BAUMANN
CONSULTING

Vision to Verification

ACHIEVING BUILDING PERFORMANCE GOALS THROUGH SMART BUILDING TECHNOLOGY VERIFICATION

DC Sustainability Summit 2024

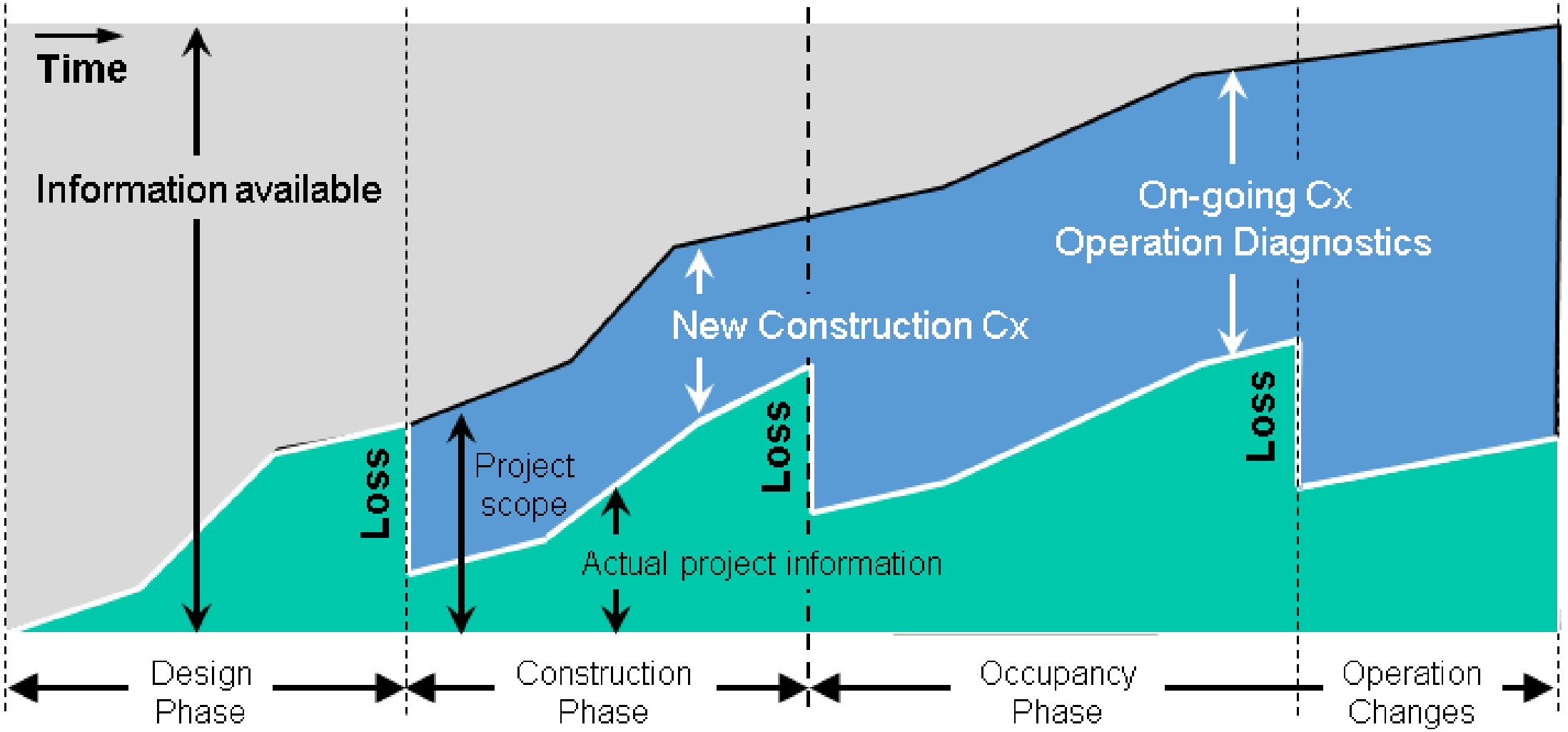
Session Speaker

Brandon Pieczynski, C.E.M.
Commissioning & Energy Engineer
Baumann Consulting

Learning Objectives

- Learn the importance of why commissioning in high performance buildings.
- Understand why schools are at the forefront of net zero energy certifications
- Understand common building enclosure and MEP system approaches to achieving high performance in a building.
- Learn how to leverage smart building technology to allow for remote verification in mission critical facilities where occupancy/access is a concern.
- Learn the importance of user education when working in facilities with high performance goals.

Cx Process


Time
Information available
Loss
Project scope
New Construction Cx
Loss
Actual project information
On-going Cx
Operation Diagnostics
Loss
Design Phase
Construction Phase
Occupancy Phase
Operation Changes

Why are schools seeking high performance targets?

