Marshall University Sustainability Luncheon
HVAC Systems and Energy Auditing

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Making Responsible Financial & Environmental Decisions

Presented By:

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MARSHALL

Heapy Engineering
Mechanical Electrical Commissioning Technology
Nationally Recognized Leader in Sustainability / LEED

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Heapy Engineering

In the news…

Ranked 30th in the Nation for Engineering Firms
– Consulting Specifying Engineer Magazine

A Top 100 Green Design Firm
– Engineering News Record (ENR) Magazine

Top 500 Design Firm
– Engineering News Record (ENR) Magazine

Ranked 5th in the Nation for Commissioning Services
– Consulting Specifying Engineer Magazine

AIA-CES Education Provider (Sustainability / MEP&T Design)

Heapy Engineering Headquarters – LEED PLATINUM
(Energy Star Rating +90)

Sustainability:

Meeting the needs of the present without compromising the needs of future Generations.

Why Build High Performance?

Whole Building Design Guide
U.S. Naval Facilities Command:

"Many of the factors that influence environmental comfort, such as quality lighting and adequate ventilation rates, also have a direct impact on building energy use. But the relationship between productivity and building energy use should be put in perspective."

For private sector offices:

Salaries average	$200 - $600 / SF / yr
Building leases average	$20 - $30 / SF / yr
Energy costs average	$2 - $4 / SF / yr

Thus, a "productivity" increase of just 1%.....

...can completely offset a building's entire utility bill !

Why Build High Performance?

Lockheed Martin's trailblazing 600,000 SF facility in Sunnyvale, CA, housing 2,500 employees is a case in point.

Lockheed managers reported a 15% drop in employee absenteeism.

A savings that paid for the incremental costs of the company's new high performance facility in the very first year alone.

LOCKHEED MARTIN
We never forget who we're working for™

Who's Talking About Green?

Who's Talking About Green?

The Next Generation's Perspective.....

..... will increase *GREEN* building:

89% **Choose**
brands aligned with social cause

74% **Listen to**
brands aligned with social cause

69% **Shop for**
brands aligned with social cause

66% **Recommend**
brands aligned with social cause

Myths of "Green" Building

MYTH: Only tree-hugging, granola fueled-hippies are into "green"

MYTH: Green building is a passing fad.

MYTH: Green building is too expensive.

MYTH: Green materials are not available.

MYTH: Green building is easy.
(It is only common sense).

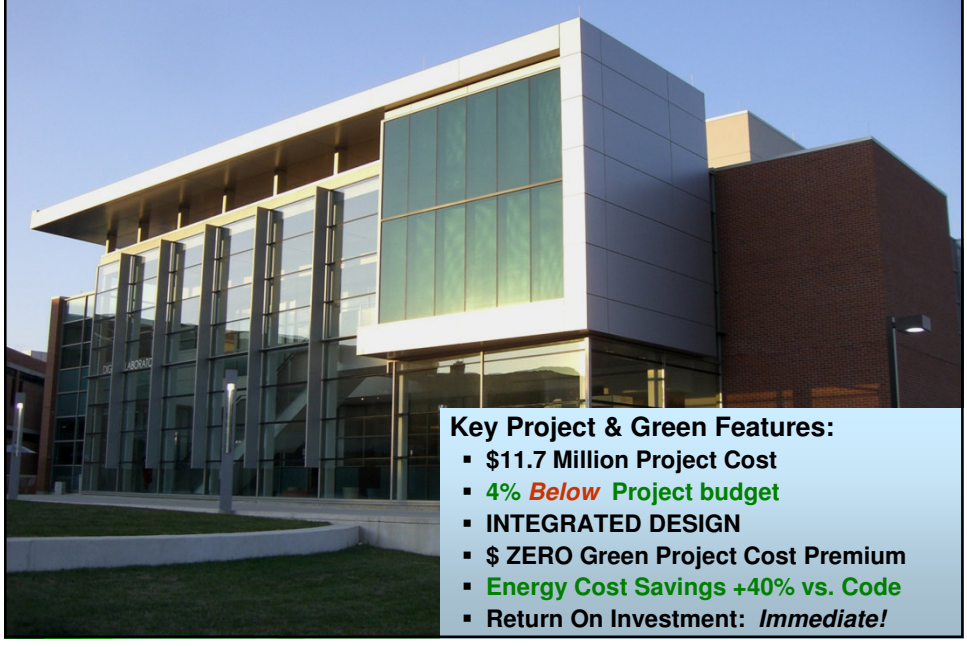
MYTH: Construction waste management is a waste of time.

