



# ASHRAE Headquarters Renovation

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What Happens When the Leaders Try to Do it  
Right?

# Building Overview

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- Built – 1965
- Original building – 30,100 sq ft
- ASHRAE acquisition – 1981
- First renovation – 1991
- January 2005 – Committee formed



# Project Administration

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- Building Committee formed January 2005
  - Bill Harrison, Trane Arkansas
  - Gordon Holness (Albert Kahn Associates)
  - Damon Gowan, Gowan Inc.
  - Darryl Boyce, Carleton University
  - Ron Jarnagin, Pacific Northwest Nat'l Labs
  - Jeff Littleton, Executive Vice President, ASHRAE
  - Cindy Simmons, Finance Director, ASHRAE
  - Lois Benedict, Executive Assistant, ASHRAE



## In the beginning...

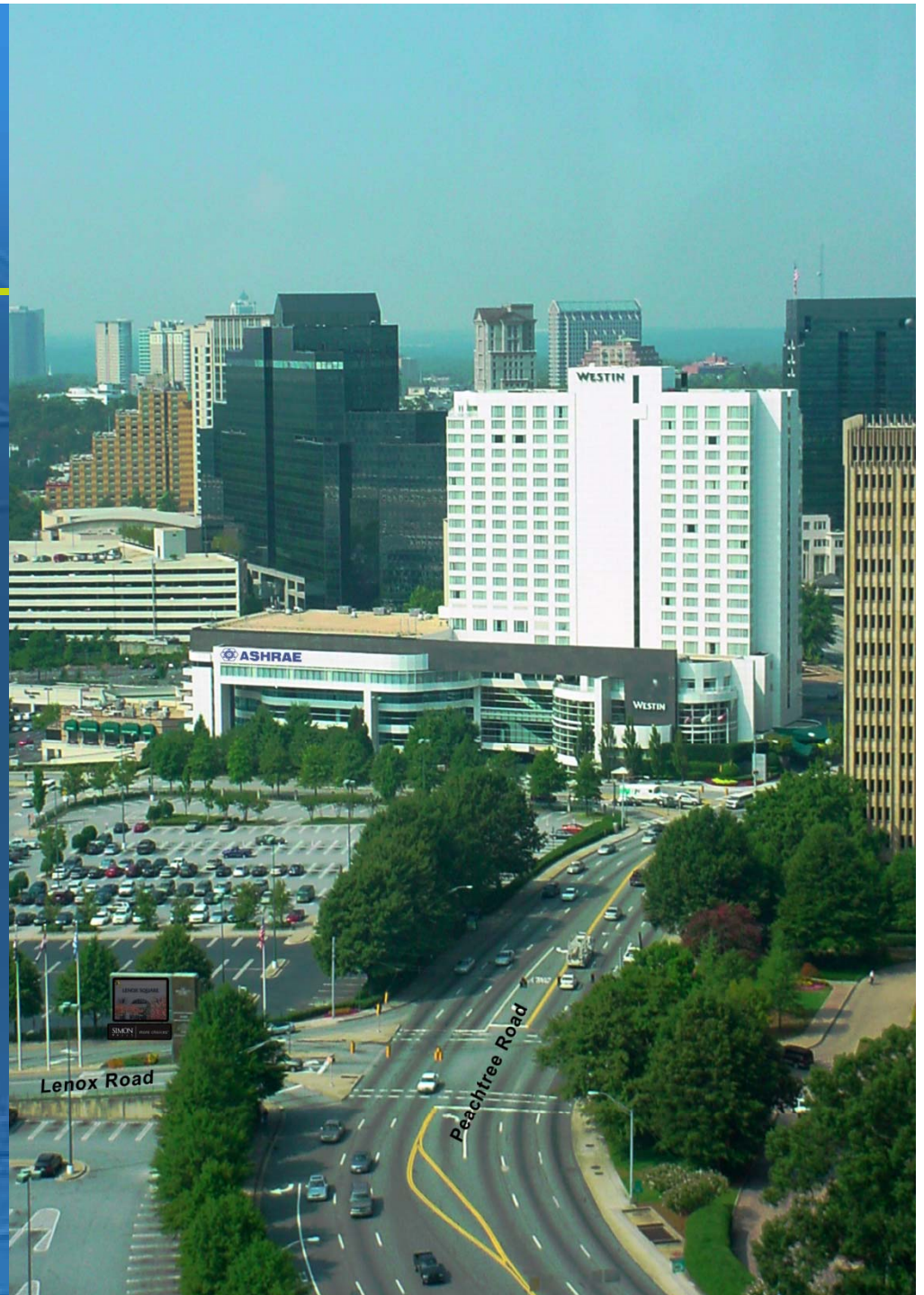
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- Options
  - Do nothing
  - Repair (code)
  - Renovate?
  - Sell and buy?
  - Sell and build?
  - Sell, buy and renovate?
  - Sell & lease?
- Information
  - Condition of building?
  - Value?
  - Purchase market?
  - Lease options?
  - Usage parameters?
    - # of staff?
    - Member use?



