Implementation in Parallel – Shortening Turnkey Lab RCx Project Timelines - A Case Study

Presented by B2Q Associates, Inc.

Chris Schmidt & Brad Newell

A Woman Business Enterprise (WBE)

UMass Amherst

- ISB
- ELAB II
- LSL North & South

Learning Objectives

1. Increase awareness of the importance of a collaborative team approach as a main driver of the success of lab safety and energy optimization projects – building the right team
2. Understand the complexities and moving parts of implementation and study projects running in parallel and how to leverage each phase for project success.
3. Improve ability to identify, develop, implement, and maintain a successful lab energy efficiency and optimization project by taking a step-wise and multi-disciplinary approach.
4. Identify potential areas for unsafe and energy intensive operations in lab facilities.

Project Introduction

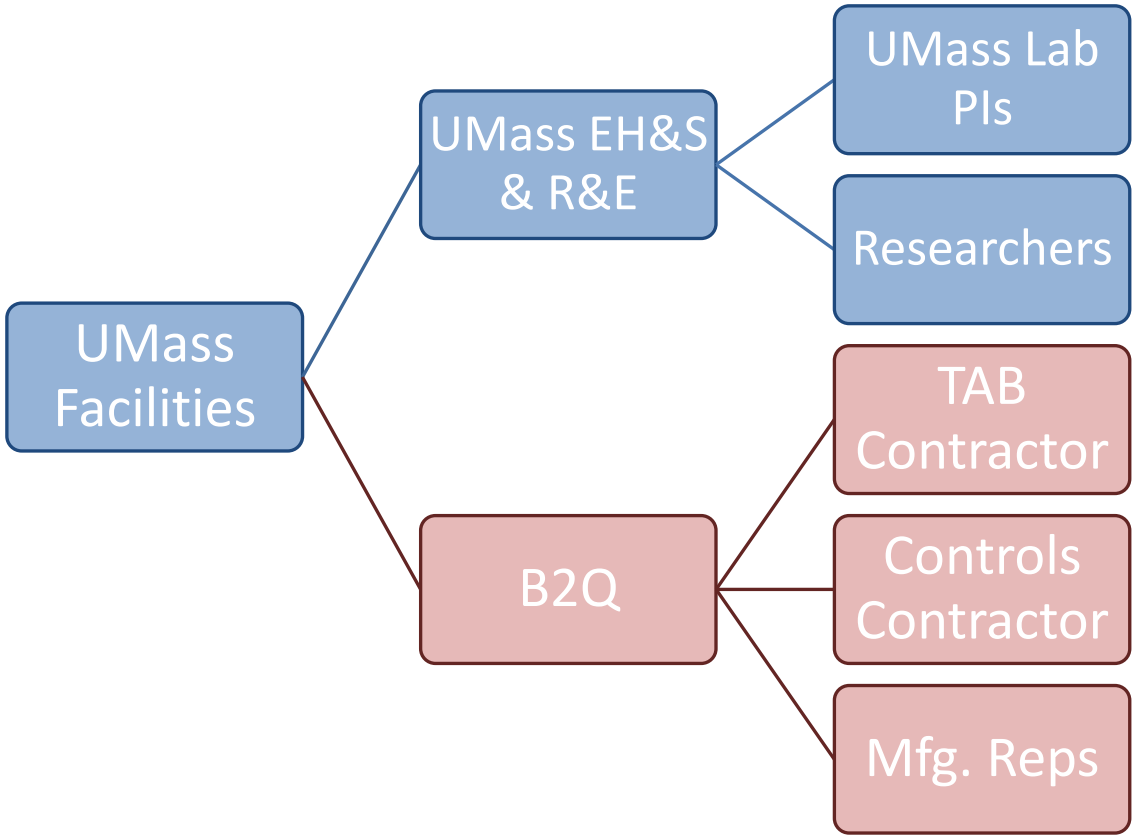
Recent projects at the University of Massachusetts Amherst provided the opportunity for B2Q to develop a stepwise, multidisciplinary approach to optimizing lab buildings and through recommissioning and turnkey implementation

2015-2016 Multidisciplinary Approach Development		2018 – Implementation in Parallel

