

**NCG NEWMAN CONSULTING GROUP**  
Profitable Ideas for High Performance Buildings Since 2002



## Green & Sustainable Practices

### How to Design a Healthier, More Profitable Building with Better Coordination Among Architects, Engineers and Owners

ASHRAE – Toronto/Hamilton – 01 April, 2019

**NCG**

**James L. Newman**  
CEM, CSDP, LEED AP BD+C, ASHRAE OPMP & BEAP

**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
- Member, 2008 Energy Position Committee
- Distinguished Service Award, 2012, 2013
- Past Board Member; Distinguished Service Award (Local), 2005

**BUILDING OWNERS & MANAGERS ASSOCIATION (BOMA)**

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

**BUILDING OWNERS & MANAGERS INSTITUTE INTERNATIONAL (BOMI)**

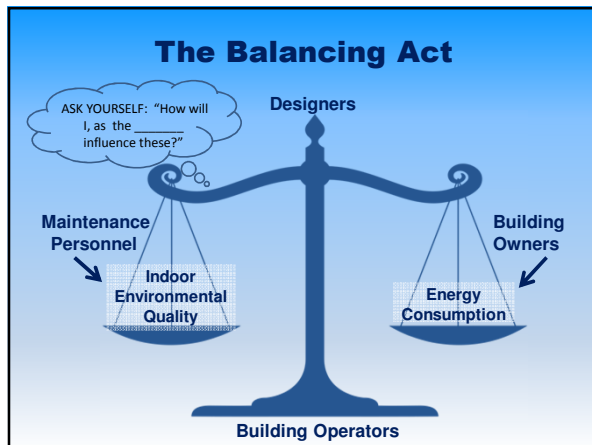
- Trainer, High Performing Buildings

**ENGINEERING SOCIETY OF DETROIT (ESD)**

- Distinguished Service Award, 2007; Fellow, 2010
- Member, Construction & Design Committee

**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)



### What We're Going To Talk About

- General Information – Energy and Buildings
- Architect – Engineer Interface
- Determining Energy Use in Buildings
- How to Decrease Energy Use
- Measuring Energy Use
- Operations & Maintenance
- Building Owners – the good, the bad and the ugly

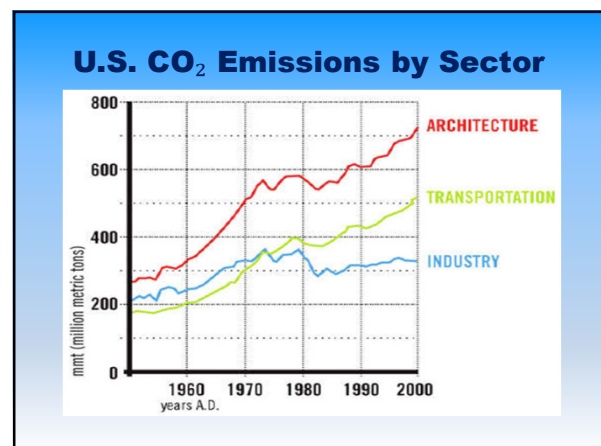
### Why Do People Change?

Only Three Reasons:

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

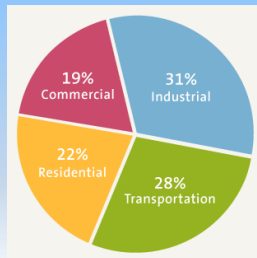


**All of these are happening today**



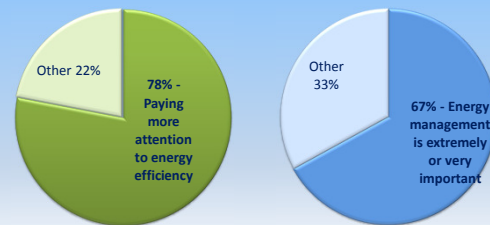
## U.S. Energy Consumed by Sector

Percentage of Energy Consumed by Each Economic Sector in the U.S. in 2008

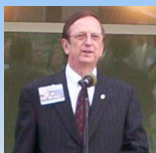


## Energy Efficiency - Never More Important

From >1400 respondents in major industries:

