CXE Group *Your Building Optimization Experts*

An Introduction to The Retro-Commissioning Process For Existing Buildings

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- Retrocommissioning (RCx) is the application of the commissioning process to existing buildings, and seeks to improve how building equipment and systems function together.
- Depending on the age of the building, RCx can often resolve problems that occurred during design or construction, or address problems that have developed throughout the building's life.
- In all, RCx improves a building's operations and maintenance (O&M) procedures to enhance overall building performance.

Commissioning Process Overview

Retrocommissioning Process Overview

RCx Program Phases (from BCxA)

- Planning Phase: Development of the RCx goals, facility requirements, and a commissioning plan.
- Investigation Phase: Field inspections, data gathering, testing and analysis to accurately assess system performance and identify improvement opportunities.
- Implementation Phase: The desired facility improvements are completed and the results and performance are verified.
- Turnover Phase: The systematic transition from a commissioning activity and the Commissioning Team to standard operating practice and the O&M team.
- Persistence Phase: Implementation of systems and tools to support both the persistence of benefits and continuous performance improvement over time.

The purpose of RCx is as follows: (from BCxA)

- Verify that a facility & its systems meet the Current Facility Requirements (CFR)
- Improve building performance by saving energy & reducing operational costs
- Identify & resolve building system operation, control & maintenance problems
- Reduce or eliminate occupant complaints & increase tenant satisfaction
- Improve indoor environmental comfort & quality & reduce associated liability
- Document system operation

The purpose of RCx is as follows: (cont.)

- Identify O&M personnel training needs & provide such training
- Minimize operational risk & increase asset value
- Extend equipment life-cycle
- Ensure persistence of improvements over the building's life
- Assist in achieving LEED for Existing Buildings
  http://www.usgbc.org/LEED
- Improve the building's ENERGY STAR rating
  http://www.energystar.gov/

RCx Program Phases (Ameren, SEDAC similar)

- Screening Phase: Preliminary evaluation to identify expected energy savings options to include in the application.
- Application Phase: Prepare the formal application for the RCx Program, including preliminary savings calculations, utility data summary, equipment list, identify unusual conditions and potential risks, Energy Utilization Index and Energy Star benchmark score.
- Survey or Investigation Phase: Field inspections, data gathering, testing and analysis to accurately assess system performance and finalize savings and implementation cost estimates. The Implementation Plan is developed and presented to the client.
- Implementation: The desired RCx facility improvements are completed.
- Verification: The results and performance are verified, first by the RSP and secondly by the program representative.

Southern Illinois Large Facilities RCx Programs

RCx Program Item	Ameren Act On Energy	Illinois Energy Now
RCx Focus	0 to 1 year payback	0 to 1.5 year payback
RCx Study/Survey Incentive	70% of survey cost reimb.	100% of survey cost
Commitment by Facility	Varies, defined in application	$10,000 minimum
0-1 year measure incentives	$0.02/KWH, $0.40/therm	None, report is incentive
Other special incentives	Early completion, etc.	Early completion
Longer Payback Options	**Ameren Act On Energy**	**Illinois Energy Now**
Study Cost	Included in the RCx Survey	Separate Assessment Report
Payback Period	1 to 10 years	1 to 7 years
Measure Incentives	$0.06/KWH, $0.90/therm	$0.12/KWH, $2.50/therm

Southern Illinois Large Facilities RCx Programs

RCx Program Item	Ameren Act On Energy	Illinois Energy Now
Building Type	Private facilities	Public facilities
Conditioned Area	100,000 sq.ft.	150,000 sq.ft.
Building Age	At least 5 years old	At least 5 years old
Building Controls	Must have an EMCS	Must have an EMCS
Project Term	June 1st to May 31st	June 1st to May 31st per phase

Primary RCx Measures

Common Opportunities Encountered During RCx Efforts

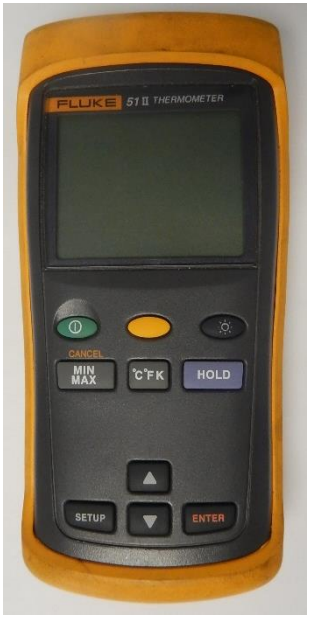
- **Equipment Scheduling**: Minimize unnecessary run-time, Exception schedules, Optimal start/stop control routines
- **Control System Fine Tuning**: Consistency (Setpoints, Control sequences, reduction in the need for operator override), Improved control sequences
- **Control System Upgrades**: Access to more improved control sequences, Increased system monitoring capability, Improved system flexibility
- **Simultaneous Heating & Cooling:** Often find this issue in large spaces.
- **Variable Speed Drives:** Effective control is necessary for success.
- **Exhaust Reduction and Rebalancing**: Changes in code requirements, Changes in space usage, Improved IEQ
- **Ventilation Air Adjustments**: Improve OA control including economizing operation, Minimum levels may typically be reduced, Improve IEQ
- **Lighting Upgrades (Limited), Delamping**: Like for like replacement resulting in over illumination, Changes in code required minimum light levels, Changes in space usage, Occupancy sensor installation, Lens replacement

Sample Capital Projects

Common Capital Opportunities Encountered During RCx Efforts

- **Lighting Control and Fixture Upgrades**: Newer technology retrofits (LED, High efficiency fluorescent), Enhanced controls (Occupancy sensor, Daylighting)
- **Major Control System Upgrades**: Advanced control sequences, Continuous monitoring and analysis, System flexibility, Enhanced energy savings
- **Incremental Cost of Enhanced Equipment Upgrades**: Beyond code required minimum capabilities, Variable speed compressors, Enhanced control options
- **Damper Replacements**: Often damper costs make this a capital project.
- **Envelope Improvements:** New windows and additional insulation are hard to pay for from energy savings alone, but incremental cost of an upgrade may apply.

Equipment Used

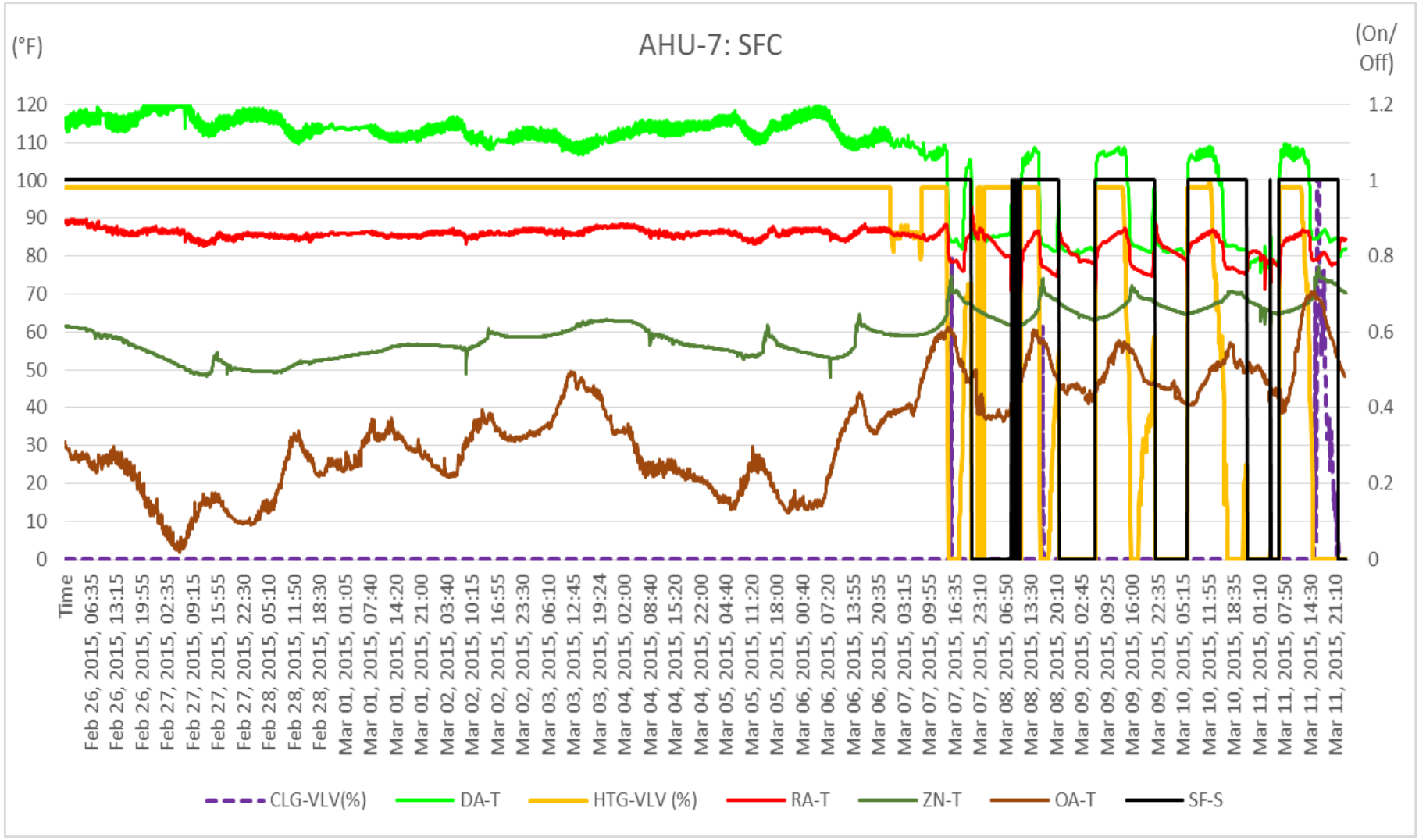


Building Automation System

Common Uses of the BAS during the Survey:

- **Screen Shots:** Taking screen shots of "point in time" control system data can provides documentation of how the facility was operating on a particular day.
- **Trend Data**: In addition to data loggers, the BAS can be very effectively used to monitor system performance over a period of time, but you have to be careful to avoid overloading control system memory in some cases. Also very useful during verification, plus it works 24 hours per day.
- **Data Queries**: Special reports can be set up to quickly look at data for similar devices, like VAV boxes.
- **Remote Access:** While some facilities avoid this option due to security concerns, there are usually relatively simple ways to obtain remote access, which helps improve the quality of the RSP's effort, and can help reduce the cost to control system upgrades.
- **Scheduling Options**: Sometimes operators have to receive additional training to implement special schedules, such as during the summer for a school.

Trend Log Reports



Data Query Reports

VAV Box	Unit AHU-1 Area Served - Cooling	ZN-T Setpoint Deg.F.	Zone Temp Deg.F.	VAV Damper % Open	Actual Supply Flow CFM	Supply Setpoint CFM	Sched'd SA CFM	Heating Valve % Open	VAV Box DAT Deg.F.	Actual SA vs. Setpt	Space Temp. Offset	Heating Valve Status	VAV Damper Status
VAV1-1	LL Fitness E	70.4	80.0	40.0	218	0	3,200	0	64.6	n/a	9.6	Verify	Verify
VAV1-2	LL Fitness S	68.0	80.0	52.6	2,909	3,000	3,325	0	59.7	97%	12.0		
VAV2-1	Office	76.0	80.0	46.6	297	297	350	0	61.2	100%	4.0		
VAV2-2	Office	68.4	80.0	54.5	725	750	750	0	59.4	97%	11.6		
VAV2-3	Office	77.0	80.0	17.1	61	68	675	0	65.2	90%	3.0	Verify	
VAV2-4	Office	70.6	80.0	100.0	426	525	525	0	59.8	81%	9.4		Short
VAV2-5	Office	71.2	80.0	100.0	549	675	675	0	59.3	81%	8.8		Short
VAV2-6	Office	72.8	80.0	100.0	368	525	525	0	59.5	70%	7.2		Short
VAV2-7	Office	72.8	80.0	100.0	574	675	675	0	59.3	85%	7.2		Short
VAV2-8	Office	72.4	80.0	100.0	638	675	675	0	59.4	94%	7.6		
VAV2-9	Office	74.0	80.0	100.0	456	500	500	0	60.7	91%	6.0		
VAV2-10	Office	70.0	80.0	44.0	211	0	950	0	60.9	n/a	10.0		Verify
VAV2-11	Lobby	73.6	80.0	53.4	1,202	1,200	1,050	0	58.8	100%	6.4		
VAV2-12	SW Vestibule	73.4	80.0	100.0	260	400	300	0	59.1	65%	6.6		Short
VAV2-13	Conference	69.8	80.0	100.0	570	600	600	0	58.6	95%	10.2		
VAV2-14	Office	73.0	80.0	82.6	1,654	1,675	1,675	0	59.3	99%	7.0		
VAV2-15	Office	73.8	80.0	95.6	1,785	1,800	1,800	0	59.1	99%	6.2		
VAV2-16	Office	74.6	80.0	100.0	1,008	1,100	1,100	0	59.5	92%	5.4		
VAV2-17	Corridor	72.0	80.0	99.9	581	600	600	0	59.5	97%	8.0		
VAV-3.1	Office	74.0	80.0	55.1	447	450	450	0	59.2	99%	6.0		
VAV-3.2	Office	71.0	80.0	38.6	545	550	550	0	59.5	99%	9.0		
VAV-3.3	Office	73.1	80.0	56.8	594	600	600	0	59.2	99%	6.9		
VAV-3.4	Office	71.8	80.0	52.1	589	600	600	0	68.2	98%	8.2	Verify	
VAV-3.5	Office/Corr.	71.8	80.0	100.0	645	750	750	0	59.5	86%	8.2		Short
VAV-3.6	Office	72.0	80.0	40.6	536	550	550	0	59.7	97%	8.0		
VAV-3.7	Office	72.0	80.0	47.7	447	450	450	0	59.1	99%	8.0		
VAV-3.8	Office	70.0	80.0	51.8	489	500	500	0	61.2	98%	10.0		
VAV-3.9	Grad Assnt.	71.4	80.0	42.2	532	550	550	0	58.5	97%	8.6		
VAV-3.10	Grad Assnt.	73.2	80.0	51.6	740	750	750	0	59.1	99%	6.8		
VAV-3.11	Office	70.0	80.0	46.7	300	300	300	0	58.9	100%	10.0		
VAV-3.12	Grad Assnt.	71.4	80.0	51.7	550	550	550	0	58.7	100%	8.6		
VAV-3.13	Office	73.8	80.0	45.5	728	750	750	0	60.9	97%	6.2		
VAV-3.14	Corridor	72.4	80.0	57.4	964	1,000	1,000	0	60.5	96%	7.6		

