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NS2024

POWER OF PARTNERSHIP

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25 Years

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CREATING HIGH PERFORMANCE BAS SYSTEMS

A GSA CASE STUDY

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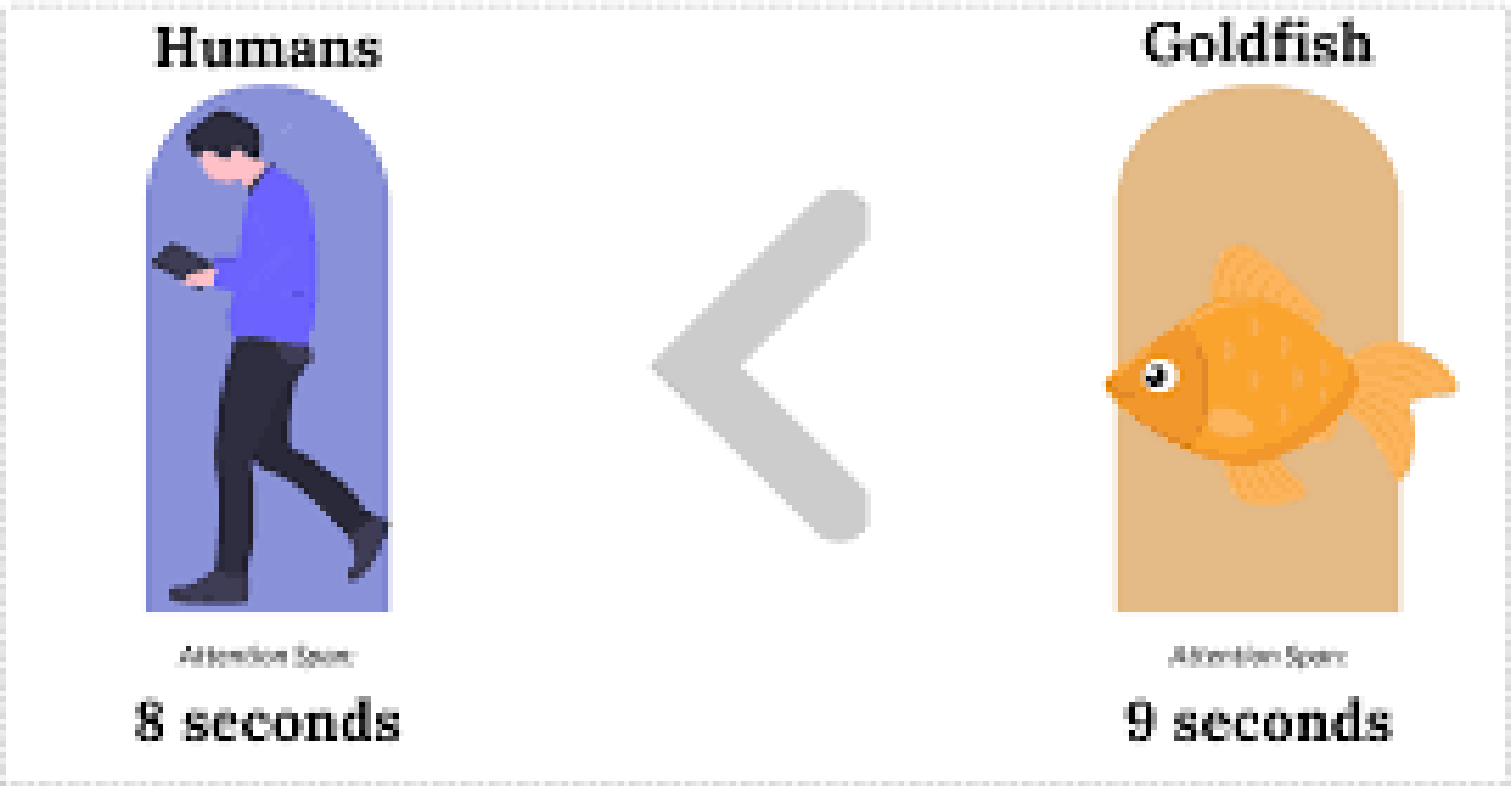

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Agenda

1. *Introductions of speakers.*
2. *What makes a high performing building or BAS system.*
3. *How to focus boatloads of data to maximize building performance.*
4. *How to Determine Key Performance Indicators (KPI).*
5. *Network design, managing traffic and critical devices to mitigate cyber security.*
6. *The keys of histories, trends and understanding graphics.*
7. *Case studies and examples.*

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Jon Christopher Larry
PE, CxA, LEED AP, CEM

- **Exp US Services Inc.** - Director of Energy Engineering
- 35 years of comprehensive experience on energy-efficient high-performance smart and intelligent buildings.
- **AEE** – Past President and named ***"Energy Engineer of the Year 2000"*** by the Association of Energy Engineers (AEE)
- **CABA** – Vice-Chair of CABA IBC, Chair of (BIQ) Building Intelligence Quotient and Zero Energy Consortium Committees.
- **ASHRAE -** Chairman of Technology, Energy and Governmental Activities, Chapter Technology Transfer Committees.
- **NIST GCTC SBSC** - Chairperson for the National Institute of Standards and Technology (NIST) Global Cities Team Challenge (GCTC) on Smart Buildings and Smart Cities (SBSC).

Jason Reed
CIPE, N4 Certified

Exp US Services Inc. – Master Systems Integrator

30 years in the industry

Knowledge of advanced BAS Controls and an expert in Tridium Integration.

Also knowledgeable of MEP systems, electrical wiring, communication and network cabling as well as cyber security

Only design consultant who provides smart building expertise

30+
intelligent building projects completed

20+
years of intelligent buildings experience

KEY SERVICES

Smart Buildings
- Systems Integration
- Integrated Automation Design
- Supervisory Control + Monitoring
- Power Monitoring Systems
- Enterprise Energy Management
- Fault Detection
- Control Panel Design

Commissioning
- Retro + Recommissioning
- Ongoing Commissioning
- HVAC System Repair + Upgrade
- Control Loop Tuning
- SharePoint Project, Program + O&M
- Web Portals

Energy Management
- Energy Audits
- Renewable Energy Feasibility Studies
- Measurement + Verification
- Advanced Energy Metering
- Biomass CHP Implementation
- Thermal Imaging
- BAS System Integration
- Automated Demand Response
- LEED Consulting
- Energy and CFD Modeling
- Wind + Photovoltaic Design/Build

- Full-service solutions backed by past performance ✓
- Facility information management experts ✓
- Integrated, client-focused approach ✓
- Leverage experience with technologies ✓
- System integration solutions ✓

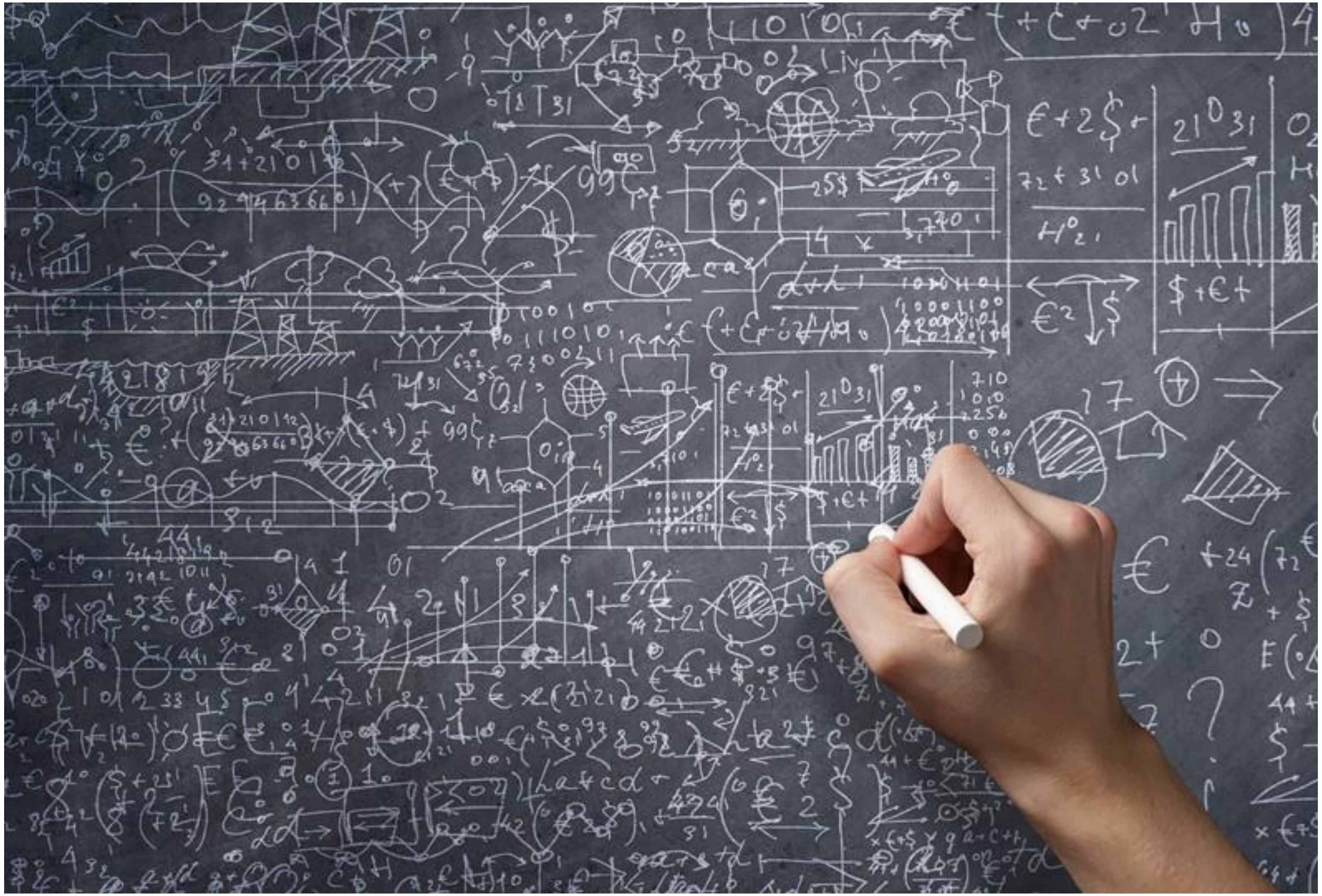
WHAT IS AN INTELLIGENT – SMART BUILDING

- Definition from CABA or Association for Smarter Homes & Buildings (ASHB):
- An intelligent building gives building owners the flexibility to integrate individual building systems to deliver an enhanced working or living environment for occupants, and optimal equipment functionality and better management of resources for owners
  - Needs or benefits:
    - Better performance
    - Interoperability
    - Occupant Satisfaction
    - Return of Investment

ISSUES - CONCERNS OR HURDLES – ITEMS TO ADDRESS TO INCREASE PERFORMANCE

- Data Overload, confusion, can't see the forest through the trees.
- Operator Knowledge and Understanding – do they know how a building performs
- How do you measure high performance - Key Performance Index (KPI)
- Basic items to be included in the BAS for high performance
- Extra items which will enhance the building performance
- Slow data transfer, slow transfer, Graphic update delays, speed of connection
- Unsecured networks, trending frequency, storage size and location
- Systems not communicating, dead points, Lack of commissioning
- Points not linked or addressed, Lack of standardization
- Visually see issues which need to be addressed to increase performance

ISSUE: DATA OVERLOAD



- Buildings are now getting connected
- Systems within the buildings are getting connected
- Millions of points are creating data
- Too much data creates confusion

