energenz
a division of NV5

ASHRAE TECHNICAL SHARING

Commissioning in Building Operations and Maintenance: Introduction to Monitoring Based Commissioning

Wednesday, May 23, 2018
Energenz Consulting Limited

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NV5 Asia

Design Phase

- Acoustics
- Audiovisual
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- Security & Surveillance Design
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- Data-analytics Commissioning
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- Certification Support

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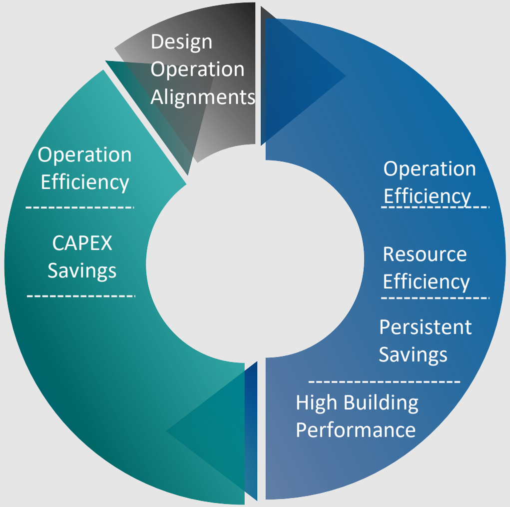
- Energy Assessment & Management
- Retro-Commissioning
- Measurement & Verification
- Metering & Monitoring Strategy
- Implementation Support
- Monitoring Based Commissioning
- Ongoing Commissioning
- Building Energy Portfolio Management
- Condition Based Operation and Maintenance

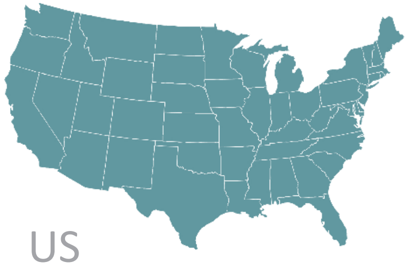


OUR LOCATIONS AND EXPERTISE

Global Employees: 2,500 | Licensed Technical Staff: 1,300

Employees in Asia Pacific: 135 | Licensed Technical Staff: 110

Global Offices: 100



ENERGENZ INTRODUCTION

Our Clients

Hong Kong Convention and Exhibition Centre
Hong Kong International Airport
The Hong Kong Jockey Club
Cathay Pacific Catering Services
InterContinental Hotels Group
Mandarin Oriental
The Peninsula Group
Hong Kong Science & Technology Parks
ZCB
EMSD
KMB
Caesars Entertainment
Macau Fisherman's Wharf
blu spas
Desert Diamond Casinos & Entertainment
Dubai Airports
Cathay Pacific
PCCW
San Manuel Indian Bingo & Casino
Tropicana Aruba Resort & Casino
Palms Casino Resort
Barona Resort & Casino
CLP 中電
CTM 澳門電訊
Swire
Hongkong Land
Li & Fung
DHL
IKEA
clas ohlson
HSBC
J.P.Morgan
JLL
The American Club Hong Kong
Cold Storage
Café de Coral
adidas
Veolia Environmental Services
MGM Grand
Wynn Macau
Sands
Galaxy Macau
Tan Chong International
United Technologies
Jabil
Arineos

01 TYPES OF COMMISSIONING

What is Commissioning?

Commissioning: A naval engineering term, is the standard practice of taking a new ship for a test run at sea to ensure that it's **fit**.

Testing ≠ Commissioning

TYPES OF COMMISSIONING

New Building and Existing Building

New Building Commissioning (Cx)

- A quality-focused process for enhancing the delivery of a project.
- For new buildings.
- Focus on verifying and documenting that commissioned systems and assemblies are planned, designed, installed, tested, operated and maintained → to meet the **Owner's Project Requirements (OPR)**.

Existing Building Commissioning (EBCx)

- A quality-focused process for attaining the Current Facility Requirements (CFR)
- For existing building and/or its systems and assemblies.
- Focus on planning, investigating, implementing, verifying and documenting that the facility and/or its systems and assemblies are operated and maintained → to meet the **Current Facility Requirements (CFR).**

TYPES OF COMMISSIONING

Commissioning on Existing Buildings

ReCommissioning (ReCx)

The decision to recommission may be triggered by a **change in building use or ownership, the onset of operational problems**, or some other needs.

Something Has Changed!

Retro Commissioning (RCx)

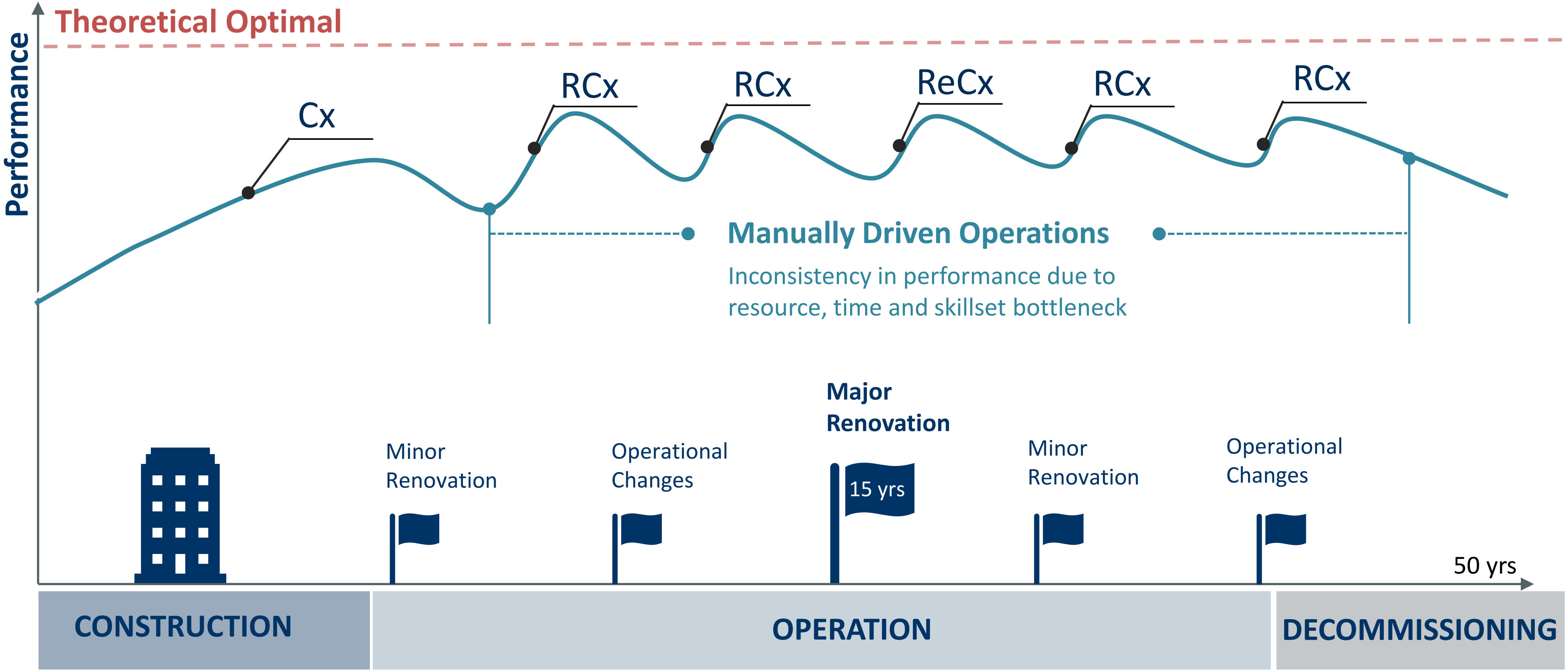
Solve problems that occurred during design or construction, or address problems that have developed throughout the building's life.

Something Seems Wrong!

Ongoing Commissioning (OCx)

A continuation of the commissioning process after the Hand-Off phase to verify that a facility continues to meet current and evolving Current Facility Requirements (CFR). OCx Process Activities occur **throughout the life of the facility**.

BUILDING LIFECYCLE AND Cx



TYPES OF COMMISSIONING

Monitoring Based Commissioning

Monitoring Based Commissioning (MBCx)

It is the integration of **Permanent Energy Monitoring Systems**, **Real-time Energy Analysis** and **Ongoing Commissioning.** MBCx is an ongoing performance analysis of an operational building that provides real-time equipment performance information to the building operators.

02 COMMISSIONING AND LEED

COMMISSIONING AND LEED

LEED BD+C – Enhanced Commissioning

0	0	0	Energy and Atmosphere		33
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
			Credit	Enhanced Commissioning	6
			Credit	Optimize Energy Performance	18
			Credit	Advanced Energy Metering	1
			Credit	Demand Response	2
			Credit	Renewable Energy Production	3
			Credit	Enhanced Refrigerant Management	1
			Credit	Green Power and Carbon Offsets	2

Enhanced Commissioning: To further support the design, construction, and eventual operation of a project that meets the **owner's project requirements** for energy, water, indoor environmental quality, and durability.

TYPES OF COMMISSIONING

Enhancing Commissioning Scoring

A max of 6 points attainable

REQUIREMENT	OPTION (AND/OR)	PATH & SCORING (OR)
Already satisfy the prerequisite requirements: 1. Fundamental Cx and verification 2. Minimum energy performance 3. Building-level energy metering 4. Fundamental refrigerant management	Option 1. **Enhanced systems commissioning**	Path 1: Enhanced Commissioning (3 points) Path 2: Enhanced Commissioning and MBCx (4 points)
	Options 2. **Envelope Commissioning**	2 points

COMMISSIONING AND LEED

LEED O+M – Existing Building Commissioning

0	**0**	**0**	**Energy and Atmosphere**		**38**
Y			Prereq	Energy Efficiency Best Management Practices	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
			Credit	Existing Building Commissioning— Analysis	2
			Credit	Existing Building Commissioning—Implementation	2
			Credit	Ongoing Commissioning	3
			Credit	Optimize Energy Performance	20
			Credit	Advanced Energy Metering	2
			Credit	Demand Response	3
			Credit	Renewable Energy and Carbon Offsets	5
			Credit	Enhanced Refrigerant Management	1

TYPES OF COMMISSIONING

O&M Existing Building EA – Existing Building Commissioning (EBCx)

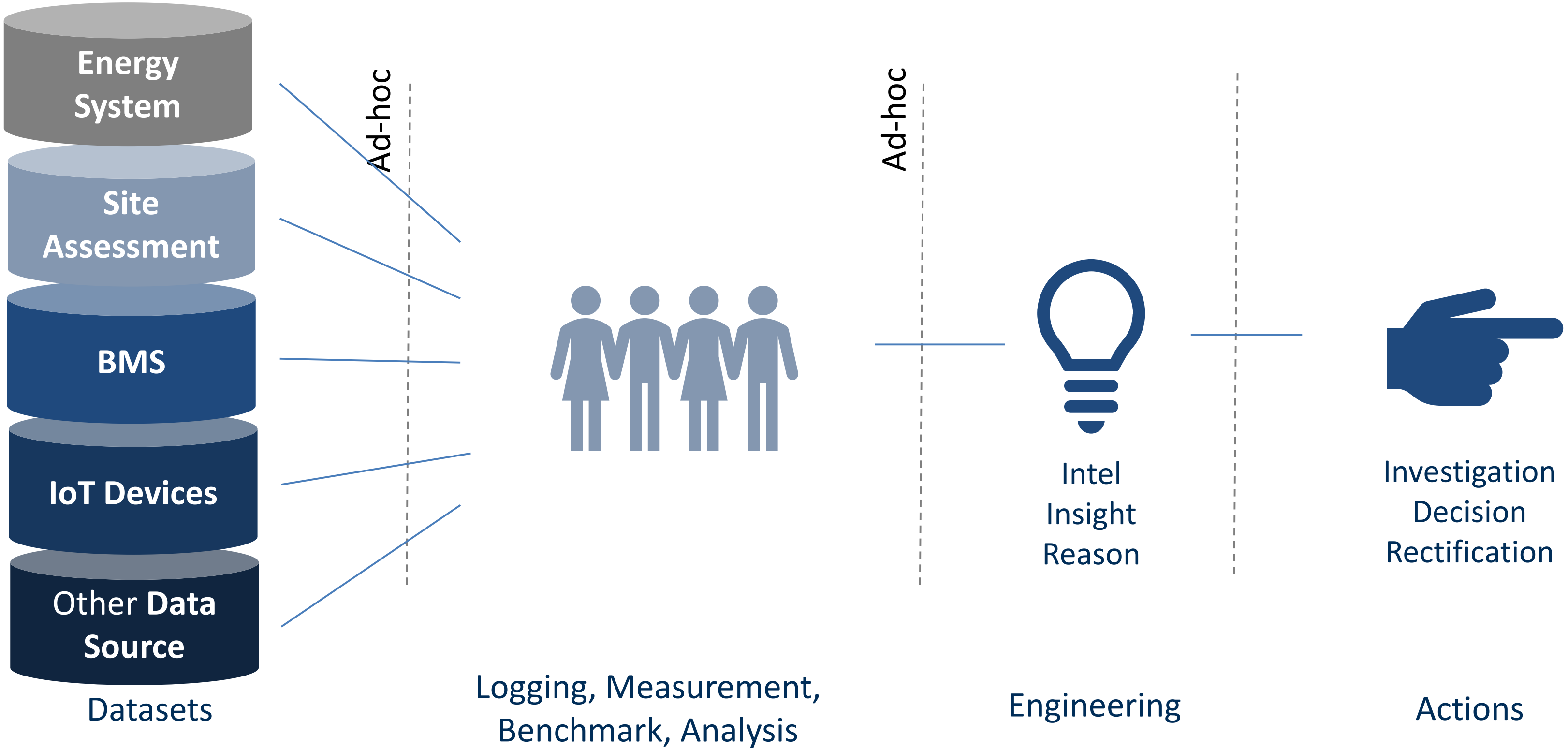
EBOM – Existing / Ongoing Commissioning (7 Credits)

REQUIREMENT	CREDITS	PATH & SCORING
Already satisfy the prerequisite requirements: 1. Energy efficiency best management practices 2. Minimum energy performance 3. Building level-energy metering 4. Fundamental refrigerant management	**EBCx - Analysis**	Options 1. EB commissioning (2) Options 2. Energy audit (2)
	EBCx - Implementation	Meeting EBCx – Analysis requirements plus implementation of no/low cost operational improvements + 5 year plan (2)
	EBCx – Ongoing Commissioning (OCx)	Meeting above and OCx (Plan and Process) (3)

