High Performance Buildings: Achieving Superior Performance for Life

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Trane

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My Background

• Leads the service and contracting business for Trane Commercial Systems in the SE US
• Responsible for the profitable growth of the services businesses in the SE which include after-market service, turnkey retrofits, controls contracting, and performance based energy services for commercial buildings
• Key leader in transforming the business by increasing revenues from solutions and services offerings
• Led growth of the performance based energy services by approximately 400% over the past 5 years
• Extensive industry experience
  – 5 years Trane
  – 21 years in several leadership roles with Johnson Controls
Our Agenda

• Today’s Operating Realities

• What is a High Performance Building?

• Adopting a High Performance Building Approach

• Case Studies

• Your Questions
Today’s Operating Realities

- Most enterprises have been affected by the long and severe recession
- Recovery has begun in some sectors, but construction activity remains weak
- Organizations are focused on doing more with less
  - Productivity, cost reduction are the order of the day
  - Access to cash and credit is becoming more limited
  - No appetite for capital investments without clear payback
- Energy, operating costs rising faster than most other costs
  - Energy makes up 40% of operating expenses of some buildings
  - Buildings account for 72% of U.S. total energy consumption
- Buildings are a major contributor to greenhouse gas emissions
- There is an increase in public policy activity aimed at:
  - Reducing energy consumption and protecting the environment
  - Reducing U.S. dependence on foreign oil
  - Stimulating the economy and creating jobs
Administration Proposes Better Building Initiative

- New tax incentives for building efficiency
- More financing opportunities for commercial retrofits
- “Race to Green” grants for universities, states and municipalities
- Better Buildings Challenge for universities and the private sector
- Training programs to grow the next generation of building technology workers

The U.S. Green Building Council says high performance buildings are 20-50% more energy efficient than conventional buildings
What is a High Performance Building?

“*The best sustainable designs are not just environmentally responsible. They produce buildings where employees can thrive and productivity can soar. We call these high performance green buildings.*”

- U.S. Green Building Council

High Performance Buildings are:
- Cost effective
- Safe and secure
- Sustainable
High Performance Buildings Defined

High performance buildings:

• Are safe, comfortable and efficient
• Help owners and occupants achieve their business mission
• Use design and operating standards that are created, measured and continually validated to deliver established outcomes within specified tolerances
• Are created using a unique methodology – combining financial, operating and energy analysis with specialized service offers and available financing
• Meet specific standards for energy and water use, system reliability and uptime, environmental compliance, occupant comfort and safety and other success factors

High performance buildings deliver optimal efficiency, reliability, value and comfort
A Whole Building, Whole Lifecycle Approach

- Typical buildings have occupied lives of 50-75 years or even longer
- Operating costs typically account for 60-85% of building lifecycle costs – compared to 5-10% for design and construction costs
- High performance buildings reduce lifecycle costs so organizations can invest in other priorities and make buildings “assets” instead of “expenses”
- Performance standards are created, measured and continually validated to deliver the desired outcomes
- Standards are typically set for:
  - Energy and water consumption
  - System reliability
  - Environmental compliance
  - Occupant health, safety and comfort

Enormous opportunities to improve the performance of existing structures
Characteristics of a High Performance Building

- **Cost effectiveness.** Including lifecycle costs, cost/benefit analysis and ROI over expected lifespan
- **Safety and security.** Focusing on safety and security of occupants and impact of building failure on the community
- **Sustainability.** Emphasizing integrated design, energy performance, water conservation, indoor environmental quality and reduced impact of materials
- **Accessibility.** Recognizing and addressing different accessibility needs
- **Functionality.** Ensuring that the building fulfills its intended purpose and meets occupants’ needs
- **Productivity.** Enabling occupants to do their best work and contribute to achieving the organization’s goals
- **Historic preservation.** Reusing or adopting building shells, materials, etc. to preserve cultural heritage
- **Aesthetics.** Contributing to the productivity of employees, reputation of the owner and operator, and quality of life in the community
High performance buildings are designed, constructed, operated and maintained to enhance organization and occupant effectiveness

- Providing a safer, healthier, more comfortable environment
- Operating reliably with minimum unscheduled downtime and fast recovery
- Maintaining performance within acceptable tolerances throughout their lifespan
- Enhancing organization and occupant performance, retaining/increasing in value and adding luster to the organization’s brand and reputation
Holistic, technology-enabled, knowledge-based approach is integral to establishing and maintaining standards throughout a building’s occupied lifespan

- Embracing predictive building maintenance strategies
- Establishing and maintaining sound operating metrics
- Adopting performance-based service concepts