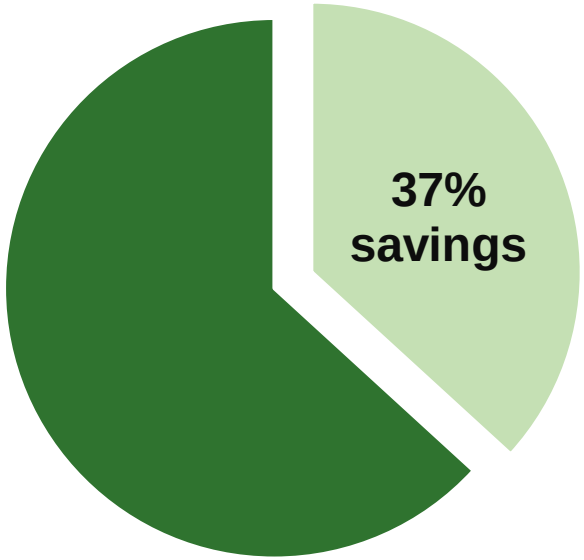
Additional Resources

Additional Sources of Information Used in Evaluating a Facility:

- **Facility Staff:** Operational and Maintenance staff are an invaluable source of information regarding the day to day functionality of a building.
- **Drawings**: Design and control drawings from initial construction are common examples. These provide insight into the intended operation of the facility as well as a starting list of available resources and equipment present.
- **Equipment Manuals, Upgrade Documentation**: Operational as well as installation manuals for existing equipment supplement any documentation regarding equipment upgrades performed over the life of a building. This aids in defining the current operating state of a facility.
- **Design Intent Documentation:** The Owner's Project Requirements and Basis of Design documents are less frequently available for older facilities but are important sources of information when they can be located.
- **Test and Balance Report:** Typically from initial construction, subsequent reports are occasionally available. These help identify the intended operation of the facility.

Public University – Student Fitness Center (SEDAC)

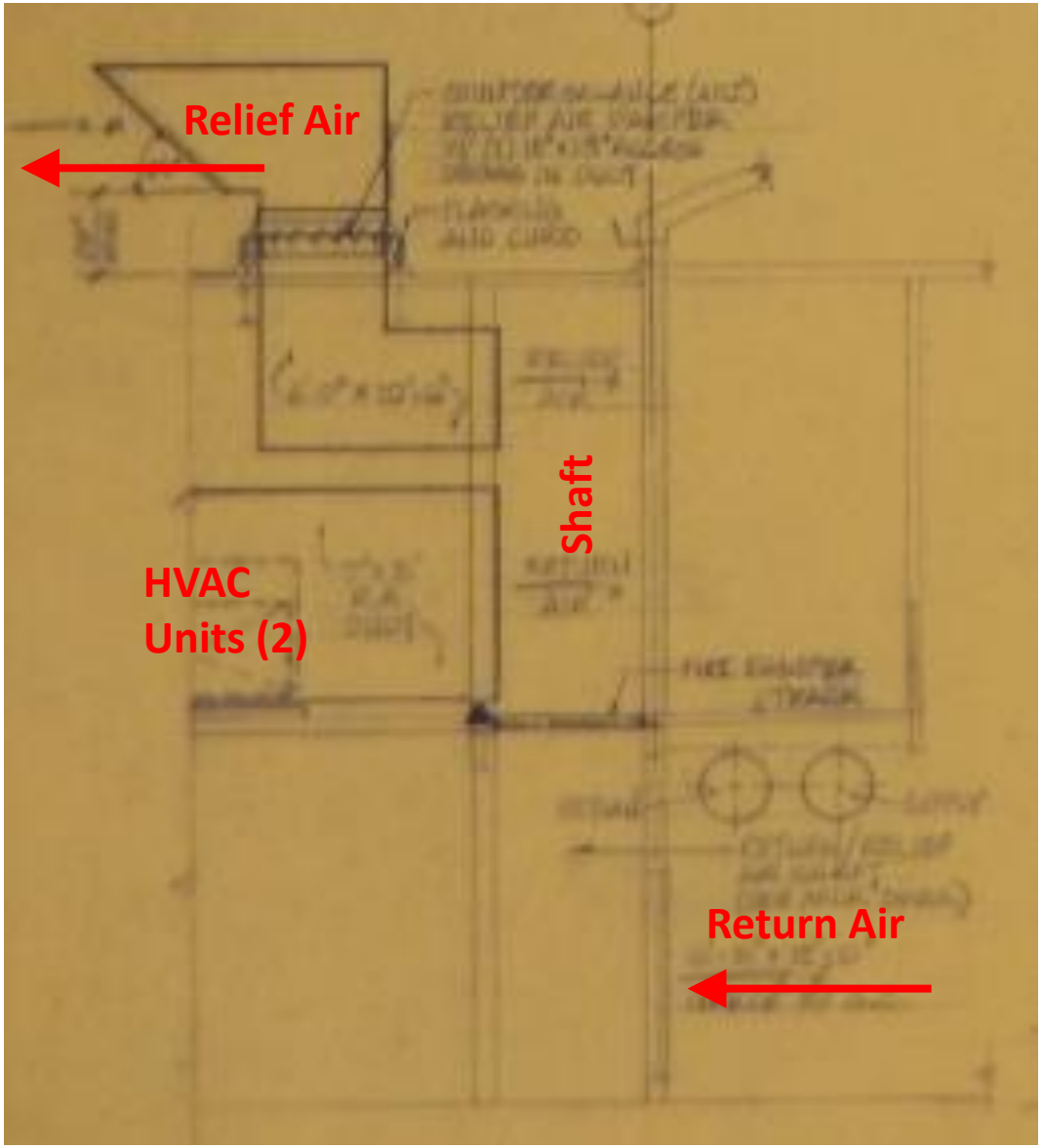
Electricity Savings (kWh):	1,148,764	26%	
Natural Gas Savings (Therms):	128,747	65%	
Overall Energy Savings (Mbtu):	16,794	48%	
Utility Cost Savings ($):	$161,237	37%	
Estimated Project Cost ($):	$277,682	1.72	Payback (yrs.)
IEN Incentives Available ($):	$187,441	68%	of Proj. Cost
Net Cost w/Incentives ($):	$90,241	0.56	Payback (yrs.)



Main Gym Stratification Issues

Secondary Gym Issues

- Constant speed operation, 2 units
- Simultaneous heating and cooling
- Damper issues
- Pump cavitation

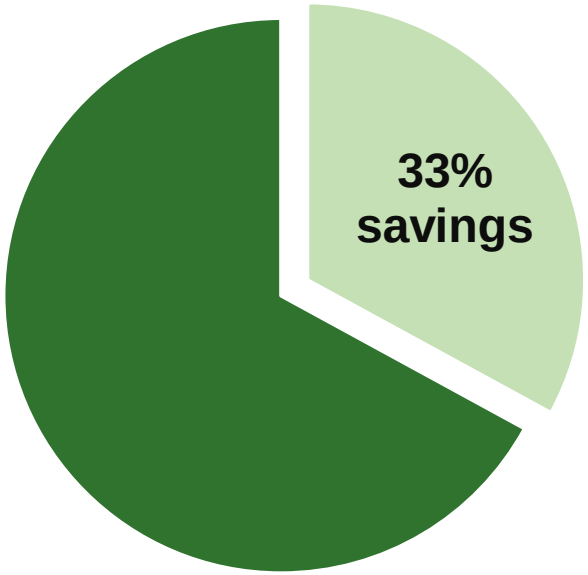


Sample Ventilation Analysis

HVAC System	Area Served	Supply Air CFM	Minimum Outside Air Intake (CFM)			
			Design	Actual	Required	% SA
AHU-1	Dining Area	15,630	9,500	0	4,500	29%
AHU-4	Dining & Office	8,030	8,030	3,812	8,030	100%
AHU-5*	Bookstore	10,500	2,000	500	1500	14%
AHU-S2	Mtg. Rms., Gallery	9,200	1,840	0	1,840	20%
AHU-S3	Offices & Common	8,700	1,780	445	1,780	20%
AHU-S4	East Mtg. Rooms	8,500	1,700	0	1,700	20%
AHU-S5	Restaurant	14,300	2,860	0	3,340	23%
AHU-S12	Offices	3,210	470	0	200	6%

Local High School (SEDAC)

Electricity Savings (kWh):	891,095	34%	
Natural Gas Savings (Therms):	18,006	28%	
Overall Energy Savings (Mbtu):	4,841	32%	
Utility Cost Savings ($):	$79,383	33%	
Estimated Project Cost ($):	$239,640	3.02	Payback (yrs.)
IEN Incentives Available ($):	$91,385	38%	of Proj. Cost
Net Cost w/Incentives ($):	$148,255	1.87	Payback (yrs.)



Energy Recovery Unit

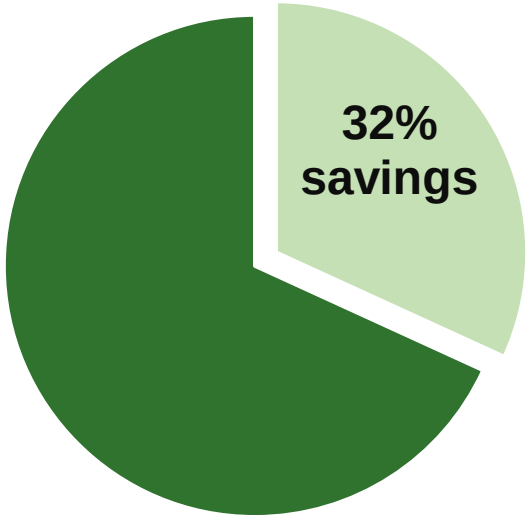
- Responsible for ventilation air
- Flow imbalance revealed by functional testing & data logging

Indoor Air Quality

- Improperly/ineffectively operating ERUs resulted in space comfort issues
- ERUs were disabled during extreme temperatures
- ***ISSUE:*** Disabling ERUs eliminated ventilation air for portions of facility!
- Corrective Action:
- Evaluation and correction of ERU operation to meet facility needs
- Control upgrade to the units tasked with conditioning the spaces with comfort issues

Private University – Classroom Building (Ameren)

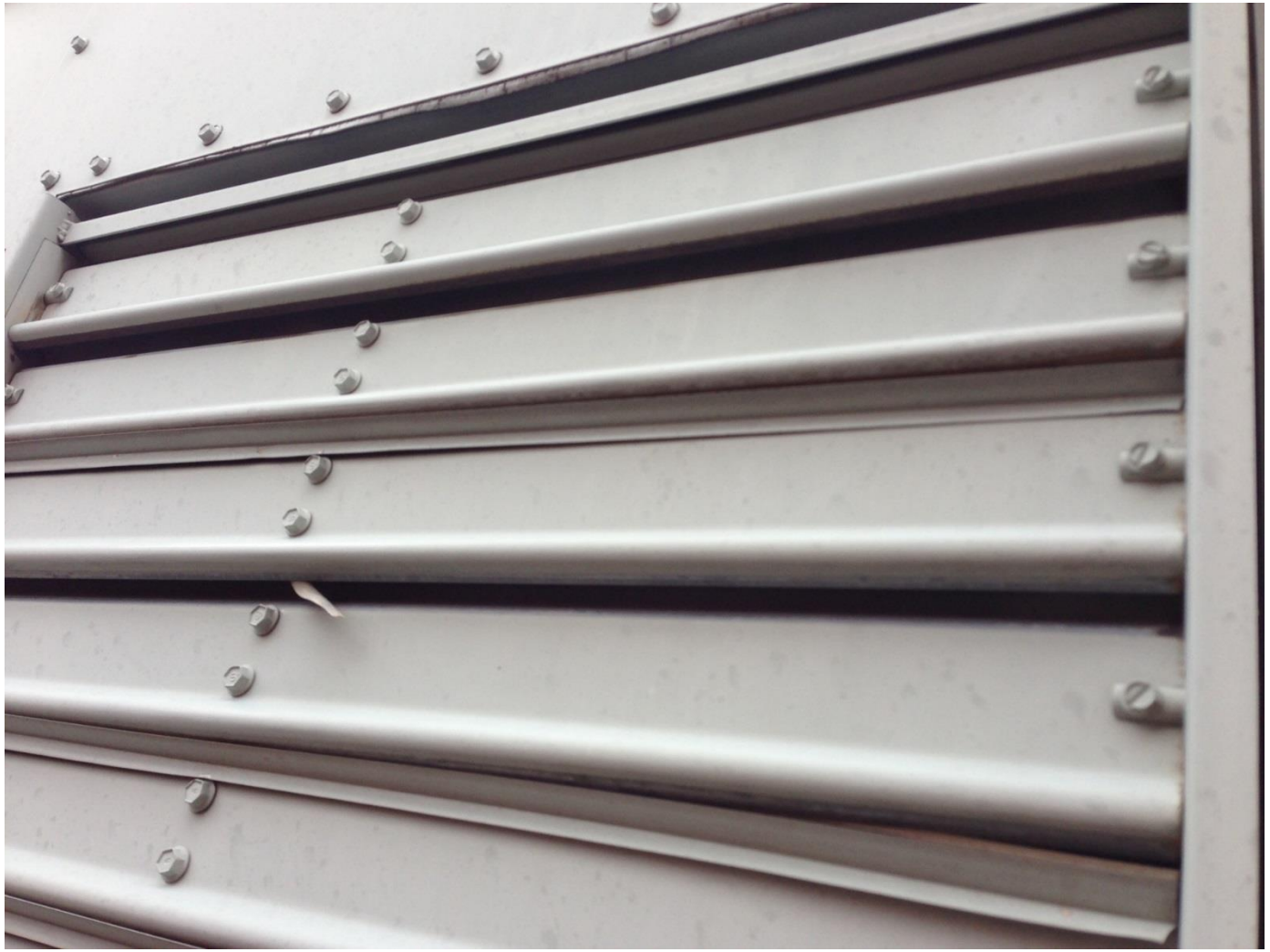
Electricity Savings (kWh):	317,390	29%	
Natural Gas Savings (Therms):	13,962	45%	
Overall Energy Savings (Mbtu):	2,479	36%	
Utility Cost Savings ($):	$32,382	32%	
Estimated Project Cost ($):	$60,275	1.86	Payback (yrs.)
IEN Incentives Available ($):	$9,273	15%	of Proj. Cost
Net Cost w/Incentives ($):	$51,002	1.58	Payback (yrs.)