MYTH: Green buildings look strange or different.

Key Project & Green Features:
- 120,000 SF
- $16.1 Million *Estimated* Project Cost
- $15.7 Million *Actual* Project Cost
- ZERO Green Project Cost Premium
- Payback: ZERO Months!
- Integrated Design Critical!!!

Green / Energy Case Studies

Wright State U. Diggs Laboratory – LEED-NC GOLD

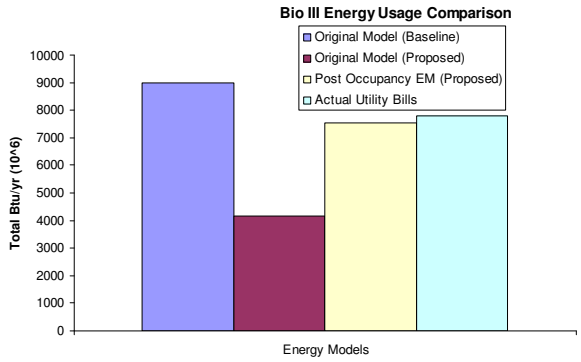


Key Project & Green Features:

- $11.7 Million Project Cost
- 4% *Below* Project budget
- INTEGRATED DESIGN
- $ ZERO Green Project Cost Premium
- Energy Cost Savings +40% vs. Code
- Return On Investment: *Immediate!*

Wright State U. Diggs Laboratory – LEED-NC GOLD

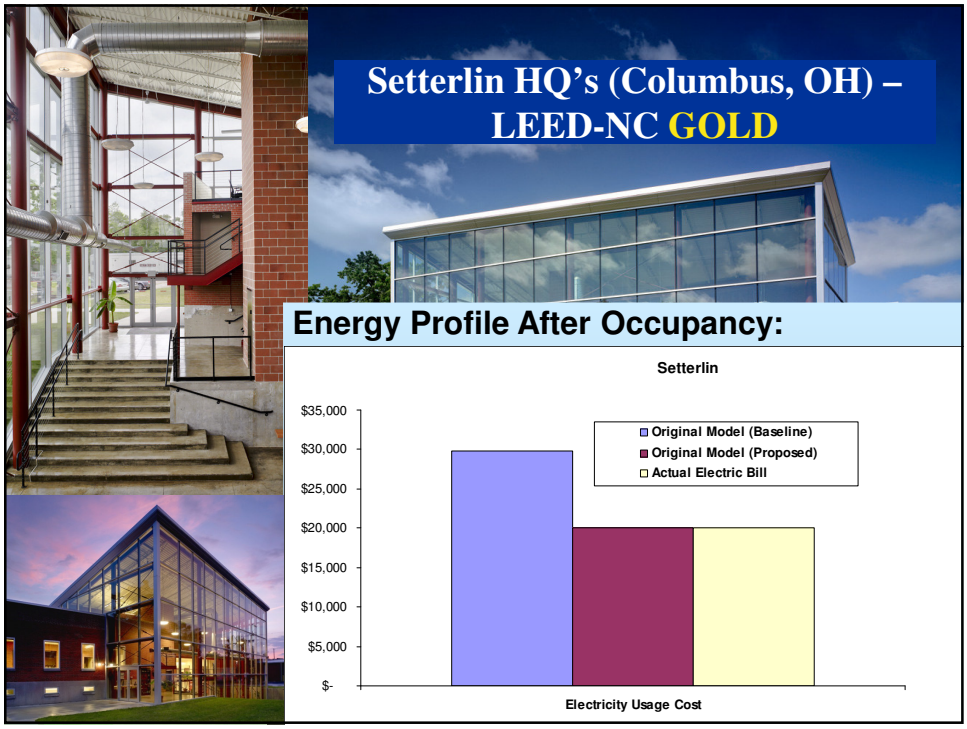
Energy Profile After Occupancy:

