Non-Invasive Retrofits for Energy Savings, Demand Response, and Operational Efficiency

Overview for

Harry Sim – Cypress Envirosystems
10 August, 2012

Harry.sim@cypress.com
Agenda

• Challenges in Existing Facilities

• Non-Invasive Wireless Pneumatic Thermostat (WPT) Retrofit Solution

• Benefits of the WPT system, RCx, MBCx applications

• Customer List & Rebates Granted by CA Utilities

• Other retrofit applications: Steam, Duct Airflow etc.
Typical Challenges in Existing Facilities

Need to save energy & improve uptime, but hindered by outdated facility?

Manual Instrumentation, Not Programmable, No Diagnostics...
Equals: Wasted Energy, Higher Downtime, More Labor Required
Non-Invasive Retrofit Solutions

- **Wireless Pneumatic Thermostat**: “Go from Pneumatic to DDC in minutes”
- **Wireless Gauge Reader**: “Remotely Read Gauges in minutes”
- **Wireless Steam Trap Monitor**: “Avoid Expensive Steam Leaks”
- **Wireless Transducer Reader**: “Remotely Read Transducers – No Wires”
- **Wireless Light Controller**: “Reduce Electricity Use”

20 Minute Installation, Payback in 18-24 Months
The Challenge of Pneumatic Thermostats

70% of Commercial Buildings Still Have Pneumatic Thermostats

- **Waste energy, more maintenance, unhappy occupants...**
  - No Night Setback, No Zone Control, No Optimal Start/Stop,
    No Occupancy Override, No Demand Response...

- **High Cost to Retrofit**
  - Market rate of $2,000 - $3,000 per zone
    for traditional DDC retrofit

- **Retrofits are Disruptive to Occupants**
  - Open Walls, Ceiling, Exposure to Asbestos
Only 30% of Buildings Ready for Analytics, Smart Grid

Non-Residential Buildings in N. America
70 billion sq-ft

- All Pneumatic 40%
- Full EMS 30%
- Partially Pneumatic 30%

Has full data for Analytics, communicating devices for Smart Grid.
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**Zone Control with Wireless Pneumatic Thermostat (WPT)**

**EXISTING LEGACY STAT**
- Manual Setpoint Control
- No Remote Readings
- No Diagnostics
- Manual Calibration Required
- Cannot support Demand Response strategies

**CYPRESS ENVIROSYSTEMS WIRELESS PNEUMATIC THERMOSTAT**
- Remote Wireless Setpoint Control
- Remote Monitoring of Temperature & Pressure
- Pager/Cell Notification of Excursions
- Automatic Self-calibration
- Programmable Temperature Setbacks
- Occupancy Override
- Enables Demand Response strategies
- BACnet Interface to BMS
- Compatible With Existing Johnson, Honeywell, Siemens, Robertshaw
- Battery life of 3 – 5 years
- Standalone operation with power failure
Fast Non-Invasive Installation

5 Step Process - 10 Minutes!

Step 1: Identify pneumatic thermostat type
Step 2: Remove thermostat and backplate
Step 3: Install WPT backplate to wall
Step 4: Attach pneumatic pipes to WPT
Step 5: Hang on wall and integrate with BAS
Integration with Building Automation Systems

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<tr>
<th>VENDOR</th>
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WPT System – Standalone Access

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Cost and Time Control vs. Conventional DDC

“Installation took only eight days and was one of the easiest, fast and most cost effective energy efficiency improvements we have ever made in our buildings”
- Jeff Draper, Manager of Building Operations

<table>
<thead>
<tr>
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<th>Cypress Envirosystems Wireless Pneumatic Thermostat Installation</th>
<th>Conventional Direct Digital Control Retrofit</th>
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<tr>
<td>Installed Price</td>
<td>~$500-700/zone</td>
<td>$1,500 - 2,500/zone</td>
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<tr>
<td>Project Completion Time Required</td>
<td>8 Days for 350 zones</td>
<td>6 Months</td>
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<tr>
<td>Disruption to Operations</td>
<td>Minimal</td>
<td>Significant</td>
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<tr>
<td>Potential Exposure to Toxic Substances in Walls</td>
<td>None</td>
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</table>
Benefits After Installation

