Optimizing Efficiency: High-Performance Strategies for New and Existing Buildings

NFMT – High Performance Buildings, Fort Worth, TX - 06/02/15
James L. Newman
CEM, LEED AP BD&C, ASHRAE OPMP & BEAP

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)
• Trainer, ANSI/ASHRAE/IESNA Energy Standard 90.1
• Member, Air-to-Air Energy Recovery Technical Committee
• Past Vice-Chair, Industrial Air Conditioning Technical Committee
• Past Board Member (Local)
• Distinguished Lecturer since 2010
• Distinguished Service Award, 2012, 2013; 2005 (Local)

BUILDING OWNERS & MANAGERS ASSOCIATION (BOMA)
• Member, Energy & Environment Committee (National)
• Past Judge, TOBY Awards (The Office Building of the Year)
• Chair, Committee on Sustainability (Local)

ENGINEERING SOCIETY OF DETROIT (ESD)
• Speakers Bureau
• Distinguished Service Award, 2007; Fellow, 2010
• Member, Construction & Design Committee

U.S. GREEN BUILDING COUNCIL (USGBC)
• Past Board Member; Distinguished Service Award (Local), 2008
• Past Chair, Public Policy and Advocacy Committee (Local)
• Member, Green Schools Committee (Local)
• LEED Project Administrator: Projects from Certified to Platinum (NC, EB, CI, CS, H)
Outline

• General Information
• LEED®, Energy Star® and Other Planning Tools
• Planning, Implementing and Assessing O & M
• Training & Staff Development
• Education and Engagement of Staff and Occupants
• References & Resources
Learning Objectives

• Review underexplored areas of HVAC systems that offer the greatest potential for energy savings at the least cost
• Learn how to ensure that operations are getting the most efficiency out of your HVAC systems
• Understand the key considerations of retro-commissioning and ongoing commissioning
• Discover new resources for information
U.S. CO$_2$ Emissions by Sector
Percentage of Energy Consumed by Each Economic Sector in the United States in 2008

- 31% Industrial
- 28% Transportation
- 22% Residential
- 19% Commercial
Cost of Owning a Building


95% Cost of Ownership

5% Cost of Construction
Environmental Impact of Buildings (U.S.)

- $260 Billion Industry in 2014

- Buildings – Approximately 15,000,000
  - 40% of total energy use
  - 70% of electricity
  - 35% of greenhouse gas emissions
  - 136 million tons of construction & demolition waste
  - 12% of potable water

8 Billion gallons of *potable* water/day – *just to flush toilets* !!
Major Building Impacts on Energy, Natural Resources and the Environment

- 12% Water Use
- 30% Greenhouse Gas Emissions
- 65% Waste Output
- 70% Electricity Consumption
Savings of Green Buildings

- **Energy Savings**: 15-40%
- **Carbon Savings**: 20-45%
- **Water Use Savings**: 30-50%
- **Waste Cost Savings**: 50-80%

Source: Capital E
Case Study: Coleman A. Young Municipal Center, Detroit, MI
Operational Impact: Utilities
Energy Efficiency - Never More Important

From >1400 respondents in major industries:
• 78%... Paying more attention to energy efficiency than last year
• 67%... Continue to say energy management is extremely or very important

From a survey by Johnson Controls and IFMA (International Facility Management Association)
What To Think About

• Turn things off!
• Repair or replace equipment/upgrade
• Energy analyses (audits)
• Retro-commissioning or Re-commissioning
• Continuous commissioning
• A sustainability or energy champion – with “clout”
• Education of tenants and employees
• Utility rebates/government programs/ PACE and other public or private partnerships
Q: What is a “Green” Building?

