Newman Consulting Group, LLC

Consultants for Energy-Efficient and Sustainable Buildings

How To Achieve a Greener, Healthier, Less Costly Building – Without Breaking the Bank

PEDCO High Performance Buildings Seminar, Cincinnati – 10/01/15

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ASHRAE

- Trainer, ANSI/ASHRAE/IESNA Energy Standard 90.1
- Corresponding Member, Air-to-Air Energy Recovery Technical Committee and Operations and Maintenance Technical Committee
- Past Vice-Chair, Industrial Air Conditioning Technical Committee
- Past Board Member; Distinguished Service Award (Local), 2005
- Member, 2008 Energy Position Committee
- Distinguished Service Award, 2012, 2013

BUILDING OWNERS & MANAGERS ASSOCIATION (BOMA)

- Member, Energy & Environment Committee (National)
- Past Judge, TOBY Awards (The Office Building of the Year)
- Chair, Sustainability for $avings Committee (Local)

ENGINEERING SOCIETY OF DETROIT (ESD)

- Member, Construction & Design Committee
- Member, DTE/ESD Energy Conference Committee
- Distinguished Service Award, 2007; Fellow, 2010

U.S. GREEN BUILDING COUNCIL (USGBC)

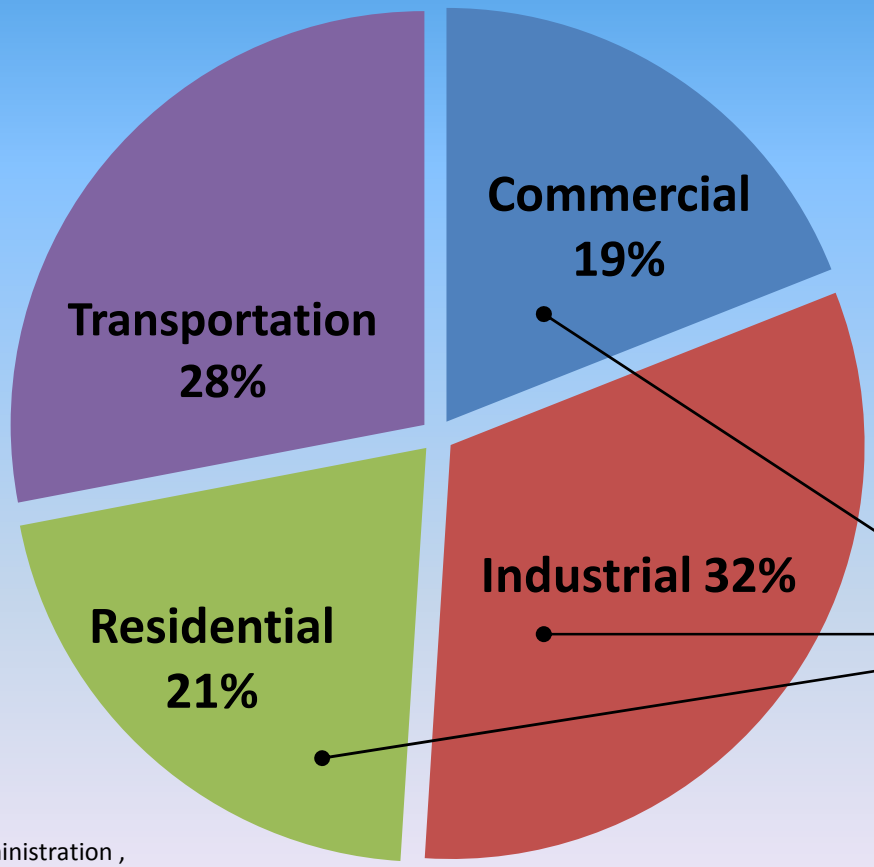
Founding Member, Detroit Regional Chapter

- Past Board Member; Distinguished Service Award (Local), 2008
- Past Chair, Public Policy/Advocacy Committee (Local)
- Member, Green Schools Advisory Committee (Local)

Learning Objectives

- Operate to reduce costs
- No-cost and low-to-medium cost measures
- Measures often not considered
- Why to re- or retro-commission your building
- How “On-going Commissioning” saves the most money
- Develop a best practice plan
- Secure support from stakeholders
- Manage the capital asset lifecycle
- Analyze funding

Percentage of Energy Consumed by Each Economic Sector in the U.S. in 2012



72% is used in buildings!

Source: U.S. Energy Information Administration , Annual Energy Outlook 2014 Early Release

Why Do People Change?

Only Three Reasons:

1. They *realize* it's in their best interests
2. They're forced to
3. It costs more not to change

All of these are happening today

Two Driving Forces

1. Regulatory
   - Building energy use disclosure
   - Benchmarking against peers
2. Business Owners
   - Energy efficient buildings
     - Lower operating costs
     - Higher net operating income
     - More valuable
     - More attractive to tenants
   - Energy inefficient buildings
     - Less competitive in the marketplace
     - In danger of obsolescence

Owner Asks: What's in It for Me and My Building(s)?

It's All about Market Forces:

- Can't manage what you don't measure
- Understand your portfolio
- Transparency: good for energy-efficient buildings; bad for poor performing buildings
- Energy usage data available for:
  - Consumers
  - Tenants
  - Prospective purchasers
  - Investors

What Happens to HVAC Systems as Time Passes?

Green  **Grey**

"Most buildings will lose up to 30% of their efficiency in the first three years of operation."

Bill Harrison, ASHRAE Presidential Member

(Data based on Texas A&M Study)

How Well is Your Building Using Energy?

EPA Energy Star Portfolio Manager Analysis

OR

ASHRAE bEQ “In Operation” Analysis

- Followed by an Energy Audit

Methods of Reducing Energy - HVAC (No Cost/Low Cost)

- Calibrate sensors and ’stats
- Adjust economizer dampers (properly)
- Optimize volume of outside air
- Optimize discharge temperature (and pressure in VAV systems)
- Install programmable thermostats
- Use occupancy-based control w/CO_2 sensors
- Optimize start-stop of equipment
- Turn systems off when not needed (Note: saves the most)
- Repair or replace faulty steam valves and traps

It’s all about *good - and proper* - O & M practices

Methods of Reducing Energy - HVAC (Moderate Cost)

- Sealing ductwork
- ***Properly*** cleaning cooling and heating coils
- Repairing AHUs rather than replacing
- Optimized VAV systems with thermally-powered diffusers
- VFDs on fans, chillers, pumps

Duct Sealing – From the Inside

Why Seal Ducts?