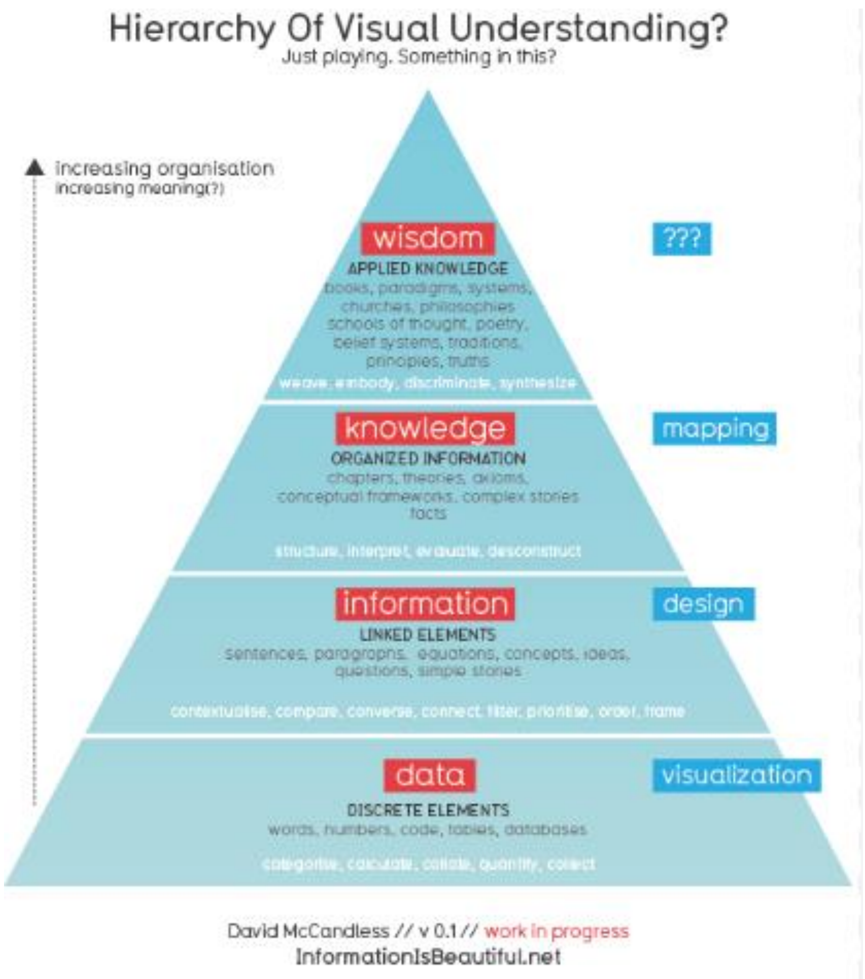
STEPS TO ADDRESS DATA OVERLOAD

- Does the system need the data in the first place? Don't pull this data in if not important.
- Don't store data on the edge. Use a data lake or storage space (cloud or on-site server).
- Don't create trends of all data and only at required intervals.
- Use data analysis software to manage and organize important from the chaff.
- Fault Diagnostics – system to sift through data to find important information.
- Graphics and tools – applications to create a data story – use to communicate
- Turn data issues into action – what is the data telling the operator to do to increase performance.
- Create a speedometer….to drive performance.

ISSUE: USER KNOWLEDGE

- The BAS is a tool for the user but how well the tool works is based upon the user's knowledge.
- There has been a trend to use less trained building operators
- BAS Contractor needs to first understand the existing knowledge base of the users and owner.
- Computer skills?
- Building System skills?
- Comfortable with data?

STEPS TO ADDRESS POOR USER KNOWLEDGE

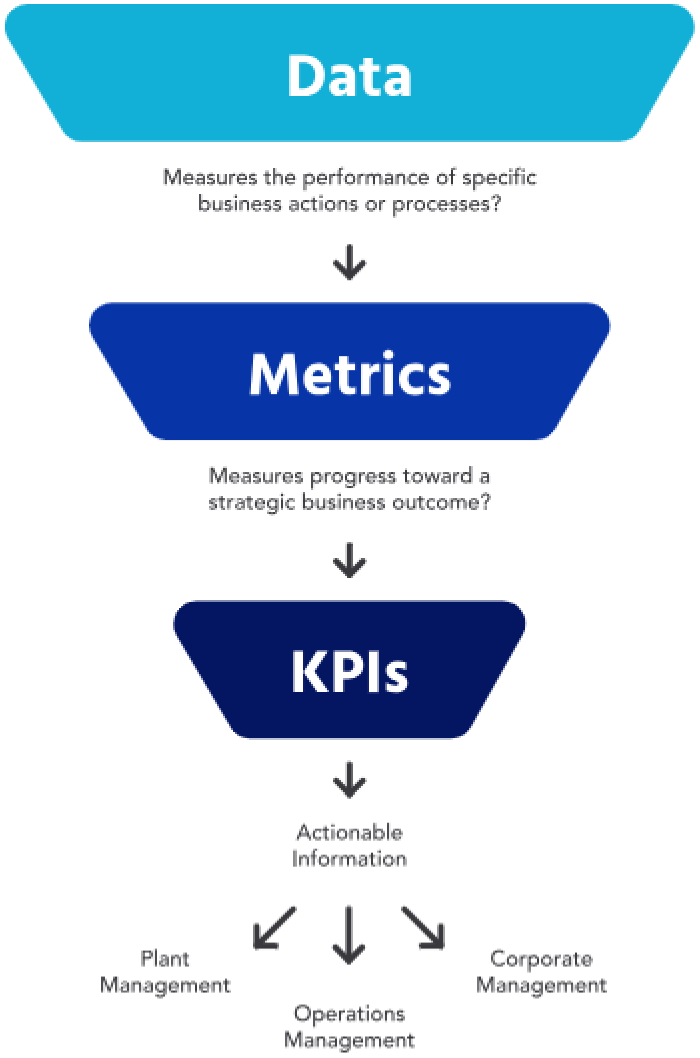


- Assess this knowledge before designing BAS.
- Provide training to users as part of the install – focus on performance.
- Building Operator Certification (BOC) – Training
- Ask owner for additional training for their people
- Don't just train them on using BAS but the tools

ISSUE: MEASURING BUILDING PERFORMANCE

- Is the building occupied by the ownership or leased?
- Is the building public or private?
- Do occupants visit, live or work in the building?
- Can vary based on Client
- Can vary based upon usage
- Can vary based upon occupants
- Talk to the client and investigate.

STEPS TO MEASURING BUILDING PERFORMANCE



- **Major areas of focus include:**
  - **Utility costs**
  - **Sustainability**
  - **Operational & maintenance costs**
  - **Annual cost of ownership (lease cost)**
  - **Value of building**
  - **Cost of staff in the building**
  - **If sales – number of visitors**
  - **Safety – if critical occupancy**

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BUILDING PERFORMANCE – KPI - BUILDING DASHBOARD EXAMPLE

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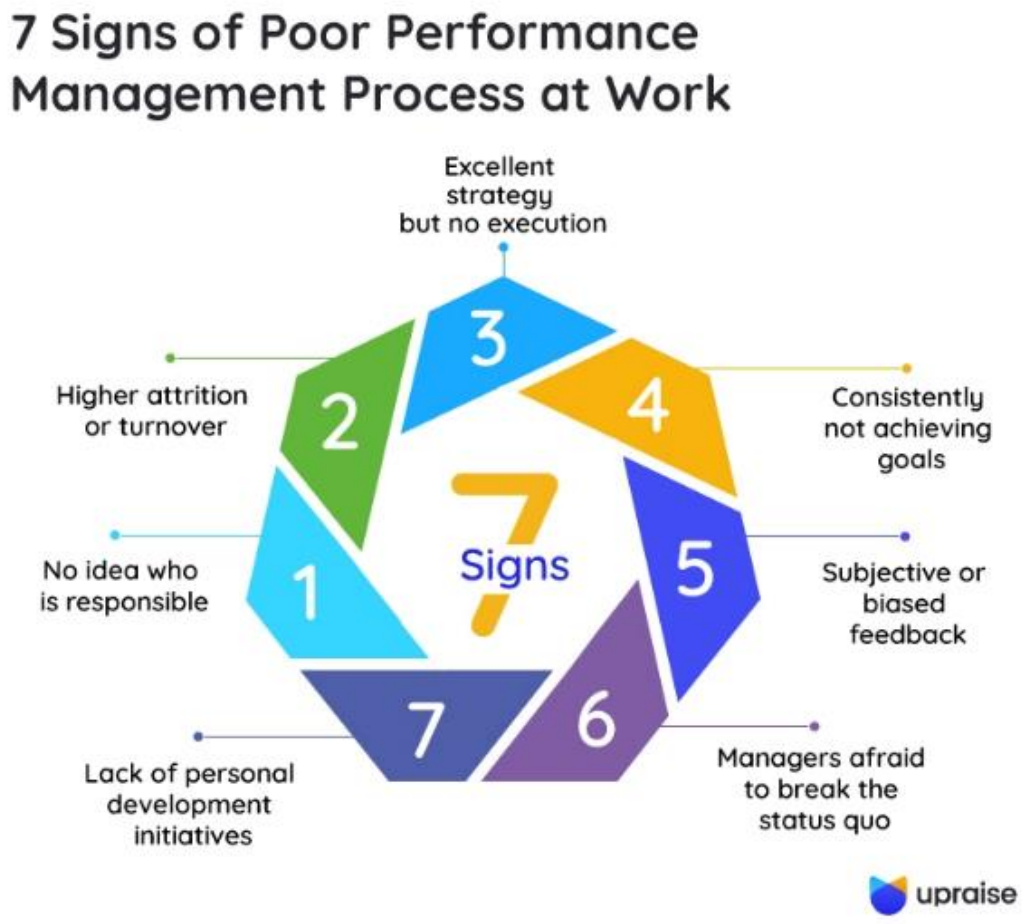
ISSUE: SYSTEMS TO BE INCLUDED TO MAXIMIZE BUILDING PERFORMANCE



- **Most systems are focused on HVAC**
- **If you limit the BAS to HVAC, you limit performance**
- **Systems are not interconnected**
- **The organization is segmented**
- **No one is measuring BAS performance**

