

# **Retrofitting Existing Buildings for Demand Response & Energy Efficiency**

*[www.CypressEnviroSystems.com](http://www.CypressEnviroSystems.com)*

# Agenda

- Who is Cypress Envirosystems?
- Auto-Demand Response and Energy Efficiency Retrofit
  - Pneumatic HVAC
  - Lighting Controls
- Energy Auditing and Continuous Commissioning

# Who is Cypress Envirosystems?

- Mission:
  - Save energy, enable demand response, improve productivity for older plants and buildings.
  - Use technologies which minimize disruption, downtime, retraining of staff.
  - Target payback of less than 18 months.
- Subsidiary of Cypress Semiconductor
- Sister company of SunPower



# Applying Silicon Valley High-Tech to Existing Buildings



## Silicon Valley Technology Today

- Wireless
- Image capture + sensors
- Intelligent Processing
- Large memory
- Programmable
- ALMOST FREE!



## Typical Legacy Plant or Building

- Pneumatic
- Analog 4-20mA wires
- Manual gauges
- COSTS HUNDREDS \$\$

# Cypress Envirosystems: Problems We Solve...



*Pneumatic  
Thermostats*



*Dial Gauges*



*Steam Traps*

Need to save energy & improve uptime, but hindered by outdated facility?



*Standalone Transducers,  
LED/LCD Displays*



*-80C Freezers*



*Legacy Fluorescent  
Lighting*



*Uninterruptible  
Power Supplies*

**Manual Instrumentation, Not Programmable, No Diagnostics...  
Equals: Wasted Energy, Higher Downtime, More Labor Required**

# What is our Solution?



**WIRELESS PNEUMATIC THERMOSTAT**  
*"Go from Pneumatic to DDC in minutes"*



**WIRELESS GAUGE READER**  
*"Remotely Read Gauges in minutes"*



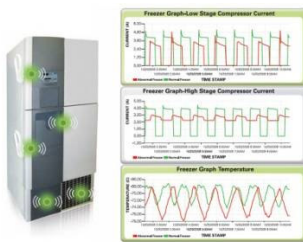
**WIRELESS STEAM TRAP MONITOR**  
*"Avoid Expensive Steam Leaks"*



**BLUE BOX HUB/RECEIVER**



**WIRELESS TRANSDUCER READER**  
*"Remotely Read Transducers – No Wires"*



**WIRELESS FREEZER MONITOR**  
*"Predicts and Avoids Costly Freezer Failure"*



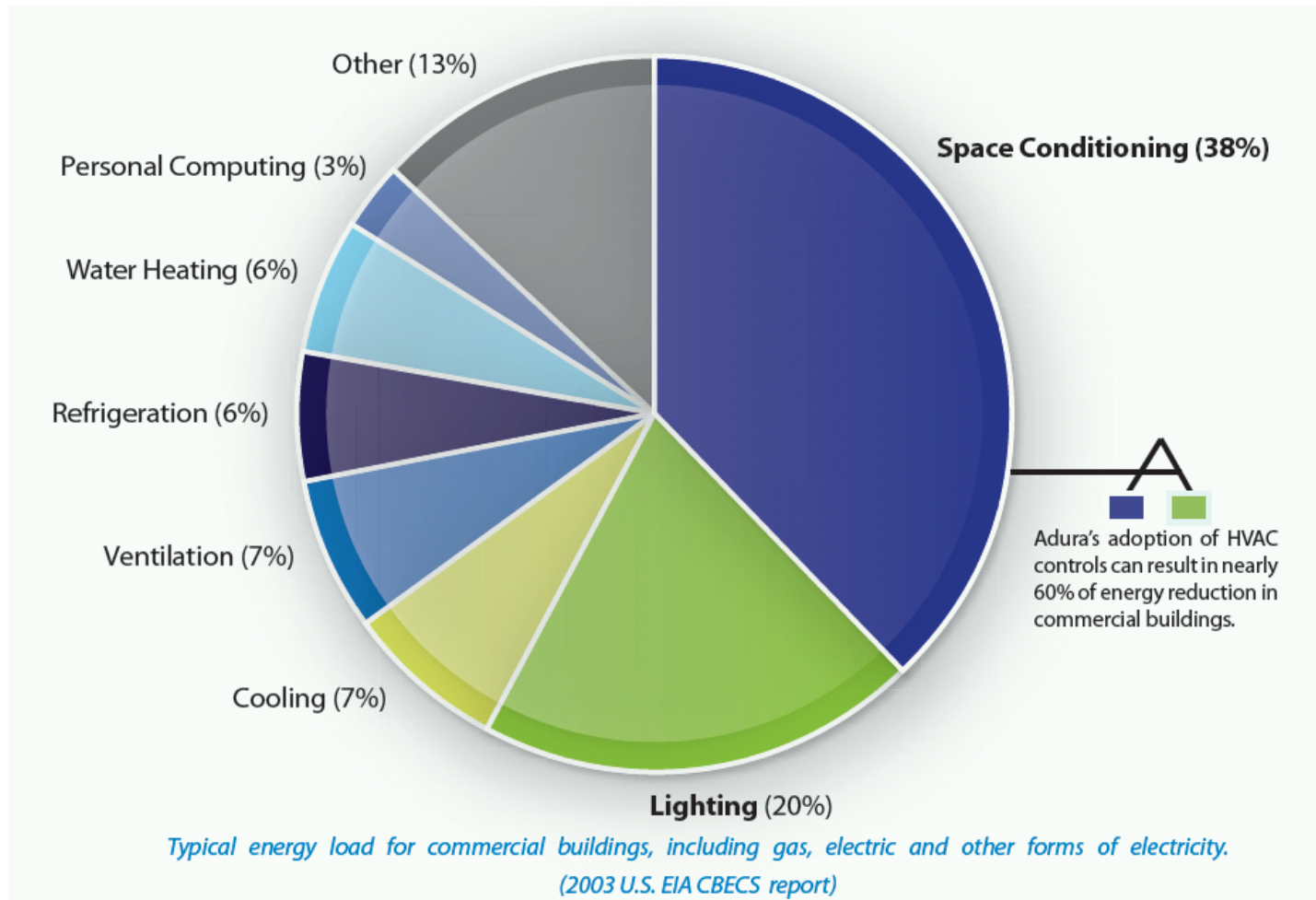
**WIRELESS LIGHT CONTROLLER**  
*"Reduce Electricity Use"*



**WIRELESS BATTERY MONITOR**  
*"Automates UPS Health Check"*

**Non-invasive, easy retrofit, energy and labor savings, payback under one year**

# Energy Use in Commercial Buildings



**HVAC and Lighting... More than 60% of Energy Use**

# Regulation Drivers: California Example

- **Default Critical Peak Pricing**

- Starting May 1<sup>st</sup>, 2010, virtually all commercial office building customers will move to a default electricity pricing rate called Critical Peak Pricing  
[www.pge.com/mybusiness/energysavingsrebates/demandresponse/cpp/](http://www.pge.com/mybusiness/energysavingsrebates/demandresponse/cpp/)
- This rate structure provides for discounted rates when no CPP events are called. However, on CPP event days, higher “critical peak” energy charges will be assessed for usage between noon and 6pm.
- Customers are notified by PG&E by 3pm the day prior to the critical event.
- Customers with Auto-Demand Response enabled buildings (e.g. communicating thermostats, lighting etc.) can automatically reduce usage using these high rate periods to avoid high charges.

