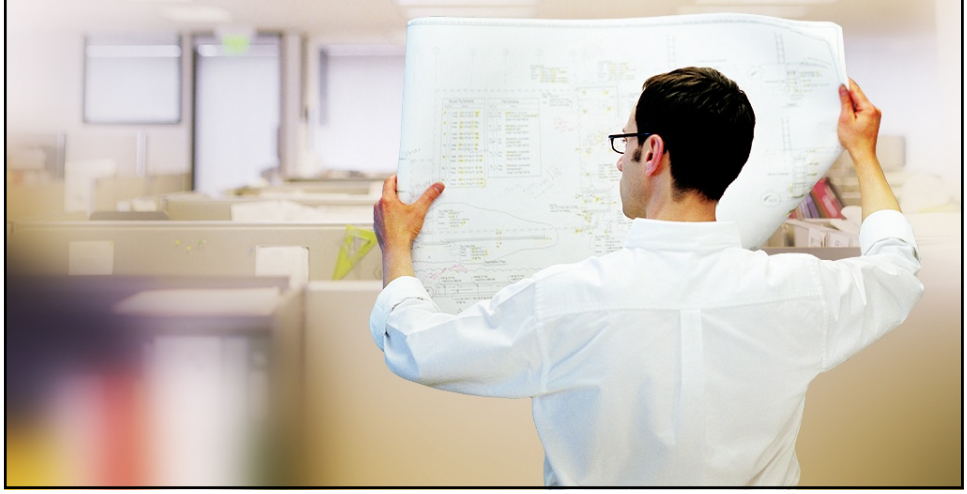
Energy Conservation in Existing Buildings

Process and Results

Julie Walleisa, Dekker/Perich/Sabatini
David Lyle, Beaudin Ganze Consulting Engineers, Inc.



Agenda

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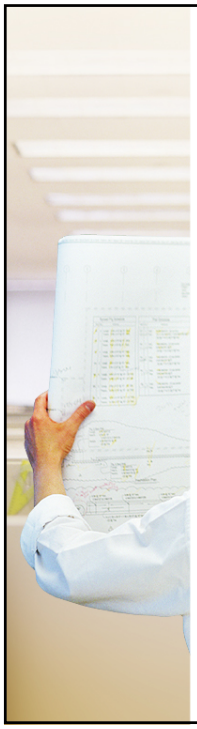
- Assessing Buildings
  - Tools/Process
  - Case Studies
  - Incentives
- Improving Buildings
  - Energy Conservation Measures
  - Case Studies

Dekker/Perich/Sabatini



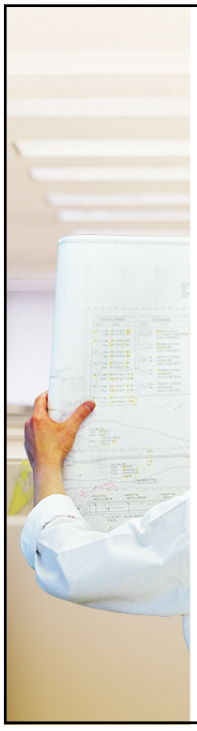
Introduction

Julie Walleisa, AIA, LEED AP

- Licensed architect
- Focused on building performance – functionality, energy efficiency, overall sustainability
- Associate with Dekker/Perich/Sabatini

Dekker/Perich/Sabatini

- 200+ architects, structural engineers, landscape architects, planners, and interior designers
- Offices in Albuquerque, Las Vegas, Amarillo
- Part of ownership team on our own LEED Gold office building



Building Assessment

- Compare performance to national or local averages, or the rest of your portfolio
- Identify opportunities for improvement and ongoing cost savings
- Discover whether the building may qualify for any incentives or recognition
- Decide what team members and level of analysis is needed upfront

Benchmarking

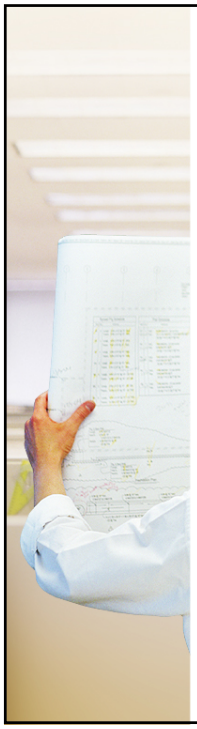
- What's needed?
  - 1 year of typical utility bill data
  - Average to compare against
- Compare to building history or your portfolio
- CBECS Database
  - Commercial Building Energy Consumption Survey
  - Calculate building EUI and compare to table

Benchmarking

CBECS (excerpt)

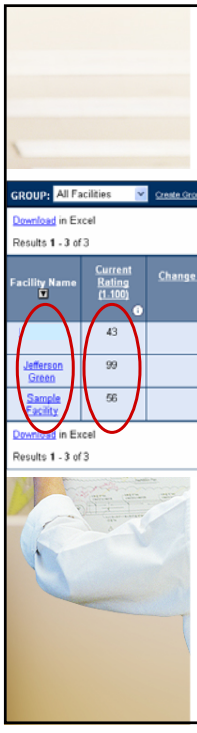
TABLE 1 2003 CBECS[1] National Average Source Energy Use and Performance Comparisons by Building Type

Building Use Description[2]	Average Source EUI[3] (Kbtu/Sqft)	Average Percent Electric	Average Site EUI (Kbtu/SqFt)
Education	170	63%	76
K-12 School	*See Target Finder / Portfolio Manager*		
College/University (Campus-level)	280	63%	120
Food Sales	681	86%	225
Grocery Store/Food Market	*See Target Finder / Portfolio Manager*		
Convenience store (with or without Gas Station)	753	90%	241
Food Service	786	59%	351
Restaurant/Cafeteria	612	53%	302
Fast Food	1308	64%	534
Health Care: Inpatient (Specialty Hospitals, Excluding Children's)	468	47%	227
Hospital (Acute Care, Children's)	*See Target Finder / Portfolio Manager*		
Health Care: Long Term Care (Nursing Home, Assisted Living)	255	54%	124
Health Care: Outpatient	183	72%	73
Clinic/Other Outpatient Health	219	76%	84
Medical Office	*See Target Finder / Portfolio Manager*		



Benchmarking

- ENERGY STAR's Portfolio Manager tool
  - Requires additional usage data to normalize
  - Enter and track information online
  - Can only benchmark certain building types:
    - Offices
    - K-12 Schools
    - Hospitals
    - Hotels
    - Supermarkets
    - Residence Halls/Dormitories
    - Warehouses
    - Medical Offices
    - Retail Space



Benchmarking

Portfolio Manager: Multiple Buildings

GROUP: All Facilities | Create Group | View All VIEW: Summary: Facilities | Create View | Edit View | View All

Download in Excel

Results 1 - 3 of 3

Search Facility Name: Search

All # A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Facility Name	Current Rating (1-100)	Change from Baseline: Adjusted Energy Use (%)	Total Floor Space (Sq. Ft.)	Energy Use Alerts	Current Energy Period Ending Date	Eligibility for the ENERGY STAR	Last Modified
	43	0.0	116,540	Data > 120 days old	12/31/2007	Not Eligible: Rating must be 75 or above (ENERGY STAR Eligibility Rules)	01/31/2008
Jefferson Green	99	1.2	85,000		03/31/2009	Apply for the ENERGY STAR	05/11/2009
Sample Facility	56	N/A	15,000	Data > 120 days old	10/31/2007	Not Eligible: Rating must be 75 or above (ENERGY STAR Eligibility Rules)	01/31/2008

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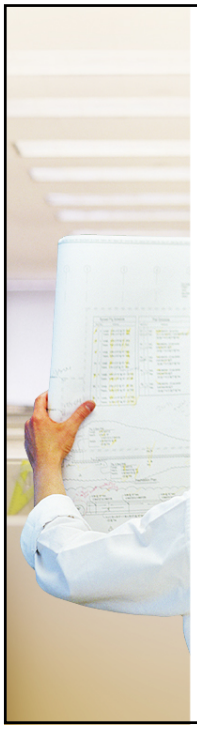
Results 1 - 3 of 3

Search Facility Name: Search

All # A B C D E F G H I J K L M N O P Q R S T U V W X Y Z



Benchmarking

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Portfolio Manager: Additional Inputs

*Space Name: office

CANCEL SAVE

Current Space Attribute Values What is this?

Space Attribute	Space Attribute Value (Temporary values should only be used if an Actual value is not currently known) What is this?
Gross Floor Area (required for benchmarking)	85000
Weekly operating hours (required for benchmarking)	55
Workers on Main Shift (required for benchmarking)	284
Number of PCs (required for benchmarking)	284
What percent of this space is air-conditioned? (required for benchmarking)	50% or more
What percent of this space is heated? (required for benchmarking)	50% or more

Dekker/Perich/Sabatini

Benchmarking

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Portfolio Manager: Meter data

Energy Meters Add Meter | Update Multiple Meters | View All Meter Data in Excel

Meter Name	Energy Type	Space(s)	Last Meter Entry (End Date)	Alerts	
electric	Electricity (kWh)	Entire Facility	05/02/2009		Delete Meter
gas	Natural Gas (therms)	Entire Facility	05/04/2009		Delete Meter

Water Meters Add Meter | View All Meter Data in Excel

Meter Name	Units	Use	Last Meter Entry (End Date)	Alerts	
No Meter Defined					

Dekker/Perich/Sabatini

Benchmarking

Portfolio Manager: EUI, Rating

Facility Summary: **Jefferson Green**

Building ID: 1431683
Level of Access: Facility/Profile Editor
Access Provided by : Caryn Grosse

Electric Distribution Utility: PNM - Public Service Co of NM
Regional Power Grid: WECC Southwest
Select my Power Generation Plant to calculate my electric emissions rate
Electric Emissions Rate ($kgCO_2e/MBtu$): 175.1 (what is this?)

Generate a Statement of Energy Performance for uses other than applying for the ENERGY STAR.

General Information Edit
Address: 7601 Jefferson NE , Albuquerque, NM 87109
Year Built: 2006
Property Type: Single Facility
Baseline Rating: 99 | **Current Rating:** 99
Eligible to Apply for the ENERGY STAR

Facility Performance Set Baseline Period | Set Energy Performance Target

Select View: Summary: Energy Use — Create View | Edit View

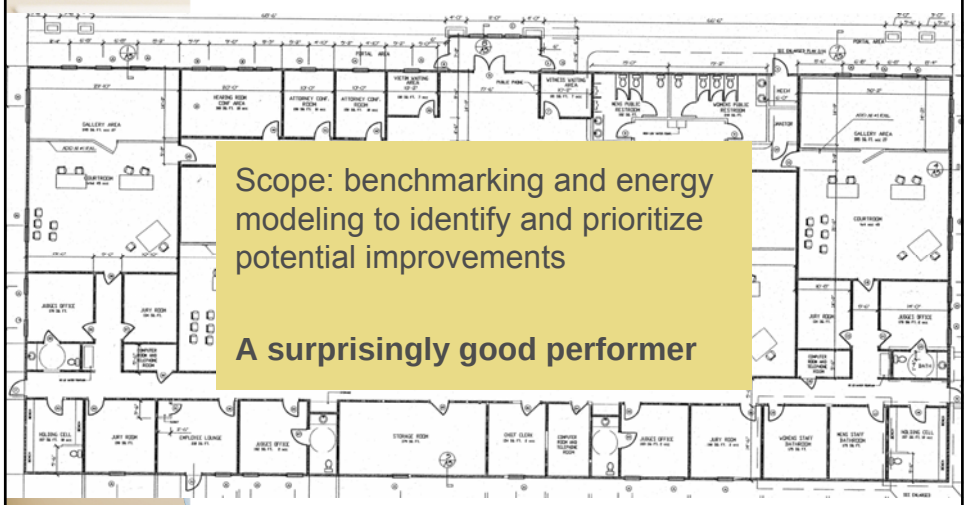
12 Months Ending	Current Rating (1-100)	Current Site Energy Intensity (kBtu/Sq. Ft.)	Current Source Energy Intensity (kBtu/Sq. Ft.)	Change from Baseline: Energy Use Intensity (kBtu/Sq. Ft.)	Change from Baseline: Adjusted Energy Use Intensity (kBtu/Sq. Ft.)	Energy Use Alerts
February 2008	99	34.6	82.7	-1.3	0.3	
Select Date						
Change						