- Improved Energy Efficiency
- Tenant Comfort - Improved Operational Visibility
- Reduced Maintenance Effort
- Enable Auto-Demand Response
- Enable LEED Points

Lead with Different Propositions for Different Customers
Wireless Pneumatic Thermostat Quantified Savings Model

**Estimated Savings Potential**
$635/year (per 1000 sq-ft)
Upfront Retrofit Cost: $600 (per 1000 sq-ft)
Payback Period: 11 months

**Energy Savings**
18-30% reduction in HVAC use
2500 kWh per year / 1000 sq-ft
$235/year @ $0.10/kWh

**Maintenance Savings**
3-6 hours/year per 1000 sq-ft
$400/year @ $80/hour

**Temp Setpoint Policy**
10-15%
1200 kWh/yr
$115/yr
*Source: Case Study*

**Retro Commissioning**

**Night/Weekend Setback & Occupancy Override**
5-10%
600 kWh
$60/yr
*Source: DOE2 eQUEST Modeling*

**Duct Static Pressure & Supply Air Temp Reset**
2-4%
300 kWh
$30/yr
*Source: Trane Application Note*

**Deadband Temp Policy**
3-5%
400 kWh
$30/yr
*Source: Cypress Modeling*

**Automatic Calibration**

**Faster Trouble-Shooting/On-going Commissioning**
5 hours/yr
$400/yr
*Source: Case Study*

**Reduced Tenant Complaints/Calls**

*Note: All calculations based on 300,000 sq-ft retrofit project, $0.10 per kWh electricity rate, and $80 per hour maintenance labor rate.*
Quantified Savings from UC San Diego

McGill-Mandler Hall Building Electric Demand  Before and after WPT installation

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<tr>
<th>Daytime: Maximum Demand</th>
<th>Night time: Minimum Demand</th>
<th>Average Demand</th>
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<tr>
<td>Before WPT Installation</td>
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<tr>
<td>Average........ 267 kW</td>
<td></td>
<td></td>
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<tr>
<td>Maximum...... 335 kW</td>
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<td></td>
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<tr>
<td>After WPT Installation</td>
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<td></td>
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<tr>
<td>Average........ 219 kW</td>
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<tr>
<td>Maximum...... 313 kW</td>
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Source: Energy Solutions Inc. under contract to California Energy Commission

PROJECT DATA

PROJECT SUMMARY
Site: McGill-Mandler Hall
Location: UC San Diego
Project area 112,500 square feet
Built: 1970

ENERGY INFORMATION
Annual electricity use before retrofit: 2,561,477 kWh
Annual natural gas use before retrofit: 111,983 therms
Annual electricity savings: 538,901 kWh
Annual natural gas savings: 56,944 therms

PROJECT ECONOMICS
Annual utility cost savings: $94,931
Total project cost: $295,665
Utility & CEC incentives:
• SDG&E UC Partnership Program Rebate – $186,280
• Energy Technology Assistance Program Rebate – $94,749
Simple payback: 0.2 years

EQUIPMENT INSTALLED
• 250 Cypress Envirosystems Deadband Wireless Pneumatic Thermostats
• 3 Cypress Envirosystems Green Box Controllers
• 25 Cypress Envirosystems “Wall Powered” or “24VAC Powered” Repeaters

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Diagnostic Data for Operational Control

Operational Benefits
- Fewer trips to zones
- Faster troubleshooting
- Proactive maintenance
- Automatic calibration

Occupant Benefits
- Fewer occupant complaints
- Faster response to occupant
- Improved occupant comfort
- Higher occupant productivity
## LEED Credits Available

### LEED for Existing Buildings: Operations & Maintenance

Registered Project Checklist

### Energy & Atmosphere, continued

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<tr>
<td>Credit 2.2</td>
<td>Implementation</td>
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<tr>
<td>Credit 2.3</td>
<td>Ongoing Commissioning</td>
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</tbody>
</table>

| Credit 3.1 | Building Automation System           | 1      |
| Credit 3.2-3.3 | System Level Metering | 1 to 2 |
| Credit 3.2 | 40% Metered                          | 1      |
| Credit 3.3 | 80% Metered                          | 2      |
Reduced Hot/Cold Calls – 345 California St, San Francisco

