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NS2024

APRIL 15 - 17 | ANAHEIM, CA

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University of California, Irvine’s Journey to Unlock Data for Decarbonization

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Introductions

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Chief Operating Officer
SkyFoundry

Decarbonization Goals

Net-zero by 2050

45% reduction in carbon emissions by 2030

Current national plans fall short of what is required –

On track for a 9% increase by 2030

Source: United Nations, https://www.un.org/en/climatechange/net-zero-coalition

Key Trends Are Converging on our Industry

The Built Environment

Electrification
- Heat pumps
- EVs
- Microgrids

Regulations
- ESG, SEC regulations
- Incentives are increasing
- Penalties are/will be coming

Data
- Proliferation of sensors
- Edge Computing
- Artificial Intelligence

Industry Specific Technology
- Advanced Supervisory Control
- Haystack (Xeto)
- Etc.

Sensor/data Explosion Will Kill the Cloud as We Know it

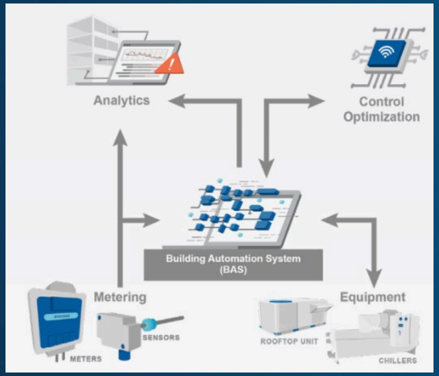
- Sensor will proliferate and produce huge amounts of data
- Existing infrastructure won’t be able to handle data volume or rates
- Too much information to push to the cloud
- Latency issues arise
- Peer-to-peer networks will be utilized to lessen the load on core networks and share data

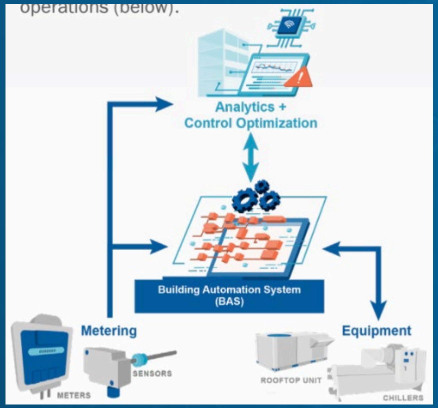
Harbor Research Predicts Edge Computing is Essential

- By 2030, estimates today suggest 90% of all data generated by sensors begins to lose its value within seconds of being generated
- 65% of all computing and data interactions will occur at the edge of the enterprise via distributed systems by 2028
- 70% of the world will have network access and as much as the sensor market could be in the trillions by 2028

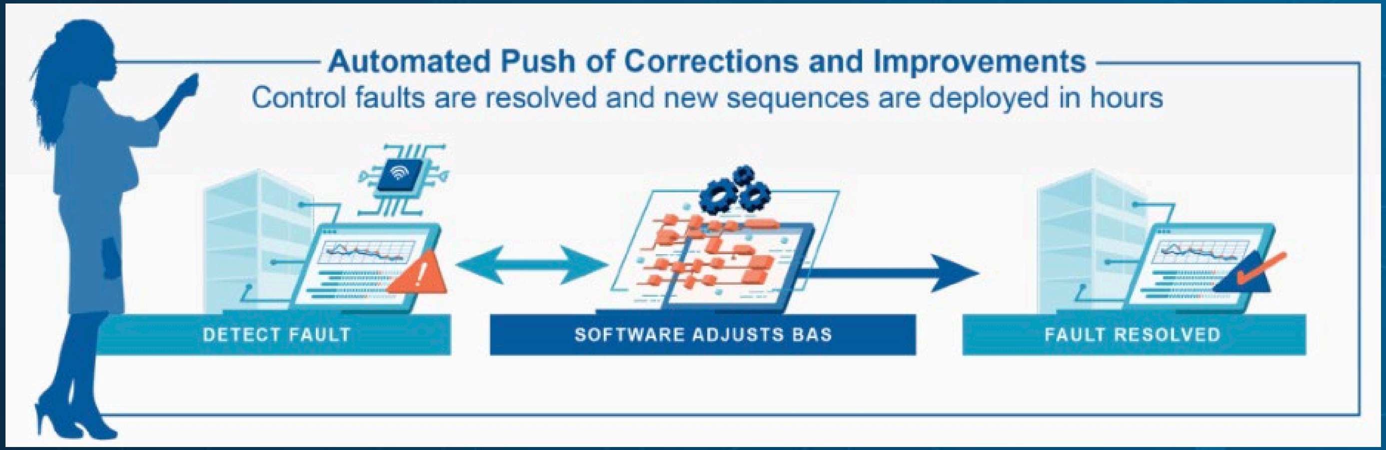
Advanced Supervisory Controls aka Automated System Optimization (ASO), Extra-Supervisory

Historically, analytics and control optimization have been siloed across different products





Today, analytics and control optimization are integrated, enhancing the BAS



A common language is necessary

Project Haystack

Haystack – Bringing Quality and Consistency to Smart Buildings

Project Haystack Leading DoE's Funded Project 2021-2025

Project Haystack's Objectives

- Create a **validation** framework for Haystack semantic models
- Establish a public **repository** for the "Specs"
- Deploy a certification/accreditation system for semantic **interoperability**
- Provided associated open-source **tools**

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Validation and Certification Brings Substantial Benefits

- Building owners and others will have **confidence** knowing how their building is tagged and what requirements are met
- **Demarcating** the tagging process will create tagging specialist that will be expert at modeling buildings without having to know all aspects of the entire system.
- Validation methodology will dramatically increase the **clarity and quality** of implementations
- Associated tools sets will **increase speed** and **lower costs** of implementations

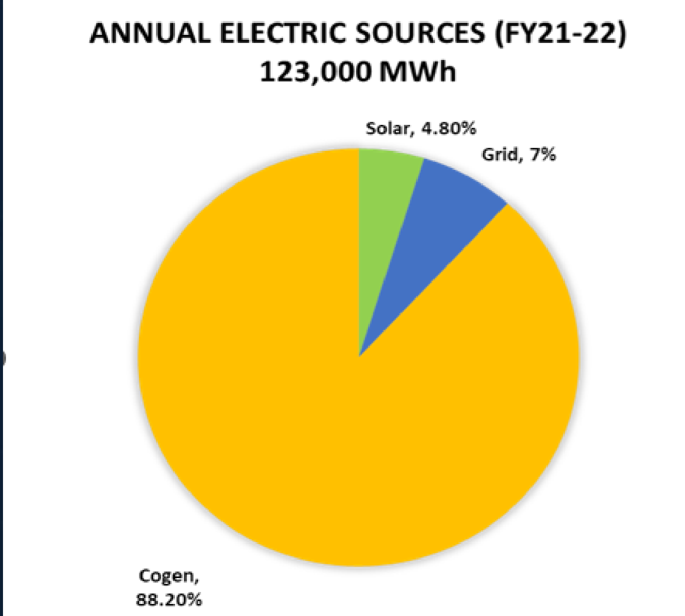
Preparing for the Explosive Growth and Use of Data

- Start collecting data
- Build the proper data infrastructure
  - Scalable
  - Secure
  - Interoperable
  - Distributed analytics
  - Data ownership and access
- Obtain the proper skills and resources
- Plan for and execute a data-driven approach to decarbonization