• **Integrated Sciences Building**
  • 8 years old
  • 150,000 ft^2 (85,000 ft^2 of Lab Space)
  • **4,620,580 kWh - Baseline**
  • **29,000 MLbs Steam - Baseline**
  • **$1,042,058 in Energy** Annually – Baseline
  • EUI: 275 kBtu/ft^2 – Baseline (2015)
	• **Engineering Lab II (ELab II)**
	  • 13 years old
	  • 61,000 ft^2 (21,474 ft^2 of Lab Space)
	  • **2,636,348 kWh - Baseline**
	  • **15,096 MLbs Steam - Baseline**
	  • **$565,554 in Energy Annually – Baseline**
	  • EUI: 359 kBtu/ft^2 – Baseline (2015)
		• **Life Science Labs North & South**
		  • 4/2 years old (N./S.)
		  • 310,000 ft^2 (50% labs)
		  • **7,432,504 kWh - Baseline**
		  • **24,580 MLbs Steam - Baseline**
		  • **$1,234,850 in Energy Annually – Baseline**
		  • EUI: 240 kBtu/ft^2 – Baseline (2016)

2014 – 2016 Stepwise - Multidisciplinary Approach

Step 1	• Multi-Building Scoping Audits
Step 2	• Focused Lab Optimization Studies on Selected Lab Buildings
Step 3	• Implementation, Commissioning & Owner Training
Step 4	• Measurement & Verification of Safety and Savings
Step 5	• Persistence via Communication & Continuous Commissioning



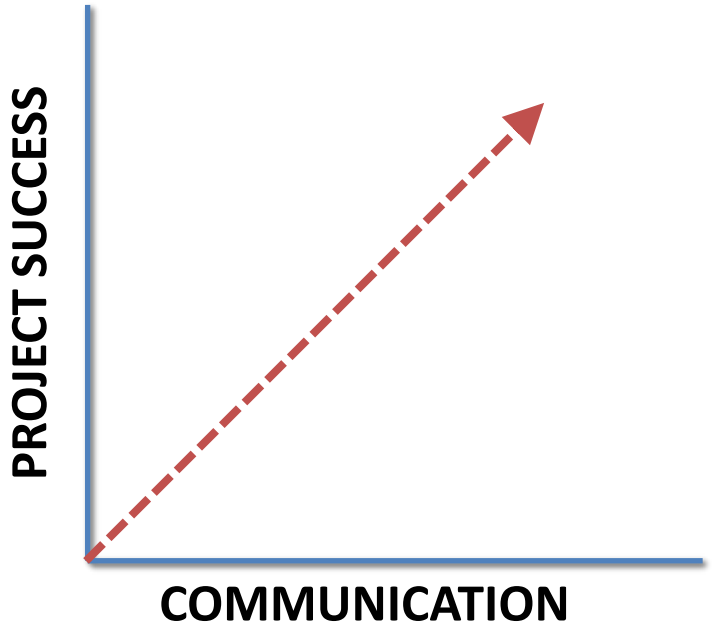
Stepwise Approach Results

UMass ISB & Elab II Measured and Verified Savings					
Building	Total Electric Energy Savings	Steam Energy Savings	Energy Cost Savings	Implementation Cost	Simple Payback Before Incentive
--	kWh	Mlb	$	$	yrs.
ISB	1,851,862	10,738	$399,946	$590,968	1.5
Elab II	677,294	6,312	$193,968	$448,907	2.3
Total	**2,529,156**	**17,050**	**$593,914**	**$1,039,875**	**1.8**

- M&V savings amount to greater than 30% savings of baseline energy use
- M&V savings exceeded predicted savings by >20%

Early and Consistent Teamwork & Communication

1. Key to project success during all project phases.
2. Allows an open stage to voice questions and concerns from different vantage points
3. No one gets left in the dark about changes in lab operation
4. Allows input from all parties where critical decisions are made before project implementation
5. Allows for the safest, most energy efficient and best functioning final product where **all parties are aware of the changes made and why.**