A poorly designed building operated and maintained effectively outperforms a well-designed building with poor operating and maintenance practices
Adopting a High Performance Building Approach
Every organization, building and project is unique

Modeling begins with understanding:
- What you’re trying to accomplish
- Specific goals and objectives
- Appetite for risk

<table>
<thead>
<tr>
<th>Public</th>
<th>Private</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve infrastructure</td>
<td>Stay competitive (Up time, manufacturing quality,)</td>
</tr>
<tr>
<td>Reduce maintenance costs</td>
<td>Reduce maintenance costs</td>
</tr>
<tr>
<td>Reduce operating costs</td>
<td>Reduce operating costs</td>
</tr>
<tr>
<td>Optimize capital budget</td>
<td>Optimize capital budget</td>
</tr>
<tr>
<td>Improve indoor environment (comfort &amp; occupant performance)</td>
<td>Improve indoor environment (comfort &amp; occupant performance)</td>
</tr>
<tr>
<td>Be socially responsible</td>
<td>Add asset value</td>
</tr>
</tbody>
</table>

Building use determines investment strategy
### What Kinds of Changes Make Financial Sense?

<table>
<thead>
<tr>
<th>Quick Return  (0-3 yr payback)</th>
<th>Intermediate  (3-8 yr payback)</th>
<th>Long-Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrofit lighting</td>
<td>Install new building automation system</td>
<td>Replace high efficiency equipment (major systems chiller/boilers)</td>
</tr>
<tr>
<td>Update existing building automation systems</td>
<td>Improve HVAC systems (CV to VAV)</td>
<td>Building envelope improvements</td>
</tr>
<tr>
<td>Conduct retro/re-commissioning</td>
<td>Implement water conservation</td>
<td>Apply renewable technologies</td>
</tr>
<tr>
<td>Make behavioral changes (turn lights off, program systems)</td>
<td>Use fans and motors (VFDs, high efficiency change outs)</td>
<td>Apply on site/distributive power generation</td>
</tr>
<tr>
<td>Explore utility procurement options, Compressed air systems</td>
<td>Apply load shifting technology (ice storage)</td>
<td>Implement comprehensive maintenance and repair strategies</td>
</tr>
</tbody>
</table>

Taking a lifecycle, whole-building approach offers the best long-term ROI
Identify and Quantify Mission-Critical Factors

For example:

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Category</th>
<th>Cost of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>Health and welfare</td>
<td>Total costs per day of a winter HVAC failure (teacher salaries, revenue from student attendance, cost of student transportation, etc.)</td>
</tr>
<tr>
<td>Industrial facility</td>
<td>Reliability/uptime</td>
<td>Total costs per hour of shutting down an assembly line (worker salaries, missed deadlines, restart costs, etc.)</td>
</tr>
<tr>
<td>Retail location</td>
<td>Reliability/uptime</td>
<td>Total cost per hour of shutting down a store (lost revenue, employee salaries, lost customer loyalty, etc.)</td>
</tr>
<tr>
<td>Municipal building</td>
<td>Health and welfare</td>
<td>Total cost per hour of employee absenteeism due to poor indoor air quality (employee salaries, lost productivity, risk to reputation, etc.)</td>
</tr>
</tbody>
</table>

Consider the cost of a building failure on operations and stakeholders
Example: School building

<table>
<thead>
<tr>
<th>Critical Areas Served</th>
<th>Equipment System</th>
<th>Performance Parameters - Acceptable Quality Limits</th>
<th>Validation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry lab</td>
<td>Exhaust fan 1</td>
<td>400 cfm</td>
<td>24/7 monitoring</td>
</tr>
<tr>
<td></td>
<td>Unit ventilator 1</td>
<td>100 cfm OA</td>
<td>quarterly inspection</td>
</tr>
<tr>
<td>Swimming pool</td>
<td>Air handling unit 1</td>
<td>2,500 cfm</td>
<td>24/7 monitoring</td>
</tr>
<tr>
<td></td>
<td>Pool pump 1</td>
<td>82°F; 200 gpm</td>
<td>24/7 monitoring</td>
</tr>
<tr>
<td>Data storage facility</td>
<td>Rooftop unit 1</td>
<td>48°F SA</td>
<td>24/7 monitoring</td>
</tr>
<tr>
<td></td>
<td>In-ceiling unit 1</td>
<td>45% RH</td>
<td>annual inspection</td>
</tr>
<tr>
<td>Cafeteria</td>
<td>H&amp;V unit 1</td>
<td>8,000 cfm</td>
<td>quarterly inspection</td>
</tr>
<tr>
<td></td>
<td>Exhaust fan 1</td>
<td>9,000 cfm</td>
<td>annual inspection</td>
</tr>
<tr>
<td></td>
<td>Freezer</td>
<td>28°F</td>
<td>24/7 monitoring</td>
</tr>
</tbody>
</table>