REFRESH VIEW

Benchmarking

- Preliminary analysis:
  - Online Q&A tools
  - Energy modeling
- What can benchmarking and preliminary analysis tell you?
  - Already performing well
  - Performing poorly in areas that might be difficult to address
  - Clear areas of potential improvement and operating savings

Case Study #1:

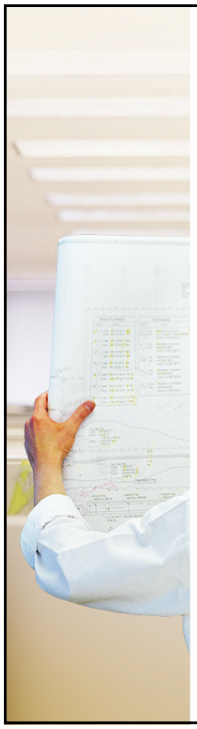


Scope: benchmarking and energy modeling to identify and prioritize potential improvements

A surprisingly good performer

Dekker/Perich/Sabatini

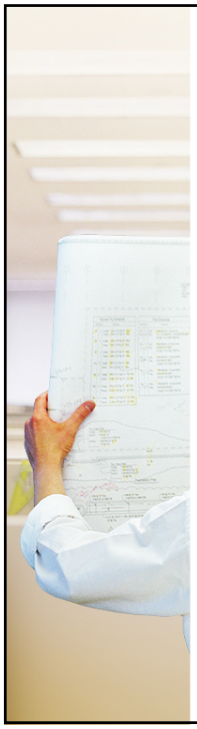
Case Study #1:



- 14,500sf building
- Wood frame, stucco, built up roof
- Packaged RTUs
- Leased: courtrooms, offices, support spaces

- **Step 1: Portfolio Manager benchmarking of utility bills**
- **EUI 26kBtu/sf = ES rating of 92**

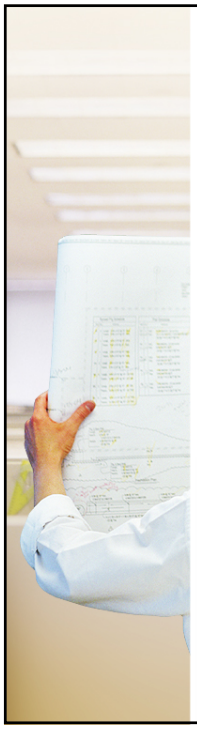
Dekker/Perich/Sabatini



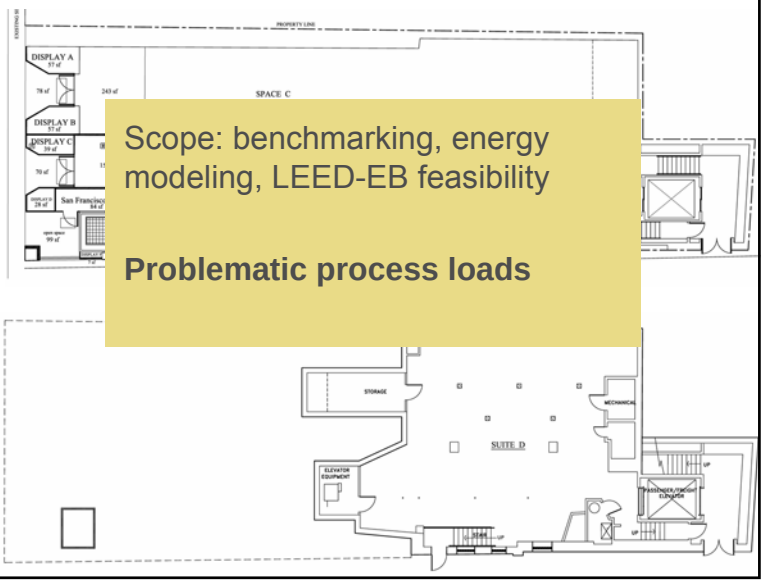
Case Study #1:

- Not likely to be significant/cost effective gains, unless systems at end of life
- Don't need model to study physical changes
- Submit for ENERGY STAR recognition

- Focus on operational tweaking
  - Schedules, office equipment, maintenance
- Consider retrocommissioning
  - $0.30-0.70/sf = $4,000 to $10,000

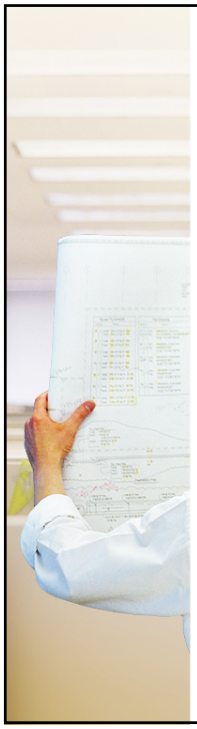


Case Study #2:



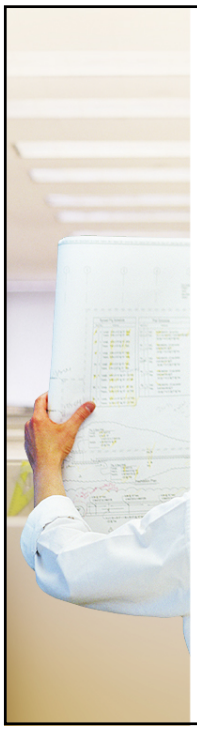
Scope: benchmarking, energy modeling, LEED-EB feasibility

Problematic process loads



Case Study #2:

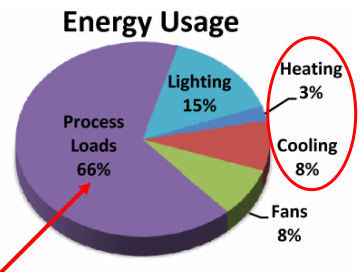
- 15,000sf building
- Leased: restaurant, retail stores
- Masonry units, stucco, tan roof
- Mix of single and double pane windows
- Packaged RTUs, mix of T12, T8, MR16 lights
- **Step 1: Utility benchmarking**
  - Restaurant use = CBECS required
- **Step 2: Energy modeling**
  - **Synchronized to utility bills**
  - **Breakdown of energy uses**



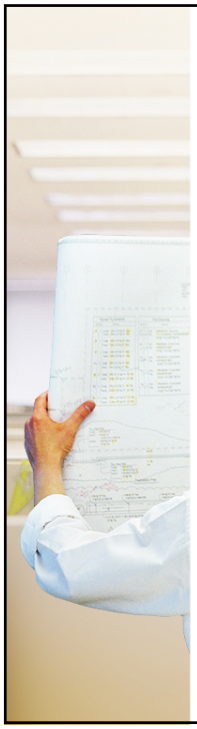
Case Study #2:

Building Summary		
Area	14,825	ft^2
Site Energy Use	169	$kBtu/ft^2/yr$
Source Energy Use	311	$kBtu/ft^2/yr$
Energy Cost	3.00	$/ft^2

Energy Usage (kBtu/yr)	
Lighting	375,318
Space Heating	61,947
Space Cooling	208,517
Fans	204,403
Process Loads	1,668,742
Total	**2,518,928**



- 169 kBtu/sf/yr EUI
- 66% process loads
- Only 11% heating and cooling



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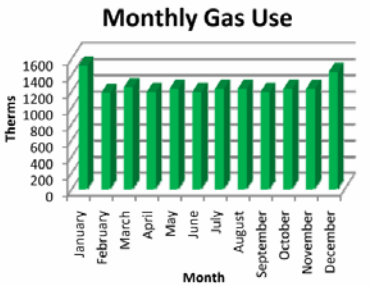
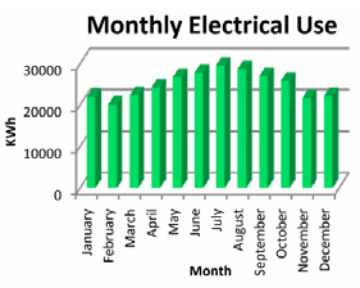
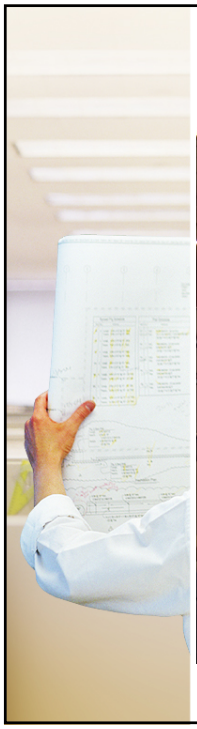




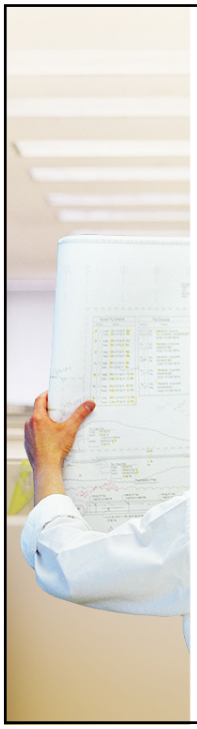
- High gas use year-round due to restaurant
- Restaurant use exceeds allowable LEED EUI
- Process uses overshadow potential base building improvements
- Can't qualify for LEED-EB, considering LEED-CS



Case Study #3:

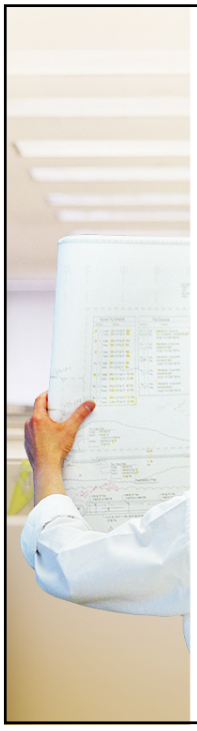
Scope: LEED-EB feasibility

Low performer with clear opportunities & challenges



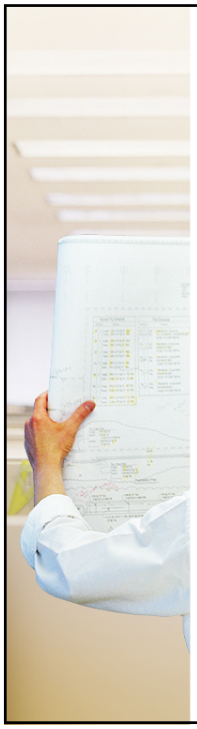
Case Study #3:

- 13,000sf office building built in 2000
- 6” metal stud, cavity insulation, stucco
- Tinted double paned windows
- Multiple packaged RTUs on central thermostats with timed setbacks
- Mostly T12 lighting
- **Step 1: utility benchmarking & building walkthrough**
- **125 kBtu/sf/yr = EPA rating of 31**
- **Energy 35% higher than LEED-EB threshold**



Case Study #3:

- Major changes needed to meet LEED-EB, reduce utility costs
- Preliminary analysis done with Business Analyzer from www.energyguide.com



Case Study #3:

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Please tell us about your energy bill:

	Don't Have / Don't Pay	Electric	Gas	Propane	Oil
Heating (primary): *	○	○	○	○	○
Heating (secondary): *	○	○	○	○	○
Cooling (primary): *	○	○	○		
Cooling (secondary): *	○	○	○		
Water Heating: *	○	○	○	○	○
Refrigeration: *	○	○			
Cooking: *	○	○	○	○	
Laundry: *	○	○	○	○	
Interior Lighting: *	○	○			
Exterior Lighting: *	○	○			

What percentage of total area is ...	... Heated?	... Cooled?
	100%	100%

	Opening Time / Start-up	Closing Time / Shut-down
Weekdays (M-F) *	8 am	6 pm
Saturday *	8 am	6 pm
Sunday, Holidays *	Sorry - We're Closed	Sorry - We're Closed

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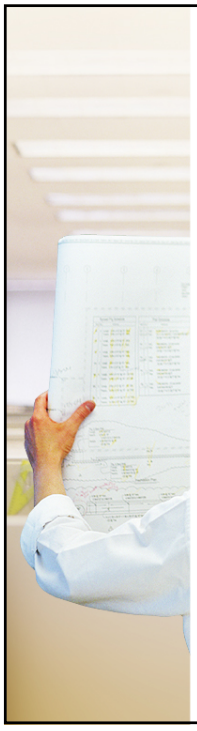

Case Study #3:

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What type(s) of INTERIOR lighting do you use?