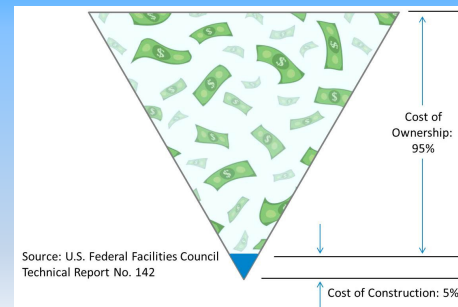


*"Most buildings will lose up to 30% of their efficiency in the first three years of operation."*

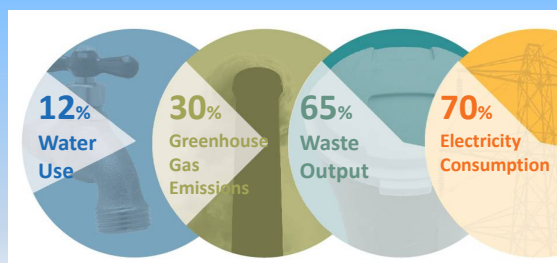


Bill Harrison,  
ASHRAE Presidential Member  
(Data based on Texas A&M Study)

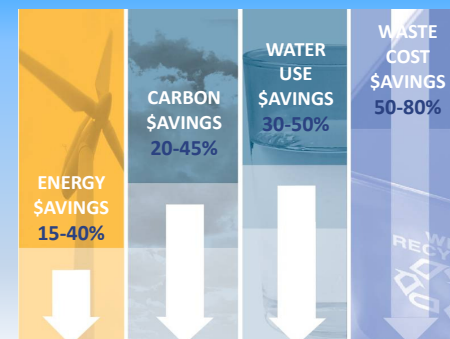
## Cost of Owning a Building



## Major Building Impacts on Energy, Natural Resources and the Environment



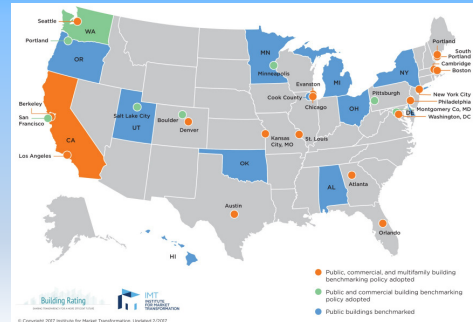
## \$avings of Green Buildings



## What Is EUI ??

Energy Utilization Index  
(or Energy Use Index)  
Measured as Btu/SF/year

## U.S. Building Benchmarking and Transparency Policies



## Architect – Engineer Tradeoffs in Integrated Design

### Building Envelope

- Insulation
  - Type
  - Thickness
- Roof
- Walls
- Windows
- Daylight
- Doors

### HVAC/Lighting/Plumbing

- HVAC System Type
- HVAC System Size
- No. & Type of Lights, Fixtures
- Plumbing Fixtures

## What Does “Green” Mean to HVAC?

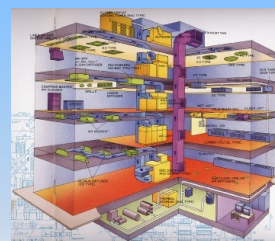
- Install a high-efficiency boiler / chiller / RTU
- Reduce the size of that boiler / chiller / RTU
- Avoid the need for that boiler / chiller / RTU
- Provide a high-performance, hybrid HVAC system
  - Energy efficient components
  - Design strategies to maximize capabilities of those components

## Electrical Loads

- Lower Electrical Loads = Smaller Starters, Wiring, Switchgear, etc. = Lower First Cost
- Important to remember when reducing size of mechanical equipment



