Linuad Airflaw Deduction
30%	CDACU->= "O="
J 701/	And CDAC For Second
70%	Avg, URAU Fan Opeed
Cooling Energy C	onsumption
57,346	Yrly. AHU Fan kWh
319,206	Yrly.Mechanical Cooling kWh
376,552	Total Cooling kWh
281,690	Achieved Ann. kWh Savings
43% Reduction	
Energy Use Breakdown	
,	
Implemented	14.2
Implemented LIUAC	K W
Esp	85
	0.0
TT Compressor	202.0
	203.0
	24.0
Savings	22.5
PUE (Partial)	1.33
Fan, E.S. Compressor, Sevings, 22.5 UPS Loss, 24.0	

PROS

- Relatively quick estimate of energy savings
 - ~30 min for an 800 kW data center with 13 AHU's
- Accommodates common cooling designs
- Default assumptions can be overwritten w/ measured values
 - Formatting flags modified inputs in orange
- Based on transparent documented engineering principles, equipment performance data

Trade-offs

- Use of macros "Manual" calculation button to facilitate hourly calculations
 - -8,760 calcs for each AHU
- Only intended to model key "buckets" of savings from AFM improvements
 - Reduced fan energy
 - Reduced mechanical cooling energy
 - Increased hours of economizer use
- User must have some knowledge of serverroom operation

Server-Room AFM Walk-Thru Audits

BPA will assist utilities to providing walk-thru assessments to identify energy efficiency opportunities, including AFM projects.

A request form and other resources, including a link to the calculator can be found at: <u>https://www.bpa.gov/EE/Technology/EE-emerging-</u> <u>technologies/Projects-Reports-Archives/Pages/Air-Flow-</u> <u>Management.aspx</u>

AFM Calculator Resources

The following resources are posted at: http://rtf.nwcouncil.org/subcommittees/it/

- AFM Calculator
- User Guide
- Technical Guide

Server-Room AFM Audit Process

- 1. Airflow and temperatures will be measured, and equipment info gathered;
- 2. Baseline and potential AFM strategy info entered in the calculator;
- Potential AFM energy savings will be sent to the serving utility, as the basis for a streamlined custom project; and
- 4. After AFM implementation, actual AFM energy savings will be verified.

Questions?

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