BAUMANN CONSULTING

Academy for Global Citizenship

Size: 72,000 SF
Opened: September 2023
Location: Chicago, IL
Owner: Cultivate Collective
Architect: Farr Associates
MEP Engineer: dbHMS
GC: Power Construction
Baumann Consulting: MEPCx, BECx, Energy Model Peer Review, Performance Verification

Living Building Challenge & PHIUS Commercial – **Achieved**

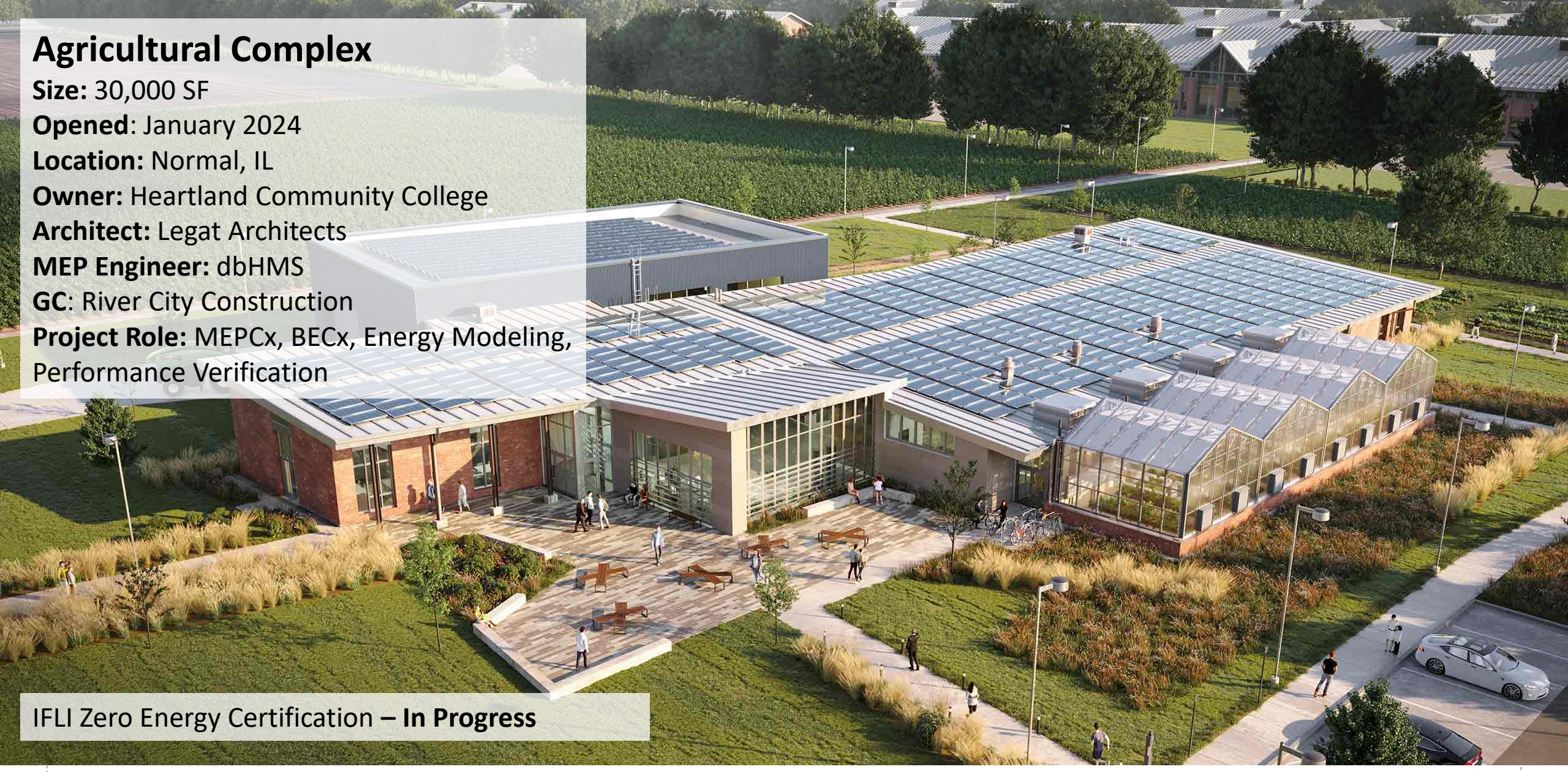
Brock Environmental Center

Size: 10,500 SF
Opened: November 2014
Location: Virginia Beach, VA
Owner: Chesapeake Bay Foundation
Architect: SmithGroup
MEP Engineer: SmithGroup
GC: Hourigan Construction
Baumann Consulting: Energy Modeling

LEED NC Platinum & Living Building Challenge - **Certified**

Agricultural Complex

Size: 30,000 SF
Opened: January 2024
Location: Normal, IL
Owner: Heartland Community College
Architect: Legat Architects
MEP Engineer: dbHMS
GC: River City Construction
Project Role: MEPCx, BECx, Energy Modeling, Performance Verification