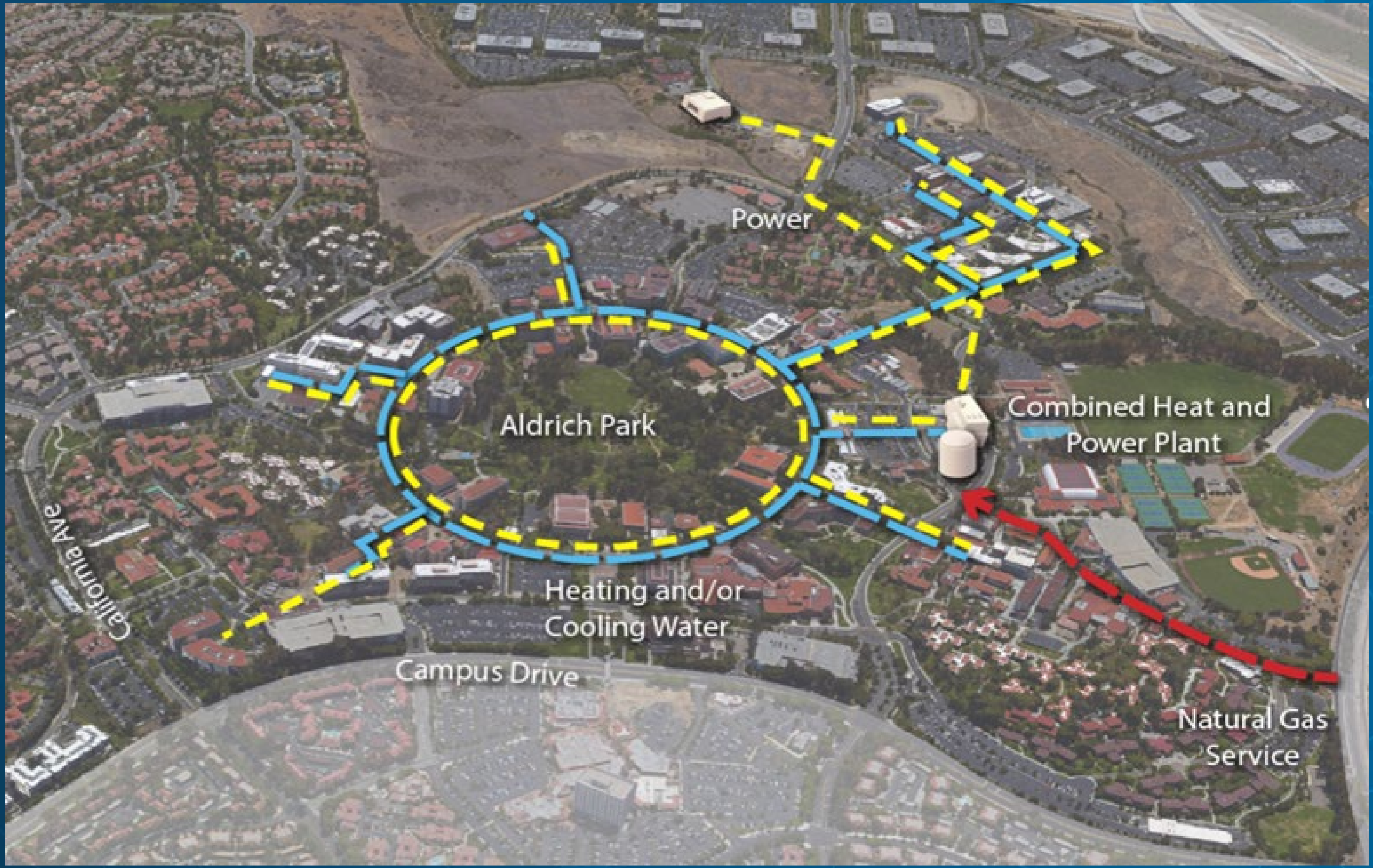
Existing Automation Systems

- Typical Building Controllers
  - Siemens MBC and PXCM
  - Johnson NAE
  - Distech EC
  - ABB Cylon
- Building Graphics as of April 2024:
  - Siemens Insight - 70%
  - Johnson Metasys - 10%
  - Tridium Niagara - 20%
  - All new buildings go on Tridium Niagara
  - Campus-wide migration from Insight and Metasys to Niagara is in progress but will take years.
- Central Plant is on WonderWare HMI with Allen Bradley PLCs, trended in SkySpark but maintained separately from rest of building automation.

Central Utility Generation & Distribution



- Peak Elec Demand - 27 MW
- Peak CHW - 16,000 tons
- Peak HTW - 78 MMBTU/hr



UCI's Decarbonization Journey

1. Build the bones – Smart Labs, Deep retrofits, and solid standards (2000-2012)
2. Maintain and optimize – metering and MBCx (2010-2015)
3. Unlock the data – network upgrades and Niagara BAS standards (2016-ongoing)
4. Harness the data – SkySpark analytics for Cx, Decarb planning, and recharge (2017-ongoing)
5. Expand the data – accelerated transition to Niagara from ~20% to 100% (2023-ongoing)
6. Drive new processes – ongoing Cx workflow (2024-ongoing)
7. Plan for decarbonization – data-driven infrastructure upgrades (2023-ongoing)
8. Implement the plan – leverage the data and BAS to optimize and validate (future)

Key standards every institution should invest in

1. MEP design and specifications
2. Building automation system (BAS)
3. Facilities IT data architecture
4. BAS graphics, alarming and scheduling
5. Data point naming and tagging
6. Sequences of operations
7. Data analytics

Most people have

Few people have

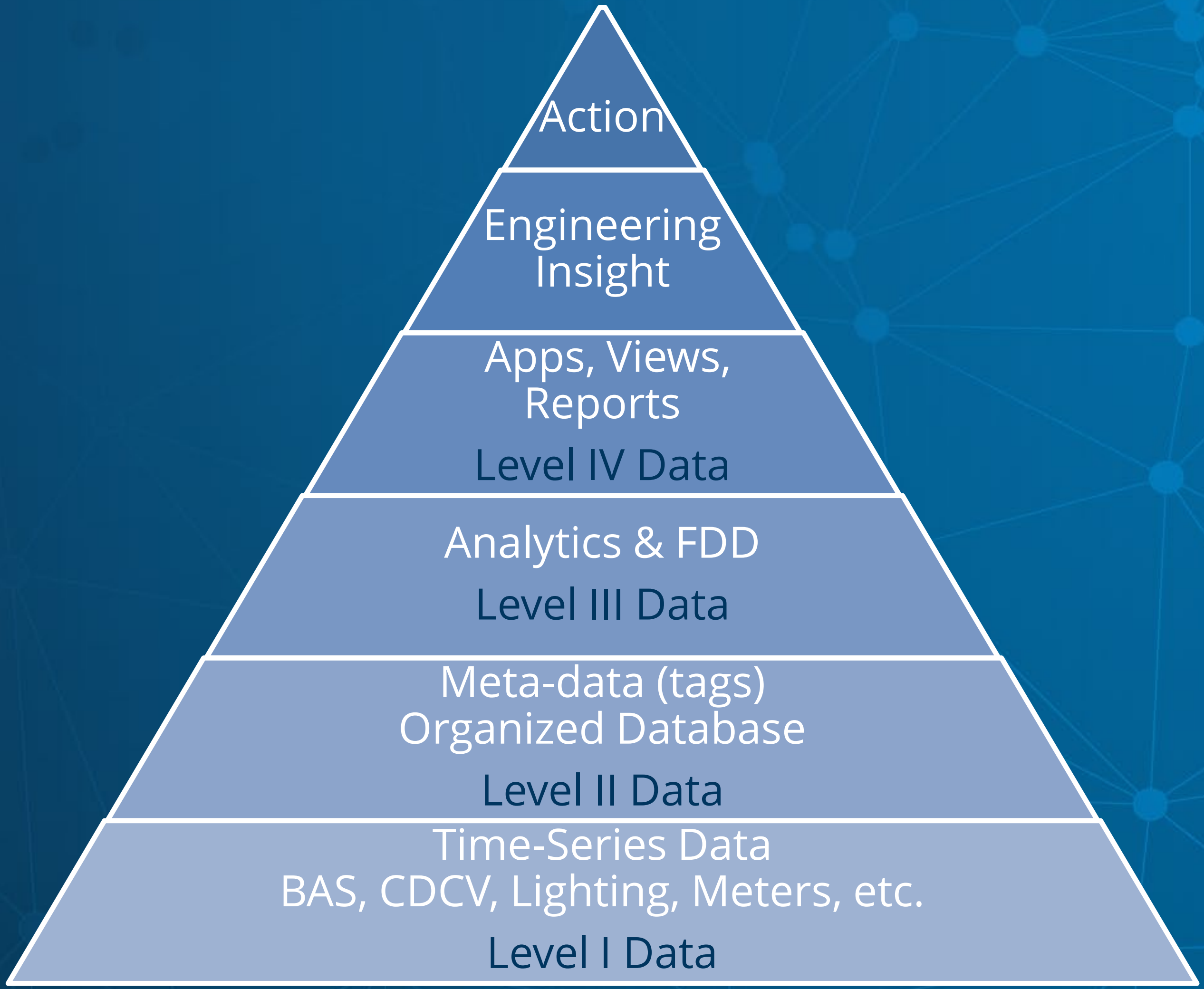
See https://www.nexuslabs.online/p/implementing-the-bas-architecture for a sample BAS specification you can download