## Why Be So Concerned about HVAC Systems?



HVAC  
is the  
“Heart and Lungs”  
of a  
Building

**Don't compromise!**

### High Performing HVAC Systems – a Major Component of High Performing Buildings.



### High Performance HVAC Benefits

#### Innovative Engineering and Design

- Increases Life of Building Equipment
- Improves
  - System Performance
  - Indoor Air Quality (IAQ)
  - Productivity



### High Performance HVAC Benefits

#### Innovative Engineering and Design

- Reduces (Or Maintains) First Costs
- Reduces
  - Energy Costs
  - Life Cycle Costs
  - Maintenance Costs



### Methods of Reducing Energy - Lighting

#### Lighting

- Linear Fluorescent Lamps: T-8/T-5 w/Electronic Ballast
- LED Lamps
- Sensors: Light, Motion
- Dimming
- Zoning



#### Natural Daylighting

- Light Shelves
- Skylights
- Light Tubes



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!

### Methods of Reducing Energy (Renewable and Other)

#### Renewable Energy: Passive and Active

- Solar
- Solar Photo-Voltaic
- Wind Energy
- Wave Energy
- True Geothermal

#### Additional Options

- Radiant Cooling
- Radiant Heating
- Reheat from Waste Energy
- Thermal Chimneys
- Fuel Cells



## 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!

### Water Savings

- Exterior
  - Water efficient landscaping
  - No potable water use or no irrigation
- Interior
  - Toilets & urinals (low-flow or waterless)
  - Sinks (low-flow, with or without sensors)
  - Showers (low-flow)
  - Shower with a friend



### Water Saving/Reuse

Gray Water ≡ Water that can be recycled and reused:

- Condensate from (clean) drain pans
- Water from sinks
- Water from washing machines, dishwashers
- Rainwater
  - Collection cisterns
  - “Green” Roofs



### Be Careful What You Ask For

Less potable water being used for flushing toilets

- Good
  - Conserve potable water
  - Lower power requirements for water distribution plants
  - Lower volume of leakage in infrastructure
- Not So Good
  - Drains and drain lines plug up

### These Buildings are “Green” But How Efficiently Do They Use Energy?



← This Building has a **Good** Energy Quotient

### Why Should Owners be Interested? (1)

#### Manage portfolios and identify investment opportunities

Existing Building Portfolios (*In Operation Rating*):



- What can the staff managing this building share with my other building managers?
- Am I getting a premium for this building?
- Is there a particular reason this building is performing better?
- This building could use improvement.
- What investments could improve energy use?
- Does the O&M team need additional training?
- Can re-commissioning or retro-commissioning address poor performance?

### Why Should Owners be Interested? (2)

#### Make educated decisions on new building design

Design Options for a New Building (*As Designed Rating*):

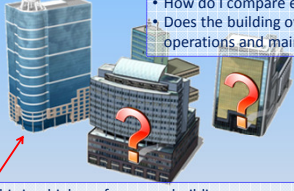


- Which design will be most marketable?
- What can I expect in future energy costs?
- Does the design meet my initial energy use expectations?
- What will I need to do to assure the building performs to its potential?

### Why Should Owners be Interested? (3)

#### Tenants are looking to understand energy use and cost


Potential Lessees:




- Is this a bad building or just not measured?
- What will my energy bills be?
- How do I compare energy use for different buildings?
- Does the building owner invest in necessary operations and maintenance?
- This is a high-performance building.
- My energy costs will be manageable.
- The building owner pays attention to operations and maintenance.
- I can afford to put more money towards rent.