A. Intelligent, Integrated Systems

B. Above Standards

C. Costs Less to Operate & Maintain
What’s Coming (or Here Now)?

- LEED V3 2009 (LEED V4 – 2016)
- ASHRAE Energy Standard 90.1 – 2013 (≈30% more stringent than 2004)
- ICC’s International Green Construction Code (IGCC) – 2012 – (input from ASHRAE, AIA, USGBC, IESNA, BOMA, etc.)
- ASHRAE Building Energy Quotient (bEQ) Label (3/1/2012)
- **Energy Use Index (EUI) – Btu/SF/ yr. or kW/SF/yr**
Two Driving Forces

• Regulatory
  - Building energy use disclosure
  - Benchmarking against peers

• Business
Regulatory: Exposing Energy Performance
- Energy Disclosure

- Reporting Mandates – pick up where codes leave off – EUI made public
  - Public disclosure
    - good for high-performing buildings
    - not so good for under-performing buildings
    - what about buildings with high-energy use tenants?
Driving Forces - Business

• 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
Why Be So Concerned about HVAC Systems??

HVAC is "Heart and Lungs" of Building

Why compromise?
High Performing HVAC Systems – a Major Component of High Performing Buildings
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?

• Not always about installing a high efficiency boiler or high efficiency chiller

• Avoiding the need for that boiler or chiller (or at least significantly downsizing them)

• Providing a high performance hybrid HVAC system
  – Energy efficient components
  – Design strategies to maximize capabilities of components
Electrical Loads

- Lower Electrical Loads = Smaller Starters, Wiring, Switchgear, etc. = **Lower First Cost**
- This is something designers don’t always think about when reducing size of mechanical equipment
- Must look at *Whole System*, not just mechanical portion
What Happens to HVAC Systems as Time Passes?

Green  →  Grey
A Shared Problem

“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)
An Effective Maintenance Strategy Improves Performance (and Increases the Bottom Line)

- 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!)
Common Upgrades

• Building Envelope
  – Insulation
  – Caulking, weather-stripping, and air sealing
  – New, energy efficient windows, roof and doors
  – Energy conserving architectural enhancement

• HVAC Upgrades
  – Upgraded energy control systems
  – Energy recovery systems

• Lighting, Electrical and Water
  – New, energy efficient lighting fixtures and day lighting systems
  – Electrical systems to charge EVs (hybrid/plug-in electric vehicles)
  – Water use reduction

• Renewable Energy
What To Think About

• Turn things off!
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• Retro-commissioning or Re-commissioning
• Continuous commissioning
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• Education of tenants and employees
• Utility rebates/government programs/ PACE and other public or private partnerships
Plug loads increased from 3% to 14% between 1990 and 2010.

The Rise of Plug Loads
How many people actually turn off devices

- Never: 20%
- Never: 16%
- Sometimes: 13%
- Often: 11%
- Always: 40%
Reasons for O & M Management

• Thermal Comfort

• Indoor Air Quality (IAQ)

• Energy Efficiency

• Equipment Life

• Safety/Liability (Lawsuits)

• Cost Savings
Three Rules of Machines:

Rule One: Machines Break
Rule Two: Machines Break
Rule Three: Machines Break

-Bryan Sherman

More cost effective to maintain than to repair

– Preventive Maintenance: Routine application of lubricants, checking of belts, electrical connections, settings, alignment, etc.

– Predictive Maintenance: Art and science of monitoring of machinery condition
An Effective Maintenance Strategy Improves Performance (and Increases the Bottom Line)

- Reduces unscheduled downtime
- Reduces maintenance costs including emergencies, scheduled teardowns & secondary damage
- Quality assurance for warranty & recurring problems
- Reduces energy and operating costs
- Extends equipment life & operating efficiency
- Allows for proactive & predictive analysis of problems rather than reactive, which is crisis management (expensive!)
Maintenance Costs: Reactive vs. Preventive vs. Predictive

Maintenance Cost/HP
For General Rotating Machinery*

*D.J. Hudachek and V.R. Dodd, ASME "Progress & Payout of Machinery Surveillance & Diagnostic Program"
Benefits of Predictive Maintenance