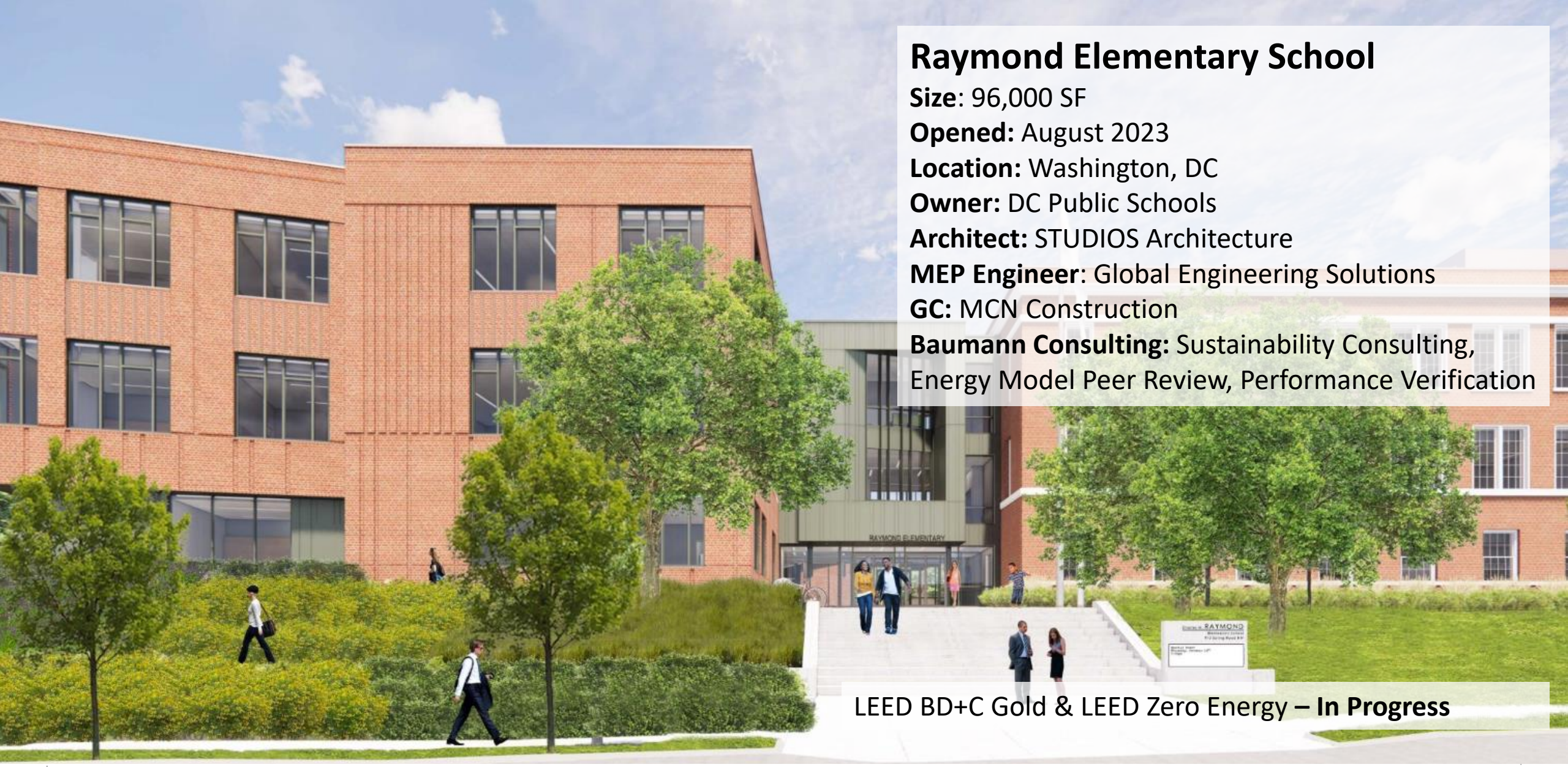


IFLI Zero Energy Certification – **In Progress**

Henry Ford College

Size: 75 Acre Campus
Location: Dearborn, MI
Owner: Henry Ford College
Baumann Consulting: Integrated Energy Master Planning, Commissioning, Energy Model Peer Review, Performance Verification

Integrated Energy Master Plan **– In Progress**



Raymond Elementary School

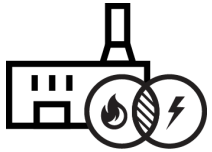
Size: 96,000 SF
Opened: August 2023
Location: Washington, DC
Owner: DC Public Schools
Architect: STUDIOS Architecture
MEP Engineer: Global Engineering Solutions
GC: MCN Construction
Baumann Consulting: Sustainability Consulting, Energy Model Peer Review, Performance Verification