- 17,000 sq-ft Class A Office Space, 31st Floor
- 48 Story Hi-Rise, managed by Cushman & Wakefield
- San Francisco Financial District
- Tenant: Private Equity Firm

### Post-WPT Installation
Mar – Nov, 2010

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<tr>
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<th>FLOOR</th>
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- 66% reduction in hot/cold calls
- 25 avoided calls/year
- 7-10¢/sq-ft/year savings

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## Reduced Hot/Cold Calls – 345 California St, San Francisco

### Pre-WPT Installation
Mar – Nov, 2009

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- 66% reduction in hot/cold calls
- 25 avoided calls/year
- 7-10¢/sq-ft/year savings
Utility Demand Response Integration

- OpenADR communications link technology developed by Lawrence Berkeley National Labs.

- Cypress Envirosystems GBC communicates directly with utility DRAS via internet.

- Signals received by GBC – can be configured to respond or to opt out.

- Average peak load reduction per WPT 0.6 to 1.0 kW
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Commercial Real Estate Customers
Higher Education Customers
Health Care and Government Customers

Health Care

- Kaiser Permanente
- Catholic Healthcare West
- VA
- Manitoba Health
- Québec
- Health Net
- Summa Health System
- St. Joseph Health System
- Presbyterian
- National Jewish Health
- The Chester County Hospital and Health System
- Massachusetts General Hospital
- St. Tammany Parish Hospitals
- Heartland Regional Medical Center
- Loma Linda University Medical Center
- Care1st
- Palomar Health
- NASA
- The Architect of the Capitol
- California Republic
- City of Phoenix
- Citywide Administrative Services
- Sacramento County
- Cypress Envirosystems

Government

- NASA
- The Architect of the Capitol
- California Republic
- VA
- The County of Santa Clara
- Montreal
- Cyress Envirosystems

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Industrial Customers
Utility Programs – PG&E, SCE and SDG&E

- **Auto Demand Response Incentives from IOU’s**
  - PG&E Program offers $125 per kW.
  - SCE and SDG&E offers $300 per kW.
  - Each WPT sheds 0.6 kW to 1.0 kW.

- **Energy Savings**
  - Custom Retrofit Program 9 cents per kWh saved in first year
  - Requires modeling of savings

- **On-Bill Financing**
  - Up to $100,000 interest free, five year loan ($250,000 for institutions)
  - Repayment on utility bill.
  - WPT approved technology for this program.
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Energy Audits, MBCx of Legacy Air Handlers, Duct Pressure, Velocity

- Most older Air Handler Units (AHU’s) are not monitored/automated
- Labor intensive to detect problems, check filters
- Proper air flow is the critical parameter - but can only be seen via manual dial gauges (e.g. Magnehelics)
- Solution: Wireless Magnehelic Reader clamps on in minutes and transmits reading wirelessly to BMS/BAS
- No downtime, no wiring, no leak checks
- Alarm notification for filter changeout, low air flow
- Condition-based maintenance, not schedule-based

Enables Monitoring of Legacy Air Handlers for 70% Less Than Traditional Transducers
Wireless Transducer Reader (WTR)

- Enables wireless remote monitoring of virtually any analog transducer or instrument with the following outputs: 4-20mA, 0-5V, or 0-10V, RS-232, RS-485, thermocouple, thermistor
- Non-disruptive – no need to change out transducers, break pressure seals, or run wires
- Compatible with most existing flow meters, current meters, particle counters, thermocouples, weigh scales etc.
- Enables data logging to enable trend analysis, notification, or statistical process control
- Optional Class 1 Div 2 and IP65/NEMA 4 enclosures available
- Battery life of 3+ yrs under typical sampling rates
- Optional OPC or BACnet interface to existing building or plant automation system
Wireless Steam Trap Monitor (WSTM)