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

- Lighting
- Building Envelope
- HVAC/R Systems
- Service Water Systems
- Compressed Air Systems
- Temperature Controls & Building Automation Systems
- Production Machinery
Instrumentation

• Temperature/Humidity Sensors and Recorders
• Meggers to Measure Resistance in Chiller Components
• Data Loggers
• Cameras
  – Standard (photographs)
  – Infrared (much more than photos)
Infrared Thermography
Conference Center, Detroit

Visible Photo

Thermal Map (qualitative)

R-value Map (quantitative)

R-4
University in Detroit (Steam Plant)

Steam pipes in Good condition

Confidential & Proprietary to Ming Scientific
University in Detroit (Steam Tunnels)

Visible Photo

Thermal Map (qualitative)

Steam pipes in Poor condition

R-value Map (quantitative)
How to Reduce Energy Consumption
Determine Where A Building Is Operating Relative to Energy Use

EPA Energy Star Portfolio Manager Analysis

OR

ASHRAE bEQ “In Operation” Analysis

- Followed by an Energy Audit
Q: How Do I Determine Where My Building Is Relative to Energy Costs?

A: Energy Audits
Energy Audits (1)

- **Purpose:** Identify and develop modifications to reduce energy use and/or cost of operating a building
- **Types:**
  - Preliminary: Examine Utility Bills for Information
  - Level I: Walk-Through Analysis
  - Level II: Energy Survey & Analysis
  - Level III: Detailed Analysis of Capital Intensive Modifications
Energy Audits – (2)

- Building Energy Consumption:
  - *Envelope (Walls, Windows, Roof)
  - *Lighting (Interior & Exterior)
  - *HVAC
  - *Domestic & Process Water (Hot & Cold)
  - Laundry
  - Food Preparation
  - Conveying Systems
  - Plug Loads
  - Other Systems – Compressed Air, etc.

* in EPAct 2005 for tax deductions
Energy Audits – (3)

Steps:
1. Collect & analyze historical energy use
2. Study building, operation, characteristics
3. Identify potential modifications to reduce energy use/cost
4. Analyze engineering & economics of potential modifications
5. List rank-order, appropriate modifications
6. Document analysis process, results, report
How Do You Maintain Sustainability?
By Good Operation & Maintenance

• Best Designs & Construction - Doomed to Failure Without Proper and Ongoing Maintenance

• Commissioning and Re-Commissioning

• Retro-Commissioning to Return to Original Design Concepts and Operation
Reasons for O & M Management

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

“Continuous Commissioning”
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

Higher Profitability!
How to Reduce Energy Consumption
Methods of Reducing Energy - HVAC (No Cost/Low Cost)

- Calibrate Sensors and ’Stats
- Adjust Economizer Dampers
- Optimize Volume of Outside Air
- Optimize Discharge Temperature (and Pressure in VAV systems)
- Install Programmable Thermostats
- Use Occupancy-Based Control w/CO₂ 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)

- Low S.P. Drop, High MERV-Rated Filters
- Optimized VAV Systems with Thermally-powered Diffusers
- VFDs on Fans, Chillers, Pumps
- Sealing of Ductwork
- **Properly** Cleaning Cooling and Heating Coils
- Repairing AHUs rather than Replacing
Clogged Filters
Clogged Filters That Didn’t Make It
Potential IAQ Problems: HVAC

PROTECT THE HVAC SYSTEM
Most of Today’s HVAC Cleaning Methods are Unproven and Unreliable

Standard methods only reach into the first 1-2 rows of the coil structure. Inner rows on 5-8 row coils typically are unaffected by most cleaning processes.
## Metro Area Elementary School