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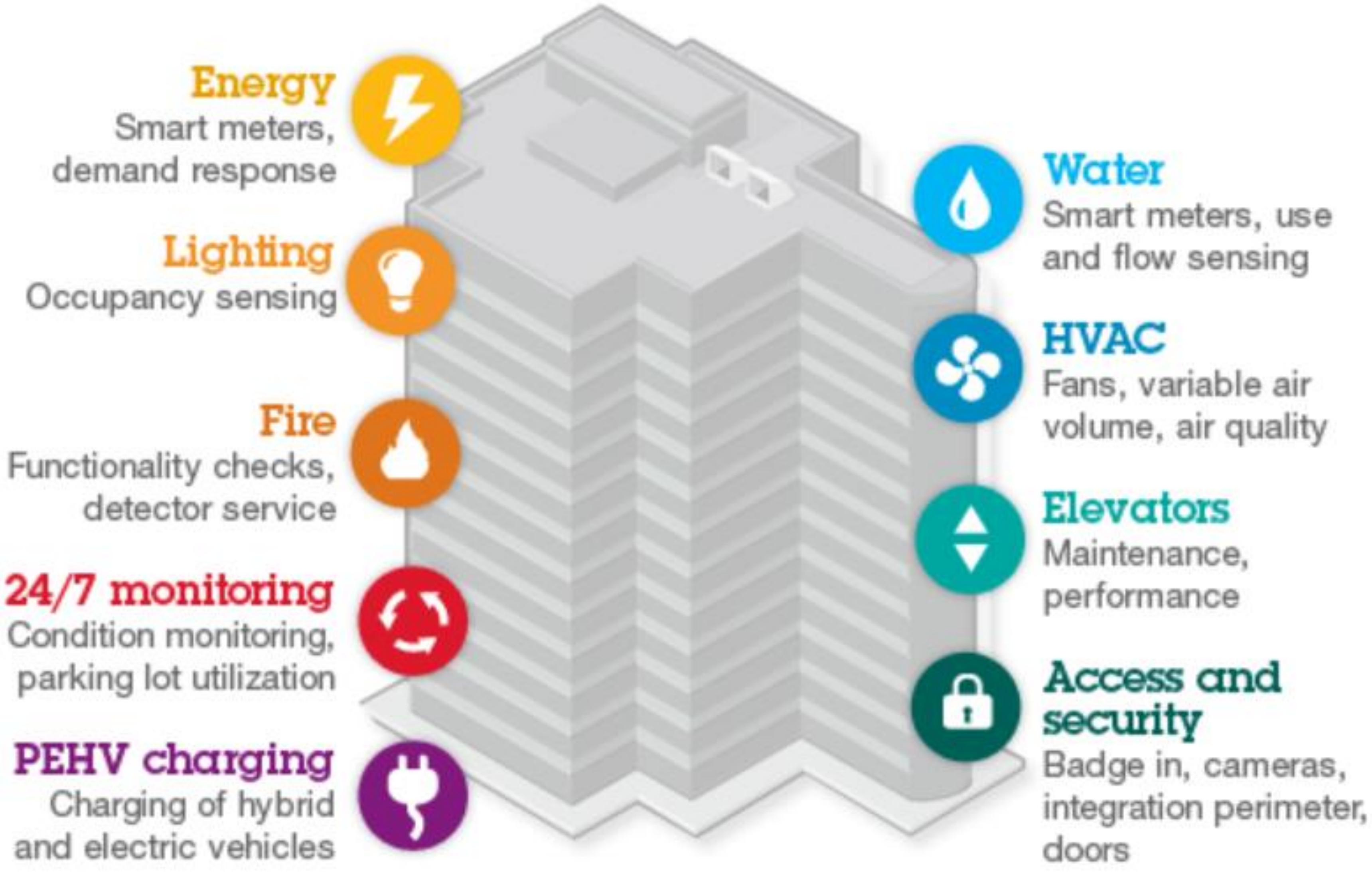
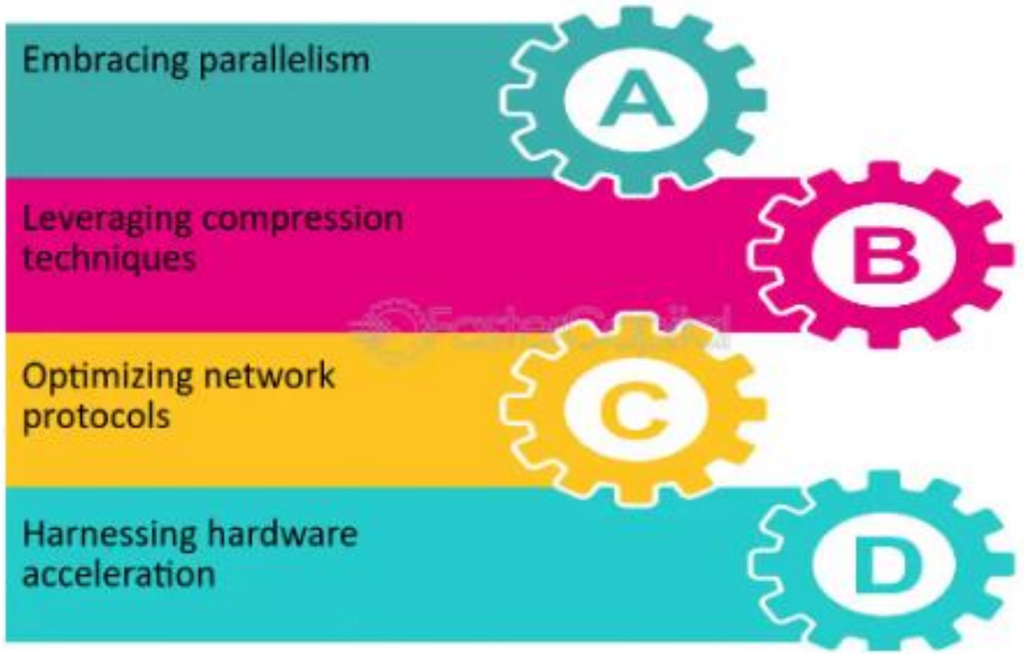
STEPS TO ADD SYSTEMS TO BE INCLUDED TO MAXIMIZE BUILDING PERFORMANCE

- Other systems may include:
  - Utility meters and submeters
  - Computerized maintenance Systems
  - Lighting control
  - Enhancing occupant experience
  - IAQ, Comfort, ease of work
  - DAS (Distributed Antenna System)
  - Facility Network (OT vs. IT)

SYSTEMS TO BE INCLUDED IN A SMART BUILDING



ISSUE: SLOW DATA AND PROCESSING SPEED



- Today data and processing speed needs to be almost instantaneous.
- This includes device processing and reaction.
- Users may click and unclick if slow response causing frustration.
- If refresh times are slow, users will not use the system or ignore issues
- Trends, data, etc. may not be processed.
- Meters may be delayed.

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NETWORKS: STEPS TO SPEED UP DATA AND PROCESSING SPEED

- Start with a well designed, security network framework where all OT systems communicate. Propose a new common shared network
- Don't reuse existing. Use new CAT6 cabling, move toward IP with spider runs (not a loop).
- Watch run lengths (if too long provide fiber)
- Controller loads – try not to overload controllers (20% spare)
- Program graphics so all the data is not re-freshing each time. Minimize data across the network
- Trending, updates – set trend data and updates (don't need them every second and you don't need every point)
- Use data storage or data lake to store data, not controllers.

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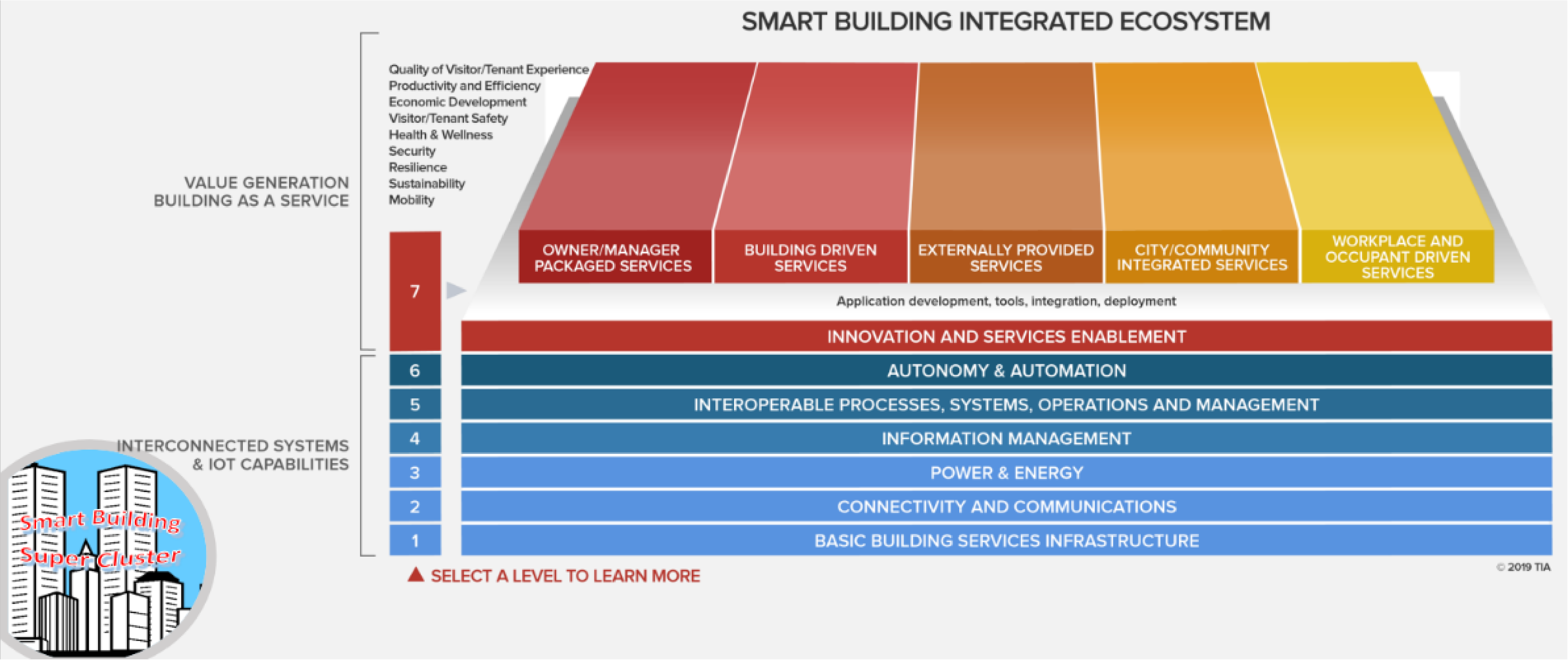
SMART BUILDINGS



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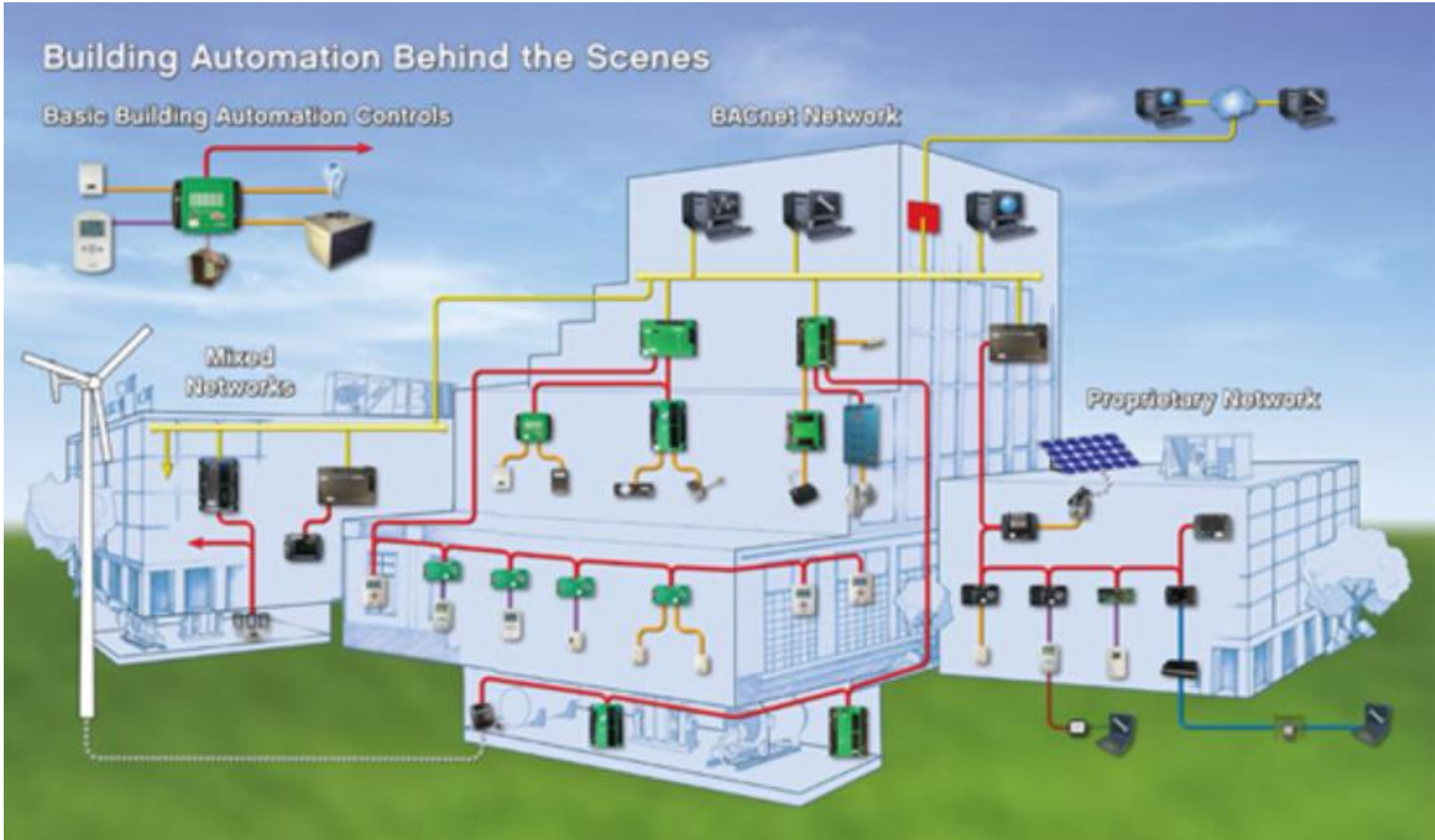
FACILITY NETWORK THROUGHOUT THE SMART BUILDING