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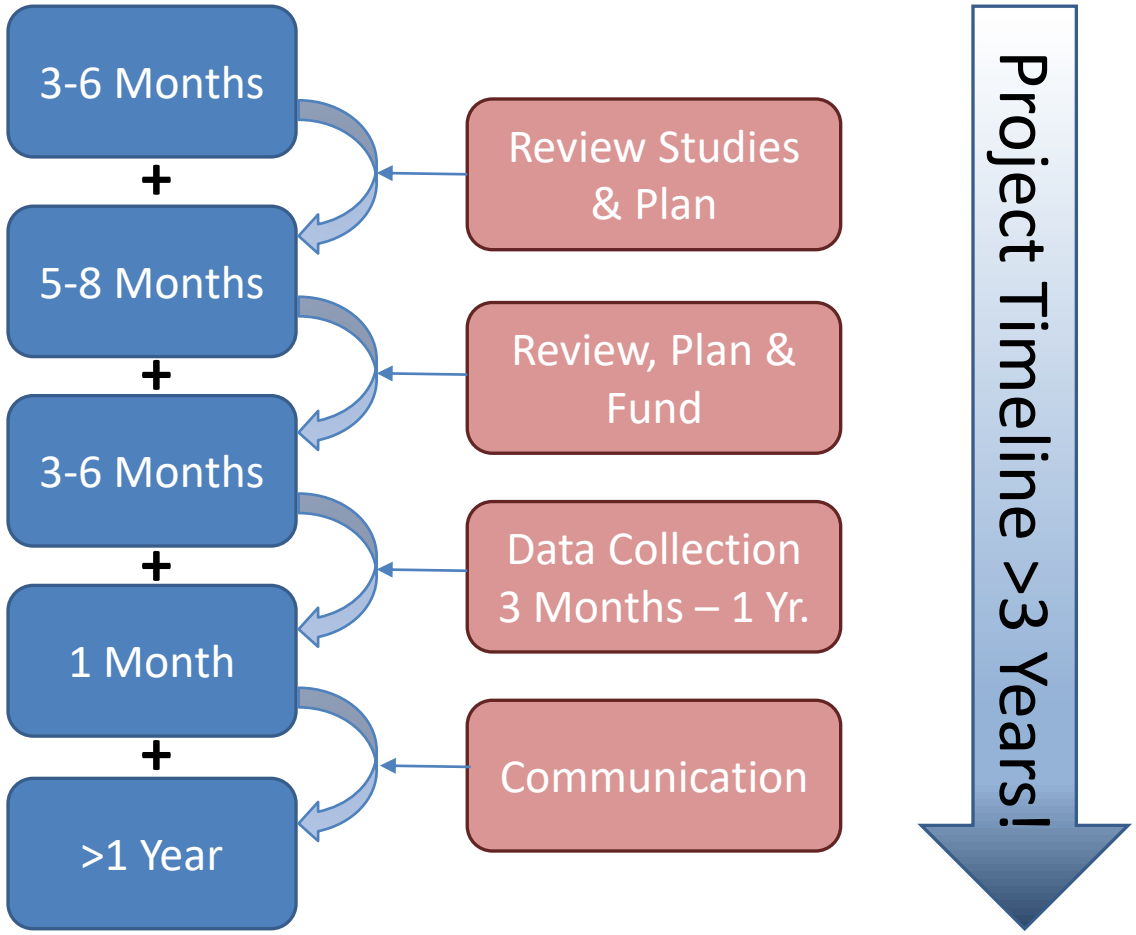
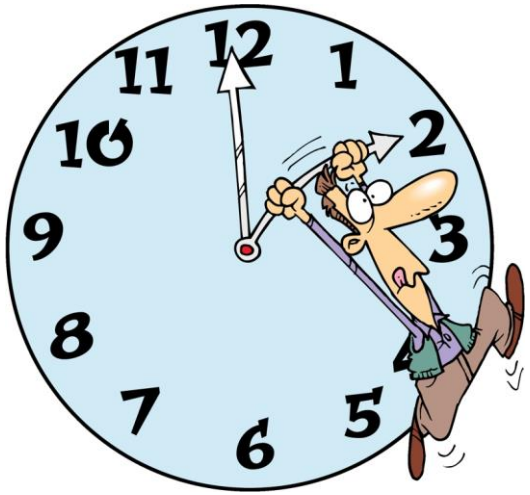


How can Owners and Consultants make better use of time?

