City of Fort Collins Building Automation Systems – Enhances Savings and Commissioning

Efficiency Works Training

iconergy

Energy Management & Sustainability

November 18, 2015

Agenda

- Commissioning
- Monitoring Based Commissioning
- Building Tune-up Case Studies
- Small Commercial Building Solutions

Building Commissioning Terms

- **Cx** = New Construction Commissioning
- **RCx** = Retro-Commissioning
- **Re-Cx** = Re-Commissioning
- **CCx** = Continuous Commissioning
- **MBCx** = Monitoring Based Commissioning
- **Ongoing Cx** = Ongoing Commissioning

Single Instance / Periodic Activities

Ongoing Optimization

Drivers for Ongoing Cx

- Four years after energy efficiency projects were completed, energy savings dropped by 25% (loss of ~ 6%/year)

  **Study by Texas A&M Energy Systems Lab for the US DOE and IEA (IEA Annex 47 Subtask C Final Report, 2009)*

- 22 of 96 (23%) energy efficiency measures failed since installation 3-4 years ago

  **SBW, Final Report 2006-08 CA RCx Impact Evaluation, 2010*

5-20%
Initial Energy
Savings Potential

OCx Drivers - Building Drift

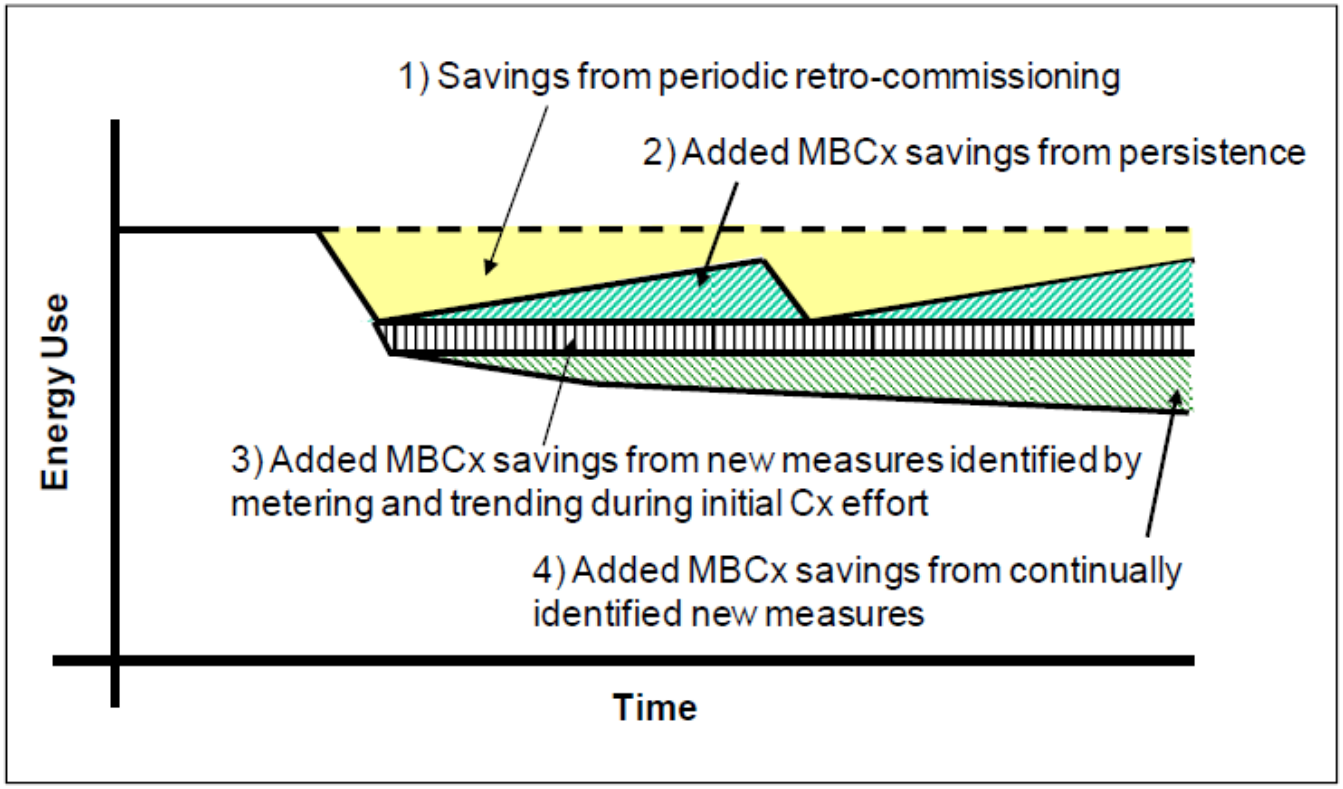
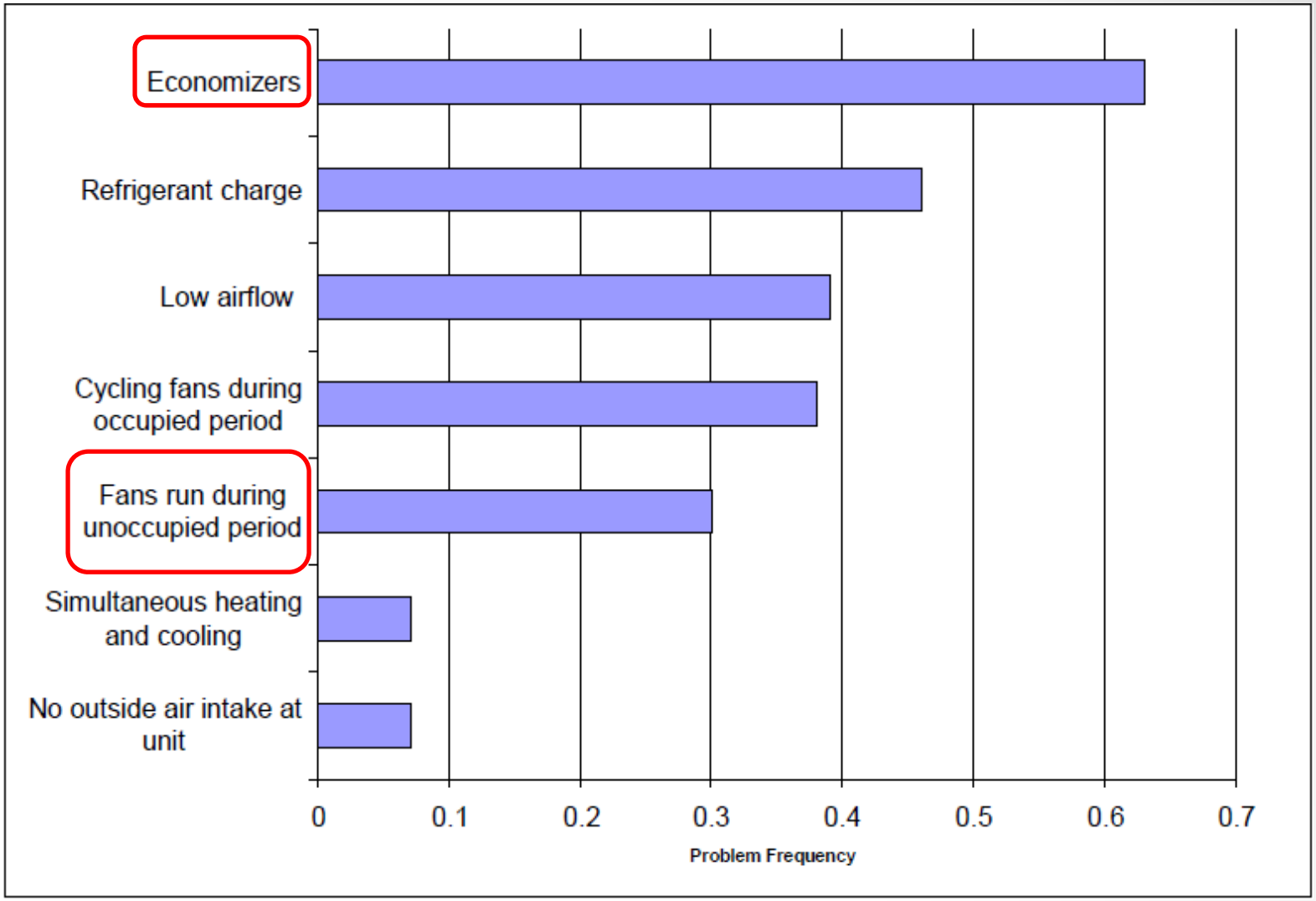


Figure 1. MBCx provides three streams of additional energy savings relative to RCx.