- Energy Conservation
- Indoor Air Quality
- Comfort
- Avoid cost and turmoil of replacing ductwork
- Eliminate unsightly mastic on architectural ductwork in occupied spaces

Air Ducts Leak

- 75% of ducts leak 10-25%
  - ASHRAE
- Light commercial duct leakage is typically 30% or more
  - Florida Solar Energy Center, California Energy Commission
- Typical ductwork loses 25-40% of heating & a/c energy. Newly installed systems experience 10-30% leakage
  - Berkeley Lab (LBNL)

Duct Sealing Payback

- Exhaust Ducts: 2-3 years
- Supply/ Return Ducts: 3-7 years

- Who cares?
  - Building owners (cost)
  - Facility managers (cost)
  - Tenants and employees (comfort)

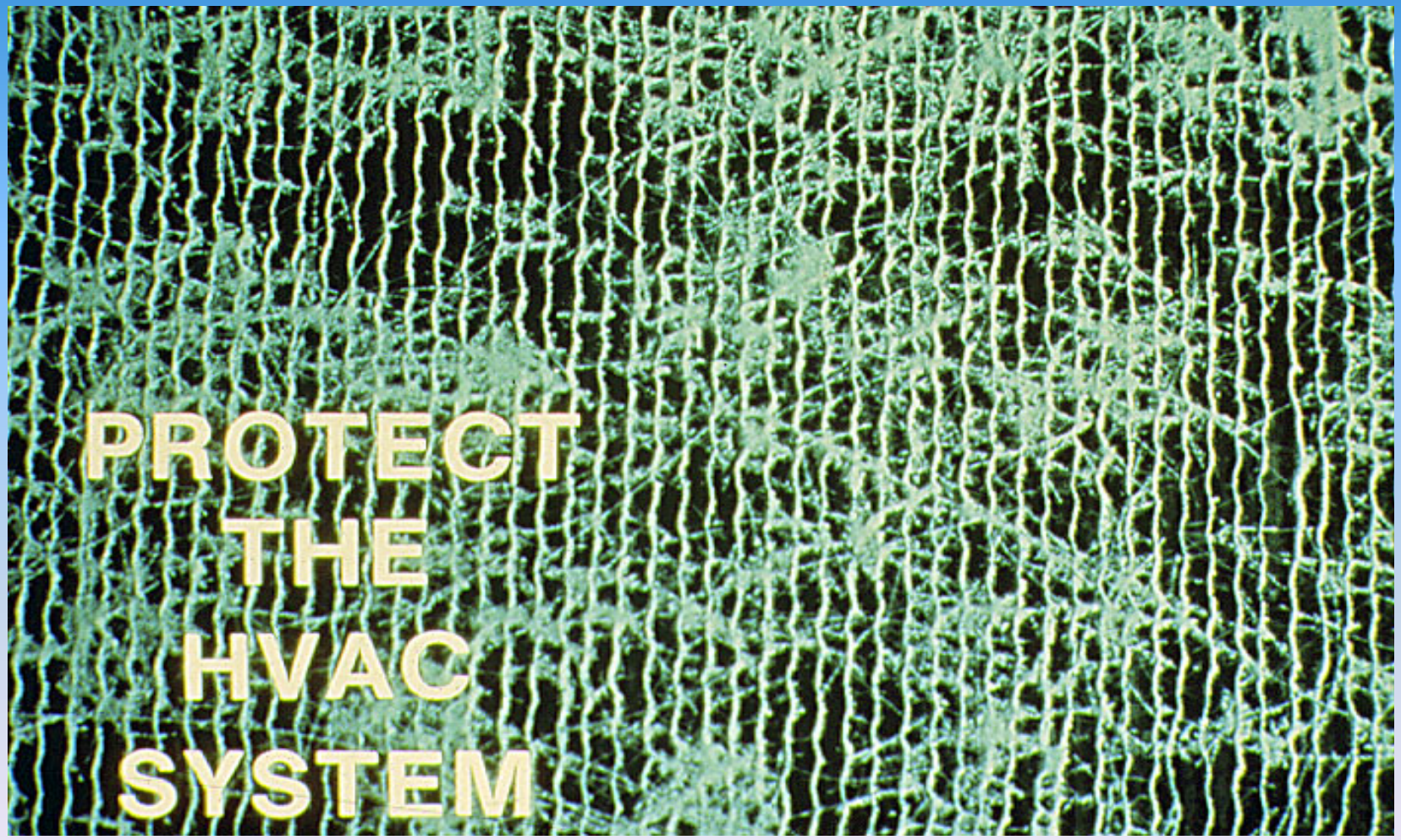
What is the cost of an uncomfortable employee?