	Most	Some	Few	None
Incandescent	○	○	○	○
standard fluorescent	○	○	○	○
compact fluorescent	○	○	○	○
metal halide	○	○	○	○
mercury vapor	○	○	○	○
other HID	○	○	○	○

If applicable, what type of fluorescent tubes are installed?

- ○ T-12 standard fluorescent
- ○ T-12 energy-saver fluorescent
- ○ T-8 energy-efficient fluorescent
- ○ Other
- ○ Unsure
- ○ None

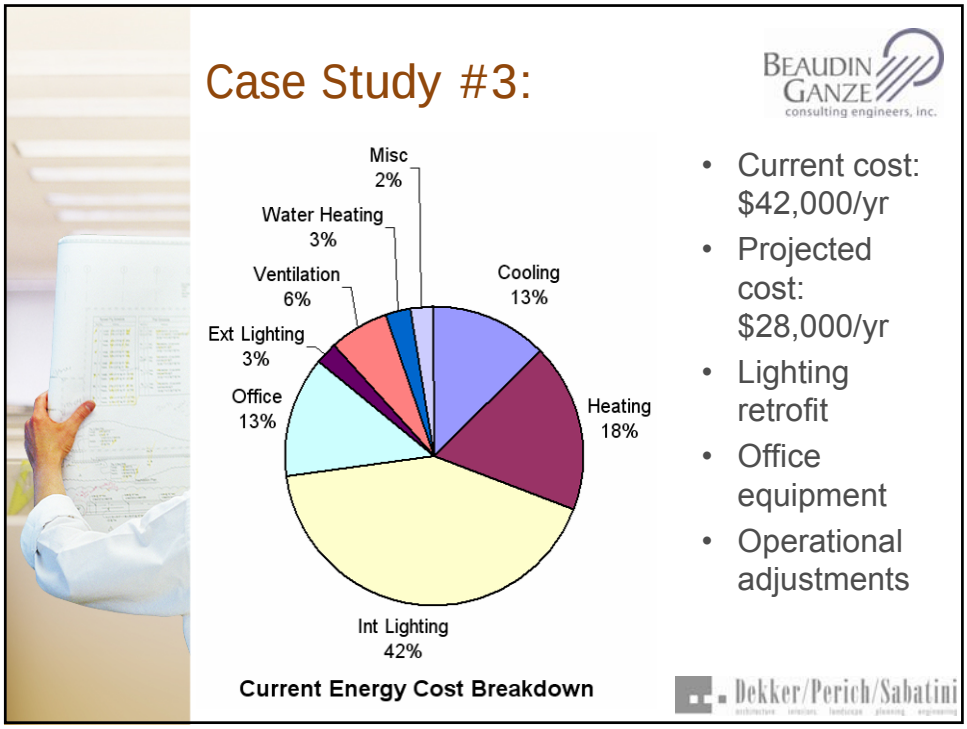
What type of fluorescent ballasts are installed?

- ○ Magnetic ballasts (typical, for T-12's)
- ○ Electronic ballasts (standard, for T-8's)
- ○ Don't know/don't have fluorescents

Do you have occupancy sensors or other automatic lighting controls?

- ○ Yes
- ○ No

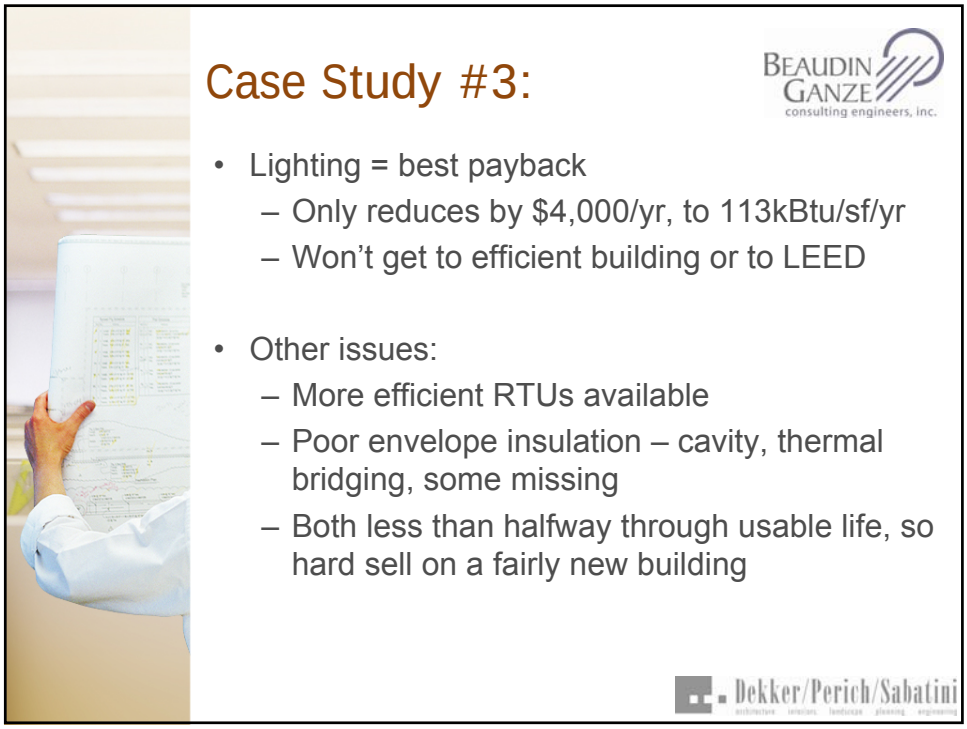
Dekker/Perich/Sabatini



Case Study #3:

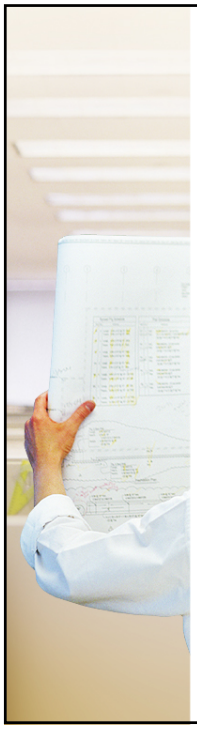
Current Energy Cost Breakdown

- Current cost: $42,000/yr
- Projected cost: $28,000/yr
- Lighting retrofit
- Office equipment
- Operational adjustments



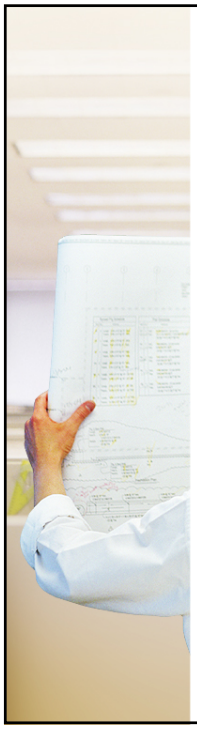
Case Study #3:

- Lighting = best payback
  - Only reduces by $4,000/yr, to 113kBtu/sf/yr
  - Won't get to efficient building or to LEED
- Other issues:
  - More efficient RTUs available
  - Poor envelope insulation – cavity, thermal bridging, some missing
  - Both less than halfway through usable life, so hard sell on a fairly new building



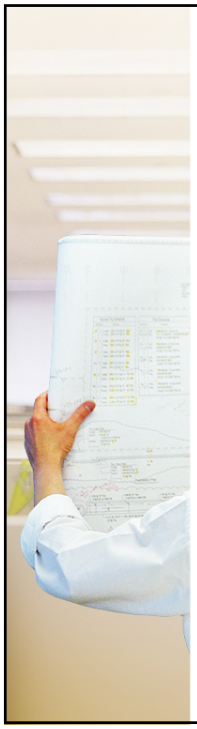
Ideal Case

- Performance is in average to low range
- Systems nearing time for replacement
  - Able to upgrade lighting and HVAC
  - Able to consider insulation, roof, glazing improvements
- Load mostly base building, not processes
- Possibility of integrating renewable energy



Incentives

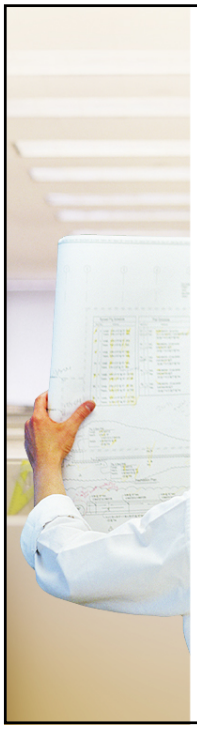
- Beyond operating savings:
  - State tax credits
  - Local utility programs
  - Solar incentives
  - Higher occupancy rates
  - Higher rental rates
  - Higher sales price



Incentives

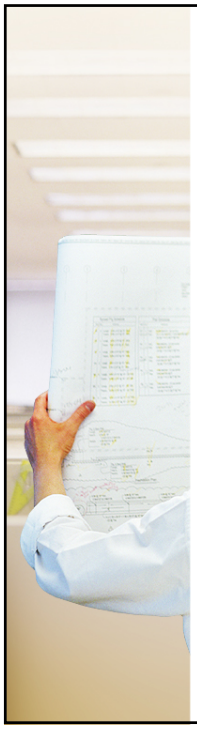
- **NM Sustainable Building Tax Credit**
  - LEED-EB Silver or Higher
  - Less than half the average energy use
  - from $1.40/SF for LEED CI Silver to $6.25/SF for LEED NC Platinum

	First 10,000 ft²	Next 40,000 ft²	Next 450,000 ft²
LEED-NC *New construction*			
Silver	$3.50/ft²	$1.75/ft²	$0.70/ft²
Gold	$4.75/ft²	$2.00/ft²	$1.00/ft²
Platinum	$6.25/ft²	$3.25/ft²	$2.00/ft²
LEED-EB/CS *Existing building/Core and shell*			
Silver	$2.50/ft²	$1.25/ft²	$0.50/ft²
Gold	$3.35/ft²	$1.40/ft²	$0.70/ft²
Platinum	$4.40/ft²	$2.30/ft²	$1.40/ft²
LEED-CI *Commercial interiors*			
Silver	$1.40/ft²	$0.70/ft²	$0.30/ft²
Gold	$1.90/ft²	$0.80/ft²	$0.40/ft²
Platinum	$2.50/ft²	$1.30/ft²	$0.80/ft²