**Lawrence Berkeley National Laboratory, June 2009 report - Monitoring-Based Commissioning: Benchmarking Analysis of 24 UC/CSU/IOU Projects*

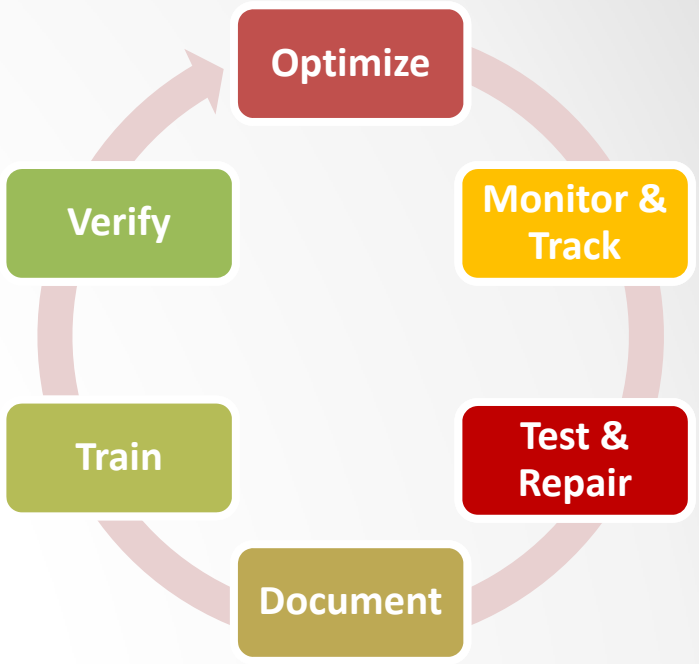
OCx Drivers – Common RTU Faults



**Public Interest Energy Research Program, 500-03-082*

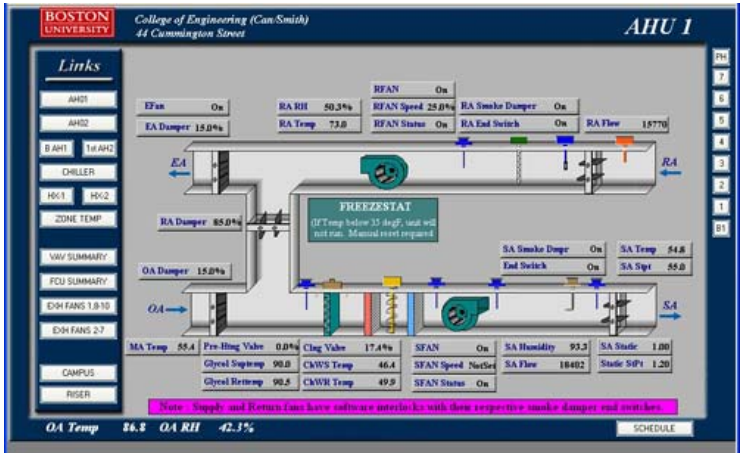
Ongoing Cx Process

- Optimize with Cx/RCx – correct issues, change sequences
- Track performance - monitor operation over time
- Test equipment with faults, make repairs (fix issues, calibrate, fine tune)
- Update documentation and staff training
- Verify energy consumption and savings with monitored data



Implementing OCx / MBCx

- Monitoring Based Commissioning (MBCx)
  - Automated Ongoing Cx
  - Integrate to the Building Automation System
    - Bacnet, Lon, OBIX, SQL, Haystack
    - Link MBCx Software Server to BAS data

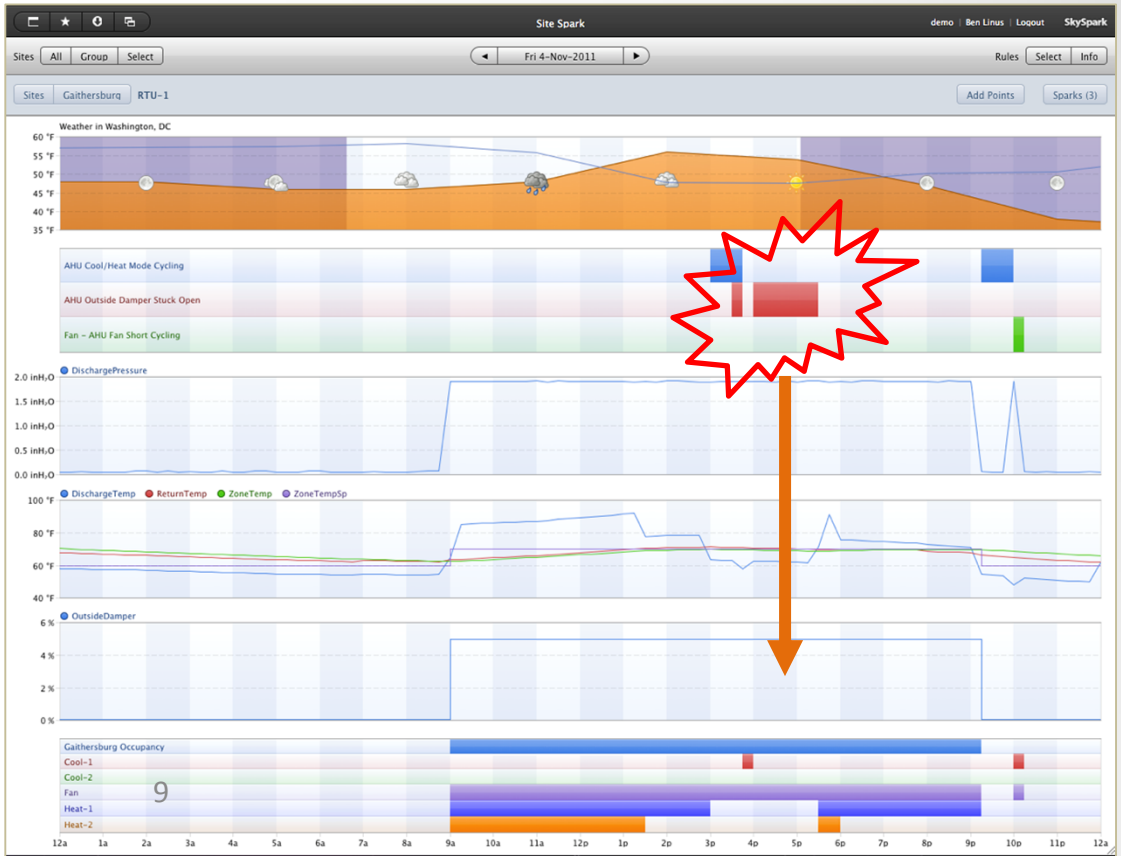


Iconergy Project Approach

- Monitoring Based Commissioning
  - Retro-Commissioning
  - Ongoing Commissioning

SkySpark by SkyFoundry

* Continuous Monitoring-based Commissioning
* Performance for the life of the building



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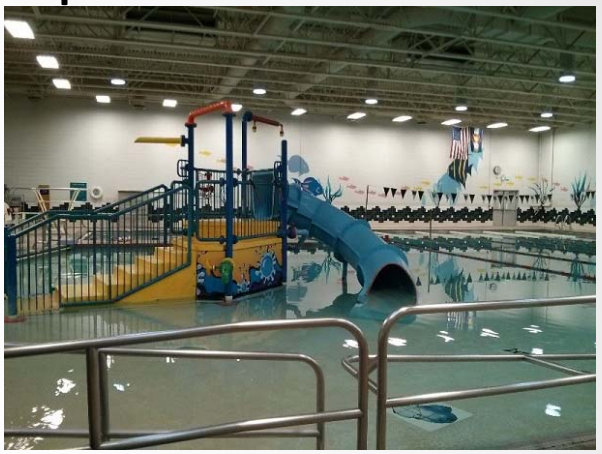
Energy Management & Sustainability

RCx Case Study: Mulberry Pool

Measures Identified and Completed:

- ✓ Replaced Broken Pool Humidity Sensor
- ✓ Corrected schedules for Non-Pool RTUs
- ✓ Reset outside airflow and controls for Pool RTUs
- ✓ Improved Pool Exhaust Airflow Control
- ✓ Optimized Heat Recovery Pump and Damper Control
- ✓ Optimized Water Feature Controls
- ✓ Implemented Pool Daylighting Controls
- ✓ Optimized 2 RTU Economizers