- **Assembly Bill 1103 – Building Energy Efficiency Disclosure**

- Starting January 1, 2010, all commercial building lease transactions must disclose the energy efficiency history and Energy Star rating of the facility. More efficient buildings will be able to attract premium tenants, and potentially command a rental premium.

Source: California Public Utilities Commission Decision, July 31<sup>st</sup>, 2008 (see page 21 and Attachment B)  
[http://docs.cpuc.ca.gov/word\\_pdf/FINAL\\_DECISION/85984.pdf](http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/85984.pdf)

***Peak Load 50% over Base Load – Mostly Commercial Buildings.  
Peak Load Costs \$100-150/kW To Keep on Standby.***





# ***Retrofit of Pneumatic HVAC Controls***

# 70% of Commercial Buildings Still Pneumatic

- **Waste energy, more maintenance, unhappy tenants...**
  - No Night Setback, No Zone Control, No Optimal Start/Stop, No Occupancy Override, No Demand Response...
- **High Cost to Retrofit**
  - Market rate of \$2500 - \$3000 per zone for traditional DDC retrofit
- **Disruptive to Tenants**
  - Open Walls, Ceiling, Exposure to Asbestos



***Retrofitting Existing Buildings is a PAIN IN THE NECK!!***

# Wireless Pneumatic Thermostat (WPT)

*EXISTING LEGACY STAT*



- Manual Setpoint Control
- No Remote Readings
- No Diagnostics
- Manual Calibration Required
- Cannot support Demand Response strategies

**DDC in 20 Minutes!**

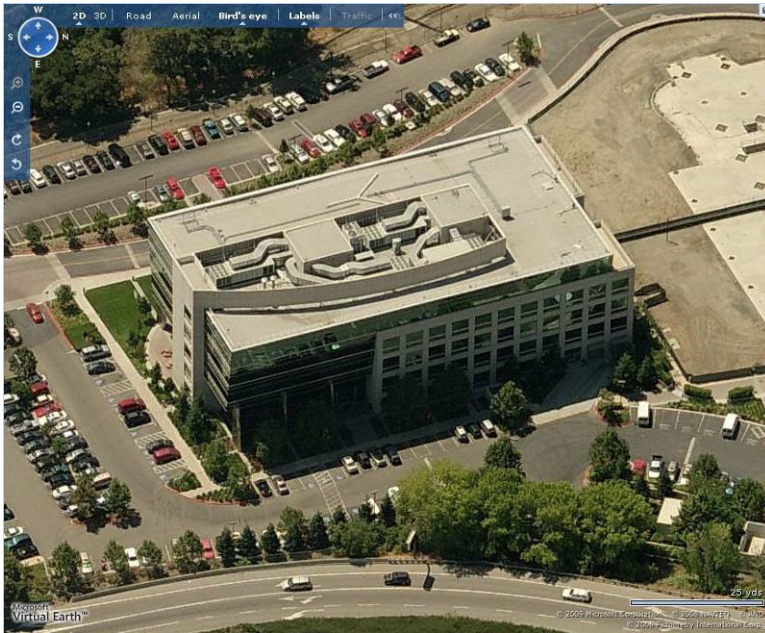
*CYPRESS ENVIROSYSTEMS  
WIRELESS PNEUMATIC THERMOSTAT*



- 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
- Minimum 2yr battery life

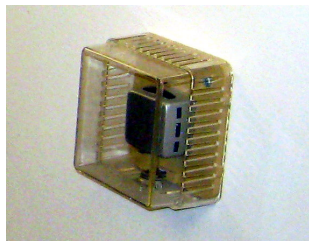
***Get the benefits of Direct Digital Control (DDC) in less than 20 minutes, 80% Lower Cost***

# Enabling Smart Grid – Auto Demand Response



- County of Santa Clara, Social Services Administration
- 2 Buildings, each 5 story, built 2000
- Total 300,000 sq-ft
- 350 Pneumatic Thermostats, non-communicating
- Estimated Demand Response load shed: 200kW
- Would like to participate in PG&E Auto-DR program, but challenging with pneumatic thermostats

# 15 Minute Replacement of Thermostat



# 80% Lower Cost, 5% of the Time vs. Conventional DDC

## Santa Clara County Government Project



	<b>Cypress Envirosystems Wireless Pneumatic Thermostats Retrofit</b>	<b>Conventional Direct Digital Control Retrofit</b>
Installed Price	350 x \$500 = \$175,000	350 x \$2,500 = \$875,000
Time Required	8 days	6 months
Disruption to Operations	Minimal	Significant
Potential Exposure to Toxic Substances in Walls	None	Unknown
Paid for by PG&E Auto DR Incentive	100% covered	31% covered

**“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**

# Quantified Savings for Santa Clara County

- 300,000 sq-ft facility, \$175,000 cost to retrofit (before utility incentives)
- Energy Savings: \$42,000 per year
  - 350,000 kWh per year base load reduction, at \$0.12 per kWh
  - Derived from enforcing Temperature Setpoint Policy and Retrocommissioning
- Demand Response Savings: \$7,500 per year
  - 10,700 kWh curtailed at peak rates \$0.70 per kWh
  - Based on 12 events per year, 4 hours each, 0.6kW shed per thermostat
- Maintenance Cost Savings: \$156,000 per year
  - Continuous commissioning data helped prioritize maintenance and reduced troubleshooting time
- Estimated Payback Period for Santa Clara County Project: 16 months *BEFORE UTILITY INCENTIVES*
  - Some savings kick in partially in first year, fully in subsequent years.

