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A River of Energy Solutions

Excellence in O&M – Case Studies

Jonathan Soper, P.E., Principal, Enovity Inc

Maintain to Sustain

- Six Steps to Success
  - Committed Owner
  - Financial Investment
  - Integrated O&M Services
  - Training
  - Reporting & Optimization
  - Quality Control
- Case Study Demonstrates the Six Steps

Phillip Burton Federal Building, San Francisco

- GSA Region 9 Headquarters
- 1.4 million sq.ft, 20 Stories
- Central Chilled Water & Hot Water Plant
- Dual Duct VAV Air Handlers
- On site Co-generation
- Alerton BACnet DDC System
- Advanced Lighting System

Committed Owner

- Facilities Management and Services Programs Div.
  - Mark Levi and his project team
- Building Property Management
  - Jason Cawthorne and his property management team
- Energy Efficiency and Optimization Projects Well Funded
  - Existing projects ARRA funded
- As a Headquarters Building 'In the Spotlight'

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Integrated Services

- O&M Supported by Technical Services from Same Company
  - RCx of Phillip Burton Building
  - Detailed systems manuals and building operating plans by professional staff
  - All DDC controls work done in-house by Enovity controls engineers.
  - Professional staff complete concept designs, Cx and project management on TI and infrastructure projects.

Training

- In House and Outside Focused and Continuous Training
  - Last Friday of every month dedicated to training
- Train the Right People to do the Right Things
- Enovity Invests Tens Thousands Dollars per Year – Alerton DDC, Powerlogic, VFD operation, Troubleshoot & Install.

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Quality Control

- Regular verification of quality maintenance
- Multiple levels of QC
- Monthly inspections by management of all major equipment
- Monthly review of sample work orders
- Monthly reports to GSA detailing QC

No	PM Work Order Description	PM Work Order Number	Date	Is There Sufficient Information in the Remarks	Are Labor Hours Representative of Equipment Type?	Any Follow Up CM?	Physical PM Inspection Satisfactory? If No, Comment
1	PM-M:A-7-17:AC Unit #17 FBI Dark Room	1203161	5/26/11	Yes	Yes	No	Yes
2	PM:W-2-2:Emergency Eye Wash Station #2	1204001	5/10/11	Yes	Yes	No	Yes
3	PM:W:E-42-1:Main Building Emergency Generator	1204007	5/3/11	Yes	Yes	No	Yes
4	PM:W:F-6-1:Electric Fire Pump	1204009	5/11/11	Yes	Yes	No	Yes
5	PM:W-8-1:Water Treatment for Cooling Towers and Closed	1205781	5/13/11	Yes	Yes	No	Yes
6	PM:F-16-1:Fire Alarm Printer	1206615	5/17/11	Yes	Yes	No	Yes
7	PM:F-10-3[1]:Turk St Fire Dept Pumper Connections	1207420	5/24/11	Yes	Yes	Yes	Yes
8	PM:F-1-2:Fire Alarm Check Valve No 2	1207470	5/24/11	Yes	Yes	No	Yes
9	PM:W-1-1[1]:Domestic Water Filters	1209950	5/26/11	No	Yes	No	Yes
10	PM for AED Unit 2-C (Monthly)	1210863	5/31/11	Yes	Yes	No	Yes

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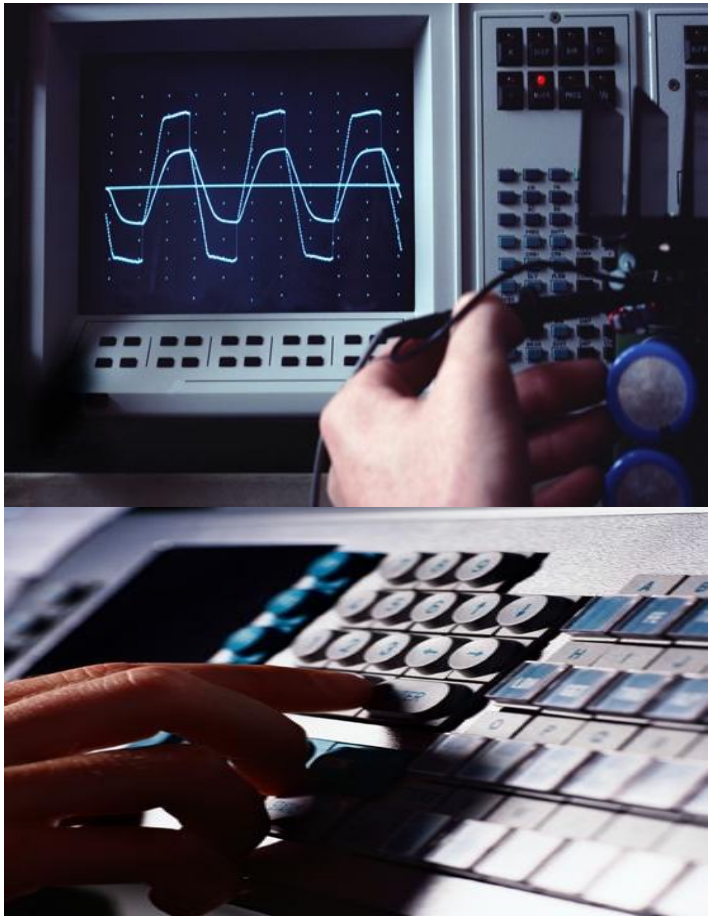
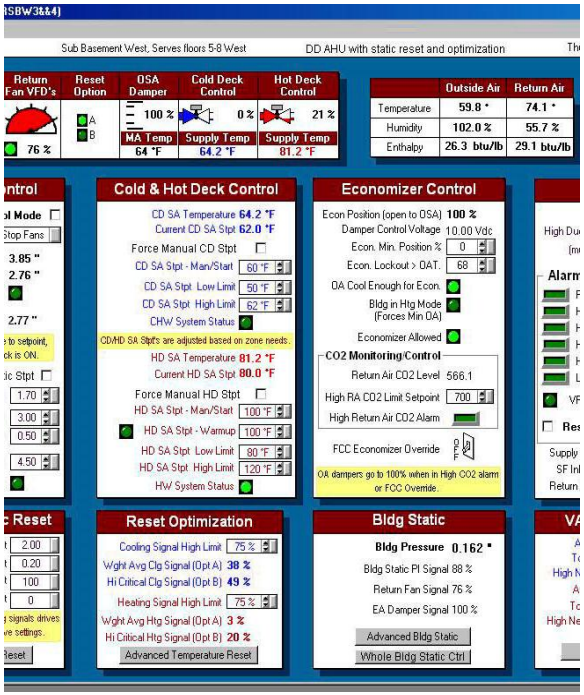
Reporting & Optimization