1. Have an end goal before starting campus wide optimization projects
2. Take advantage of a well assembled project team when reviewing studies, planning and funding.
   - Cuts down on time between project phases.
3. Have confidence in preliminary scoping study results.
   - Invest enough time up front to avoid pitfalls.
4. Capitalize on low hanging fruit and items related to safety that should be addressed regardless of payback or energy benefit.



"How did it get so late so soon?" – Dr. Seuss

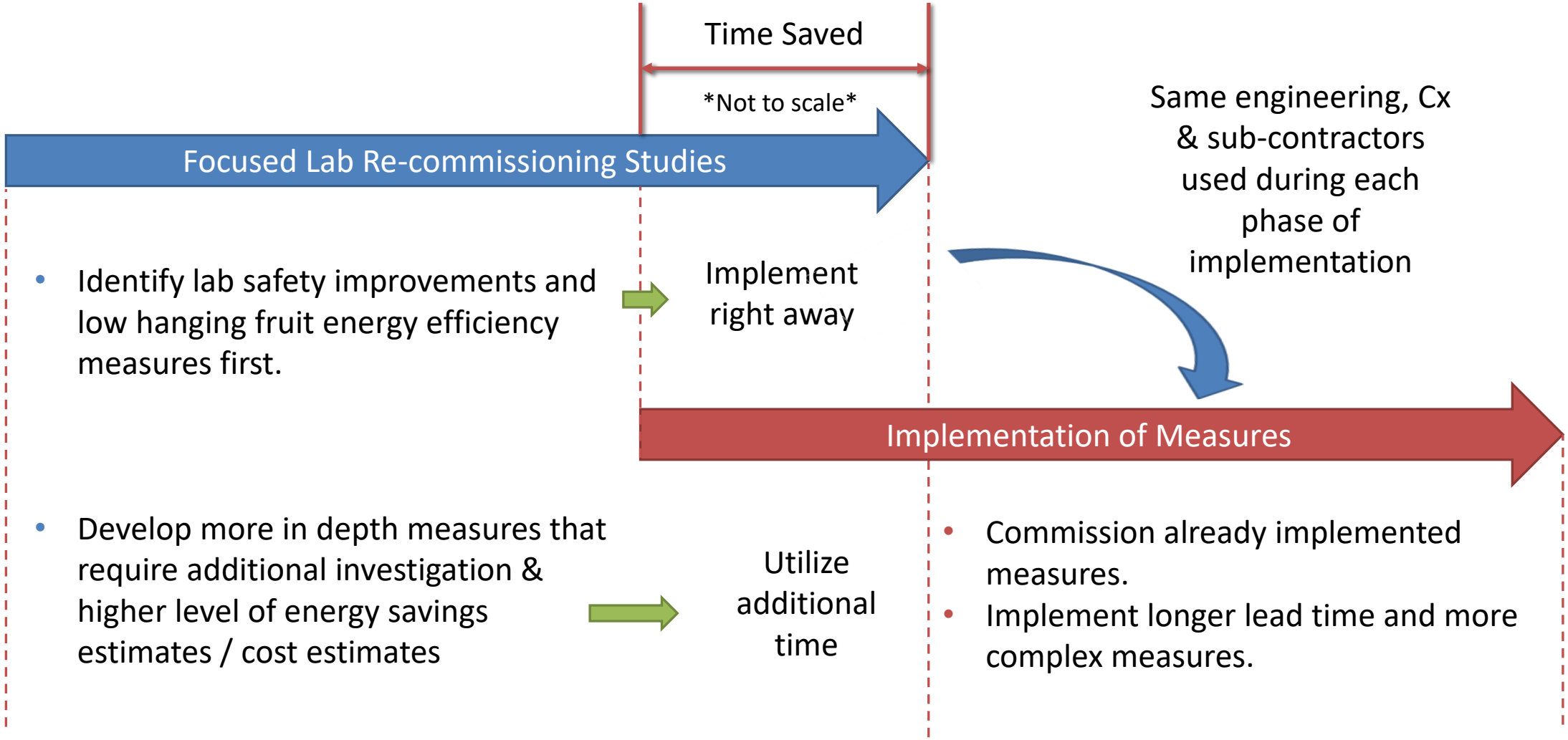
2018 – Life Science Labs

- **Life Science Labs North & South**
  - 4/2 years old (North/South)
  - 310,000 ft^2 (50% labs)
  - **7,432,504 kWh - Baseline**
  - **24,580 MLbs Steam - Baseline**
  - **$1,234,850 in Energy Annually – Baseline**
  - EUI: 240 kBtu/ft^2 – Baseline (2016/2017)