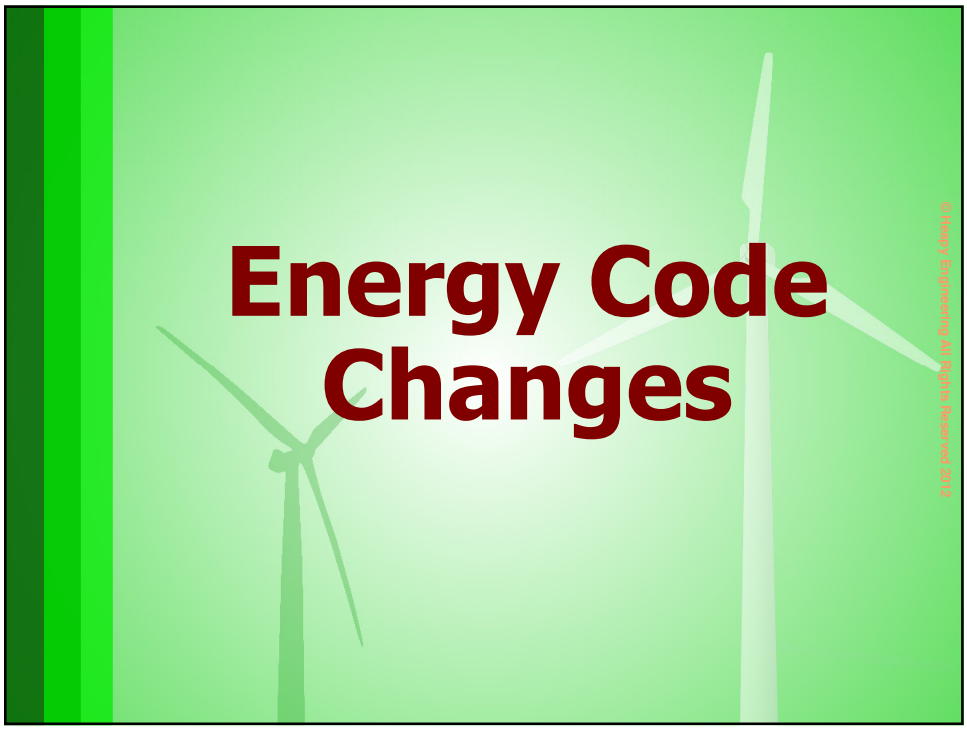


Setterlin HQ's (Columbus, OH) – LEED-NC GOLD

Key Project & Green Features:

- 13,000 SF, $1.2 Million
- Open Loop Groundwater-Based Heat Pump System
- Over 32% Annual Energy Cost Reduction
- Reused Over 90% of Existing Abandoned Structure
- Diverted over 80% of Construction Waste from Landfill





Impact of Energy Code Change

Case Study – Higher Education:

43,000 SF Laboratory Facility

	90.1-2004 Baseline	90.1-2007 Baseline	Design Case
Wall R-value	R-11.9	R-15.6	R-3.173
Roof R-value	R-15	R-20	R-18
Window U-factor	U-0.46	U-0.55	U-0.31
Window SGHC	SHGC-0.26	SHGC-0.40	SHGC-0.34
Lighting (W/sq ft)	1.2	1.2	1.5
System Type	Constant Volume Rooftop Air Conditioner (System 3)	Variable Volume with Reheat (System 5)	Variable Volume with Reheat
% Energy Savings	**41%**	**10%**	
EAc1 (v2.2, v3)	**9 points**	**0 points**	

Impact of Energy Code Change

Key Changes:

90.1–2007 Energy Code Updates from 90.1–2004:

- Any project between 25,000 ft² and 75,000 ft² will now be System 5 (VAV w/ Reheat) instead of System 3 (CV Rooftop Unit)
- Envelope - 20 to 25% increase in U-Factors
- Glass - 20% Reduction in maximum glass allowance

ASHRAE 2010:

- Standard to be nearly 30% more stringent than 90.1-2004
- Lighting Controls will be significant factor
- Extensive Building Envelope and Glass Orientation Revisions
- Sub-Metering to be Required – Lighting, Plug Loads, HVAC Systems
- Computer Rooms now Covered by Standard

Energy Issues – Cap & Trade

(Potential) Impact / Effect of Cap & Trade

Title II: Global Warming Pollution Reduction Modifies the Clean Air Act to incorporate:

- cap-and-trade mechanism
- two-thirds of the revenues raised from auctions are paid back to electricity ratepayers in the form of refunds.
- Similar to the House's American Clean Energy and Security Act (ACES) counterpart, APA sets goals of reducing domestic greenhouse gas emissions (GHGs):

17 percent in 2020 & 83 percent in 2050

Also, APA pre-empts specific portions of the Clean Air Act, removing EPA's authority to regulate GHGs from sources covered under the legislation.