- Optimized Sequences of Operation
  - Every building is a prototype
  - Requires good engineering and good programmers
  - 'Black Boxes' not always the answer
- Continuous Performance Monitoring
  - Continuous feedback on HVAC system performance
- Fault Diagnostics
  - Identify anomalies as they happen



Optimized Sequences of Operation

- Programmed and Commissioned by Enovity Staff
- Water Side
  - Optimal chiller staging
  - CHW DP re-set
- Air Side
  - Static pressure reset based on zone feedback
  - Temperature reset based on zone feedback
  - Optimum start



Optimized Sequence of Operation
Duct Static Pressure Re-Set

Device 945 (AHU SSBE-2/RSBE3&&4)

BACtalk Edit View Tools Help

Device 945 | AHU SSBE-2/RSBE3&4 | OA Temperature: 59.1 °F

Previous | Properties

Advanced Duct Pressure Control

Option Select

Option A

-Selecting an option affects optimum start, duct pressure reset, cold deck temperature reset and hot deck temperature reset.

-Option A bases duct pressure reset on the percentage of zones with airflow shortfall.

-Option B bases duct pressure reset on the highest need more air signal amongst critical zones.

Operating Status

Duct Static Stpt 1.41 "
HD Pressure 0.06 "
CD Pressure 1.43 "

VFD Speed Limits

	Min %	Max %	Cmd %
SF VFD	20 %	90 %	50 %
RF VFD	20 %	90 %	43 %

Preliminary Proportional Duct Pressure Reset

Applies to both Option A & B.

Preliminary duct pressure setpoint varies proportionally with the higher of clg/htg signal unless Ignore Hot Deck is on.

Prelim. Duct Static High Stpt	2.0
Prelim. Duct Static Low Stpt	0.2
Clg/Htg Signal High Limit	100 %
Clg/Htg Signal Low Limit	0 %

Avg. Cooling Signal 20 %
Avg. Heating Signal 0 %
Ignore Hot Deck

Option A

Normal % Zones w/Air Shortfall Setpoint	8.0
Demand Reduction % Zones w/Air Shortfall Setpoint	20.0
% Zones w/Air Shortfall Max. Overage	20.0

(Defines how much over stpt results in max. incr.)

Avg Zone % Needing More Air 7.7 %
Ignore Hot Deck
Force ON Ignore HD

Duct Static Stpt Incr. Rate Minimum	0.010 "/min.
Duct Static Stpt Incr. Rate Maximum	0.100 "/min.
Duct Static Stpt Decrease Rate	0.010 "/min.

Option B

Normal High Need More Air Setpoint	8.0
Demand Reduction High Need More Air Setpoint	20.0

Highest Need More Air Signal 6.4 %
Highest Need More Cool Air Signal 6.4 %
Highest Need More Warm Air Signal 4.8 %
Ignore Hot Deck
Force ON Ignore HD

Duct Static Stpt Incr. Rate Minimum 0.010 "/min.
(Max. rate = 10 times minimum)
Duct Static Stpt Decr. Rate Minimum 0.010 "/min.
(Max. rate = 3 times minimum)

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Optimized Sequence of Operation
Supply Air Temperature Re-Set

Device 945 (AHU SSBE-2/RSBE3&&4)

BACtalk Edit View Tools Help

Device 945 | AHU SSBE-2/RSBE3&4 | OA Temperature: 58.6 °F

Previous

Advanced Temperature Reset Parameters

Reset Option Select

-Selecting an option affects optimum start, duct pressure reset, cold deck temperature reset and hot deck temperature reset.

-Option A bases deck temperature reset on the weighted average cooling and heating signals.

-Option B bases deck temperature reset on the highest critical cooling and heating signals.

Option A

Cold Deck Setpoint Limits

CD SA Temperature 62.5 °F
Current CD SA Stpt 62.0 °F
Force Manual CD Stpt
CD SA Stpt - Man/Start 50 °F
CD SA Stpt Low Limit 50 °F
CD SA Stpt High Limit 62 °F
CHW System Status

Hot Deck Setpoint Limits

HD SA Temperature 79.2 °F
Current HD SA Stpt 80.0 °F
Force Manual HD Stpt
HD SA Stpt - Man/Start 120 °F
HD SA Stpt - Warmup 120 °F
HD SA Stpt Low Limit 80 °F
HD SA Stpt High Limit 120 °F
HW System Status

Advanced Cold Deck Setpoint Reset

Cooling Signal Setpoint 75.0
OPT A - Weighted Average Cooling Signal 5.9 %
OPT B - Highest Critical Zone Cooling Signal 24.8 %
CD Temp. SP Decrease Rate High Lmt 1.0 °F/min.
CD Temp. SP Decrease Rate Low Lmt 0.1 °F/min.
CD Temp. SP Increase Rate 0.1 °F/min.

Advanced Hot Deck Setpoint Reset

Heating Signal Setpoint 75.0
OPT A - Weighted Average Heating Signal 0.0 %
OPT B - Highest Critical Zone Heating Signal 0.0 %
HD Temp. SP Increase Rate High Lmt 1.0 °F/min.
HD Temp. SP Increase Rate Low Lmt 0.1 °F/min.
HD Temp. SP Decrease Rate 0.1 °F/min.