Dirty Air Flow Station

- Inaccurate readings
- Improved unit operation & efficiency after corrected


08/21/2012

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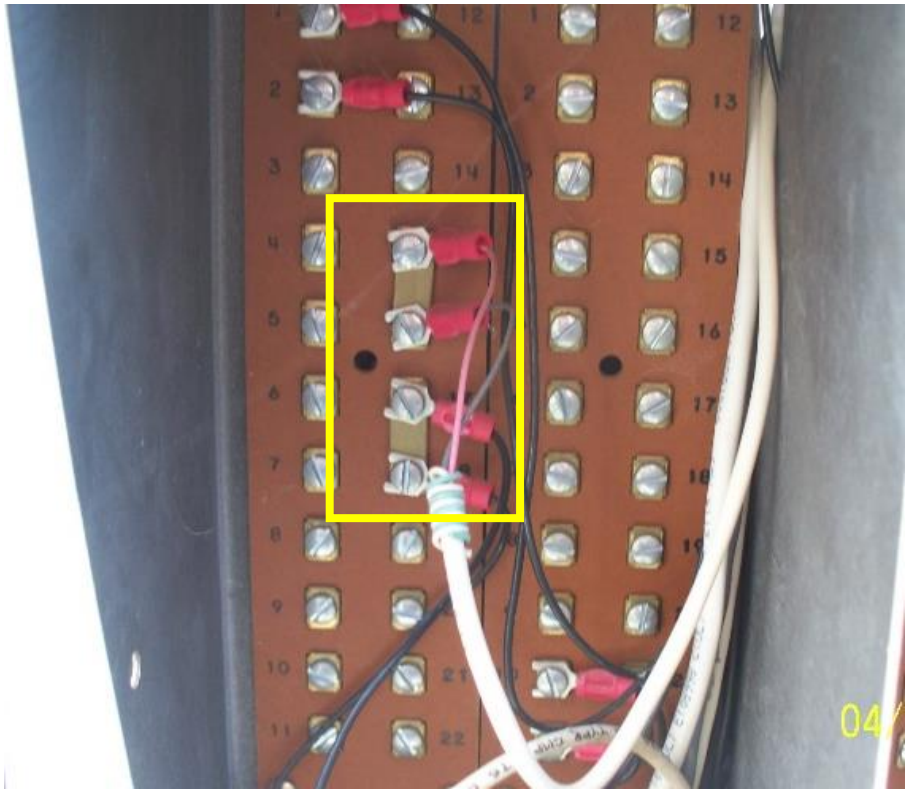
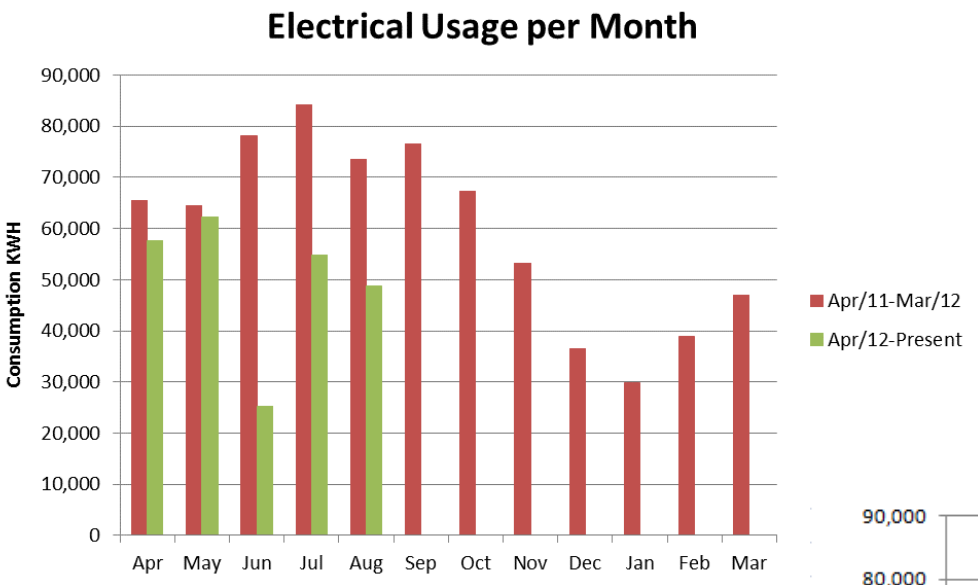
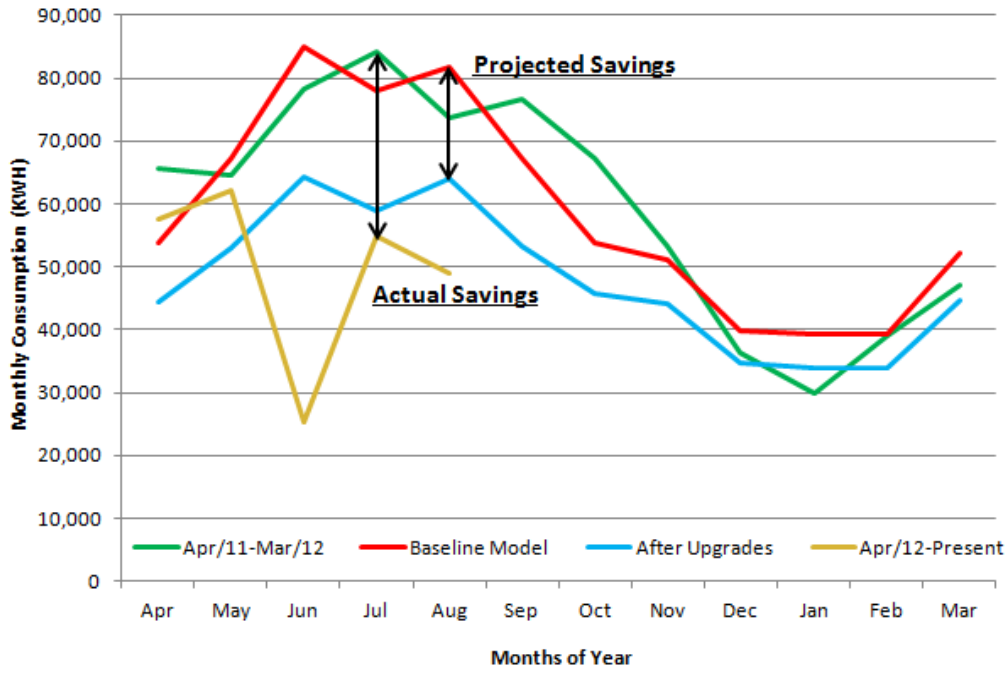
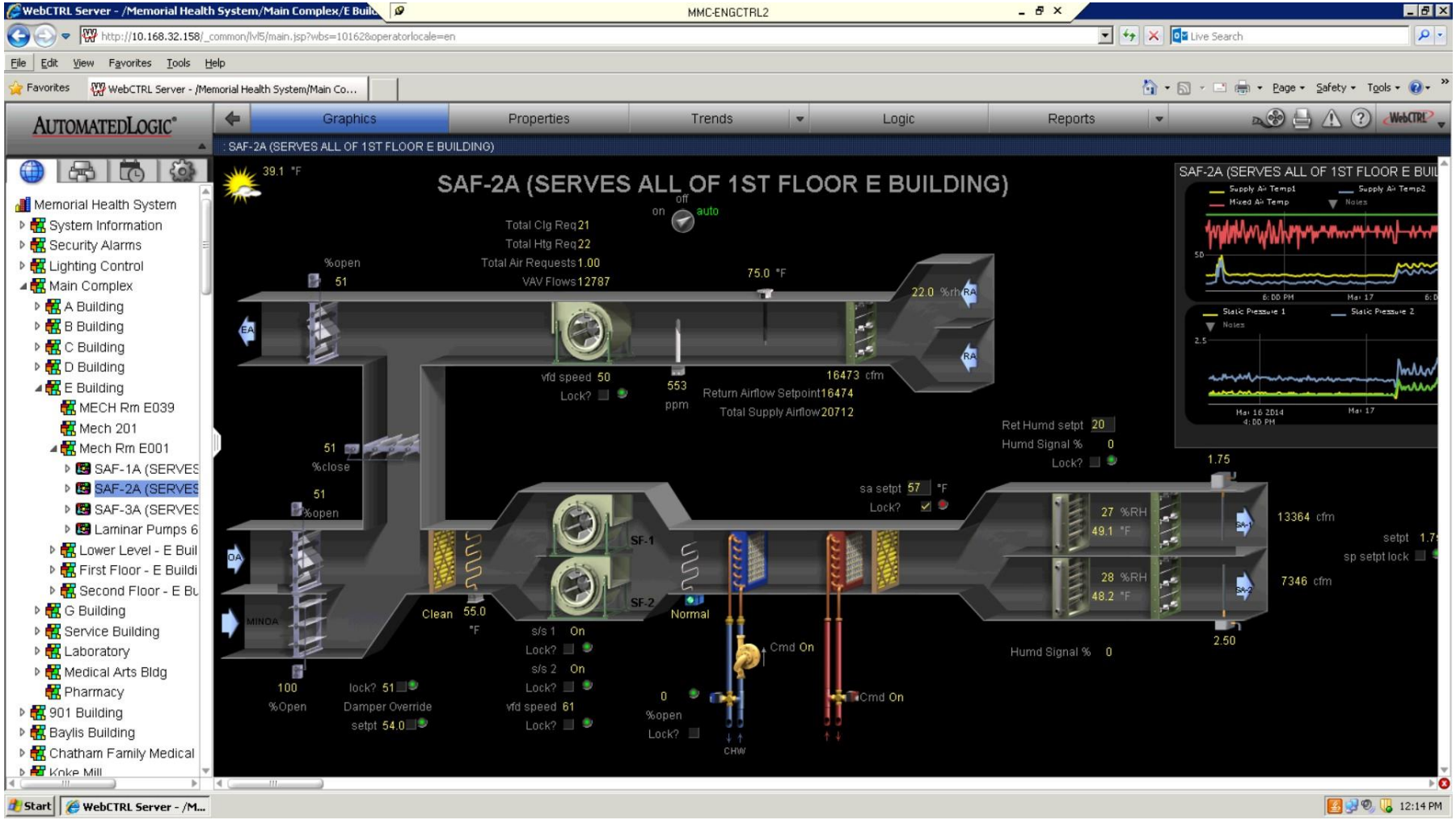



Electrical Usage per Month
Consumption KWH
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar
Apr/11-Mar/12
Apr/12-Present


Monthly Consumption (KWH)
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Projected Savings
Actual Savings
Apr/11-Mar/12
Baseline Model
After Upgrades
Apr/12-Present
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar
Months of Year

Springfield Hospital (Ameren)

Electricity Savings (kWh):	**4,909,924**	**13%**	
Natural Gas Savings (Therms):	**874,026**	**47%**	
Overall Energy Savings (Mbtu):	**104,155**	**33%**	
Utility Cost Savings ($):	**$1,114,121**	**22%**	
Estimated Project Cost ($):	**$1,190,531**	**1.07**	**Payback (yrs.)**