Project Constraints / Objectives

- Re-commission LSL North & South by 12/31/2018 – Start date 2/1/2018
  - Focused RCx Study & Implementation of Energy Efficiency Measures
- Focus on building functionality & energy improvement opportunities.
- UMass felt as though original building commissioning was not thorough or complete.
- B2Q Scoping Study completed on LSL North in 2015
  - LSL South was not finished construction at this time

Implementation in Parallel



What kind of measures?

LSL North - Summary of Recommended Measures for Immediate Implementation

2015 EEM #	2018 EEM # FIM #	Measure Description	Total Electric Savings	ISB CHW Savings	Electric Cost Savings	Steam Savings	Steam Cost Savings	Total Cost Savings	Project Cost Estimate
			kWh	kWh	$	MLbs	$	$	$
1A,B,C	1	*Optimize Air Change Rates and add/revise Occupancy Control*	*490,059*	*83,882*	*$49,006*	*868*	*$17,360*	*$66,366*	*$281,755*
--	2	Repair Airside Mechanical Issues	168,653	89,215	$16,865	48	$960	$17,825	$72,740
2	3	*AHU-1.3, 1.4, 1.5, 1.6 Supply Static Pressure Reset*	*62,300*	*0*	*$6,230*	*0*	*$0*	*$6,230*	*$44,522*
4	4	*Optimize Heat Pipe Control of AHU-1.5 & 1.6*	*27,234*	*27,234*	*$2,723*	*33*	*$666*	*$3,389*	*$11,743*
5	5	*Optimize Enthalpy Wheel Control on AHUs-1.3 & 1.4*	*62,777*	*62,777*	*$6,278*	*0*	*$0*	*$6,278*	*$18,760*
--	6	Optimize Heat Reclaim Chiller CHW Pump Operation	52,571	0	$5,257	0	$0	$5,257	$7,294
--	7	Optimize DAT Reset on AHUs 1.3, 1.4, 1.5 & 1.6	0	0	$0	375	$7,500	$7,500	$8,582
6A,B,C	8	*Optimize Heat Reclaim Chiller Operation*	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*	*$26,550*
3	9	*Exhaust Fan Static Pressure Control Reduction*	*100,664*	*0*	*$10,066*	*0*	*$0*	*$10,066*	*$16,389*
--	FIM-1	Repair VAV Reheat Valve Mechanical Issues	--	--	--	--	--	--	$24,856
--	FIM-2	Repair FCU Cooling Valve Mechanical Issues	--	--	--	--	--	--	$13,032
--	*FIM-3A*	*Fume Hood Recertification*	--	--	--	--	--	--	*$49,460*
--	*FIM-3B*	*Fume Hood Integration to Metasys*	--	--	--	--	--	--	*$106,046*
--	FIM-3C	Fume Hood Control RCx, Optimization & Integration (Inc. FIMs 3A & 3B)	--	--	--	--	--	--	$276,312
--	FIM-4	Optimize Lab Purge Mode Operation	--	--	--	--	--	--	$19,104
--	FIM-5	Reprogram Labs N240CD & N240G	--	--	--	--	--	--	$3,629
--	FIM-6	CHW, Steam & HW Metering Upgrades Allowance	--	--	--	--	--	--	$61,824
7A		*Optimize Primary CHW Pump Control*	*Original Report Measure Has Been Implemented*						*$2,760*
7B		*Optimize Secondary CHW Pump Control*	*Original Report Measure Has Been Implemented*						*$2,760*
LSL North Totals			**964,258**	**263,108**	**$96,426**	**1,324**	**$26,486**	**$122,912**	**$892,612**

Baseline Annual Energy Use		% Reduct.	Simple Payback Before Potential Incentive:	**7.3**
Electric Consumption (kWh/yr)	5,053,920	19%	Energy Savings for Eversource Incentive (kWh):	**964,258**
Steam Consumption (MLbs/yr)	17,149	8%	Potential Electric Incentive from Eversource:	**$241,065**
CHW Consumption (kWh/yr)	616,879	43%	Net Project Cost After Potential Incentive:	**$651,548**
			Simple Payback After Potential Utility Incentive:	**5.3**