03 THE PROCESS OF MBCx

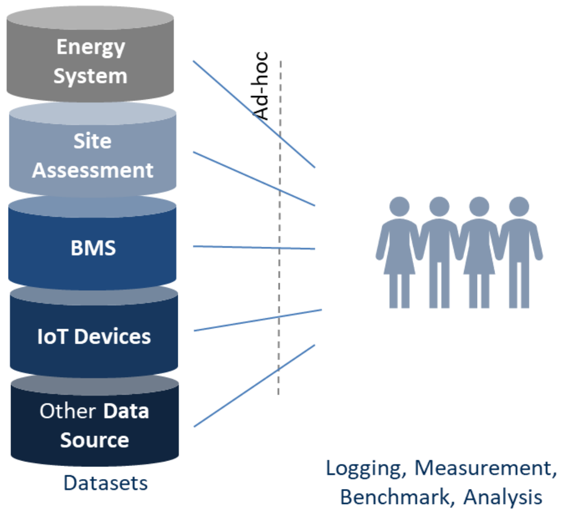
THE PROCESS OF MBCx

Conventional Process



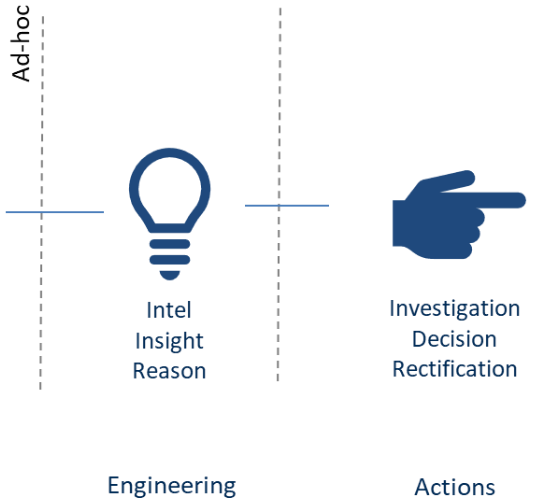
THE PROCESS OF MBCx

Conventional Process



Data Collection **Data Mapping** **Data Crunching** **Data Analyses**

- Can be substituted by computers
- Computers can do it 24/7, continuously with higher precision and accuracy



Issue Identification **Rectification of Issues**

- Cannot be substituted by computers
- Need higher level of thinking, cannot be easily programmed

MONITORING BASED COMMISSIONING

Key Components and System Requirements

KEY COMPONENTS

Permanent data monitoring systems

Real-time analysis

Ongoing commissioning

SYSTEM REQUIREMENTS

1. Data Acquisition

- BMS/EMS
- Digital sub-metering

2. Analytics Module

Performance analytics

Fault Detection and Diagnostics (FDD)

3. Workflow and Dashboard Module

Cx and Implementation

TECHNOLOGY ENABLERS

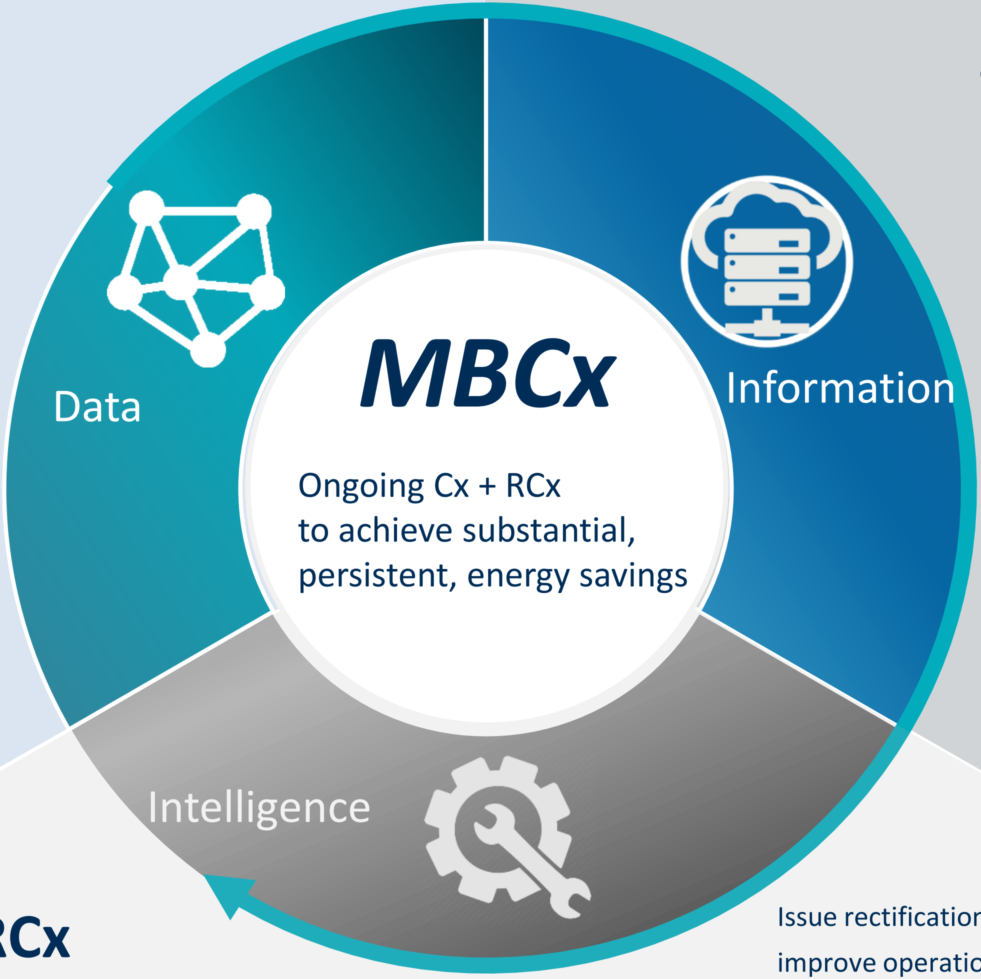
Smarts Devices	Digital devices that measures multiple parameter with time-stamping capacity
IoT Devices and Platform	Also referred to as "connected device items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data, over common IP
Cloud-based Computation	An information technology (IT) paradigm, a model for enabling of configurable resources pools of configurable resources
Big Data Analytics	Massive and multiple data sets that allows cross -disciplinary analyses that enables more comprehensive, faster and deeper discovery of engineering, business and social issues

BIG DATA

Datasets from BMS, PMS, POS, EMS, Wireless devices, design parameters, performance data, business metrics…etc.

TECHNOLOGY

Continuous monitoring and data analytics on properties’s big data to reveal operational or performance issue or opportunities

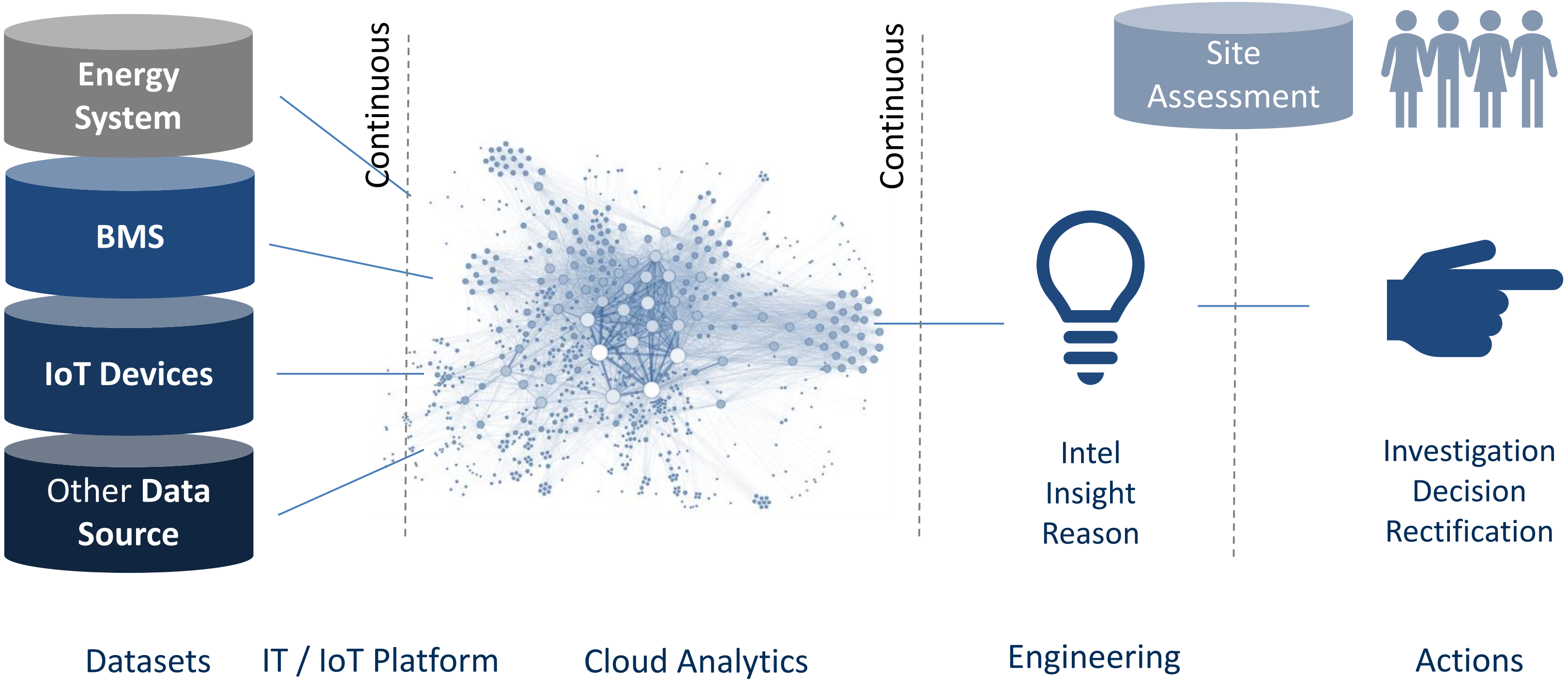


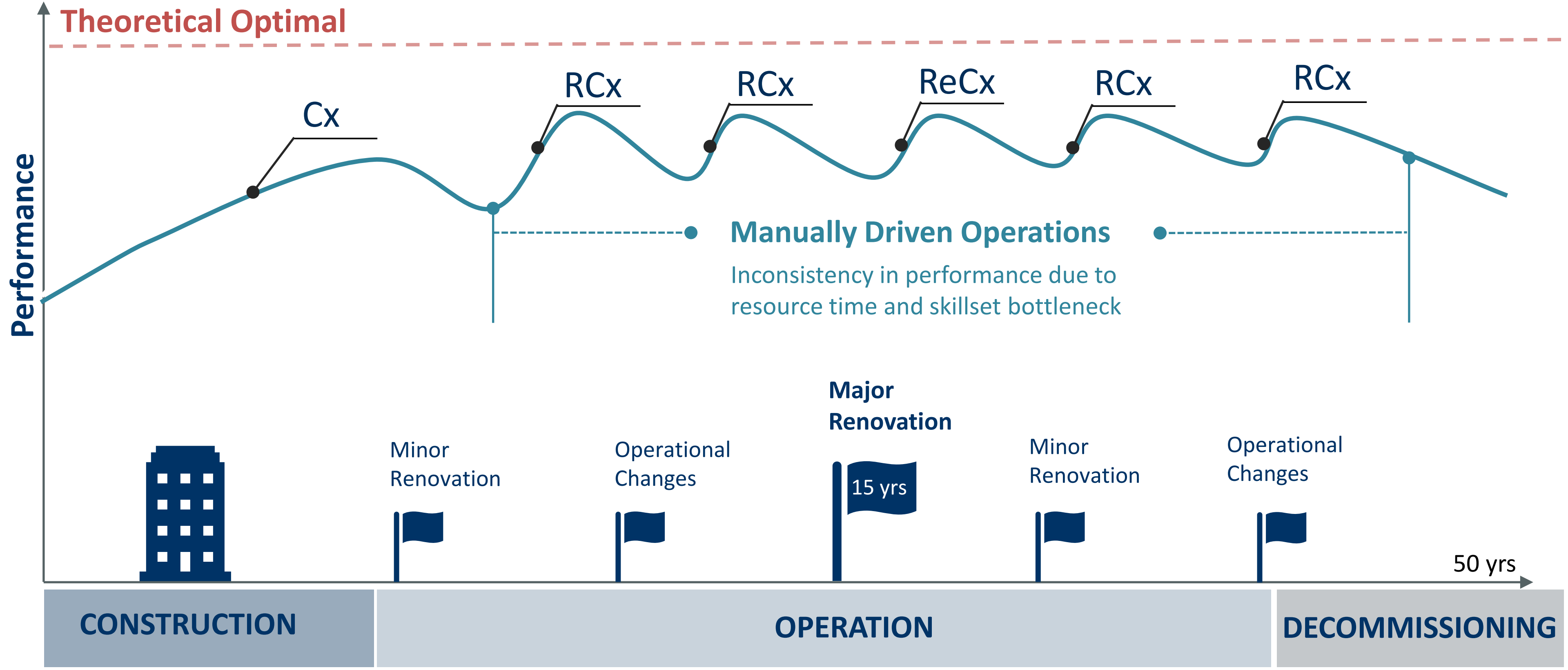
Cx/RCx

Issue rectification and tune-up improve operational efficiency

THE PROCESS OF MBCx

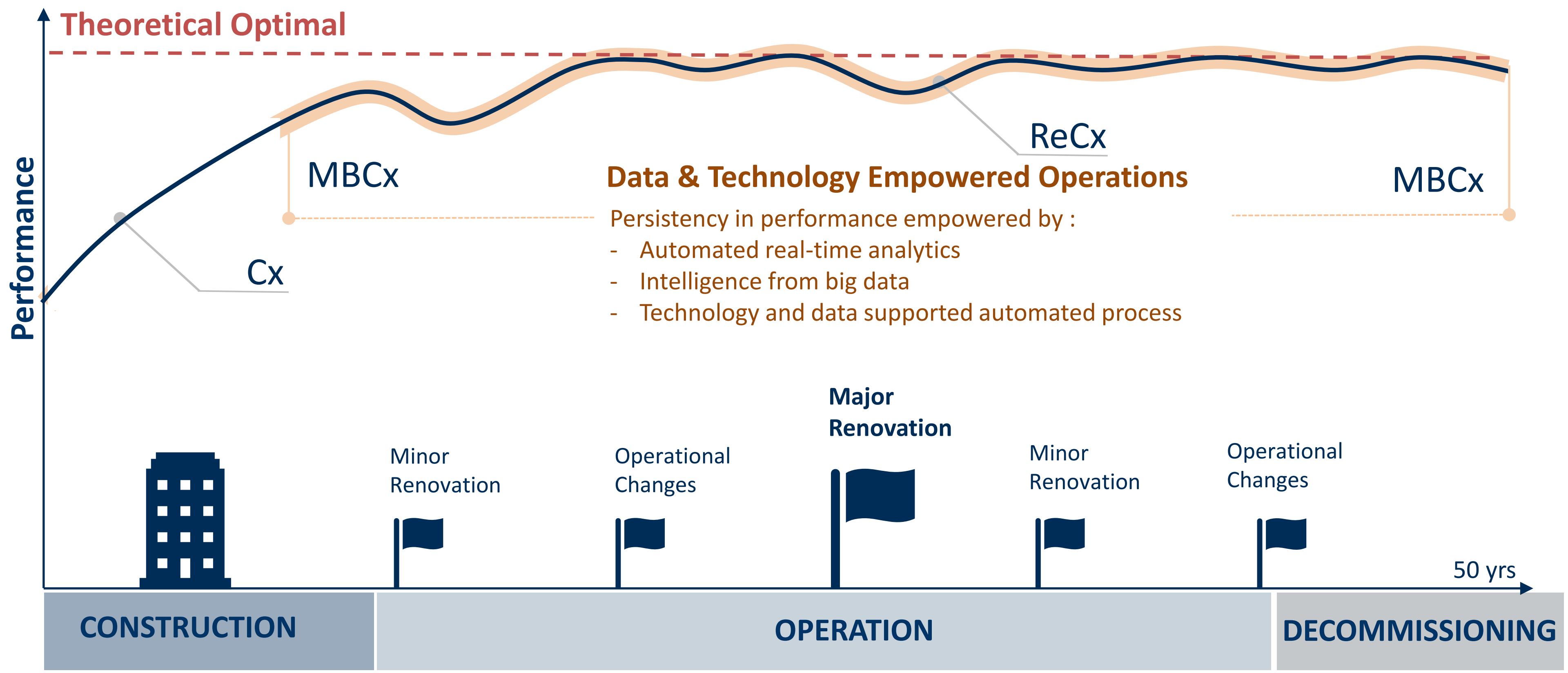
Data Driven Cx Process





Manually Driven Commissioning

Commissioning in Building Life-cycle



Data Driven Commissioning

Commissioning in Building Life-cycle

MBCx Outcome

Research Results

Survey on 130 large buildings showed that saving of 20% energy use is possible

Enhanced comfort, health and safety with proper temperature and humidity control with adequate ventilation