# WPT – Reducing Energy Use & Improving Productivity

<i>Savings Type</i>	<i>Typical Reduction per 1200 sq-ft Zone</i>	<i>Annual Savings per 1,200 sq-ft zone</i>	<i>Comments</i>
<b>Reduced Energy Cost</b>			
Improved Calibration	1% to 5%	\$17 to \$83	Typical pneumatic thermostat is out of calibration in under 6 months
Programmable Zone Control, Night Setback	5% to 15%	\$83 to \$248	2% per every degree F of setback general rule
Lower Tariffs - Demand Response	0% to 3%	\$0 to \$50	Utility Demand Response program for electricity
<b>Reduced Maintenance Labor</b>			
Fewer tenant complaints/calls	0.0 man-hrs to 1.0 man-hrs	\$0 to \$85	Average 0 to 2 calls per year per thermostat
Reduce Calibration work	0.1 man-hrs to 0.5 man-hrs	\$9 to \$43	Average 20 minutes for calibration per year per thermostat
Reduce Troubleshooting	0.1 man-hrs to 0.2 man-hrs	\$9 to \$17	Average 10 minutes for troubleshooting per year per thermostat
<b>Lower Tenant Related Costs</b>			
Better occupancy override cost recovery		\$5 to \$50	Enable tenant zone override with automatic tracking
Improvement in lease retention rate	5% to 10%	\$60 to \$120	Happier tenants (tenant turnover cost \$10 per sq-ft)
<b>TOTAL</b>		<b>\$175 to \$700</b>	

Source: US Energy Information Administration (2003 - 2007), ASHRAE, Cypress Envirosystems customer surveys



# LEED Credits

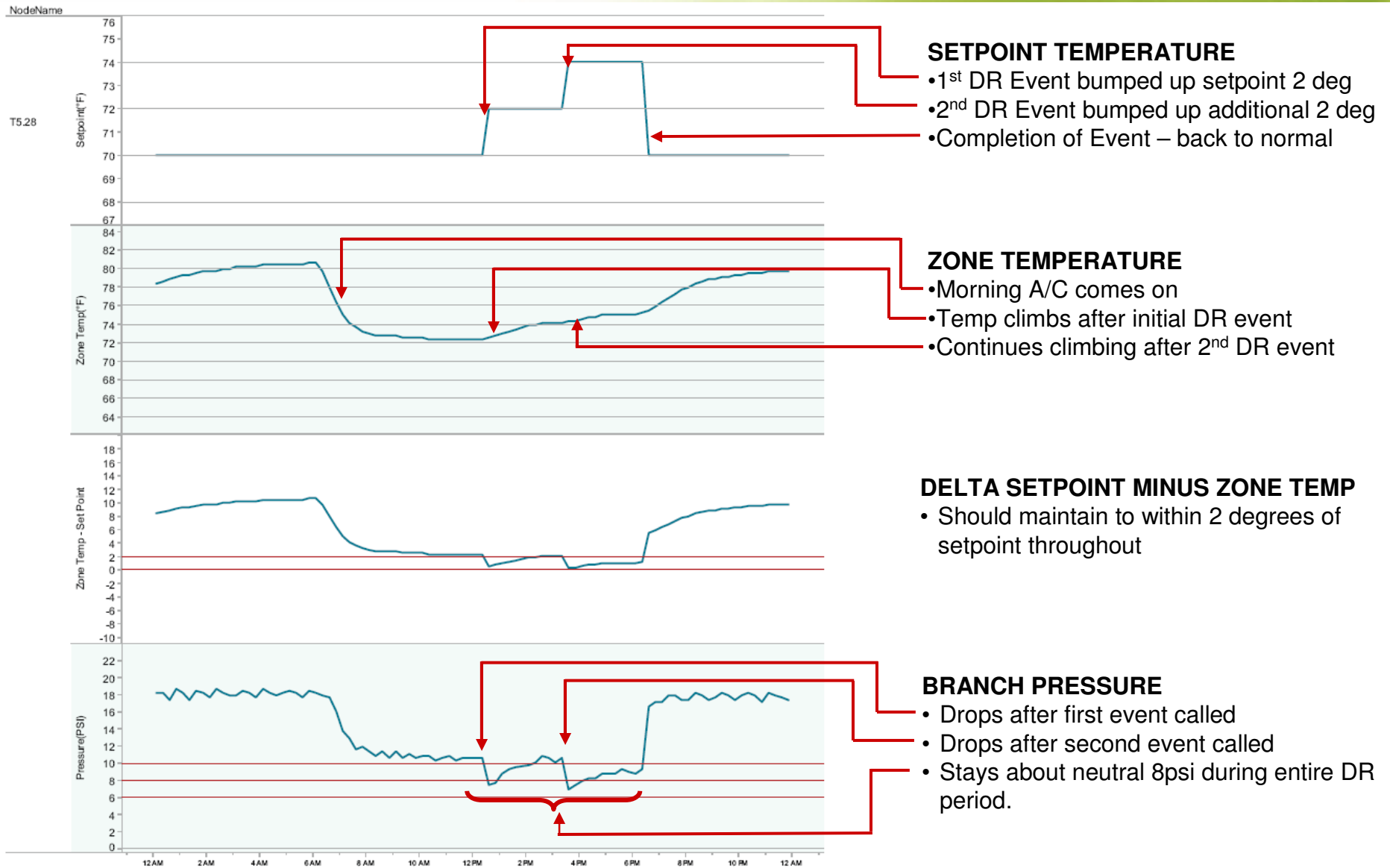


## LEED for Existing Buildings: Operations & Maintenance Registered Project Checklist

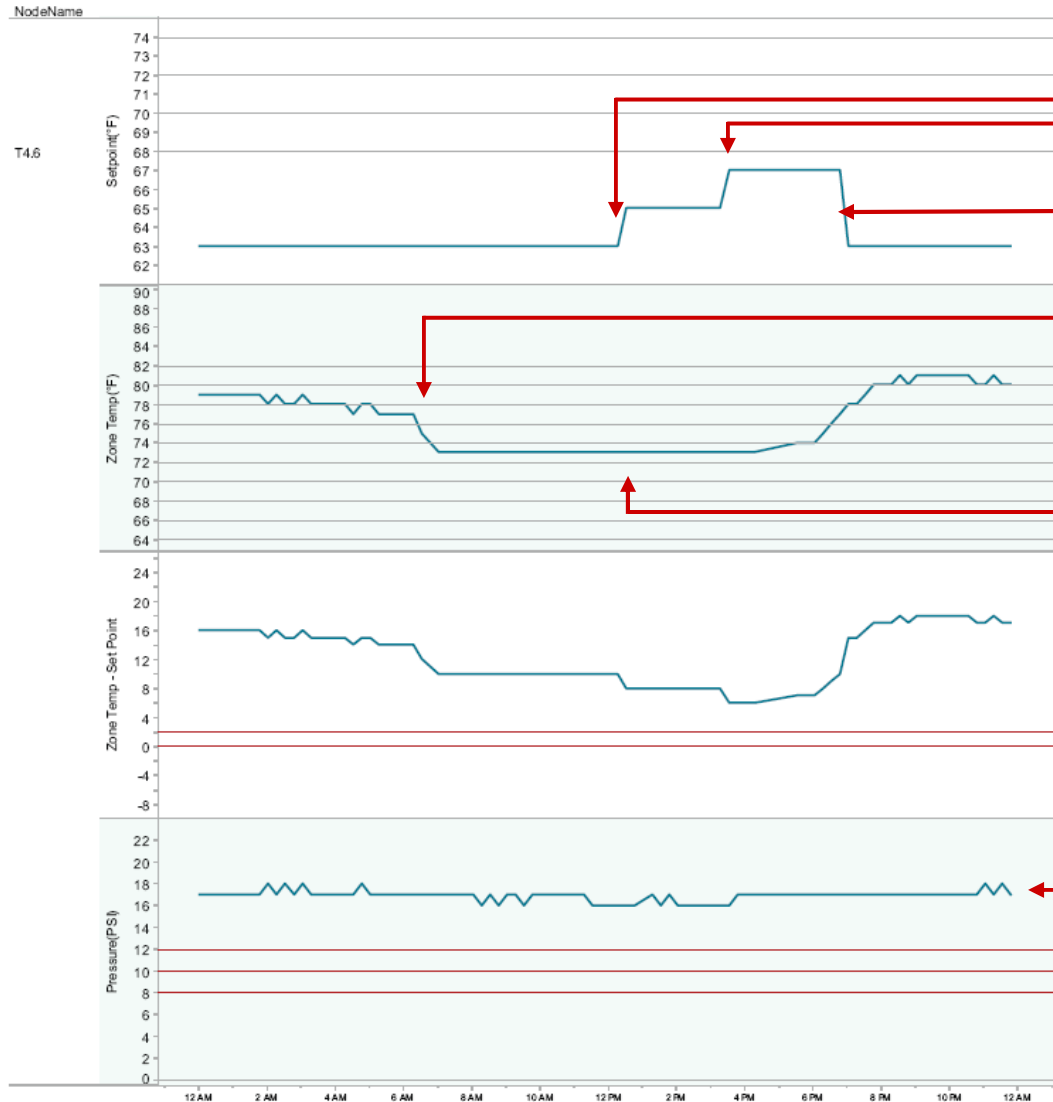
			Energy & Atmosphere, continued			
			<b>Existing Building Commissioning</b>			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Credit 2.1	<b>Investigation and Analysis</b>	✓	2
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Credit 2.2	<b>Implementation</b>	✓	2
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Credit 2.3	<b>Ongoing Commissioning</b>	✓	2
			<b>Performance Measurement</b>			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Credit 3.1	<b>Building Automation System</b>	✓	1
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Credit 3.2-3.3	<b>System Level Metering</b>		1 to 2
			Credit 3.2	40% Metered		1
			Credit 3.3	80% Metered		2