See https://bitbucket.org/alturaassociates/altura-standard-libraries/src/master/ for Altura's shared metadata tagging library

Not all data are created equal

Our success with Smart Buidings and analytics hinges on having **high-quality, meaningful data**

This requires new thinking about the ***data architecture*** to enable high quality data flows across multi-vendor solutions



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“Future-proof” data architecture standard is a critical first step

Leverage data for other vendors & future services	Cloud Applications (3rd Party Emerging Services)			
Open and centralized interface tools that enhance operational efficiency	BAS Graphics & Alarms	Analytics	Work Order Management System	Asset Management System
Create a layer for standardized integration	BAS Optimization Layer			
Competitively bid field automation Select the best Smart Building technologies	Field-Level Controllers			
	HVAC	Lighting	Equipment	Meters

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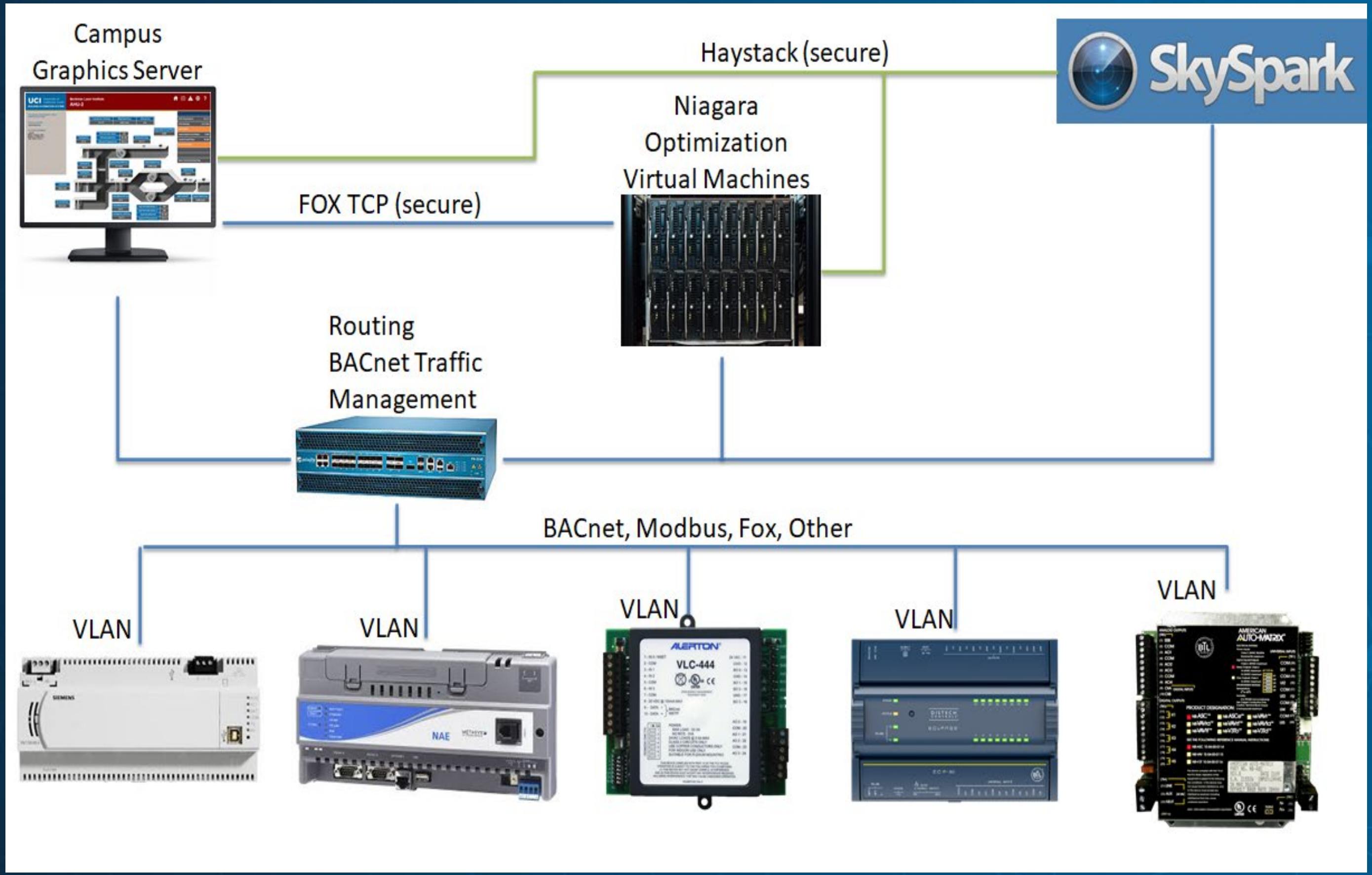
Data architecture lays the foundation for success: **UCI's network**



Data naming & tagging standards

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	A	B	C	D	E	F	G
1	StandardName	Example_Value	Trending	Override	Graphics	Full Name Description (where necessary)	Exception Notes
2	AHUSupTmp	55.0 °F	YES	CxOvrd	YES	AHU Supply Temp	
3	ClgDmdLmtLvl1	1				Cooling Demand Limit Level 1	
4	ClgDmdLmtLvl2	2				Cooling Demand Limit Level 2	
5	ClgDmdLmtLvl3	4					
6	ClgReq	0					
7	ClgReqDly	2.0 min					
8	ClgReqLpHiStpt	0.95					
9	ClgReqLpLowStpt	0.85					
10	ClgReqZnTmpErrHiStpt1	3.0 °F					
11	ClgReqZnTmpErrHiStpt2	5.0 °F					
12	HtgReq	0					
13	HtgReqDly	2.0 min					
14	HtgReqRhVlvHiDStpt	0.95					
15	HtgReqRhVlvLowStpt	0.85					
16	HtgReqSupTmpLowStpt1	15.0 °F					
17	HtgReqSupTmpLowStpt2	30.0 °F					
18	OccEffSts	Unoccupied	YES	C			
19	OccLocalSnsr	TRUE					
20	OccRemoteSnsr	Unoccupied					
21	OccSts_1	Unoccupied					
22	OccSts_2	Unoccupied					
23	StatReq	0					
24	StatReqSupDmprHiStpt	0.95					

Spec | Definitions | VAV Reheat Zone | F

Same as?
AHU_DAT
AHUSupplyT
AHUDischT

Project Haystack

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absorption	Indicates a chiller which uses absorption driven by hot water (as opposed to vapor compression).
ahu	Air Handler Unit which heats and/or cools air.
ahuRef	Associate an entity such as a vav with an ahu.
air	Point associated with the measurement or control of air.
airCooled	Indicates chiller which uses air to cool the hot refrigerant.
apparent	Used with temp to define the perceived temperature which takes into account wind chill and heat index.
area	Floor area of a site measured in ft² or m².
barometric	Defines the mean atmospheric pressure at sea level measured in millibar or inHg.
blowdown	Paired with water to indicate control or measurement of the blowdown water expelled from a coolingTower or boiler to remove mineral build up.
boiler	Boiler equip used to generate hot water or steam for heating.
bypass	If used with valve indicates a by-pass in a piping system.
centrifugal	Indicates chiller compressor which uses a continuous flow of fluid through an impeller.
chilled	Marker tag used with water for the chilled water system between the plant and ahu.