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Fault Diagnostic – APAR for Air Handlers
Real Time Anomalies

Device 945 (AHU 5SBE-2/R5BE3&&4)

BACtalk Edit View Tools Help

ALARMS

Clear Latched Alarms

Previous

	Status	Latch	
Rule 1 Alarm			Hot deck should be warmer than mixed air.
Rule 2 Alarm			Mixed air temperature doesn't match economizer position.
Rule 3 Alarm			Hot water valve full open, hot deck still too cold.
Rule 4 Alarm			Hot water valve full open, more load will exceed capacity.
Rule 5 Alarm			OA too warm for cooling with OA only.
Rule 6 Alarm			Cold deck should be cooler than return air.
Rule 7 Alarm			Cold deck temperature should match mixed air when cooling is off.
Rule 8 Alarm			Hot deck temperature should match mixed air when heating is off.
Rule 9 Alarm			OAT is too cool for mechanical cooling
Rule 10 Alarm			OAT is too warm for 100% outside air.
Rule 11 Alarm			Mixed air temperature should be close to OAT when at 100% outside air.
Rule 12 Alarm			Cold deck temperature should be less than mixed air when cooling is on.
Rule 13 Alarm			Chilled water valve full open, cold deck still too warm.
Rule 14 Alarm			Chilled water valve full open, more load will exceed capacity.
Rule 15 Alarm			Outside air is too cold for mechanical cooling and minimum outside air.
Rule 16 Alarm			Economizer and cooling valve are modulating simultaneously.
Rule 17 Alarm			Persistent error in cold deck temperature.
Rule 18 Alarm			Persistent error in hot deck temperature.
Rule 19 Alarm			Mixed air is cooler than both return air and outside air.
Rule 20 Alarm			Mixed air is warmer than both return air and outside air.
Rule 21 Alarm			Outside air damper is cycling between minimum and maximum
Rule 22 Alarm			Cooling is cycling on and off.

SETTINGS

3600	Rule Delay (seconds)
3.0	Supply Fan Temperature Rise
2.0	Return Fan Temperature Rise
4.0	Temperature Error Threshold
600	Simultaneous Modulation Time Threshold (seconds)
6	Mode Switch Limit (# per hour)

MONITORING DATA

- Occupied delay status
- Outside air at minimum
- Outside air at maximum
- Cooling on
- Cooling at maximum
- Heating off
- Heating at maximum
- CHW system enabled
- HW system enabled

0	Econ. mode change counter
0	Cooling status change counter
0 %	CHW valve
62.5 °F	Cold deck temperature
62.0 °F	Cold deck temperature setpoint
23 %	HW valve
79.6 °F	Hot deck temperature
80.0 °F	Hot deck temperature setpoint
58.7 °F	Outside air temperature
75.0 °F	Return air temperature
60.6 °F	Mixed air temperature
100 %	Economizer position

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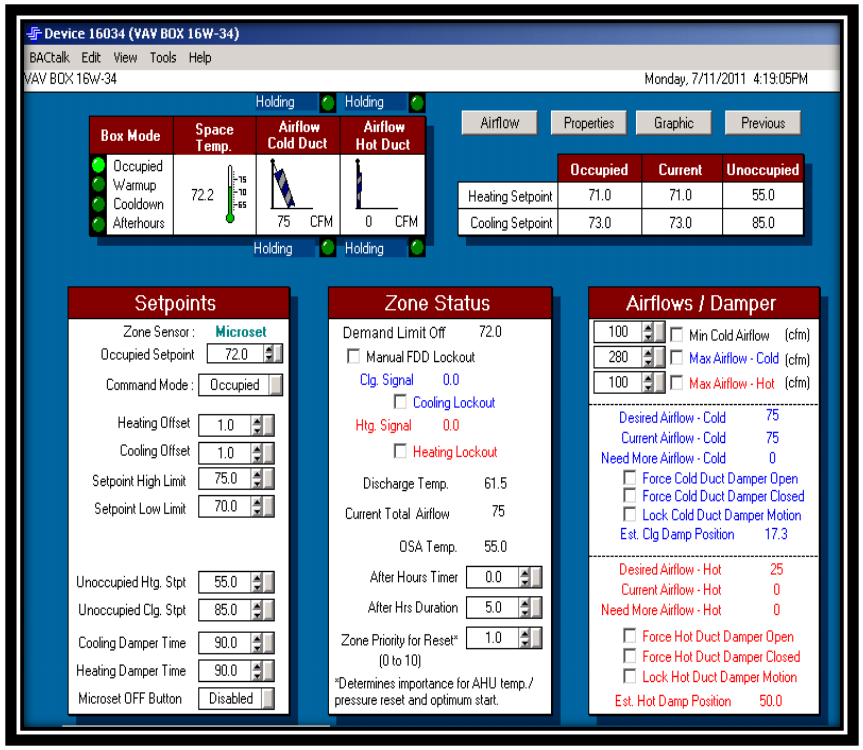
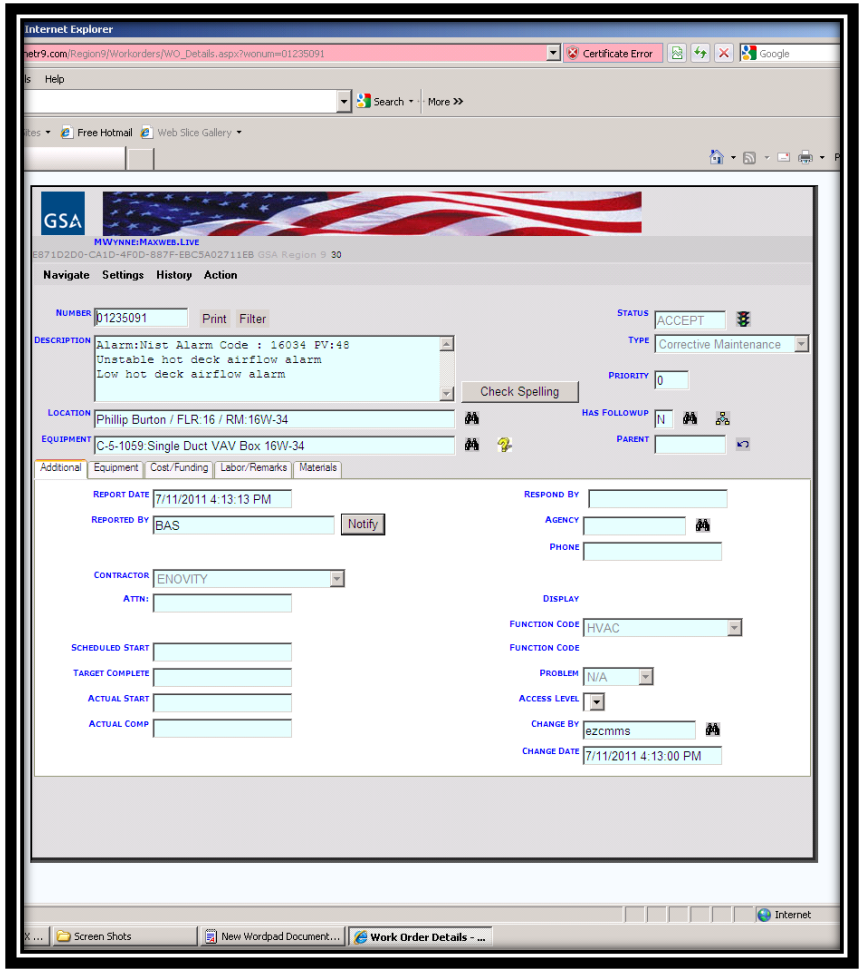
Fault Diagnostic – VPACC for VAV Boxes
Real Time Anomalies