Occupancy Sensors either failed or not tied to HVAC control

"Airside" mechanical issues – Supply & Exhaust VAV damper actuator failures

Pumps left in operator override @ 100% speed when proper control is feasible

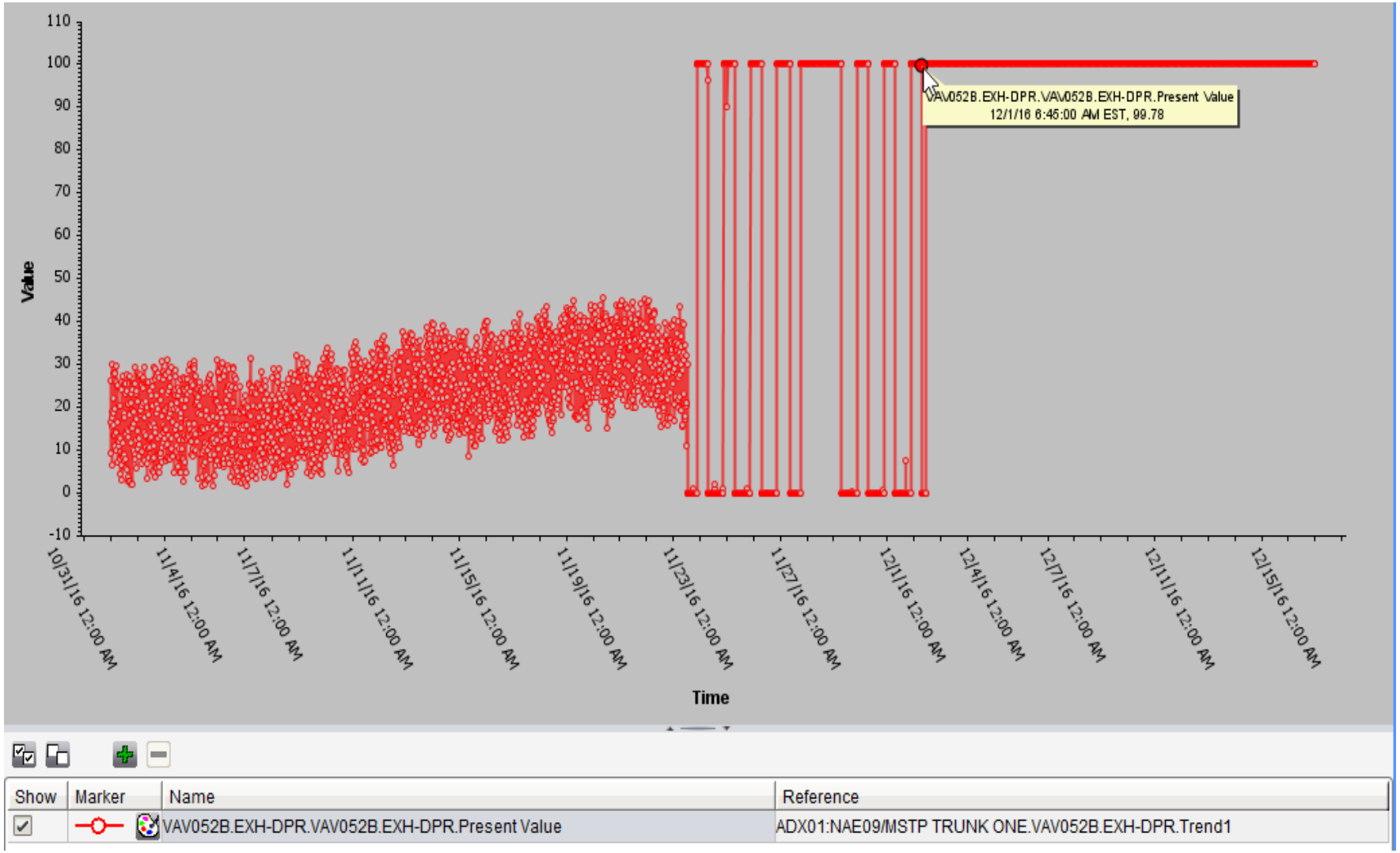
"Waterside" mechanical issues – Supply VAV & FCU valve actuator failures & leaking valves