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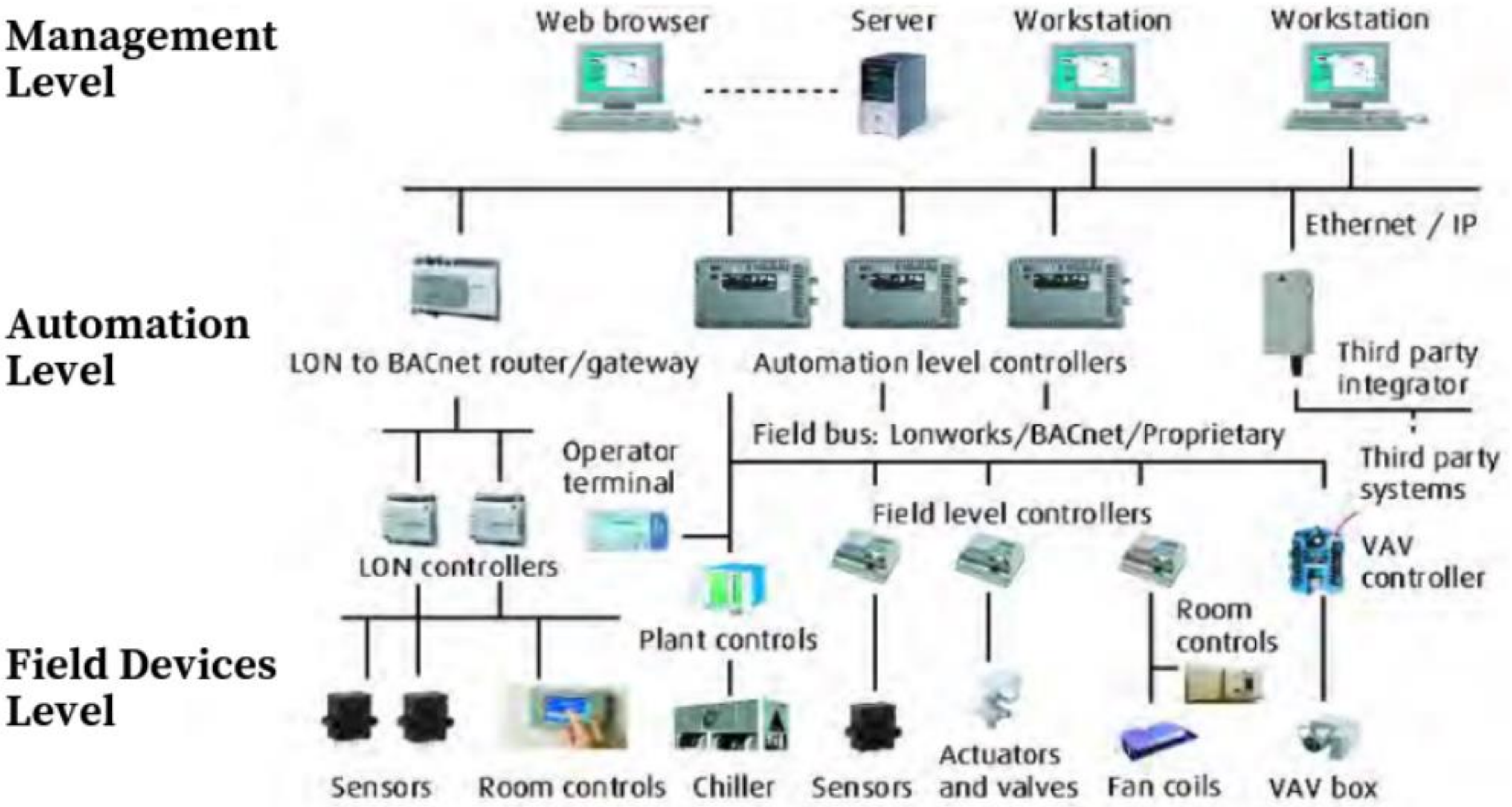
MULTI-LEVELS OF NETWORKS IN A SMART BUILDING



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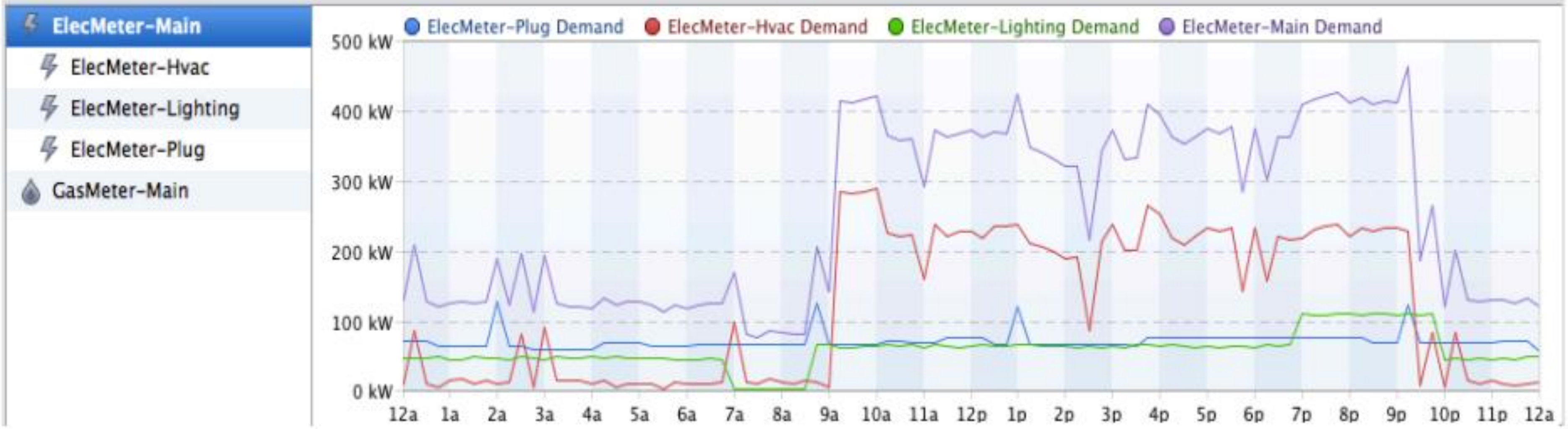
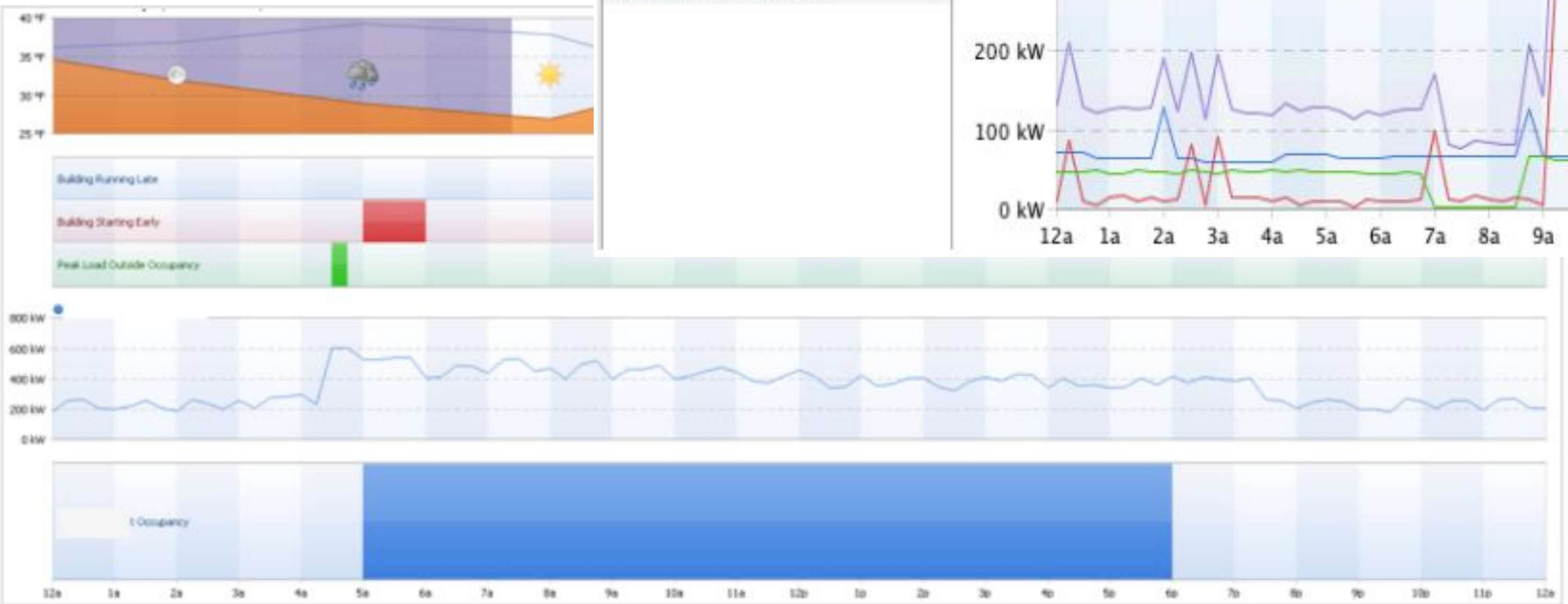
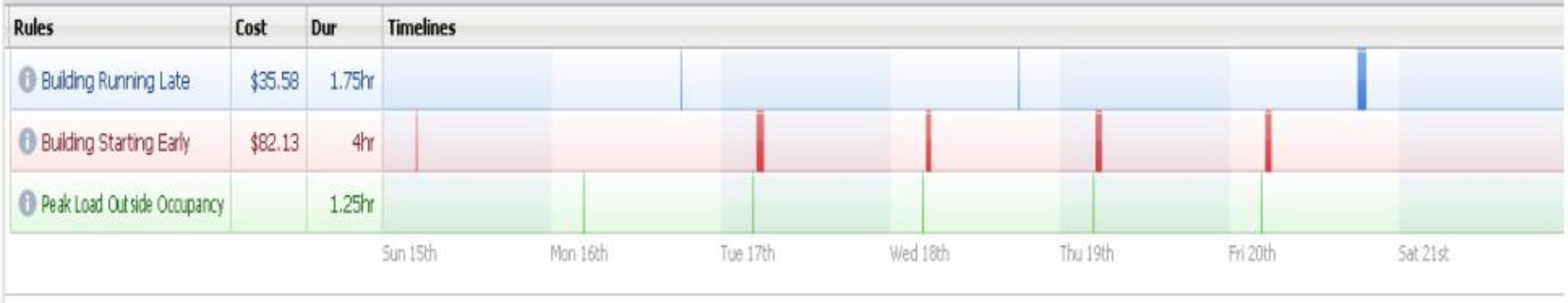