# Lease is cheaper..

- Best financial option
  - Invest proceeds of the sale of existing building
  - Investments appreciate faster than real estate value.
  - The Great Debate: HQ as a demonstration project.
  - *Infamous LEFT turn settles the issue*



# But renovation wins.....

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- Culture – ‘We should own our building...’.
- Walk the Sustainability Talk – Lead by example.
  - Re-use is the purest form of sustainability.
  - Opportunity to do LEED-NC and LEED-EB
- Control our headquarters destiny.
- Renovation seen as lower risk.
- Donor funding possibilities
- Living lab potential
- Demonstration project





# Our Goals

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- Deliver a healthy and productive workplace for staff
- Demonstrate commitment to sustainability
- Provide a learning center to advance education
- Create a living lab for access by members

**The greatest opportunity to change energy consumption in the built environment is through modification of existing buildings.**

**Only 2 percent of building stock is new construction each year.**



# Project Team

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- Architects – Richard Wittschiebe Hand
- General Contractor - Gay Construction
- Mechanical Engineer – Johnson, Spellman and Associates
- Mechanical Contractor – Batchelor and Kimball
- Electrical Engineer – Jeffers Engineering Associates
- Electrical Contractor – Gene Lynn Electric
- Commissioning Agent – CxGBS
- TAC – Technical Advisory Committee (**Volunteers**)

# Timeline

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- March 2006 – Architect’s team selected
  - Included LEED consultant and MEP team
- May 2006 – General Contractor selected
  - GMP Contract
- June 2006 – Independent commissioning agent selected
- Design development- late 2006 to mid 2007
- Board approval of project and budget – June, 2007
- Sept. 2007 – Moved out
- July 28, 2008 – First day in building



## What Guidance was Followed?

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- Standard 90.1-2004 (energy efficiency)
- Standard 55-2004 (thermal comfort)
- Standard 62.1-2004 (ventilation)
- Standard 100-2006 (energy in existing buildings)
- Standard 15-2007 (refrigerant safety)
- Guideline 0-2005 (commissioning)
- Guideline 1-2006 (HVAC&R system commissioning)
- USGBC LEED® Rating System EB Version 2.0
- USGBC LEED®-NC Rating System 2.2
- Applicable local, state and national building codes