<table>
<thead>
<tr>
<th>AHU</th>
<th>Pre-Clean Velocity Avg (ft/min)</th>
<th>Post-Clean Velocity Avg (ft/min)</th>
<th>% Increase</th>
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<tbody>
<tr>
<td>1</td>
<td>217</td>
<td>664</td>
<td>206</td>
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<tr>
<td>2</td>
<td>197</td>
<td>715</td>
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<td>748</td>
<td>876</td>
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<td>6</td>
<td>231</td>
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<td>282</td>
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<td>7</td>
<td>4</td>
<td>331</td>
<td>7476</td>
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<td>8</td>
<td>578</td>
<td>670</td>
<td>16</td>
</tr>
<tr>
<td>9</td>
<td>646</td>
<td>667</td>
<td>4</td>
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# Metro Area High School Results

<table>
<thead>
<tr>
<th></th>
<th>AHU1</th>
<th>AHU2</th>
<th>AHU3</th>
<th>AHU4</th>
<th>AHU5</th>
<th>AHU6</th>
<th>AHU7</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before cleaning</td>
<td>1.20</td>
<td>.93</td>
<td>.85</td>
<td>1.07</td>
<td>.89</td>
<td>1.32</td>
<td>1.15</td>
<td>1.05</td>
</tr>
<tr>
<td>After cleaning</td>
<td>.25</td>
<td>.17</td>
<td>.18</td>
<td>.21</td>
<td>.17</td>
<td>.20</td>
<td>.19</td>
<td>.19</td>
</tr>
</tbody>
</table>

Pressure differential inches/wc

Average pressure differential of coil was reduced 80%
Average CFM was increased by 40%
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
What Is Biofilm?


- A biofilm forms when bacteria begin to excrete a slimy, sticky substance that allows them to adhere to surfaces

- This extracellular polymeric substance (EPS), is what provides the biofilm with increased resistance to antimicrobial agents, heat/cold and cleaners

Micro-organisms
(bacteria, fungi, algae…)

Biofilm EPS binding matrix
(exopolysaccharides, proteins…)
Typical Median Service Life (yrs.)
(Examples)

- DX Air Distribution Equipment (except Rooftop Units) >25
- Chillers, Centrifugal >25
- Cooling Towers, Metal >22
- Boilers, Water-Tube (H.W., Steam) >22

- ASHRAE, Abramson et al., 2005

See ASHRAE database for up-to-date information:
www.ashrae.org/database
Example: Air Handling Units

Repair

or

Replace?
System Installation

BEFORE

AFTER

BEFORE

AFTER
Epoxy Halts Corrosion & Restores Structure to Surfaces

Epoxy with Nanotechnology Provides Superior Bond Strength

Advanced Fire Barrier Provides Fire Code Compliance (NFPA 90A)

Sloped Application Improves Drainage & Eliminates Standing Water (ASHRAE 62.1)

Durable Water-Proof Polymeric Topcoat Provides Extended-Life

Smooth Hygienic Surface with Active Antimicrobial Abates Biological Growth
Methods of Reducing Energy -Lighting

• Lighting
  – Linear Fluorescent Lamps: T-8, T-5 w/Electronic Ballast
  – Compact Fluorescent Lamps (CFL)
  – LED Lamps
  – Sensors: Light, Motion
  – Dimming
  – Zoning

• Natural Daylighting
  - Light Shelves
  - Skylights
  - Light Tubes
Energy-Efficient Bulb Era...

...so now when we leave every light in the house on...

...we'll be conserving energy.
Methods of Reducing Energy - HVAC (Higher Cost)

- Variable Flow Chilled Water systems
- Smaller Centrifugal Compressors – Oilless, with Magnetic Bearings (now up to 700+ tons)
- Total Energy Recovery Heat Exchangers
- Geothermal Heat Pumps
- Microchannel Heat Exchangers
- Cool Storage (ice, water)
- Desiccant Systems/Dedicated Outdoor Air Systems
- Displacement Ventilation & Underfloor Air Distribution
- Indirect Evaporative Cooling
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 (Chilled Beam)
- Radiant Heating
- Reheat from Waste Energy
- Thermal Chimneys
- Fuel Cells
What Else is There?
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...
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 & 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 water
    • Lower power requirements for water plants
  – Not so good
    • Drain lines plug up
    • Treatment in waste plants not being rebalanced for higher waste/water ratio, or for more and different chemicals being flushed down drains
Building Automation Systems