***Tenant Comfort and Satisfaction, Ability to Attract Top Tier Tenants, and Lower Lease Churn Rates Are Incremental to Energy Savings Benefits***

# Zone Behavior – Proper Response (example)



# Zone Behavior – Insufficient Cooling (example)



## SETPOINT TEMPERATURE

- 1<sup>st</sup> DR Event bumped up setpoint 2 deg
- 2<sup>nd</sup> 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.

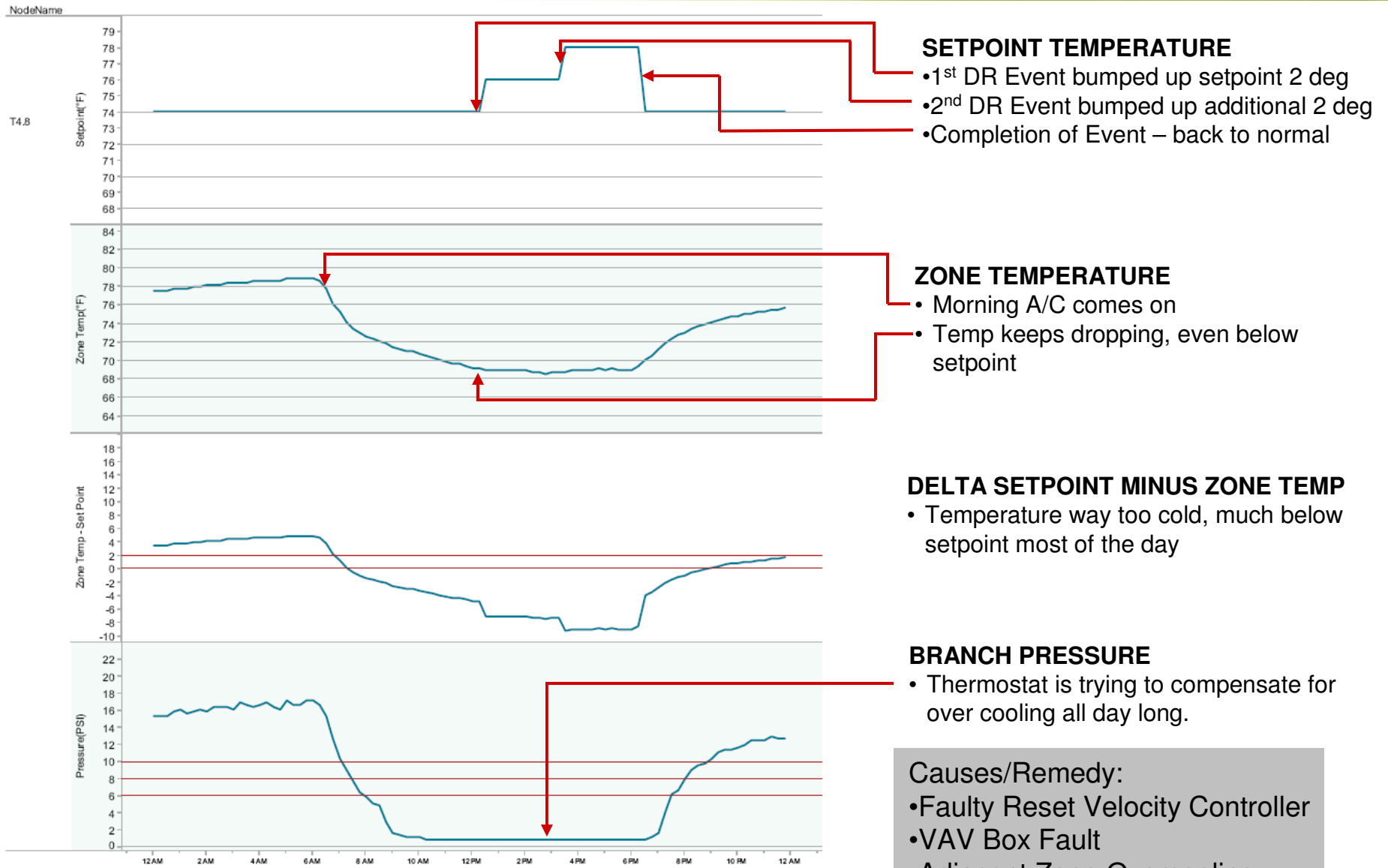
## BRANCH PRESSURE

- 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)