## Multiple system decision made

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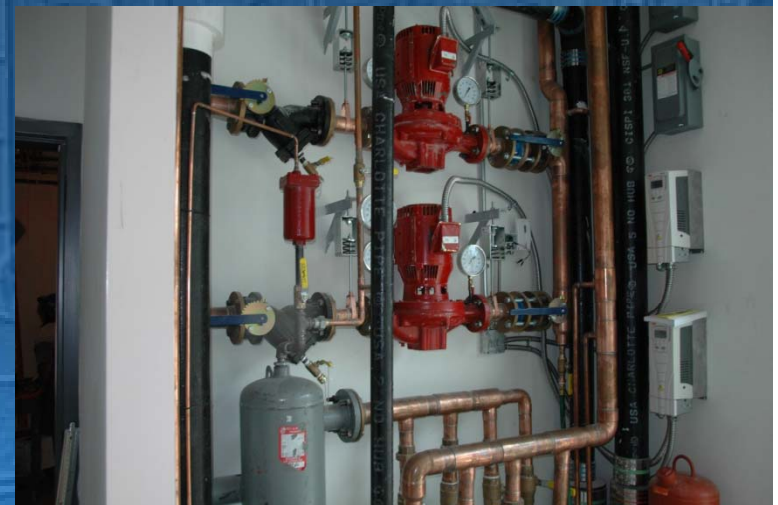
- Decided to showcase alternate technologies
- Wanted to be able to compare multiple systems against one another
- Wanted to demonstrate the operation of technologies that had lower penetration in the marketplace
- Desire to not do the “standard thing”
- Technical Advisory Committee developed a rating matrix to evaluate and recommend technologies



# Primary Mechanical Systems

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- **First floor:** Multi-split air-cooled variable refrigerant flow fan coil units with inverter-driven outdoor DX heat pumps (refrigerant HFC 410A) - 28 ton capacity
- **Second floor:** 13 ground-source direct expansion heat pumps serviced by 12 wells – 32 ton capacity





# Dedicated Outdoor Air System (DOAS)

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- 6,000 cfm roof mounted air-to-air heat exchanger with dual-state, total enthalpy wheel and packaged DX air-cooled condensing unit
  - 55F air at 46F dewpoint
  - 35 tons of cooling and 250 MBH heating
- 24 supply VAV units (100-600 cfm)
- 2 exhaust VAV units (500-1000 cfm)
- Supply Fan 6.22" TSP, 15 hp
- Exhaust Fan 3.69" TSP, 7.5 hp
- Feeds both mechanical systems



This is one big DOAS!

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# IAQ Monitoring

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- Dry bulb temp
- Dew point temp
- Relative humidity
- Fine particulates (PM 2.5)
- Enthalpy
- CO<sub>2</sub>
- Total VOCs
- 24 separate locations throughout the building
- Outdoor sampling for comparison





# PV System

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- 20 kW capacity
- Power flows to grid
- Donation and purchase agreement
- Designed to provide about 8% of building load



# Weather station

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- Outside air temp
- 10 minute minimum/maximum air temp (1 min. samples)
- Humidity – Dew point
- Barometric pressure
- Wind direction, speed (10 min. average), gust
- Solar radiation



# Construction

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# Construction

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# Surprises

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- Parking lot system
- Soffit de-lamination
- Standard 15 issues