Coil Cleaning

Clogged Filters

Clogged Filters That Didn’t Make It

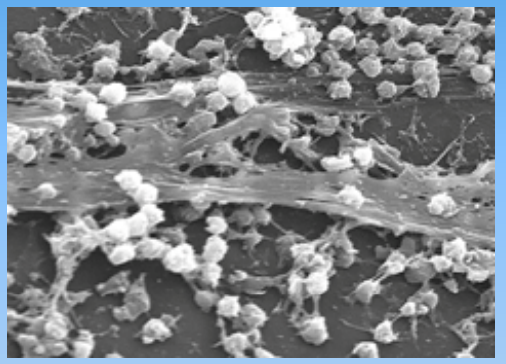
Potential IAQ Problems: HVAC

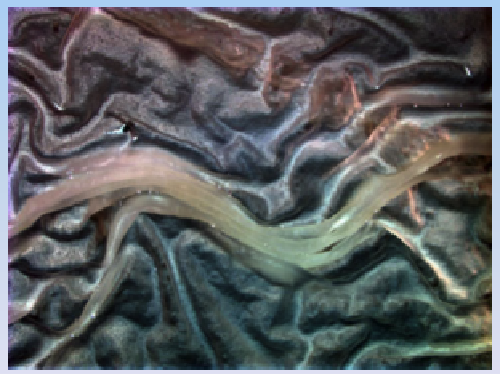


Poor IAQ – Supply Air

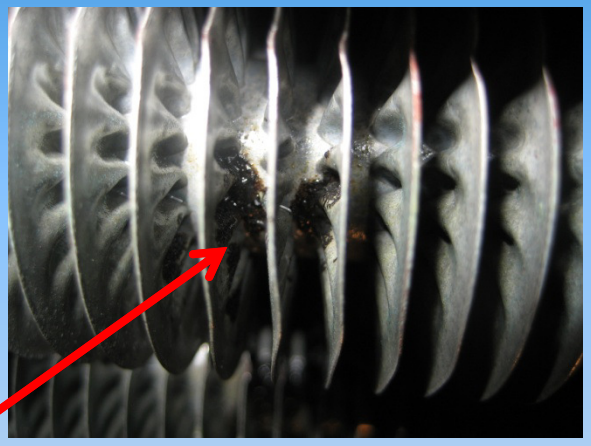
Biofilm Challenge

- Bacteria grow in/on coils and fins.
- This clogs them and reduces the efficiency of the system.
- Bacteria on coils and fins can generate odors that become a severe irritant - may lead to health issues.

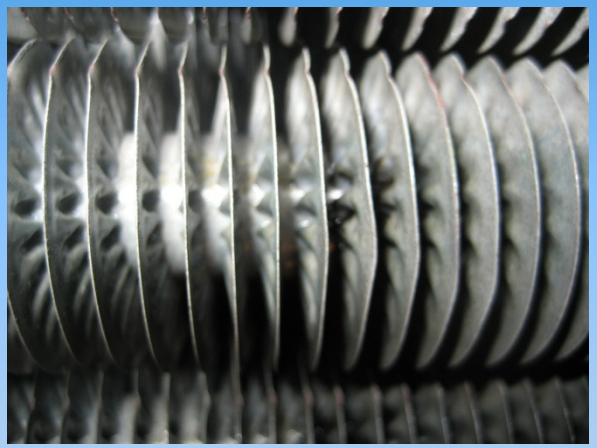




Biofilm Challenge



Close-up of coil after conventional cleaning (note: black tar like substance is biofilm)



Close-up of coil after cleaning using engineered EFM after conventional cleaning

Repairing

or

Replacing Equipment

Example: Air Handling Units

Repair or Replace?

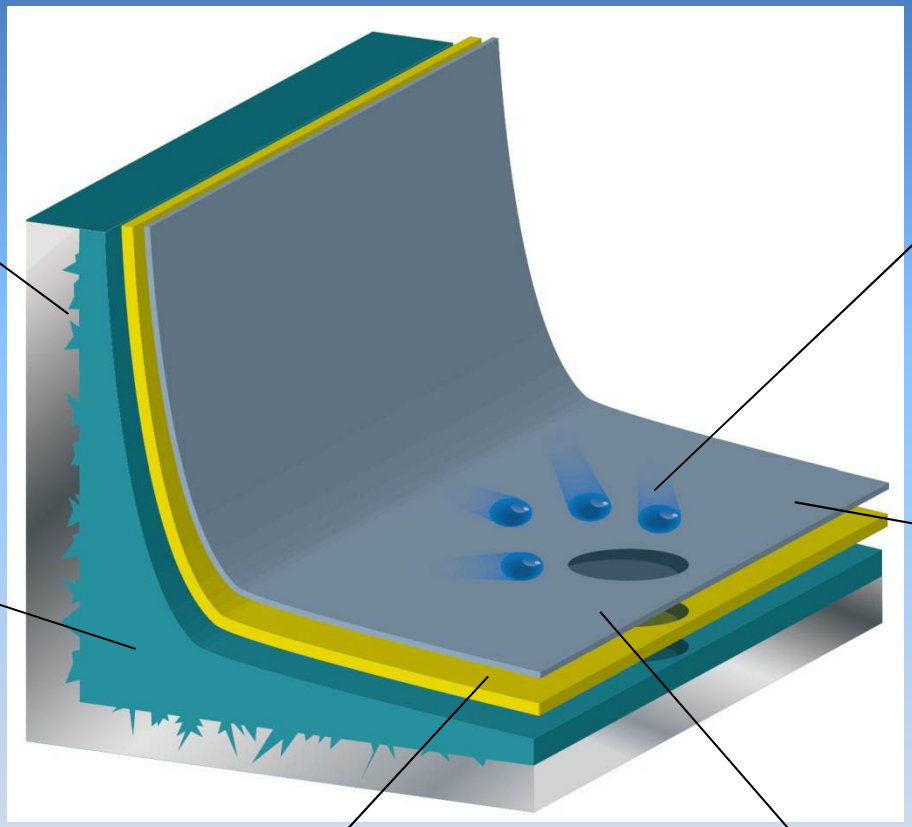
Many things to think about:

- Age
- Available space
- Efficiency of new equipment
- Cost of removal and installation
- Time involved/disruption of operation
- Etc.

Technology

Epoxy with nanotechnology provides superior bond strength

Epoxy halts corrosion & restores structure to surfaces



Sloped application improves drainage & eliminates standing water (ASHRAE 62.1)