Incentives

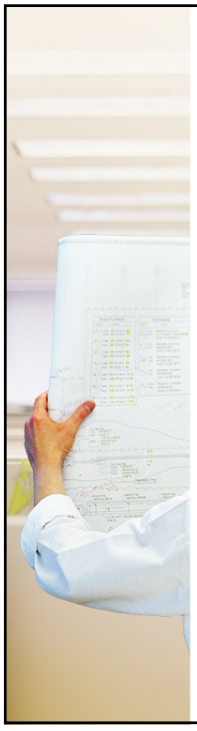
- **PNM Commercial Rebate Programs**
  - Lighting retrofits, up to $75/fixture
  - Advanced evaporative cooling, up to $500/unit
  - Peak Saver program, quarterly incentives
  - http://www.pnm.com/rebates/business_rebates.htm



Incentives

- **Solar Incentives**
  - Federal tax credit: 30% system cost, no cap
  - NM tax credit: additional 10% of system cost
  - http://www.emnrd.state.nm.us/ecmd/index.htm
  - PNM Large PV program: 15 cents/kWh
  - http://www.pnm.com/customers/pv_large/home.htm?source=smallpv

Dekker/Perich/Sabatini

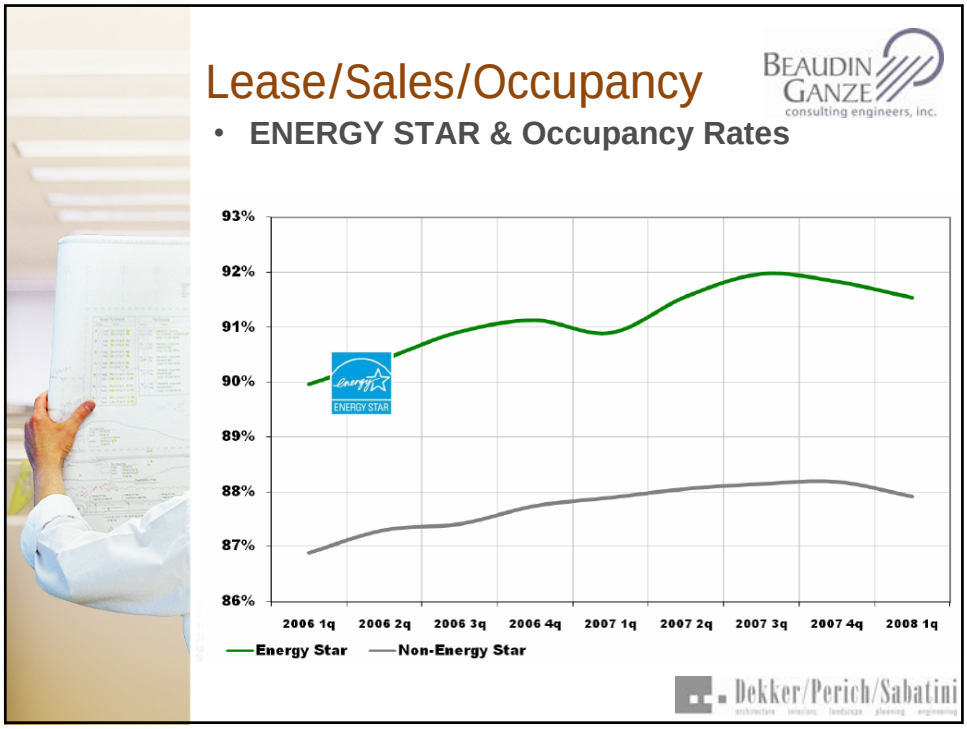


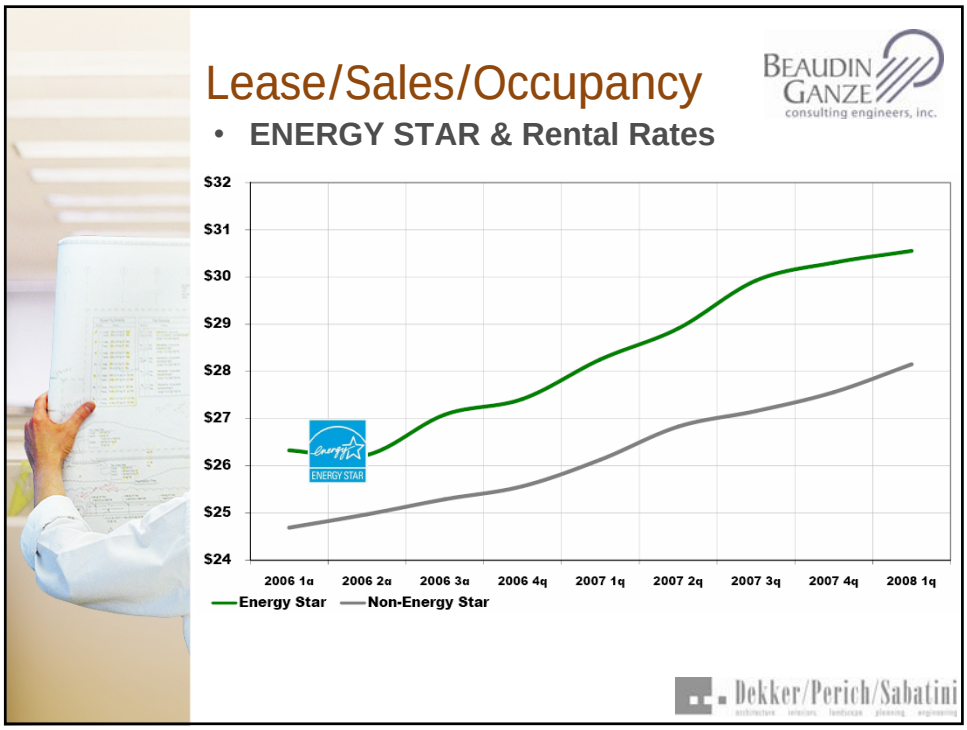
Lease/Sales/Occupancy

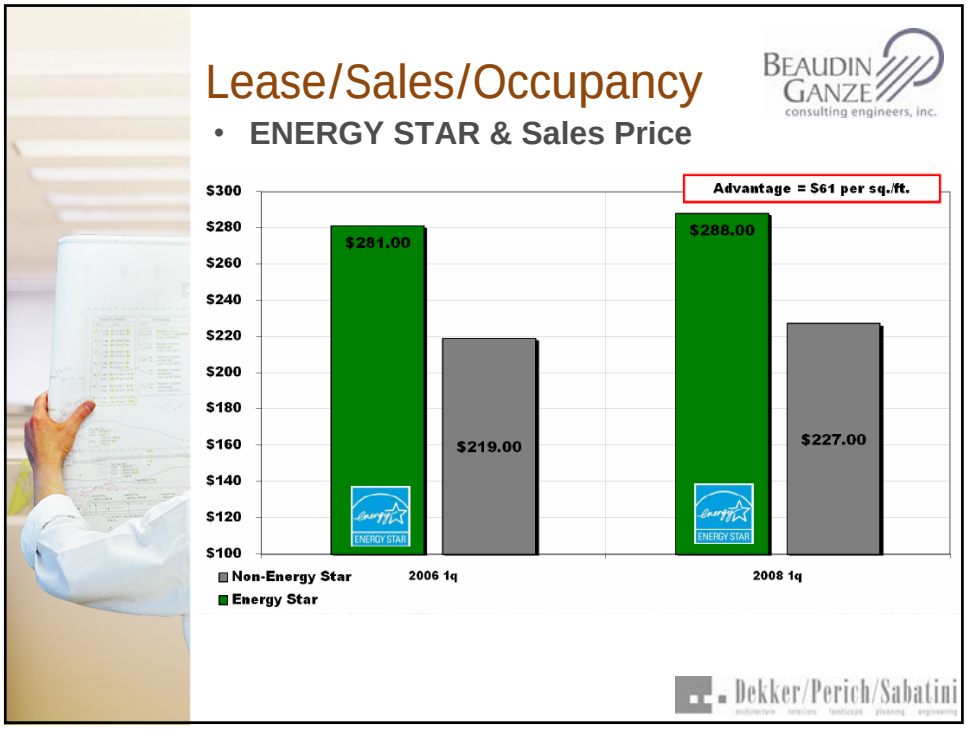
- CoStar Study: Does Green Pay Off?
  - Analyzed over 1,300 LEED and Energy Star buildings
  - Over 350 million square feet
  - Assessed buildings against non-green properties with similar size, location, class, tenancy and age characteristics http://www.costar.com/josre
  - Not yet evident in our market