Standardized sequences of operations

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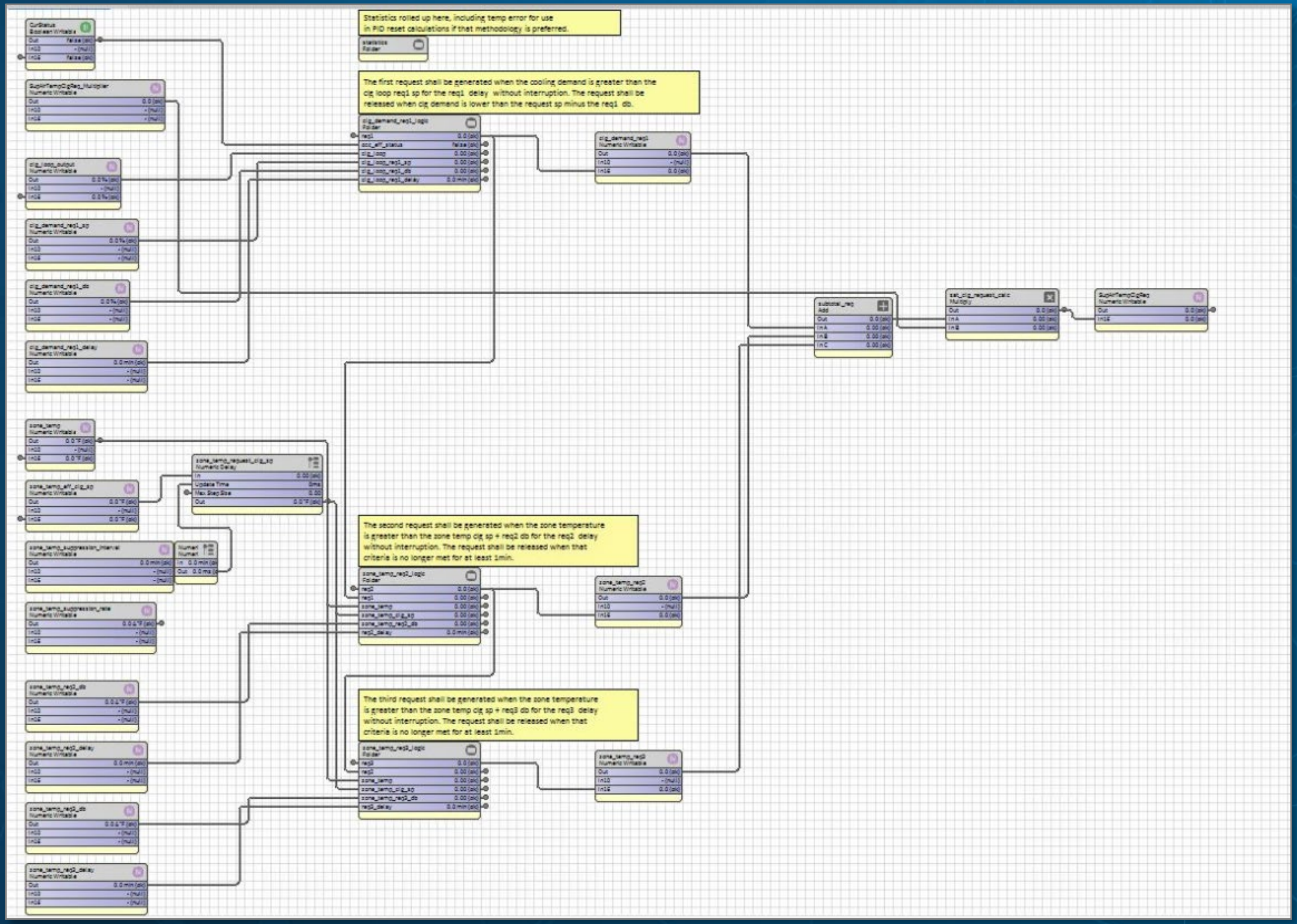
Benefits:

- Consistent high-performance optimization (i.e. ASHRAE GL36)
- Makes operator training easier
- Don’t need to re-invent the wheel every project!
- You can own the code:
  - Lower project costs
  - Easy to move across projects
  - Easier to update



Standards work! 3 projects, 3 different BAS vendors

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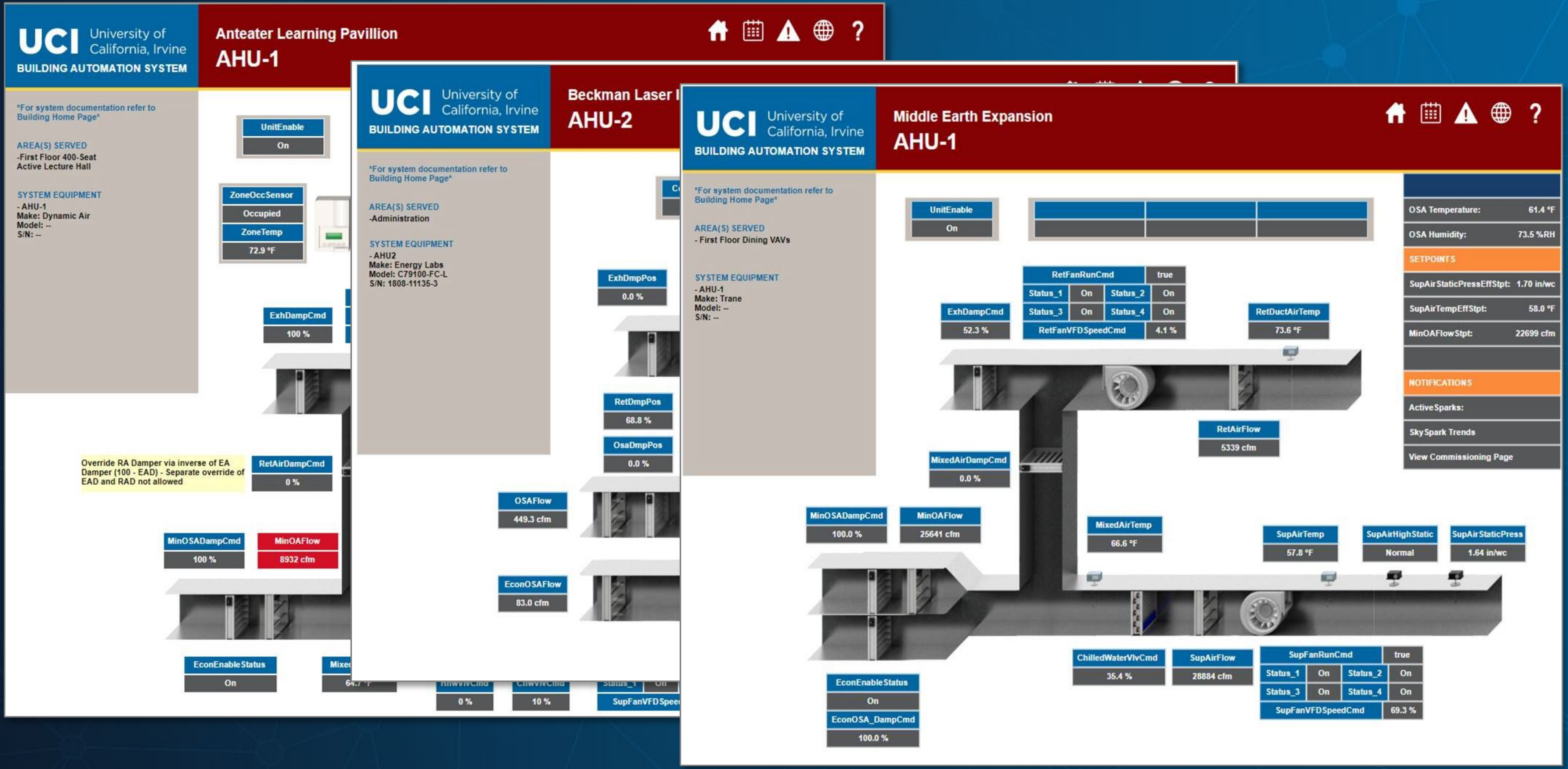