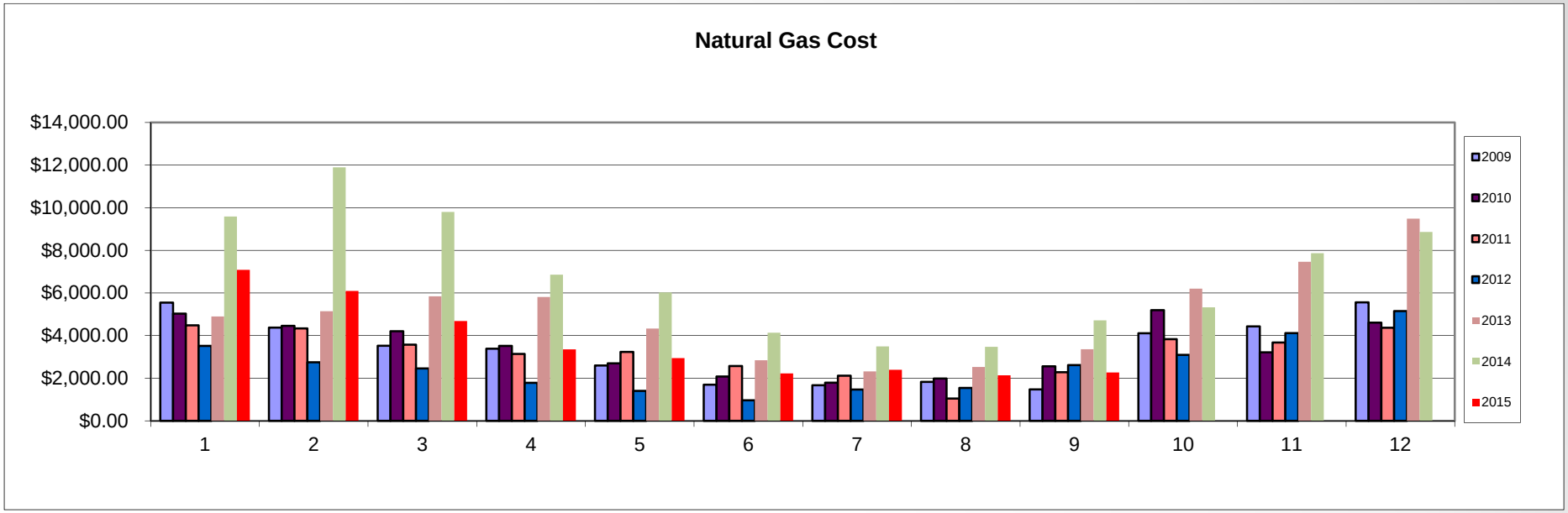


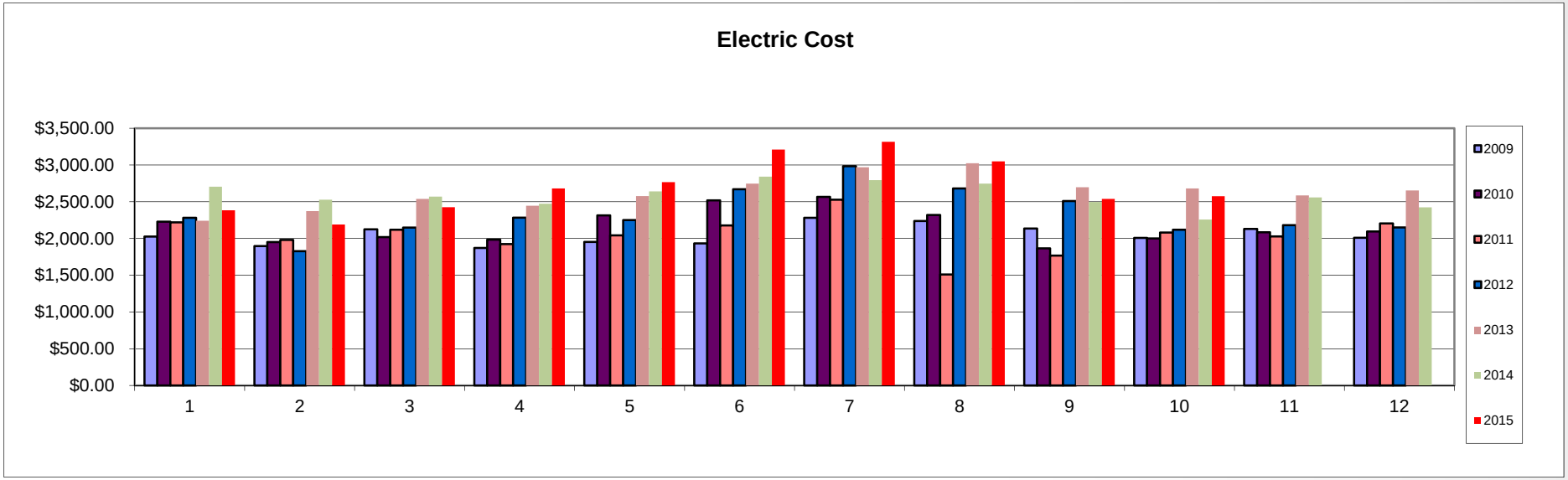
RCx Case Study: Mulberry Pool

RCM Measure Description	Total Cost Savings	Measure Incremental Cost ($)	Simple Payback (yrs)
Schedule Non-Pool RTUs (RTU-1 and RTU-2)	$998	$675	0.68
Control Outside Air on Pool RTUs (RTU-3 and RTU-4)	$16,101	$2,500	0.16
Pool Exhaust AirFlow Control	$11,442	$2,900	0.25
Optimize Heat Recovery Pump and F/B Damper Control	$2,617	$900	0.34
Optimize Water Feature Pumping	$532	$75	0.14
Pool Daylighting Controls	$636	$400	0.63
RTU-1 & RTU-2 Economizer Optimization	$71	$600	8.48
Totals (For all Selected (X) values only)	$32,396	$8,050	0.25