• Watch out for:

  – Systems that are too sophisticated for the operator(s)

  – Systems that have no feedback loops
Recycling – or Not

Source: YRG Waste Audit
Four Attributes of a “Smart Building”

1. Provides actionable information on performance of building systems and facilities
2. Proactively monitors and detects errors or deficiencies in building systems
3. Integrates systems for real-time reporting and management utilization of operations, energy and occupant comfort
4. Incorporates the tools, technologies, resources and practices to contribute to energy conservation and environmental sustainability

- from Smart Buildings Institute
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.
What Drives Building Performance?

- Tenants
  - Computers
  - Equipment
  - Schedule
  - Habits

- Design
  - Layout
  - Integration
  - Installation
  - Components
  - Systems

- Operation
  - Staffing
  - Controls
  - Maintenance
  - Commissioning
  - Retro-commissioning

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- Retro-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!
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.
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.”
Planning Tools

- EPA Energy Star: Portfolio Manager
- USGBC LEED-EB O&M
- Green Globes
- Living Building Challenge
- Society of Environmentally Responsible Facilities (SERF)
- BOMA 360 Program & 7-Point Challenge
- IFMA & IFMA Foundation
Guidelines for Energy Management - EPA

• Proven Strategy
• Tools and Resources
• Based on Energy Star partners’ strategies
• Assist your organization
  – Improve energy performance
  – Improve financial performance
  – Distinguish your organization as environmental leader

www.energystar.gov/index.cfm?c=guidelines.guidelines_index
Getting Started

Assemble a Project Team → Create a Project Schedule

Set Clear Goals

Choose a “Champion” (if not you)

Involve End Users → Get Executive Buy-In
Guidelines for Energy Management
Guidelines for Energy Management
- Overview

• The steps:
  – STEP 1: Make Commitment
  – STEP 2: Assess Performance
  – STEP 3: Set Goals
  – STEP 4: Create Action Plan
  – STEP 5: Implement Action Plan
  – STEP 6: Evaluate Progress
  – STEP 7: Recognize Achievements
Make a Commitment

• Form a dedicated team
  – Appoint a sustainability director
  – Establish a sustainability team
  – Have a committed person from the C-suite as part of the team (this is very important)

• Institute an Energy Policy and other policies
  – Provides the foundation for setting goals and integrating sustainability concepts and actions into an organization’s culture and operations
Assess Performance

• Data collection and management
  – Gather and track data

• Baselining and benchmarking
  – Establish baselines
  – Benchmark
  – Analyze
  – Evaluate
Set Goals

• Develop effective – and realistic – performance goals
  – Determine scope
  – Estimate potential for improvement
  – Establish clear and measurable goals – with target dates – for entire organization, facilities and other units
Create Action Plan

• Define technical steps and targets
• Determine roles and resources

Must have buy-in and backing from upper management and all organizational areas affected by the action plan before implementing it.

Communication, Communication, Communication
Implement Action Plan

- Create a communication plan
- Raise awareness - to build support at all levels of the organization
- Build capacity of your staff – through training, access to information, successful practices, procedures and technologies
- Motivate – create incentives that encourage staff
- Track and monitor progress regularly
Evaluate Progress

• Measure results – compare current performance to established goals
• Review action plan – understand what worked well and what didn’t to identify best practices

By doing this on a regular basis, you can
  – Measure effectiveness of projects and programs
  – Make informed decisions about future projects
  – Reward individuals and teams for accomplishments
  – Document additional opportunities
Recognize Achievements

• Provide internal recognition – to individuals, teams and facilities within your organization

• Receive external recognition – from government agencies, the media, other 3rd party organizations that reward achievement
# LEED® 2009
for Existing Buildings: Operations & Maintenance