It ensures GHGs are not considered criteria air pollutants or hazardous air pollutants under the Clean Air Act.

Energy Issues – Example: Cap & Trade

(Potential) Impact / Effect of Cap & Trade

Annual Campus Energy (Utility) Bill

Mid-Range Target Carbon Cost: $20 / MTCO2e

Metric Tonne CO2 equivalent (MTCO2e):

Natural Gas: 0.053 MTCO2e per 1 Million BTUs

Electricity (Coal Based): 0.21 MTCO2e per 1 Million BTUs

Example:

Mid-West University: $5.1 MILLION Annual Utility Bill

450,000 MMBTU Annual Energy Consumption

Carbon Tax impact could be: +$1.0 MILLION annually!

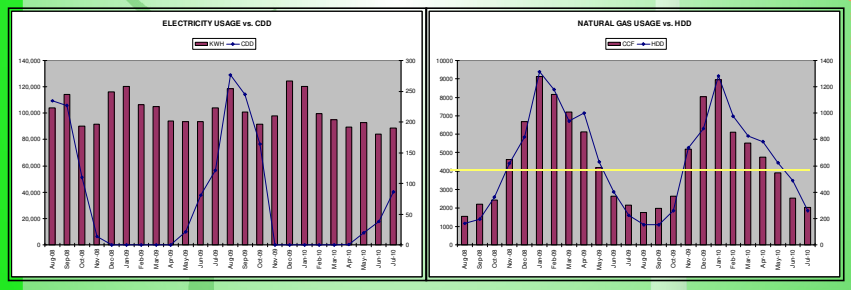
Energy Audits

ASHRAE Audits – Level I – Energy Audit:

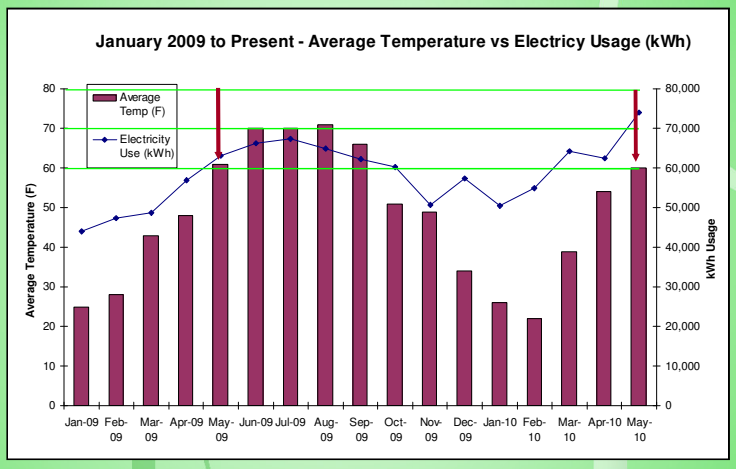
- Perform Walk-thru Survey of Building
- Meet with Owner & Operators
- Perform a space function analysis – determine whether building use has changed systems effectiveness
- Perform a rough estimate to determine approximate breakdown of energy use by major categories
- Identify potential low-cost or no-cost changes to the facility or to O&M procedures (estimate savings)
- Identify potential capital improvements for further study

Utility Bill Assessment

- Track / compare utility consumption based on patient count
- Track / compare utility consumption based on SF & EUI
- Normalize for Weather / Location / etc.
- *What can quickly be derived from the bills…..?*



Utility Bill Assessment



Energy Audits

ASHRAE Audits – Level II – Energy Audit:

- Review Mech-Elec system design, installed condition maintenance and operations practices
- Review existing O&M problems
- Measure actual operating parameters, as compared to design levels (ie: schedules, temperature, humidity, light levels, etc.)
- Breakdown annual energy use into end-use components (manually or via computer modeling)
- List all possible modifications to equipment and operations that would save energy, then estimate costs and savings and review with Owner/Operator
- Include interaction between energy conservation measures

Energy Audits

ASHRAE Audits – Level III – Energy Audit:

- Expands on Level II analysis
- Provides rigorous engineering analysis with detailed cost and payback
- Capital intensive projects

Energy Conservation Measures

Partial List of Typical Low Cost / High Value Projects

- *Retro-Commissioning*
- Lighting Retrofits
  - Utility Rebate Programs
- Load Shedding
- Occupancy Sensors
- Temperature Settings
- EPACT
- Low Flow Plumbing Fixtures
- Utility Rate Structure Review
- Utility Source Review (Deregulation)
- Scheduling
- Vending Machine Control
- Etc.