WebCTRL Server - /Memorial Health System/Main Complex/E Build
MMC-ENGCTRL2
http://10.168.32.158/_common/lvl5/main.jsp?wbs=10162&operatorlocale=en
File Edit View Favorites Tools Help
Favorites
WebCTRL Server - /Memorial Health System/Main Co...
AUTOMATEDLOGIC
Graphics
Properties
Trends
Logic
Reports
WebCTRL
: SAF-2A (SERVES ALL OF 1ST FLOOR E BUILDING)
Memorial Health System
System Information
Security Alarms
Lighting Control
Main Complex
A Building
B Building
C Building
D Building
E Building
MECH Rm E039
Mech 201
Mech Rm E001
SAF-1A (SERVES
SAF-2A (SERVES
SAF-3A (SERVES
Laminar Pumps 6
Lower Level - E Buil
First Floor - E Buildi
Second Floor - E Bu
G Building
Service Building
Laboratory
Medical Arts Bldg
Pharmacy
901 Building
Baylis Building
Chatham Family Medical
Koke Mill
SAF-2A (SERVES ALL OF 1ST FLOOR E BUILDING)
39.1 °F
Total Clg Req 21
Total Htg Req 22
Total Air Requests 1.00
VAV Flows 12787
off
on
auto
%open
51
75.0 °F
22.0 %rh
RA
EA
vfd speed 50
Lock?
553
ppm
16473 cfm
Return Airflow Setpoint 16474
Total Supply Airflow 20712
Ret Humd setpt 20
Humd Signal % 0
Lock?
51
%close
51
%open
sa setpt 57 °F
Lock?
1.75
27 %RH
49.1 °F
13364 cfm
setpt 1.7
sp setpt lock
SF-1
SF-2
28 %RH
48.2 °F
7346 cfm
OA
MINOA
Clean
55.0
°F
Normal
s/s 1 On
Lock?
s/s 2 On
Lock?
vfd speed 61
Lock?
Cmd On
Cmd On
2.50
Humd Signal % 0
100
%Open
lock? 51
Damper Override
setpt 54.0
0
%open
Lock?
CHW
SAF-2A (SERVES ALL OF 1ST FLOOR E BUIL
Supply Air Temp1
Supply Air Temp2
Mixed Air Temp
Notes
6:00 PM
Mar 17
Static Pressure 1
Static Pressure 2
Notes
Mar 16 2014
4:00 PM
Mar 17
Start
WebCTRL Server - /M...
12:14 PM

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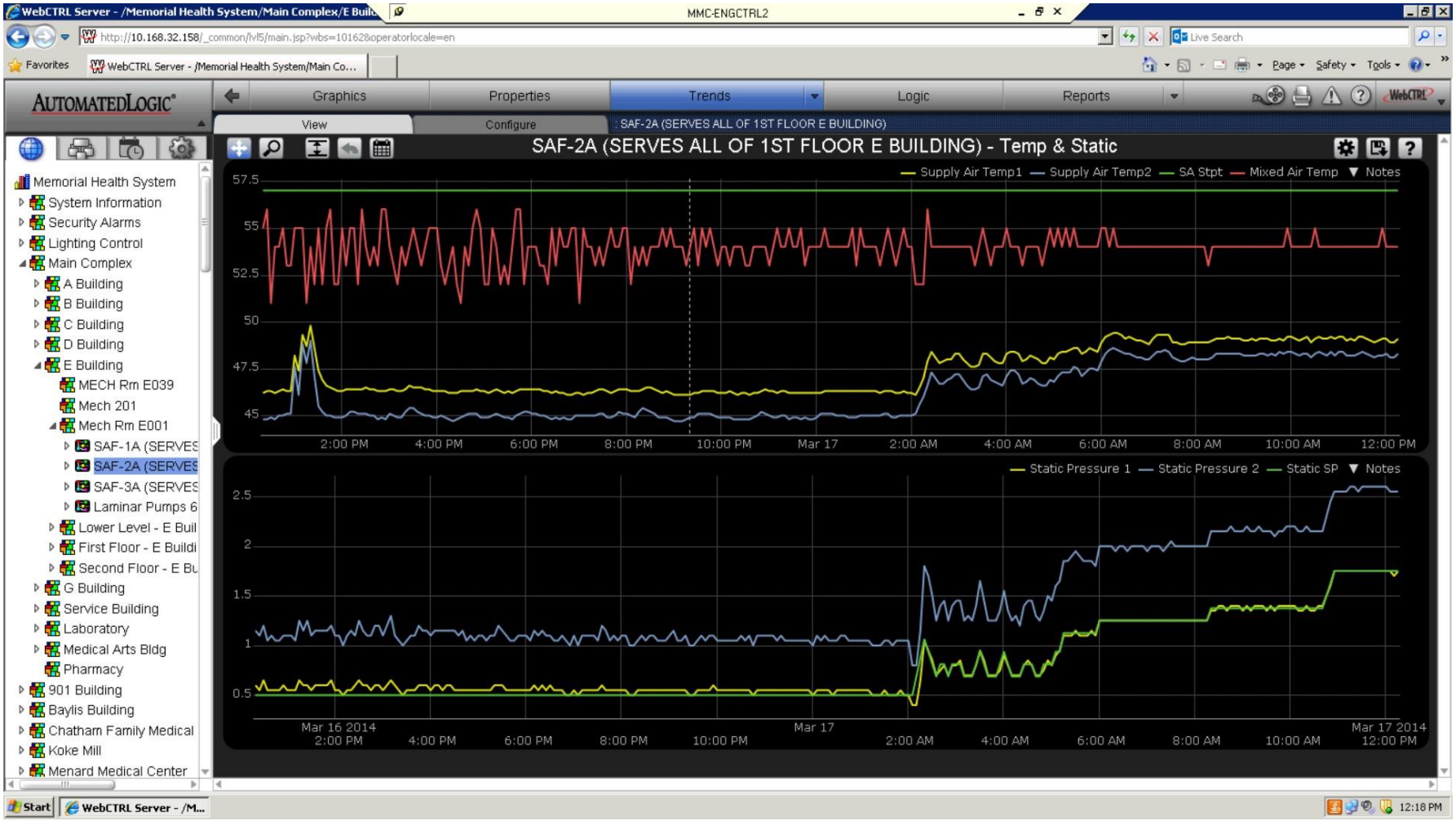

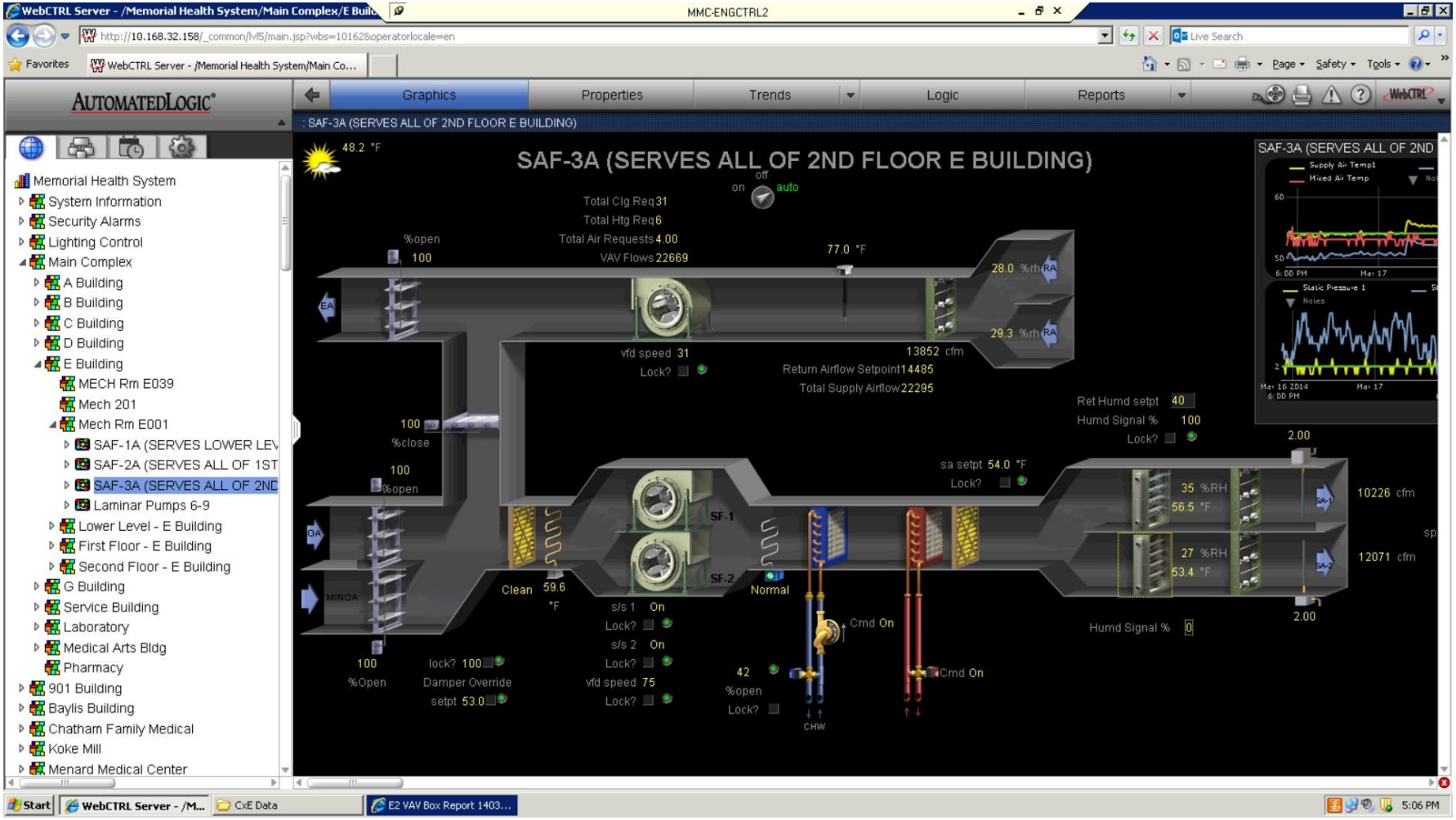
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MMC-ENGCTRL2
http://10.168.32.158/_common/lvl5/main.jsp?wbs=101628&operatorlocale=en
AUTOMATEDLOGIC
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Memorial Health System
System Information
Security Alarms
Lighting Control
Main Complex
A Building
B Building
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D Building
E Building
MECH Rm E039
Mech 201
Mech Rm E001
SAF-1A (SERVES LOWER LEV
SAF-2A (SERVES ALL OF 1ST
SAF-3A (SERVES ALL OF 2ND
Laminar Pumps 6-9
Lower Level - E Building
First Floor - E Building
Second Floor - E Building
G Building
Service Building
Laboratory
Medical Arts Bldg
Pharmacy
901 Building
Baylis Building
Chatham Family Medical
Koke Mill
Menard Medical Center
48.2 °F
Total Clg Req 31
Total Htg Req 6
Total Air Requests 4.00
VAV Flows 22669
%open 100
77.0 °F
28.0 %rh RA
29.3 %rh RA
vfd speed 31
Lock?
13852 cfm
Return Airflow Setpoint 14485
Total Supply Airflow 22295
Ret Humd setpt 40
Humd Signal % 100
100 %close
100 %open
sa setpt 54.0 °F
35 %RH
56.5 °F
10226 cfm
27 %RH
53.4 °F
12071 cfm
SF-1
SF-2
Clean 59.6 °F
Normal
s/s 1 On
s/s 2 On
vfd speed 75
Cmd On
Humd Signal % 0
100 %Open
lock? 100
Damper Override
setpt 53.0
42 %open
CHW
SAF-3A (SERVES ALL OF 2ND
Start
WebCTRL Server - /M...
CxE Data
E2 VAV Box Report 1403...
5:06 PM


WebCTRL Server - /Memorial Health System/Main Complex/E Build
MMC-ENGCTRL2
http://10.168.32.158/_common/lvl5/main.jsp?wbs=10162&operatorlocale=en
Favorites
WebCTRL Server - /Memorial Health System/Main Co...
AUTOMATEDLOGIC
Graphics
Properties
Trends
Logic
Reports
View
Configure
SAF-3A (SERVES ALL OF 2ND FLOOR E BUILDING)
Memorial Health System
System Information
Security Alarms
Lighting Control
Main Complex
A Building
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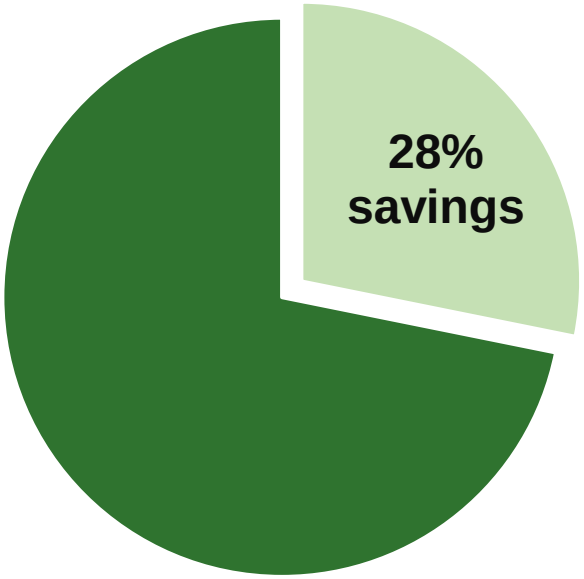
C Building
D Building
E Building
MECH Rm E039
Mech 201
Mech Rm E001
SAF-1A (SERVES LOWER LEV
SAF-2A (SERVES ALL OF 1ST
SAF-3A (SERVES ALL OF 2ND
Laminar Pumps 6-9
Lower Level - E Building
First Floor - E Building
Second Floor - E Building
G Building
Service Building
Laboratory
Medical Arts Bldg
Pharmacy
901 Building
Baylis Building
Chatham Family Medical
Koke Mill
Menard Medical Center
SAF-3A (SERVES ALL OF 2ND FLOOR E BUILDING) - E3 Valves & Dampers
SF VFD Speed 1
SF VFD Speed 2
RF VFD Speed1
Cooling Valve
Notes
60
40
20
0
6:00 PM
8:00 PM
10:00 PM
Mar 17
2:00 AM
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
4:00 PM
Max OA
Humidifier
Return Air Humidity 1
Supply Air Humidity
Notes
100
75
50
25
Mar 16 2014
6:00 PM
8:00 PM
10:00 PM
Mar 17
2:00 AM
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
Mar 17 2014
4:00 PM
Start
WebCTRL Server - /M...
CxE Data
E2 VAV Box Report 1403...
5:19 PM

Private Laboratory & Research Facility (Ameren Missouri)

Electricity Savings (kWh):	806,755	26%	
Natural Gas Savings (Therms):	32,467	31%	
Overall Energy Savings (Mbtu):	5,999	29%	
Utility Cost Savings ($):	$87,595	28%	
Estimated Project Cost ($):	$182,735	2.09	Payback (yrs.)
IEN Incentives Available ($):	$35,252	19%	of Proj. Cost
Net Cost w/Incentives ($):	$147,483	1.68	Payback (yrs.)