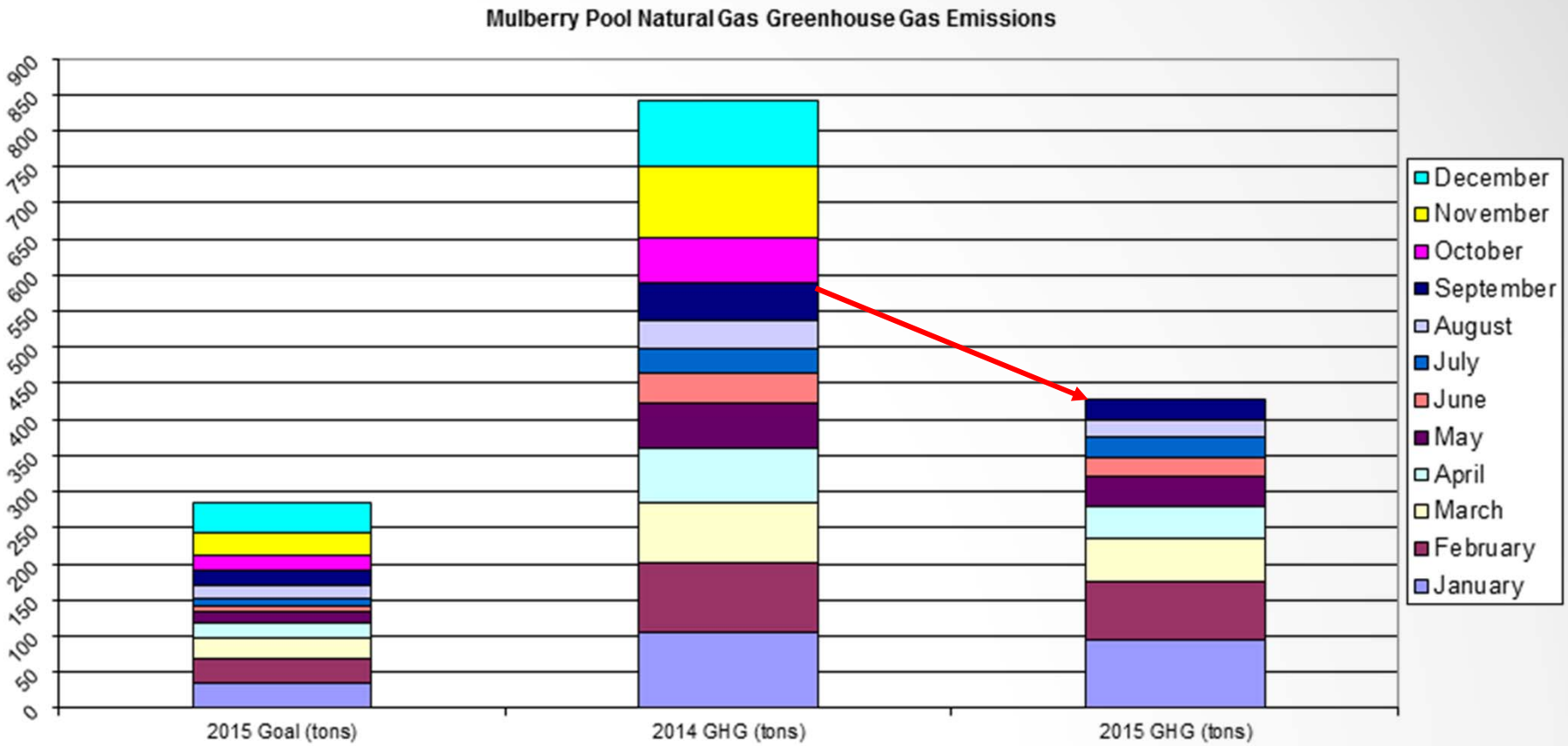
	Electric	Gas
Percent Savings	11%	38%

RCx Case Study: Mulberry Pool



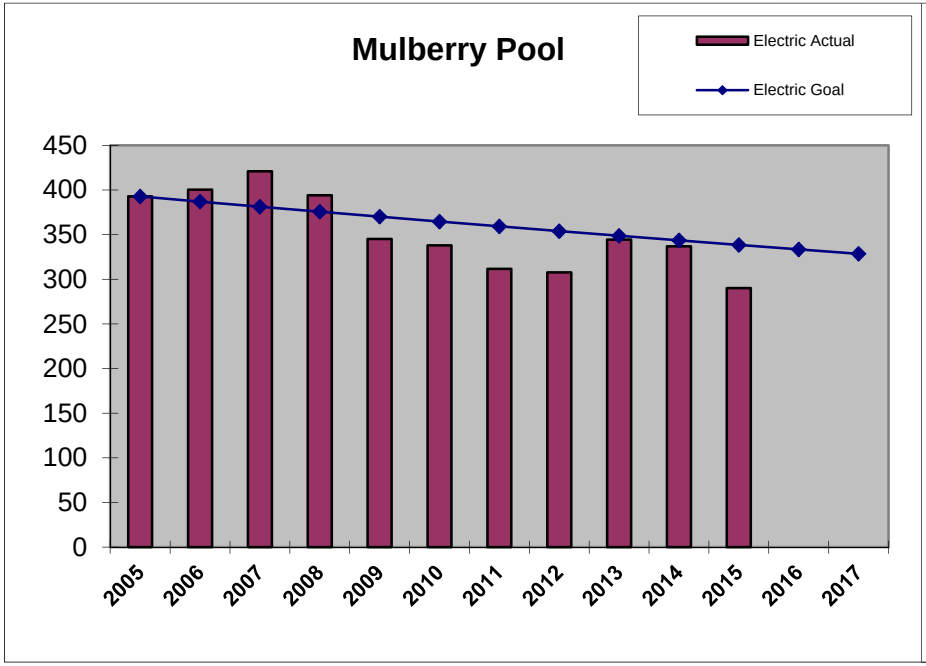


RCx Case Study: Mulberry Pool

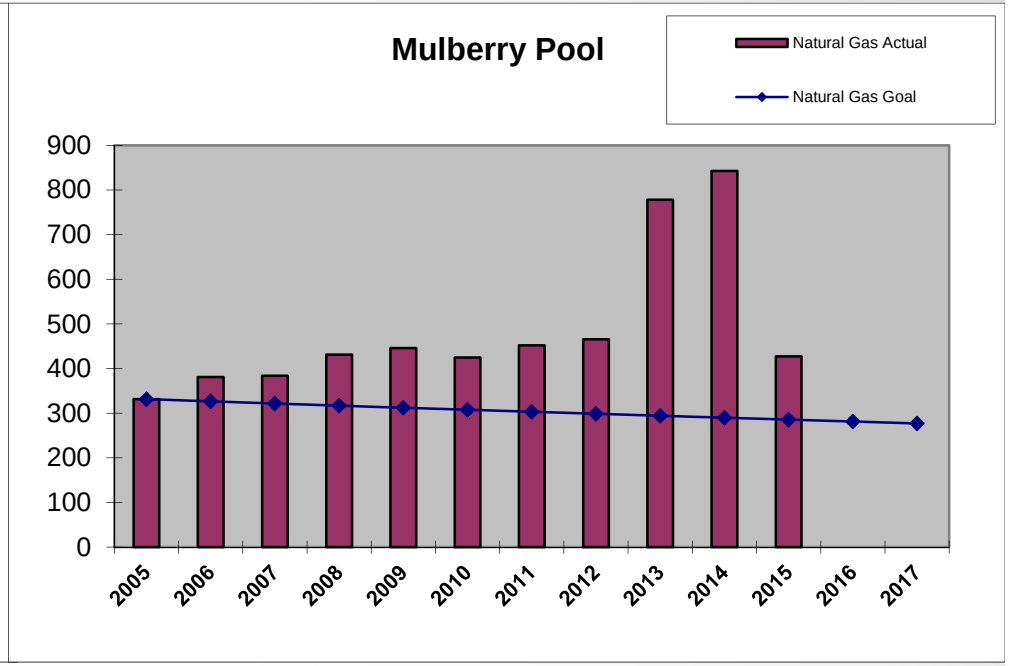


RCx Case Study: Mulberry Pool

Electric Use



Natural Gas Use



Note 2015 gas data is missing Oct, Nov, Dec
Note 2015 electric data is missing Nov, Dec

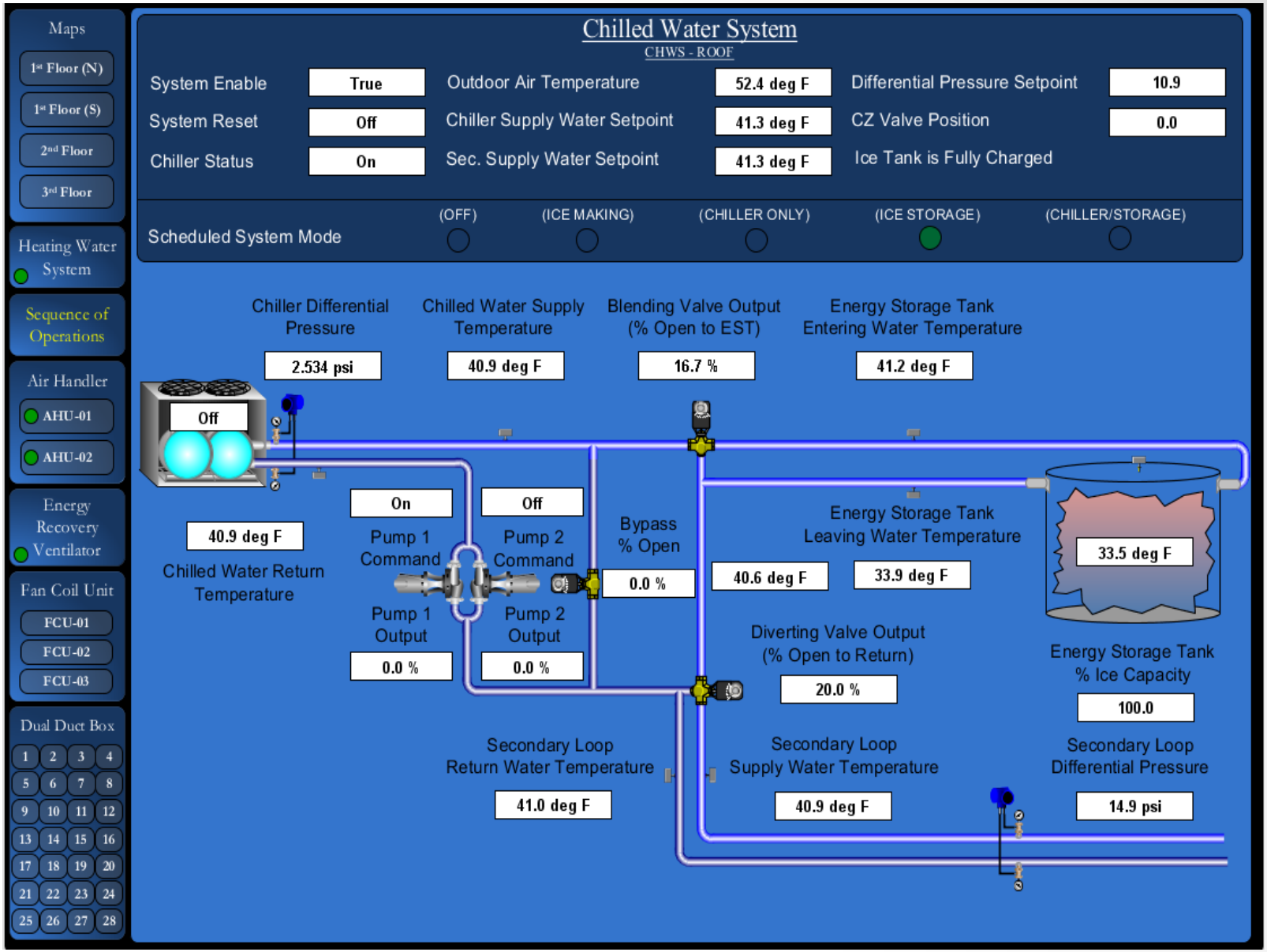
RCx Case Study: Museum of Discovery

Measures Identified and Completed:

- ✓ Heating Plant ran 24/7/365
- ✓ Chiller Thermal Ice Storage Plant made ice **every** night
- ✓ AHUs and ERV were operating 24/7/365
- ✓ AHU Evap Cooling had a broken valve, didn't operate
- ✓ Optimized AHU temp and pressure setpoints
- ✓ De-lamp daylight areas

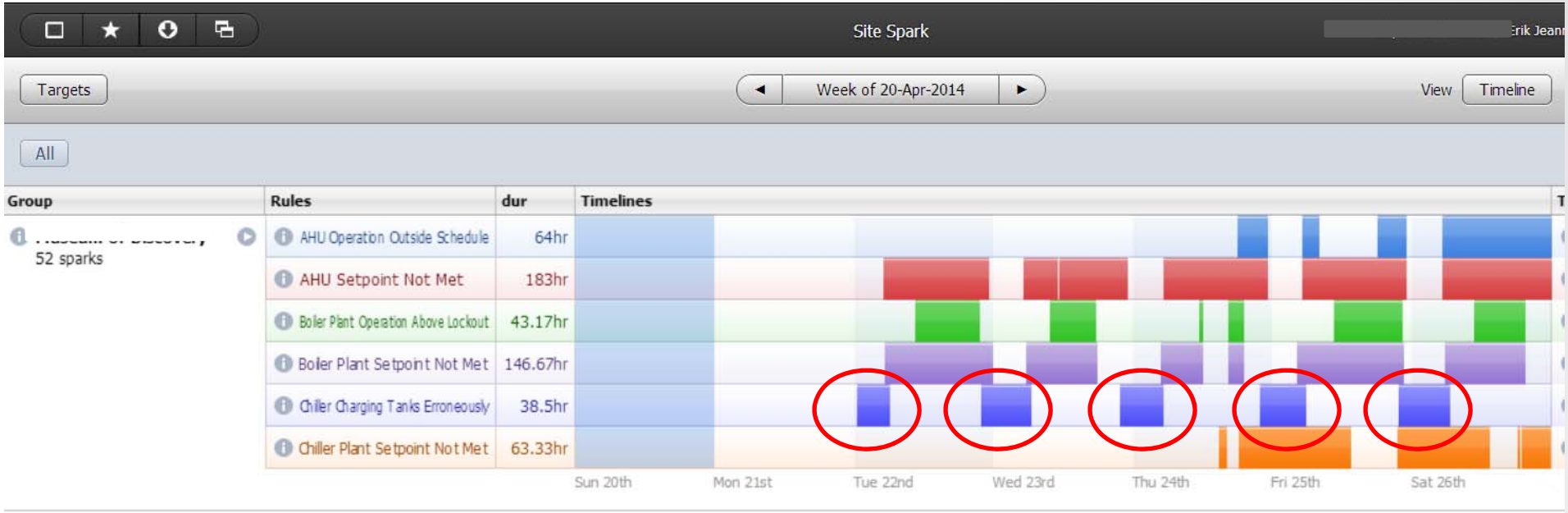
FORT COLLINS MUSEUM OF DISCOVERY
Expand your mind. Engage your world.