LEED BD+C Gold & LEED Zero Energy **– In Progress**

A Word on Loading Order

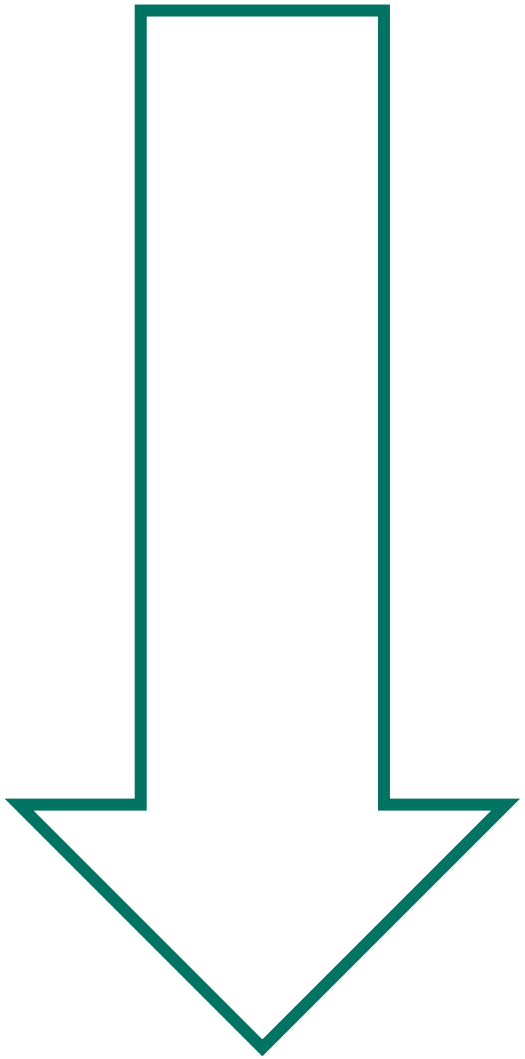
PASSIVE STRATEGIES

OPTIMIZED SYSTEMS



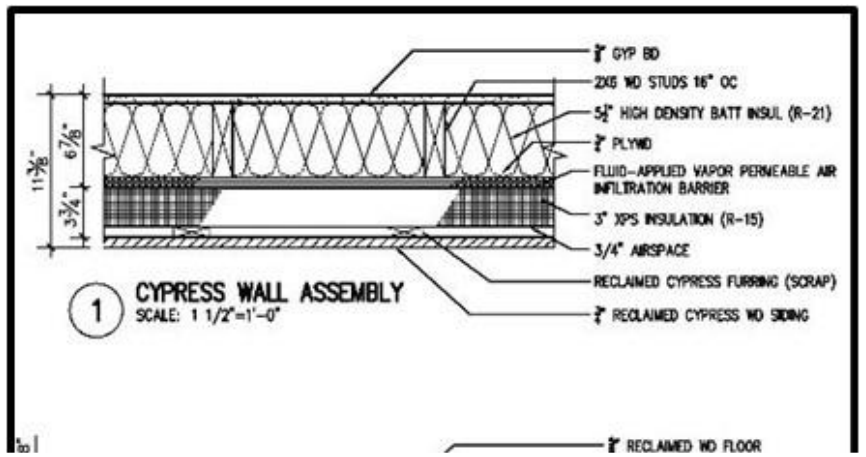
SHARED RESOURCES

ON-SITE RENEWABLES



Opaque Envelope

Insulation Thickness Decision

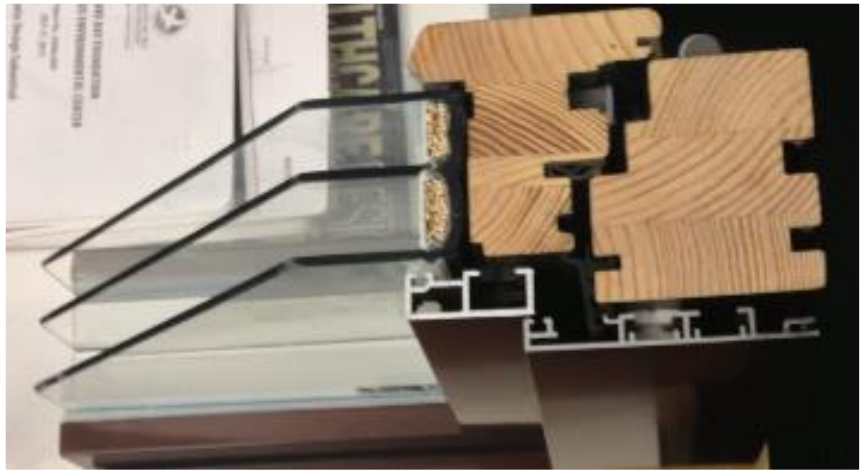


Insulation Cost Premium	**$22,204**
Energy Savings	27,000 kbtu/yr
# of PV Panels Saved	35 PV panels
	11.2kW
Reduced PV Cost Savings	**$44,800**

Brock Environmental Center Energy Model Results

Glazed Envelope

Glazing Decisions



Triple Glazing (U-0.20) energy savings relative to double glazing (U-0.30)	19,000 kbtu/yr
Triple Glazing Cost Premium	**$26,235**
Equivalent PV Required	25 PV panels
	8.0 kW
Equivalent PV Cost	**$32,000**