Every building has unique factors to consider
Conduct a Critical Building Systems Audit

- Assemble a team
- Define program objectives
  - Reduce operating costs
  - Increase operational performance
  - Improve occupant comfort and safety
  - Enhance employee productivity
  - Achieve environmental certification

Build an energy management team with buy-in from key internal stakeholders, including owners, managers and department heads
• Determine the current level of performance of key building systems: HVAC, lighting, water, electrical, compressed air, etc.
• Gather 3-5 years of actual energy cost data
• Use actual data to estimate annual cost of planned and unplanned maintenance
• Compare actual costs against industry averages and best-in-class performance
## Top 25 Energy Conservation Measures

<table>
<thead>
<tr>
<th>Major ECM Category</th>
<th>ECM Type</th>
<th>Technology/ECM Name</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>General/Special</td>
<td>Upgrade to Direct Digital Control</td>
<td>100%</td>
</tr>
<tr>
<td>Industrial</td>
<td>Compressed Air</td>
<td>Implement Compressed Air Utility Management</td>
<td>100%</td>
</tr>
<tr>
<td>Water</td>
<td>Reduce Use</td>
<td>Install Low Flow/Use Fixtures</td>
<td></td>
</tr>
<tr>
<td>Controls</td>
<td>General/Special</td>
<td>Retro/Recommission Controls for Optimizing Savings</td>
<td>96%</td>
</tr>
<tr>
<td>Controls</td>
<td>General/Special</td>
<td>Install Lab Hoods Control - Flow Safe Lab Hoods</td>
<td></td>
</tr>
<tr>
<td>Supply Side Management</td>
<td>Manage Energy Supply</td>
<td>Change Regulated Utility Rate/Tariff</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>Smart Metering</td>
<td>Install Smart Meters &amp; software -- for Billing</td>
<td></td>
</tr>
<tr>
<td>Electrical</td>
<td>Lighting</td>
<td>Install Lighting Controls</td>
<td></td>
</tr>
<tr>
<td>Electrical</td>
<td>Lighting</td>
<td>Replace T-8s for HiBays with T5s</td>
<td></td>
</tr>
<tr>
<td>Plant</td>
<td>Boilers</td>
<td>Install Tankless/Instantaneous Water Heaters</td>
<td></td>
</tr>
<tr>
<td>Supply Side Management</td>
<td>Manage Energy Supply</td>
<td>Change to Interruptible Rates and Use Electric Generators</td>
<td></td>
</tr>
<tr>
<td>Architectural</td>
<td>Envelope</td>
<td>Install Weather-Stripping</td>
<td></td>
</tr>
<tr>
<td>Electrical</td>
<td>Lighting</td>
<td>Upgrade Fluorescent Fixtures w/ T8 or T5 Lamps</td>
<td></td>
</tr>
<tr>
<td>Electrical</td>
<td>Lighting</td>
<td>Retrofit Incandescent Lamps w/ Compact Fluorescent Fixtures</td>
<td></td>
</tr>
<tr>
<td>Electrical</td>
<td>Lighting</td>
<td>Replace Exit Sign w/new LED Fixture</td>
<td></td>
</tr>
<tr>
<td>Plant</td>
<td>Boilers</td>
<td>Adjust Burner as Regular Maintenance</td>
<td></td>
</tr>
<tr>
<td>HVAC (Building/ Non-Plant)</td>
<td>Unit Upgrade</td>
<td>Convert CV to VAV</td>
<td></td>
</tr>
<tr>
<td>HVAC (Building/ Non-Plant)</td>
<td>Unit Upgrade</td>
<td>Convert Dual Duct to VAV</td>
<td></td>
</tr>
<tr>
<td>Electrical</td>
<td>Lighting</td>
<td>Replace HID HiBay fixtures with T5s or T8s</td>
<td>86%</td>
</tr>
<tr>
<td>Electrical</td>
<td>Lighting</td>
<td>Add LED night lights in halls</td>
<td>86%</td>
</tr>
<tr>
<td>Architectural</td>
<td>Roof</td>
<td>New Construction with Green Roofs (Plants)</td>
<td>85%</td>
</tr>
<tr>
<td>Plant</td>
<td>Systems</td>
<td>Install Water Source Heat Pump System</td>
<td>83%</td>
</tr>
<tr>
<td>Plant</td>
<td>Motors/Pumping</td>
<td>Install VFD/VSDs for Pumps</td>
<td>81%</td>
</tr>
<tr>
<td>Controls</td>
<td>Resetting</td>
<td>Reduce Outdoor Air To Design Level</td>
<td>78%</td>
</tr>
<tr>
<td>Controls</td>
<td>Resetting</td>
<td>CO2-Based Demand-Controlled Ventilation</td>
<td>78%</td>
</tr>
</tbody>
</table>