CYPRESS ENVIROSYSTEMS
WIRELESS STEAM TRAP MONITOR

- Necessary part of the steam distribution system, usually hundreds of units per site
- 15-20% average failure rate; leaks steam
- Failed traps lose $5,000 per year (1/8” orifice)
- Manual inspection typically done annually – labor intensive, do not catch problems in timely manner
- Solution: Wireless steam trap monitor detects faults and alarms on error, avoiding expensive leak loss
- Non-invasive installation: no breaking seals, wireless, integrates with BMS
- Battery life of 3+ years at typical sample rates
- IP65/NEMA 4 rated for outdoor use
- One year payback on investment
How Steam Trap Monitoring Saves Energy

Without Steam Trap Monitoring

With Steam Trap Monitoring

Typical savings for 1/8” orifice steam trap

Timely Detection and Correction of Trap Failures Avoids Prolonged Costly SteamLeaks
WSTM Executive Summary Report

Overview

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<tr>
<th>Health Status</th>
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<th>% of Total</th>
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<tr>
<td>Nodes with poor RF signal strength</td>
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Energy Summary

- Steam loss (lbs/hr): 35.70
- Dollar loss ($/y): 4,691.38

Condition Summary

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Type Summary

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Application Summary

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Q&A?
Wireless Pneumatic Thermostat (WPT)

- Uses proven pneumatic bi-metallic strip technology for room control
- Added electronics to remotely control setpoint and monitor temperature, branch pressure and battery status
- If batteries fail and electronics stop working, unit will function just like a traditional pneumatic thermostat
WPT Energy Savings Strategies by Application

Energy Savings Measures Enabled by WPT

- Fully applicable
- Partially applicable, high impact
- Partially applicable, lower impact
- Not applicable

Energy Conservation Measures

<table>
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<th>Supply Air Temp Resets</th>
<th>Duct Static Pressure Reset</th>
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Energy Conservation Measures

- Setpoint Policy Enforcement
- Retrocommissioning/Ongoing commissioning
- Deadband Setpoints
- Pre-cooling, Load Shifting
- Auto-Demand Response
- Programmable setbacks/occupancy override
- Supply Air Temp Resets
- Duct Static Pressure Reset
Zone Behavior – Proper Response (example)

**SETPOINT TEMPERATURE**
- 1st DR Event bumped up setpoint 2 deg
- 2nd DR Event bumped up additional 2 deg
- Completion of Event – back to normal

**ZONE TEMPERATURE**
- Morning A/C comes on
- Temp climbs after initial DR event
- Continues climbing after 2nd DR event

**DELTA SETPOINT MINUS ZONE TEMP**
- Should maintain to within 2 degrees of setpoint throughout

**BRANCH PRESSURE**
- Drops after first event called
- Drops after second event called
- Stays about neutral 8psi during entire DR period.
Zone Behavior – Insufficient Cooling (example)

SETPOINT TEMPERATURE
- 1st DR Event bumped up setpoint 2 deg
- 2nd DR Event bumped up additional 2 deg
- Completion of Event – back to normal

ZONE TEMPERATURE
- Morning A/C comes on
- A/C working, but never makes it to 63 deg setpoint. Stabilizes at 73 deg.

DELTA SETPOINT MINUS ZONE TEMP
- Best able to achieve is about six degrees higher than setpoint.

BRANCH PRESSURE
- Always maxed out i.e. calling for maximum cooling.

Causes:
- Setpoint too low
- Faulty Reset Velocity Controller
- Mechanical Equipment Fault
- Undersized cooling capacity design
Zone Behavior – Too Much Cooling (example)

SETPOINT TEMPERATURE
- 1st DR Event bumped up setpoint 2 deg
- 2nd DR Event bumped up additional 2 deg
- Completion of Event – back to normal

ZONE TEMPERATURE
- Morning A/C comes on
- Temp keeps dropping, even below setpoint

DELTA SETPOINT MINUS ZONE TEMP
- Temperature way too cold, much below setpoint most of the day

BRANCH PRESSURE
- Thermostat is trying to compensate for over cooling all day long.

Causes/Remedy:
- Faulty Reset Velocity Controller
- VAV Box Fault
- Adjacent Zone Overcooling