Smooth hygienic surface with active antimicrobial abates biological growth

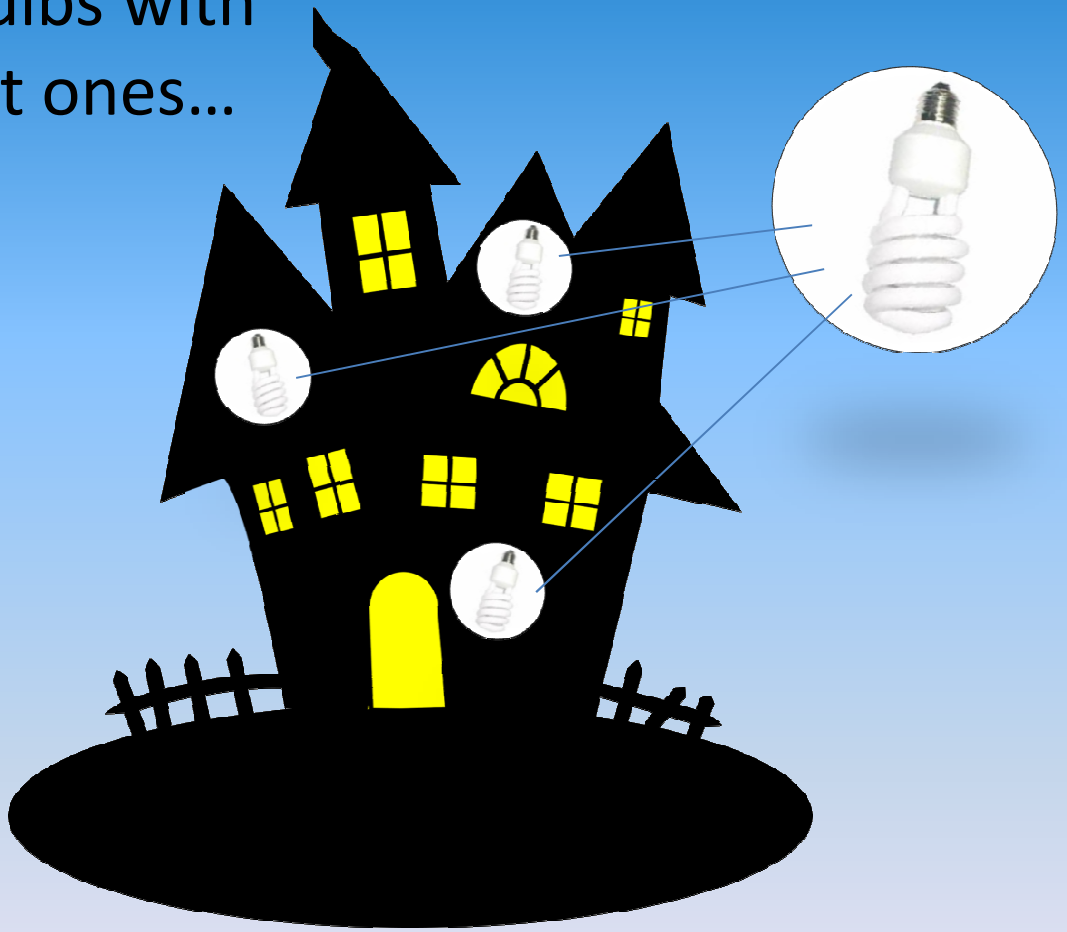
Advanced fire barrier provides fire code compliance (NFPA 90A)

Durable water-proof polymeric topcoat provides extended-life

What To Think About

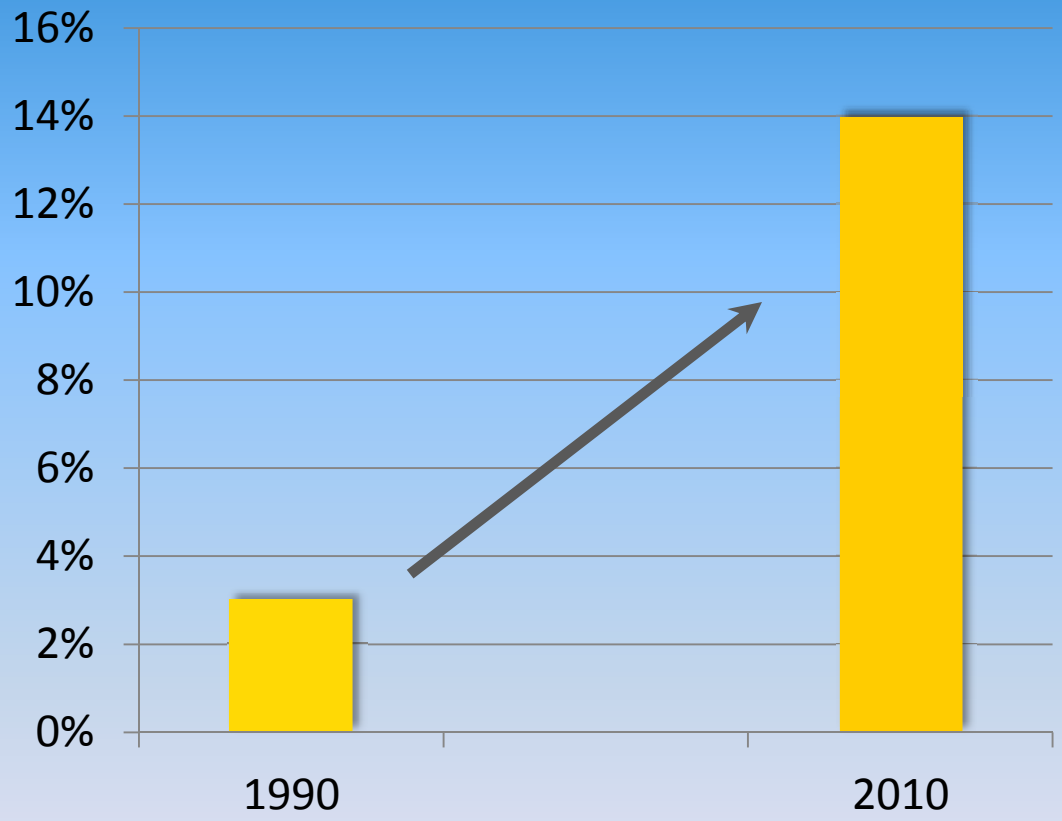
- Turn things off!
- Repair or replace equipment/upgrade
- Energy analyses (audits)
- Retro-commissioning or Re-commissioning
- On-going commissioning
- A sustainability or energy champion – with “clout”
- Education of tenants and employees
- Utility rebates/government programs/PACE/other public or private partnerships

Just because you replace your bulbs with energy-efficient ones…



…doesn't mean you can leave them on all night and still claim to be conserving energy!

The Rise of Plug Loads



Plug loads increased from 3% to 14% between 1990 and 2010.

Reasons for O & M Management

- Thermal Comfort
- Indoor Air Quality (IAQ)
- Energy Efficiency
- Equipment Life
- Safety/Liability (Lawsuits)
- Profitability
- Sustainability

Operation & Maintenance

- Best Designs and Construction
  - Doomed to failure without proper and ongoing maintenance
- Retro-Commissioning
  - Return to original design concepts and operation
  - Be aware of changes in space and operation

An Effective Maintenance Strategy Improves Performance
(and Increases Profitability)

- Reduce unscheduled downtime
- Reduce maintenance costs - including emergencies, scheduled teardowns and secondary damage
- Reduce energy and operating costs
- Quality assurance for warranty and recurring problems

An Effective Maintenance Strategy Improves Performance (cont.)