Reduce maintenance costs, problems are corrected first time.

MBCx Outcome

Research Results

Monitoring-Based Commissioning:

Benchmarking Analysis of 24 UC/CSU/IOU Projects

Evan Mills, Ph.D
Paul Mathew, Ph.D.

Lawrence Berkeley National Laboratory
Berkeley, California

Report Prepared for:
California Energy Commission
Public Interest Energy Research (PIER)
Technology Demonstration Program

June 2009

	All Sites		By Climate		By Building Type	
Sample	MA*	MBCx**	MA - non-Lab	MBCx - non-Lab	MA - Lab	MBCx - Lab
Location	US	CA	CA/OR/WA	CA	US	CA
Number of projects	84	21	36	14	13	12
Number of buildings	128	26	72	9	15	12
Median building size (square feet, sf)	154,000	121,214	197,953	117,607	139,361	106,592
Total Source Energy						
Pre-cx (kBTU/sf, source)	323	335	231	189	543	534
Savings (kBTU/sf, source)	31	24	15	18	119	40
Savings (%)	12%	11%	9%	10%	16%	12%
Building Electricity						
Pre-cx (kWh/sf-year)	23	21	16	14	29	35
Savings (kWh/sf-year)	1.7	1.6	1.2	0.9	1.5	1.7
Savings (%)	8%	7%	9%	8%	5%	6%
Building Peak Power						
Pre-CX	4.2	3.7	4.2	2.7		4.4
Savings	0.5	0.2	0.1	0.3		0.2
Savings	2%	4%	9%	8%		3%
Building Fuel						
Pre-cx (kBTU/sf, source)	89	153	89	50		195
Savings (kBTU/sf, source)	7	12	3	2		20
Savings (%)	9%	7%	5%	5%		10%
Central Thermal* **						
Pre-cx (kBTU/sf, source)	211				388	
Savings (kBTU/sf, source)	56				142	
Savings (%)	32%				24%	
Central Hot Water						
Pre-cx (kBTU/sf, source)		42		19		68
Savings (kBTU/sf, source)		8		8		16
Savings (%)		25%		36%		23%
Central Steam						
Pre-cx (kBTU/sf, source)		98		24		213
Savings (kBTU/sf, source)		32		2		41
Savings (%)		19%		12%		19%
Central Chilled Water						
Pre-cx (kBTU/sf, source)		45		27		95
Savings (kBTU/sf, source)		8		6		9
Savings (%)		19%		29%		16%
Economics						
Project costs ($/sf)	$ 0.29	$ 1.00	$ 0.24	$ 0.72	$ 0.31	$ 1.15
Cost savings ($/sf)	$ 0.33	$ 0.32	$ 0.16	$ 0.22	$ 1.65	$ 0.46
Simple payback time (years)	0.6	2.5	1.4	2.7	0.1	1.9

MBCx Outcome

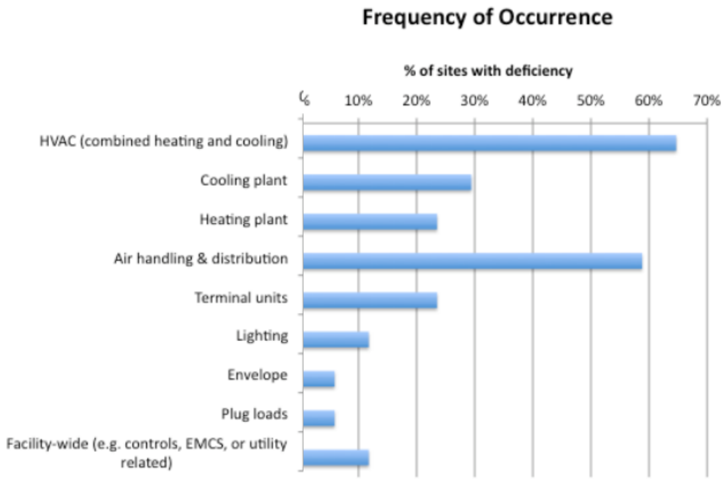
Research Results

Increasing Reoccurrence Rate

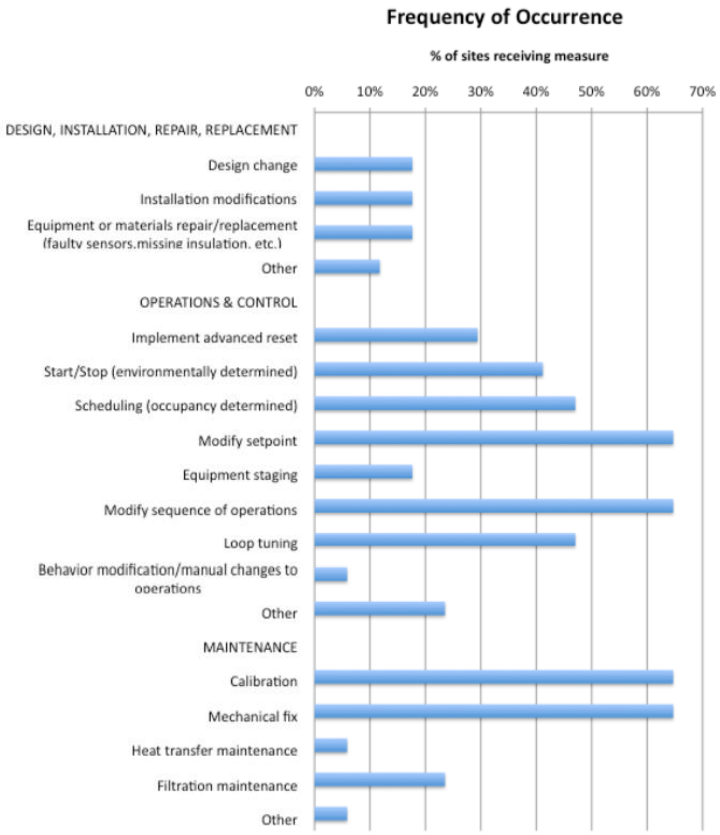
		Commissioning Measures Implemented																		
		Design, Installation, Retrofit, Replacement				Operations & Control									Maintenance					
		Design change	Installation modifications	Retrofit/equipment replacement	Other	Implement advanced reset	Start/Stop (environmentally determined)	Scheduling (occupancy determined)	Modify setpoint	Equipment staging	Modify sequence of operations	Loop tuning	Behavior modification/manual changes to operations	Other	Calibration	Mechanical fix	Heat transfer maintenance	Filtration maintenance	Other	*SUM*
Component being Commissioned		D1	D2	D3	D4	OC1	OC2	OC3	OC4	OC5	OC6	OC7	OC8	OC9	M1	M2	M3	M4	M5	
HVAC (combined heating and cooling)	V	2	2	1	0	11	9	12	47	0	29	17	0	0	97	123	0	7	0	357
Cooling plant	C	1	1	0	0	2	4	0	1	2	2	2	0	2	2	0	0	0	1	20
Heating plant	H	0	2	1	1	1	3	1	9	6	1	1	0	0	1	6	0	0	2	35
Air handling & distribution	A	0	0	6	1	30	2	17	12	9	23	4	0	2	29	38	9	9	0	191
Terminal units	T	0	0	0	0	0	0	0	5	0	6	5	0	0	136	10	0	0	0	162
Lighting	L	1	1	1	0	1	286	49	0	0	0	0	3	0	0	0	0	0	0	342
Envelope	E	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3
Plug loads	P	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3
Facility-wide (e.g. EMCS or utility related)	F	0	0	0	4	0	0	0	0	0	0	0	0	3	0	0	0	0	0	7
Other	O	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUM		4	6	9	6	45	304	79	74	17	61	29	9	7	265	177	9	16	3	1120

MBCx Outcome

Research Results



By System



By Nature

04 THE BENEFITS OF MBCx

LIMITATIONS & BOTTLENECKS (Cx)

Performance Life Cycle

Data Availability

- Usage, Occupancy and Activity
- Building Loading Intensity

Data Quality

- Space Functions & Usage
- Activity

Contextual Feedback

- Previous Project (Commissioning? DLP?)
- Qualitative (it’s good, it doesn’t work…etc)
- Aim, hit and hope

Planning, Design, Construction → **Commissioning** → **Operations** → **Renovation**

LIMITATIONS & BOTTLENECKS (Cx)

Performance Life Cycle

Data Availability

- Commissionability
- One-off / instantaneous
- Lack of usage / real load

Data Quality

- Data could be misrepresentative

Contextual Feedback

- Non-contextual Feedback
- Fine-tune to?

Planning, Design, Construction → **Commissioning** → **Operations** → **Renovation**

LIMITATIONS & BOTTLENECKS (Cx)

Performance Life Cycle

Data Availability

- Insufficient data coverage
- Capture, communication and storage limitation
- Data integration

Data Quality

- Faulty / drifted sensors
- Time series resolution

Contextual Feedback

- Normalisation & Benchmark
- Invisible issues limited by resource (human / computer)

Planning, Design, Construction → **Commissioning** → **Operation** → **Renovation**

LIMITATIONS & BOTTLENECKS (Cx)

Performance Life Cycle

Data Availability

- Usage, Occupancy and Activity
- Building Loading Intensity

Data Quality

- Space Functions & Usage
- Activity

Contextual Feedback

- Previous project (Commissioning? DLP?)
- Qualitative (its good, it doesn’t work…etc)
- Aim, hit and hope

Planning, Design, Construction → Commissioning → Operations → Renovation

LIMITATIONS & BOTTLENECKS (Cx)

Performance Life Cycle

Planning, Design, Construction

- Sizing of equipment (built cost implications)
- Controllability and inflexibility

Commissioning

- System not fine-tune to real usage (real usage often not known)

Operations

- Lack of resource and feedback
- Invisible design, installation, control and issues

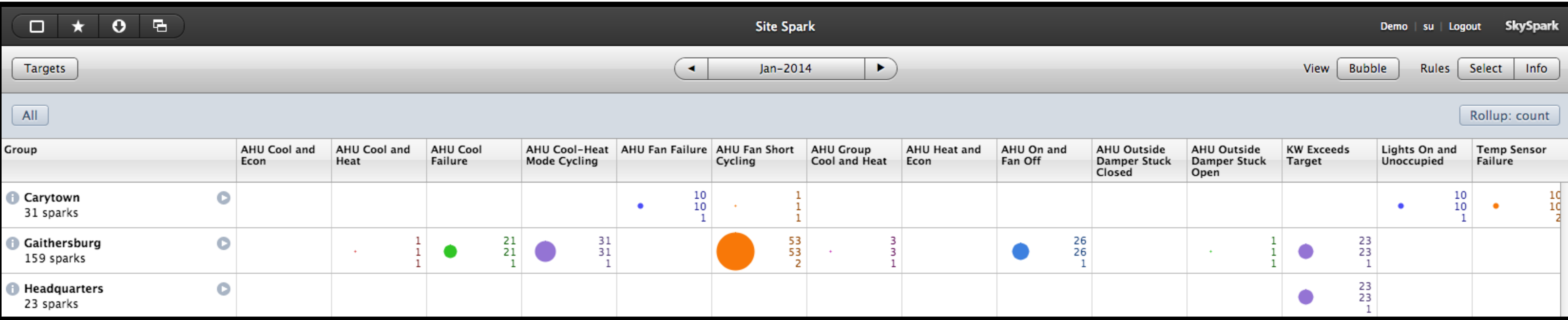
Renovation

- Sizing of equipment (built cost implications)
- Controllability and Inflexibility

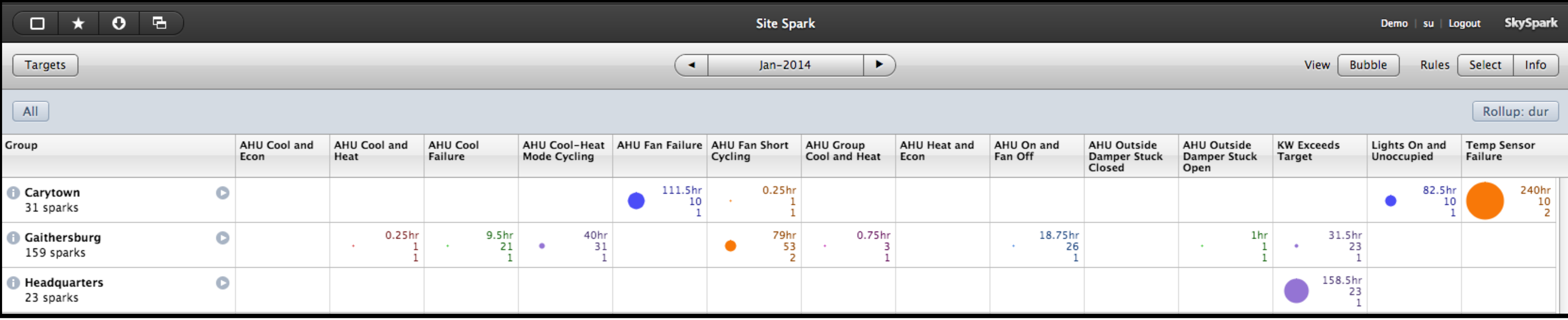

Making Invisible Visible
Design Issues
Control Issues
O&M Issues
Procedure Issues
Technical Level
Skillset Gaps
Human Error
Human Culture
Human Level
Supplier Issue
Service Contract Issues
Supply Chain Level