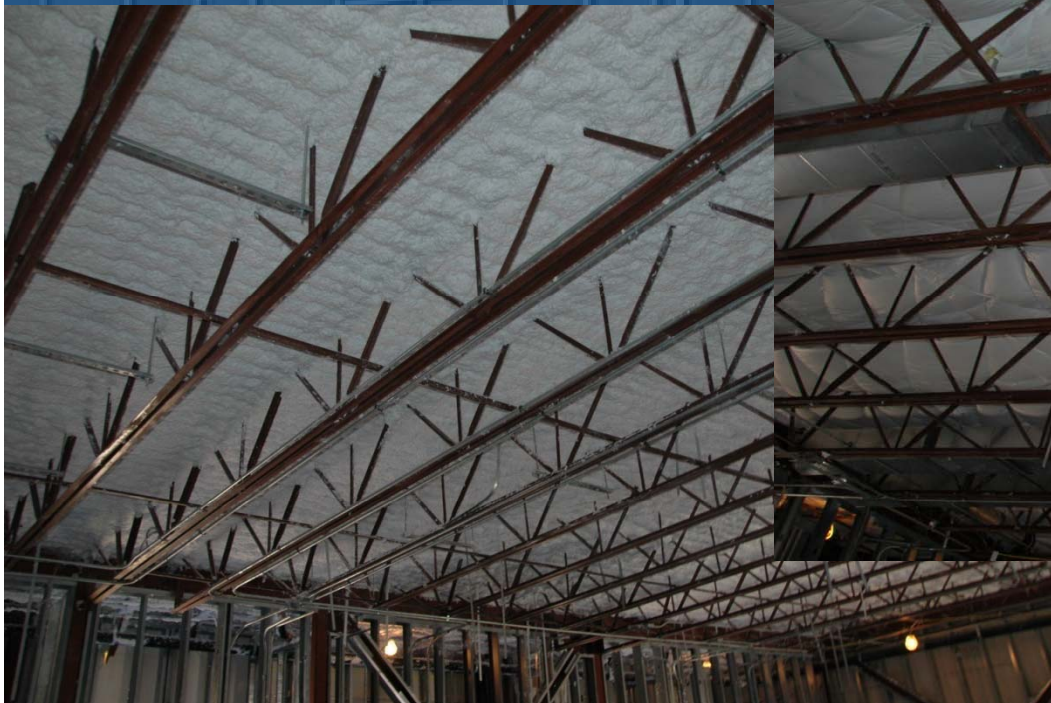


# Surprises

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- Learning center roof moisture





# Sustainable Features

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- Reduced estimated annual energy usage by more than **31 percent**
  - Dedicated outside air supply with energy recovery
  - Ground-source heat pumps
  - Mini-split systems with heat recovery
- Providing **30 percent** additional outdoor air ventilation to improve indoor air quality for improved occupant comfort, well-being and productivity
- Reduced estimated overall annual water consumption by **46 percent** (135,921 gallons to 253,021 gallons) through low-flow fixtures



# Sustainable Features

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- Reduced site runoff by **34 percent** and reduced runoff rate by **30 percent** through stormwater detention and bioretention
- Installation of a cool white reflective roof membrane with a solar reflectance index of 78 to minimize heat island effects
- Installation of parking lot reflective coating to reduce heat island effect
- Working to demonstrate how **PV arrays** can be used to generate clean power by taking advantage of under-utilized space on building roof



# LEED Status (NC)



- 56 LEED Credits Attempted (52 needed for Platinum)
- Additional points possible for Platinum
  - Community Connectivity
  - Public transportation
  - Construction waste management (91% = Second point)
  - Onsite renewable energy
  - Innovation & Design (IAQ)
  - Indoor pollutant control

**LEED**  
Leadership in Energy & Environmental Design

Project Name: ASHRAE Headquarters Renovation  
 Location: Atlanta, Georgia

**LEED NC v2.2 Checklist**

**Sustainable Sites** 14 Points D or C

Req	Y	N	Part	Points	Required	D or C
Prereq 1	Y		Construction Activity Pollution Prevention	1	Required	C
Credit 1	Y		Site Selection	1	Required	D
Credit 2	Y		Development	1	Required	D
Credit 3	Y		Brownfield Redevelopment and Community Connectivity	1	Required	D
Credit 4.1	Y		Alternative Transportation, Public Transportation Access	1	Required	D
Credit 4.2	Y		Alternative Transportation, Bicycle Storage & Changing Rooms	1	Required	D
Credit 4.3	Y		Alternative Transportation, Low Emitting & Fuel Efficient Vehicles	1	Required	D
Credit 4.4	Y		Alternative Transportation, Parking Capacity	1	Required	D
Credit 5.1	Y		Alternative Transportation, Maximizing Open Space	1	Required	D
Credit 5.2	Y		Alternative Transportation, Quality Control	1	Required	D
Credit 6.1	Y		Stormwater Management, Quantity Control	1	Required	D
Credit 6.2	Y		Stormwater Management, Protect or Restore Habitat	1	Required	D
Credit 7.1	Y		Landscape Management, Minimizing Open Space	1	Required	D
Credit 7.2	Y		Landscape & Exterior Design to Reduce Heat Islands, Roof	1	Required	D
Credit 8	Y		Light Pollution Reduction	1	Required	D