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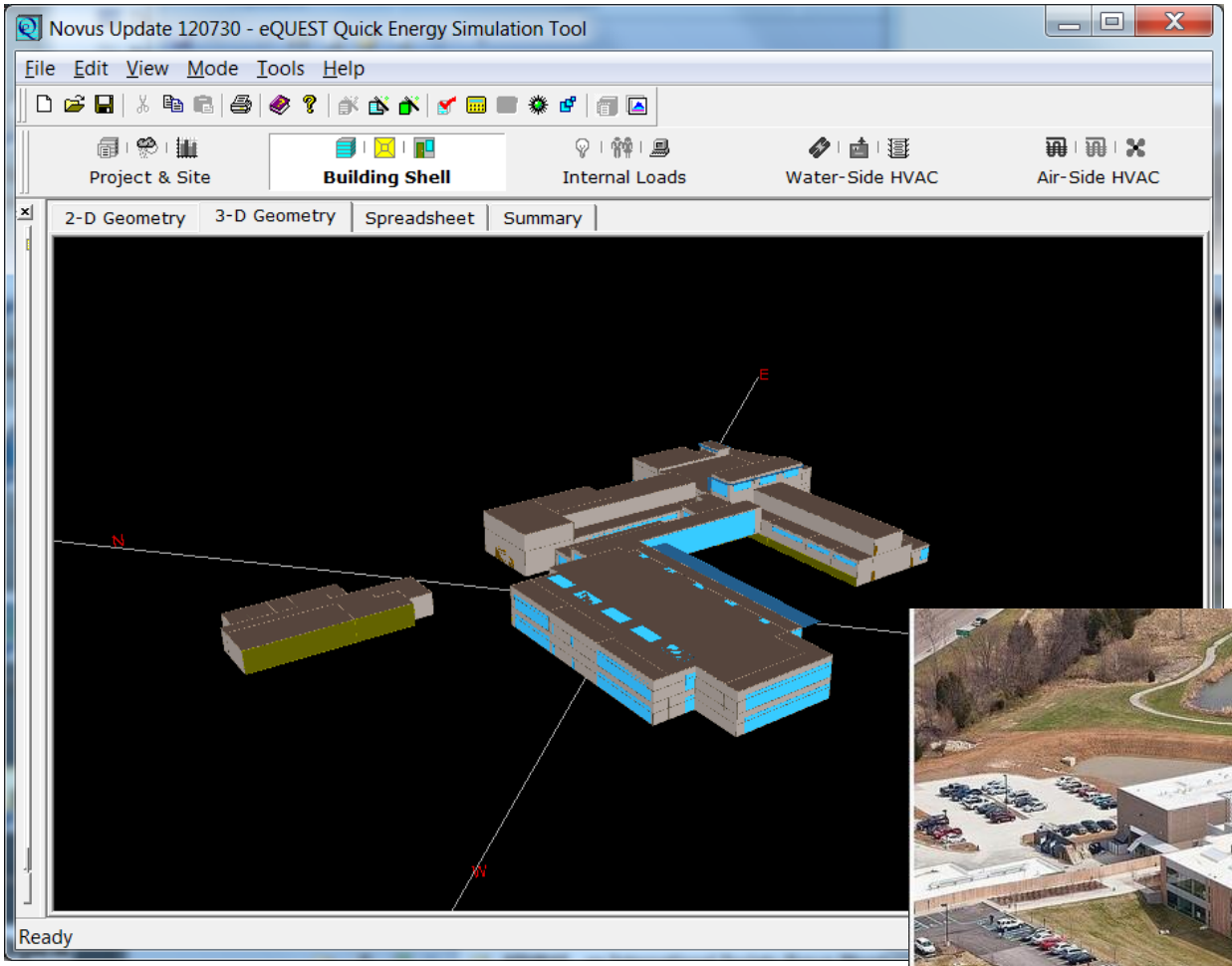
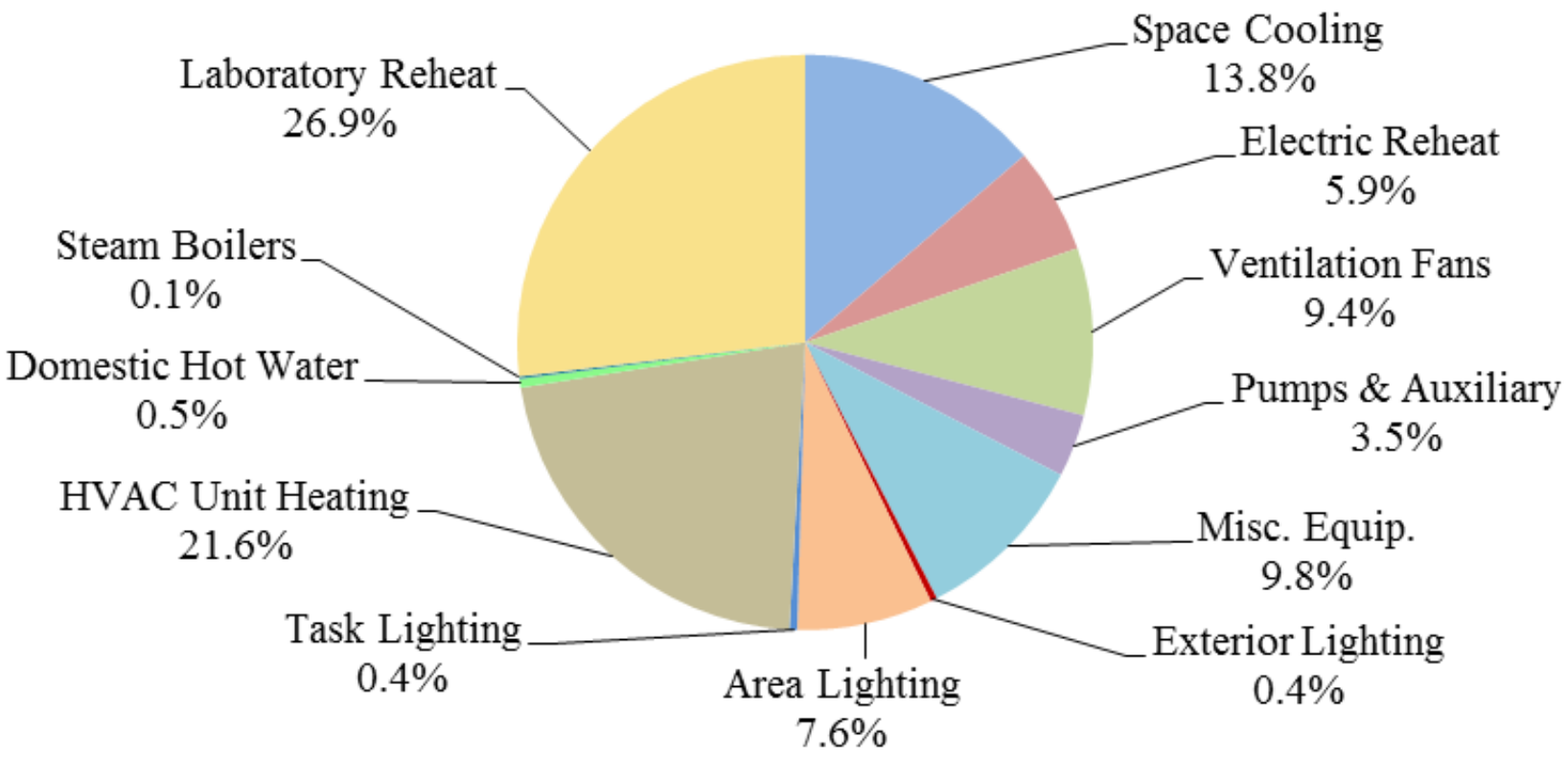
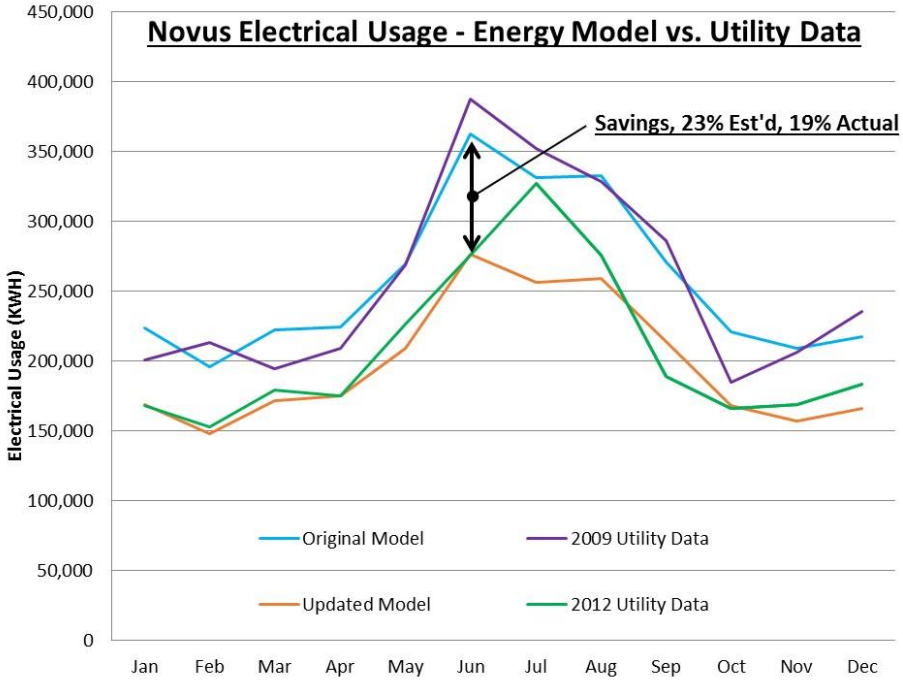
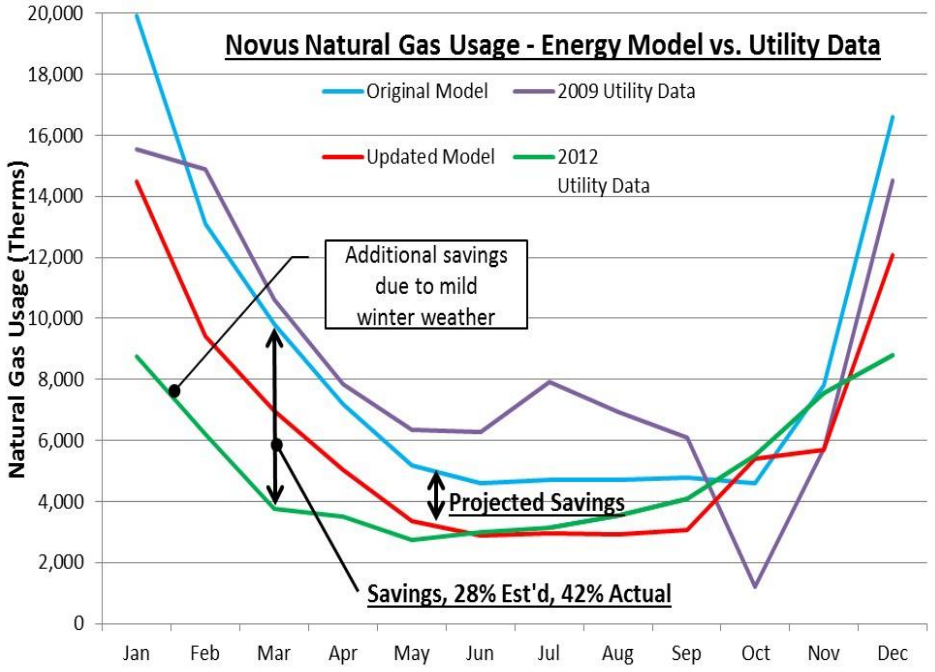
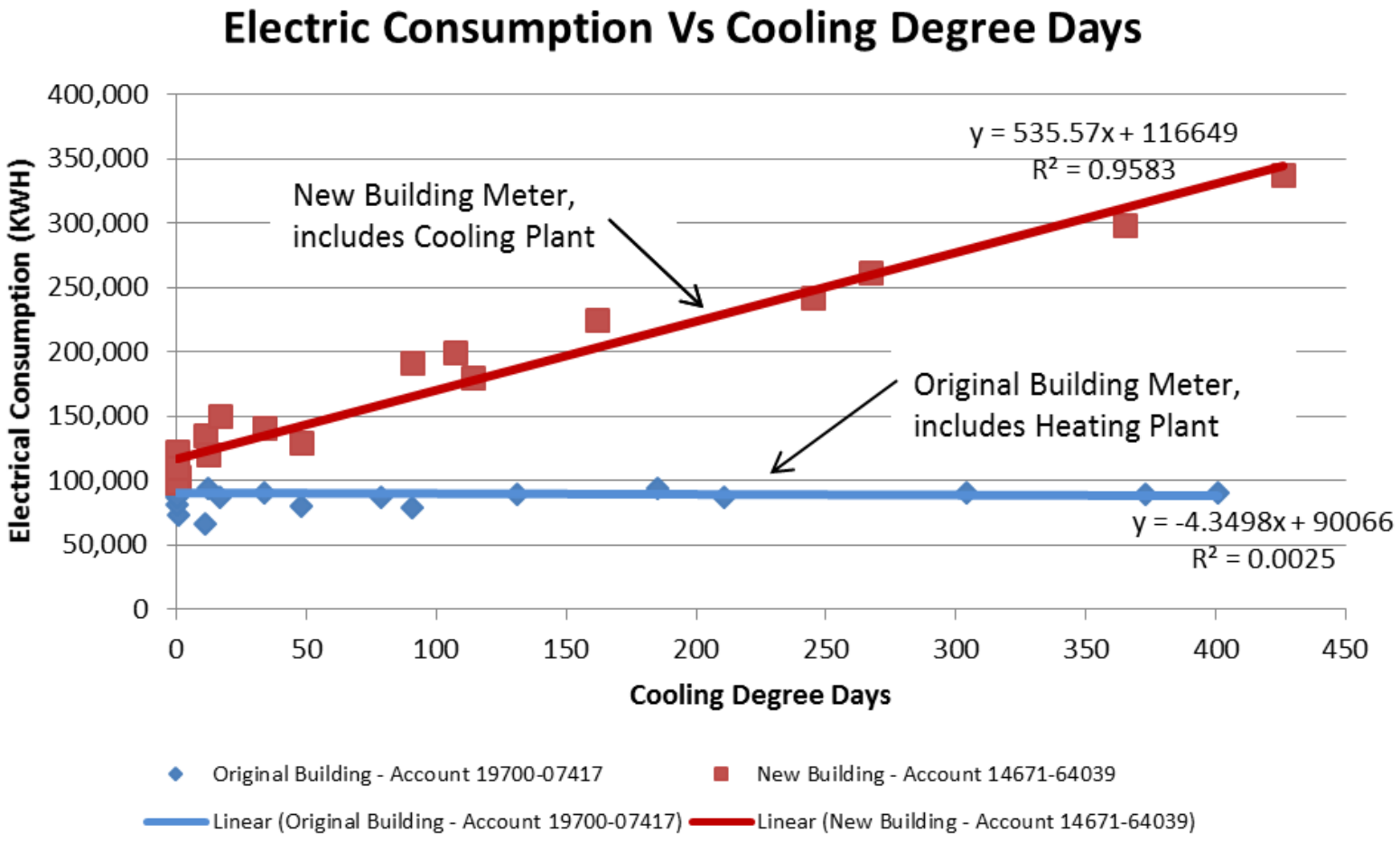