THE BENEFITS OF MBCx

Heatmap of Prioritised Issues



Group	AHU Cool and Econ	AHU Cool and Heat	AHU Cool Failure	AHU Cool-Heat Mode Cycling	AHU Fan Failure	AHU Fan Short Cycling	AHU Group Cool and Heat	AHU Heat and Econ	AHU On and Fan Off	AHU Outside Damper Stuck Closed	AHU Outside Damper Stuck Open	KW Exceeds Target	Lights On and Unoccupied	Temp Sensor Failure
Carytown 31 sparks					10 10 1	1 1 1							10 10 1	10 10 2
Gaithersburg 159 sparks		1 1 1	21 21 1	31 31 1		53 53 2	3 3 1		26 26 1		1 1 1	23 23 1		
Headquarters 23 sparks												23 23 1		



Group	AHU Cool and Econ	AHU Cool and Heat	AHU Cool Failure	AHU Cool-Heat Mode Cycling	AHU Fan Failure	AHU Fan Short Cycling	AHU Group Cool and Heat	AHU Heat and Econ	AHU On and Fan Off	AHU Outside Damper Stuck Closed	AHU Outside Damper Stuck Open	KW Exceeds Target	Lights On and Unoccupied	Temp Sensor Failure
Carytown 31 sparks					111.5hr 10 1	0.25hr 1 1							82.5hr 10 1	240hr 10 2
Gaithersburg 159 sparks		0.25hr 1 1	9.5hr 21 1	40hr 31 1		79hr 53 2	0.75hr 3 1		18.75hr 26 1		1hr 1 1	31.5hr 23 1		
Headquarters 23 sparks												158.5hr 23 1		

MBCx Benefits

Technical Issues (Primary Benefits)

- More Consistent Energy Saving
- Better Service Quality
- More Efficient Operation
- Greater Visibility in Issues

PERSISTENCY

Primary Benefits

Secondary Benefits

Human Issues

- Better Use of Human Resources
- Enhanced FM/Operator Skillset
- Best Practice

Supply Chain Issues

- Improved Maintenance Services
- Predictive Maintenance
- Longer Equipment Lifespan

05 APPLICATION AND CASE STUDY OF MBCx

MBCx APPLICATION

Data Driven Cx Analytics Engine

- Identify Data
- Get Data
- Map Data
- Data Assurance
- Establish Real-time link

Analytics Engine

1 Analytics Category

- ✓ Sequence of Operations Issues
- ❑ Design and Sizing Issues
- ❑ Control / Setpoint Issues
- ❑ Component / Equipment Failures
- ❑ Performance Issues (unknown cause)

2 Equipment Type

- ✓ AHU
- ❑ PAUs
- ❑ Kitchen Exhaust Fans
- ❑ VAVs
- ❑ Ventilation Fans
- ❑ Chiller / Heat Pump
- ❑ Cooling Tower
- ❑ Pumps
- ❑ Boilers
- ❑ Sensors

3 Issue Discovery

- ❑ AHU in "Unoccupied Mode" and chilled water valve is commanded to an open state
- ❑ AHU in "Unoccupied Mode" and hot water valve is commanded to an open state
- ❑ AHU supply fan minimum speed < 5 Hz
- ❑ AHU exhaust fan minimum speed < 5 Hz
- ❑ AHU supply fan is short cycling ON and OFF within a short period of time
- ❑ AHU exhaust fan is short cycling ON and OFF within a short period of time
- ❑ AHU in "Occupied Mode" and fresh air damper is not commanded to fully open state during start up
- ❑ AHU in "Occupied Mode" and exhaust air damper is not commanded to fully open state during start up
- ❑ AHU in "Occupied Mode" and return air damper is commanded to open state during start up
- ❑ AHU hot water valve is commanded to an open state when supply air temperature set point - supply air temperature <0.5 Degree C (0.5 Degree C is dead band defined on SOO and can be modified)
- ❑ AHU hot water valve is commanded to an open state when supply air temperature - supply air temperature set point > 0.5 Degree C (0.5 Degree C is dead band defined on SOO and can be modified)
- ❑ AHU cooling water valve is commanded to an open state when supply air temperature - supply air temperature set point < 0.5 Degree C
- ❑ AHU cooling water valve is commanded to an open state when supply air temperature set point - supply air temperature > 0.5 Degree C
- ❑ AHU cooling water valve is commanded open and hot water valve is commanded open simultaneously (These types of AHUs don't have any dehumidification mode)
- ❑ AHU cooling water valve is commanded open and heating valve is commanded open simultaneously when return air

4 Cost Assignment

5 Prioritisation

6 Team Assignment

7 Actions

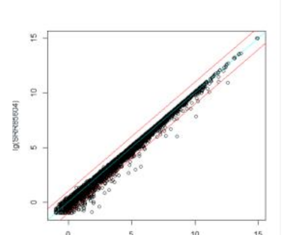
8 Verification & Reporting

MBCx APPLICATION

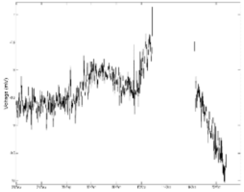
Different Level of Sophistication of Issues

PRIMARY

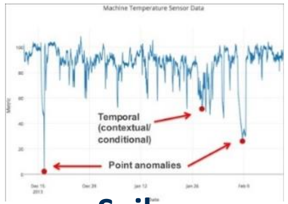
Equipment Failure



Threshold



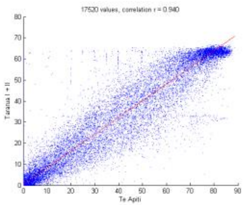
Gap



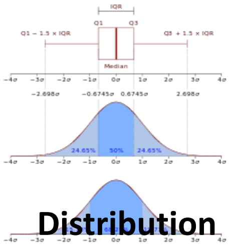
Spikes

SECONDARY

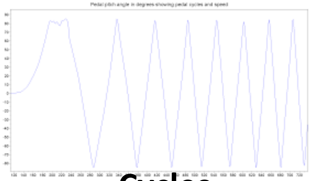
Control Defects



Correlation



Distribution



Cycles

TERTIARY

Systematic Issues

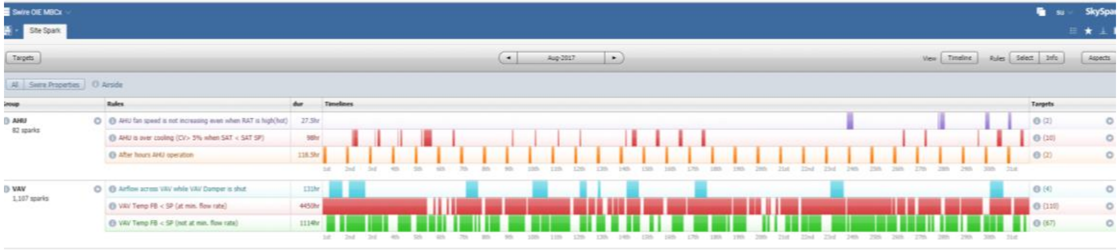
System Performance

CASE STUDY OF MBCx

Summary of Rules

Waterside Analytics Rules

Chiller Plant Sequence of Operation (Control)
Chiller Equipment Performance
System Performance

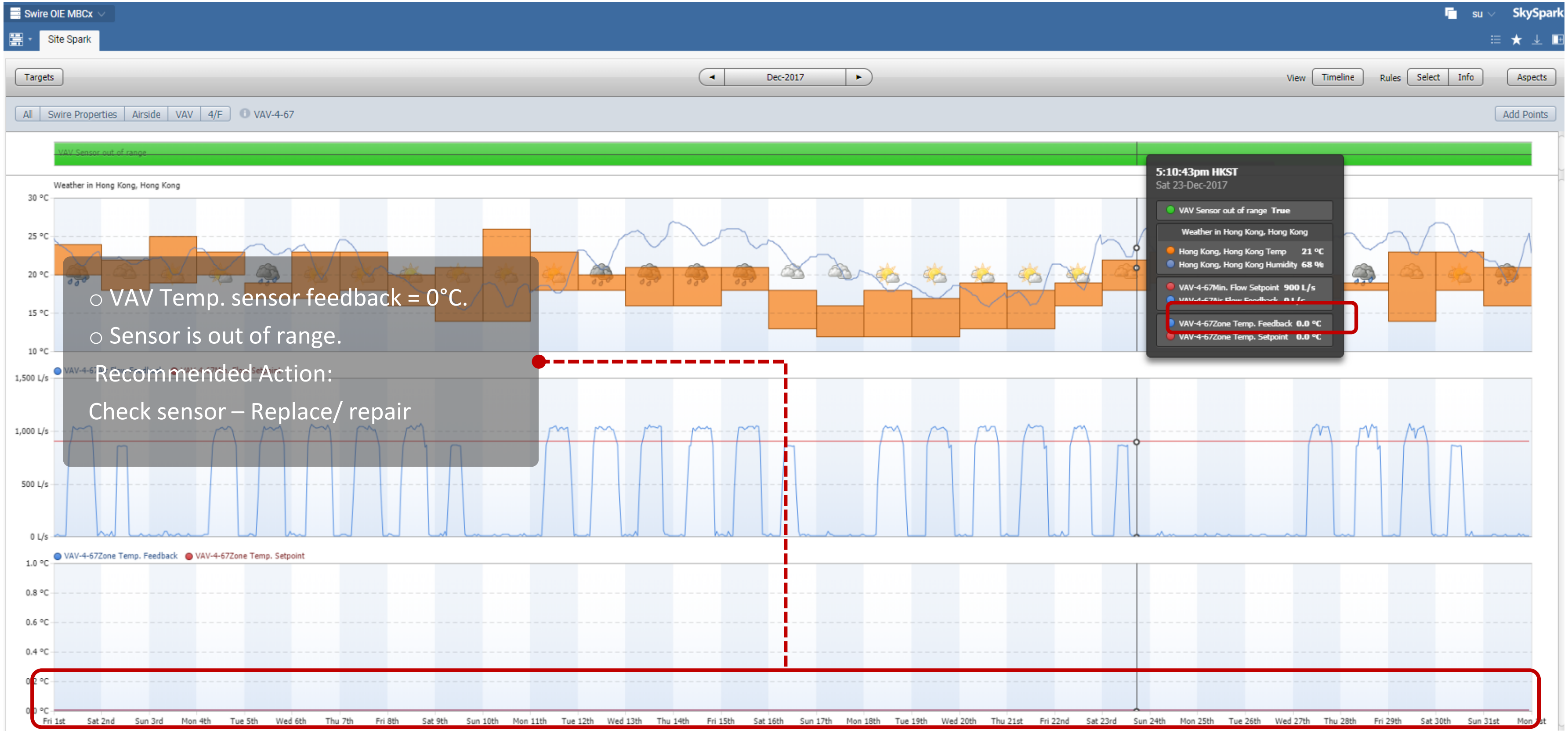


Airside Analytics Rules

Chiller Plant Sequence of Operation
Chiller Equipment Performance

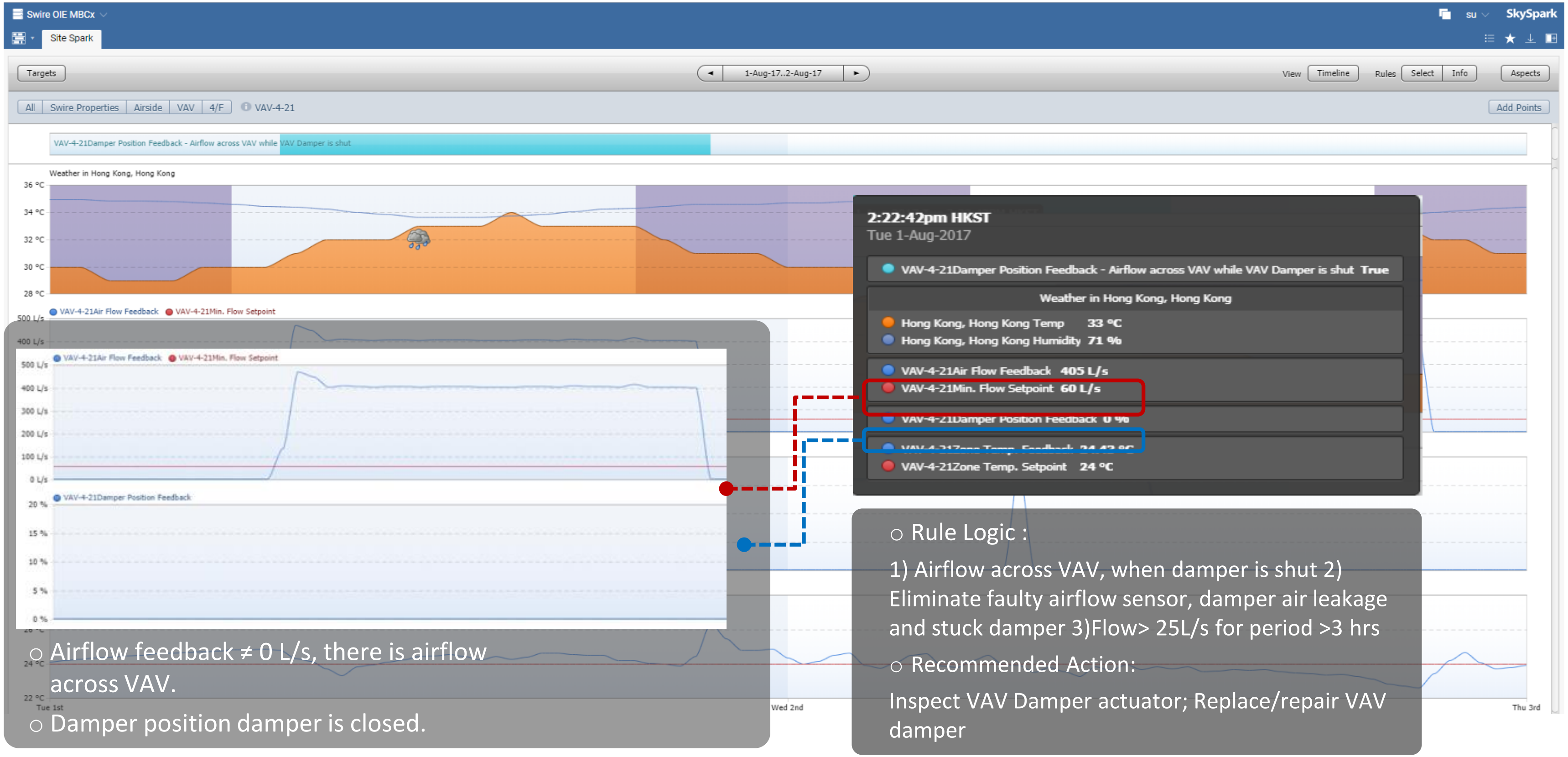
CASE STUDY OF MBCx

Secondary Issue – VAV Sensor Out of Range (Equipment Failure)



CASE STUDY OF MBCx

Secondary Issue – Airflow Across VAV When Damper is OFF (Equipment Failure)



- Airflow feedback ≠ 0 L/s, there is airflow across VAV.
- Damper position damper is closed.