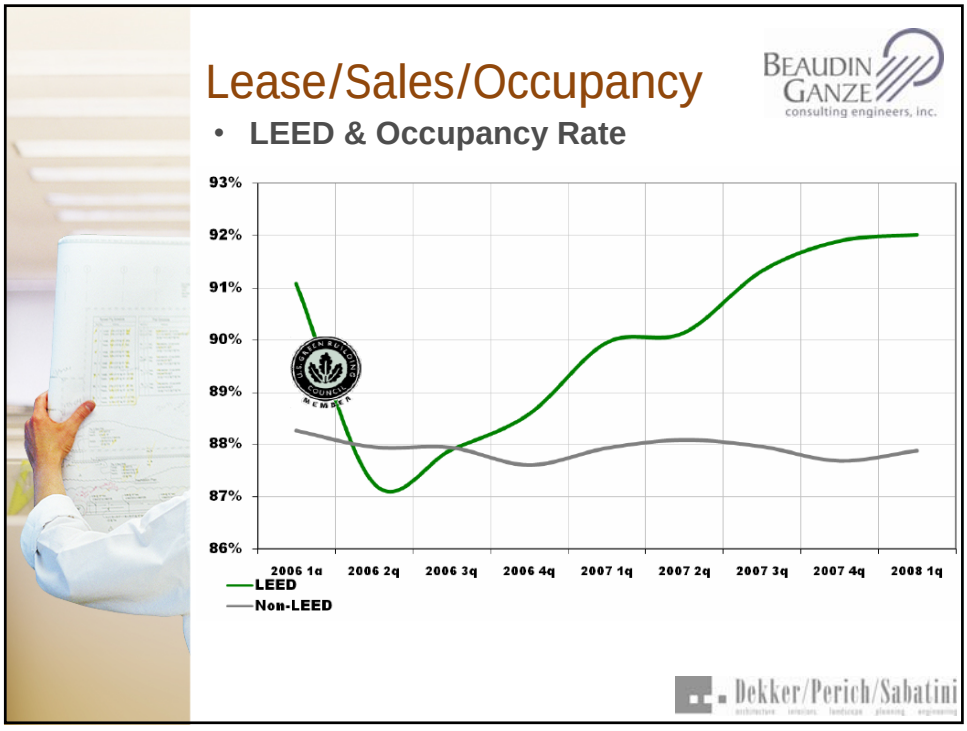
CoStar Group
Real Estate Information

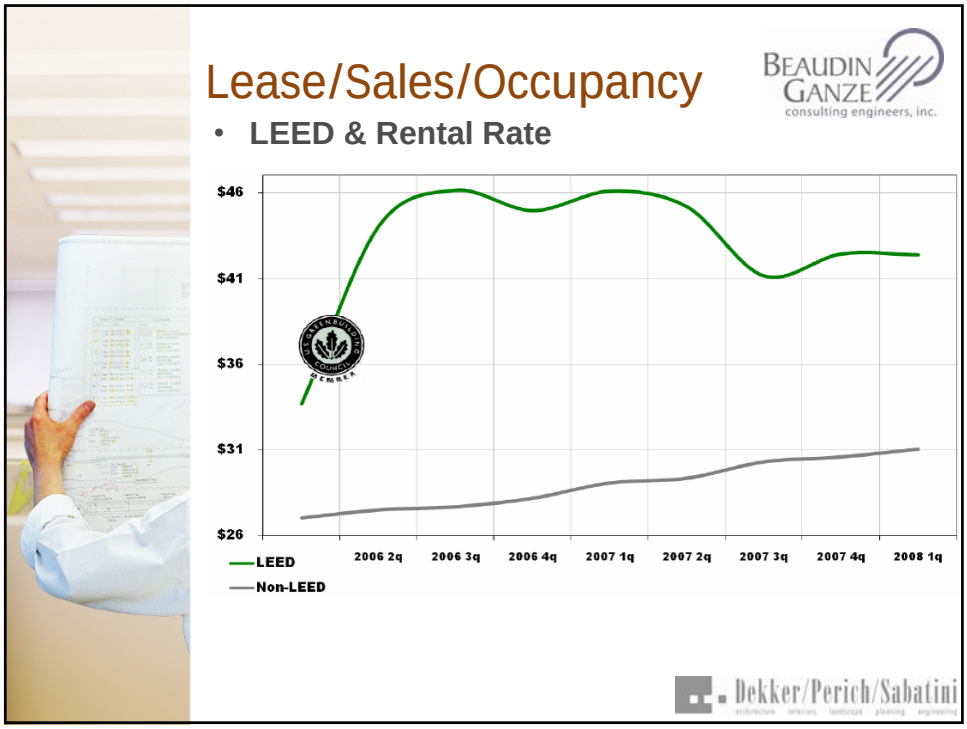
Dekker/Perich/Sabatini

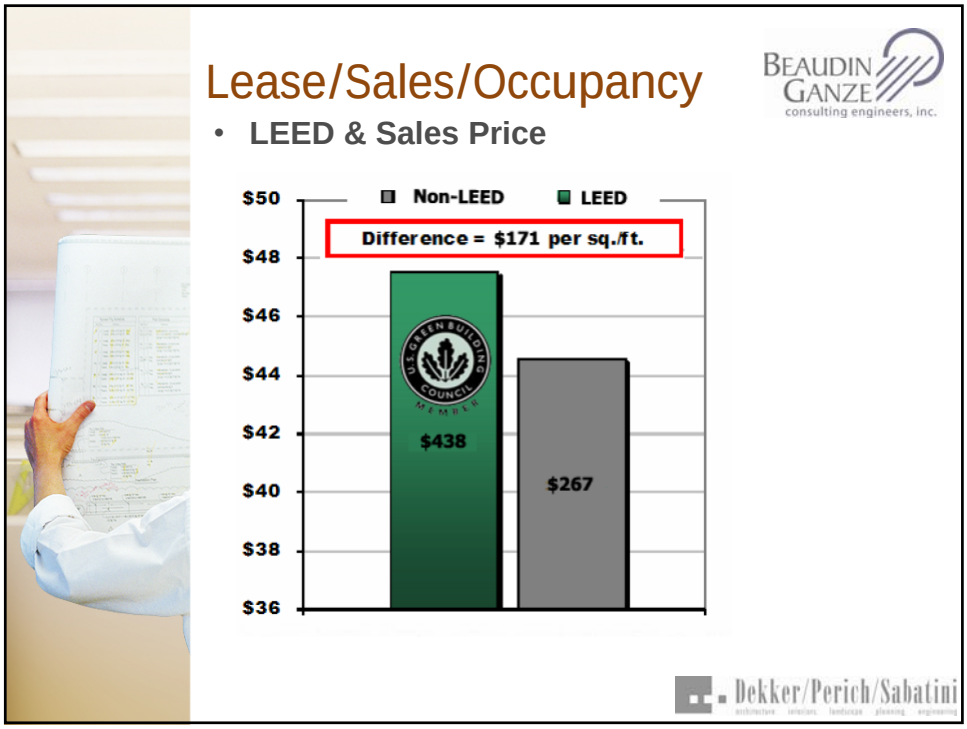

Lease/Sales/Occupancy
BEAUDIN GANZE
consulting engineers, inc.
• ENERGY STAR & Occupancy Rates
93%
92%
91%
90%
89%
88%
87%
86%
2006 1q
2006 2q
2006 3q
2006 4q
2007 1q
2007 2q
2007 3q
2007 4q
2008 1q
Energy Star
Non-Energy Star
Dekker/Perich/Sabatini

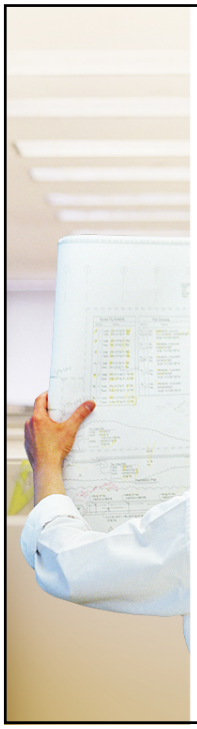

Lease/Sales/Occupancy
BEAUDIN GANZE
consulting engineers, inc.
• ENERGY STAR & Rental Rates
$32
$31
$30
$29
$28
$27
$26
$25
$24
2006 1q
2006 2q
2006 3q
2006 4q
2007 1q
2007 2q
2007 3q
2007 4q
2008 1q
Energy Star
Non-Energy Star
Dekker/Perich/Sabatini


Lease/Sales/Occupancy
BEAUDIN GANZE
consulting engineers, inc.
• ENERGY STAR & Sales Price
Advantage = $61 per sq./ft.
$300
$280
$260
$240
$220
$200
$180
$160
$140
$120
$100
$281.00
$219.00
$288.00
$227.00
ENERGY STAR
ENERGY STAR
Non-Energy Star
Energy Star
2006 1q
2008 1q
Dekker/Perich/Sabatini


Lease/Sales/Occupancy
BEAUDIN GANZE
consulting engineers, inc.
• LEED & Occupancy Rate
93%
92%
91%
90%
89%
88%
87%
86%
2006 1q
2006 2q
2006 3q
2006 4q
2007 1q
2007 2q
2007 3q
2007 4q
2008 1q
LEED
Non-LEED
Dekker/Perich/Sabatini

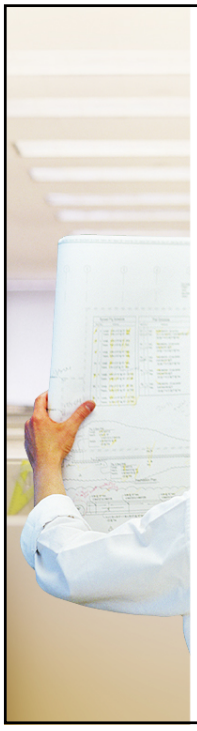

Lease/Sales/Occupancy
BEAUDIN GANZE
consulting engineers, inc.
• LEED & Rental Rate
$46
$41
$36
$31
$26
2006 2q
2006 3q
2006 4q
2007 1q
2007 2q
2007 3q
2007 4q
2008 1q
LEED
Non-LEED
Dekker/Perich/Sabatini


Lease/Sales/Occupancy
BEAUDIN GANZE
consulting engineers, inc.
• LEED & Sales Price
$50
$48
$46
$44
$42
$40
$38
$36
Non-LEED
LEED
Difference = $171 per sq./ft.
$438
$267
Dekker/Perich/Sabatini



Next Steps

- Benchmarking:
  - In-house or by consultant
- Analysis:
  - Self-analysis with online Q&A tools
  - Energy modeling analysis
  - Retrocommissioning
  - Incentive/tax analysis
- Reporting to management/boards:
  - Detailed analysis results
  - Cost/savings estimates



Next Steps

ENERGY MODEL SUMMARY

*The Energy Model Summary is a means of energy use comparision and may vary slightly from actual building performance.

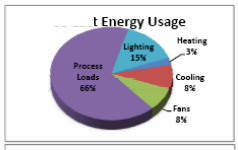
Building Summary		
Area	14,825	ft^2
Site Energy Use	169	$kBtu/ft^2/yr$
Source Energy Use	311	$kBtu/ft^2/yr$
Energy Cost	3.00	$/$ft^2$

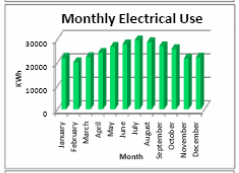
Environmental Impact		
CO2	2,895,766	lbm/yr
SO2	5,480	gm/yr
NOX	6,938	gm/yr

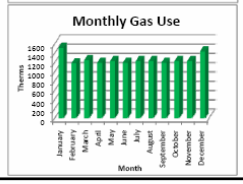
Energy Usage (kBtu/yr)	
Lighting	376,318
Space Heating	61,947
Space Cooling	208,517
Fans	204,403
Process Loads	1,668,742
Total	**2,518,928**

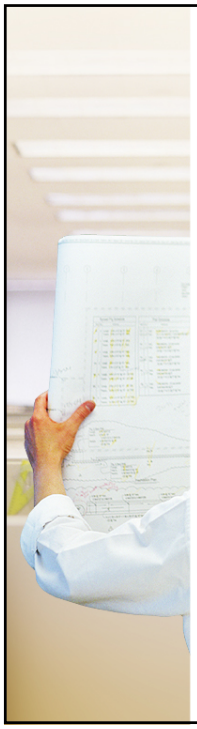
Annual Energy Cost		
Energy Source	Total Energy kBtu/yr	Total Cost $/yr
Electricity	1,013,128	28,567
Gas	1,505,800	15,964
Total	**2,518,928**	**44,531**

Monthly Energy Summary		
Month	Electricity Use KWh	Gas Use therms
January	21,874	1,512
February	20,054	1,177
March	22,233	1,246
April	24,052	1,187
May	26,638	1,226
June	27,710	1,187
July	29,470	1,226
August	28,825	1,226
September	26,865	1,187
October	25,715	1,226
November	21,576	1,225
December	22,031	1,433









Next Steps

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SUMMARY OF RECOMMENDATIONS

Credit	Recommended Changes	Changes Are: Physical	Changes Are: Operational	Estimated Cost
SSc2	Ice and snow removal, exterior cleaning paints and sealants	X	X	
SSc3	Pest control, erosion/sedimentation control(construction)		X	
SSc4	Survey occupants about commuting behaviors		X	
SSc7.1	Replace part of sidewalk	X		
	Clean every 2 years		X	
SSc7.2	Coat roof	X		
	Clean every 2 years		X	
SSc8	Install controls	X		
WEp1	Add aerators to lav faucets	X		
	Assessment Policy for future renovations		X	
WEc2	Replace toilets with 1.1 gpg-3 points	X		
	Also replace urinals with 0.5 gpf-5 points	X		
EAp1	Sequence of operations and audit done as part of report		X	
EAc2.1	Audit done as part of report		X	
EAc2.2	Initiate commissioning		X	$5,000 one-time
EAc2.3	Ongoing commissioning-every 2 years		X	$5,000 every 2 years
EAc3.3	Add submeters for main service, retail spaces, basement	X		$6,000/one-time
EAc4	2 year contract for off-site and/or		X	$1,932-$6,331/year
	Add PV system for on-site	X		$96,000/one-time

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Next Steps

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EAp2: Minimum Energy Efficiency Performance (required)

no | ops | phys

Prerequisite Summary:
This prerequisite uses the energy performance of similar buildings to establish a baseline for energy efficiency. The requirements provide three options: for buildings which achieve an ENERGY STAR rating of at least 69, for buildings which demonstrate energy efficiency at least 19% better when benchmarked against buildings of the same type, and for buildings for which no comparable data is available.

Status and Recommendations:
The ENERGY STAR rating is not applicable to all building types, such as the restaurant at -- ----, so Option B was selected as the most appropriate way to establish energy efficiency baseline.