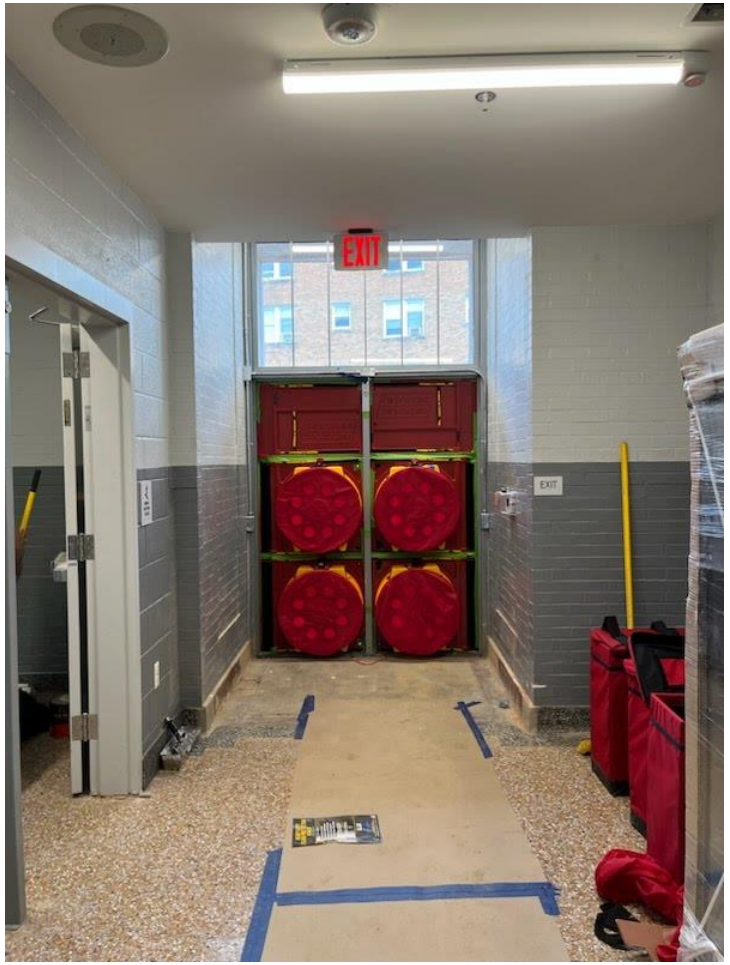
Brock Environmental Center Energy Model Results

Building Enclosure Verification

Building enclosure testing @ Academy for Global Citizenship

BAUMANN
CONSULTING

Building Enclosure Verification



Common Building Enclosure Tests

Adhesion Tests

- •ASTM C1521 Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints
- •ASTM D 4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

Opening Airtightness tests

- •ASTM E 783 Field Measurement of Air Leakage Through Installed Exterior Windows and Doors ASTM E 1186 Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.