- Rule Logic :

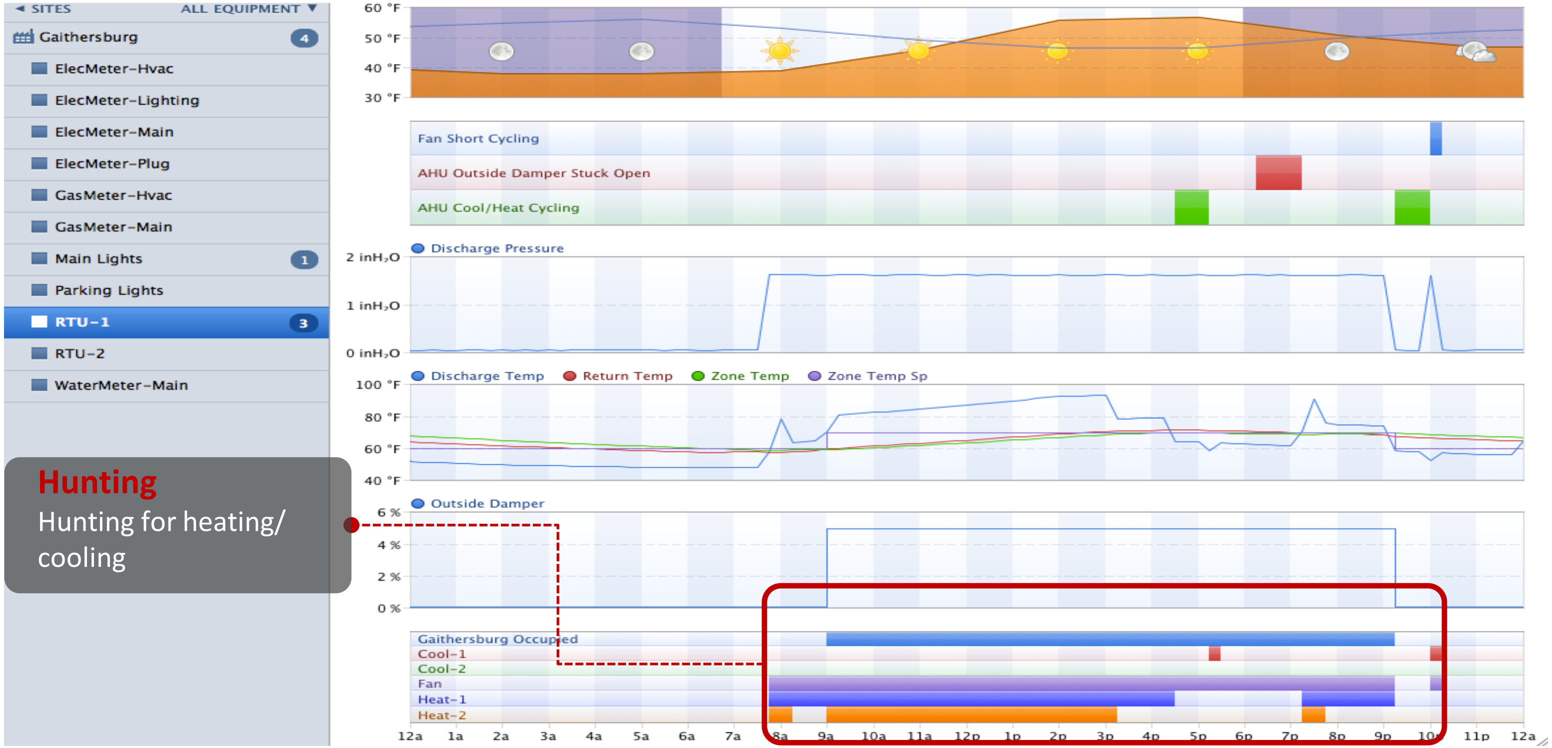
1) Airflow across VAV, when damper is shut 2) Eliminate faulty airflow sensor, damper air leakage and stuck damper 3)Flow> 25L/s for period >3 hrs

- Recommended Action:

Inspect VAV Damper actuator; Replace/repair VAV damper

CASE STUDY OF MBCx

Secondary Issue – Hunting (Control Logic)



Hunting

Hunting for heating/ cooling

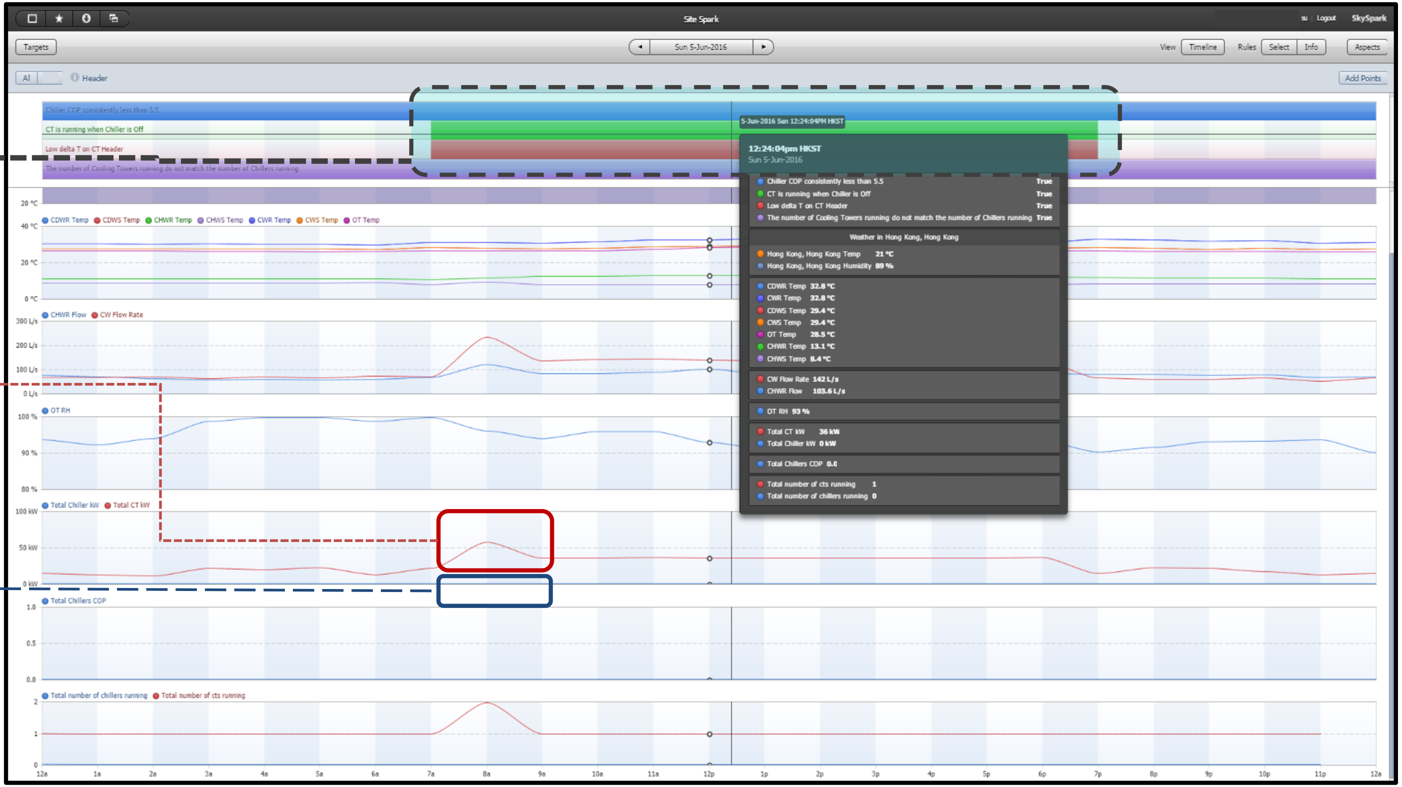
CASE STUDY OF MBCx

Secondary Issue – Cooling Tower Turned On Unnecessary – (Control Logic)

Issues- ‘Sparks’ indication pane

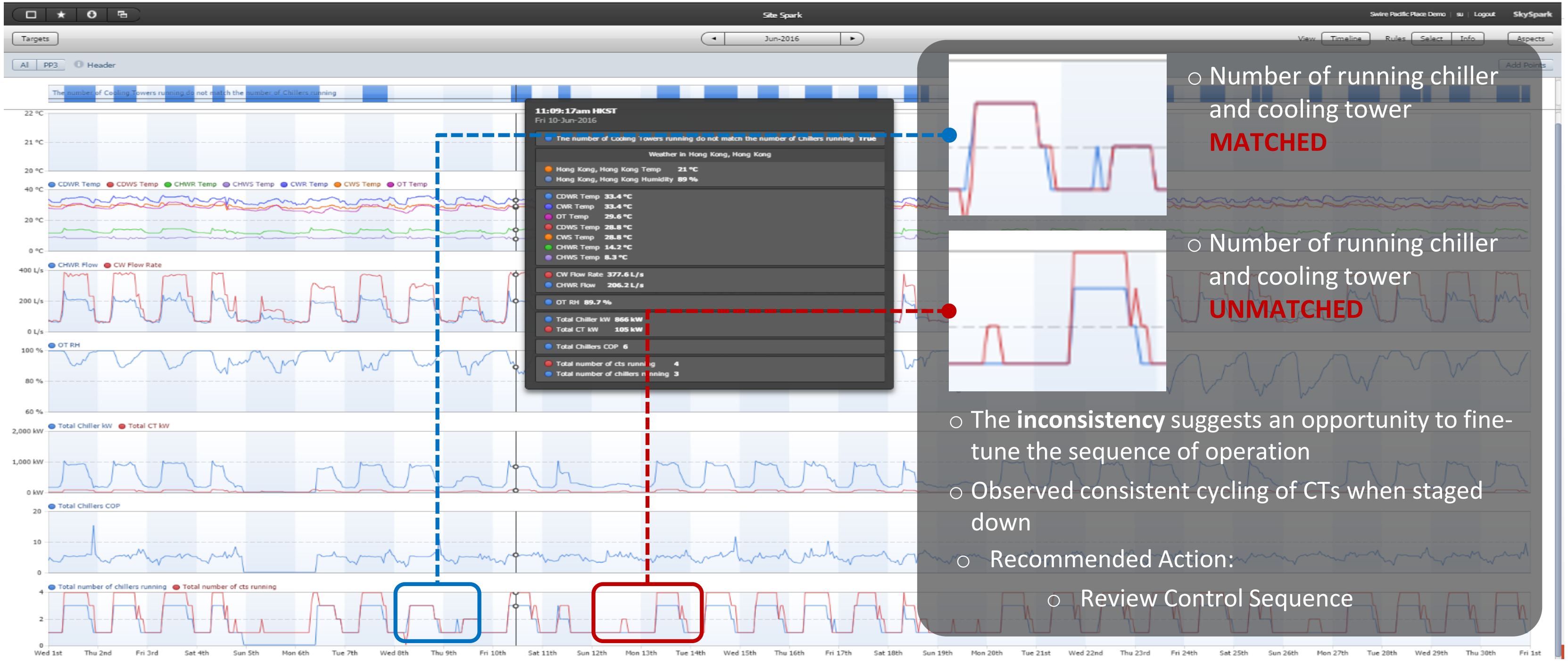
CT is ON

Chiller is OFF



CASE STUDY OF MBCx

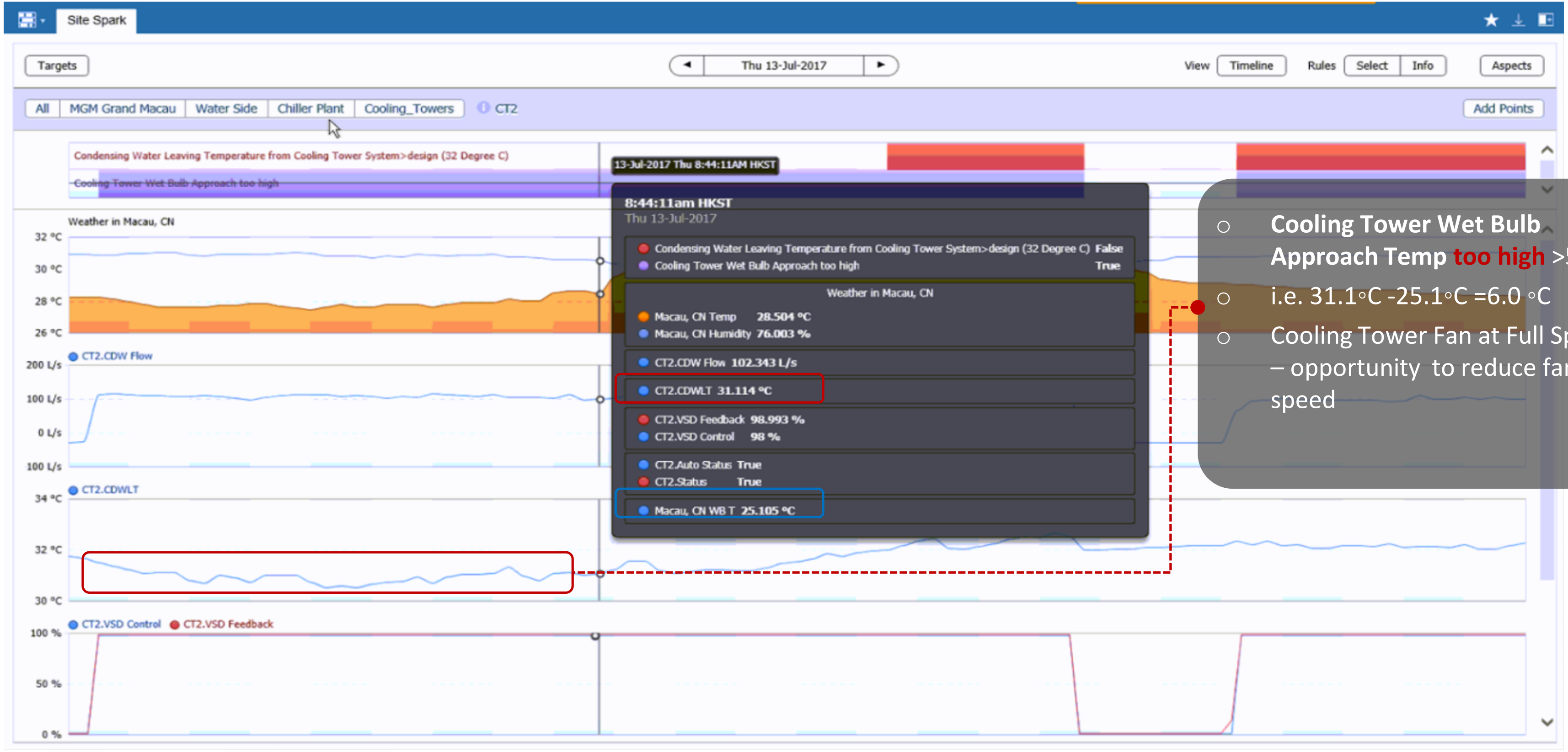
Secondary Issue – Mismatched Pairing of Equipment (Control Logic)