### Educating Consumers is Not New

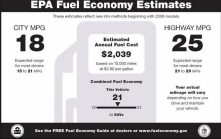
#### Restaurant Sanitation Ratings



#### Nutrition Fact Label



#### Car Fuel Economy Estimates



### Building Rating Systems – Energy


#### Energy Only

- EPA Energy Star® Portfolio Manager

#### Energy +


- ASHRAE Building Energy Quotient (bEQ) Label

### Value of Building EQ



Building EQ provides a framework for realizing energy improvements in existing buildings

- **Greatest Value:**
  - Streamlining the energy audit process
  - Actionable recommendations for improving building energy performance
  - Documentation of the assessment and results
  - Building Label to recognize high performance
- **Long Term Value:**
  - Ability to assess effectiveness of EEMs after implementation
  - Standard and consistent process to track improvement over time





## Current US/Canada Labeling Efforts



- EPA ENERGY STAR Portfolio Manager (benchmarking)
- DOE Commercial Building Energy Asset Score
- USGBC LEED (sustainability rating)
- GBI Green Globes (sustainability rating)
- BOMA 360 (six O&M focused criteria including energy)
- State and municipal building energy reporting and disclosure ordinances (BERDO)



## Building EQ is Different



### From green building programs:

- Based solely on a building's energy use
- Focused on understanding energy use
- Identifies opportunities for improved energy performance (In Operation)
- Allows for comparison between buildings with different operating variables (As Designed)
- Consistent energy rating method for both Existing Buildings and New Construction programs



## Building EQ is Different



### From benchmarking programs:

- Consistent process to assess energy performance
- Identifies actionable recommendations for improving energy performance (In Operation)
- Connects Building owners with a credential practitioner to help implement recommendations identified in the assessment process
- Unified system for assessing assets and operations
- Greater differentiation for high performing buildings
- Label score emphasizes zero net energy



## In Operation Rating



- Assessment of actual energy performance with building's existing characteristics and operation
- Based on metered energy use of a building
- Confirmation that indoor environmental quality is not compromised for energy savings.
- On-site assessment with actionable recommendations for improving energy performance
- Applicable for buildings after at least 12 months of operation



## As Designed Rating



- Assessment of energy performance potential, based on building's physical characteristics and systems
- Independent of building occupancy and operating conditions
- Based on results of a standardized energy model of as-built conditions as compared to a baseline
- Applicable to both new and existing buildings



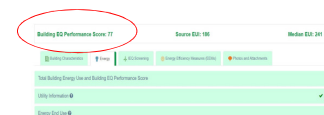
## Building EQ Performance Score

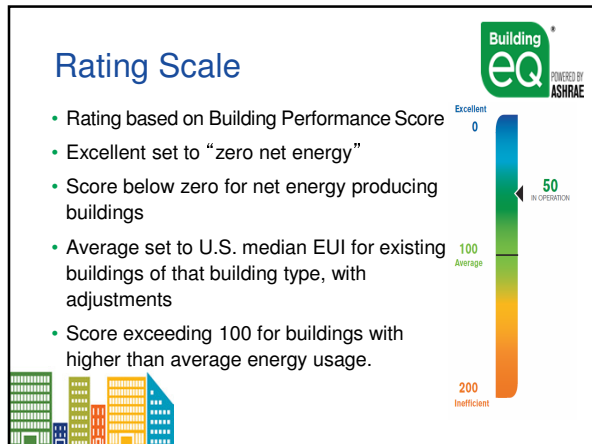


- Building EQ tracks a building's energy performance with the Building Performance Score
- The score compares the candidate building's EUI to a baseline (median) EUI for that building type.

$$(EUI_{\text{building}} / EUI_{\text{baseline}}) \times 100$$

- EUIs are calculated for source energy using US national site-to-source ratios.





### Rating Scale

Score Range	Energy Performance
$\leq 0$	Net zero or energy producer
1-25	75-99% energy savings over median
26-55	45-74% energy savings over median
56-85	15-44% energy savings over median
86-115	Within 15% of median energy use
116-145	16-45% more energy than median
>145	>45% more energy than median

The graphic shows a vertical color bar with a gradient from blue at the top to red at the bottom. Key points on the scale are: 0 (Excellent, blue), 50 (Incorporation, green), 100 (Average, yellow), and 200 (Inefficient, red). The Building EQ logo is in the top right corner.