- Constantly analyze facility data
- Keep facility information properly updated
- Extend equipment life and operating efficiency
- Allows for proactive and predictive analysis of problems rather than reactive, which is crisis management (expensive!)

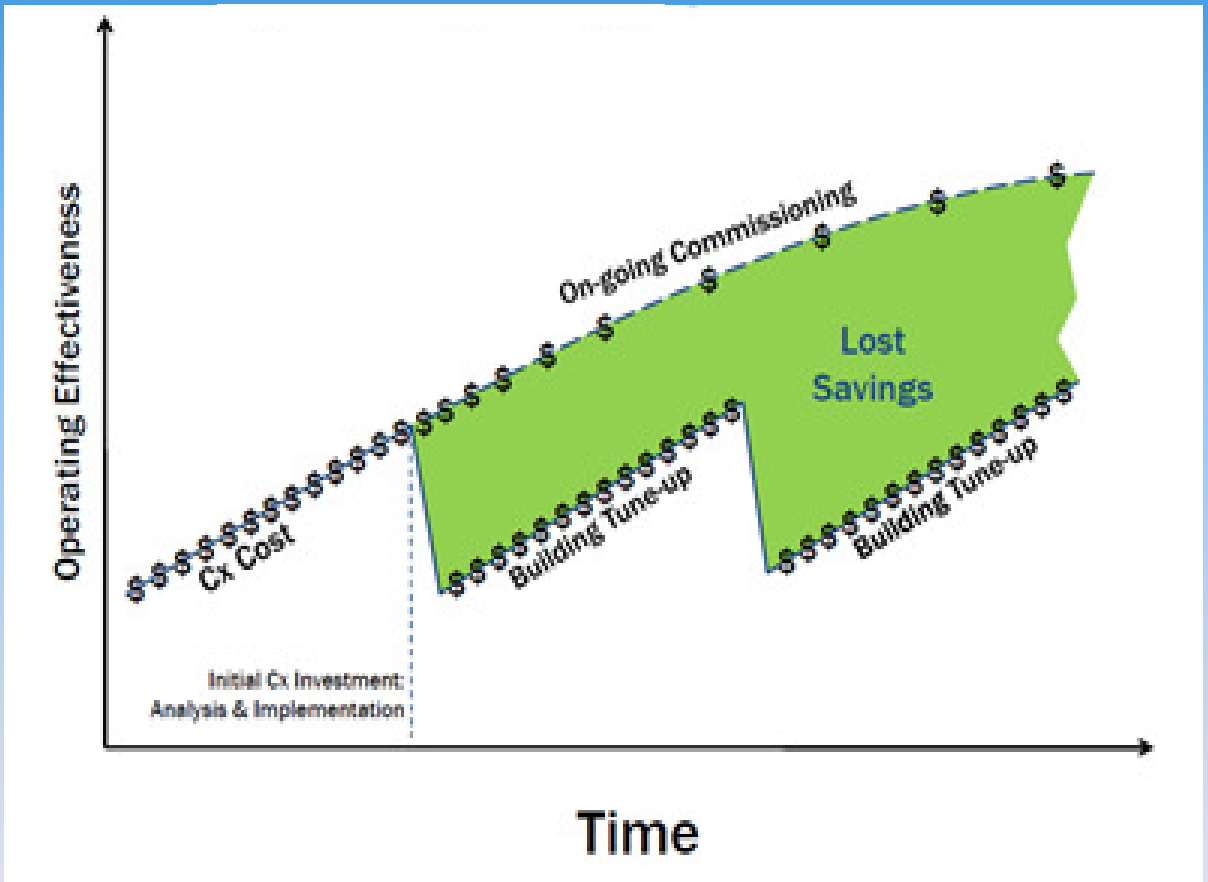
Benefits of Retro-Commissioning (1)

- Gain full understanding of energy usage, requirements, and savings
- Reduce energy consumption, operating costs
- Return equipment to its proper operational state and prolong life of equipment
- Reduce operational and maintenance expense
- Reduce consumption of natural resources
- Improve air quality and indoor environment

Benefits of Retro-Commissioning (2)

- Increase productivity
- Reduce staff time spent on emergency calls
- Increase tenant satisfaction, reduce complaints, and improve occupant comfort
- Update building information
- Improve facility equipment operation and energy efficiency
- Reduce impact on the planet

Why On-going Commissioning?



Costs: O & M vs. People

- O & M = $4-6.00/SF/yr in standard C.O.B.
- People
  - Say $40,000/person/yr with fringes (average)
  - 200 SF/person

  = $200/person/SF/yr

3% increase in productivity = $6.00/SF/yr !

What Else is There?

Smarter Water for a Smarter Planet

Q: How many gallons of potable water do Americans use every day – *just to flush toilets*?