Implementing OCx / MBCx

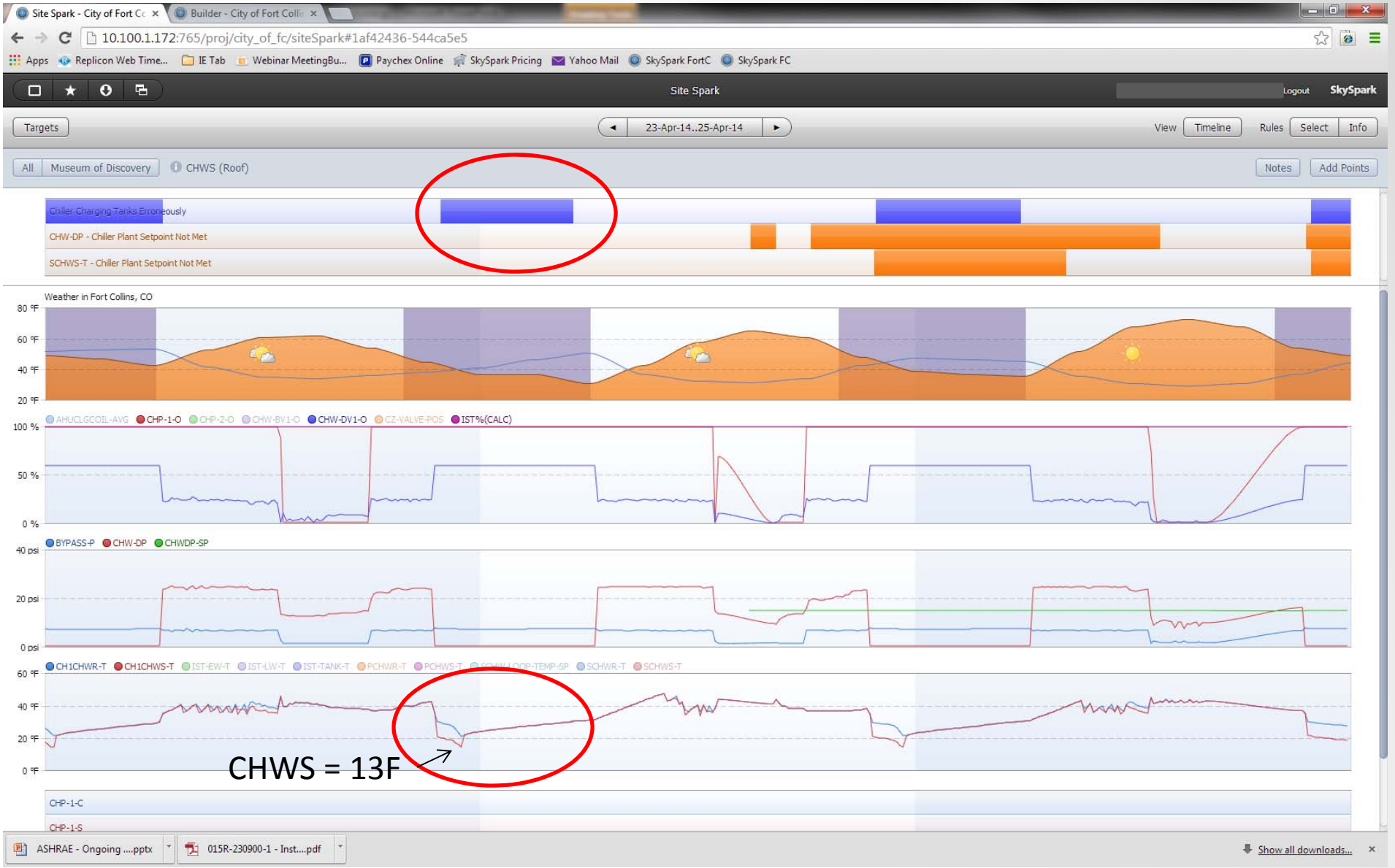


Implementing OCx / MBCx

- Writing “Rules”
  - Rules are used to identify operational or efficiency issues. Fault Detection Diagnostics



Implementing OCx / MBCx



Implementing OCx / MBCx

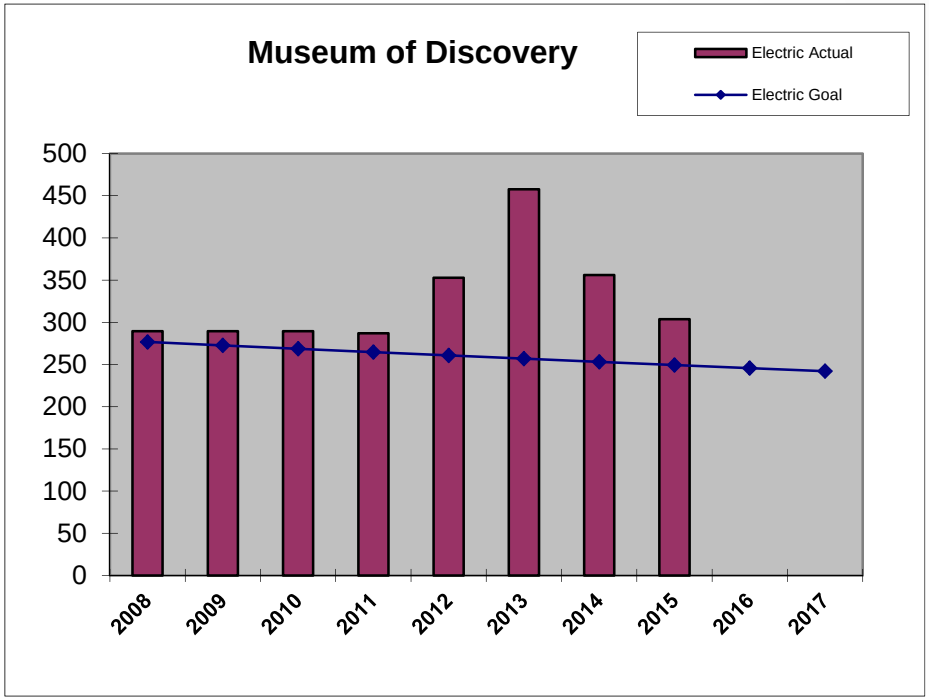
- "Rule" Example
  - Ice Tank Thermal Energy Storage
    - **Every night (7 days) Ice Charge enables when ice is already Full!**
    - **Pumps run, chiller runs at 100% for 1.5 hr**
    - **Secondary valve is 60% instead of 0% bldg**
      - **13^{0}F water to entire building**

RCx Case Study: Museum of Discovery

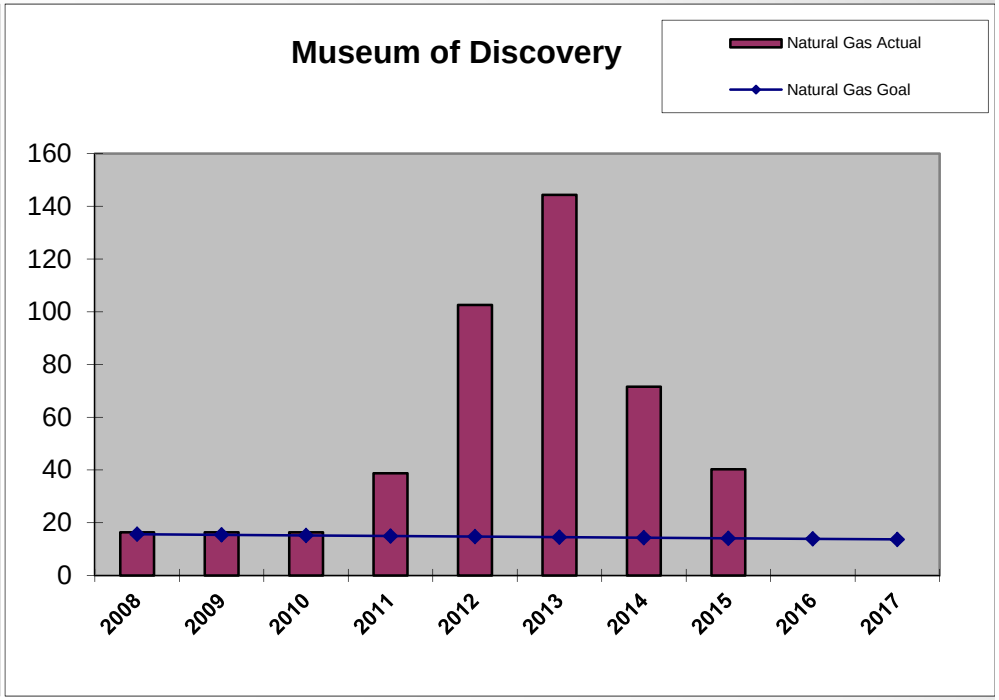
RCM Measure Description	Annual Electric Energy Savings (kWh/yr)	Annual Gas Energy Savings (Therms/yr)	Total Cost Savings	Measure Incremental Cost ($)	Simple Payback (yrs)
Heating Plant Lockout	1,781	1,444	$939	$675	0.72
Cooling Plant Lockout	5,964	-	$245	$675	2.76
Chiller Ice-Making Operation	22,562	-	$945	$675	0.71
Chilled Water Pump VFD Control	6,699	-	$275	$2,450	8.92
Utility Hot Shot Demand Limiting	-	-	$189	$675	3.57
AHU + ERV Schedule Operation	23,214	2,922	$2,714	$675	0.25
AHU Supply Duct Static Pressure Reset	530	-	$22	$675	31.02
AHU Unoccupied Mixed Air Temperature Control	1,909	605	$441	$375	0.85
ERV Direct Evap Control & SAT Reset	1,510	206	$169	$1,700	10.08
South Hall and Entry Daylighting Control	818	-	$34	$4,075	119.04
Plug Load Management (3)	9,100	-	$378	$3,375	8.92
Totals (For all Selected (X) values only)	**74,086**	**5,177**	**$6,350.46**	**$16,025.00**	2.52