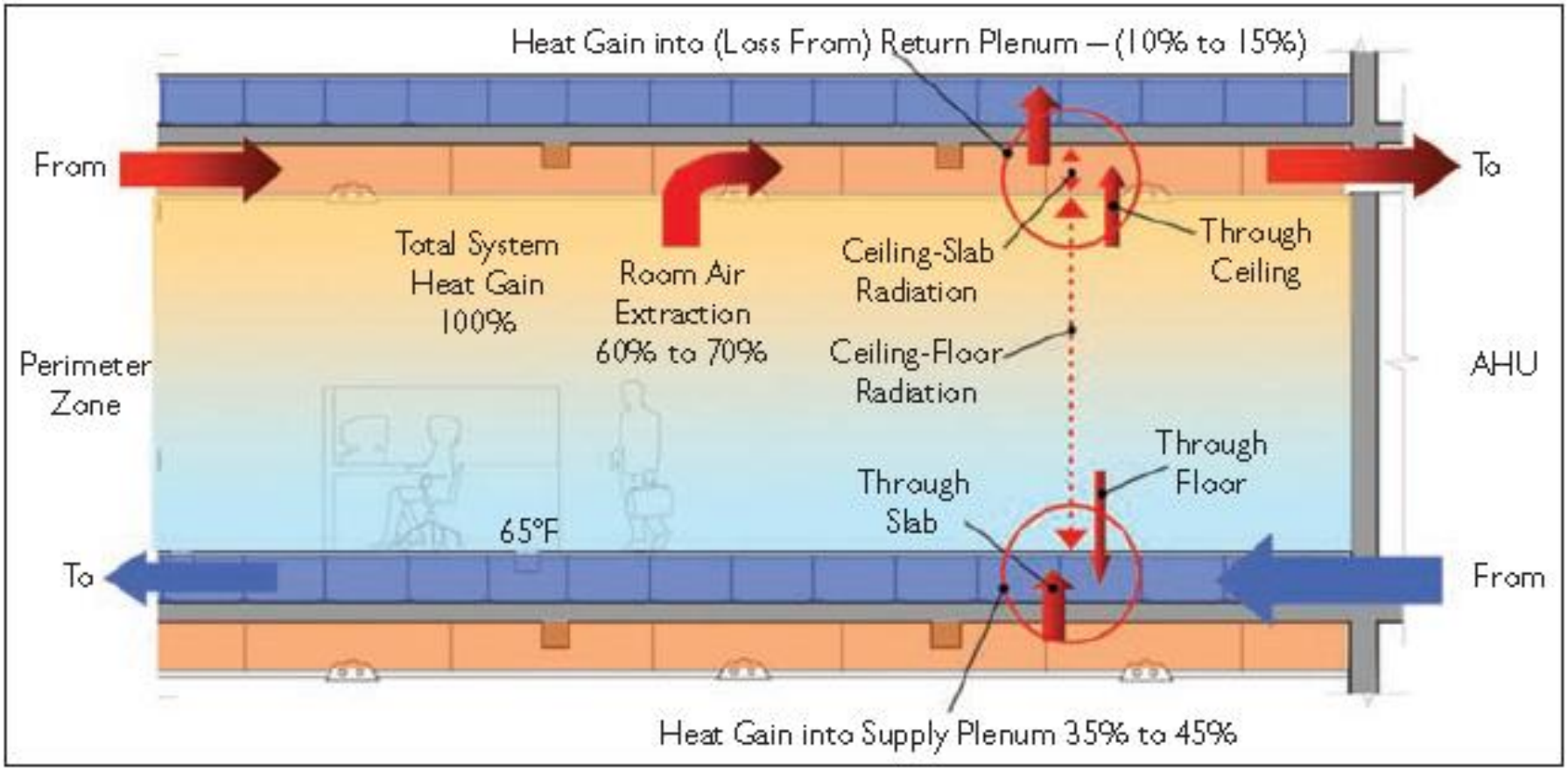
Total Energy Consumption by Category

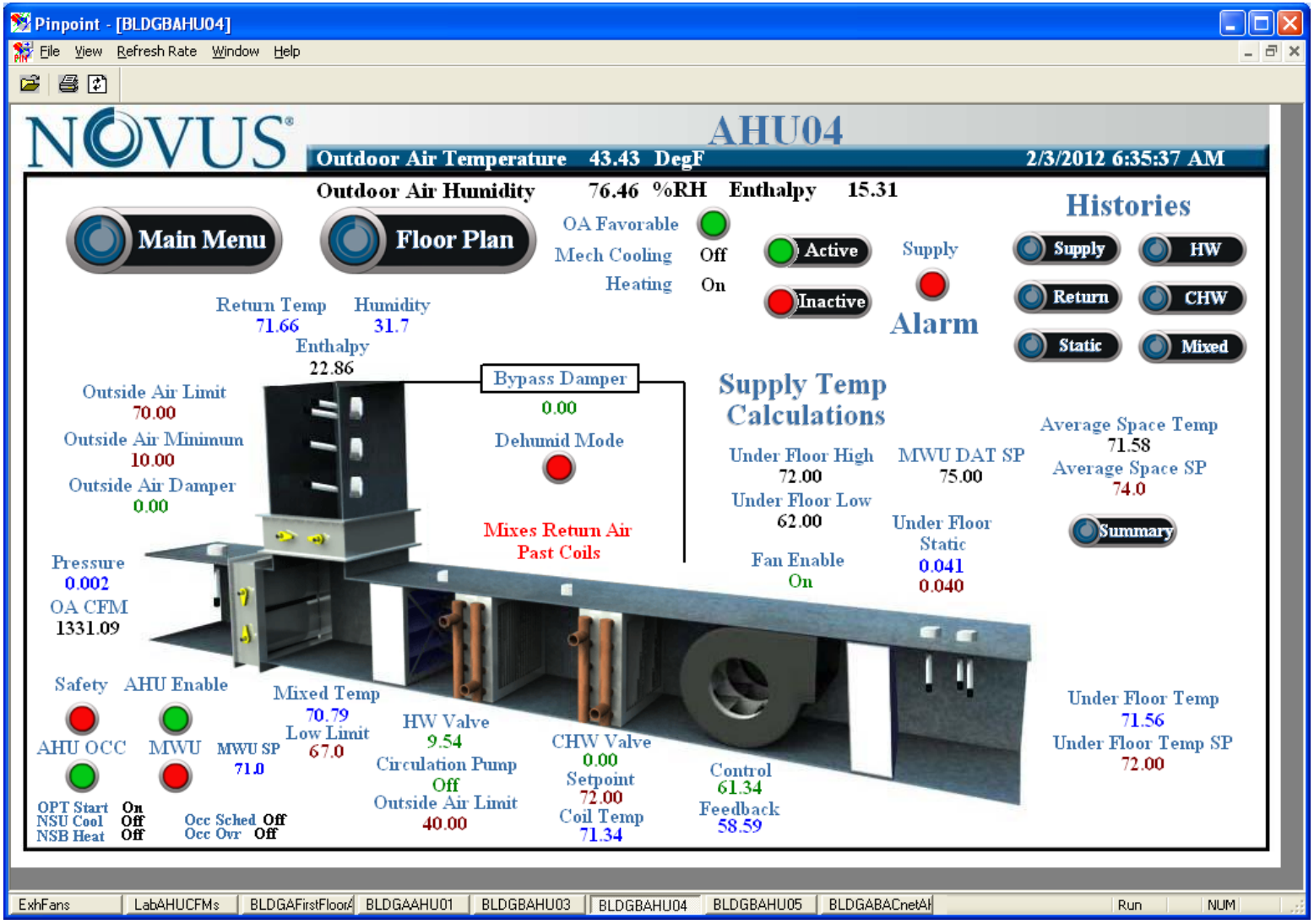



Novus Electrical Usage - Energy Model vs. Utility Data
Savings, 23% Est'd, 19% Actual
Electrical Usage (KWH)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Original Model
2009 Utility Data
Updated Model
2012 Utility Data


Novus Natural Gas Usage - Energy Model vs. Utility Data
Original Model
2009 Utility Data
Updated Model
2012 Utility Data
Additional savings due to mild winter weather
Projected Savings
Savings, 28% Est'd, 42% Actual
Natural Gas Usage (Therms)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Electric Consumption Vs Cooling Degree Days
Electrical Consumption (KWH)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
0
50
100
150
200
250
300
350
400
450
Cooling Degree Days
y = 535.57x + 116649
R² = 0.9583
New Building Meter,
includes Cooling Plant
Original Building Meter,
includes Heating Plant
y = -4.3498x + 90066
R² = 0.0025
Original Building - Account 19700-07417
New Building - Account 14671-64039
Linear (Original Building - Account 19700-07417)
Linear (New Building - Account 14671-64039)


Heat Gain into (Loss From) Return Plenum – (10% to 15%)
From
To
Total System
Heat Gain
100%
Room Air
Extraction
60% to 70%
Ceiling-Slab
Radiation
Through
Ceiling
Perimeter
Zone
Ceiling-Floor
Radiation
AHU
Through
Floor
Through
Slab
65°F
To
From
Heat Gain into Supply Plenum 35% to 45%


Pinpoint - [BLDGBAHU04]
File View Refresh Rate Window Help
NOVUS
AHU04
Outdoor Air Temperature 43.43 DegF
2/3/2012 6:35:37 AM
Outdoor Air Humidity 76.46 %RH Enthalpy 15.31
Main Menu
Floor Plan
OA Favorable
Mech Cooling Off
Heating On
Active
Inactive
Supply
Alarm
Histories
Supply
HW
Return
CHW
Static
Mixed
Return Temp 71.66
Humidity 31.7
Enthalpy 22.86
Outside Air Limit 70.00
Outside Air Minimum 10.00
Outside Air Damper 0.00
Bypass Damper 0.00
Dehumid Mode
Mixes Return Air Past Coils
Supply Temp Calculations
Under Floor High 72.00
Under Floor Low 62.00
MWU DAT SP 75.00
Fan Enable On
Under Floor Static 0.041 0.040
Average Space Temp 71.58
Average Space SP 74.0
Summary
Pressure 0.002
OA CFM 1331.09
Safety
AHU Enable
AHU OCC
MWU
MWU SP 71.0
Mixed Temp 70.79
Low Limit 67.0
HW Valve 9.54
Circulation Pump Off
Outside Air Limit 40.00
CHW Valve 0.00
Setpoint 72.00
Coil Temp 71.34
Control 61.34
Feedback 58.59
Under Floor Temp 71.56
Under Floor Temp SP 72.00
OPT Start On
NSU Cool Off
NSB Heat Off
Occ Sched Off
Occ Ovr Off
ExhFans
LabAHUCFMs
BLDGAFirstFloorA
BLDGAAHU01
BLDGBAHU03
BLDGBAHU04
BLDGBAHU05
BLDGABACnetAH
Run
NUM