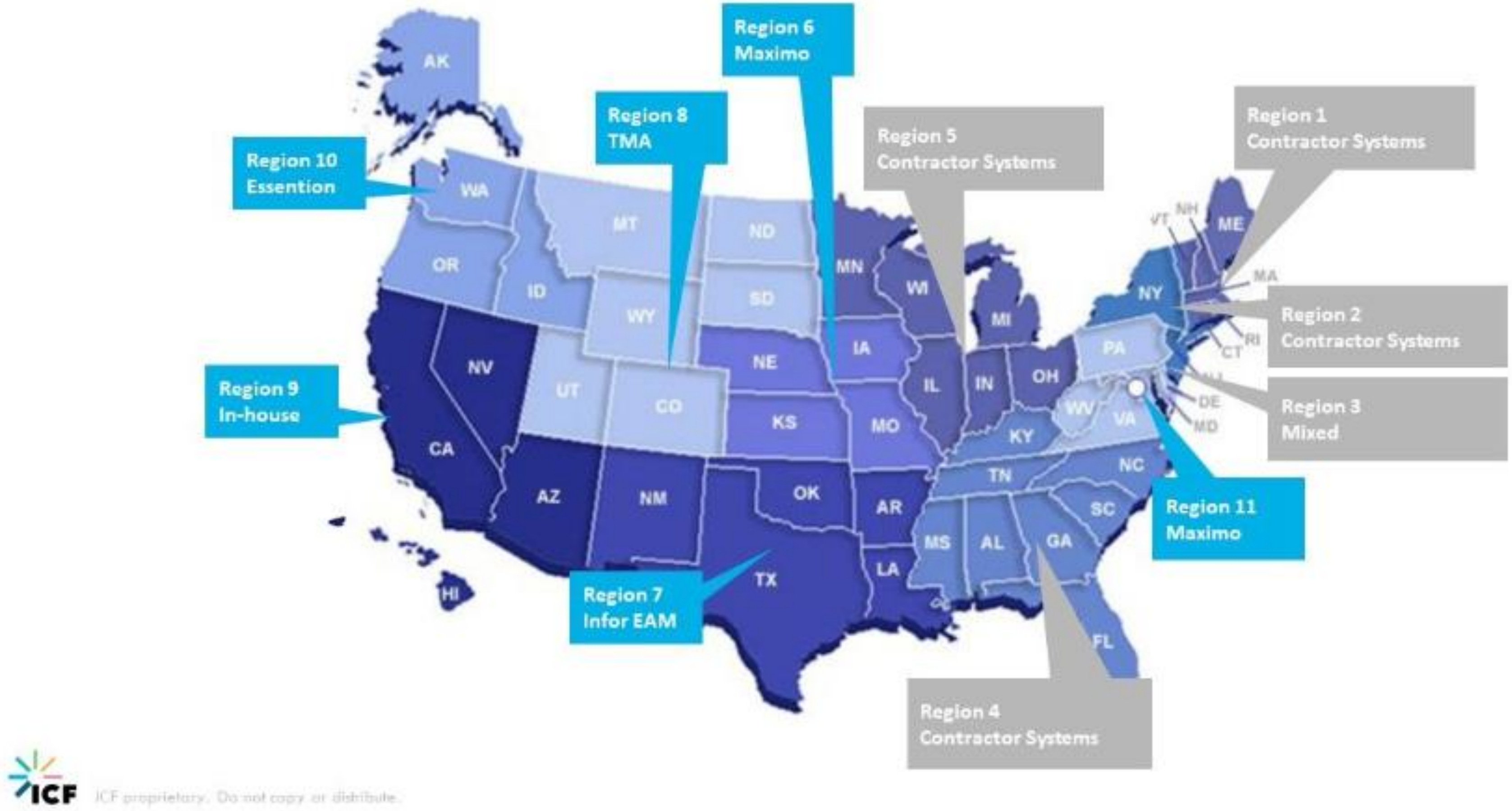


- **370 Million GSF**
- **20% Gas reduction, 25% electricity reduction**

GSA uses Sky Sparks – GSALink

GSA use of CMMS

Legacy situation: No national standard for CMMS



BAS PERFORMANCE: LACK OF TOOLS

- A BAS is more than data & monitoring
- It does not just control the building
- System operation is a must but only a minimum requirement
- The use of the BAS needs to be instructed
- Systems should not operate by themselves
- Graphics need to drive change
- Tools need to create input

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BAS PERFORMANCE: TURNING THE BAS INTO A SOLUTION

- Think about how to maximize performance before design.
- Understand organization and what makes high performance
- Work with client and operators to educate them
- Develop tools for the users
- Make the graphics create questions of the operator
- Allow interaction so operators get connected
- Provide modification portals to tweak performance
- Add icons for reports, trends, sequences
- Allow personalization of GUI by user

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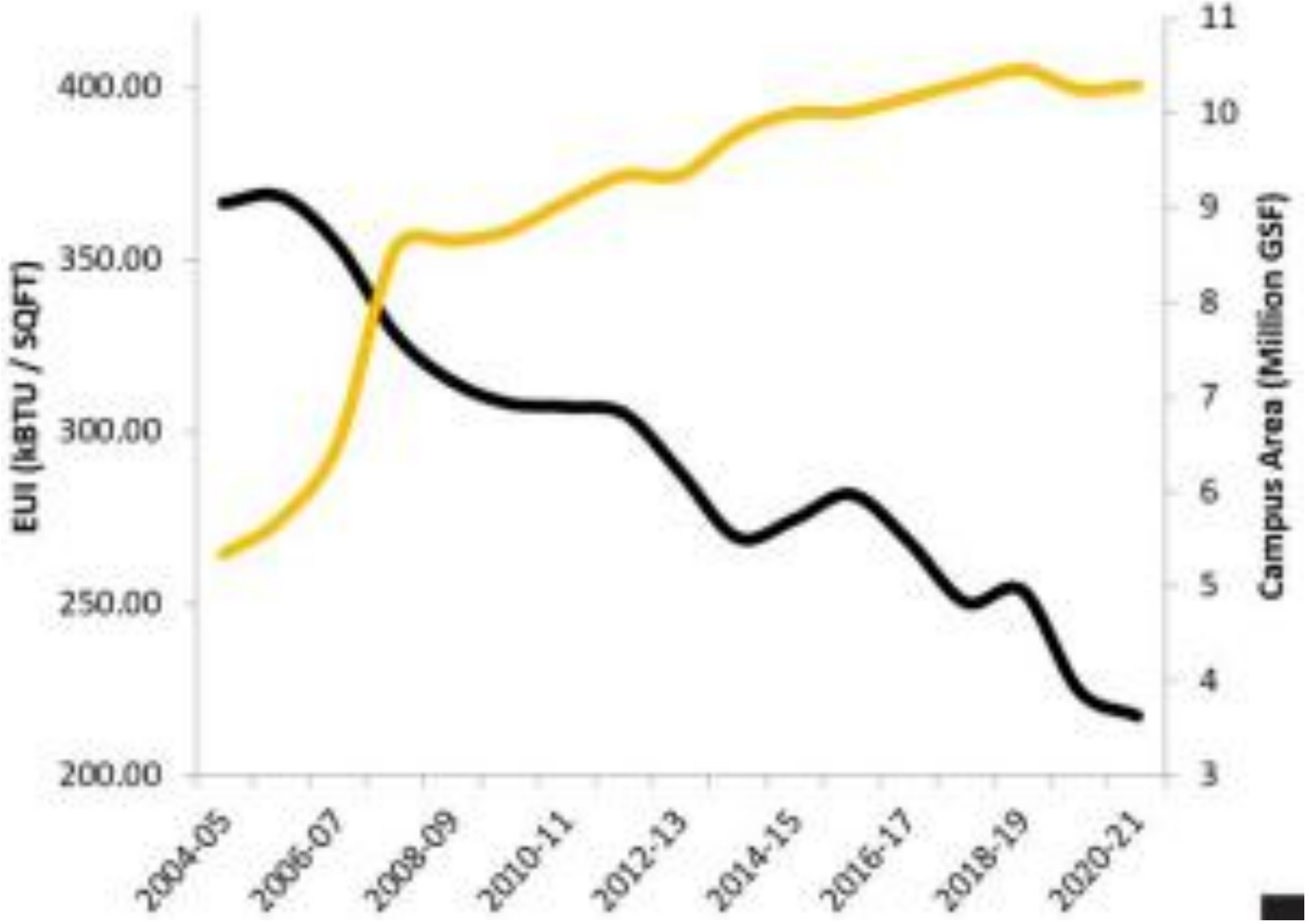
GRAPHICS & EXAMPLES

KPI EXAMPLES

- Energy or Water
  - Tie meters into EMCS and track use
  - Add faults for loss of connection
  - Add faults for too high or too low
  - Set daily, weekly, monthly limits
- Efficiency
  - Trend chiller KW/ton with temperatures
  - Trend boiler % with temperatures
  - Add faults if out of range
- Operations
  - Add faults if equipment is running outside of schedule
  - Add faults if setpoints are out of range
- Comfort
  - Add faults if temperatures are outside set points
  - Add faults if IAQ are outside set points
  - Add faults if humidity are outside set points
  - No glare
- Maintenance
  - Work order faults – filters not changed
  - Simultaneous heating and cooling
  - Doors/windows left open

Energy USE KPI



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KPI EXAMPLES

- Energy or Water
  - Energy Utilization – BTU/SF
  - Water Utilization – Kgallons/SF
- Efficiency
  - chiller KW/ton – <0.6 only above 60 F
  - boiler % - >80% only below 50 F
  - Fan VFDs <80% speed
- Operations
  - equipment following schedule
  - setpoints within range
- Comfort
  - Space ~72 F, 50% RH IAQ 1,000 ppm CO_2
  - FCs at 30 FC?
- Maintenance
  - Reduced sick days
  - Increased billable hours.
  - Work orders closed < 5 days
- Revenue
  - Increased # of visitors
  - Increased remote meetings