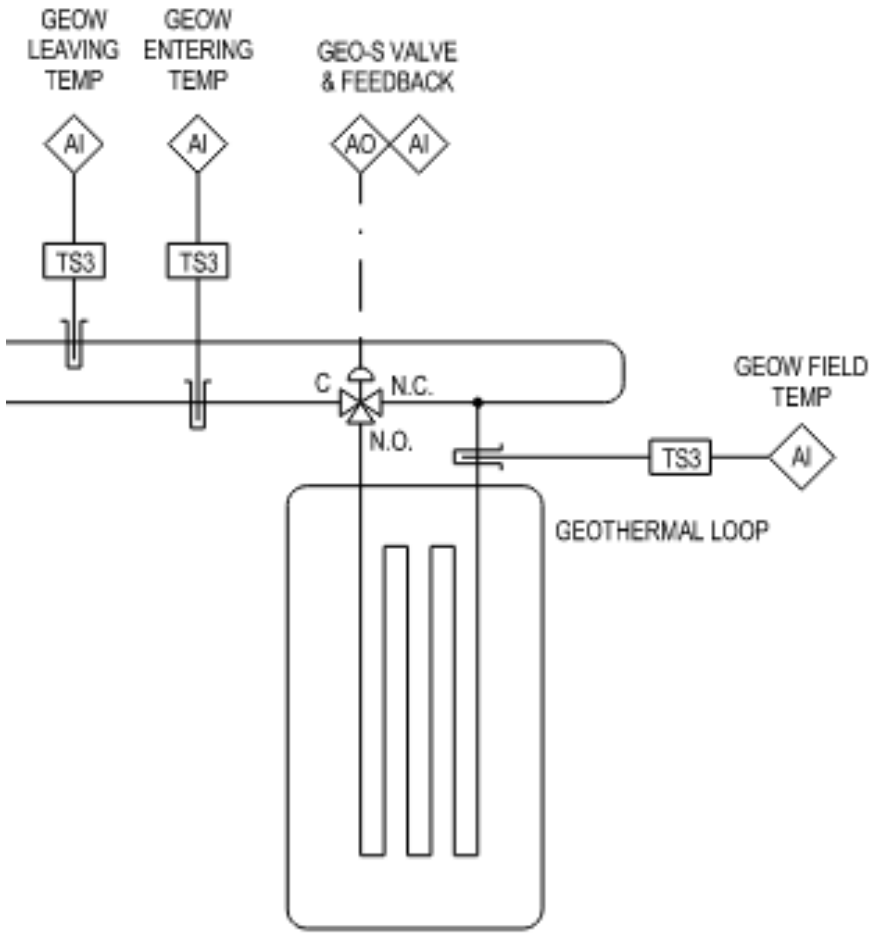
Watertightness Tests

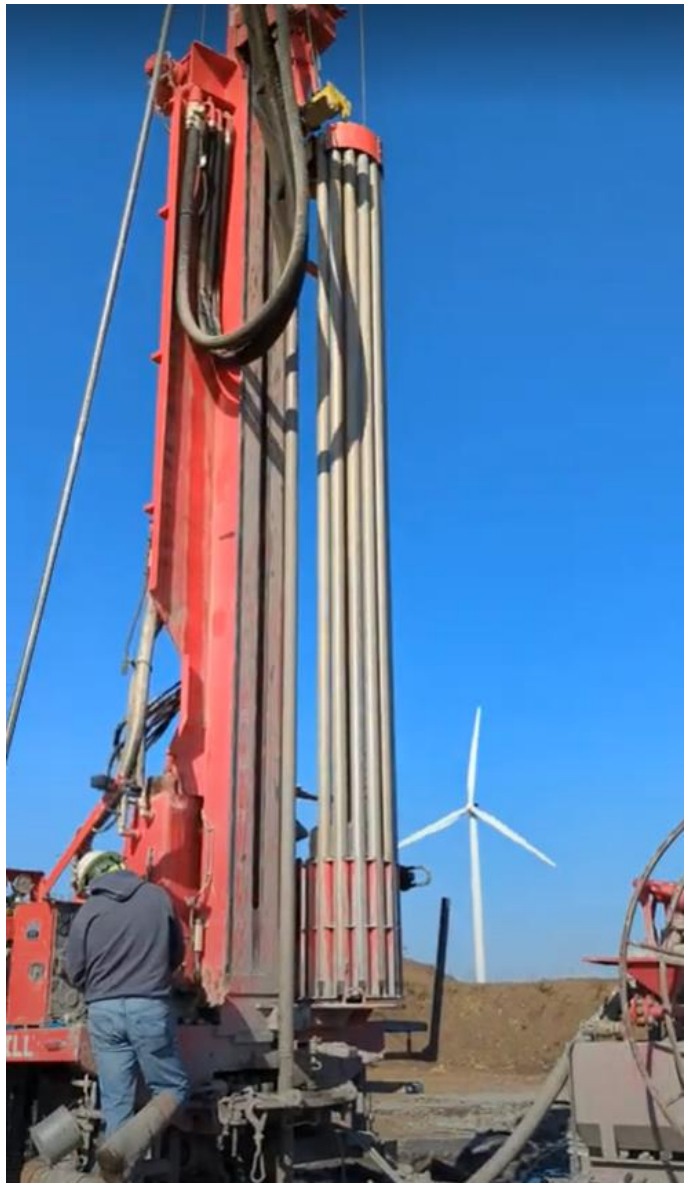
- •AAMA 501.1 Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors using Dynamic Pressure
- •AAMA 501.2 Field Check of Metal Storefronts, Curtainwalls, and Sloped Glazing Systems for Water Leakage.
- •ASTM E 1105 Field Determination of Water Penetration of Installed Exterior Windows, Curtainwalls and Doors by Uniform Static Air Pressure Difference.
- •ASTM D7877 Standard Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes

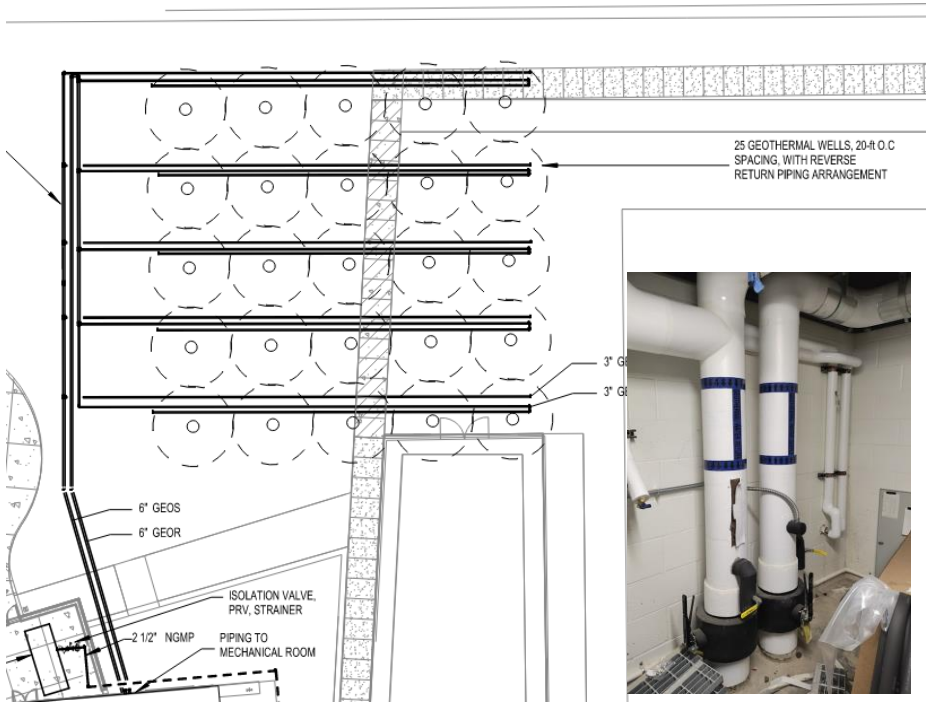
Whole Building Airtightness Tests

- **•ASTM E 779 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization**
- **•ASTM E 3158 Standard Test Method for Measuring the Air Leakage Rate of a Large or Multizone Building**

Ground Source Heat Pumps







Geo-exchange Borefield Drilling

BAUMANN CONSULTING

HVAC – Space Conditioning

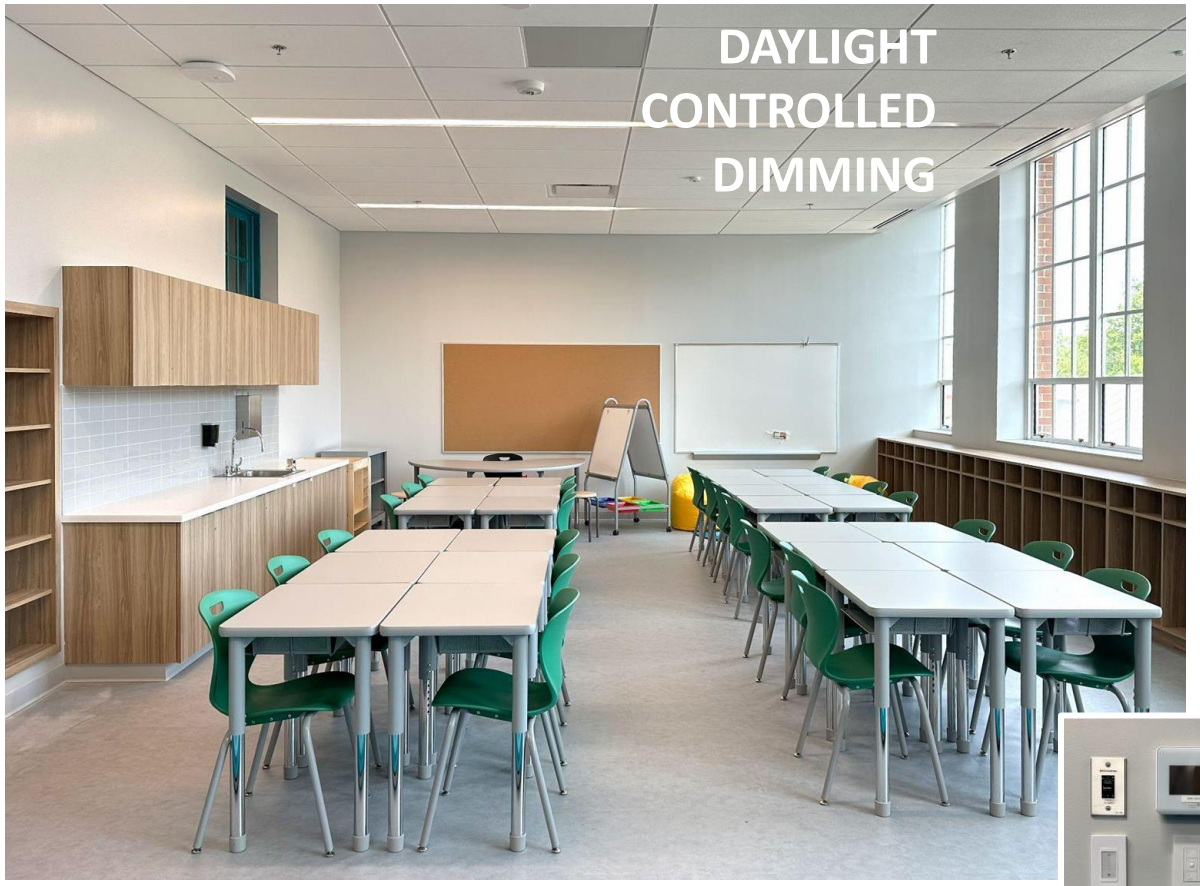
Ground-Source VRF @ Brock Center (Top)

Terminal GSHP @ Raymond Elementary (Bottom)