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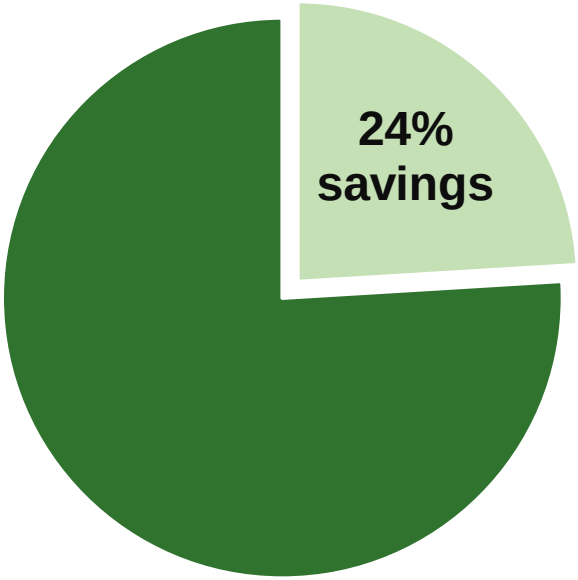
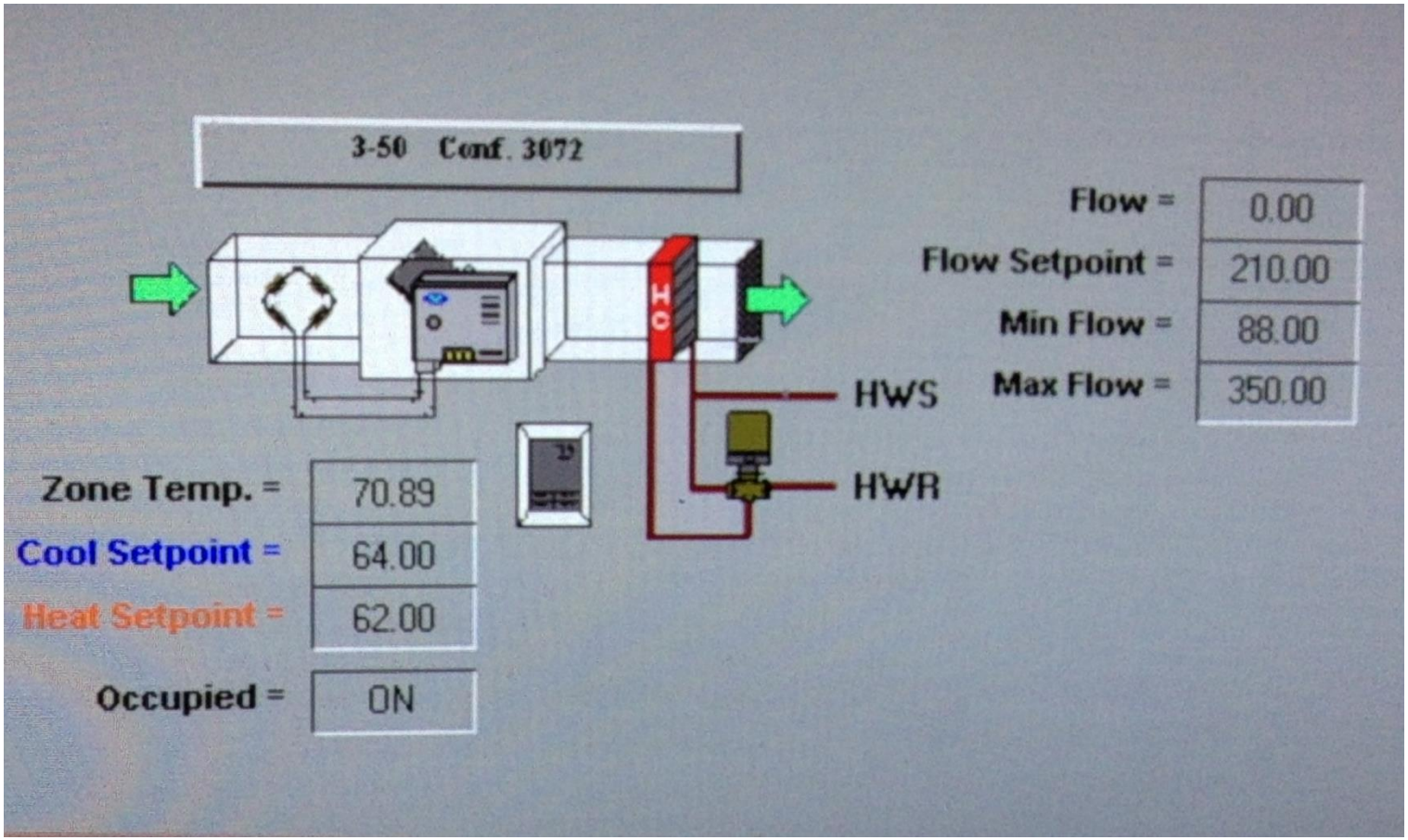
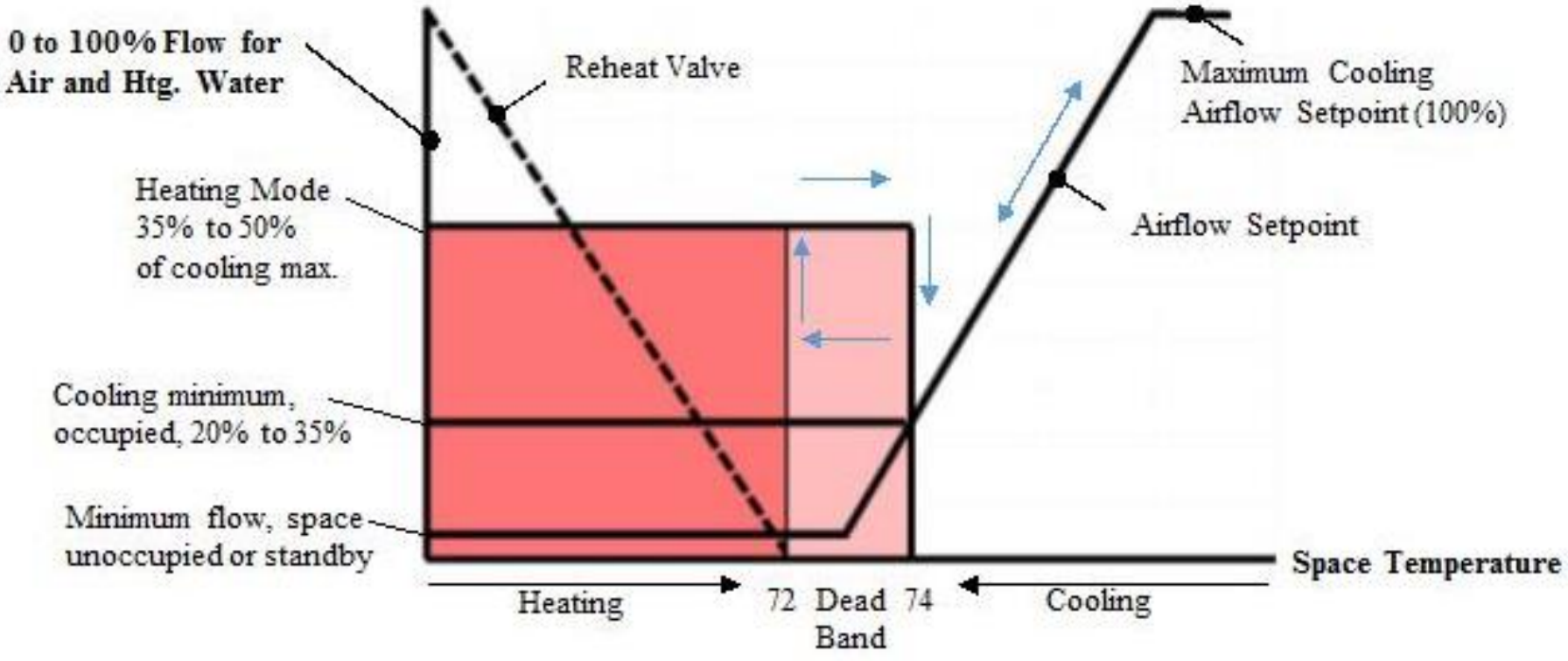
Public University – Classroom & Laboratory Building (SEDAC)

Electricity Savings (kWh):	**555,112**	**24%**	
Natural Gas Savings (Therms):	**15,257**	**25%**	
Overall Energy Savings (Mbtu):	**3,420**	**24%**	
Utility Cost Savings ($):	**$71,940**	**24%**	
Estimated Project Cost ($):	**$170,277**	**2.37**	**Payback (yrs.)**
IEN Incentives Available ($):	**$100,152**	**59%**	**of Proj. Cost**
Net Cost w/Incentives ($):	**$70,125**	**0.97**	**Payback (yrs.)**

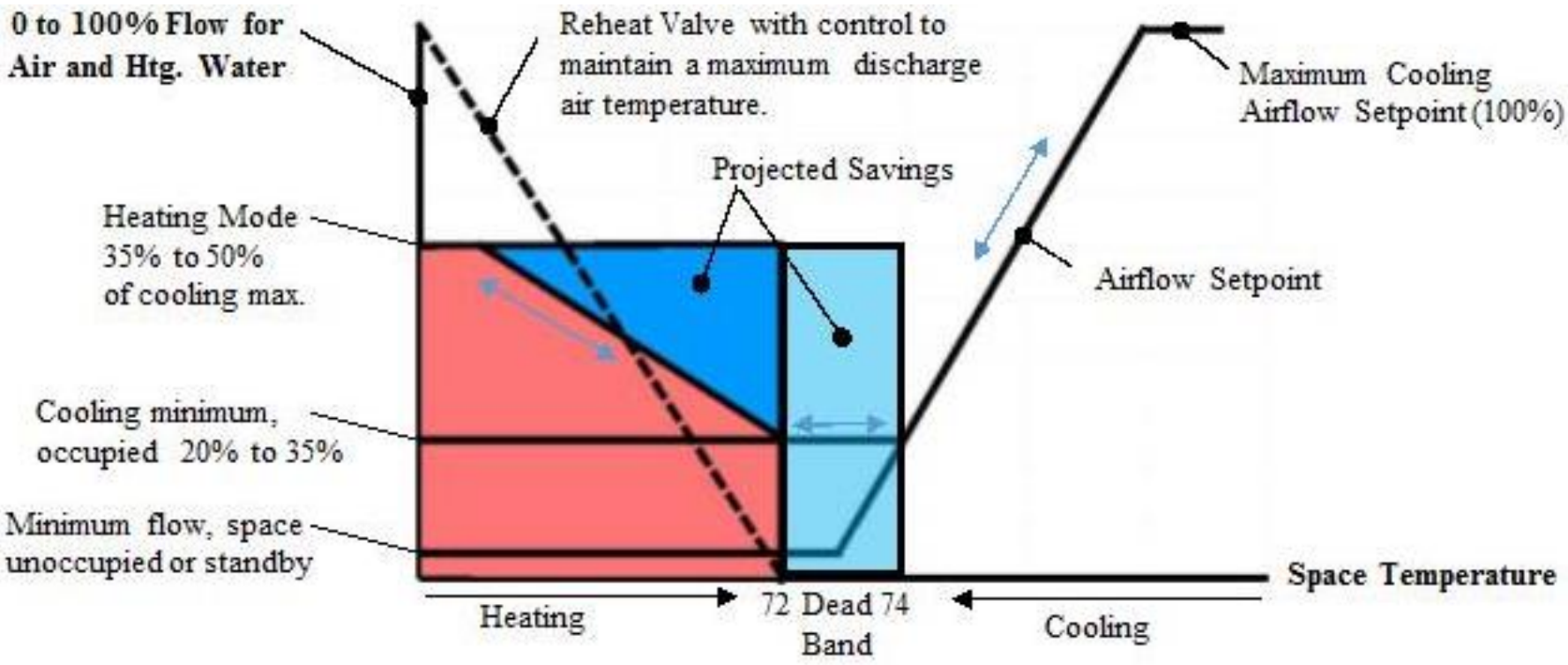



3-50 Conf. 3072
HC
HWS
HWR
Flow = 0.00
Flow Setpoint = 210.00
Min Flow = 88.00
Max Flow = 350.00
Zone Temp. = 70.89
Cool Setpoint = 64.00
Heat Setpoint = 62.00
Occupied = ON