DASHBOARD OF PROJECTS IN A REGION

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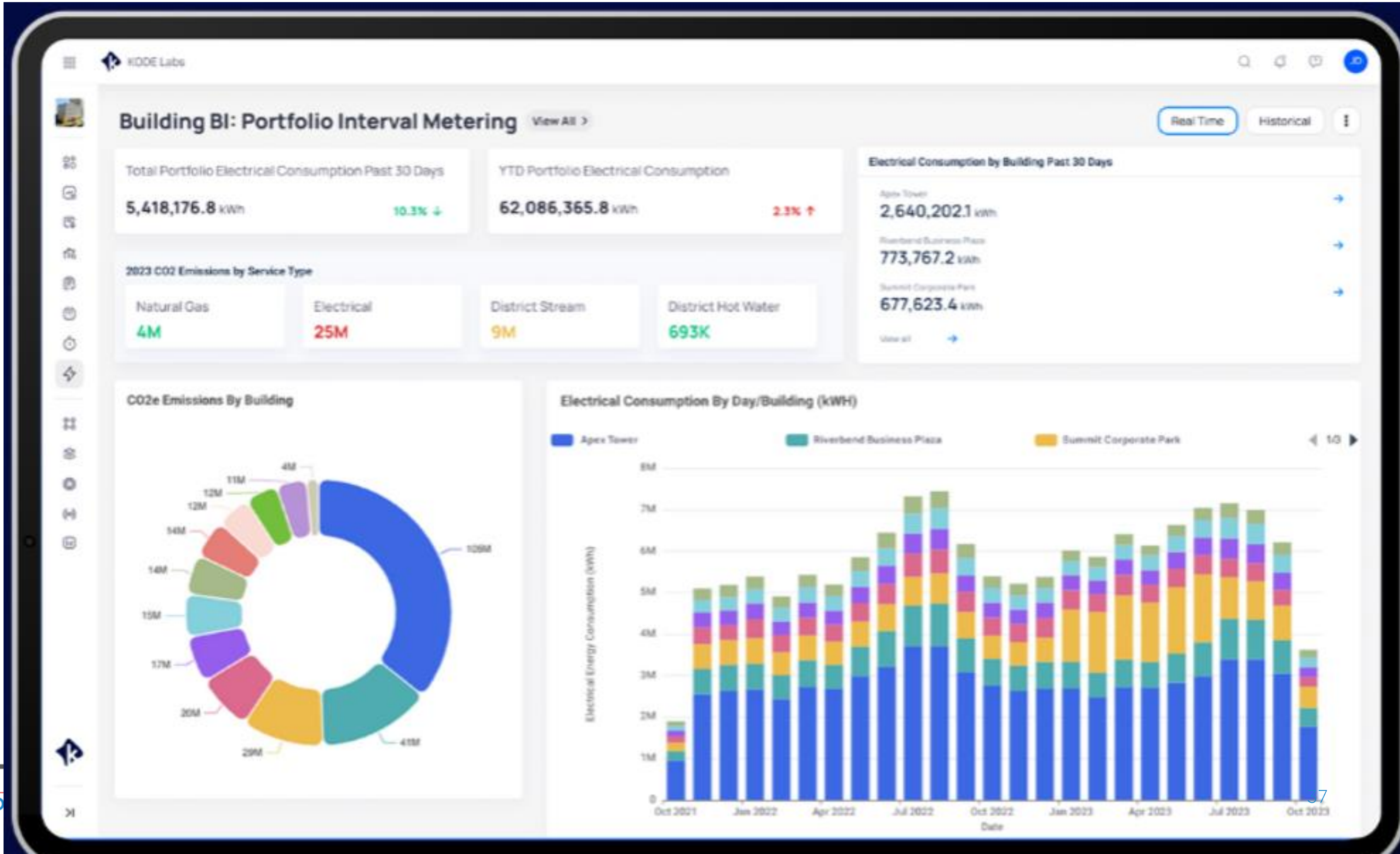
BUILDING DASHBOARD EXAMPLE

KODE LABS



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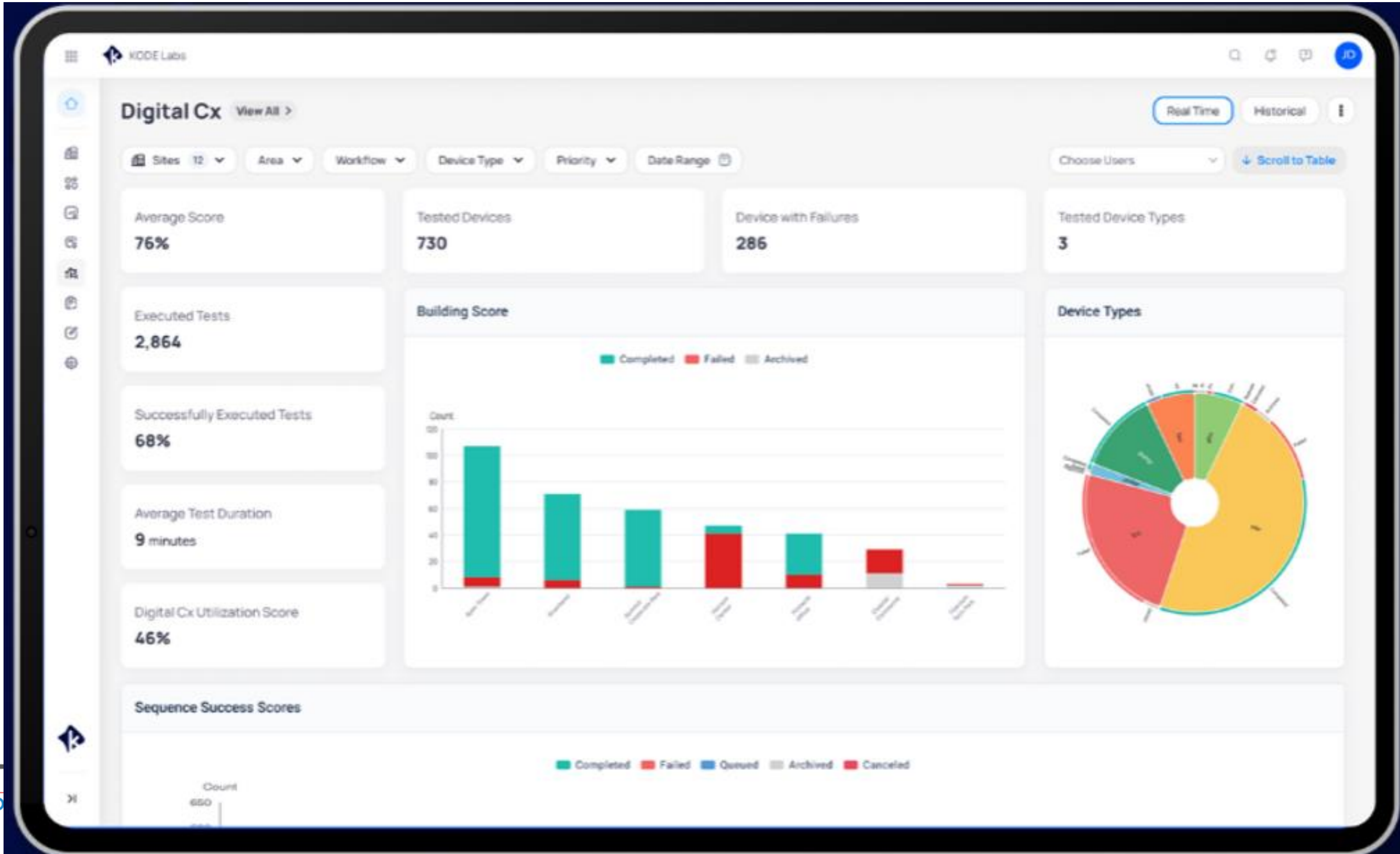
KODE LABS



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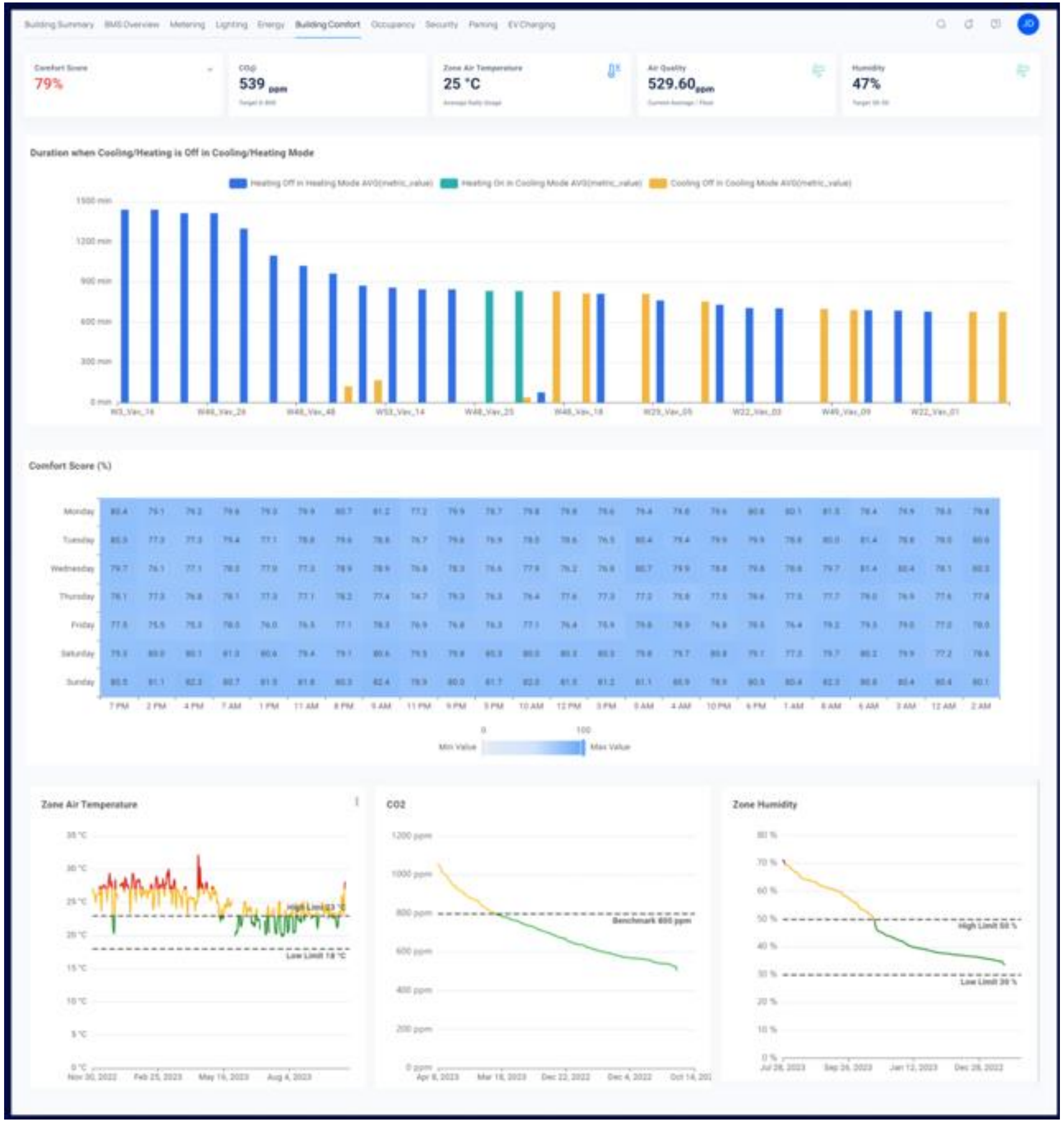
KODE LABS