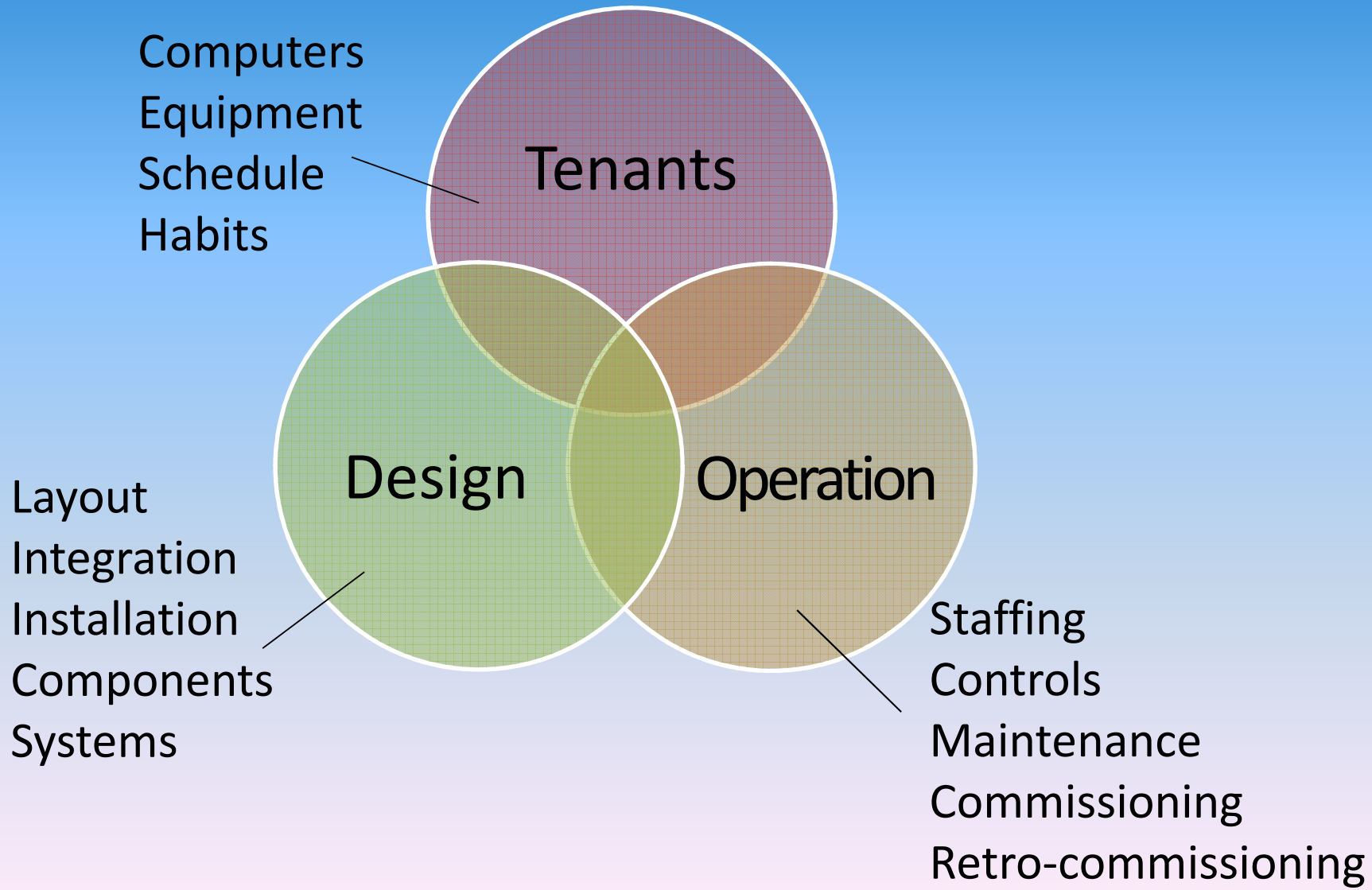
A: Almost 8 billion!!

That's close to 10,000 gallons per person/year!!!

And it takes a lot of energy, too…

Putting it All Together

What Drives Building Performance?



Awareness is Not Enough - Economic Self-interest is Not Enough

- Providing information about sustainability behavior leads to an understanding of what sustainable behavior is, not changed behavior.*
- Financial Benefits ≠ Behavior Change
- Utility programs that advertise to customers how to save energy and money are largely ineffective.

Must involve stakeholders to gain buy-in.

*Source: R.S. Brewer, G.E. Lee, and P.M. Johnson, "The Kukui Cup: A Dorm Energy Competition Focused on Sustainable Behavior Change and Energy Literacy"

Methods of Reducing Energy – HVAC *Often Not Considered*

- Ensure useful feedback in building management systems (BMS)
- Conduct fault detection and diagnostics (FDD)
- Automatically repair faults (when possible)
- Have actionable analytics for energy use

It's all about proper, effective O & M practices

Use Effective Tools

- Real-time Feedback
- Commitments
- Social Norms
- Competition
- Communication / Messaging
- Incentives
- Convenience
- Maybe even a little fun

Enabling Feedback

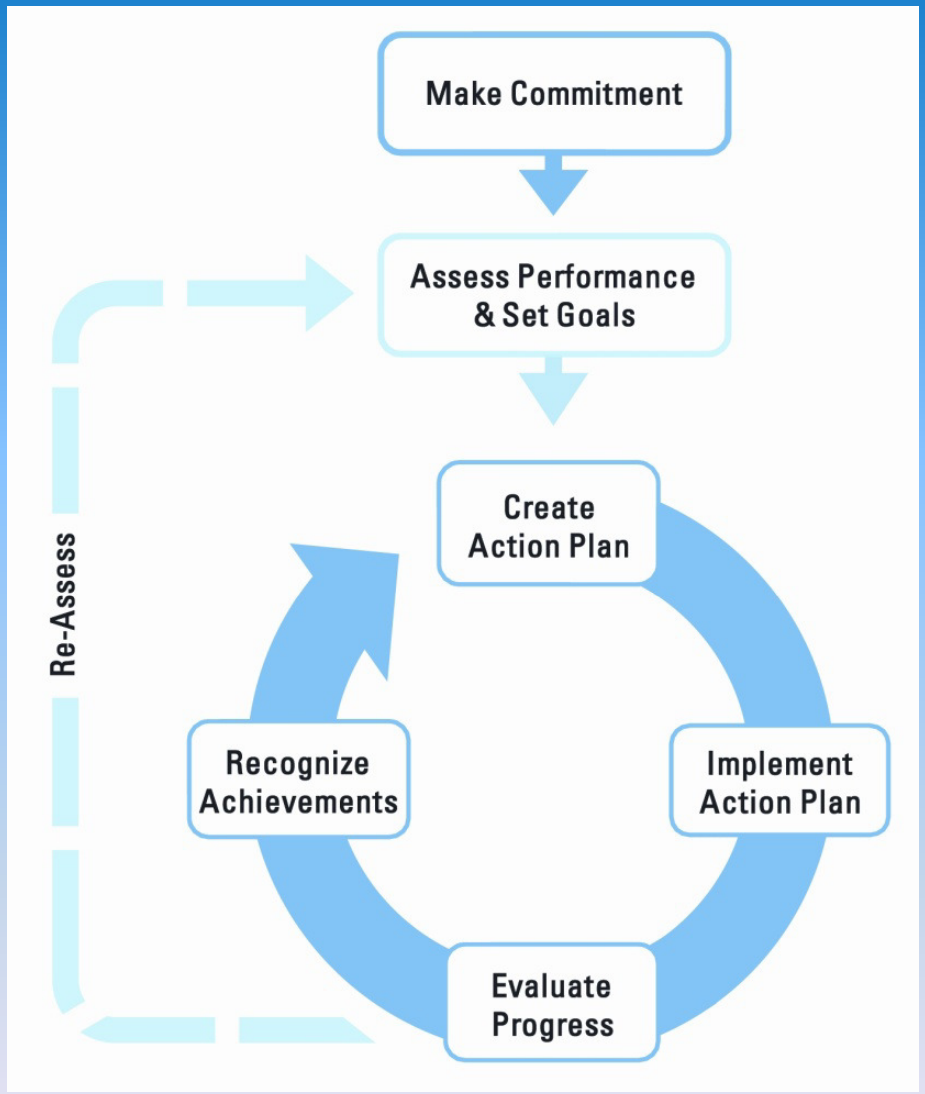
- On average, the introduction of real-time consumption feedback systems ("dashboards") leads to energy use reductions between 5-15%.