**Water Efficiency** 5 Points D or C

Req	Y	N	Part	Points	Required	D or C
Credit 1.1	Y		Water Efficient Landscaping, Reduce by 60%	1	Required	D
Credit 1.2	Y		Water Efficient Landscaping, No Potable Use or No Irrigation	1	Required	D
Credit 2	Y		Innovative Wastewater Technologies	1	Required	D
Credit 3.1	Y		Water Use Reduction, 20% Reduction	1	Required	D
Credit 3.2	Y		Water Use Reduction, 30% Reduction	1	Required	D

**Energy & Atmosphere** 15 Points D or C

Req	Y	N	Part	Points	Required	D or C
Prereq 1	Y		Fundamental Energy Building Systems Commissioning	1	Required	C
Prereq 2	Y		Minimum Energy Performance	1	Required	D
Prereq 3	Y		Optimize Refrigerant Management	1	Required	D
Credit 1	Y		On-site Energy Performance	1	Required	D
Credit 2	Y		Enhanced Renewable Energy	1	Required	D
Credit 3	Y		Enhanced Commissioning	1	Required	D
Credit 4	Y		Enhanced Commissioning (2 pts required)	2	Required	D
Credit 5	Y		Measurement & Verification	1	Required	D
Credit 6	Y		Green Power	1	Required	D

# ASHRAE Foundation Learning Center

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- One large room
  - Subdivided into three rooms
  - 200 person capacity
- Two smaller rooms
  - Subdivided into two rooms
  - 75 person capacity
- 7 rooms, + two upstairs
- Fully AV equipped
- Wireless mini-networks



# ASHRAE Foundation Learning Center

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- Committee meetings
- Topical conferences
  - NZEB Conference
  - DOE Energy Alliance Workshops
- Member gatherings
- Tours and demonstrations
  - Grand opening: “Building Bootcamp”
  - YEA Leadership Weekend
- Other organizations
  - USGBC, AIA, IESNA, etc.
- Video conferencing

# Building performance online

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- Part of the renovation plan was the development of a “living laboratory” to help members learn about building performance
- Additional electrical circuits and sensors were installed to monitor equipment, systems and sub-systems
- Ultimately the actual energy use and performance data will be made available online for members – **now available!**