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Fault Diagnostic – PACRAT Anomalies From Historical Data

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WORKORDERS:WORKORDER DETAILS

JSOPER:EZDEMO

BB555DF5-27C2-40DA-A591-33CF4264EE3A

Navigate | Settings | History | Action

Number	00413107 (Print)	Filter	Status: ENTERED
Description	S20W_1->Hot deck supply air temp deviates from setpoint S20W_1->Hot deck supply air control loop is unstable S20W_1->Output for return air CO2 has failed or is not working properly		Type: Corrective Maintenance
			Priority: 0
Location	Phillip Burton / FLR:20 / RM:20W-PLENUM		Has Followup: N
Equipment	C-6-1:Air Handler S20W1&2 DDC Sensors		Parent:
			Create Followup
Reported By	PACRAT		Agency:
Report Date	4/18/2006 12:50:00 PM	Respond By:	Phone:
Task			
PM			
Est Hrs	0	Target Start:	Contractor: ENOVITY
Labor Hrs	0	Schedule Date:	Attn:
Material Cost	0	Actual Start:	Function: HVAC
Reimbursable	N	Target Comp:	Problem: N/A
ProjectID	N/A	Actual Finish:	
Funding Source			Change By: jsoper

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Energy Reporting

- Can't Manage What You Don't Measure
- Performance Monitoring
  - Energy Dashboards for HVAC Equipment Performance
  - Targets in Process
- End Use Breakdowns
  - Focus on Areas of Opportunity

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Energy Dashboards

http://192.168.10.35/db/CA030935/ENGY_DASH/SUMMARY - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media Links

Total Performance Summary - Energy Dashboard

		Electrical Power Demand (kW)	Energy Usage (kW*h)
CH Water Plant	Chiller	196.693 kW	78939.906 kwh
	CHW Plant Additional Equipment	97.117 kW	56701.199 kwh
	CHW Plant	293.810 kW	135641.109 kwh
Air Handlers	Air Handler	219.385 kW	110903.305 kwh
	Chilled Water Plant & Air Handlers	513.196 kW	246544.406 kwh

		Load	Accumulated Load
	Chilled Water Plant Load	381 tons_rfg	209133 ton_hours
	Hot Water Plant Load	0. kBtu/Hr	2698 MBtu
Hot Water Plant	HW Plant Gas Energy	871 therms(BTU)	
	Hot Water Plant Thermal Efficiency	0.00%	

	Real Time Efficiency (kW /ton)	Accumulated Efficiency (kWh/tonHr)
Chillers	0.516	0.377
CHW Plant	0.771	0.649
Air Handler	0.576	0.530
Chilled Water Plant & Air Handlers	1.346	1.179