**Causes/Remedy:**

- Faulty Reset Velocity Controller
- VAV Box Fault
- Adjacent Zone Overcooling

# Additional Energy Savings: Deadband Option

## What is it?

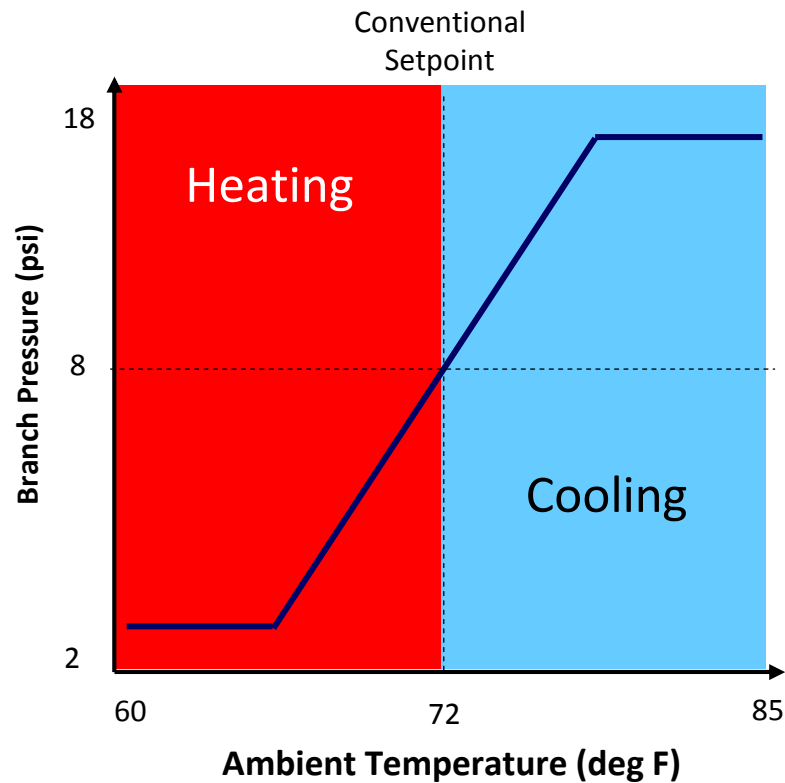
- When ambient temperature is within certain limits e.g. between 68F and 78F, *ALL HEATING AND COOLING IS DISABLED*.
- When ambient temperature is outside these limits, heating and cooling is *ENABLED* to maintain basic comfort.

## Why?

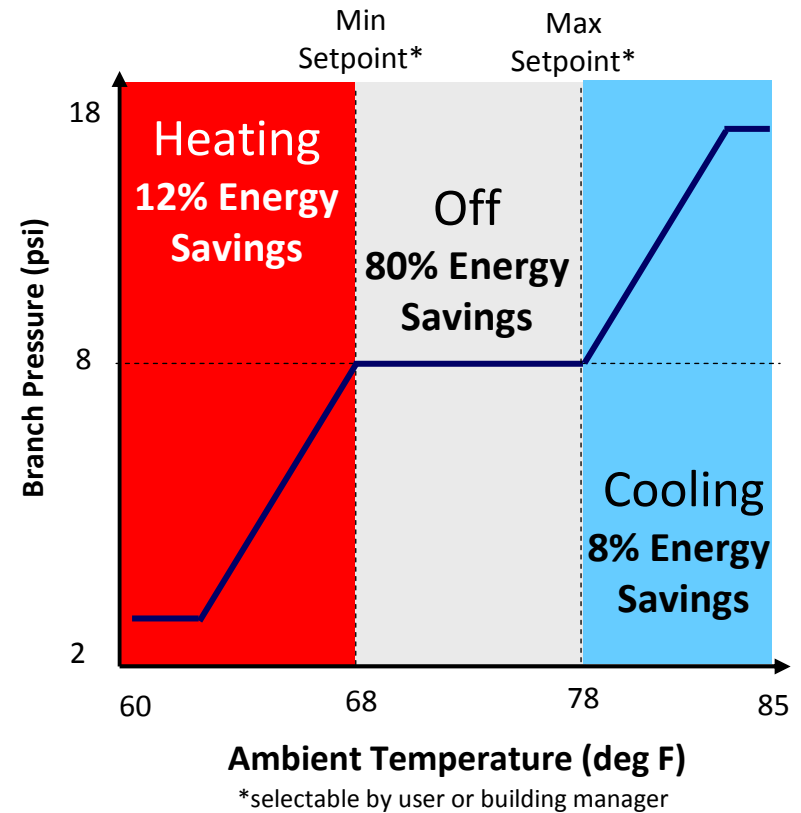
- Up to 60% energy savings potential, for occupants who can tolerate some range of temperature swing.
- Many universities and public institutions have mandated this type of temperature setpoint policy...the Deadband WPT enables and automatically enforces the policy.
- Benefits are INCREMENTAL to Night Setback, Occupancy Override, Demand Response and other energy management strategies available with the standard WPT (and also available on deadband WPT).

# Comparison: Standard Pneumatic vs. Deadband

Standard Pneumatic  
Thermostat Behavior  
(Typical, Direct Acting)











Deadband Pneumatic  
Thermostat Behavior  
(Typical, Direct Acting)



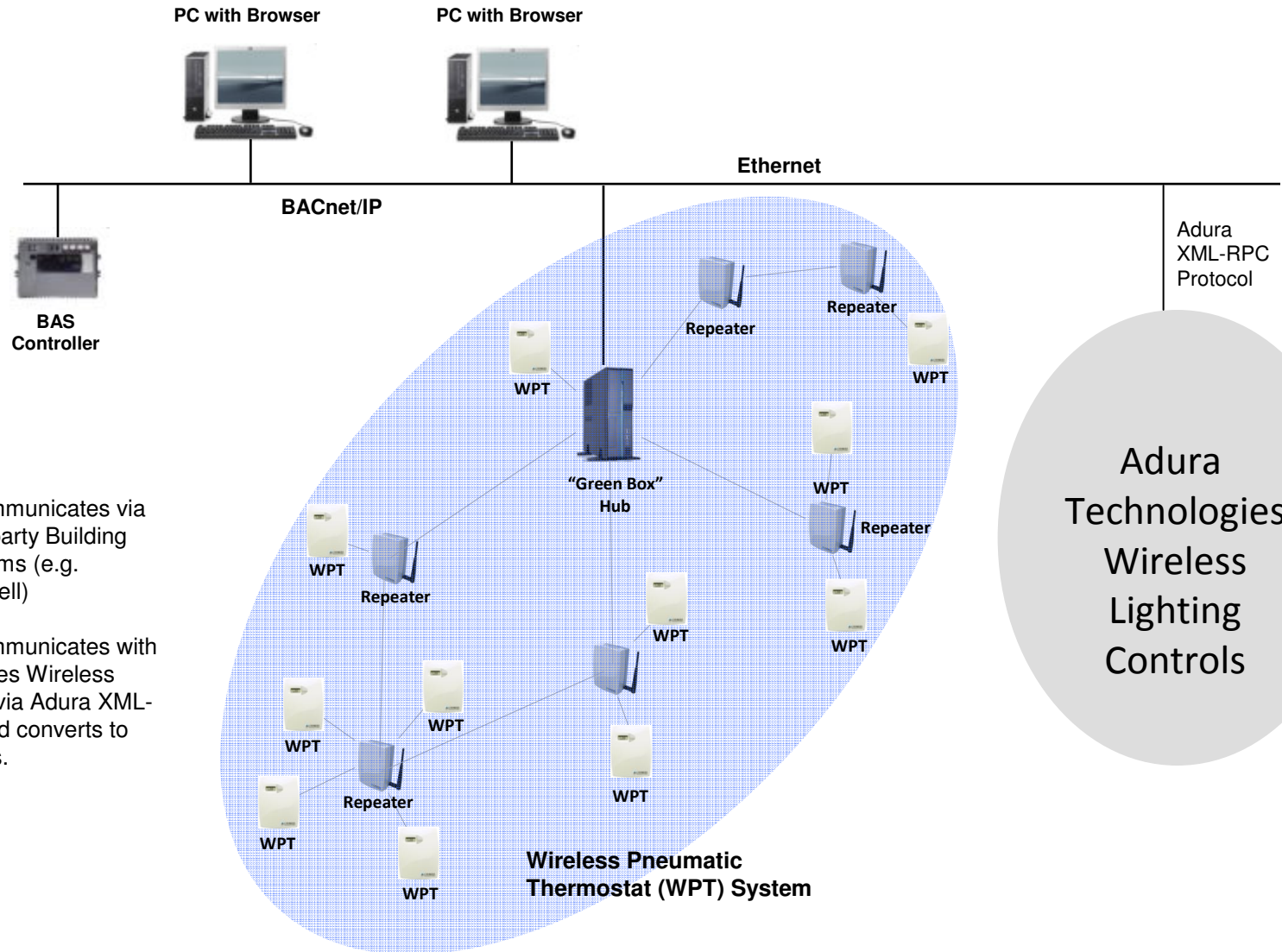
**Up to 60% Energy Savings vs. Conventional Thermostat Control**