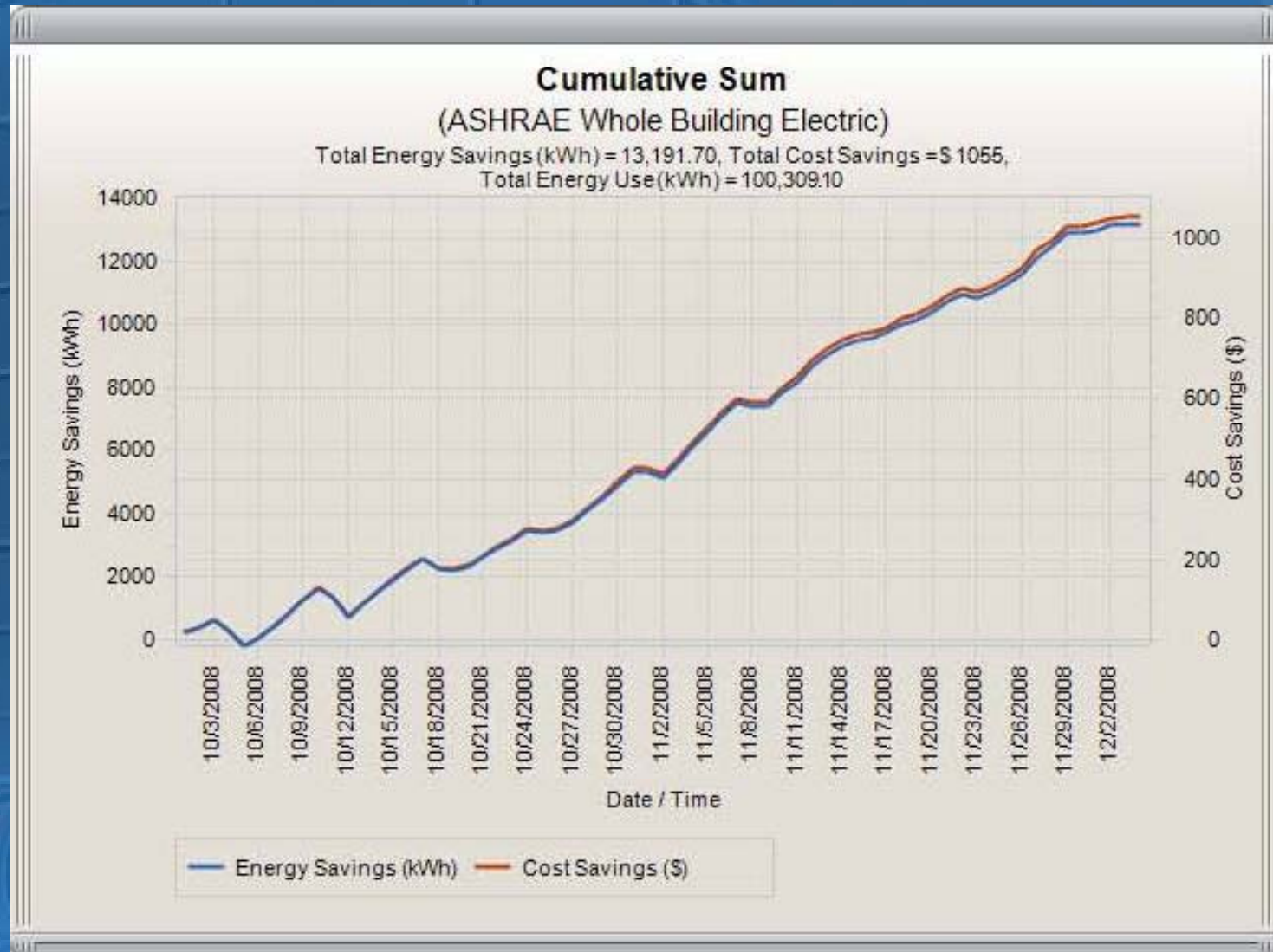


<u>DOAS</u>		<u>VRV System</u>		<u>power monitoring-TPI E-SHP's</u>		<u>1st Fl Lighting</u>		<u>TPI-Third Party Interface 2nd Fl Lighting</u>	
42.0	Amps A	61.6	Amps A	10.3	Amps A	25.2	Amps A	32.9	Amps A
37.9	Amps B	53.7	Amps B	5.4	Amps B	32.6	Amps B	22.5	Amps B
29.4	Amps C	25.6	Amps C	10.1	Amps C	20.1	Amps C	24.5	Amps C
207.4	Volts A-B	207.6	Volts A-B	207.6	Volts A-B	207.7	Volts A-B	207.4	Volts A-B
205.3	Volts B-C	205.4	Volts B-C	205.4	Volts B-C	205.3	Volts B-C	205.3	Volts B-C
207.7	Volts C-A	207.5	Volts C-A	208.0	Volts C-A	207.6	Volts C-A	207.5	Volts C-A
120.1	Volts A Phase	120.3	Volts A Phase	120.1	Volts A Phase	120.3	Volts A Phase	120.2	Volts A Phase
119.3	Volts B Phase	119.3	Volts B Phase	119.4	Volts B Phase	119.3	Volts B Phase	119.3	Volts B Phase
119.0	Volts C Phase	118.8	Volts C Phase	119.1	Volts C Phase	118.9	Volts C Phase	118.8	Volts C Phase
60.0	Hz	60.0	Hz	60.0	Hz	60.0	Hz	60.0	Hz
12.9	KVA	16.6	KVA	2.8	KVA	9.2	KVA	9.5	KVA
730.0	KWH	2196.3	KWH	845.1	KWH	1498.1	KWH	1204.3	KWH
11.2	KW	13.0	KW	2.8	KW	9.1	KW	9.3	KW
0.9	Power Factor	1.0	Power Factor	1.0	Power Factor	1.0	Power Factor	1.0	Power Factor
<u>1st Fl Plugloads</u>		<u>2nd Fl Plugloads</u>		<u>CL1 Computer Room</u>		<u>L10 Outside Lighting</u>		<u>Total Bldg Load</u>	
23.6	Amps A	17.0	Amps A	22.3	Amps A	0.0	Amps A	242.7	Amps A
21.7	Amps B	35.3	Amps B	24.2	Amps B	0.0	Amps B	227.7	Amps B
13.2	Amps C	8.7	Amps C	19.2	Amps C	0.0	Amps C	171.9	Amps C
207.7	Volts A-B	207.8	Volts A-B	207.8	Volts A-B	207.8	Volts A-B	207.4	Volts A-B
205.3	Volts B-C	205.4	Volts B-C	205.4	Volts B-C	205.6	Volts B-C	205.4	Volts B-C
207.7	Volts C-A	207.6	Volts C-A	207.8	Volts C-A	207.6	Volts C-A	207.9	Volts C-A
120.2	Volts A Phase	120.3	Volts A Phase	120.3	Volts A Phase	120.3	Volts A Phase	120.1	Volts A Phase
119.2	Volts B Phase	119.3	Volts B Phase	119.3	Volts B Phase	119.2	Volts B Phase	119.4	Volts B Phase
118.9	Volts C Phase	118.8	Volts C Phase	118.8	Volts C Phase	118.9	Volts C Phase	119.0	Volts C Phase
60.0	Hz	60.0	Hz	60.0	Hz	60.0	Hz	60.0	Hz
4.6	KVA	7.2	KVA	7.6	KVA	0.0	KVA	67.0	KVA
917.4	KWH	1014.2	KWH	1961.9	KWH	382.1	KWH	11999.4	KWH
4.6	KW	6.7	KW	7.2	KW	0.0	KW	67.0	KW
1.0	Power Factor	0.9	Power Factor	0.9	Power Factor	0.0	Power Factor	1.0	Power Factor

Miscellaneous Power Consumption