Energy Audit Case Study

Energy Audit – Case Study

Northwest Ohio Hospice – Project Statistics

- 2 locations NW Ohio – (Perrysburg and Toledo), nearly identical in size
- Heapy designed Mechanical-Electrical systems for the Perrysburg location
- *Toledo facility used 40% more energy than Perrysburg*
- Heapy performed Retro-Commx and Energy study for the Toledo facility

Perrysburg, OH

Toledo, OH

Energy Audit – Case Study

Northwest Ohio Hospice – Project Statistics

Retro Commissioning Effort Identified:

- Controls (Simultaneous Economizer and Chiller operation)
- Improper Functioning Controls (Fan inlet Vanes, Coil Valves, Freeze Protection Sequence, Boiler controls, etc.)
- Install HW Coil Pump (Freeze Protection)

Energy Study Identified:

- Heat Recovery
- Constant Volume to Variable Volume Supply
- Reduction of Supplied Outside Air (per Code)

Perrysburg, OH

Toledo, OH

Energy Audit – Case Study

Northwest Ohio Hospice – Project Statistics

Led to Energy Systems Retro-fit Project

Energy Study Estimated Savings	$30,500
Actual Cost *Differential* ('08 vs '09):	$50,000
Actual Cost *Savings***:	$28,600

*** Weather adjusted ('09 was 30% milder than '08) and Natural Gas Utility Rates fell ~20%*

Perrysburg, OH

Toledo, OH

Energy Conservation Measure #1:

(Retro)Commissioning

Building Commissioning

Commissioning:

"…a quality–oriented process for achieving, verifying and documenting that the performance of the facilities, systems, and assemblies meets the defined objectives and criteria."

- ASHRAE, *The Commissioning Process*
(American Society of Heating, Refrigerating and Air-Conditioning Engineers)

Building Commissioning

	All		Existing buildings			New construction		
	Total	Sample size	Total	Median per project	Sample size	Total	Median per project	Sample size
Number of projects	175	175	106		106	69		69
Number of buildings[1]	224	175	150	**1.4**	106	74	**1.1**	69
Number of states	21	175	15		106	15		69
Total project floor area, million square feet	30.4	175	22.2	**0.151**	106	8.2	**0.07**	69
Year built				**1978**	78		**1996**	59
Total new-building construction costs, millions of dollars[2]						1,514	**10.2**	58
Number of deficiencies identified	6,805	120	3,500	**11**	85	3,305	**26**	35
Commissioning cost as a fraction of total building-construction cost (excluding non-energy benefits), percent							**0.6**	65
Total commissioning costs (excluding non-energy impacts[3])								
Thousands of dollars	16,984	171	5,223	**34**	102	11,760	**74**	69
Dollars per square foot				**0.27**	102		**1.00**	69
Total savings[3]								
Thousands of dollars per year[4]	8,840	133	8,022	**45**	100	818	**3**	33
Dollars per square foot per year[4]				**0.27**	100		**0.05**	33
Whole-building energy-cost savings, percent[5]				**15**	74			
Simple payback time, local energy prices, years				**1.0**	99		**5.6**	38
Simple payback time, standardized U.S. energy prices, including some cases with non-energy impacts, years[6]				**0.7**	59		**4.8**	35

"...energy savings tended to rise with the comprehensiveness of commissioning."

Source: HPAC Magazine

The Cost-Effectiveness of Commissioning

http://eetd.lbl.gov/emills/PUBS/PDF/Cx/Cx_HPAC.pdf

Energy Efficiency & Sustainability

Marshall University Sustainability Luncheon
HVAC Systems and Energy Auditing

Sustainability

Steps to Improve Sustainability:

- Energy Efficiency Improvements (ECM's)
  - Commissioning, Re-Commissioning & Continuous Commissioning
- Water Conservation Strategies
- Alternative Energy Systems
  - Combined Heat and Power / Solar Thermal & PV / etc.
- Implement Ongoing Sustainability Education Program
- Phase Out of Older Type Refrigerants
- Building Envelope Assessment (Water and Air leaks)
- Chemical Usage
  - Pest Control & Green Cleaning

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Thank You !

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