<u>Excluding EEM-1 Occupancy Sensors… these measures combine for a 2.7 yr simple payback after utility incentives</u>

Occupancy Sensor Issues

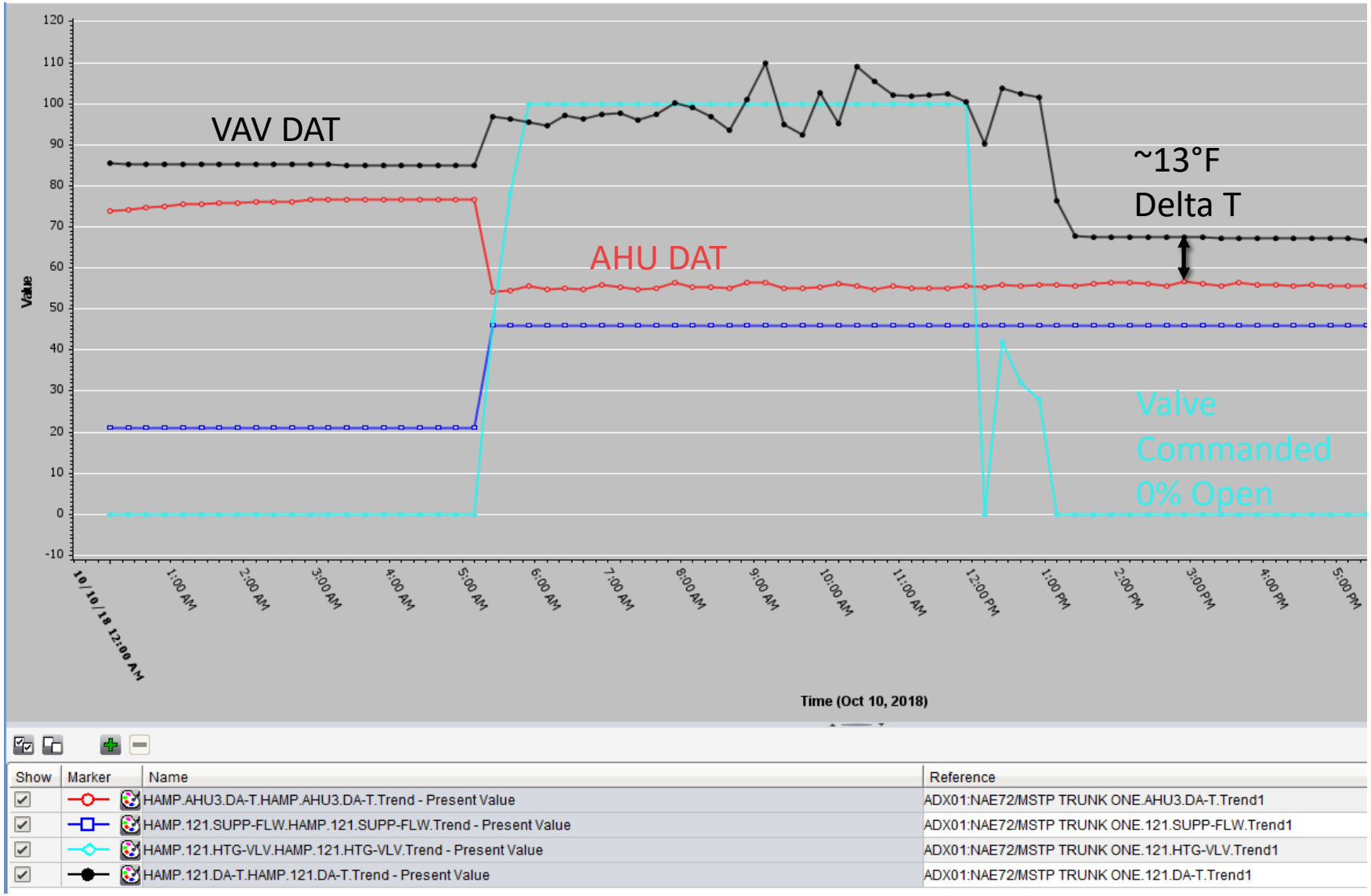
- 53 Lab zones in LSL North had unresponsive occupancy sensors reporting occupancy 100% of the time
- Occupancy control is crucial to control occupied and unoccupied ACH.
- These issues needed to be addressed prior to implementing new lab ventilation rates in accordance with EH&S recommendations.
- **NOT** low cost **OR** low time but extra time was required to implement one of the largest energy efficiency measures in a safe manner