	Gallons (Rate)	Gallons (Volume)
Domestic Water Supply	0. gal/min	78719960 gal

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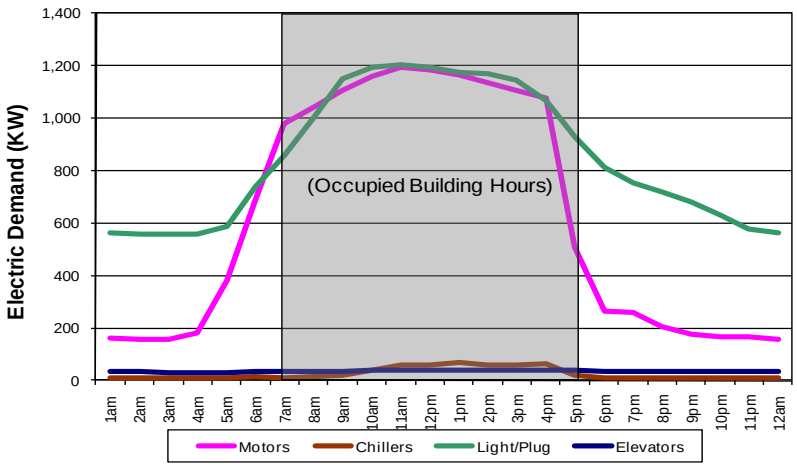
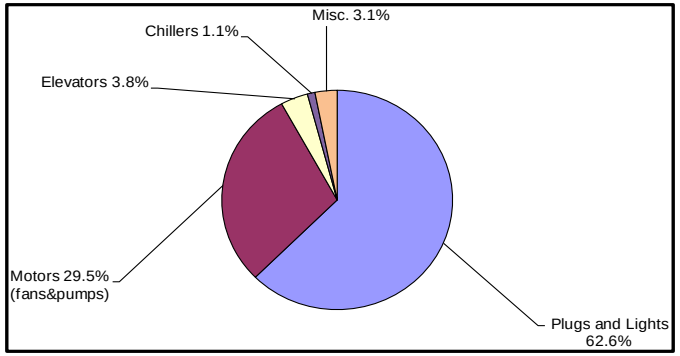
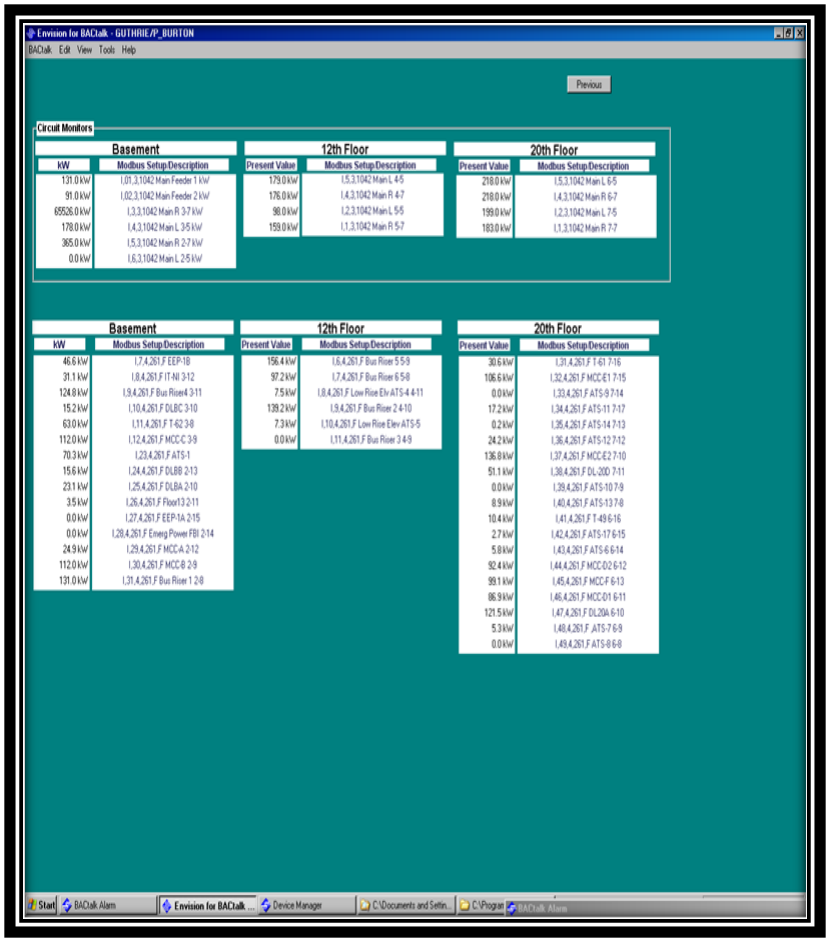
Energy Breakdown By End Use, June 2011







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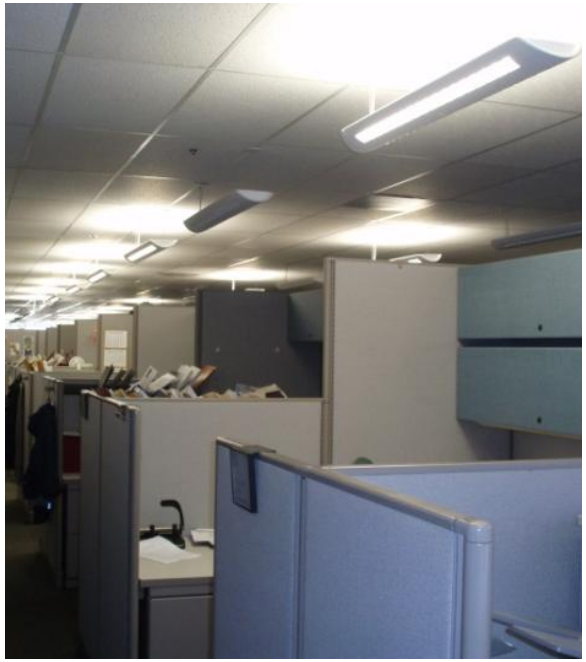
Recent and Current Energy Projects

- Co-generation – Completed
- Advanced Lighting – Completed June 2011
- Central Plant Optimization – Cx Complete Aug 2011
- Additional Sub-metering and Energy Dashboards – Complete Sep 2011
- New VFDs and Premium Efficiency Motors Sep 2011



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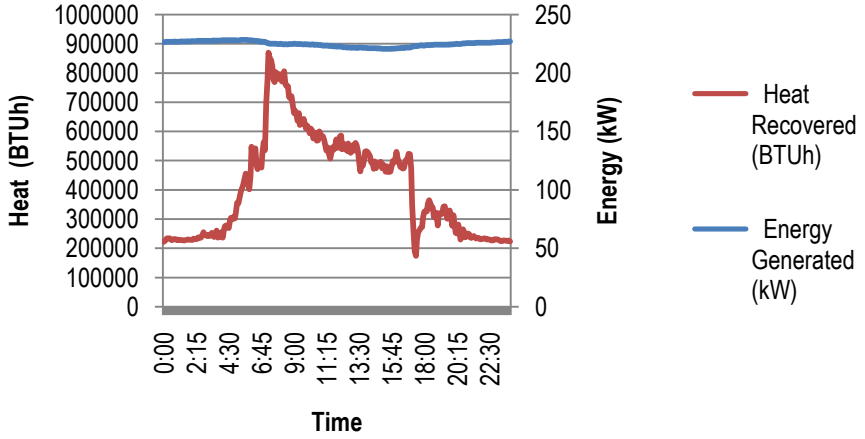
Co-generation System

- Ingersoll Rand 250 kW microturbine
- $1,772,000 capital cost, $200,000 utility incentives
- Services provided:
  - Feasibility study
  - Incentive application (SGIP)
  - Controls design & Installation
  - Bid collection
  - Construction management
  - Commissioning
  - Interconnection (Rule 21)
  - Operations and maintenance