- Feedback alone is good, but maybe not enough.

Source: S. Darby, "The effectiveness of feedback on energy consumption."

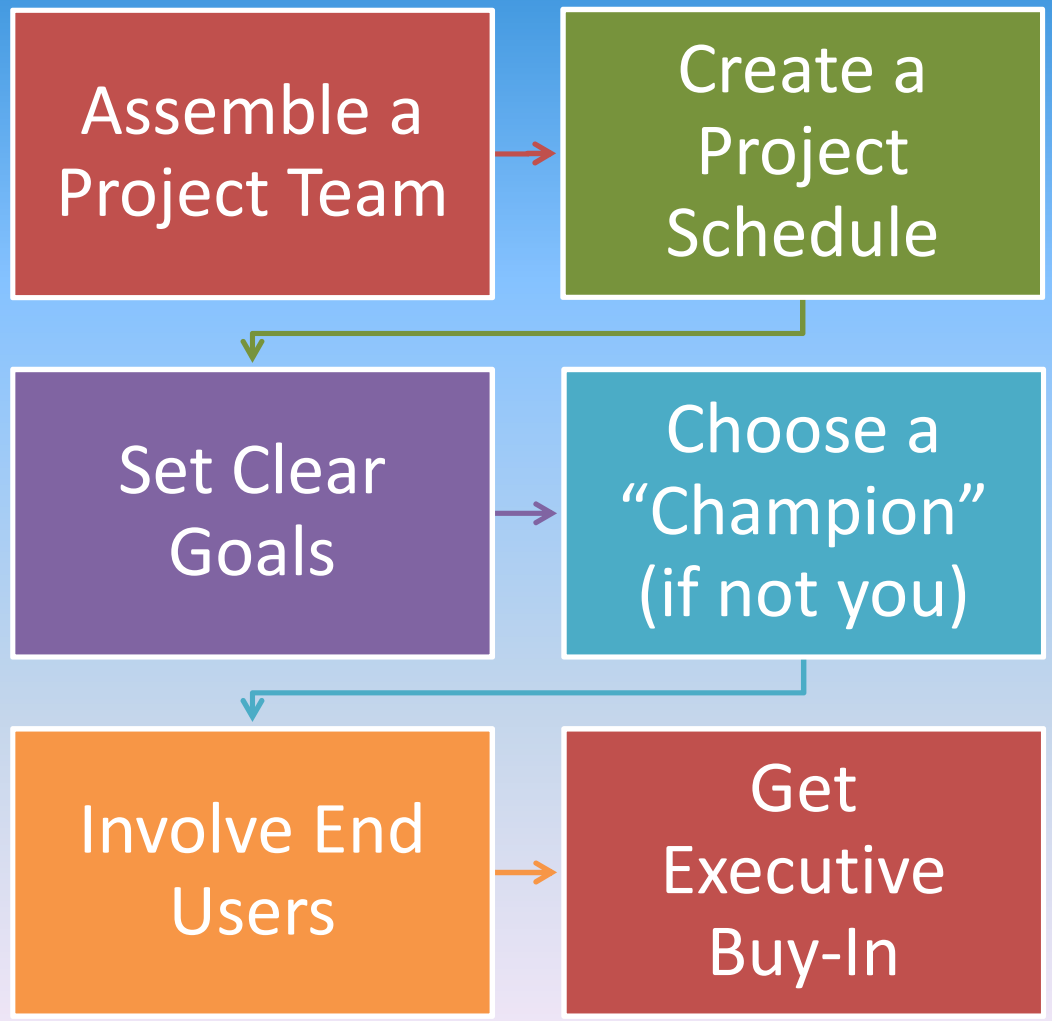
What You Get from *Total* "Real-Time" Feedback

- Energy Management in real time – not 60 days later from utility bills
- Fault detection diagnostics and notification
  - Provides maintenance staff with real-time analytics
  - Operate the facilities more efficiently, identify HVAC problems faster, and better prioritize maintenance work
- Trending data help pinpoint abnormalities in system operations
- Maintenance staff spend less time identifying the cause of a heating or cooling problem and more time fixing it – and preventing future issues



http://www.energystar.gov/buildings/about-us/how-can-we-help-you/build-energy-program/guidelines

Getting Started




SMART Goals
S = Specific
M = Measurable
A = Achievable
R = Relevant
T = Time-Bound

How to Sell a Project to Management

- Owners will want to see a clear financial result
- Simple Payback??
  Not a good way to analyze energy conservation opportunities, or many other opportunities!

Better:

- Return on Investment (ROI)
- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Minimum Acceptable Rate of Return (MARR)
- Life Cycle Cost Analysis (LCCA)

Definitions

- Simple Payback, years = Cost/Savings per year
- ROI = reciprocal of Simple Payback (in percent)
  - 2 year payback = 1/2 =50% ROI!

Drawbacks to both:

- A risk metric rather than a financial metric
- Uses today's costs against todays savings – future benefits not taken into account – especially poor for energy savings

Definitions (cont.)

True Financial Measures – use an interest rate

- NPV: value in today's dollars
  - Discounts future savings
  - Long term value of a project
- IRR and MARR: similar to the interest rate from a bank
  - Minimum rate that a company needs to meet
- LCCA = initial cost, O & M costs, salvage value
  - Some companies also include recycling costs

Where's the Money?