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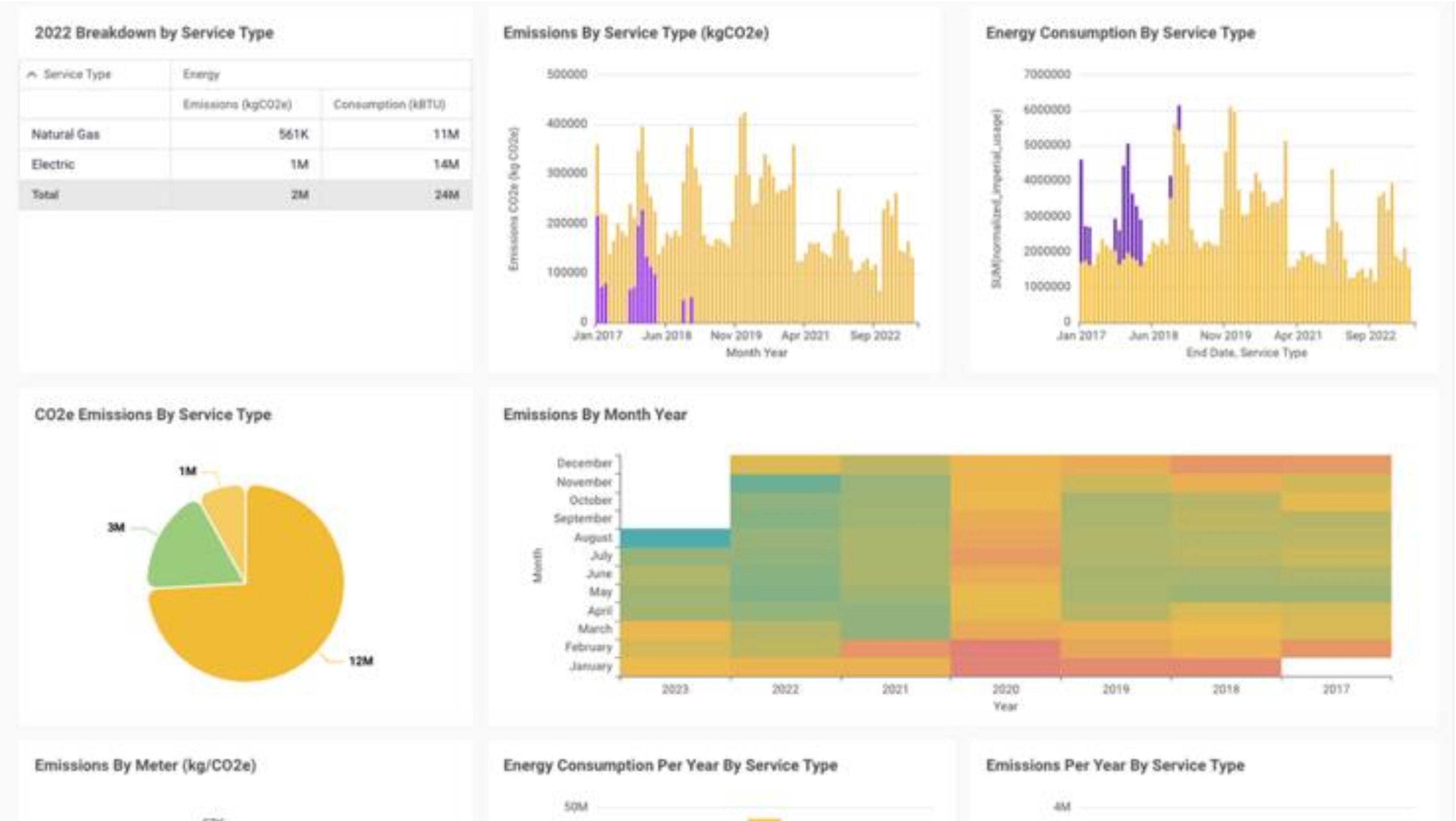

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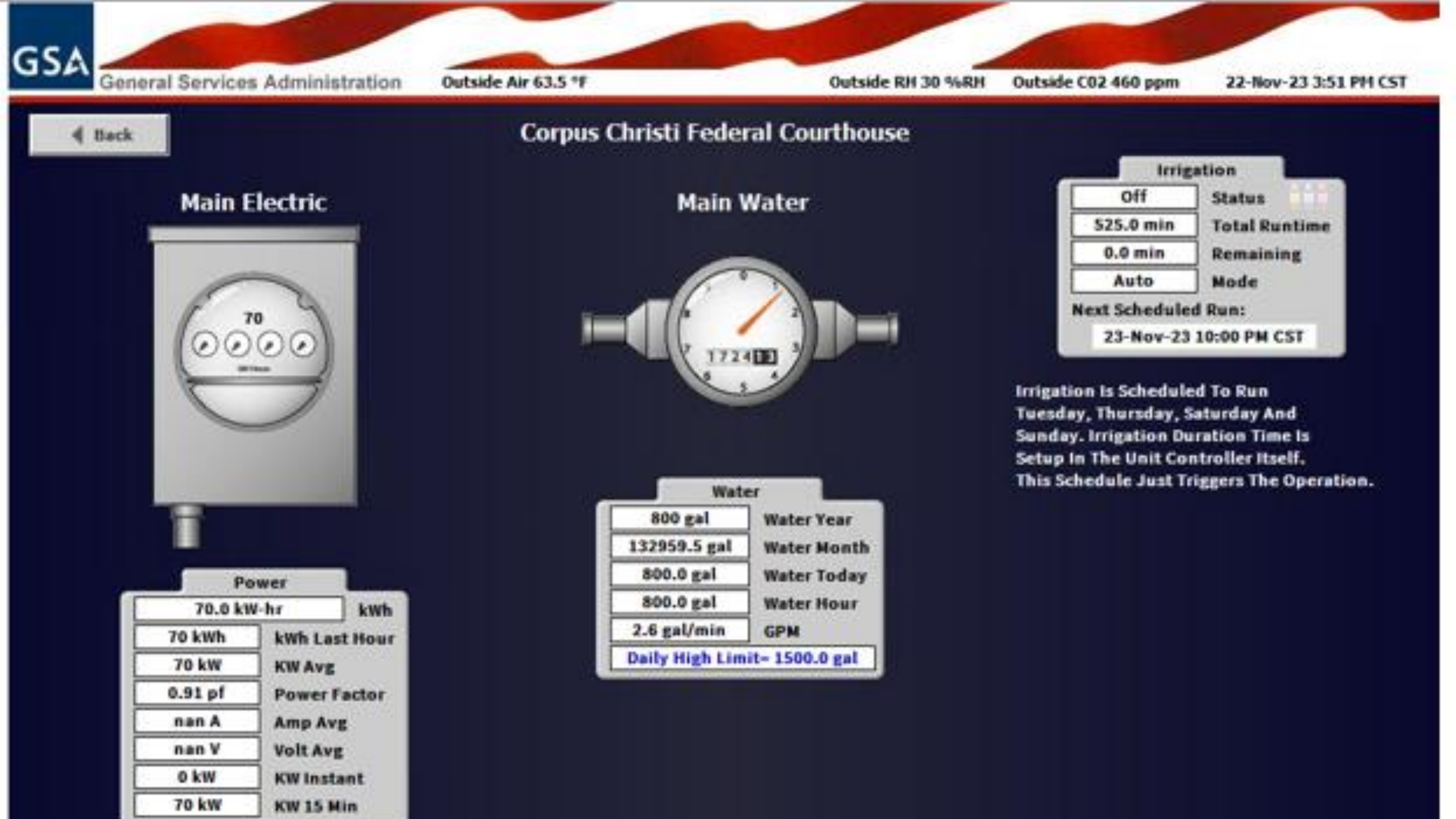
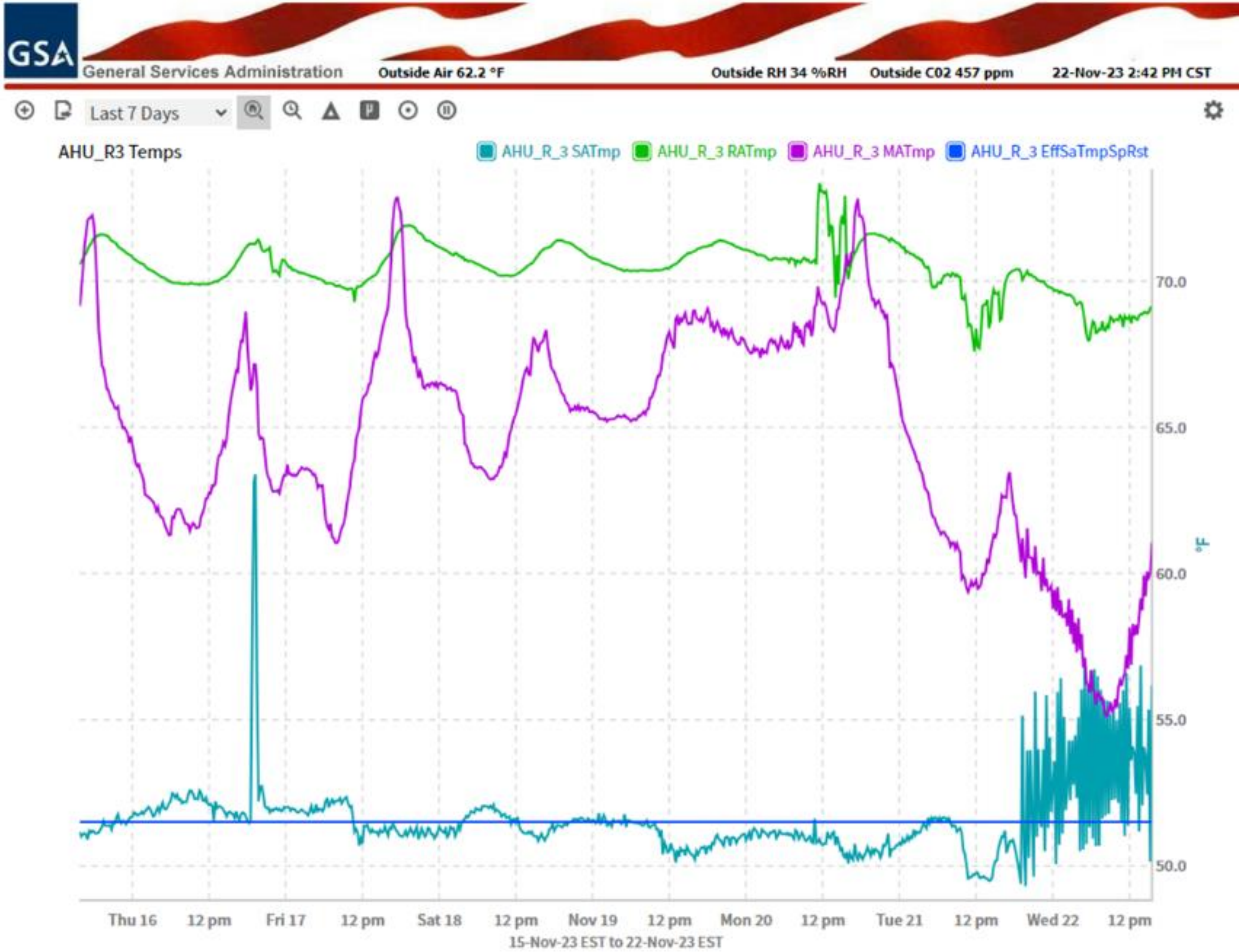

GSA
General Services Administration
Outside Air 63.5 °F
Outside RH 30 %RH
Outside C02 460 ppm
22-Nov-23 3:51 PM CST
Back
Corpus Christi Federal Courthouse
Main Electric
70
Main Water
Irrigation
Off
Status
525.0 min
Total Runtime
0.0 min
Remaining
Auto
Mode
Next Scheduled Run:
23-Nov-23 10:00 PM CST
Irrigation Is Scheduled To Run Tuesday, Thursday, Saturday And Sunday. Irrigation Duration Time Is Setup In The Unit Controller Itself. This Schedule Just Triggers The Operation.
Water
800 gal
Water Year
132959.5 gal
Water Month
800.0 gal
Water Today
800.0 gal
Water Hour
2.6 gal/min
GPM
Daily High Limit= 1500.0 gal
Power
70.0 kW-hr
kWh
70 kWh
kWh Last Hour
70 kW
KW Avg
0.91 pf
Power Factor
nan A
Amp Avg
nan V
Volt Avg
0 kW
KW Instant
70 kW
KW 15 Min