RCx Case Study: Museum of Discovery

Electric Use



Natural Gas Use



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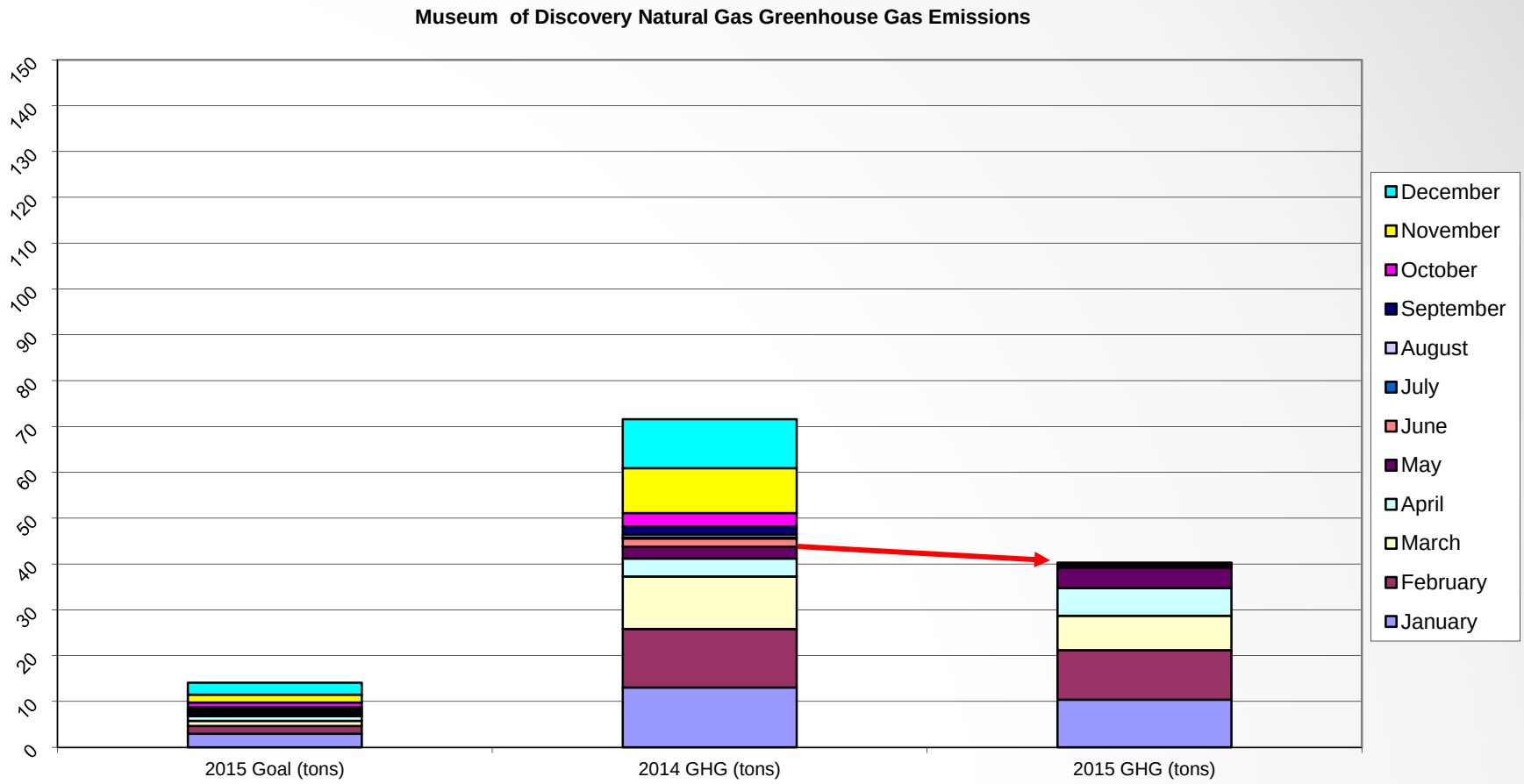
RCx Case Study: Museum of Discovery



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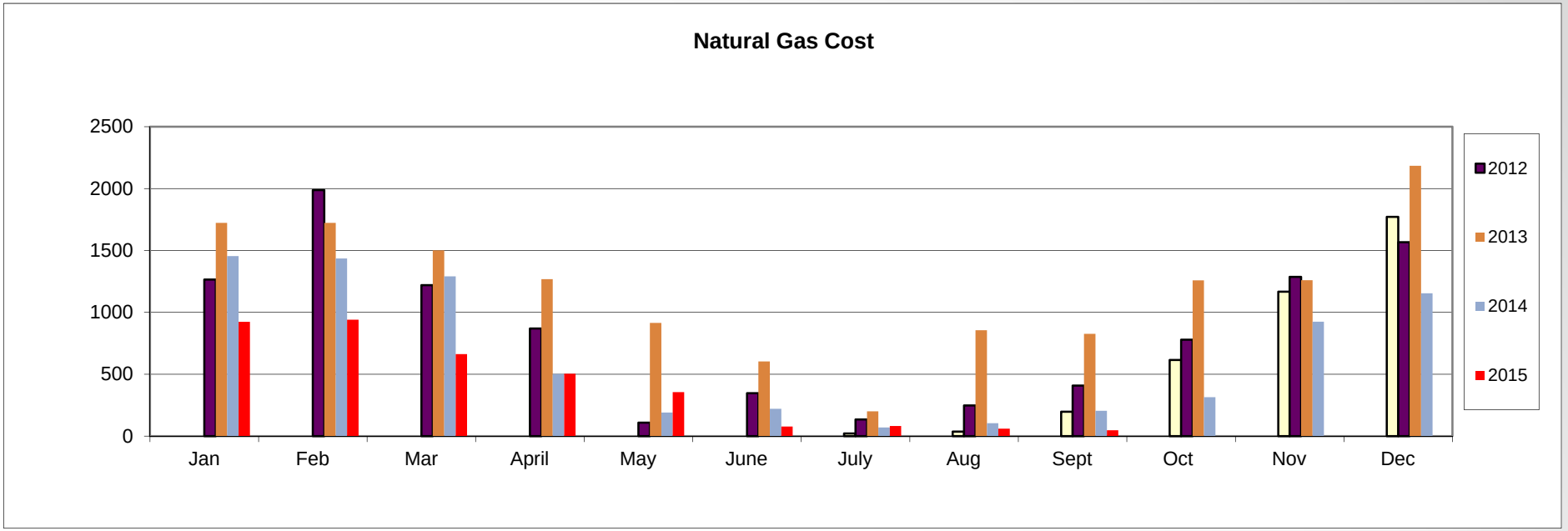
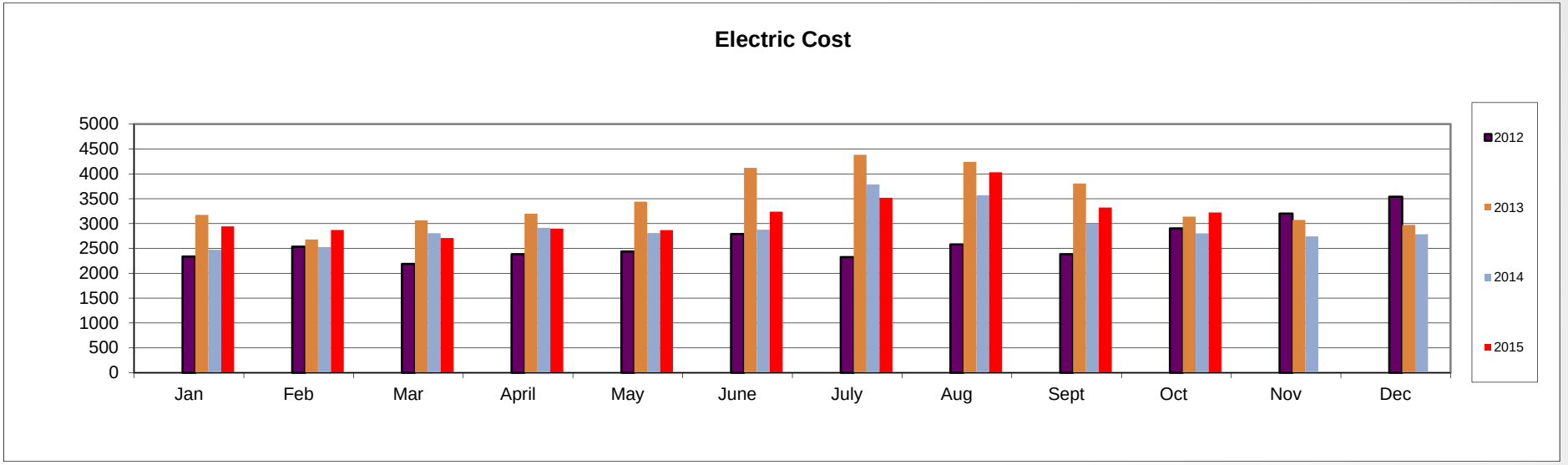