Typically, CBECS (Commercial Buildings Energy Consumption Survey) is used to benchmark buildings for which an ENERGY STAR rating is not available, however, USGBC has adjusted the national averages for certain categories, including Food Service-Restaurant/Cafeteria, in their calculator to keep the levels more consistent with the expected levels for other building activities. The result is that -- ----, is unable to meet the prerequisite due to the high energy use of the restaurant. ____ would not be able to meet this requirement even with major improvements to the HVAC system, since the issue relates to the energy consumption associated with the restaurant, rather than the base building systems.

Gas meters used for evaluation of EAp2 and EAc1

ENERGY & ATMOSPHERE

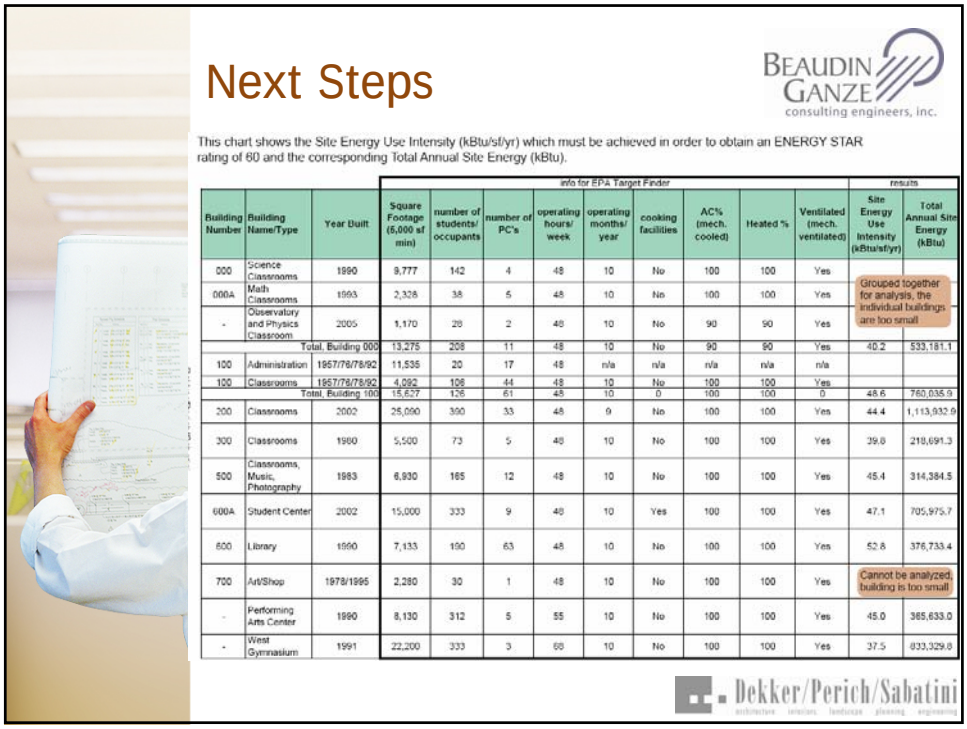
EAp3: Refrigerant Management: Ozone Protection (required)

yes | ops | phys

Prerequisite Summary:
This prerequisite prohibits the use of chlorofluorocarbon (CFC) based refrigerants for heating, ventilation, air conditioning and refrigeration (HVAC&R) systems unless it can be shown that replacing the system is not economically feasible or a phase-out plan for the CFCs is in place.

Status and Recommendations:
-- ----- could achieve this prerequisite without changes. R-22 refrigerant is used in all HVAC and refrigeration equipment and is permissible for this prerequisite.

Kitchen refrigerator compressors. The R-22 refrigerant complies with EAp3, but not with EAc5.



Next Steps

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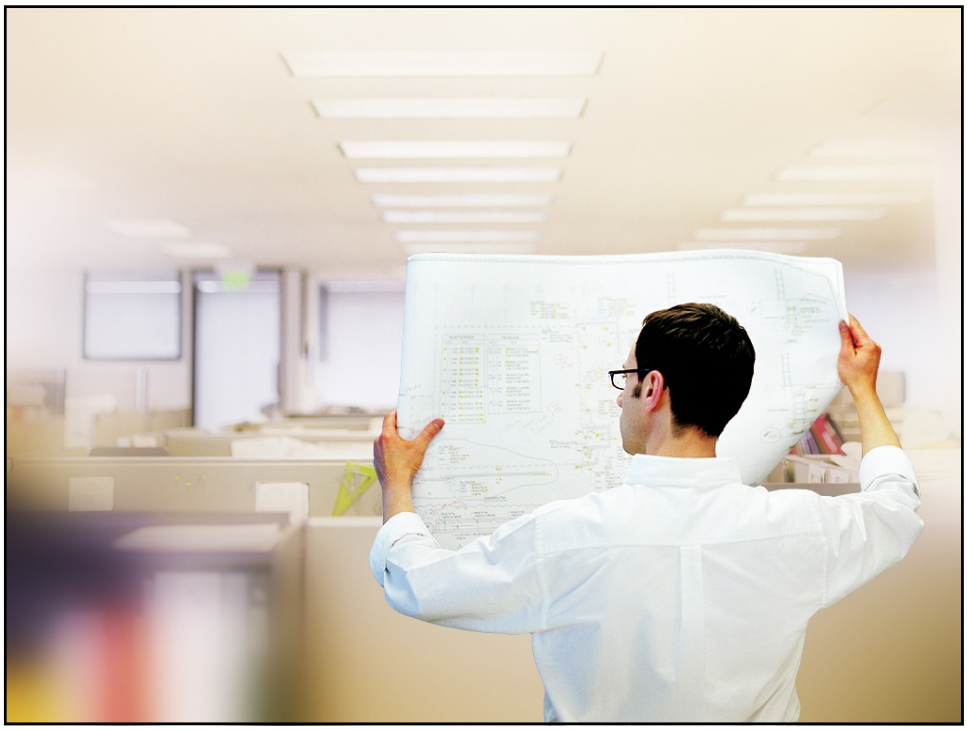
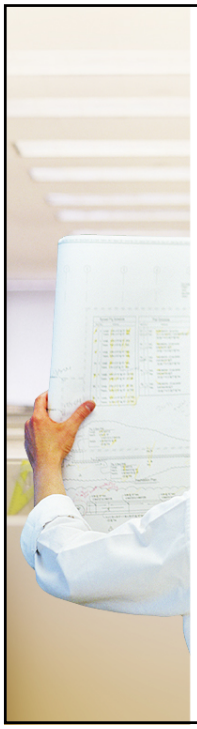
This chart shows the Site Energy Use Intensity (kBtu/sf/yr) which must be achieved in order to obtain an ENERGY STAR rating of 60 and the corresponding Total Annual Site Energy (kBtu).

			info for EPA Target Finder									results	
Building Number	Building Name/Type	Year Built	Square Footage (5,000 sf min)	number of students/ occupants	number of PC's	operating hours/ week	operating months/ year	cooking facilities	AC% (mech. cooled)	Heated %	Ventilated (mech. ventilated)	Site Energy Use Intensity (kBtu/sf/yr)	Total Annual Site Energy (kBtu)
000	Science Classrooms	1990	9,777	142	4	48	10	No	100	100	Yes		
000A	Math Classrooms	1993	2,328	38	5	48	10	No	100	100	Yes	Grouped together for analysis, the individual buildings are too small	
-	Observatory and Physics Classroom	2005	1,170	28	2	48	10	No	90	90	Yes		
	Total, Building 000		13,275	208	11	48	10	No	90	90	Yes	40.2	533,181.1
100	Administration	1957/78/78/92	11,535	20	17	48	n/a	n/a	n/a	n/a	n/a		
100	Classrooms	1957/78/78/92	4,092	106	44	48	10	No	100	100	Yes		
	Total, Building 100		15,627	126	61	48	10	0	100	100	0	48.6	760,035.9
200	Classrooms	2002	25,090	390	33	48	9	No	100	100	Yes	44.4	1,113,932.9
300	Classrooms	1980	5,500	73	5	48	10	No	100	100	Yes	39.8	218,691.3
500	Classrooms, Music, Photography	1983	6,930	165	12	48	10	No	100	100	Yes	45.4	314,384.5
600A	Student Center	2002	15,000	333	9	48	10	Yes	100	100	Yes	47.1	705,975.7
600	Library	1990	7,133	190	63	48	10	No	100	100	Yes	52.8	376,733.4
700	Art/Shop	1978/1995	2,280	30	1	48	10	No	100	100	Yes	Cannot be analyzed, building is too small	
-	Performing Arts Center	1990	8,130	312	5	55	10	No	100	100	Yes	45.0	365,633.0
-	West Gymnasium	1991	22,200	333	3	68	10	No	100	100	Yes	37.5	833,329.8

Dekker/Perich/Sabatini





Introduction

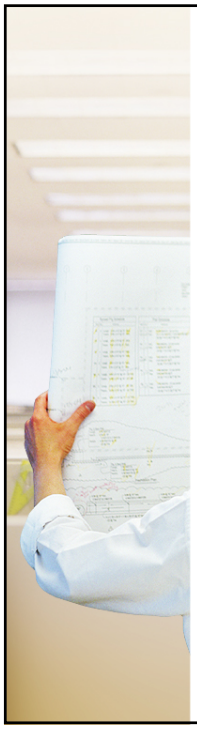
David A. Lyle, P.E., LEED, CxA

- Professional Engineer
- Commissioning Agent
- 15 years Design, Installation and Operation experience with HVAC Systems
- Principal for Beaudin Ganze Consulting Engineers, Inc.

Beaudin Ganze Consulting Engineers

- 18 Year old Consulting Engineering Firm
- 55 Employees across 6 offices around the country
- Provides existing building services including:
  - **Energy Audits**
  - **Retro Commissioning**
  - **LEED EB Feasibility Studies**
  - **Engineering Design and Analysis**

Dekker/Perich/Sabatini



Energy Conservation Measures (ECMs)

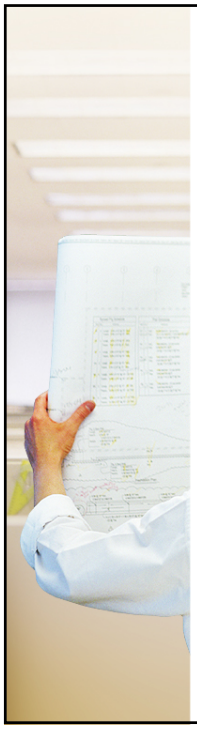
What is an ECM:

Unique, systematic modification to system(s) or process(es) to improve performance, reduce operating costs, increase asset value.