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Sites</td>
<td>26</td>
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<tr>
<td>Water Efficiency</td>
<td>14</td>
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<tr>
<td>Energy &amp; Atmosphere</td>
<td>35</td>
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<tr>
<td>Materials &amp; Resources</td>
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<tr>
<td>Indoor Environmental Quality</td>
<td>15</td>
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<tr>
<td><strong>Total Possible Points</strong></td>
<td>110*</td>
</tr>
</tbody>
</table>

* Out of a possible 100 points + 10 bonus points

** Certified 40+ points, Silver 50+ points, Gold 60+ points, Platinum 80+ points

- Innovation in Operations: 6 points
- Regional Priority: 4 points
## LEED CERTIFICATION ASSESSMENT SUMMARY

All prerequisites are met or can be met: □ Yes □ No

<table>
<thead>
<tr>
<th>PREREQUISITE</th>
<th>Is met:</th>
<th>Can be met:</th>
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<tbody>
<tr>
<td>1. WEP1 – Minimum Indoor Plumbing Fixture and Fitting Efficiency</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
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<tr>
<td>2. EAp1 – Energy Efficiency Best Management Practices – Planning, Documentation, and Opportunity Assessment</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
</tr>
<tr>
<td>3. EAp2 – Minimum Energy Efficiency Performance</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
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<td>4. EAp3 – Fundamental Refrigerant Management</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
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<tr>
<td>5. MRP1 – Sustainable Purchasing Policy</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
</tr>
<tr>
<td>6. MRP2 – Solid Waste Management Policy</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
</tr>
<tr>
<td>7. IEOp1 – Minimum Indoor Air Quality Performance</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
</tr>
<tr>
<td>8. IEOp2 – Environmental Tobacco Smoke (ETS) Control</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
</tr>
<tr>
<td>9. IEOp3 – Green Cleaning Policy</td>
<td>□ Yes □ No</td>
<td>□ Yes □ No</td>
</tr>
</tbody>
</table>

Notes:
Appendix D: Project Tracking Tool

The project tracking tool helps the LEED Coordinator organize the many tasks that must be coordinated among the project team members and other school/school district staff. It tracks project team efforts, milestones, and basic project information needed for LEED project registration.

1. Project Management Team

   A. LEED Coordinator
      
      Name:
      Office Phone:
      Cell Phone:
      Email:

   B. Assistant LEED Coordinator
      
      Name:
      Office Phone:
      Cell Phone:
      Email:

   C. School/School District
      
      Name:
      Address:
LEED PROJECT CHARRETTE

Welcome and Introduction (15 – 30 minutes)
Acknowledge and welcome leadership, stakeholders, community supporters, and project team members. Leadership delivers opening remarks and expresses support for initiative to green ongoing operations and maintenance.

PART 1 – EDUCATION PRESENTATION

Green Schools Overview (45 – 90 minutes)
Present characteristics of green schools and high-performance operations and maintenance to the entire group.

LEED for Existing Buildings: O&M Certification Overview (30 – 90 minutes)
Provide orientation on USGBC and LEED for Existing Buildings: O&M rating system, including an overview of the LEED certification process.

Introduction of School Project(s) Selected to Pursue Certification (30 – 60 minutes)
Deliver presentation on schools pursuing certification and summary of project activities already accomplished.

PART 2 – TECHNICAL WORKSHOP (60 – 180 MINUTES)

Complete LEED Project Scorecard
Complete the scorecard to keep track of credits project team intends to pursue. Credits allocated to each building type and site work. "Must," "Maybe," and "Optional" credits will require further analysis and a deeper understanding of the project's characteristics.
## DRAFT SCHEDULE