- Many, many Energy Conservation Measure (ECM) technologies and applications → need a methodology to assess and rate
- Methodology developed using Six Sigma analysis processes and tools
- Evaluation process based on 5 key customer and Trane “importance factors”
  - Savings potential, Practicality, Commercial viability, Risk management, Business differentiation
- Score of 0-100% with 100% being the best ranking

Use six sigma methodology to select energy measures
Consider All High Performance Building Benefits

• Human performance – Studies show high performance buildings enhance occupant productivity, comfort and morale

• Organizational performance – High performance buildings enable organizations to apply their resources to other priorities and improve results

• Property values – High performance buildings command premium rents, enjoy higher occupancy rates and sell for more on the open market

• Brand and reputation – High performance buildings help organizations attract and retain employees, students, customers and community supporters
“Re-commissioning” has become a mainstream concept

- Many buildings fail to live up to standards their designers envisioned – even when new
- Most buildings “drift” from original parameters and perform less efficiently as their functions change, equipment wears and controls strategies deviate from original design intentions

A disciplined re-commissioning project typically yields 10-20% energy savings
Top Control Strategy Improvements

• Air Handling Systems (HVAC)
  • Temperature setup/setback
  • Sensors that are out of calibration, especially OA sensors
  • Synchronizing the mechanical equipment with building occupancy
  • Economizers that haven’t been maintained
  • Discharge air reset
  • Static pressure reset
  • Demand Control Ventilation
  • Dirty condenser and evaporator coils and filters

• Chilled Water Systems
  • Chilled and condenser water reset
  • Optimal start/stop of major equipment
  • Cooling tower optimization
  • Fan and pump speed drives

• Heating Systems
  • Boiler hot water reset
Proving the Model: Case Examples of High Performance Building Projects
High Performance Building Case Study

Trane Manufacturing Facility, Texas

SITUATION
• Trane needed to trim energy and operating costs, improve reliability, add asset value and adjust to reduced production volume

APPROACH
• Comprehensive energy analysis
• Energy conservation measures
  – Building automation system upgrade
  – Lighting system/fixtures retrofit
  – HVAC system improvements – boiler, air compressors, etc.
  – Operations, maintenance and schedule improvements

RESULTS
• $1.4 million annual energy and ops savings – 2 year payback
• Reduced energy consumption by 11.5 million kilowatt hours
• Replaced aging systems – some mid-1960s era
• Improved environmental performance of building

Better comfort, safety and efficiency while right-sizing for reduced volume
High Performance Building Case Study

TIAA CREF Headquarters, New York City

SITUATION
- Trane customer looking to save energy, improve reliability, enhance returns and reduce environmental impact

TRANE METHODOLOGY
- Analyze building systems, energy use, rate structure and procurement methods
- Recommend mission-focused ECMs
- Design & install upgrades
  - State-of-the-art chilled water system
  - Rooftop thermal storage system
  - Reprogrammed central automation control system

MEASURE/VALIDATE RESULTS
- Estimated $765,000+ annual energy/operations savings
- 25% internal rate of ROI on incremental spending
- 6.1 million pounds of carbon emission reduction
- No sacrifice of rentable space

Created an improved facility for the company, employees and tenants
SITUATION
• Trane customer looking to reduce energy and operating costs spent on aging infrastructure while improving the learning environment at 46 district schools

TRANE METHODOLOGY
• Assess building systems and energy use
• Recommend mission-focused ECMs
• Design & install upgrades district-wide
  – HVAC upgrades & re-commissioning
  – Web-enabled building control system
  – Sky lighting & lighting retrofits
  – Electric-gas oven conversion
  – Water conservation measures

MEASURE/VALIDATE RESULTS
• Estimated annual energy savings of $750,000+ per year
• Maintenance cost savings of $390,000
• $10.7M program funded entirely by energy savings

Created an improved learning environment for students, teachers and staff
Energy efficiency makes more sense than ever

Environmental performance is becoming more critical

Organizational performance and employee productivity drive value, ROI

Effective service strategy maintains lifecycle performance

→ Link the building to its primary business mission

→ Determine the funding strategy

→ Understand energy conservation measures and their payback

→ Focus on total cost of ownership over occupied life

→ Conduct the financial analysis – including cash flow
Your Questions