RCx Case Study: Police Services

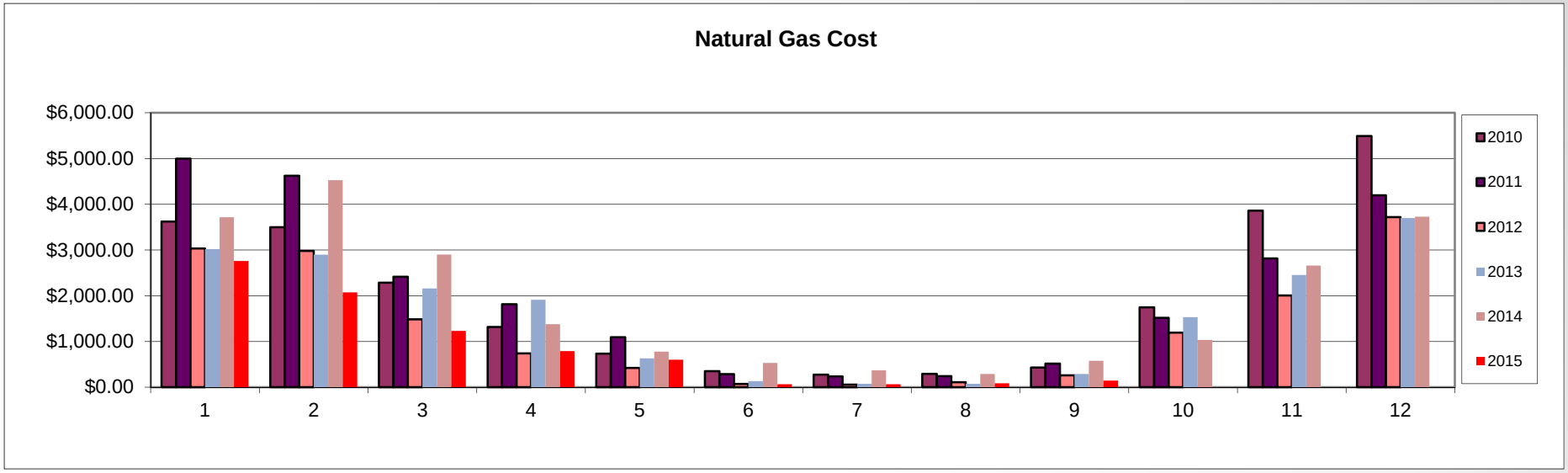
Measures Identified and Completed:

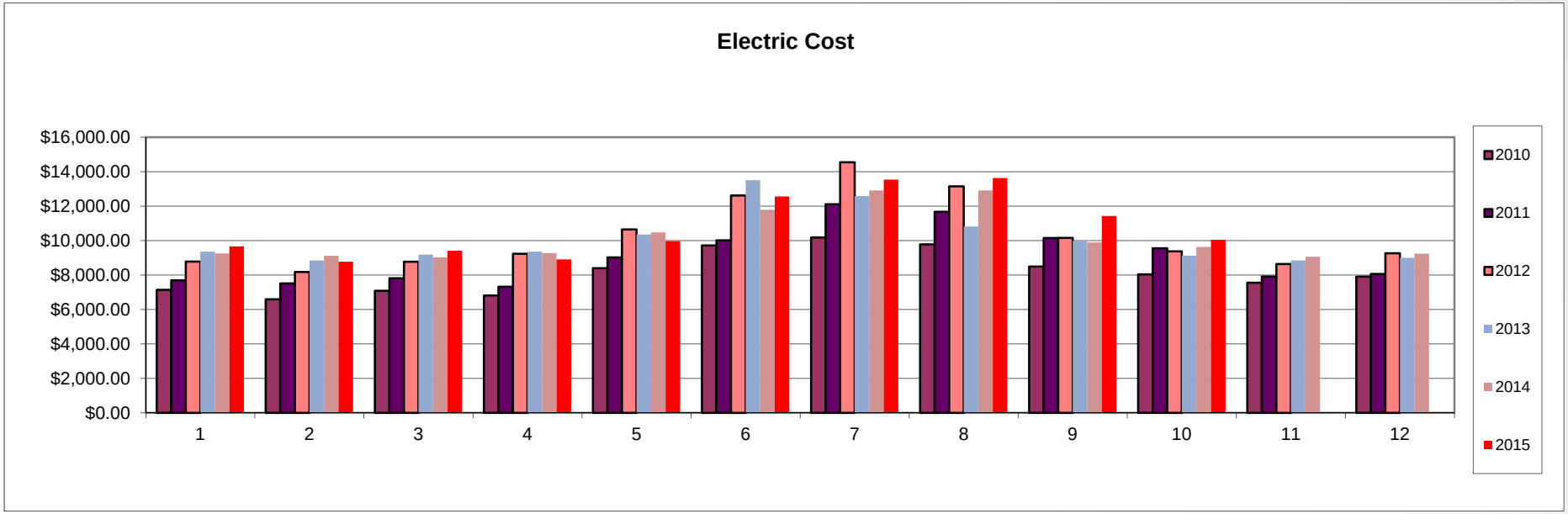
- ✓ Added schedules to Terminal VAV boxes (set to 0CFM)
- ✓ Install synchronous belts on large fans
- ✓ RTU hot water valve water leakby

RCx Case Study: Police Services

RCM Measure Description	Annual Electric Energy Savings (kWh/yr)	Annual Gas Energy Savings (Therms/yr)	Total Cost Savings	Measure Incremental Cost ($)	Simple Payback (yrs)
Heating Plant Lockout	1,028	598	$401	$375	0.94
Adjust Hot Water Supply Temp Reset	(369)	65	$20	$150	7.50
Repair Hot Water Loop Differential Pressure Control	39,761	-	$1,965	$675	0.34
Utility Hot Shot Demand Limiting	-	-	$1,805	$675	0.37
Terminal Unit Scheduling	45,354	317	$2,127	$1,800	0.85
RTU-1/2 Duct Static Pressure Reset	5,734	-	$377	$675	1.79
RTU-3 Meeting Room Occupancy Control	12,034	424	$756	$3,575	4.73
RTU-3 Economizer Control	173	-	$27	$900	33.33
RTU-1/2 Hot Water Valve Leakby	13,803	6,928	$4,745	$4,400	0.93
Corridor Delamping / Daylighting Controls	23,836	-	$1,032	$750	0.73
Install Synchronous Belts on RTUs	4,566	-	$1,292	$1,818	1.41
Lobby Electric Baseboard	23,743	-	$1,070	$225	0.21
Totals (For all Selected (X) values only)	**8,267**	**$4,960.00**	**$15,617.00**	**$15,868.00**	1.02

RCx Case Study: Police Services





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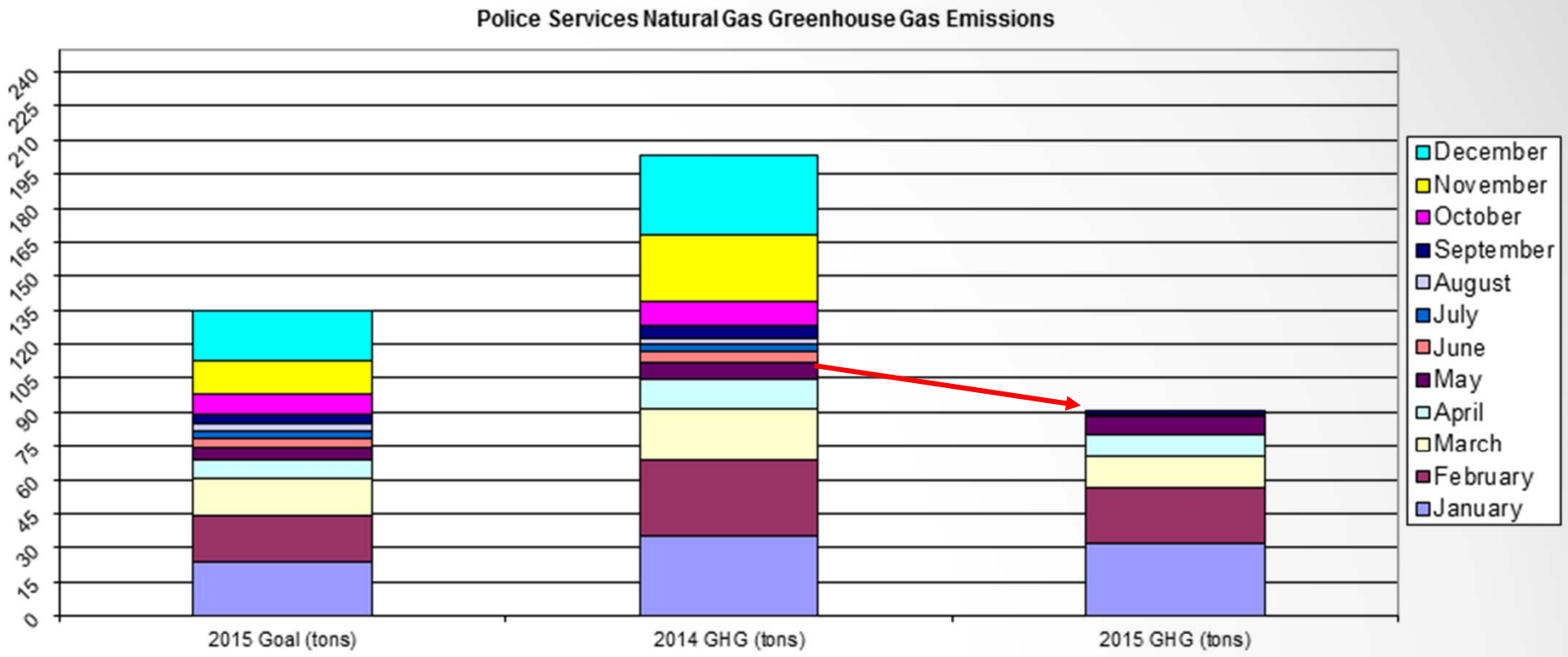
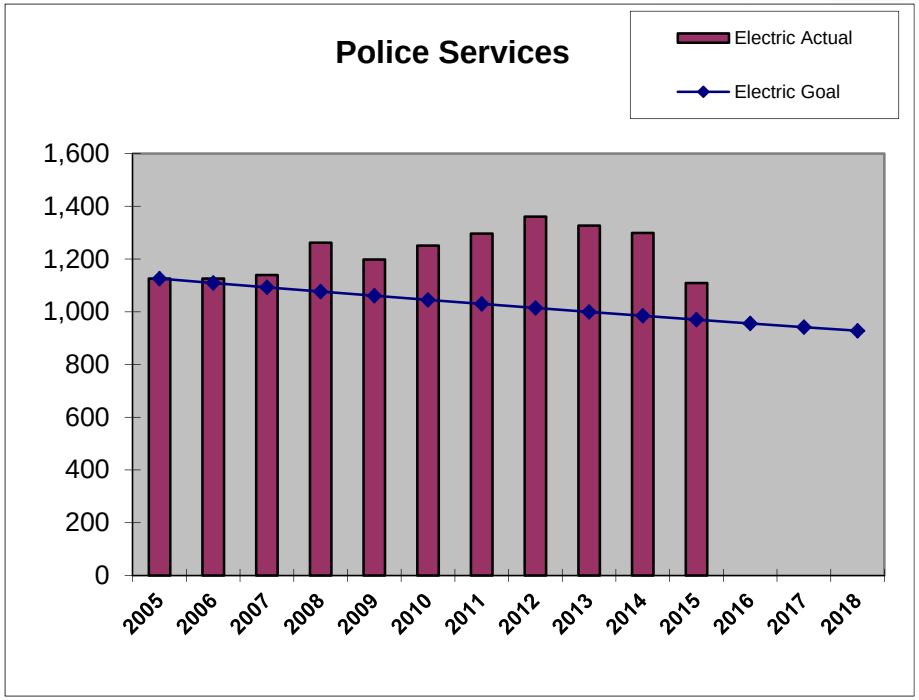