Figure 2.5 – Sunshine Middle School Project Schedule: Excerpt

<table>
<thead>
<tr>
<th>Prerequisite/Credit</th>
<th>Performance Periods</th>
<th>LEED Certification Application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 Green Grounds</strong></td>
<td>Pts Qtr 1 Qtr 2 Qtr 3 Qtr 4 Qtr 5 Qtr 6 Qtr 7 Qtr 8</td>
<td></td>
</tr>
<tr>
<td>SSc2 Building Exterior and Hardscape Management Plan</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SSc3 Integrated Pest Management, Erosion Control, and Landscape Management Plan</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>2 Alternative Commuting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSc4 Alternative Commuting Transportation</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td><strong>3 Water Efficiency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEp1 Minimum Indoor Plumbing Fixture and Fitting Efficiency</td>
<td>3</td>
<td>(Performance period N/A)</td>
</tr>
<tr>
<td>WEc2 Additional Indoor Plumbing Fixture and Fitting Efficiency</td>
<td></td>
<td>(Performance period N/A)</td>
</tr>
<tr>
<td><strong>4 Energy Efficiency Best Management Practices</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EAc2.1 Existing Building Commissioning—Investigation and Analysis</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>EAc2.2 Existing Building Commissioning—Implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>5 Energy Performance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EAp2 Minimum Energy Efficiency Performance</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>EAc1 Optimize Energy Efficiency Performance</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>EAc6 Emissions Reduction Reporting</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Implementation and continuing performance
- One-time activity or event
- Remainder of Performance Period
<table>
<thead>
<tr>
<th>Responsible Department</th>
<th>LEED Prerequisite</th>
<th>Tasks/Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EAp2 Minimum Energy Efficiency Performance</td>
<td>Establish ENERGY STAR Portfolio Manager Account and determine facility's energy performance rating (must be at least 69 at time of application).</td>
</tr>
<tr>
<td></td>
<td>EAp3 Fundamental Refrigerant Management</td>
<td>Measure outside air ventilation rates (must be capable of at least 10 CFM/person at time of application).</td>
</tr>
<tr>
<td>Electric Shop</td>
<td>MRP1 Sustainable Purchasing Policy</td>
<td>Assess and provide input to environmentally preferable purchasing (EPP) policy regarding mercury in lamps.</td>
</tr>
<tr>
<td>Plumbing Shop</td>
<td>WEp1 Minimum Indoor Plumbing Fixture and Fitting Efficiency</td>
<td>Determine age of fixtures. If prior to 1993, inventory existing fixture types and provide report.</td>
</tr>
<tr>
<td>Carpenter Shop</td>
<td>MRP1 Sustainable Purchasing Policy</td>
<td>Assess and provide input to EPP policy regarding facility alterations and additions.</td>
</tr>
<tr>
<td></td>
<td>MRP2 Solid Waste Management Policy</td>
<td>Provide assessment of capability for recycling waste from facility alterations and additions at the school site.</td>
</tr>
<tr>
<td>Planning Section</td>
<td>MRP1 Sustainable Purchasing Policy</td>
<td>Assess and provide input to EPP policy regarding facility alterations and additions.</td>
</tr>
<tr>
<td></td>
<td>MRP2 Solid Waste Management Policy</td>
<td>Provide assessment of capability for recycling waste from facility alterations and additions.</td>
</tr>
<tr>
<td>Custodial Services</td>
<td>MRP2 Solid Waste Management Policy</td>
<td>Provide assessment of capability for recycling ongoing consumables at the school site.</td>
</tr>
<tr>
<td>School</td>
<td>IEOp3 Green Cleaning Policy</td>
<td>Provide assessment of capability to develop a green cleaning policy.</td>
</tr>
<tr>
<td></td>
<td>MRP1 Sustainable Purchasing Policy</td>
<td>Assess and provide input to EPP policy regarding furniture and equipment (durable goods).</td>
</tr>
<tr>
<td></td>
<td>MRP2 Solid Waste Management Policy</td>
<td>Provide assessment of capability for recycling ongoing consumables.</td>
</tr>
</tbody>
</table>
SMART Goals

S = Specific
M = Measurable
A = Achievable
R = Relevant
T = Time-Bound
How to Sell Your 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)
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!
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 today’s 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 the Money (cont.)