Airside Mechanical Issues



- Hunting VAV caused actuator to fail.
- Could cause lab pressurization & safety issues.
- Simple fix to tune PID control loop to eliminate hunting & install a new damper actuator
- Low cost & low implementation time
- LSL North & South(4 & 2 yrs. Old) Combined for 33 airside mechanical issues
- ISB (8 years old) had 96 airside issues!

Waterside Mechanical Issues



Show	Marker	Name	Reference
☑		HAMP.AHU3.DA-T.HAMP.AHU3.DA-T.Trend - Present Value	ADX01:NAE72/MSTP TRUNK ONE.AHU3.DA-T.Trend1
☑		HAMP.121.SUPP-FLW.HAMP.121.SUPP-FLW.Trend - Present Value	ADX01:NAE72/MSTP TRUNK ONE.121.SUPP-FLW.Trend1
☑		HAMP.121.HTG-VLV.HAMP.121.HTG-VLV.Trend - Present Value	ADX01:NAE72/MSTP TRUNK ONE.121.HTG-VLV.Trend1
☑		HAMP.121.DA-T.HAMP.121.DA-T.Trend - Present Value	ADX01:NAE72/MSTP TRUNK ONE.121.DA-T.Trend1

- Likely failed valve body.
  - Actuator works as temperature responds to valve position.
- Simple fix to replace valve body and re-attach actuator.
- Low cost & low implementation time
- Other issues include un-responsive valve actuators.
- LSL North & South Combined for ~30 waterside issues

Pros & Cons to Implementing in Parallel

Pros

- Cut down on project timelines
- Engage your implementation team/sub-contractors early in the study phase and get into a rhythm
- Allows for easier/quicker/lower cost implementation items to get out of the way early
- Allows for some longer implementation items to get started, and therefore finished, earlier.
- Allows for additional time to be spent on complex measures during the tail end of the study phase.
- Commissioning can be completed during the true implementation phase; allowing fixes, if needed, to be performed.

Cons

- Project funding needs to be in place up front.
  - This can be overcome with early communication of findings that precede a final study
  - Sound economic analysis, energy modeling and similar past project success aided in this hurdle being overcome
- Taxing on manpower and project management to oversee an energy study as well as sub-contractors performing implementation

How Much Time Was Saved?

ISB & ELAB II

- Combined 211,000 ft^2
- Total implementation cost $1,039,875
- Scoping studies completed Dec. 2015.
- Focused lab optimization study completed Sept. 2016
- 100% Implementation completed Sept. 2017
- Total timeline just under 3 years.
  - +1 year M&V completed Sep. 2018

LSL North & South

- Combined 310,000 ft^2
- Total implementation cost ~$1,600,000
- Scoping studies completed Dec. 2015.
- Focused lab optimization studies started Feb. 1, 2018
- 100% Implementation projected to be complete by Feb./Mar. 2019
- Total timeline ~1.5 yrs.
  - ~2 year pause between scoping & focused lab study for Elab II & ISB

Concluding Thoughts

1. Taking an implementation in parallel approach allowed the project team to receive project funding and begin implementation prior to completing the "study phase" of the project.
2. Early, consistent and clear communication throughout all project stakeholders was key to allowing this process to take place.
3. While there was a ~2 year gap between scoping study & focused lab study/implementation, the total project time worked on LSL is projected to be cut in half for LSL when compared to ISB & ELab II
    - The 2 year gap was used to perform focused lab studies and implementation on ISB & ELab II while the remainder of LSL South was built out.

Questions?

A Woman Business Enterprise (WBE)

100 Burtt Rd. Ste. 212
Andover, MA 01810

Chris Schmidt – Senior Project Manager
cschmidt@b2qassociates.com
(603) 247-1575 (Cell)

Brad Newell – Project Manager
bnewell@b2qassociates.com
(603) 703-3932 (Cell)
(978) 447-5604 (Office)

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