- Number of running chiller and cooling tower **MATCHED**
- Number of running chiller and cooling tower **UNMATCHED**
- The **inconsistency** suggests an opportunity to fine-tune the sequence of operation
- Observed consistent cycling of CTs when staged down
- Recommended Action:
  - Review Control Sequence

CASE STUDY OF MBCx

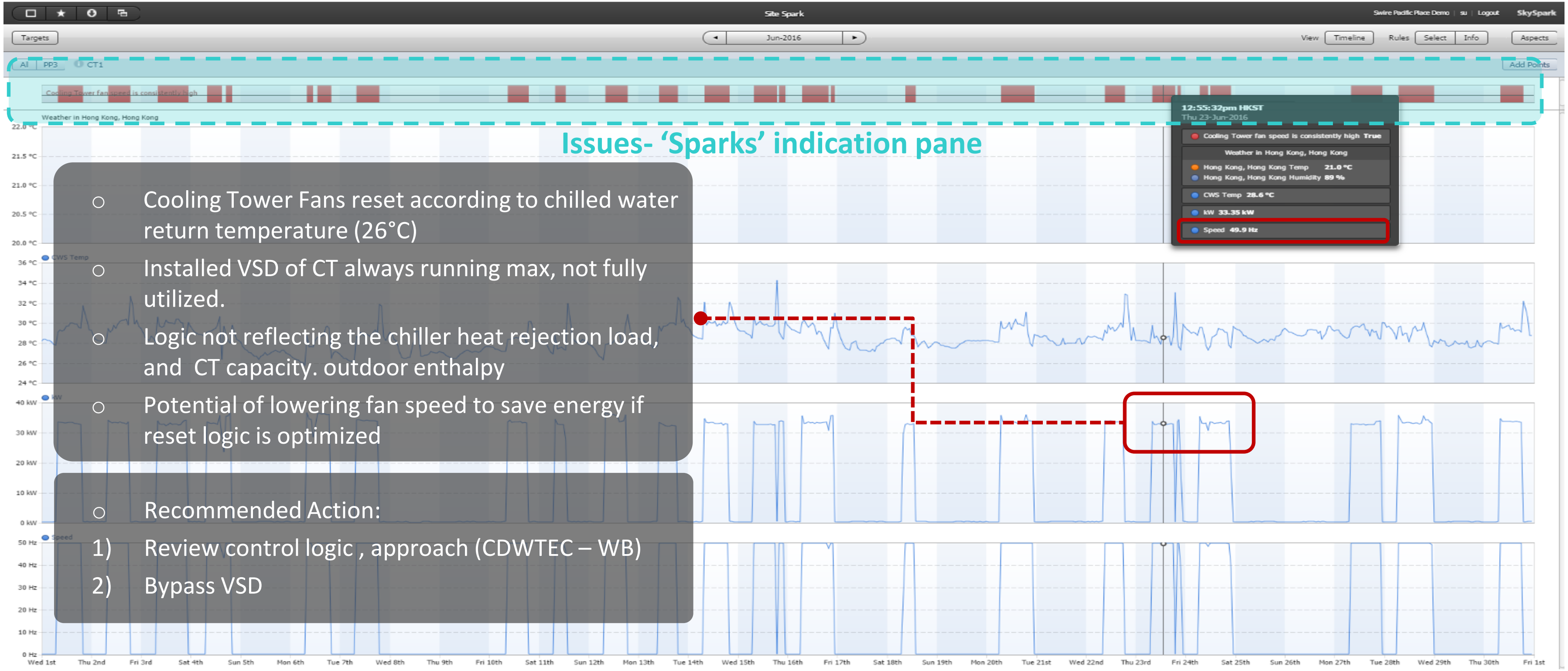
Secondary Issue – Cooling Tower Fan Control Not Optimised (Control Logic)



- **Cooling Tower Wet Bulb Approach Temp too high** >5 ◦C
- i.e. 31.1◦C -25.1◦C =6.0 ◦C
- Cooling Tower Fan at Full Speed – opportunity to reduce fan speed

CASE STUDY OF MBCx

Secondary Issue – VSD Failing to Set Back (Control Logic)



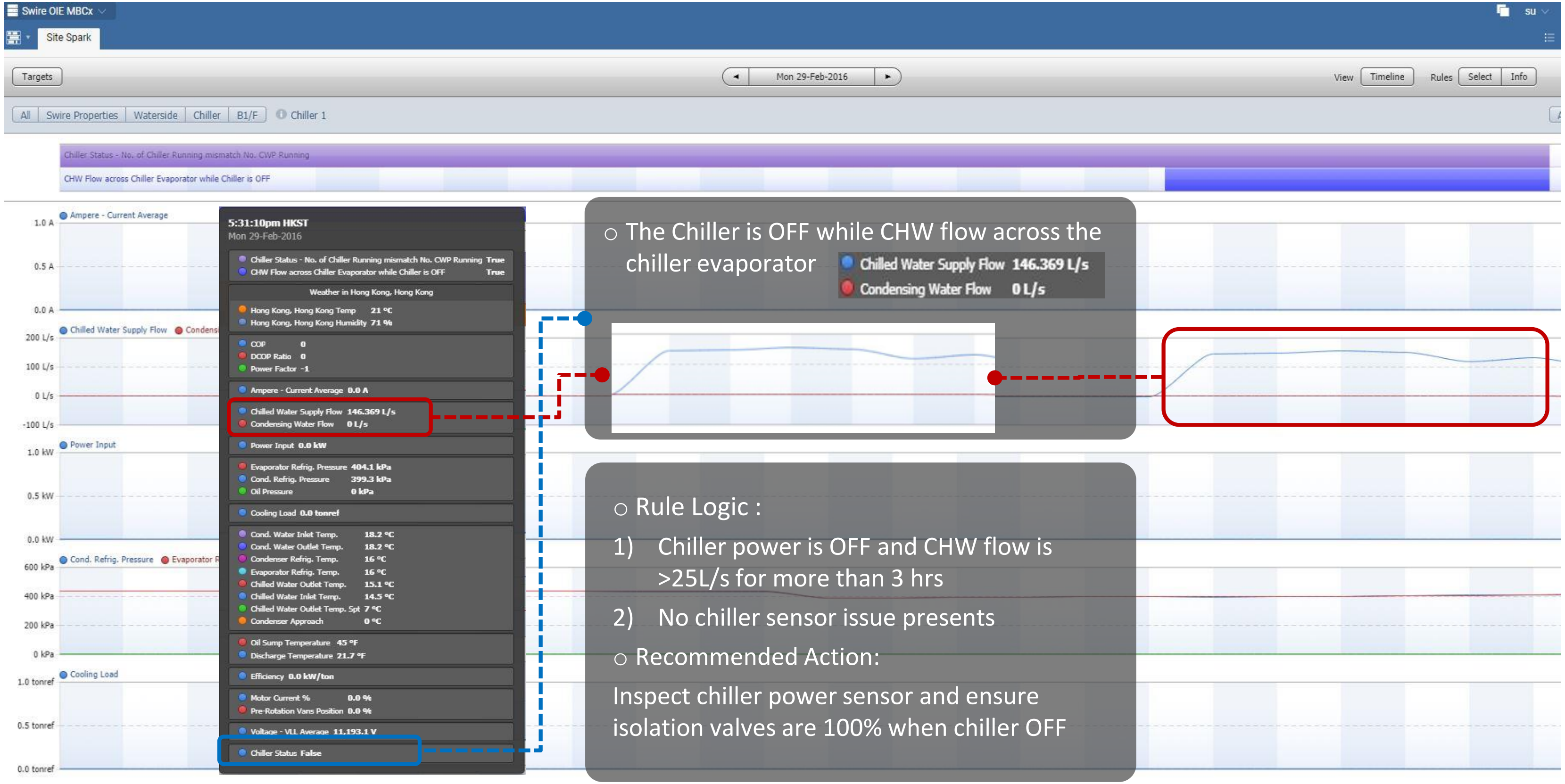
- Cooling Tower Fans reset according to chilled water return temperature (26°C)
- Installed VSD of CT always running max, not fully utilized.
- Logic not reflecting the chiller heat rejection load, and CT capacity. outdoor enthalpy
- Potential of lowering fan speed to save energy if reset logic is optimized

- Recommended Action:

1) Review control logic , approach (CDWTEC – WB)
2) Bypass VSD

CASE STUDY OF MBCx

Secondary Issue – CHW Flow Through Evaporator When Chiller is OFF (Control Logic)



- The Chiller is OFF while CHW flow across the chiller evaporator

- Rule Logic :

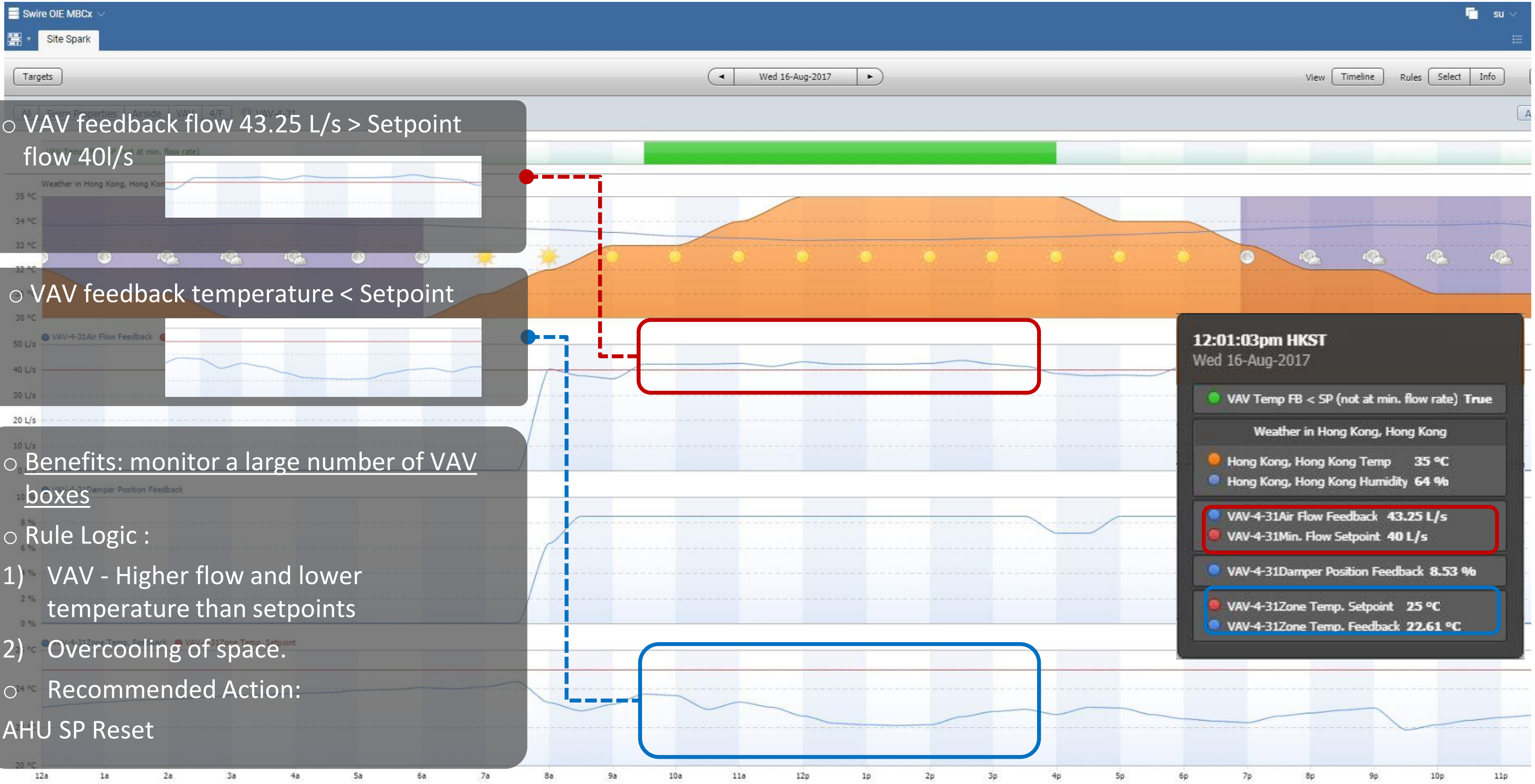
1) Chiller power is OFF and CHW flow is >25L/s for more than 3 hrs
2) No chiller sensor issue presents

- Recommended Action:

Inspect chiller power sensor and ensure isolation valves are 100% when chiller OFF

CASE STUDY OF MBCx

Secondary Issue – Overcooling of Space (Control Logic)



- VAV feedback flow 43.25 L/s > Setpoint flow 40l/s
- VAV feedback temperature < Setpoint

- <u>Benefits: monitor a large number of VAV boxes</u>
- Rule Logic :