- 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.
Implementation: Find Creative Solutions

Your #1 Resource: Your People

- Training programs
- Operation & Maintenance Changes
  - Reduce energy consumption
  - Improve IAQ
  - Improve system reliability & performance
  - Simplify maintenance
  - Reduce operating costs
- For each operational measure identified, must do cost/benefit analysis

Your #1 Challenge: Your People

1. Must get your people to buy into it
2. Must get management to buy into it
Training & Staff Development - How To Get Your People Involved
Training and Certification

• Internal Training
  – Classes
  – Webinars

• External Training
  – Conventions
  – Seminars
  – *Audio books while commuting, flying, exercising, etc.
  – *Streaming videos
  – *E-learning courses
    * www.3LeafGroup.com
Certifications

- IFMA (International Facility Management Assoc.)
- BOMA (Building Owners and Managers Assoc.)
- AEE (Association of Energy Engineers)
- ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers)
- USGBC (US Green Building Council)
- GBI (Green Building Initiative)
- ISSA (The Worldwide Cleaning Industry Assoc.)

to name only a few
Change = Fear for Many People

- Most people prefer the status quo
- Must make them feel comfortable
- Must make them feel like they are contributing (because they will be)
- Involve them from the beginning, get their ideas
- Be prepared to meet resistance
- Be able to explain why new procedures and policies must be implemented
Questions To Be Answered

• **What** are we going to be doing?
• **Why** are we doing it?
• **Who** is going to be doing it?
• **How** is it going to be done – and how is it going to affect me? (be aware of the fear)
• **When** will we have to start doing this?

Most important message is the “**Why**”
Communication

Must be done on a continuous basis

• Why we’re doing it
• What are the results
• Benchmark changes that show the results
• Recognize people, teams, facilities
  - Incentives such as signs, mention in company newsletter, parking space, special lunch, etc.
  - Accomplishments: better IAQ, reduced trash to landfills, lower utility bills, etc.
• Publicize results internally and externally
The performance of every organization depends on adequate (and correct) information being available to decision makers at the exact moment that decisions have to be made.
Reasons for O & M Management

• Thermal Comfort
• Indoor Air Quality (IAQ)
• Energy Efficiency
• Equipment Life
• Safety/Liability (Lawsuits)
• Money
Technology ≠ Performance

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

Jim Newman
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.
• BOMA: Preventive Maintenance & Building Operation Efficiency (2003 – written by ASHRAE member)
• IFMA Foundation: Sustainability “How-To” Guides
• EPA Energy Star
• Rocky Mountain Institute
• PECI
• ICSC
Summary

1. Know your costs
   – Gather data from all properties
   – Have an audit or use 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
   – 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
Putting it all together
Technology ≠ Performance

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

- Newman
References & Resources

www.ashrae.org
www.usgbc.org
www.wgbc.org (World Green Building Council)
www.aia.org/cote (AIA Committee on the Environment)
www.eren.doe.gov
www.sustainable.doe.gov
www.energystar.gov
www.nrel.gov (Renewable Energy)
www.rmi.org (Rocky Mountain Institute)
www.icsc.org/sustainability
References & Resources (cont.)

www.peci.org (Portland Energy Council – O & M Techniques)

www.greenseal.org

www.greenguard.org

www.fpl.fs.fed.us/ahrc/mold/mold-methods.html (Forest Products Lab)

www.ifmafoundation.org

www.NCGconsulting.us.com
Why Do People Change?

Only Three Reasons:

1. They *realize* it’s in their best interest
2. They’re *forced* to
3. It costs more *not* to

All of these are happening today.
For Further Information:

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Jimn@newmanconsultinggroup.us
www.newmanconsultinggroup.us

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

Build Green – Everyone Profits! - USGBC
“If we do not change our direction, we are likely to end up where we are headed”

- Chinese proverb