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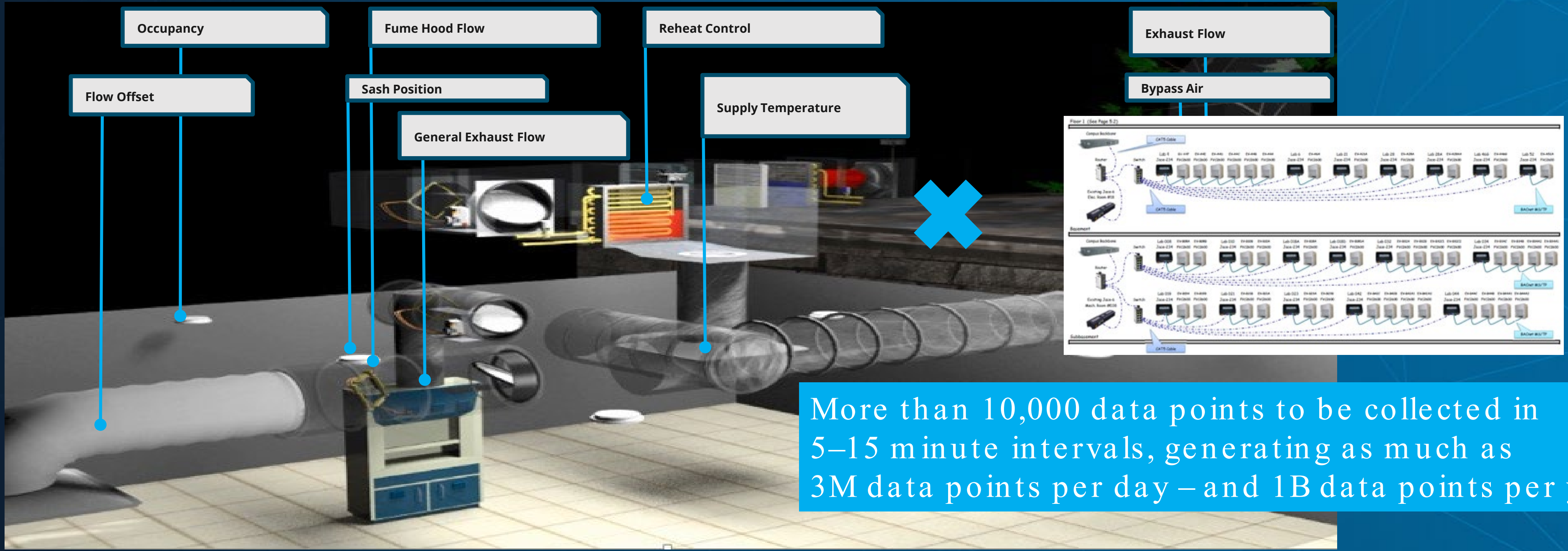
Why do we need data analytics for Smart Buildings?



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More than 10,000 data points to be collected in 5–15 minute intervals, generating as much as 3M data points per day – and 1B data points per year!

150 Data Points in each zone!

Why do we need data analytics for Smart Buildings?

Voting-based Reset Parameters

Variable	Definition
Device	Associated device (e.g., fan, pump)
SP_0	Initial setpoint
SP_{min}	Minimum setpoint
SP_{max}	Maximum setpoint
T_d	Delay timer
T	Time step
I	Number of Ignored Requests
R	Number of Requests from zones/systems
SP_{trim}	Trim amount
SP_{res}	Respond amount (must be opposite in sign to SP_{trim})
$SP_{res\text{-}max}$	Maximum response per time interval (must be same sign as SP_{res})

+

Increasing amount of data from building systems and components

=

Greater need for use of analytics platforms to ensure proper operations both during initial commissioning an in on-going operations

Analytics can support multiple use cases

A well modeled analytics database can be the foundation of a robust Energy Management Information System (EMIS)

Use Cases:

- Flight data recorder for all bldg. devices – get all data in one place
- Fault detection & diagnostics tool
- Commissioning testing and validation
- Automated functional testing
- Energy project and issues tracking
- Measurement & Verification reporting
- Automated Work Order generation
- Predictive maintenance
- Asset data collection and management
- Utility billing and recharge management

SkySpark®

Start small and build – it does not take artificial intelligence to identify and resolve most performance issues!

Analytics-driven commissioning

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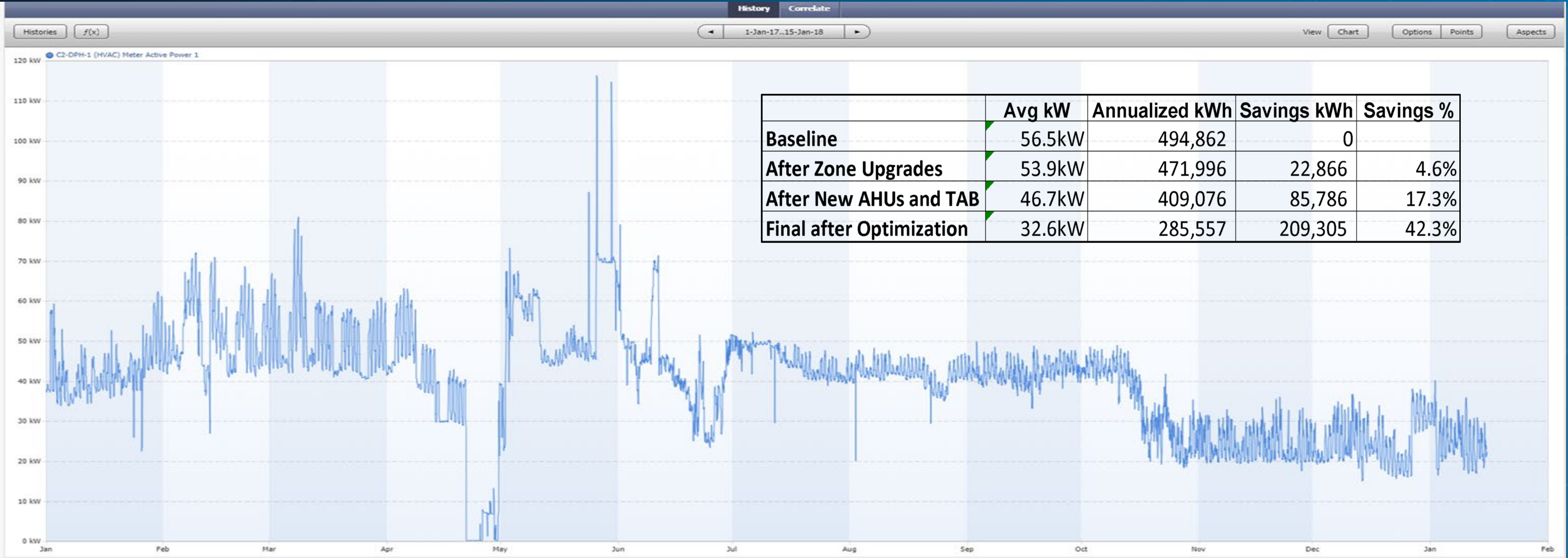
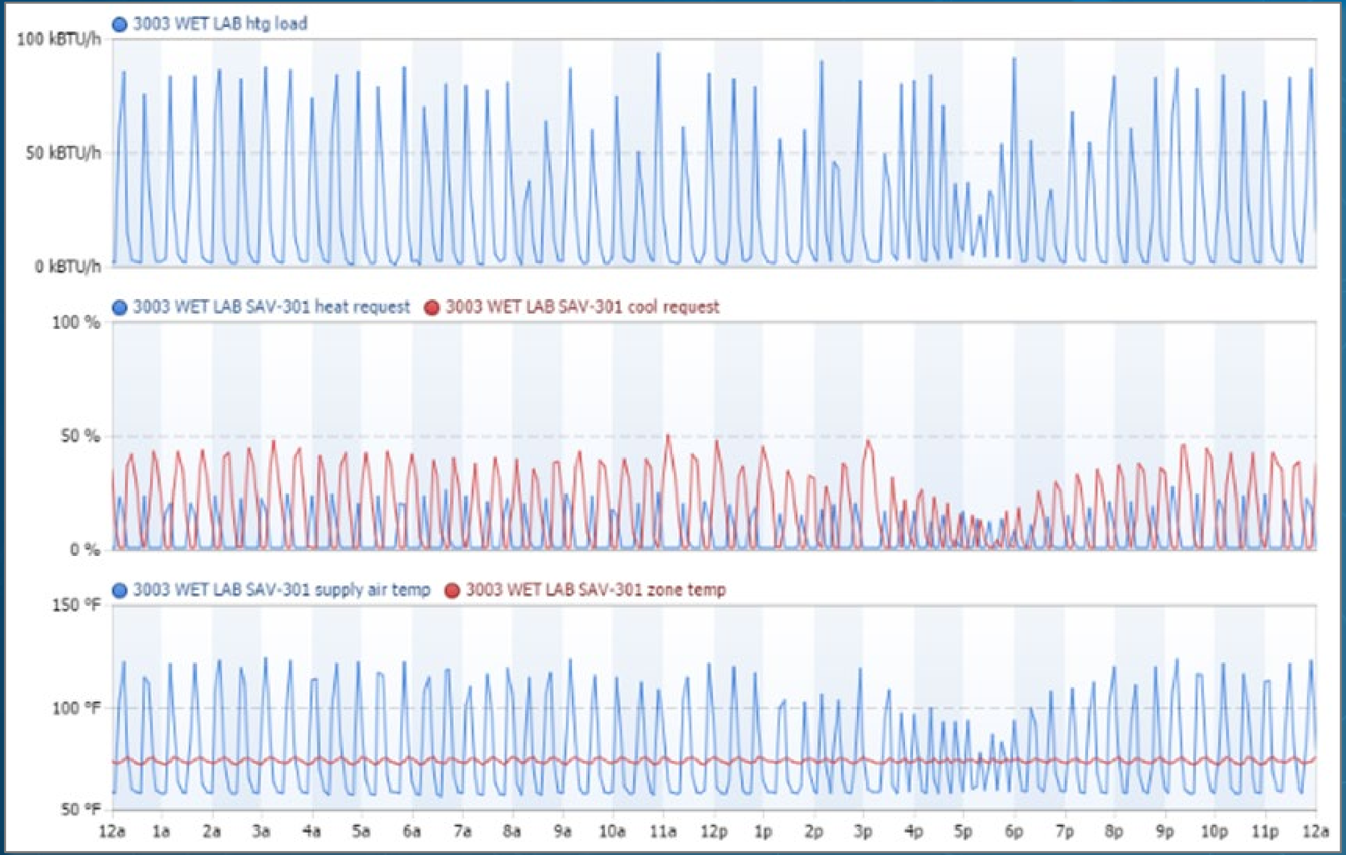
Data-driven commissioning 7 months out from functional testing