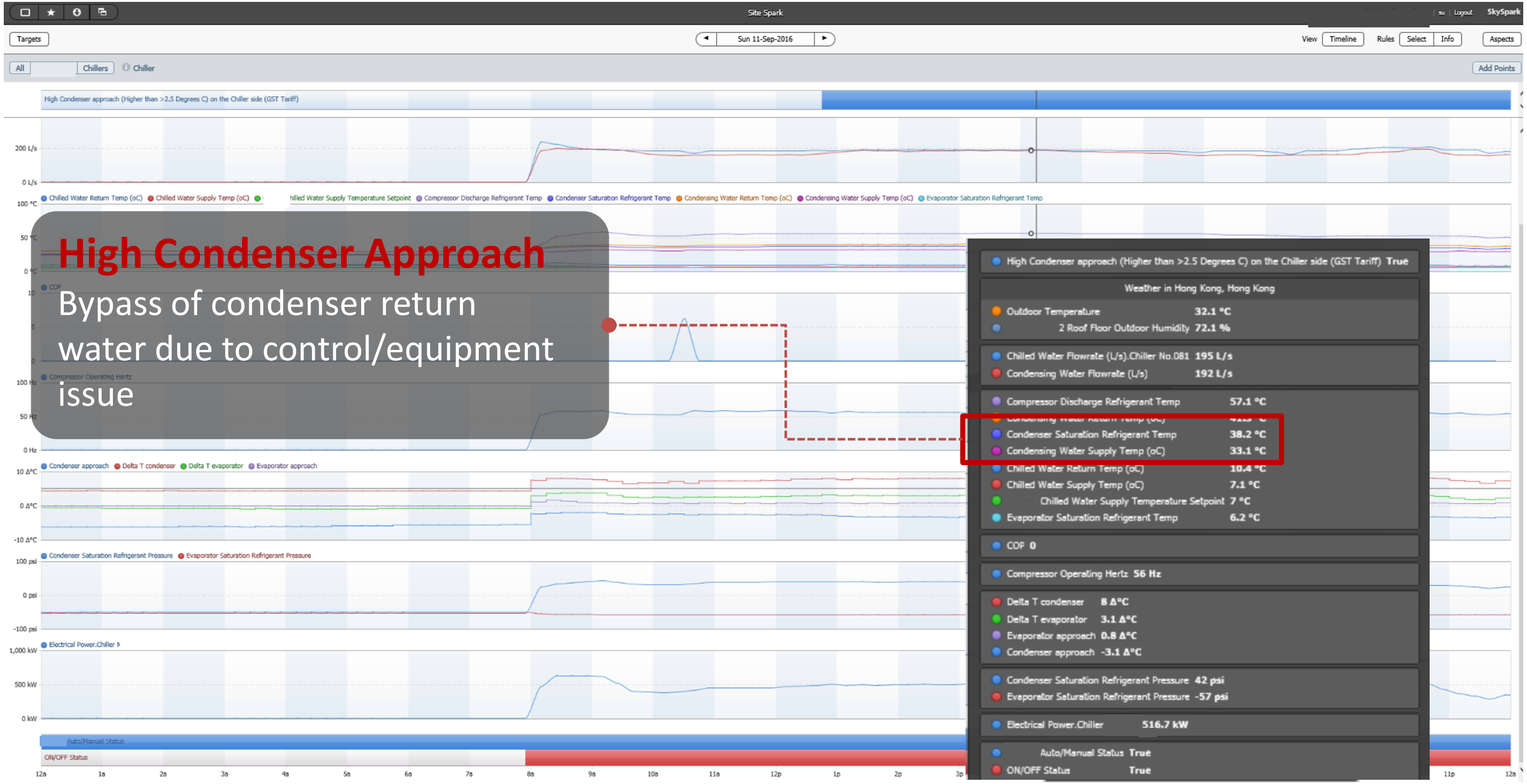
1) VAV - Higher flow and lower temperature than setpoints
2) Overcooling of space.

- Recommended Action:

AHU SP Reset

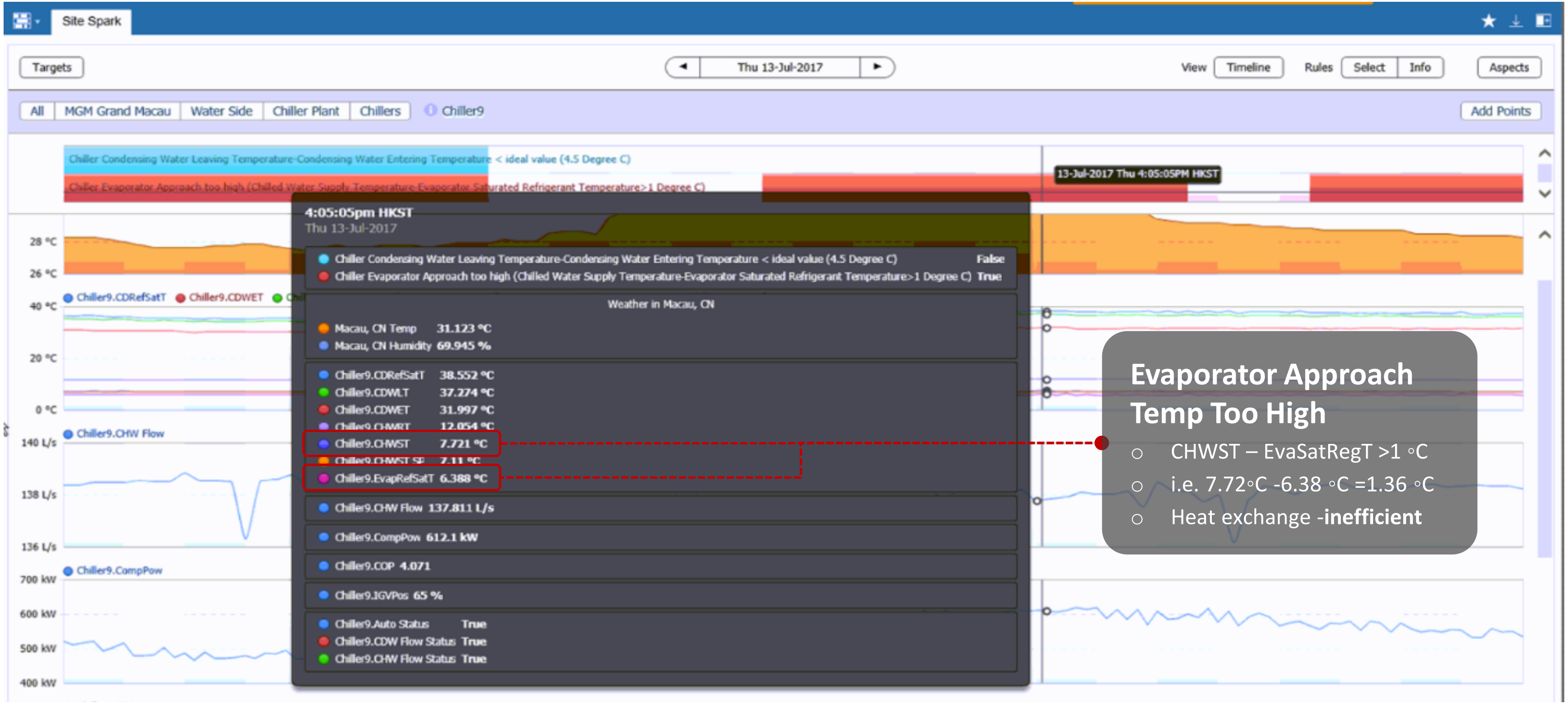
CASE STUDY OF MBCx

Tertiary Issue – Performance Issue



CASE STUDY OF MBCx

Tertiary Issue – Evaporator Approach Temp. Too High (Performance Issue)

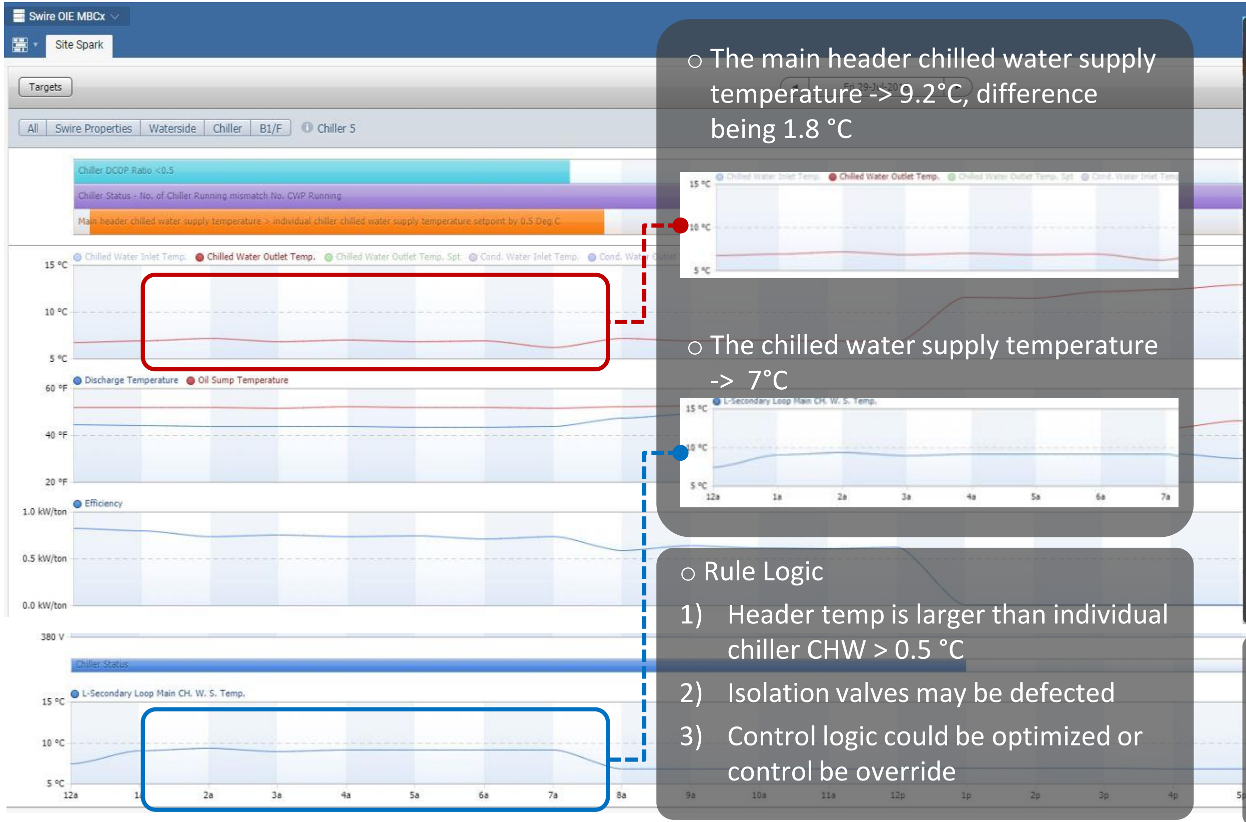


Evaporator Approach Temp Too High

- CHWST – EvaSatRegT >1 ◦C
- i.e. 7.72◦C -6.38 ◦C =1.36 ◦C
- Heat exchange -**inefficient**

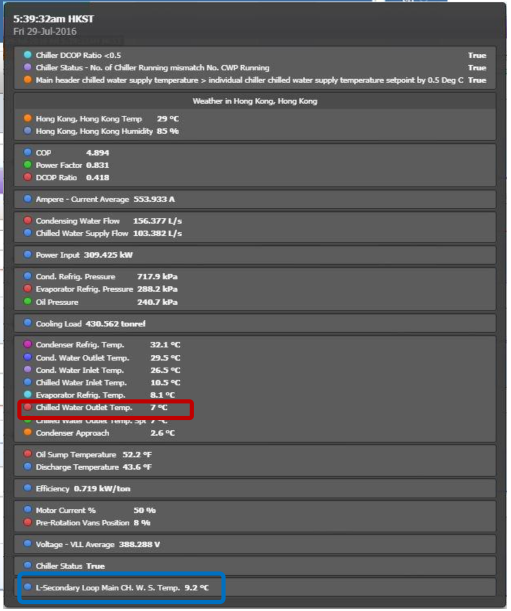
CASE STUDY OF MBCx

Tertiary Issue – Main Header CHW Supply Temp. > Chiller CHW Supply Temp.



- The main header chilled water supply temperature -> 9.2°C, difference being 1.8 °C
- The chilled water supply temperature -> 7°C

- Rule Logic
1) Header temp is larger than individual chiller CHW > 0.5 °C
2) Isolation valves may be defected
3) Control logic could be optimized or control be override



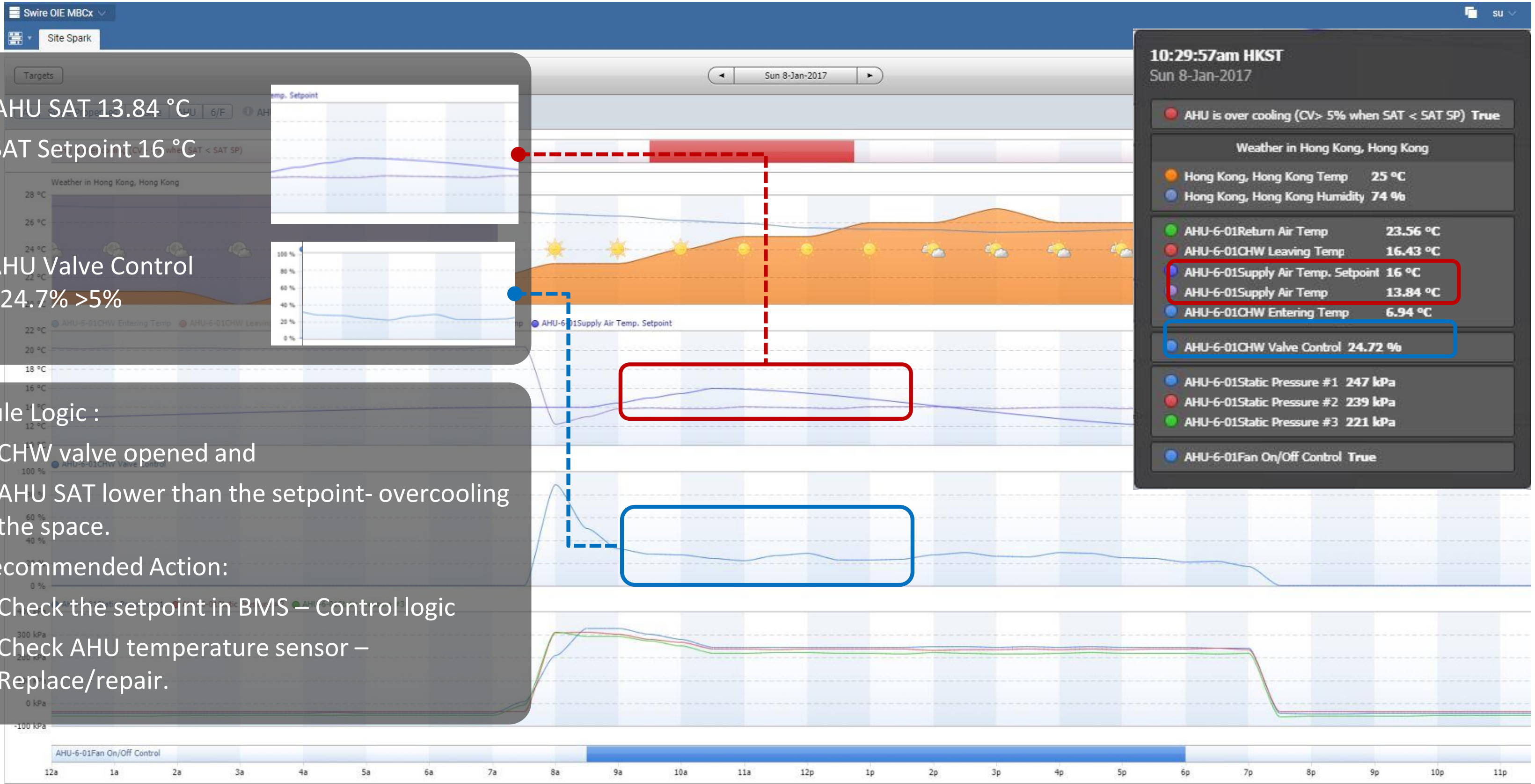
- Recommended Action:
1) Check control logic – optimise
2) Check isolation valves – repair

CASE STUDY OF MBCx

Tertiary Issue – Overcooling of Space (Control or Equipment Issue)

- AHU SAT 13.84 °C < SAT Setpoint 16 °C
- AHU Valve Control =24.7% >5%

- Rule Logic :
  1) CHW valve opened and
  2) AHU SAT lower than the setpoint- overcooling the space.
- Recommended Action:
  1) Check the setpoint in BMS – Control logic
  2) Check AHU temperature sensor – Replace/repair.