OPR/OFR and BoD/DI compliant

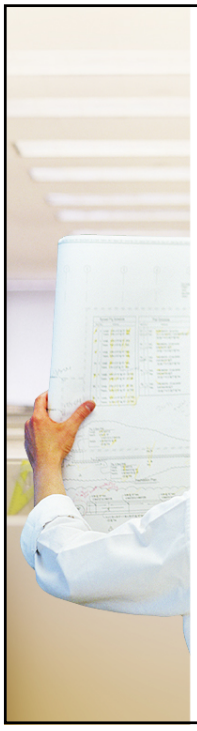
Often similar for building/sector types

Dekker/Perich/Sabatini



Energy Conservation Measures (ECM's)

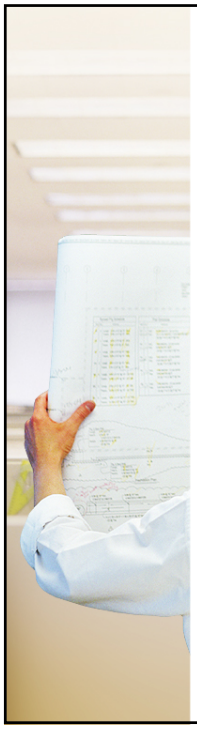
- Low Hanging Fruit:
  - **Usually identified in basic energy assessment/audit**
    - benchmarking process
    - simple walkthrough
    - Commissioning often addresses
    - 0-36 month ROI
- Other opportunities:
  - **Found in more detailed building system energy assessment /audit**
    - May require energy modeling
    - More detailed economic analysis required
    - 36+ month ROI



Energy Conservation Measures (ECMs)

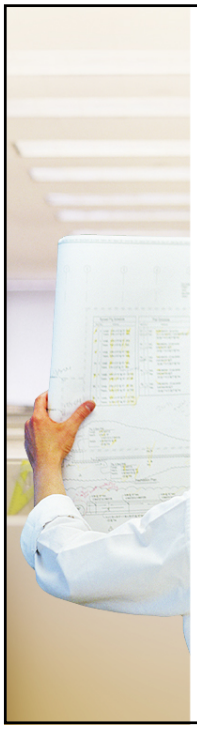
Primary ECM Categories:

Operation and Maintenance (O&M)
HVAC
Plumbing
Power and Lighting
Envelope



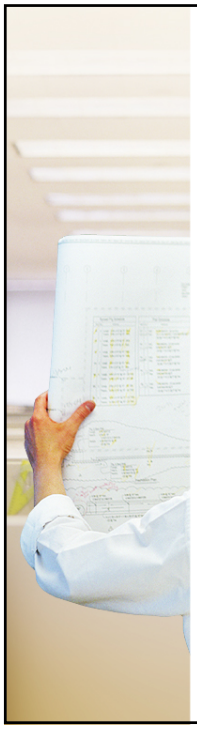
O&M ECM's Commissioning:

- Retro/Re Commissioning (Cx) is a systematic, quality process for improving the current conditions and operations of an *existing* building.
- Building Systems most commonly addressed include:
  - **HVAC**
  - **Lighting Controls**
  - **Domestic Hot Water**
  - **Building Envelope**
- Retro-Cx evaluates the conditions of the buildings energy related systems, and optimizes the operation, performance, and maintenance in accordance with the original design intent and the owner's operational needs.



O&M ECM's Commissioning:

- Retro/Re-Cx is analogous to a tune up for your building, establishing or restoring the building's operation to the design intent.



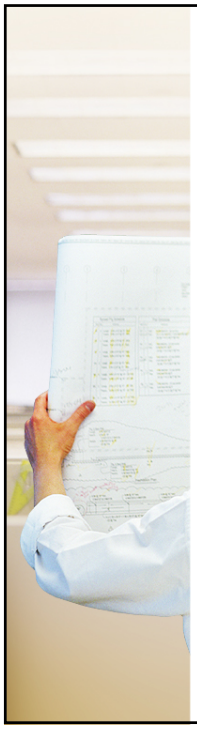
O&M ECM's Commissioning:

- **Benefits:**
  - Determines root cause of the problem to optimize building systems – not quick fix.
  - Validates BoD and established baseline.
  - Corrections are typically low cost measures to implement. Can be funded through O&M budget, not requiring capital funds.
  - Improvement in temperature control, indoor air quality, and energy efficiency
  - Paybacks are typically 6 months to 2 years
  - Allows for training of O&M staff to sustain ongoing building performance improvement

O&M ECM's Commissioning:

- **Costs/Savings:**
  - Median commissioning costs of $0.27/ft^2
  - Median building energy savings of 15 percent
  - Median payback of 0.7 years.
  - The most cost-effective results occurred among energy-intensive facilities such as hospitals and laboratories. Less cost-effective results are most frequent in smaller buildings. Energy savings tend to rise with increasing comprehensiveness of commissioning.
  - We find that commissioning is one of the most cost-effective means of improving energy efficiency in commercial buildings

2004 Assessment - Lawrence Berkeley National Laboratory



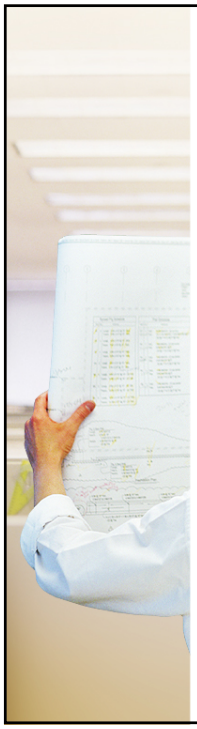
O&M ECM's Preventative Maintenance:

How do you operate?

"The best offense is a good defense"

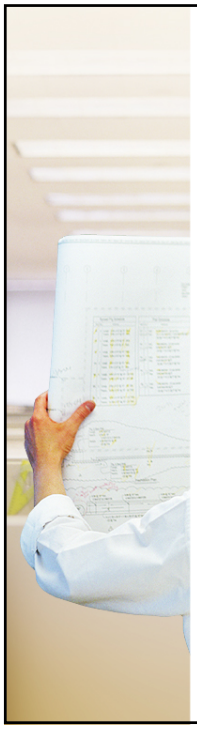
Or

"The best defense is a good offense"



O&M ECM's Preventative Maintenance

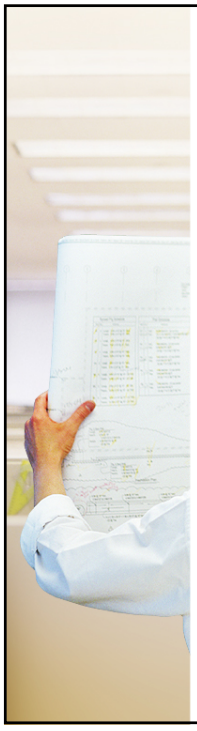
- **Benefits:**
  - Improved system reliability.
  - Decreased cost of replacement.
  - Decreased system downtime.
  - Better "spares" inventory management.
  - Better staff management (limited overtime, increased efficiency.



O&M ECM's
Preventative Maintenance

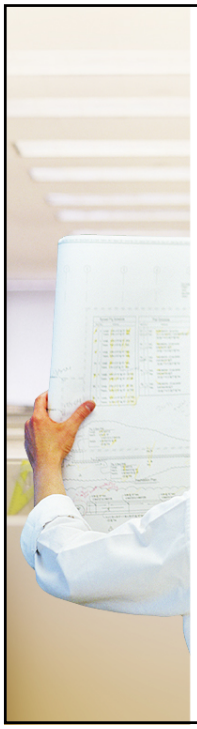
- **Savings:**
  - Vary – case by case, but long-term effects and cost comparisons usually favor preventive maintenance over performing maintenance actions only when the system fails.

Preventing fires is much easier than putting them out!



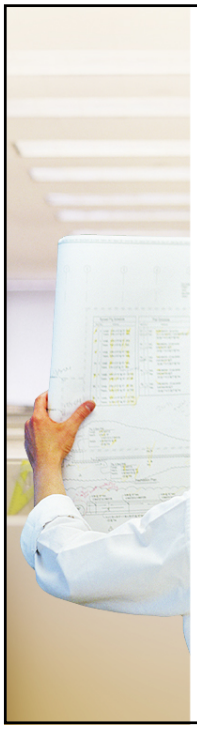
HVAC ECM's

- **Controls:** (adjustment/enhancement/replacement/integration)
  - **Examples:**
    - Occupancy Sensors\Scheduling
    - Integration with other systems – lighting, heating, air conditioning, power, security, etc.
    - Ventilation Control
    - Setback/Reset - air, water
    - Setpoint adjustment (heating water, pressure, chilled water, supply air, etc.)



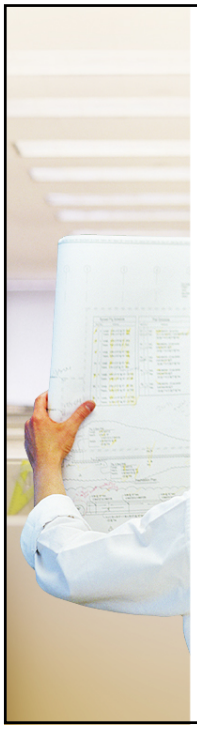
HVAC ECM's

- **Controls:**
  - **Benefits:**
    - Identified early in process.
    - Low or No Cost if system already in place.
    - Can be done relatively quickly.
    - Enhanced system performance and occupant comfort.



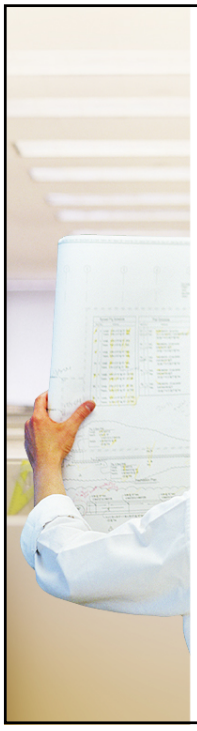
HVAC ECM's

- **Controls:**
  - **Costs/Savings:**
    - Typically this is the area where Cx pays for itself with 10%-30% building energy savings (even with newly constructed bldgs. 0 to 36 month ROI
    - Adding whole Building Automation Systems and/or Energy Management Systems to existing building is cost prohibitive unless incentives are available.
    - Varied other cost if adding control points, controllers, and programming.



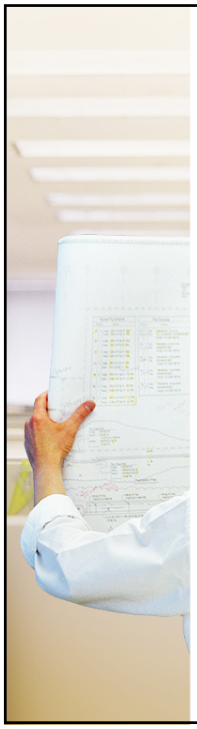
HVAC ECM's

- **Equipment Upgrades/Replacement:**
  - **Examples:**
    - Variable speed motors (fans and pumps)
    - High efficiency equipment
    - Modulating vs. Two Position
    - Energy recovery
    - Economizer
    - Evaporative Cooling (direct/indirect)
    - Insulation (piping and equipment)



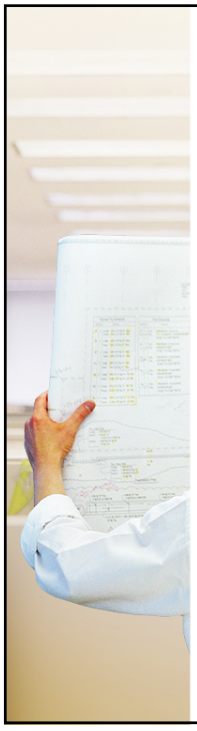
HVAC ECM's

- **Equipment Upgrades/Replacement:**
  - **Benefits:**
    - Enhanced system performance and occupant comfort.
    - Reduced operating costs.
    - Increased asset value.



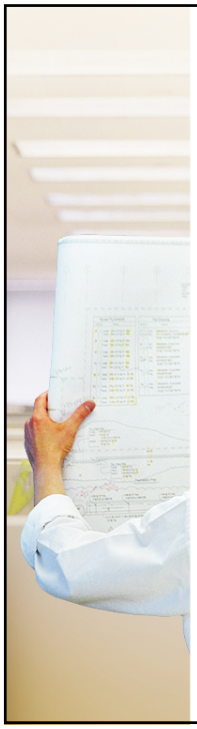
HVAC ECM's

- **Equipment Upgrades/Replacement:**
  - **Costs/Savings:**
    - Varies significantly on the upgrade, facility type, accessibility, etc.
    - Smaller changes like variable speed motors and/or modulating devices result in more acceptable 3 to 7 year payback.
    - 10% to 50% savings range is typical; however often not enough to provide a reasonable ROI given the costs of implementation.
    - Most viable when equipment or systems are scheduled for replacement or significant renovation.