Existing VAV Flow Diagram



Proposed VAV Flow Diagram – Dual Maximum Flow



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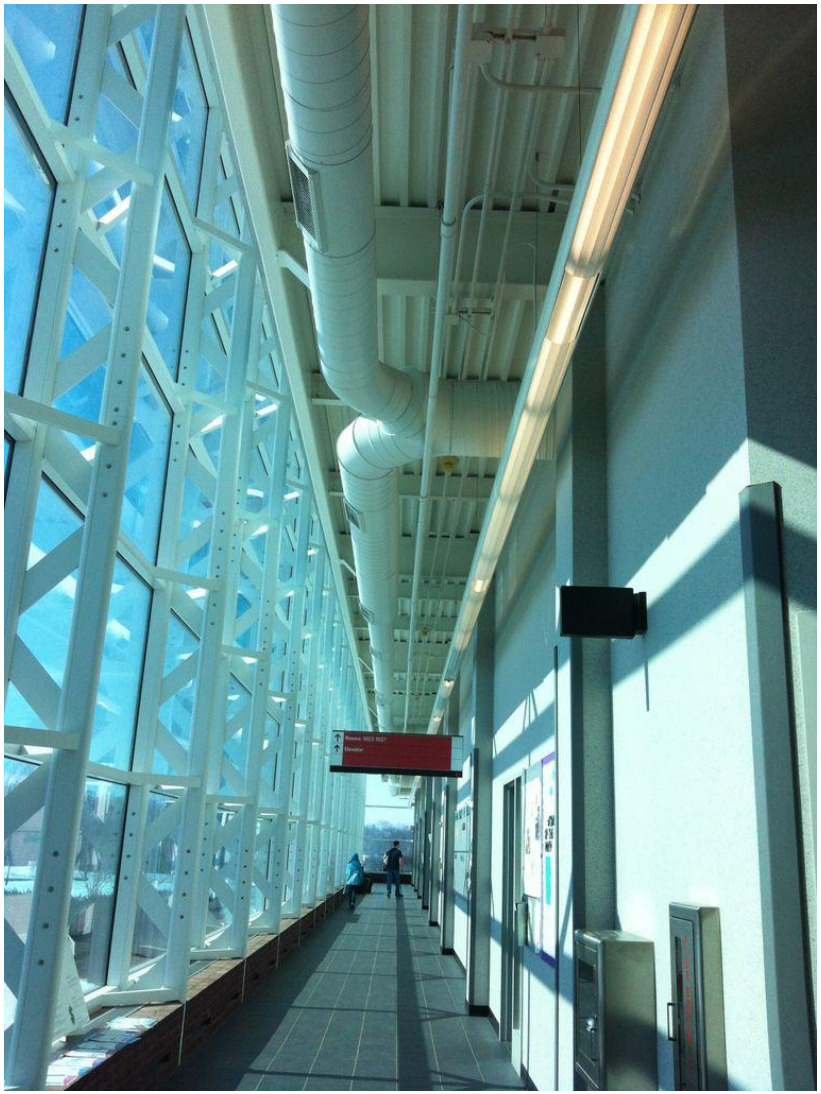
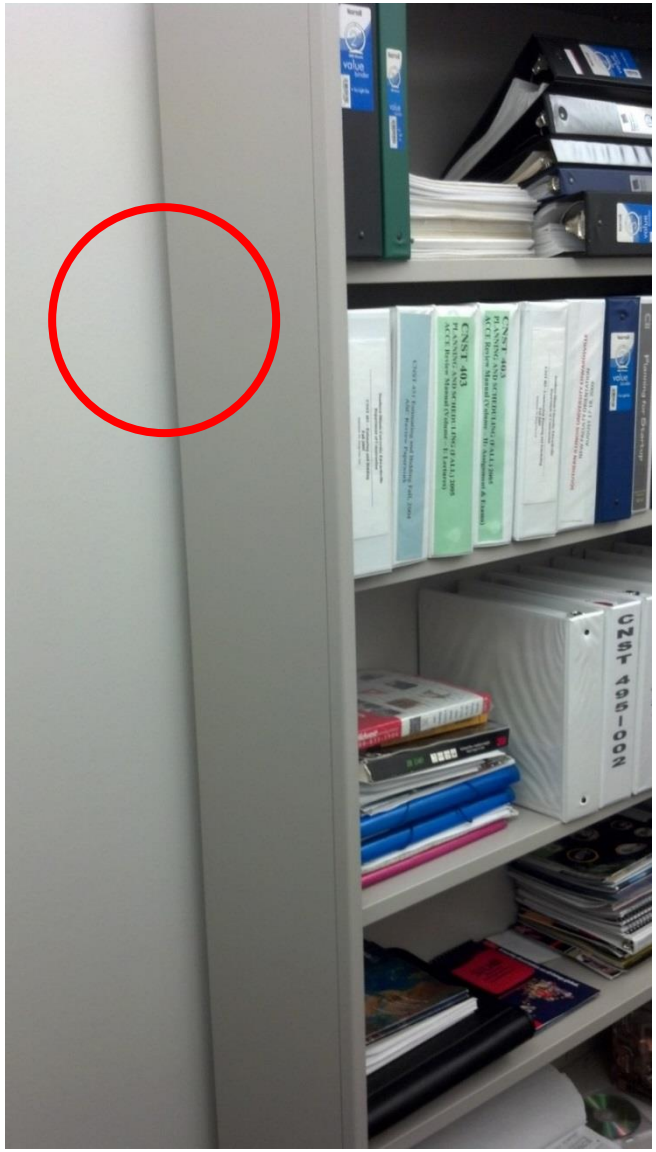
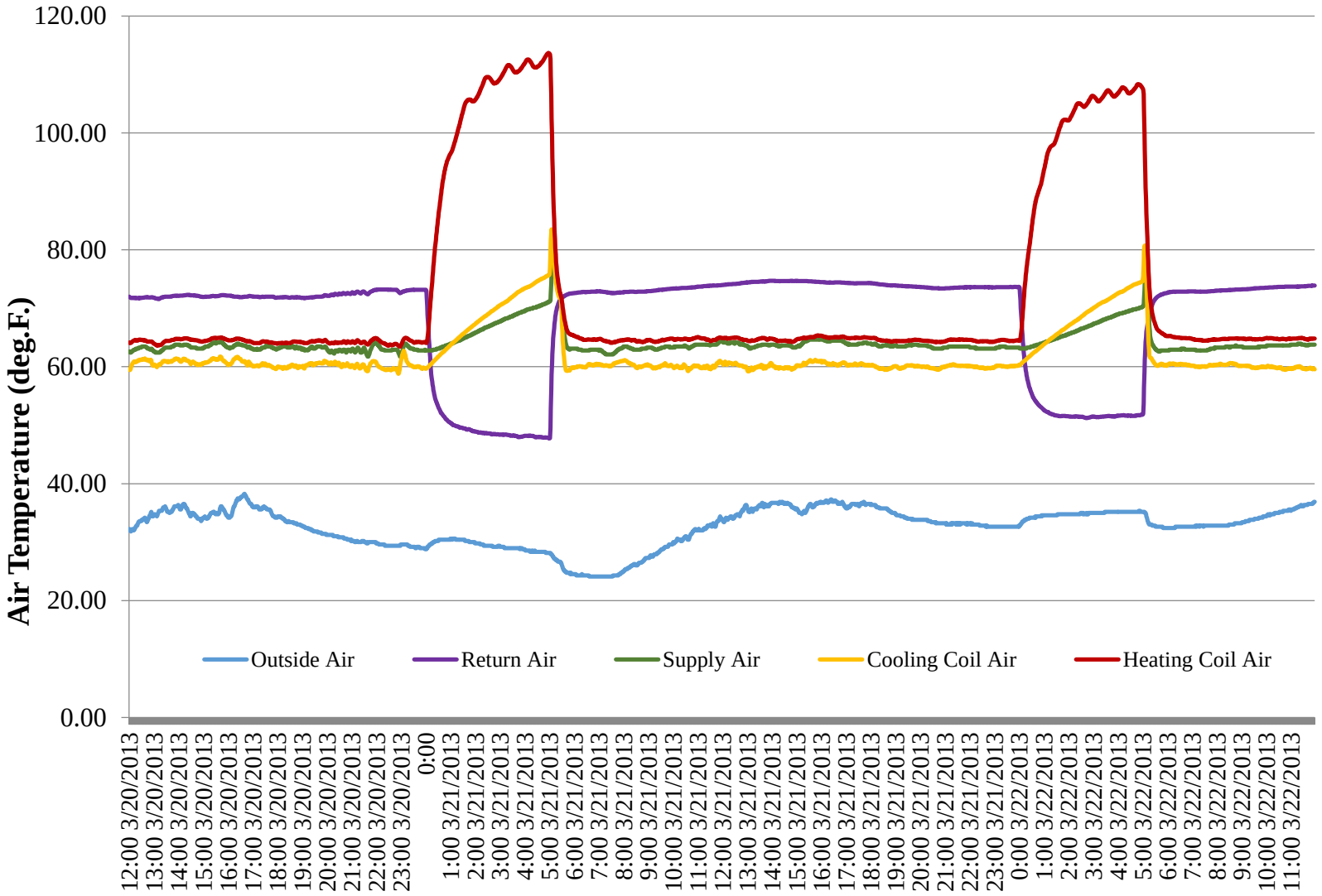
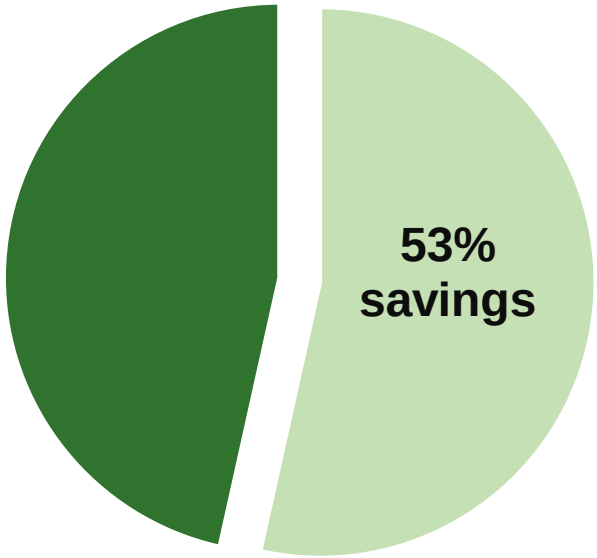



CNST 403
CNST 495-003N


120.00
100.00
80.00
60.00
40.00
20.00
0.00
Air Temperature (deg.F.)
Outside Air
Return Air
Supply Air
Cooling Coil Air
Heating Coil Air
12:00 3/20/2013
13:00 3/20/2013
14:00 3/20/2013
15:00 3/20/2013
16:00 3/20/2013
17:00 3/20/2013
18:00 3/20/2013
19:00 3/20/2013
20:00 3/20/2013
21:00 3/20/2013
22:00 3/20/2013
23:00 3/20/2013
0:00
1:00 3/21/2013
2:00 3/21/2013
3:00 3/21/2013
4:00 3/21/2013
5:00 3/21/2013
6:00 3/21/2013
7:00 3/21/2013
8:00 3/21/2013
9:00 3/21/2013
10:00 3/21/2013
11:00 3/21/2013
12:00 3/21/2013
13:00 3/21/2013
14:00 3/21/2013
15:00 3/21/2013
16:00 3/21/2013
17:00 3/21/2013
18:00 3/21/2013
19:00 3/21/2013
20:00 3/21/2013
21:00 3/21/2013
22:00 3/21/2013
23:00 3/21/2013
0:00 3/22/2013
1:00 3/22/2013
2:00 3/22/2013
3:00 3/22/2013
4:00 3/22/2013
5:00 3/22/2013
6:00 3/22/2013
7:00 3/22/2013
8:00 3/22/2013
9:00 3/22/2013
10:00 3/22/2013
11:00 3/22/2013

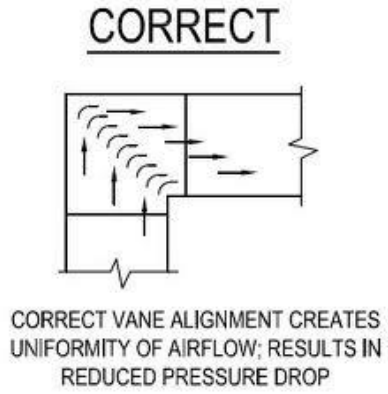
Public University – Dormitory Building (SEDAC)

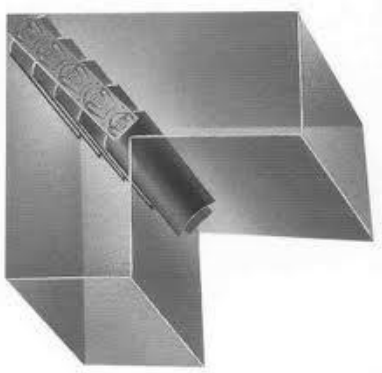
Electricity Savings (kWh):	**474,999**	**36%**	
Natural Gas Savings (Therms):	**123,857**	**61%**	
Overall Energy Savings (Mbtu):	**14,006**	**57%**	
Utility Cost Savings ($):	**$237,927**	**53%**	
Estimated Project Cost ($):	**$948,573**	**3.99**	**Payback (yrs.)**
IEN Incentives Available ($):	**$434,910**	**46%**	**of Proj. Cost**
Net Cost w/Incentives ($):	**$513,663**	**2.16**	**Payback (yrs.)**

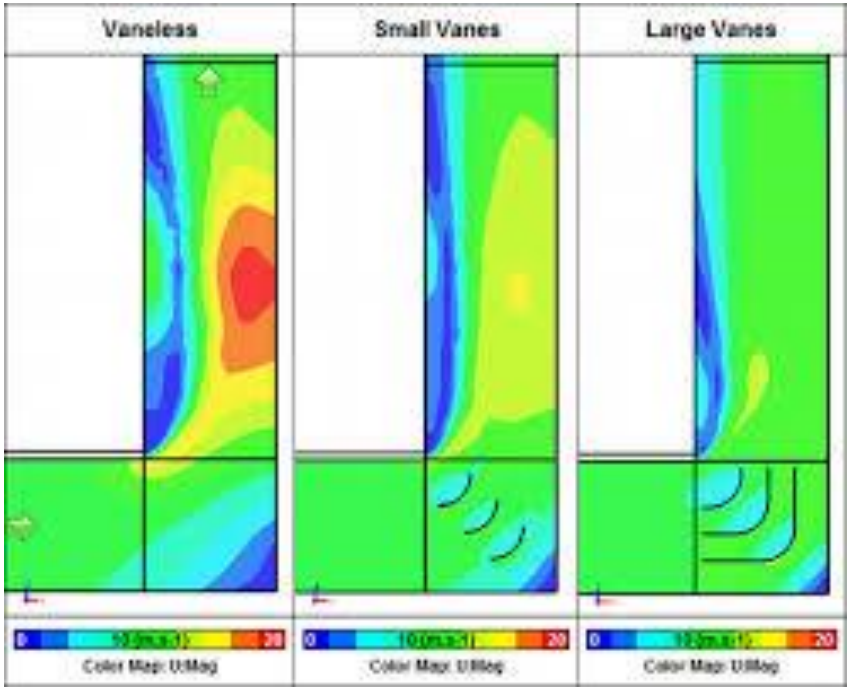


Missing Turning Vanes

- Observed inconsistent installation during site walkthrough
- Vanes being installed ‘per the plans’
- Plans found to not call out every instance where vanes were applicable
- 5x higher pressure drop w/o vanes
- Turning vanes were installed in all 90º elbows







Undersized Circulation Pump

- 2 GPM pump installed to circulate water between storage tank and water heater
- Heater recovery capacity was 460 GPH
- Pump capacity insufficient to permit heater to operate at full capacity as installed

Questions?

www.cxegroup.com