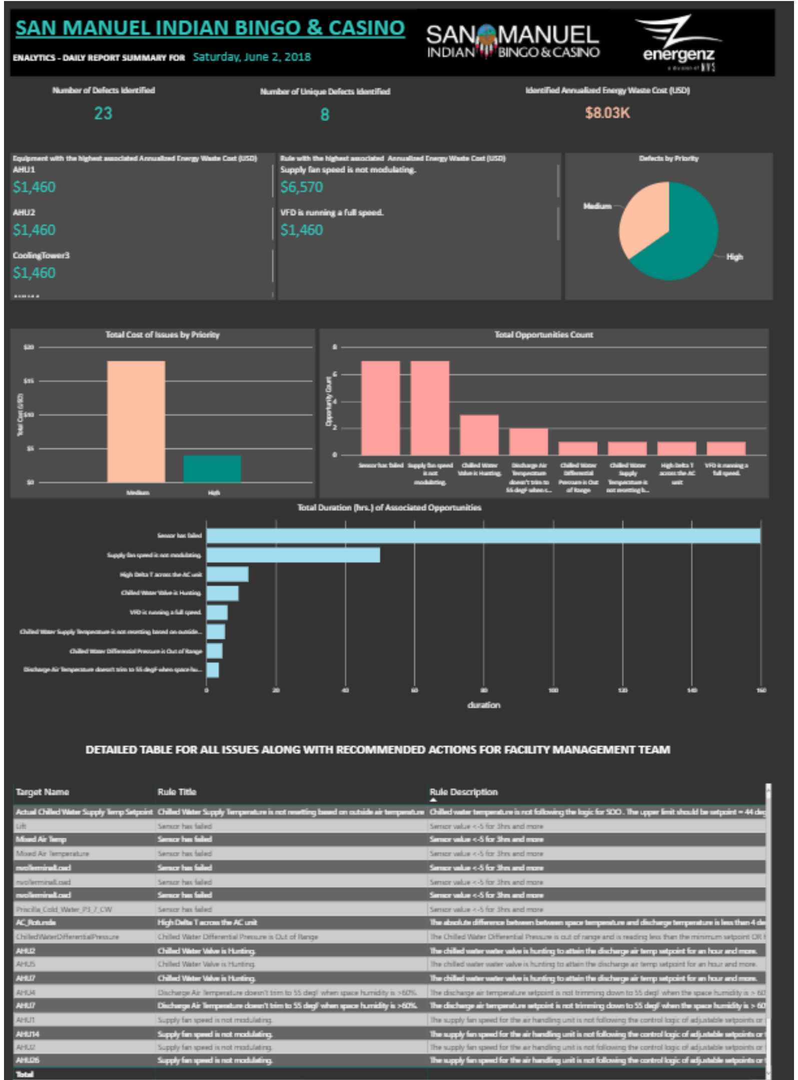


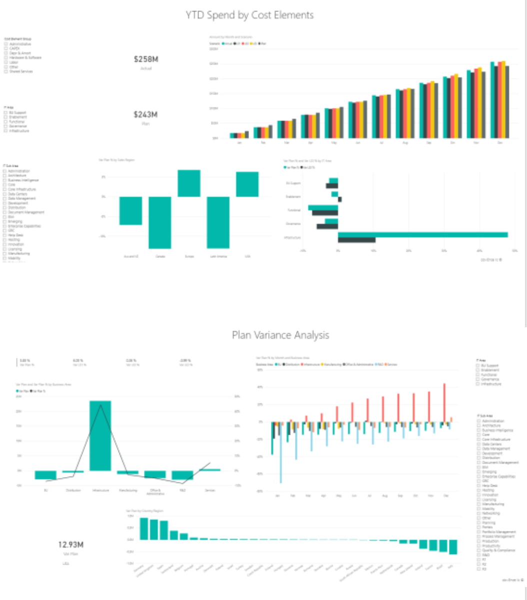
CASE STUDY OF MBCx

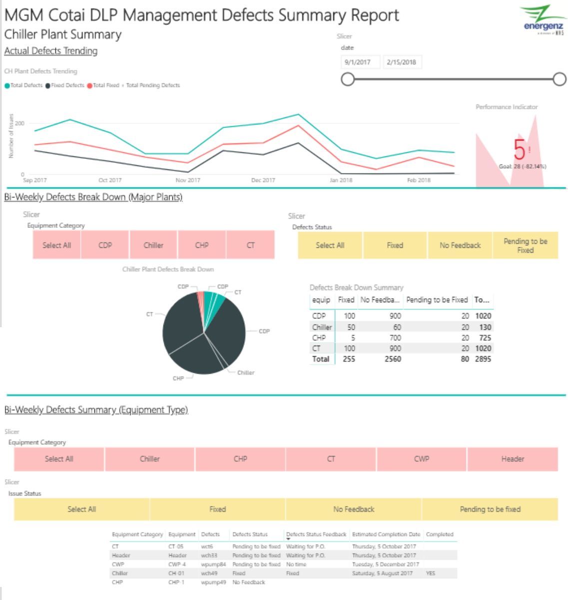
Issue Statistics

Analytics Rule	Issues Occurrence (Number of Hours)	Issues Occurrence (Number of Equipment)	Occurrence Rate (%)	Occurrence Rate on Equipment with Issue (%)
CHW Flow through evaporator when chiller is Off	292	3	0.24%	0.55%
Main header chilled water supply temperature > individual chiller chilled water supply temperature setpoint by 0.5 °C	94	-	0.91%	0.91%
Airflow across VAV when Damper is Off	1,292	7	0.29%	8.36%
VAV Sensor Out of Range	33,714	108	**7.48%**	**14%**
VAV Temp FB < SP (not at min. flow rate)	5,065	129	1.12%	1.78%
VAV Temp FB < SP (at min. flow rate)	40,918	164	**9.09%**	**11.30%**
AHU is over cooling (CV>5% when SAT < SAT SP)	1,720	24	**5.20%**	**5.63%**

Energenz Analytics™


SAN MANUEL INDIAN BINGO & CASINO
ENALYTICS - DAILY REPORT SUMMARY FOR Saturday, June 2, 2018
SAN MANUEL INDIAN BINGO & CASINO
energenz
Number of Defects Identified
23
Number of Unique Defects Identified
8
Identified Annualized Energy Waste Cost (USD)
$8.03K
Equipment with the highest associated Annualized Energy Waste Cost (USD)
AHU1
$1,460
AHU2
$1,460
CoolingTower3
$1,460
Rule with the highest associated Annualized Energy Waste Cost (USD)
Supply fan speed is not modulating.
$6,570
VFD is running a full speed.
$1,460
Defects by Priority
Medium
High
Total Cost of Issues by Priority
Total Opportunities Count
Total Duration (hrs.) of Associated Opportunities
duration
DETAILED TABLE FOR ALL ISSUES ALONG WITH RECOMMENDED ACTIONS FOR FACILITY MANAGEMENT TEAM
Target Name
Rule Title
Rule Description
Total


YTD Spend by Cost Elements
$258M
$243M
Plan Variance Analysis
12.93M


MGM Cotai DLP Management Defects Summary Report
Chiller Plant Summary
Actual Defects Trending
energenz
Bi-Weekly Defects Break Down (Major Plants)
Equipment Category
Select All
CDP
Chiller
CHP
CT
Defects Status
Select All
Fixed
No Feedback
Pending to be Fixed
Chiller Plant Defects Break Down
Defects Break Down Summary
Bi-Weekly Defects Summary (Equipment Type)
Equipment Category
Select All
Chiller
CHP
CT
CWP
Header
Issue Status
Select All
Fixed
No Feedback
Pending to be fixed


Phase 1 Building Spark Summary
Hong Kong Convention and Exhibition Centre
Light Mode
Sort by Priority
Sort by Rule
Spark Summary Table


energenz

Achievement

Confidential Facility of Sport (central chiller plant, since April 2016) - Paybacks less than 1 year, verified 6% of chiller plant energy saving (approx. 0.5Mil HKD) and with further 2% saving in progress in Apr 2016- Mar 2017.

MGM Macau (whole site, since 2016) –Verified 10.2% normalised whole site electricity savings (approx. 8.5Mil MOP), of which is partly contributed by MBCx along with other energy saving projects in 2016.

Intercontinental Hong Kong (whole site, since 2015) – Verified 3.4% normalised whole site electricity savings, of which is partly contributed by MBCx along with other energy saving projects in 2015-2016.

Awards

2017 – IFMA Asia Pacific Technology Excellence Award
2018 – Hong Kong ICT Award – Smart Business: Open Data/Big Data
2018 – MGM Won IFMA Asia Pacific Innovation Award for using Energenz Enalytics™ for MBCx

TAKEAWAYS

DESIGNERS

Specify

1. Sufficient data collection points (sensors and meters)
2. Data transparency, availability and accessibility
3. Dedicated database to access and store inter-system data (BMS, PMS…etc)
4. Analytics to assist MBCx

OPERATORS

Check

1. Sufficient data collection points (sensors and meters)
2. Data transparency, availability and accessibility

Modify

1. Data and communication protocol of proprietary system

Install

1. Dedicated database to access and store inter-system data (BMS, PMS…,etc)
2. Analytics to assist MBCx

Big Data

Correlation vs Causation

Is wine good for health?

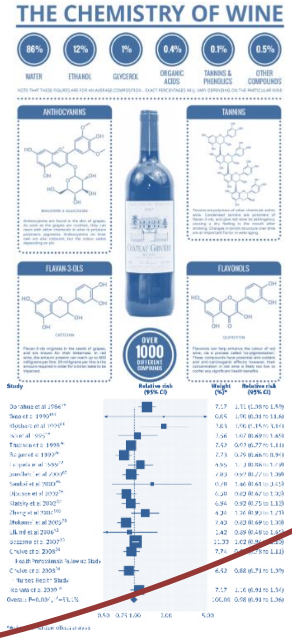
VALUE OF DATA

From No Data to Big Data

Value to Business

No Data
Intuition

Small Data
Relation



Good Stuff
Resveratrol
Antioxidants
Melatonin

Carbohydrate 2.6g

Sugars 0.6g

Fat 10.0g

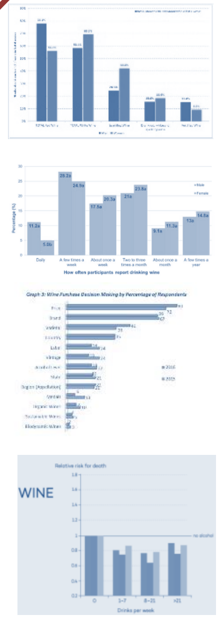
Alcohol 10.6g

Energy 85 kCal/ 100g

Big Data
Causation

Table 5 – Types of alcoholic beverages consumed and their relatio

Demographic		Wine (%)	Wine (SD)	Wine p-value*
Gender	Male	19%	1.5%	0.000
	Female	34%	1.9%	
Age	18 - 24 years	24%	2.5%	0.094
	25 - 34 years	24%	2.1%	
	35 - 44 years	22%	2.7%	
	45 - 59 years	28%	2.5%	
	60 years or above	34%	4.5%	
Marital status	Single	23%	2.1%	0.169
	Married/Concubine	25%	1.6%	
	Widower	31%	6.6%	
	Divorced/Separated	32%	4.3%	
Schooling	Up to the 5th grade, elementary school	23%	2.3%	0.057
	6th-9th grade, elementary school	24%	2.3%	
	High school	24%	2.0%	
	College	34%	3.8%	
Family income	Up to R$450.00	23%	2.1%	0.253
	R$451.00 to R$750.00	23%	2.5%	
	R$751.00 to R$1200.00	30%	3.2%	
	R$1201.00 to R$2500.00	24%	2.7%	
	More than R$2500.00	29%	3.5%	
	Does not know/refuses to answer	22%	4.6%	
Region	Northern	26%	7.8%	0.004 (cd)
	Center-Western	24%	3.8%	
	Northeastern	18%	1.9%	
	Southeastern	27%	1.8%	
	Southern	29%	3.5%	
Area	Countryside	24%	1.6%	0.245
	Capital/Metropolitan region	27%	1.9%	
Rural	Urban	26%	1.3%	0.013
	Rural	18%	2.9%	
Total		25%	1.3%	



Size of Data

VALUE OF DATA

From Data to Intelligence

INTELLIGENCE

What do you do about it?

Decision Making
Strategic & Tactics

INFORMATION

What does it mean?

Knowledge
Conclusion
Performance

DATA

What is it?

Accounting
Reporting
Transparency

Should You Want to know more…..

Monitoring Based Commissioning (MBCx) Case Study and Sharing,
Gary Hui (Energenz) Peter Chan (MGM)
The 7th Greater Pearl River Delta Conference on Building Operations and Maintenance
http://www.bsomes.org.hk/upload_pdf/GPRD2016_S2-3.pdf

Monitoring Based Commissioning: Benchmarking Analysis of 24 Projects
Lawrence Berkeley National Laboratory (LBNL)
California Energy Commissioning Public Interest Energy Research (PIER)
https://uc-ciee.org/images/downloadable_content/buildings/mbcx_lbnl_bnchmrk.pdf

Contact Me
Eric.Ao@energenz.com