	Avg kW	Annualized kWh	Savings kWh	Savings %
Baseline	56.5kW	494,862	0	
After Zone Upgrades	53.9kW	471,996	22,866	4.6%
After New AHUs and TAB	46.7kW	409,076	85,786	17.3%
Final after Optimization	32.6kW	285,557	209,305	42.3%

Analytics-driven commissioning

- Heat/cool call inducing load and airflow
- No deadband / high heating setpoints
- Implemented changes resulted in **~20% HHW / CHW savings**

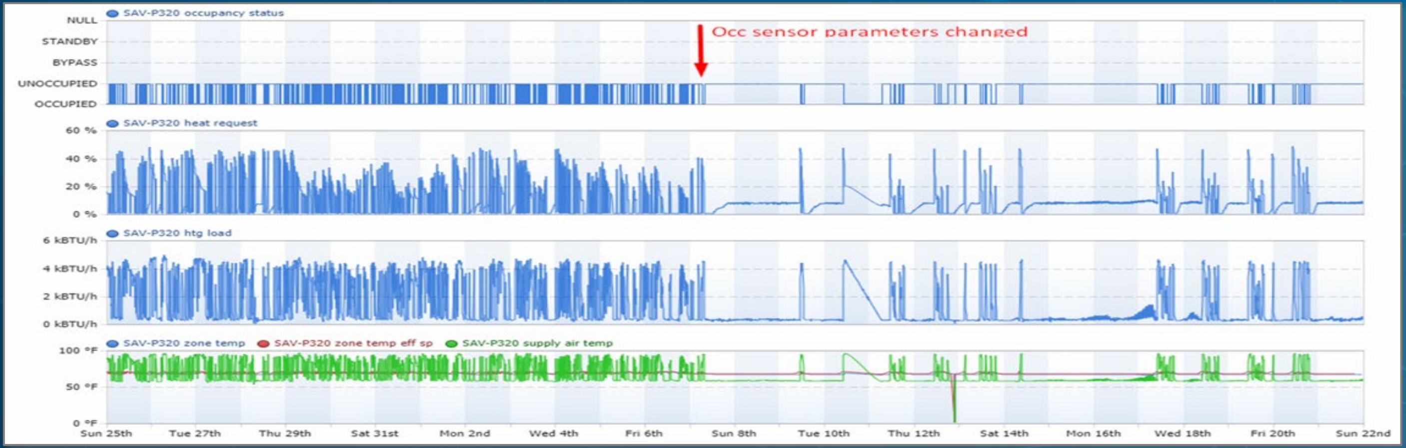


Analytics-driven O&M

- A laboratory building with ~400 zones showed **anomalies on ~50% of zones using FDD rules**
- Further investigation found that ~3-year-old valves were corroded and leaking severely because of a building water treatment issue
- Project resulted in **more than 30% HHW and CHW energy savings**

Analytics-driven O&M

- Occupancy sensors are too sensitive, triggering occupancy after hours and inducing unnecessary heating and cooling
- Occ sensors sent to lower sensitivity with longer timeout
- Induced **heating load reduced by more than 30%**



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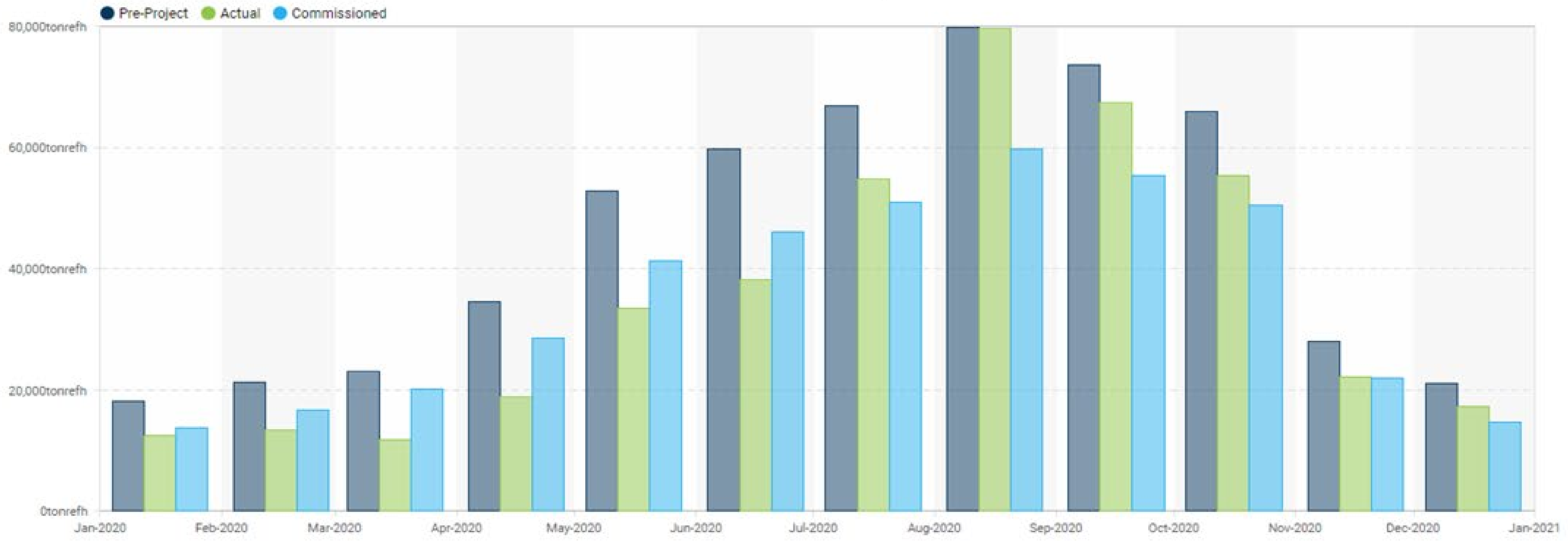
Other UCI Use Cases of Data Analytics