### Benefits for Owners (of High-Performance Buildings)

- Side-by-side comparison of *As Designed* (asset) and *In Operation* (operational) Ratings
- Measurement-based Indoor Environmental Quality (IEQ) indicators
- List of operational features, e.g., commissioning activities, energy efficiency improvements
- Information: how the building is using energy and how performance can be improved
- Differentiate building from peers to attract tenants or potential buyers*

### A Key Sustainability Goal: Improved Operating Strategies

**The Opportunity:**

- Save 10% - 40% in energy
- Improvements in software and use of expert knowledge, *not* large capital investment
- BEMIS (Building Energy Management *Information* Systems)

**Conclusion:**

Continuously maintain – and upgrade - the capabilities of the O&M staff

### 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
- Transparency: good for energy-efficient buildings, bad for poor performing buildings
- Energy usage data available to
  - Consumers
  - Tenants
  - Prospective purchasers
  - Investors

### What Happens to HVAC Systems as Time Passes?

**Green**

↓

**Gray**



## How to Determine What Energy Costs in a Building Should Be

### Energy Audits

- Purpose: Identify and develop modifications to reduce energy use *and* operating cost
- Types:
  - Preliminary: Examine Utility Bills for Information
    - Energy Star Portfolio Manager
  - Level I: Walk-Through Analysis
  - Level II: Energy Survey & Analysis
  - Level III: Detailed Analysis of Capital Intensive Modifications

### What Energy Audits Study

- Building Energy Consumption:
  - \*Envelope (Walls, Windows, Roof)
  - \*Lighting (Interior and Exterior)
  - \*HVAC
  - \*Domestic and Process Water (Hot & Cold)
  - Laundry
  - Food Preparation
  - Conveying Systems
  - Plug Loads
  - Other Systems – Compressed Air, Steam Traps, etc.
- \* In EPAct 2005 for tax deductions (extended 2017-2018 - can go back through 2016)

### Energy Audits

#### Steps:

1. Collect and analyze historical energy use
2. Study building, operation, characteristics
3. Identify potential modifications to reduce energy use/cost
4. Analyze engineering and economics of potential modifications
5. List rank-order, appropriate modifications
6. Document analysis process, results, report



## How Do You Maintain Sustainability?

### A. Energy Audits



### B. Re-commissioning and Retro-commissioning

### Building Commissioning

“A **systematic** process for investigating **how** and **why** an existing building’s **systems** are operated and **identifying ways to improve and optimize them.**”

### What To Do After the Audit

- Re-commissioning or retro-commissioning based on audit results
  - Repair building envelope (walls, windows, roof) as required
  - Ensure HVAC systems are operating properly and most efficiently – beyond simple thermostat adjustments
  - Remove and replace inefficient HVAC and service water systems

**“Ongoing Commissioning”**

### An Effective Maintenance Strategy Increases the Bottom Line

- Reduce:
  - Unscheduled downtime
  - Maintenance costs
  - Energy and operating costs
  - Crisis management
- Improve:
  - Quality assurance
  - Equipment life & operating efficiency
  - Proactive & predictive analysis (vs. reactive)

### Three Rules of Machines

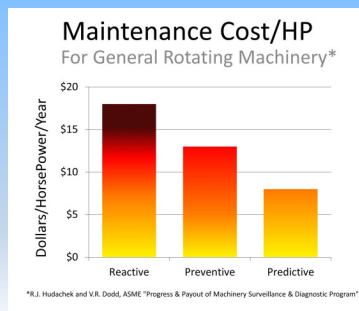
- **Rule 1: Machines Break**
- **Rule 2: Machines Break**
- **Rule 3: Machines Break**