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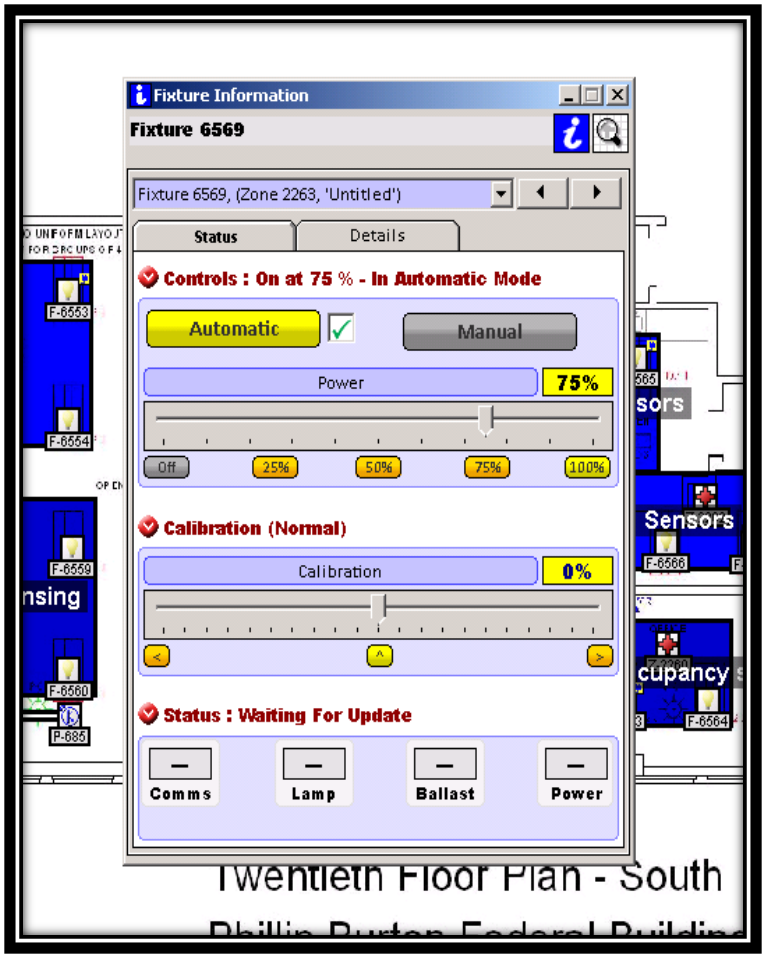
Lighting System – Addressable Fixtures



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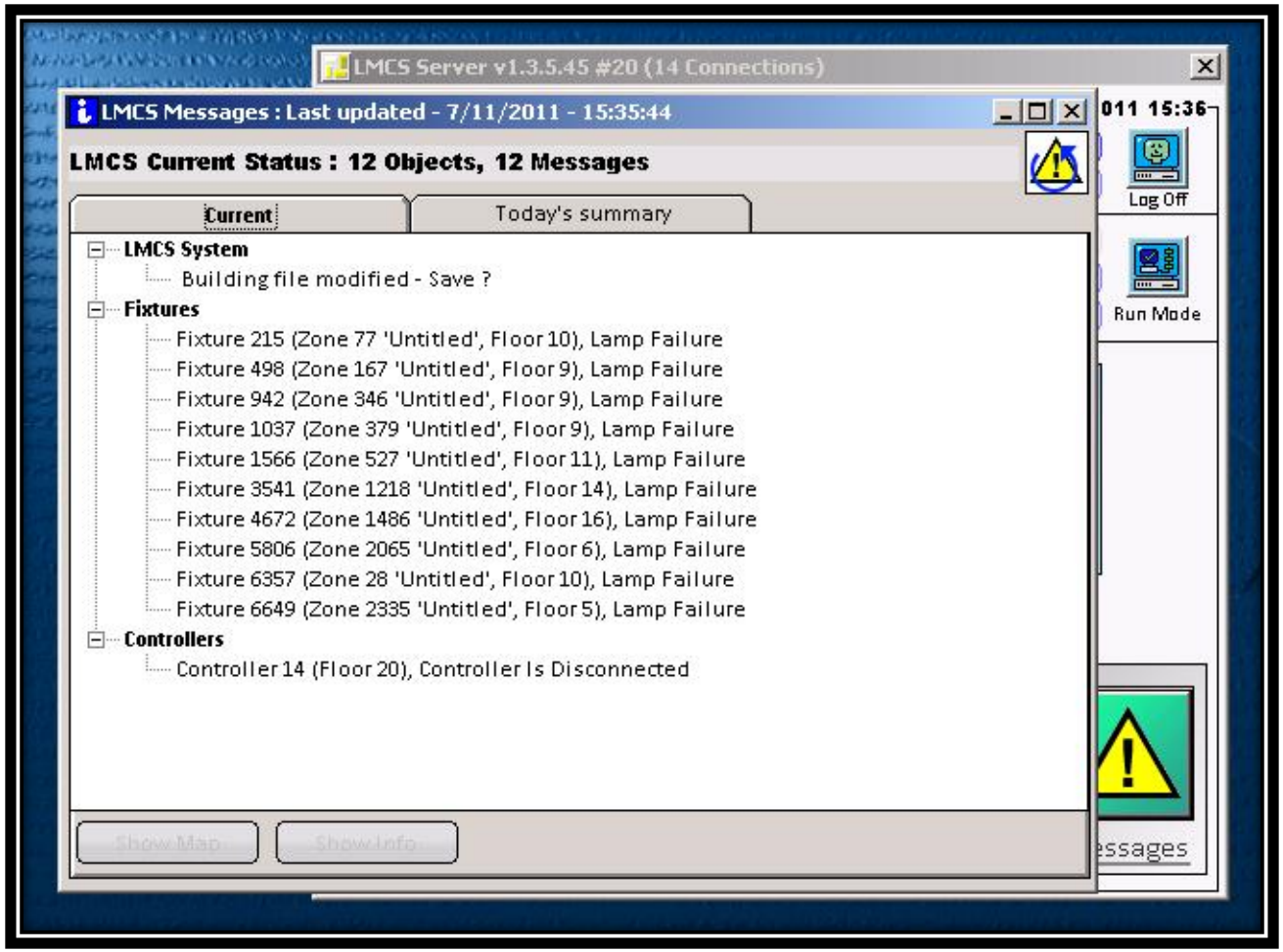
Lighting System - Alarms