- Utility recharge (250+ meters and 90+ accounts)
- Research support (Bren Hall and APEP)
- EV Charger monitoring and control
- Battery energy storage system monitoring
- Decarbonization planning and analysis
- Electricity generation and import and associated emissions reporting

Analytics-driven Measurement & Verification (M&V)

Engineering Hall	Jan-2020	Feb-2020	Mar-2020	Apr-2020	May-2020	Jun-2020	Jul-2020	Aug-2020	Sep-2020	Oct-2020	Nov-2020	Dec-2020	Total (1Jan20 - 31De
Pre-Project	18,105tonrefh	21,233tonrefh	23,161tonrefh	34,561tonrefh	52,783tonrefh	59,818tonrefh	66,844tonrefh	79,768tonrefh	73,621tonrefh	65,980tonrefh	28,003tonrefh	21,110tonrefh	544,988tonrefh
Actual	12,429tonrefh	13,336tonrefh	11,815tonrefh	18,888tonrefh	33,382tonrefh	38,250tonrefh	54,804tonrefh	79,667tonrefh	67,412tonrefh	55,316tonrefh	22,248tonrefh	17,234tonrefh	424,781tonrefh
Actual Savings	5,677tonrefh	7,897tonrefh	11,346tonrefh	15,673tonrefh	19,401tonrefh	21,568tonrefh	12,039tonrefh	102tonrefh	6,209tonrefh	10,664tonrefh	5,755tonrefh	3,876tonrefh	120,207tonrefh
Commissioned	13,745tonrefh	16,665tonrefh	20,241tonrefh	28,626tonrefh	41,334tonrefh	46,017tonrefh	50,971tonrefh	59,813tonrefh	55,433tonrefh	50,390tonrefh	21,987tonrefh	14,678tonrefh	419,899tonrefh
Commissioned Savings	4,337tonrefh	4,589tonrefh	2,921tonrefh	5,928tonrefh	11,451tonrefh	13,794tonrefh	15,876tonrefh	19,952tonrefh	18,179tonrefh	15,608tonrefh	6,043tonrefh	6,437tonrefh	125,116tonrefh
Percentage Decrease	31.35%	37.19%	48.99%	45.35%	36.76%	36.06%	18.01%	0.127%	8.434%	16.16%	20.55%	18.36%	26.45%

Chilled Water End-Use Analysis



Engineering Hall

❄ Chilled Water M&V Analysis ❄

Range: 1Jan20 - 31Dec20

Performance Summary

- **Actual Energy Use:** 424,781tonrefh
- **Pre-Project Model Energy Use:** 544,988tonrefh
- **Commissioned Model Energy Use:** 419,899tonrefh
- **Actual Savings:** 120,207tonrefh (26.45%)
- **Commissioned (Predicted) Savings:** 125,116tonrefh (22.96%)

Input Descriptions

Pre-Project: The predicted energy consumption for the 'project equipment scope' , if the project had never been implemented.

Actual: The actual energy consumption for the 'project equipment scope'.

Commissioned: The predicted energy consumption for the 'project equipment scope' based on actual performance AFTER the project has been commissioned.

Commissioned Savings: The difference between the 'pre-project' performance and the 'commissioned' performance.

Actual Savings: The difference between the 'pre-project' performance and the 'actual' performance.

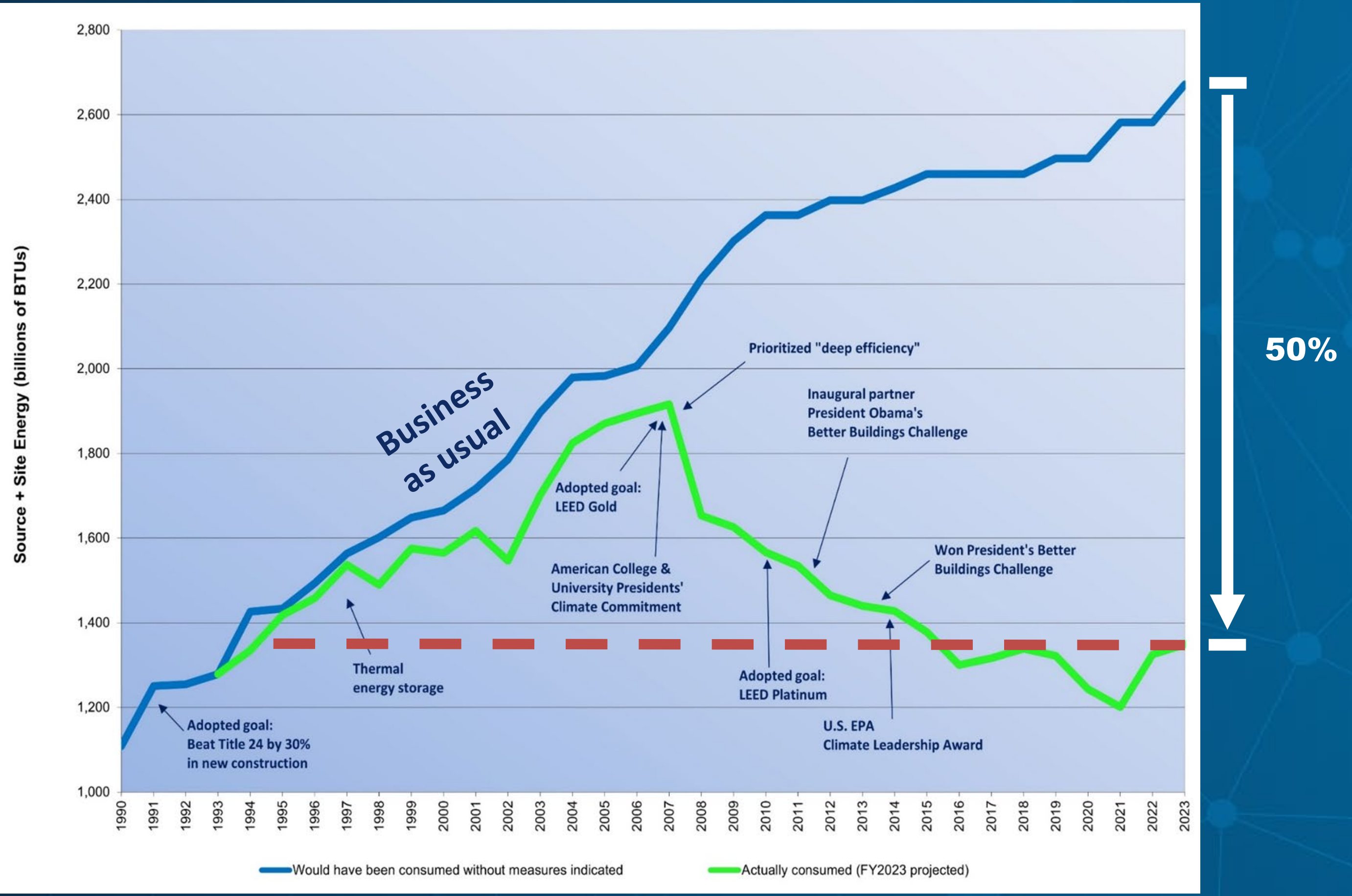
Data Quality Notes

Data gaps can occur in actual interval meter data and prediction models during the lifecycle of a energy project or building system. When these gaps are small, they are filled in through estimation. If the data gaps are excessive for a given month, the report will omit the month entirely. The minimum threshold for data is that: at least 70% of the days out of the month must have usable data. All data quality issues and interventions are listed below.