**More cost effective to maintain than to repair.**

### Three Basic Maintenance Practices

- **Reactive Maintenance –**  
Run to failure – most common practice
- **Preventive (Proactive) Maintenance –**  
Routine application of lubricants, checking of belts, electrical connections, settings, alignment, etc.
- **Predictive Maintenance –**  
Art and science of monitoring of machinery condition

### Maintenance Costs: Reactive vs. Preventive vs. Predictive



### Benefits of Predictive Maintenance

- *Predict & prevent failures from occurring*
- *Determine cause of failure*
- *Prevent same failures from occurring again*

### Reasons for O & M Management

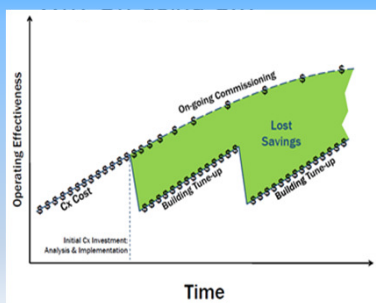
- Thermal Comfort
- Indoor Air Quality (IAQ)
- Energy Efficiency
- Equipment Life
- Safety/Liability (Lawsuits)
- Money

### How To Maintain Sustainability? Good Operation & Maintenance

**“The best designs and construction are doomed to failure without proper and ongoing maintenance.”**

- Commissioning and Re-Commissioning
- Retro-Commissioning
- Training of Facility Personnel
- On-going Commissioning

### Why On-going Cx?



### How Do You Talk to the People Who Dole Out the Dollars???

Save Energy? Probably Not  
Improve IAQ? Probably Not (unless there have been problems)  
Simplify Maintenance? Probably Not  
Improve System Performance? Probably Not  
Reduce Operating Costs? Now You're Getting Warm  
Save Money & Increase Profits?!?!? Oh, Yeah!  
Reduce Litigation Risk? There's Another Good One!

### How to Sell It to Management

Simple Payback??

**Not a good way to analyze energy conservation opportunities!**

**Better:**

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

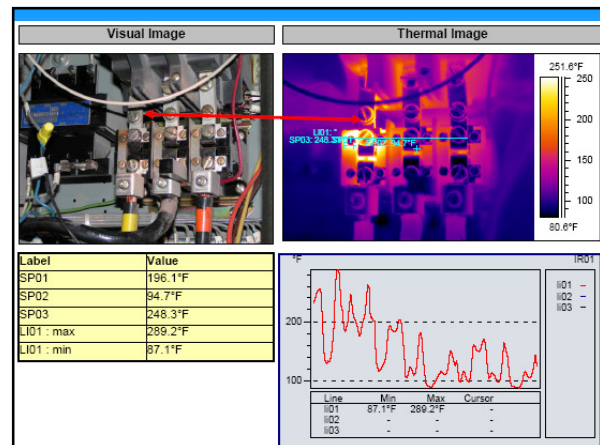


### Where's the Money?

- Governmental Bodies (Federal, State, County, Municipality)
- Utilities
- Grants
- Banks, Credit Unions
- PACE (Property Assessed Clean Energy) – special assessment on property tax
- Power Purchase Agreement (PPA)
- Database of State Incentives for Renewable Energy ([www.dsire.org](http://www.dsire.org))

- Cost of the audit
- Cost of what has to be done after the audit
- Fear - of what?
  - Lack of expertise of the auditor
  - Exposure - Poor O & M practices, no maintenance at all, lack of knowledge
  - More work for the overworked building staff
- What else?