# Compatible with Existing Systems

VENDOR	BAS	TEST PARTNER	LOCATION
	BACtalk	Syserco	Fremont, CA
	ALC	ACCO Engineered Systems	San Leandro, CA
	Excel, Tridium	Honeywell Corp.	Golden Valley, MN Wixom, MI
	Metasys	RSD-Total Control JCI Sensor Products	San Jose, CA Milwaukee, WI
	Apogee	Siemens Building Technologies	Hayward, CA
	Andover Continuum	EMCOR Integrated Solutions	Pleasanton, CA
	Trane Tracer Summit BCU	Trane	Calgary, Alberta - Canada
	ORCA	Cypress Semiconductor	San Jose, CA

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# Current Wireless Pneumatic Thermostat (WPT) Architecture



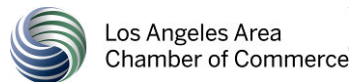
**Notes:**

WPT System Communicates via BACnet/IP to 3<sup>rd</sup> party Building Automation Systems (e.g. Johnson, Honeywell)

WPT System Communicates with Adura Technologies Wireless Lighting Controls via Adura XML-RPC interface, and converts to BACnet/IP objects.



# Selected Cypress Envirosystems Customers

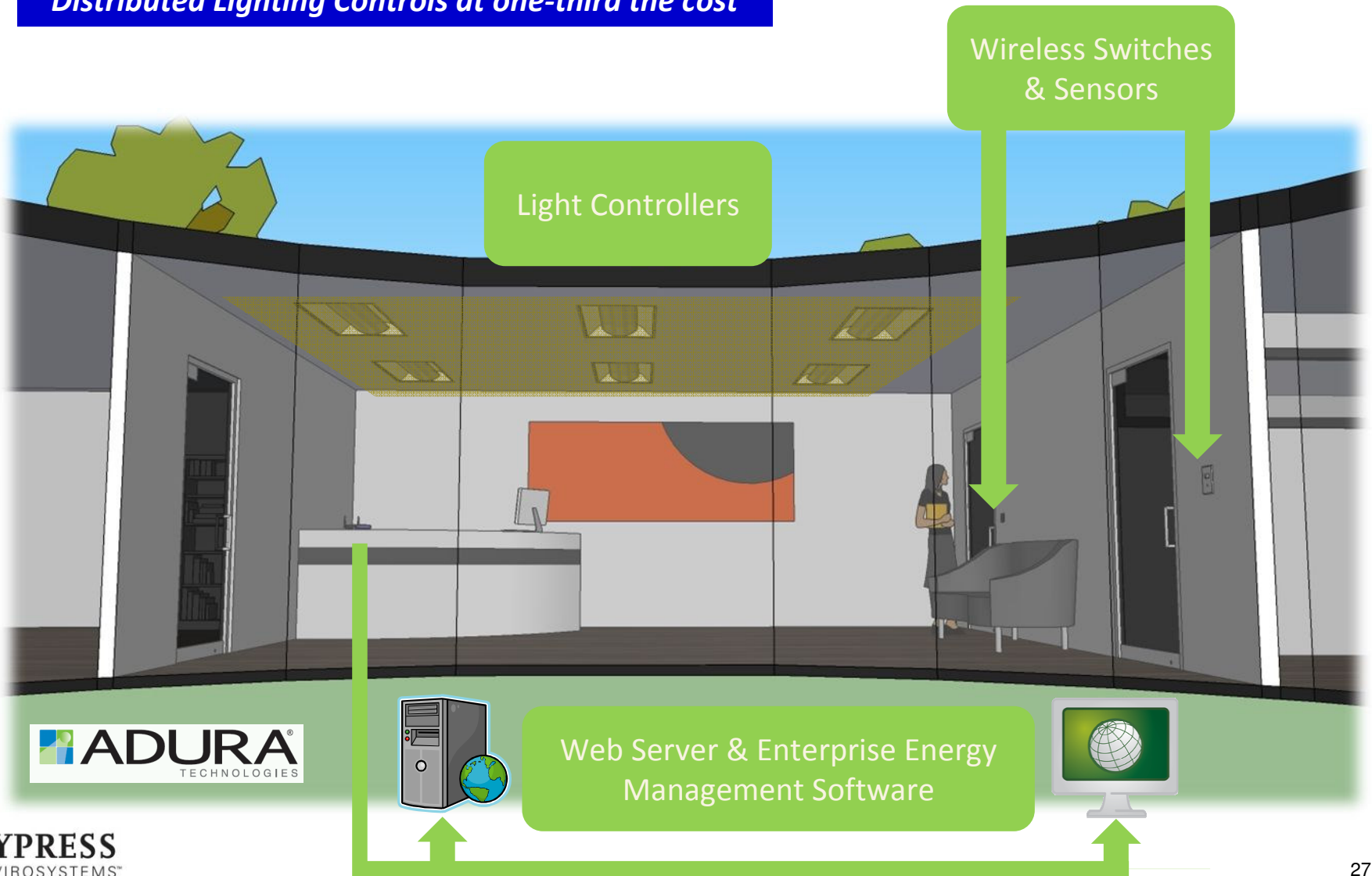




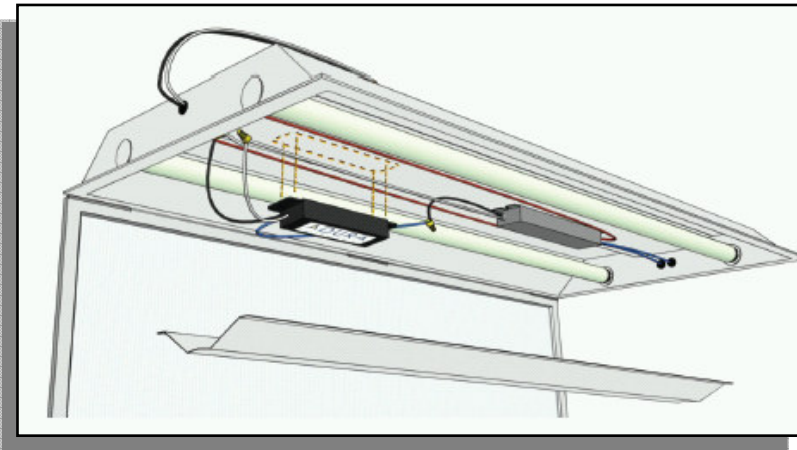
# ***Lighting Controls Retrofit***

# Wireless Lighting Controls

*Distributed Lighting Controls at one-third the cost*



# Easy Retrofit of Existing Fixtures





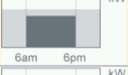

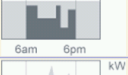
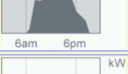
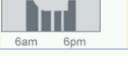
Lighting Controller



Occupancy or Light  
Sensor Interface



Wall Control  
Interface

Strategy Employed	Savings Expected	
Smart Scheduling	10-40%	