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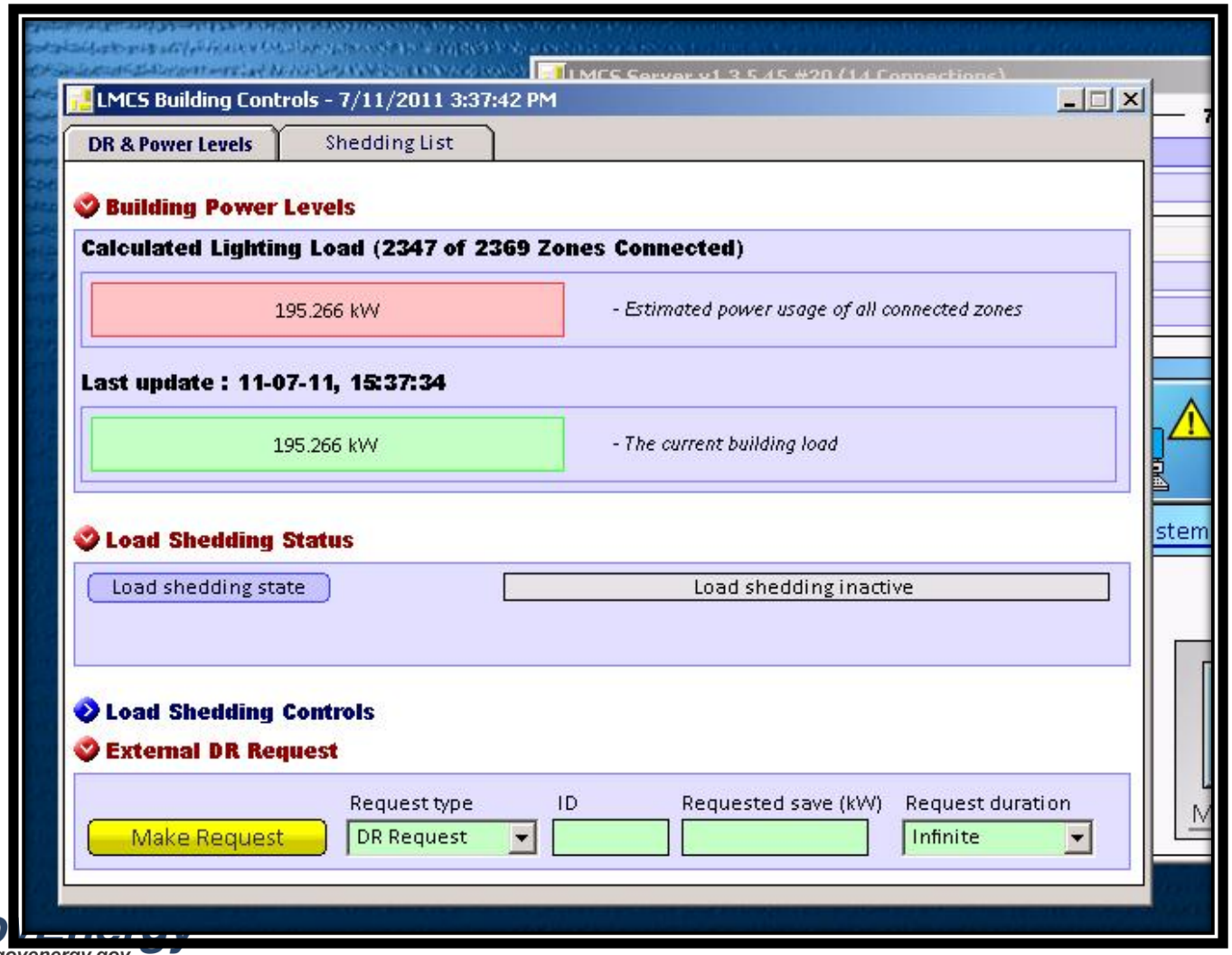
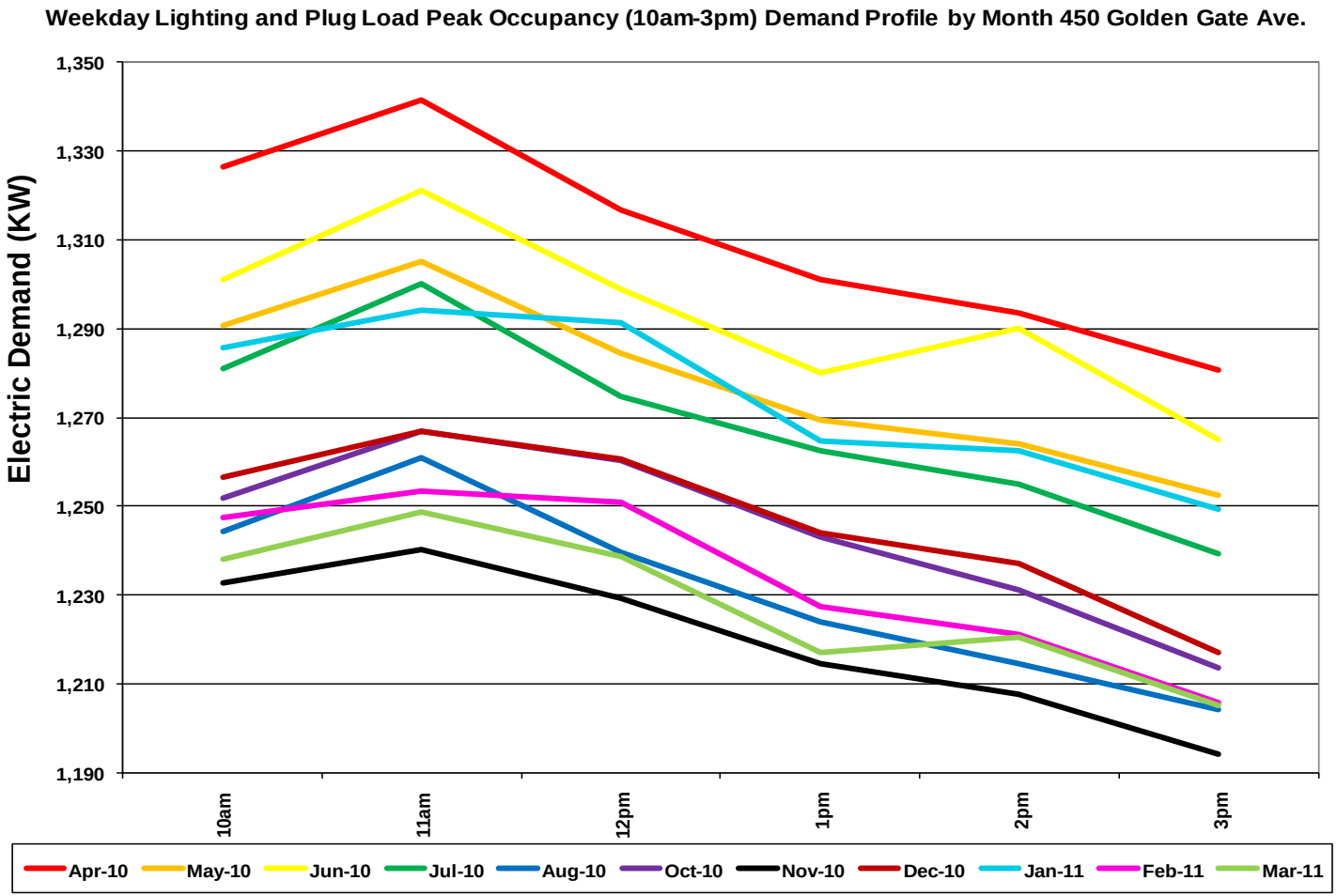
Lighting System – Automated Demand Response