The following months had some data gaps but met the minimum data viability threshold (70%). Estimation techniques were used to fill the remaining days.

- **Pre-Project:** Nov 2020 (97% availability)
- **Commissioned:** Nov 2020 (97% availability)

Three Decades of Energy Efficiency



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Lessons Learned

- Data architecture is key to successfully unlocking and managing data at scale
- Transition to open, multi vendor Niagara BAS challenges:
  - Extremely detailed standards and specs
  - Qualified providers (RFQ)
  - Oversight (Master Systems Administrator)
  - Continuous network management and tuning
  - BAS shop change management
- New workflows needed to harness the full power of the data
- (OCx, PM, reactive, etc.)

More data = more fun and more impact!

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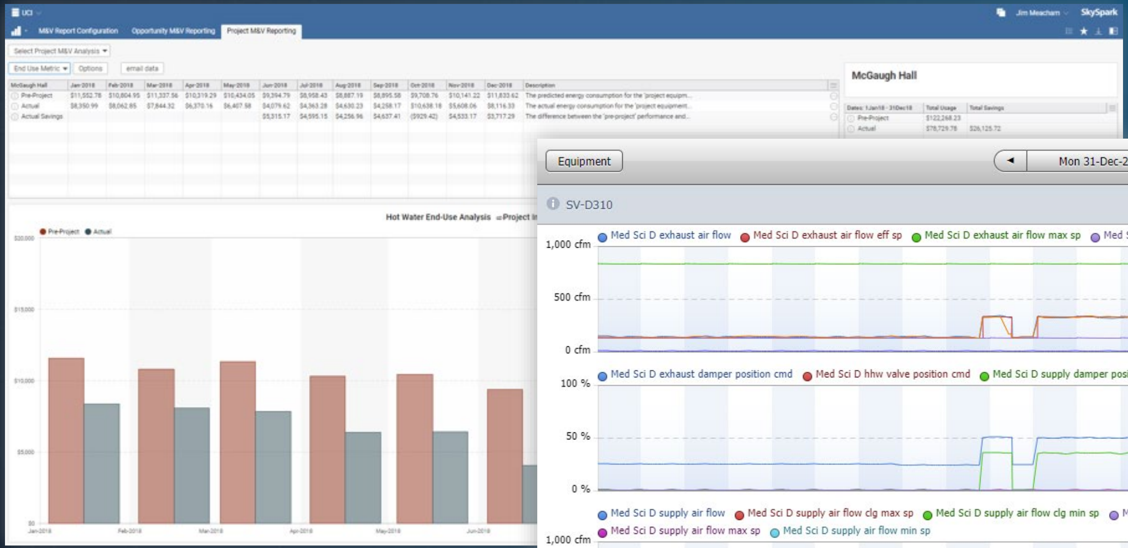

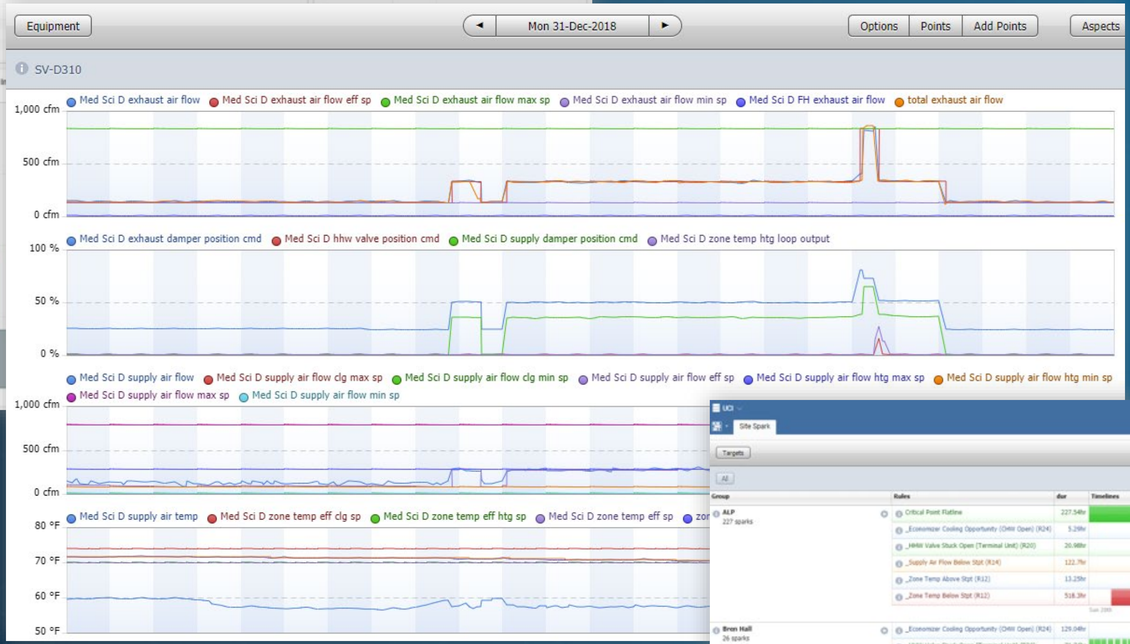

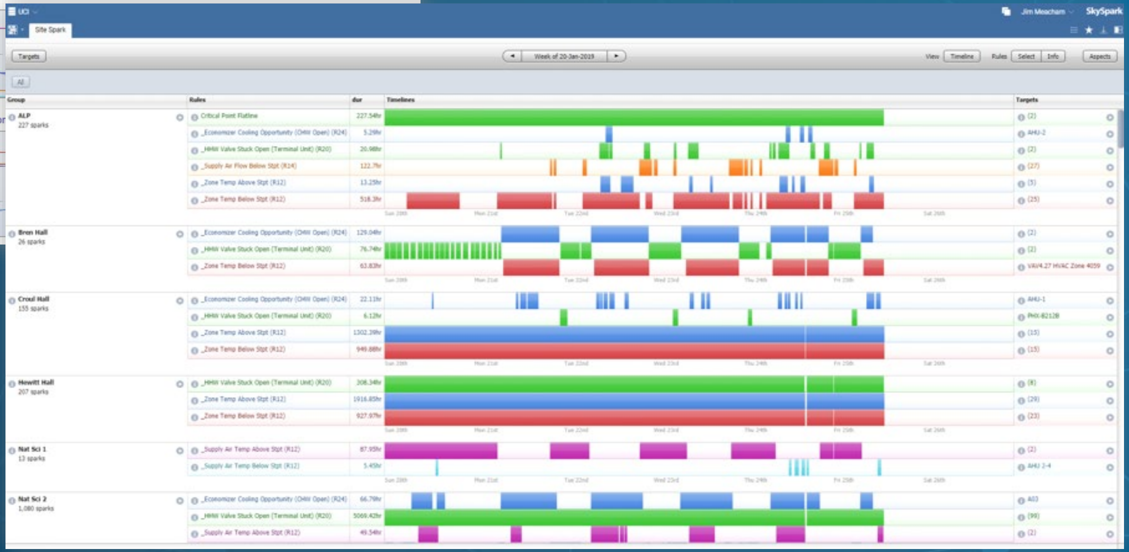

Manage risk and deliver high performance, resilient Smart Buildings

Deliver and maintain **real** energy savings

Be able to **answer the hard questions** and fix things

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Thank You!

Joe, Jim, and Roger