Daylight Harvesting	5-15%	
Task Tuning	5-20%	
Presence Detection	25-50%	
Personal Control	5-15%	
Demand Management	5%	
<b>Total</b>	<b>50-75% (Blended)</b>	

*“Plus....sophisticated Enterprise Energy Management software designed to work with your lighting system to save energy”*



# ***Energy Auditing & Continuous Commissioning***

# Cypress Envirosystems: Problems We Solve...



*Pneumatic  
Thermostats*



*Dial Gauges*

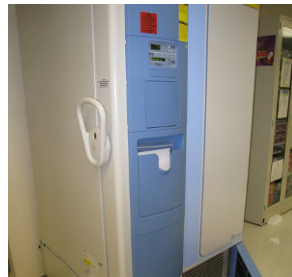


*Steam Traps*

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*Standalone Transducers,  
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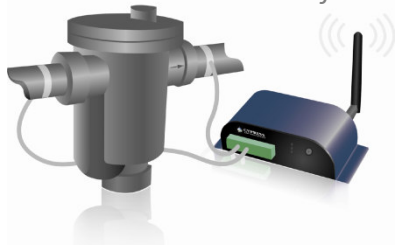
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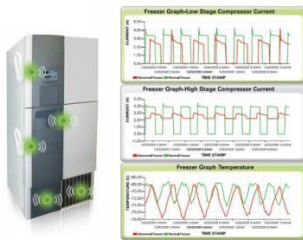
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# Energy Audits, Continuous Commissioning



Typical Air Handler Units



Wireless Magnetic Reader  
Monitors Filters and Airflow

- Chilled Water, Steam, Airflow are tough to measure in legacy buildings
- Most older Air Handler Units, Chillers, Boilers etc. are not monitored/automated
- Labor intensive to detect problems, check filters
- Manual gauges often the main means to check pressure, temperature, flow
- Solution: Wireless Gauge Reader clamps on in minutes and transmits reading wirelessly to BMS/BAS
- No downtime, no wiring, no leak checks
- Alarm notification and condition-based maintenance



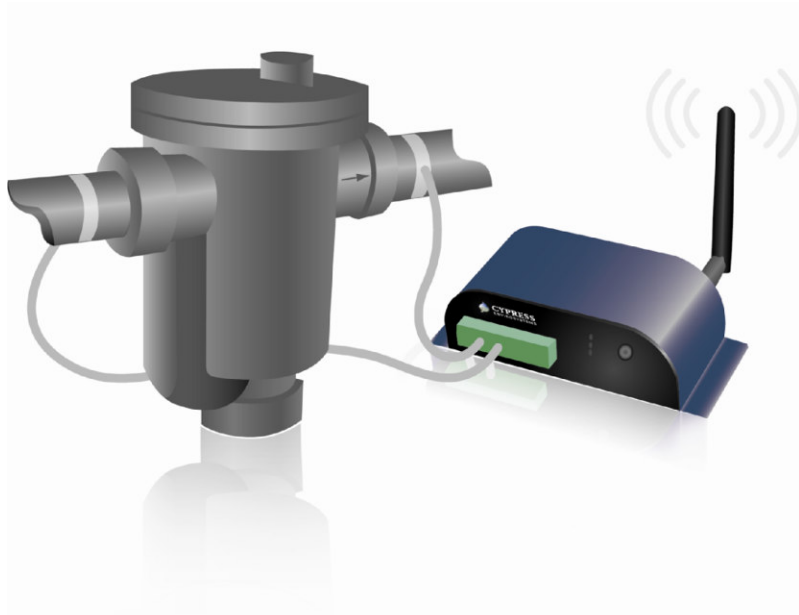
Wireless Readers  
Mounts Over Existing Gauges