Lighting System – Improved Energy Performance



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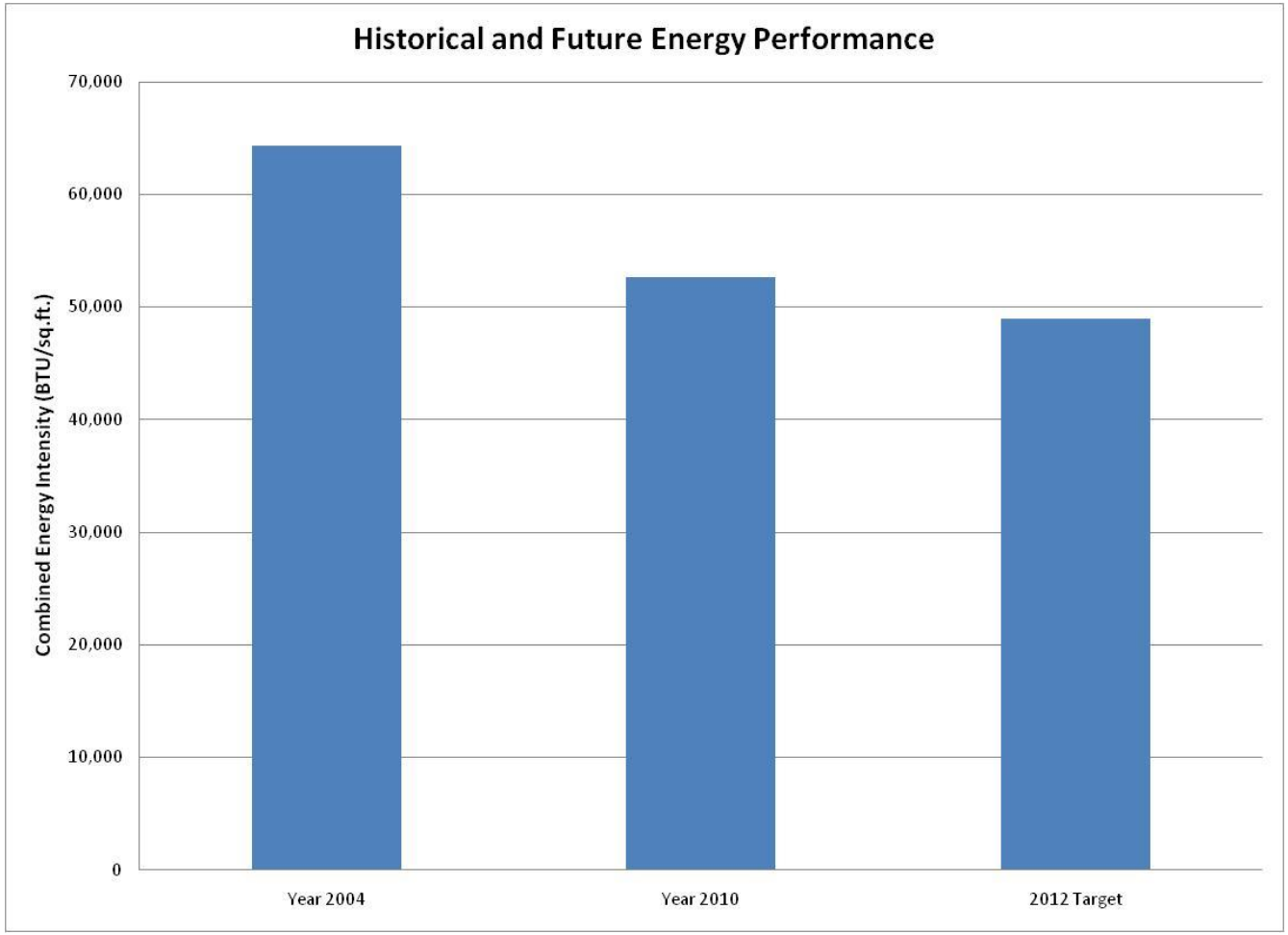
Energy Performance Goals

24% Improvement Targeted for Year 2012 Compared to Year 2004



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Enovity is an engineering firm focused on the design, commissioning and operation of high performance buildings

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