- Government (Federal, State, County, Municipality)
  - Database of State Incentives for Renewable Energy (www.dsire.org)
- Utility rebate programs
- Grants
- Commercial loans: banks, credit unions, investors
- PACE (Property Assessed Clean Energy) – special assessment on property, specifically to fund deep energy retrofits or new energy-efficient construction: see www.pacenow.org or www.ncgconsulting.us.com

Where's More Money?

- Operating Lease
- Energy Service Agreement (ESA): Energy efficiency outsourced to 3rd party. 3rd party owns and maintains the equipment.
- Power Purchase Agreement (PPA): PPA provider owns and maintains generation equipment. Building owner purchases energy from provider at agreed rate.

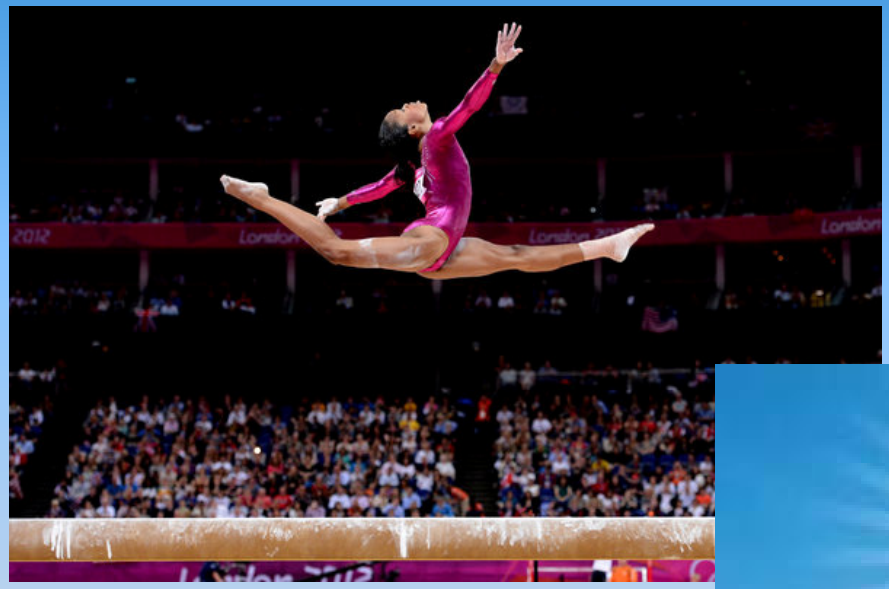
Summary

1. Know your costs
   - Gather data from all properties
   - Have an audit or use EPA Portfolio Manager/calculator
   - Data, Data, Data
2. Save where you can today
   - Optimize investments while minimizing expenses
   - Start with “no-cost” fixes, establish track record
   - Roll low-cost fixes into higher cost projects to improve ROI.

Summary (cont.)

3. Develop your plan for the future
   - Find team
   - Create schedule/wish list of capital improvements
   - Incorporate predictive maintenance
4. Find funding
   - Need data and a plan before you ask
5. Keep sustainability in mind
   - Improve the bottom line
   - Improve the triple bottom line

You Have To Be Flexible



The Best Solution

The one that solves your problem with the lowest cost and/or risk.

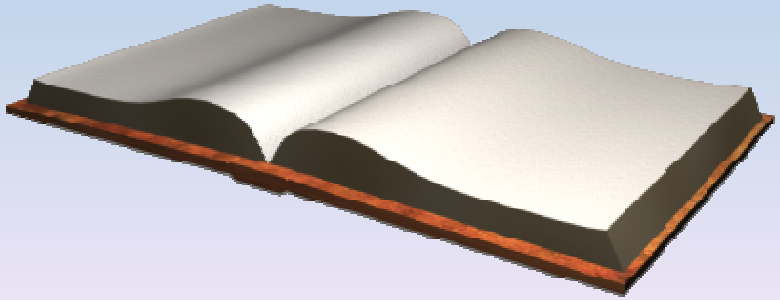
It’s Your Choice

Where To Get Information - ASHRAE

- Procedures for Commercial Building Energy Audits
- Energy Conservation in Existing Buildings
- Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
- Standard Measures of Measuring, Expressing and Comparing Building Energy Performance
- Preparation of O & M Documentation for Building Systems
- Sustainable, High-Performance O & M (2012)
- Advanced Energy Design Guides (AEDG) – 30% / 50% – free!

Where To Get Information - Other

- USGBC: LEED-EB: O & M Guidelines
  - Based on EPA Energy Star® Portfolio Manager, ASHRAE Energy Standard 90.1. Green Operations Guide (2010)
- BOMA: Preventive Maintenance & Building Operation Efficiency (2003 – written by ASHRAE member)
- IFMA Foundation: Sustainability “How-To” Guides
- EPA Energy Star
- Rocky Mountain Institute
- PECI



References & Resources (1)

- ashrae.org (American Society of Heating, Refrigerating and Air-Conditioning Engineers)
- buildingenergyquotient.org - (ASHRAE Bldg. Energy Quotient label information)
- ashrae.org/aedg — Advanced Energy Design Guides, available for free download
- usgbc.org (U.S. Green Building Council)
- usgbc.org/leed/eb — LEED for Existing Buildings: O&M Guidelines
- gbci.org (Green Building Certification Institute)
- aia.org/cote (AIA Committee on the Environment)
- boma.org (Building Owners and Managers Association)
- boma.org/evergreen — Guide to Green and Sustainable Operations and Practices
- Ifma.org (International Facility Management Association)
- ifmafoundation.org — IFMA's guides on sustainability and commissioning

References & Resources (2)

- dsireusa.org (Info on federal, state, local, utility incentives and policies)
- epa.gov/air/caa/peg (Guide to the Clean Air Act)
- facilitiesnet.com (specialized site for facility professionals)
- myfacilitiesnet.com (social networking site for facility professionals)
- energystar.gov/benchmark (EPA Portfolio Manager)
- advancedbuildings.org (energy eff. technologies, strategies for commercial buildings, case studies)
- bcxa.org (building commissioning)
- newbuildings.org (promotes energy efficiency in bldgs. through technology research, guidelines and codes)
- buildingEQ.com (ASHRAE bEQ Program)
- Pacenow.org (PACE)

For Further Information:

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"We Do Not Inherit the Earth from Our Ancestors – We Borrow It from Our Children" *– Native American Proverb*

Build Green – Everyone Profits! *- USGBC*