Computer Room Power Monitoring

# So, we started right out saving energy





# A building model is used for comparisons



# Work environment performance

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- Open office is quiet! (white noise)
  - 120 work locations, less footprint, expansion capability
- Day lighting has positive impact
- Meeting space is highly-functional
- Staff activity is highly visible
  - Productivity has improved





# Improved Environment – In and Out





# Project summary

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- Total project cost: \$7.65 million
  - \$1.65 million donated; \$6 million out-of-pocket to ASHRAE
  - Costs include moving, temporary space and all new furniture
- Goals accomplished
  - Learning and meeting center
  - Improved staff work environment
  - Existing building sustainable showcase
  - LEED-NC **Platinum Achieved!**
  - Living lab
- Need performance data?
- [www.ashrae.org/building](http://www.ashrae.org/building)



# So Where Are We Today?

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- Final commissioning being completed as we speak
- Targeting initial online data availability in March-April timeframe
- Whole building energy use tracking indicates that we have been accumulating savings since occupancy
- Comparisons are being made to the original modeling results for energy savings
- We will be applying for Energy Star rating now
- LEED-EB to follow once we have sufficient data

# Lessons Learned

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- Multiple vendors with multiple systems create multiple points of fault
- Donations are not necessarily “free”
- Everybody assumes everything that they haven’t checked is working correctly
- You can never have enough sensors (and they can never be calibrated enough either)
- Whatever you thought would work actually works the other way (that is the way you didn’t think)
- Everyone needs to report to the General Contractor
- **Big Learning: There probably isn’t a building anywhere that is operating correctly!**

# Sustainability Showcase!



Name this picture!

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# Cheapest LEED Point!

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# How to find me/Questions

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