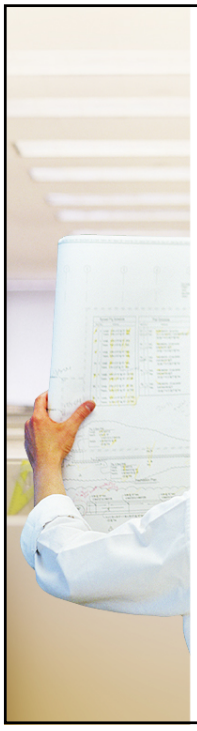
Plumbing ECM's

- **Examples:**
  - Low/No flow fixtures
  - Grey water or other process water recovery and reuse.
  - Storm water recovery and use.
  - High efficiency domestic water heater.
  - On demand domestic water heater.
  - Heat recovery.
  - Renewable – Solar water heating



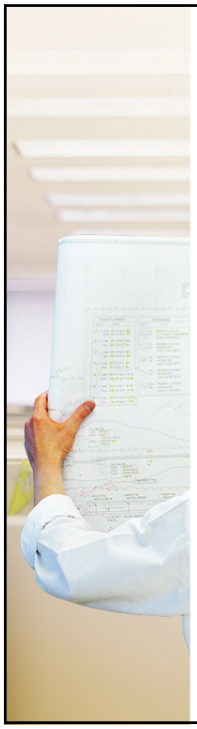
Plumbing ECM's

- **Benefits:**
  - Reduced operating costs.



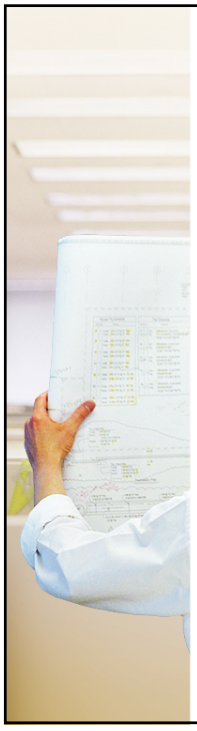
Plumbing ECM's

- **Costs/Savings:**
  - 20%-30% potable water usage typical savings. 5-10 year ROI depending on baseline water usage and quantity of fixtures.
  - Energy savings 10% to 30% common on higher efficient or on demand domestic hot water systems. 5-7 year ROI depending on baseline water usage and system size.
  - Energy savings of 1% to 2% with 3-5 year ROI on standby loss prevention of piping and equipment if easily accessible for application.



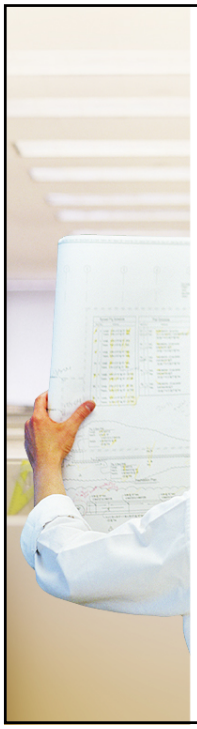
Power and Lighting ECM's

- **Examples:**
  - High efficiency lighting and ballasts
  - Load shedding/Demand Shaving
  - Dimming
  - Scheduling/Occupancy (lighting and power)
  - Renewable – photovoltaic, wind turbines, day lighting, other.
  - Power factor correction



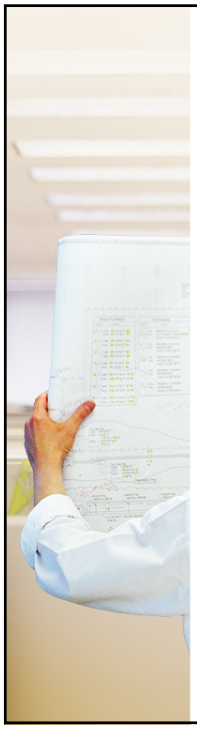
Power and Lighting ECM's

- **Benefits:**
  - Reduced operating costs.
  - Enhanced performance.
  - Enhanced occupant comfort with day lighting.



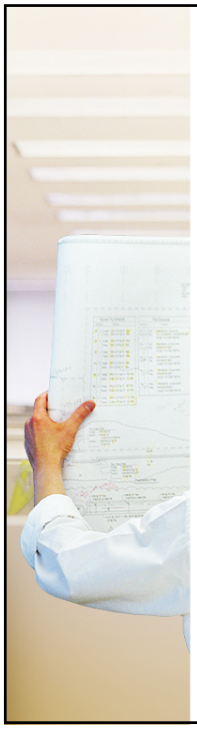
Power and Lighting ECM's

- **Costs/Savings:**
  - Cost vary based on system configuration and accessibility.
  - Controls – dimming, occupancy, scheduling, relatively low cost with ROI of 0-36 months.
  - 2% to 5% energy savings from controls, power/lighting scheduling.
  - Savings for lighting/ballast change out can be minimal or significant depending on the baseline system. Typically see 3-7 year paybacks.
  - Savings from renewable solutions varies with the quantity that can be installed. ROI is typically not feasible without incentives/credits.



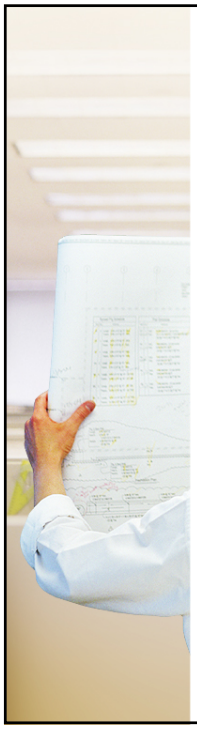
Building Envelope ECM's

- **Examples:**
  - Fenestration Improvement/Shading/Replacement
  - Envelope Insulation
  - Infiltration/Ex-filtration



Building Envelope ECM's

- **Benefits:**
  - Reduced operating costs.
  - Enhanced occupant comfort with day lighting.



Building Envelope ECM's

- **Costs/Savings:**
  - Cost vary based on system configuration and accessibility.
  - Immediate energy savings on infiltration improvements with ROI of 0-36 months.
  - 2% to 5% energy fenestrations improvements with coatings and/or shading. ROI of 3-7 years.
  - Savings from fenestration replacement or envelope insulation improvements vary significantly depending on the baseline installation. Amount of savings drives ROI.

Case #1 – Energy Audit

Engineering Consulting Saves Manitou Springs School District Money and Energy

Scope: update and improve the performance of nine buildings located on three campuses − the oldest built in the early 1900s.

Issues: District had completed several additions and expansions operating at higher than expected energy use costs and had systems that were not providing the level of heating and ventilation required for the health and comfort of the students and staff.

Process: Engineer/Cx evaluated the buildings for energy consumption, controllability, functionality, and whether they were performing as needed to match the current academic curriculum of the District.

Case #1 – Energy Audit

Team used Integrated Energy Modeling which allowed the team to select a package of energy conservation measures:.

- A District-wide BACNet DDC system
- Occupancy sensors to control lighting and HVAC equipment
- Variable Frequency Drives (VFDs) on fan-powered equipment and pumps
- Reducing the existing heating plant capacity by 22 to 33%
- Reduced DHW plant size by 64.4%
- Condensing boilers to replace aged cast-iron boilers
- High efficiency domestic water system.
- Economizer actuators and dampers with DDC control by CO2 sensors
- Commissioning of the mechanical and electrical systems.

Case #1 – Energy Audit

Project budget: $2,012,966

Savings: Gas usage has been reduced 64% and electric usage 46%. Additionally, atmospheric carbon dioxide has been brought down by 2.2 million pounds or 53%. In first nine months of 2008, MSSD has saved $135,000. Project to an approximately 10 year payback

Benefits: improved comfort, lower operating costs, easier maintenance conditions, improved safety and security of the buildings, and better overall quality to the classroom environment. These projects enhanced the comfort, health, safety, and learning environment within the School District's buildings, and demonstrate how effectively operational energy savings can be realized in school districts with aging, outdated, poorly installed, or improperly sized equipment.

Case #2 – Retro Cx

Facility: Adobe headquarters, three towers totaling 989,000 square feet of office space

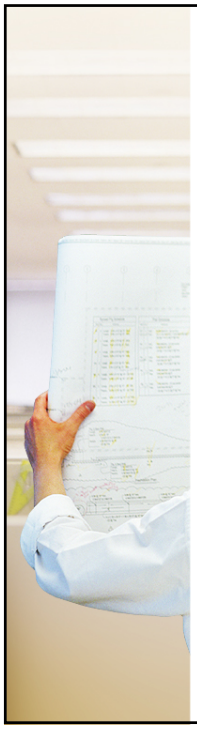
Project Timeline: 2001-2006

Costs: $1.4 million ($1.1 million after incentives)

Savings: $1.2 million per year

Simple Payback: 9 months

Costs/Savings:
• Energy cost savings: $1.2 million per year 35% (electricity), 41% (natural gas)
• All three buildings earned EPA ENERGY STAR® labels with scores of 98, 100, and 100 (does not include data centers)
• LEED®-EB Platinum Certification on all three buildings



Case #2 – Retro Cx

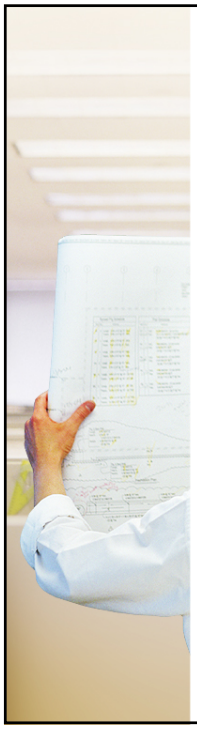
Details/Process:

Two towers, built in 1996 and 1998. Third tower built in 2003

The facilities team was well-trained and including a fifth-generation building engineer with an industrial science degree.

Buildings had never been fully commissioned

After five years of occupancy the towers were retro-commissioned



Case #2 – Retro Cx

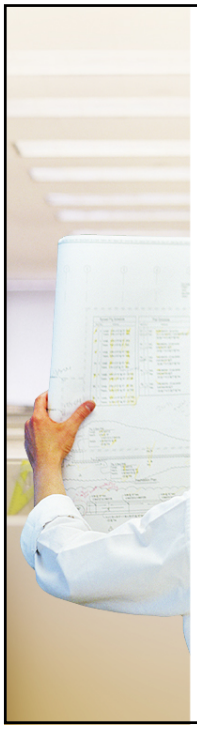
Details/Process:

Energy audit performed and implement a number of O&M and retrofit measures to fix problems identified in the audit.

More than 60 measures were implemented over a five-year period. After the first dozen measures were implemented, the results paved the way for approval of further projects.

“We took one project at a time, looking at the costs, seeing what the rebate would be, estimating savings, implementing, testing. After a while it became routine,”

Tower three was built in 2003 and was not fully commissioned and had a **score of 50 (energy star)** as a new building due to the constant operation of a chiller to cool the data centers and software labs. After **retro-commissioning, the building’s score increased to 83**.

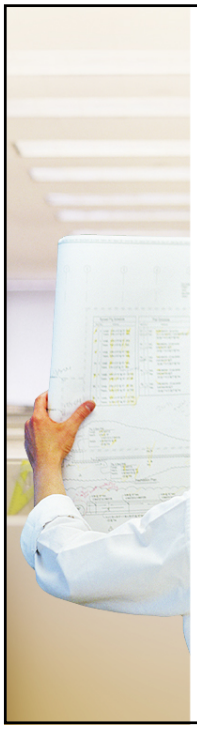


Case #2 – Retro Cx

Adobe compares building optimization to tuning up a car.

“Without a tune-up, the performance gets worse and worse until eventually the car is inoperable. Before our retro-commissioning program, the Adobe West Tower was approaching that,”

with hundreds of tenant comfort complaints each month. Now, the three buildings combined generate 20 to 40 calls per month, depending on the season.



Questions ???

Thank You!
Dekker/Perich/Sabatini
Beaudin Ganze