## Conference Center

[illegible]

- Whole building meters
- Sub-metering
- *A good metering strategy is an essential energy management tool*

**"If you don't collect it, you can't measure it.  
If you don't measure it, you can't manage it."**

### Meters + Commissioning

- Meters do not save money
- Data analysis (interpretation of data)
- + On-going commissioning program
- = Savings

### Focus on the “O” in O & M

- Maintenance programs – focus on components
- Commissioning – focuses on operation of system
  - Why a piece of equipment is operating
  - Identifies root causes of operational problems

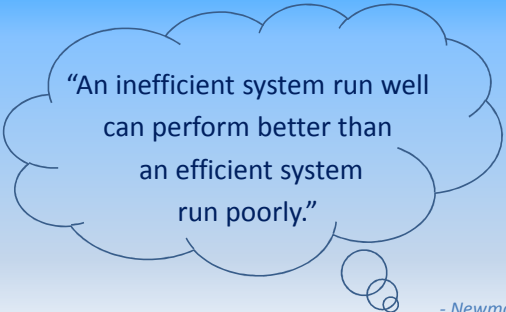
### Building Management Systems

- BAS, BEMS
  - Watch out for:
    - Systems that are too sophisticated for the operator(s)
    - No feedback loops

### Building Management Information Systems

- More than point checking of controls
- More than the “cloud”
- More than analytics
- Internet of Things (IoT)
  - “Smart” recommendations
  - *Complete integration*
  - *Real-time collection of data*
  - “Right now” analysis

### Technology ≠ Performance



“An inefficient system run well can perform better than an efficient system run poorly.”

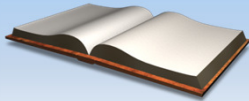
- Newman

### Resources – 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!

### Resources - 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



### Resources -Building Rating Systems

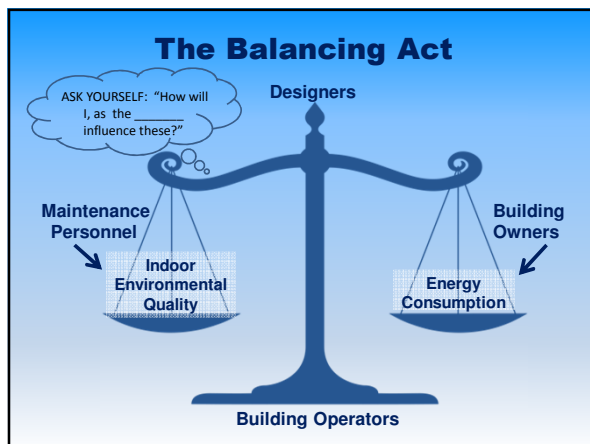
- LEED® – US Green Building Council (USGBC)
- Green Globes® – Green Building Institute (GBI)
- Living Building Challenge
- Better Bricks
- BOMA 360
- WELL Buildings (WELL Building Institute)
- Others

### Additional References & Resources (1)

[www.ashrae.org](http://www.ashrae.org)  
[www.usgbc.org](http://www.usgbc.org)  
[www.wgbc.org](http://www.wgbc.org) (World Green Building Council)  
[www.aia.org/cote](http://www.aia.org/cote) (AIA Committee on the Environment)  
[www.eren.doe.gov](http://www.eren.doe.gov)  
[www.sustainable.doe.gov](http://www.sustainable.doe.gov)  
[www.energystar.gov](http://www.energystar.gov)  
[www.nrel.gov](http://www.nrel.gov) (Renewable Energy)  
[www.rmi.org](http://www.rmi.org) (Rocky Mountain Institute)

### Additional References & Resources(2)

[www.peci.org](http://www.peci.org) (Portland Energy Council – O & M Techniques)  
[www.greenseal.org](http://www.greenseal.org)  
[www.greenguard.org](http://www.greenguard.org)  
[www.fpl.fs.fed.us/ahrc/mold/mold-methods.html](http://www.fpl.fs.fed.us/ahrc/mold/mold-methods.html)  
(Forest Products Lab)  
[www.ifmafoundation.org](http://www.ifmafoundation.org)  
[www.NCGconsulting.us.com](http://www.NCGconsulting.us.com)  
[www.leanandgreenmi.com](http://www.leanandgreenmi.com)



***"The greatest challenge we face today is failure to adapt to change"***  
***Tim Wentz, ASHRAE President, 2016-17***

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