***Enables Monitoring of Legacy Air Handlers for 70% Less Than Traditional Transducers***



# 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



Leaking Traps Waste Energy

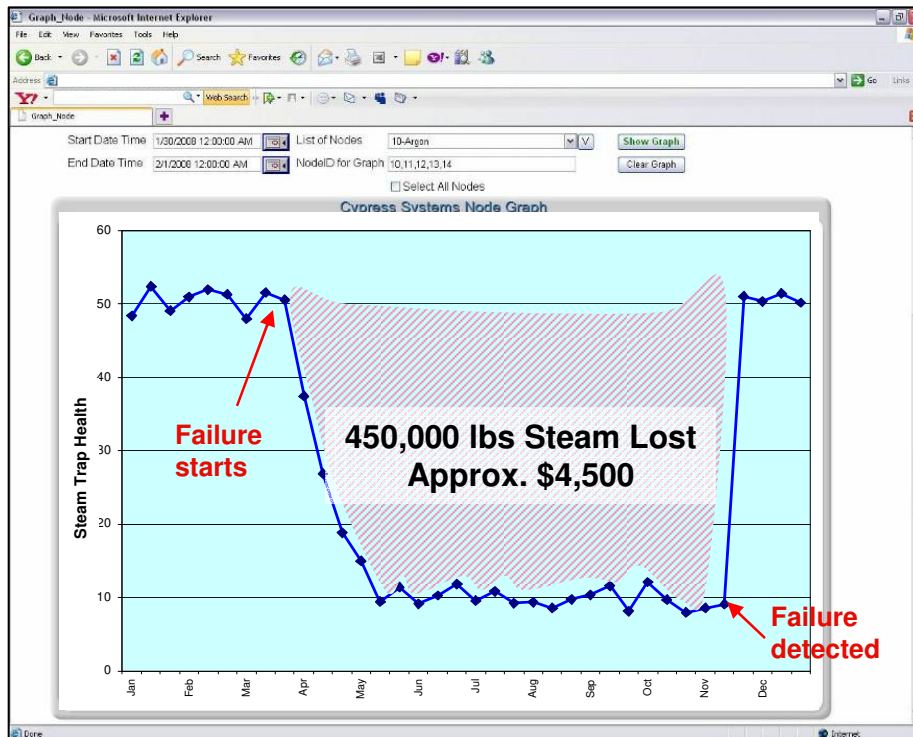


Typical Steam Trap

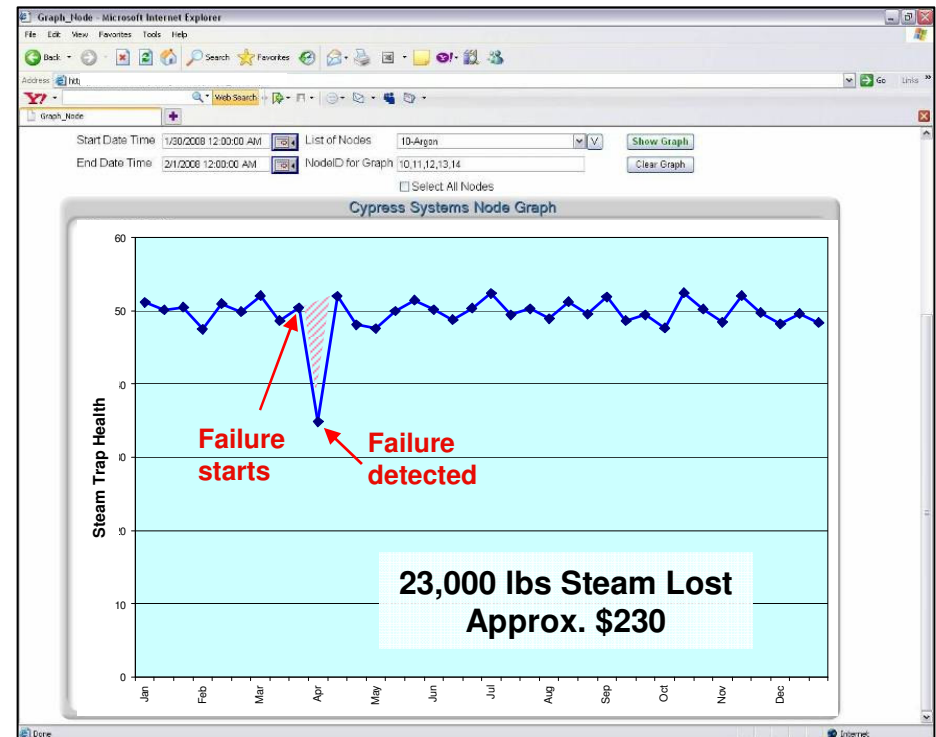
**Save Energy and Time Locating Faulty Steam Traps**

# 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 Steam Leaks**

# Summary

- Retrofit for Commercial and Industrial Plants for Energy Efficiency and Auto-Demand Response
- Key Principles:
  - Non-Invasive, Clamp-on Devices Which Install in Minutes
  - Compatible with Existing Infrastructure
    - DDC Integration
    - No new training of staff
    - No new systems software
- Typical Payback of 18 Months or Less



# ***Additional Backup Examples***

# Reduce Energy Consumption: Compressed Air

## Customer Challenge:

Compressors, pumps and fans often run at settings beyond what is needed e.g. 125psi for Compressed Dry Air instead of 85psi, wasting >20% energy.

Operators lack monitoring so they don't reduce pressure – avoid risk of process upset.

Installing transducers is very time-consuming & disruptive for multiple air branches and can introduce leaks.

## WGR Solution:

Typically manual gauges are already installed throughout CDA systems or coolant loop systems.

WGR's can monitor and alarm pressure/flow to ensure process integrity and reduce energy use.

App note available:  
*"Compressed Dry Air System Energy Savings"*



**Savings on 500hp Compressed Air System can be up to \$100K per year, with a 8 month payback.**

# Improve Asset Health and Uptime

## Customer Challenge:

Older equipment such as packaged heat exchangers, boilers, chillers, air dryers, hydraulic conveyors, water filters, HEPA filters, etc. often have little or no electronic monitoring outputs.

Adding new transducers require modifying the equipment package and may impact existing service/warranty agreements.

## WGR Solution:

Typically manual gauges are already installed on older packaged equipment.

The WGR can monitor, trend and alarm parameters for early fault detection and corrective action.

Case Studies Available:  
*“Facilities Monitoring”*

*“Tri-State Power Asset Health Monitoring”*



**“In the first two weeks of using the WGR, we were able to detect and develop corrective measures for a potentially costly issue that we never suspected” – Mike Long, Control System Supervisor, Tri-State Generation and Transmission**

# Reduce Consumables Usage

## Customer Challenge:

Gas cylinders (e.g. cal gases), water filters, HEPA filters are often replaced at scheduled intervals rather than actual usage.

This results in more frequent changes than required, or results in downtime when not replaced in a timely manner.

Installing transducers may introduce leaks and require safety inspection.

## WGR Solution:

Gas Cylinder regulators gauges, Magnehelic air flow gauges (for HEPA filters) are great examples of data which can be read and trended to optimize consumables use.

Reduces consumables cost, avoids downtime, and optimizes skilled labor.

Case Studies Available:  
*"Micrel Gas Management Savings"*



**We saved \$215K per year on our 280 Gas Cylinders, a seven month payback.  
– Ron Farry, Operations Manager, Micrel Inc.**

# Perform Faster Troubleshooting

## Customer Challenge:

When excursions occur, technicians inspect many gauges and equipment in the hope of finding the source of the problem...but the relevant data was often not captured and is not available.

Often, data from different subsystems or equipment needs to be compared and time-indexed to identify the root cause.

## WGR Solution:

The WGR may be permanently or temporarily installed to log data, and notify on excursions.

The time-indexed historical record helps reduce troubleshooting time and confidence.



**Minimize Troubleshooting Labor and Downtime with  
Non-Invasive Data Logging of Historical Data**



# Enhance Safety, Reduce Incidents

## Customer Challenge:

Many facilities perform manual rounds to inspect equipment and log gauge readings.

Some gauges are in awkward locations or may pose safety risks - high up on column, near heat sources, under floor etc.

Accurately reading gauges “face-on” (without parallax) are sometimes difficult or impossible.

## WGR Solution:

Wherever there is a gauge in a hard-to-access location that needs to be read, the WGR is a fast and low cost candidate to do the job.

Reduce likelihood of safety incidents due to reading gauges in hard-to-access locations.



**“I’m not getting more engineers, so I need to have them working smarter...using the WGR”  
- Pat Ireland, Operations Manager, Novellus Inc.**