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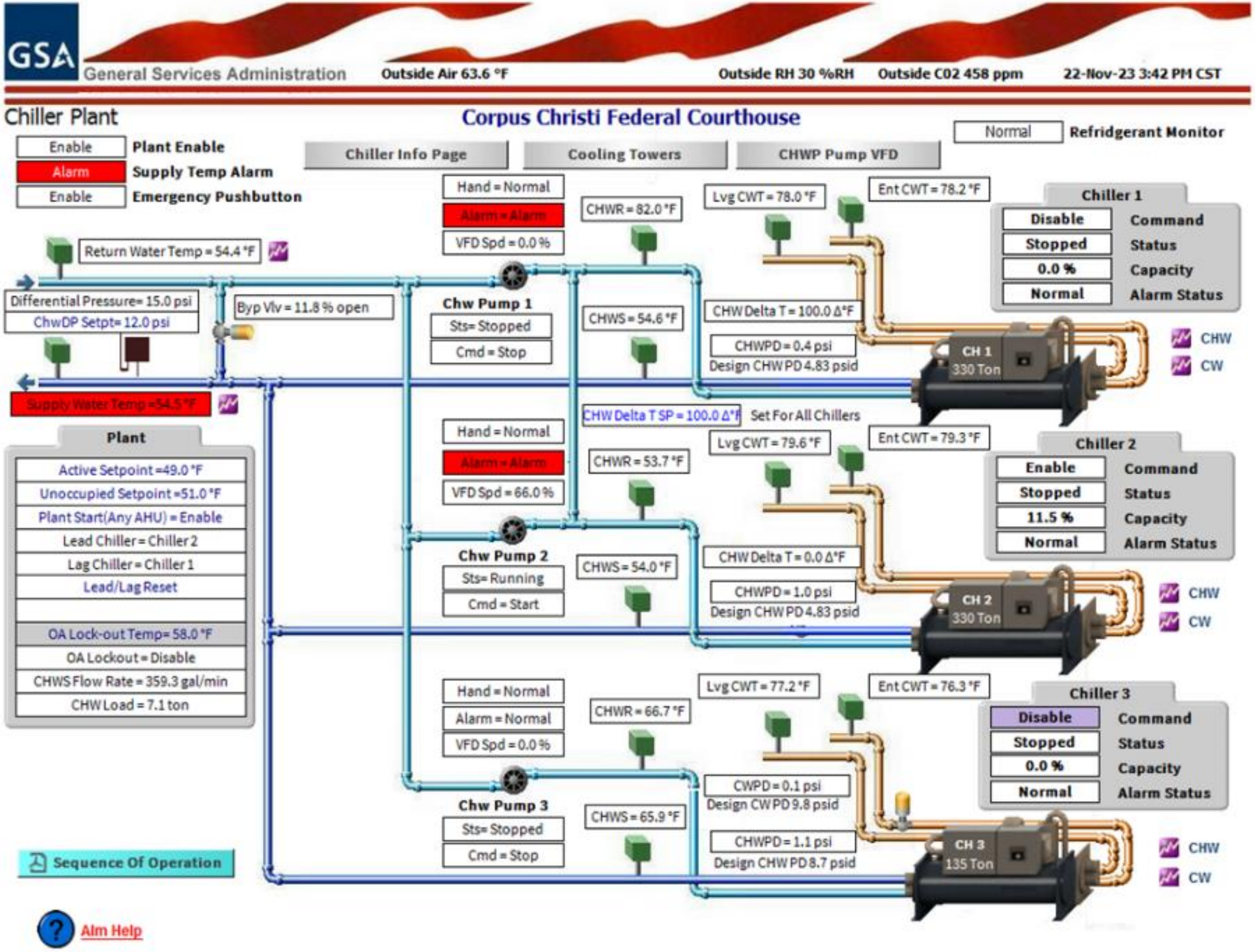

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GSA General Services Administration | Outside Air 64.0 °F | Outside RH 30 %RH | Outside C02 458 ppm | 22-Nov-23 3:44 PM CST

Back rmation

Corpus Christi Federal Courthouse

Chiller 1

Chilled Water Supply Temp=	54.57 °F
Chilled Water Return Temp=	82.04 °F
Evaporator Refrigerant Temp=	52.11 °F
Evaporator Pressure=	62.50 psi
Discharge Refrigerant Temp=	76.57 °F
Compressor Status=	Stop
Evaporator Water Flow=	No Flow
System Alarm=	Normal
Chilled Water DP =	0.4 Δpsi
Condenser Water Supply Temp=	78.0 °F
Condenser Water Return Temp=	78.2 °F
Condenser Refrigerant Temp=	52.14 °F
Condenser Pressure=	62.53 psi
Run Load Amps=	0.00 A
Condenser Water Flow=	Flow
System Mode=	Off
Condenser Water DP =	0.0 psi
Chiller Capacity =	0.00 %
Chiller Comp Oil Pressure =	62.47 psi
Emergency Stop =	Off

Chiller 2

Chilled Water Supply Temp=	55.40 °F
Chilled Water Return Temp=	55.50 °F
Evaporator Refrigerant Temp=	54.20 °F
Evaporator Pressure=	49.90
Discharge Refrigerant Temp=	107.0 °F
Compressor Status=	Stop
Evaporator Water Flow=	Yes
System Alarm=	Normal
Chilled Water DP =	1.1 Δpsi
Condenser Water Supply Temp=	80.00 °F
Condenser Water Return Temp=	79.60 °F
Condenser Refrigerant Temp=	79.60 °F
Condenser Pressure=	84.60
Run Load Amps=	23.40
Condenser Water Flow=	On
System Mode=	Auto
Condenser Water DP =	50.1 psi

Chiller 3

Chilled Water Supply Temp=	65.9 °F
Chilled Water Return Temp=	66.7 °F
Active Supply Setpoint=	48.9 °F
Chilled Water Pump Output=	Stop
Chilled Water Flow=	false
Condenser Water Pump Output=	Stop
Condenser Water Flow=	Flow
Chiller Run Mode=	chlrOff
Chilled Water DP =	1.1 Δpsi
Condenser Water Supply Temp=	77.2 °F
Condenser Water Return Temp=	76.3 °F
Actual Capactiy=	0.0 %
Capacity Limit=	100.0 %
Run Enabled=	Run
Chiller in Alarm=	Normal
System Mode=	false
Chiller Operation Mode=	hvacCool
Condenser Water DP =	0.1 psi

GSA General Services Administration Outside Air 64.2 °F Outside RH 30 %RH Outside C0

OA Damper Overrides

Corpus Christi Federal Courthouse

Master

OA Damper Override Inactive 0

Emergency Override

Emergency Auto

AHU	Override Enable	% Override Open SP	Damp
AHU R-1	Auto	20.0 %	20.0 %
AHU R-2	Auto	20.0 %	10.0 %
AHU R-3	Auto	20.0 %	100.0 %
AHU R-4	Auto	30.0 %	10.0 %
AHU R-5	Auto	20.0 %	100.0 %
AHU R-6	Auto	30.0 %	100.0 %
AHU R-7	Auto	30.0 %	20.0 %
AHU R-8	Auto	30.0 %	100.0 %
AHU R-9	Auto	30.0 %	100.0 %
AHU R-10	Auto	30.0 %	100.0 %
AHU R-11	Auto	30.0 %	10.0 %

Building

-0.03 in/wc Static

AFMS

1155 cfm	AHU R1
0 cfm	AHU R2
2037 cfm	AHU R3
0 cfm	AHU R4
866 cfm	AHU R5
0 cfm	AHU R6
7146 cfm	AHU R7
1813 cfm	AHU R8
1565 cfm	AHU R9
1647 cfm	AHU R10
508 cfm	AHU R11

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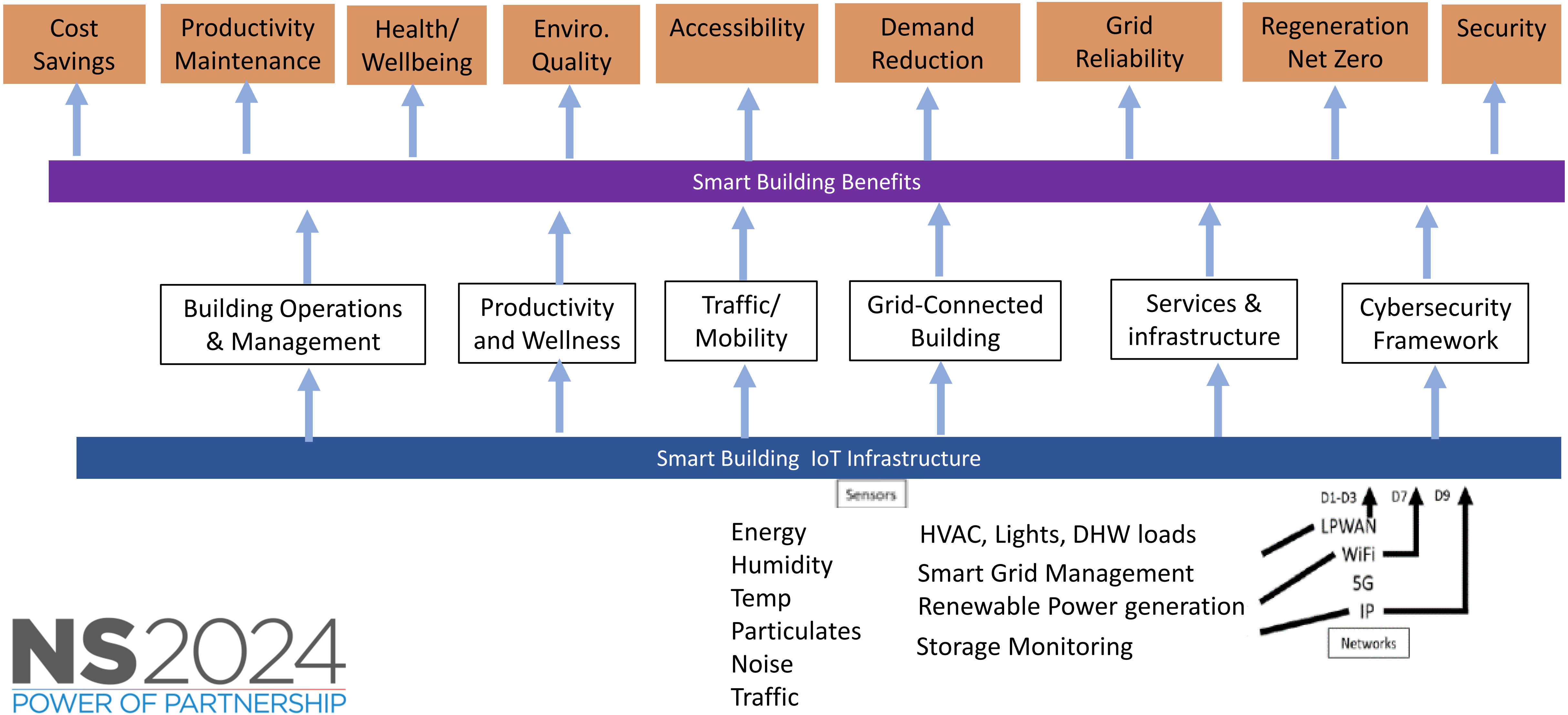
SMART BUILDING H-KPI'S
PUTTING IT ALL TOGETHER



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FUTURE SMART BUILDING OPPORTUNITIES

- More equipment is being built with Microprocessors
  - Video Surveillance (Cameras)
  - Door Access
  - Hoteling – Reservation of office spaces, equipment
  - Janitorial Equipment – waste baskets, soap dispensers, etc.
  - Appliances
- 5G will provide more options
  - WIFI internal to the buildings
  - Smart phone BAS applications
  - Increased occupant interactions
  - Digital twins live in comparison
  - Sustainability – Electrification – Visualization – Battery Management

Questions & Answers

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