RCx Case Study: Police Services

Electric Use



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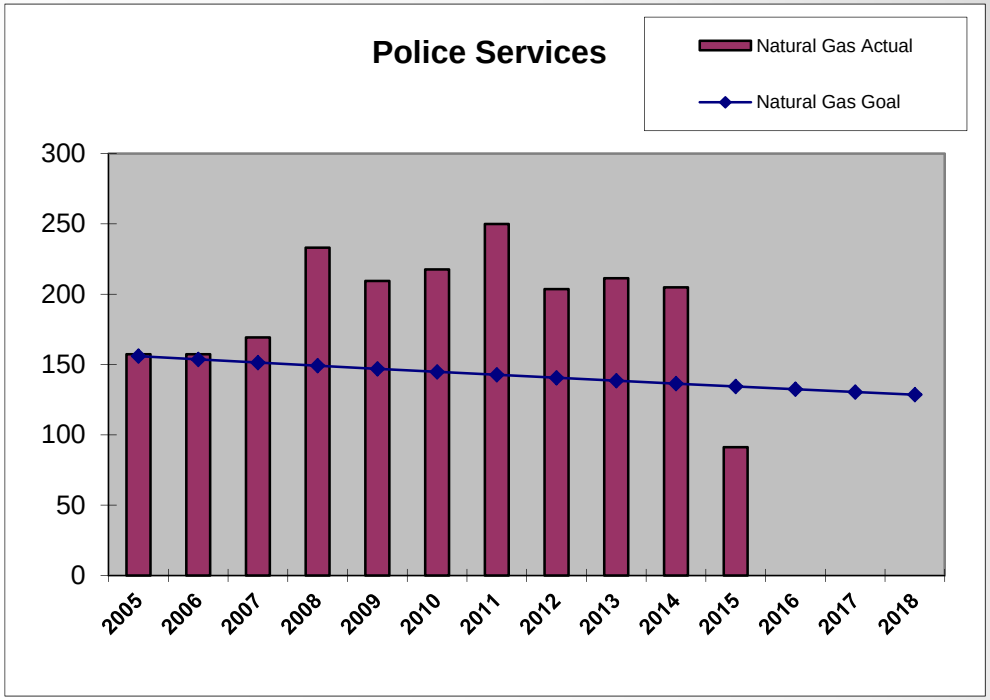

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Implementing OCx / MBCx

- Use Monitoring Based Commissioning for Retro-Cx
  - **Let *Automated Fault Detection* Look for Issues**
  - **Leave MBCx tool behind for client to do OngoingCx**
- Include it in specifications for new construction

Optimize the Building, and… *KEEP IT THAT WAY*

Small Commercial Energy Projects

- Energy Retrofits –Easier
  - ***Evap Coolers***
  - ***LED Lighting***
  - ***Appliances***
  - ***Plug Loads***
  - ***Weatherization***

Electric Rebates

Cash Incentives for Energy-Saving Improvements

This program is designed to support building efficiency improvements, save money and lower electric bills. Cash incentives are provided for upgrades that reduce electric demand and energy use, including:

- Lighting
- Air conditioning and cooling
- Building tune-up (retro-commissioning)
- Motor variable frequency drives
- Mechanical equipment
- Building envelope (windows, insulation and roofing)
- Kitchen, laundry and grocery equipment
- Office equipment/IT
- Custom projects for efficiency upgrades to your facility and operations (e.g., compressed air systems and process improvements)
- Commercial appliances

This free-cooling heat exchanger system reduces electricity bills by over $40,000 per year.

http://www.fcgov.com/utilities/business/improve-efficiency/rebates-incentives/electric-efficiency

http://www.fcgov.com/utilities/business/improve-efficiency/rebates-incentives/electric-efficiency/cooling-rebates

Small Commercial Energy Projects

- Energy Retrofits – More Challenging
  - ***Evap Condensing***
  - ***Thermostats, Controls***
  - ***Rooftop Unit Replacements***

Electric Rebates

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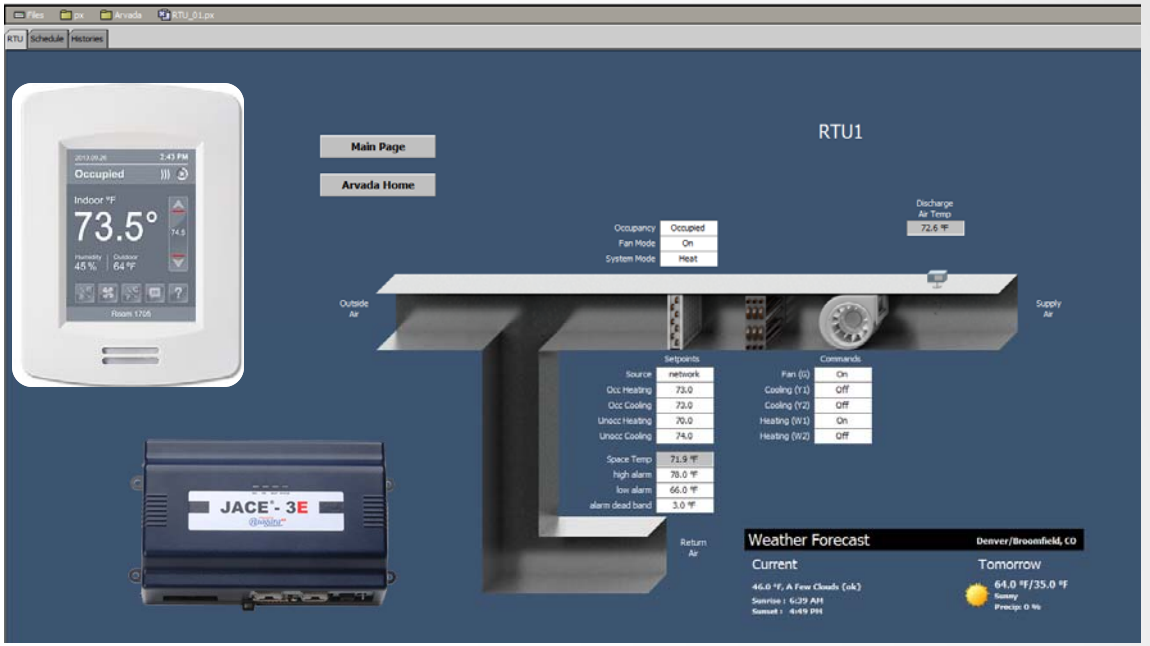
Small Commercial Energy Projects

- Retrofits
  - ***Thermostats, Controls***
    - ***Networked Thermostats, Wired or Wireless***

Wifi, Control from Anywhere

- Building Automation System Integration
- Great for multiple facilities managed by single entity



Small Commercial Energy Projects

- Retrofits
  - ***High Efficiency Rooftop Units***

Cooling Efficiency Pre-approval required

		Minimum Qualifying Efficiencies & Incentives			Incremental		
Equipment Type & Cooling Capacity (tons)	**(Btu/h)**	**Peak Efficiency**	**Seasonal or Part-Load Efficiency**	**Base Incentive ($/ton)**	**Increment**		**Incremental Incentive ($/ton)**
Split/Unitary Cooling Equipment							
<5.4 tons, split system	<65,000 Btu/h	12.5 EER	15.0 SEER	$100	0.1	SEER	$5.00
<5.4 tons, unitary	<65,000 Btu/h	12.0 EER	15.0 SEER	$100	0.1	SEER	$5.00
5.5–11.2 tons	65,000–134,999	12.0 EER	13.8 IEER	$150	0.1	IEER	$5.00
11.3–19.9 tons	135,000–239,999	12.0 EER	13.0 IEER	$150	0.1	IEER	$5.00
20–63.3 tons	240,000–759,999	10.6 EER	12.1 IEER	$150	0.1	IEER	$5.00
>63.4 tons	>760,000 Btu/h	10.2 EER	11.4 IEER	**	0.1	IEER	**
Packaged Terminal Air Conditioning (PTAC) Equipment							
<4.2 tons, PTAC	<50,000 Btu/h	11.0 EER	n/a	$50	0.1	EER	$5.00

* Economizer: when added to an existing AC unit or replacement unit where one didn't previously exist: $250/unit

** Custom rebate may be available.

THANK YOU!

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