Radiant Slab & Geothermal Heat Recovery Chiller @ Academy for Global Citizenship

BAUMANN CONSULTING

Smart Building Controls



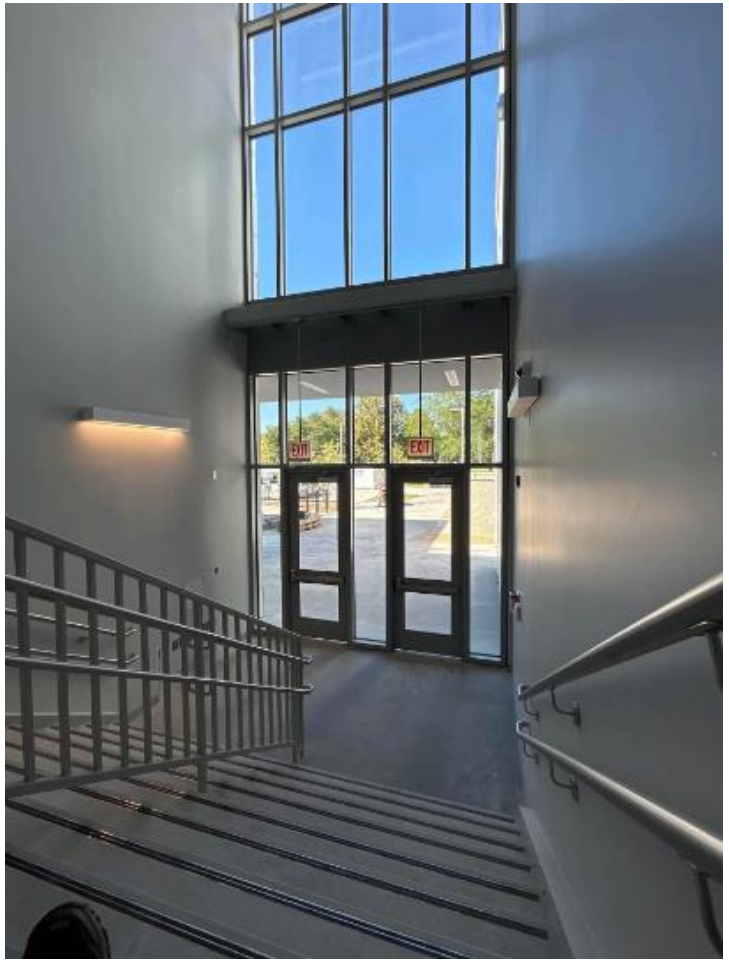
OCCUPANCY CONTROLLED RECEPTACLES

DEMAND CONTROLLED VENTILATION

Typical Issues Found During Commissioning

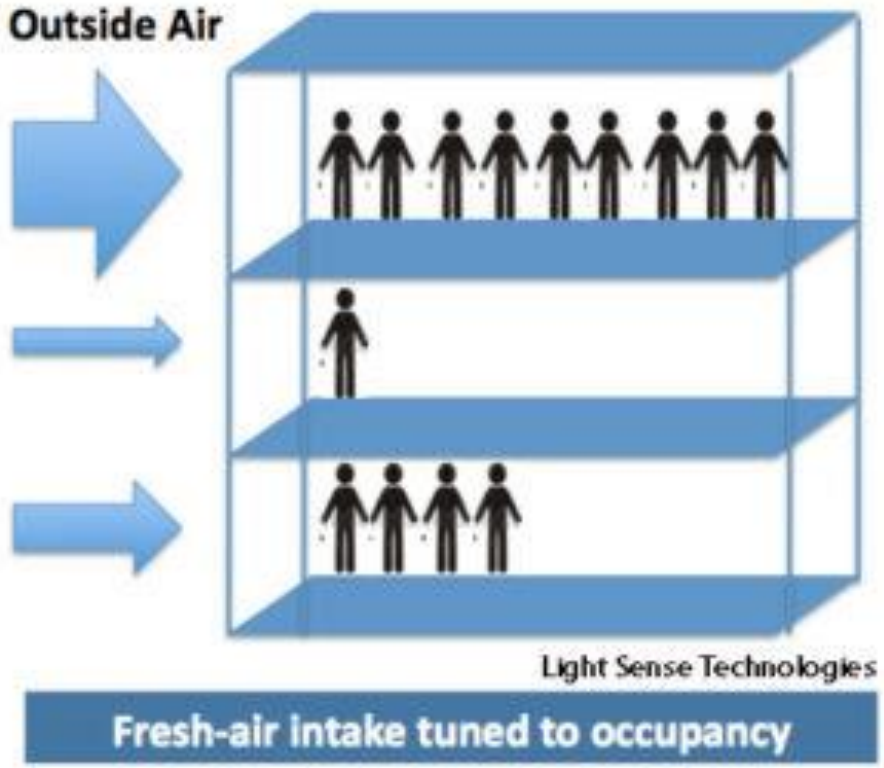
Daylight-controlled blinds stuck halfway, unresponsive to flashlight

Occupancy-controlled receptacle stays on despite 30 min lack of motion



Daylight-controlled lights: one on, one off while daylit

Control Strategies - Demand Controlled Ventilation



Lbl.gov

DEMAND CONTROLLED VENTILATION

Control Strategies - Demand Controlled Ventilation

OA Temp 45.0 °F
OA Humidity 40.2 %

IAQ Summary

intelli-building Automation System - Academy for Global Citizenship

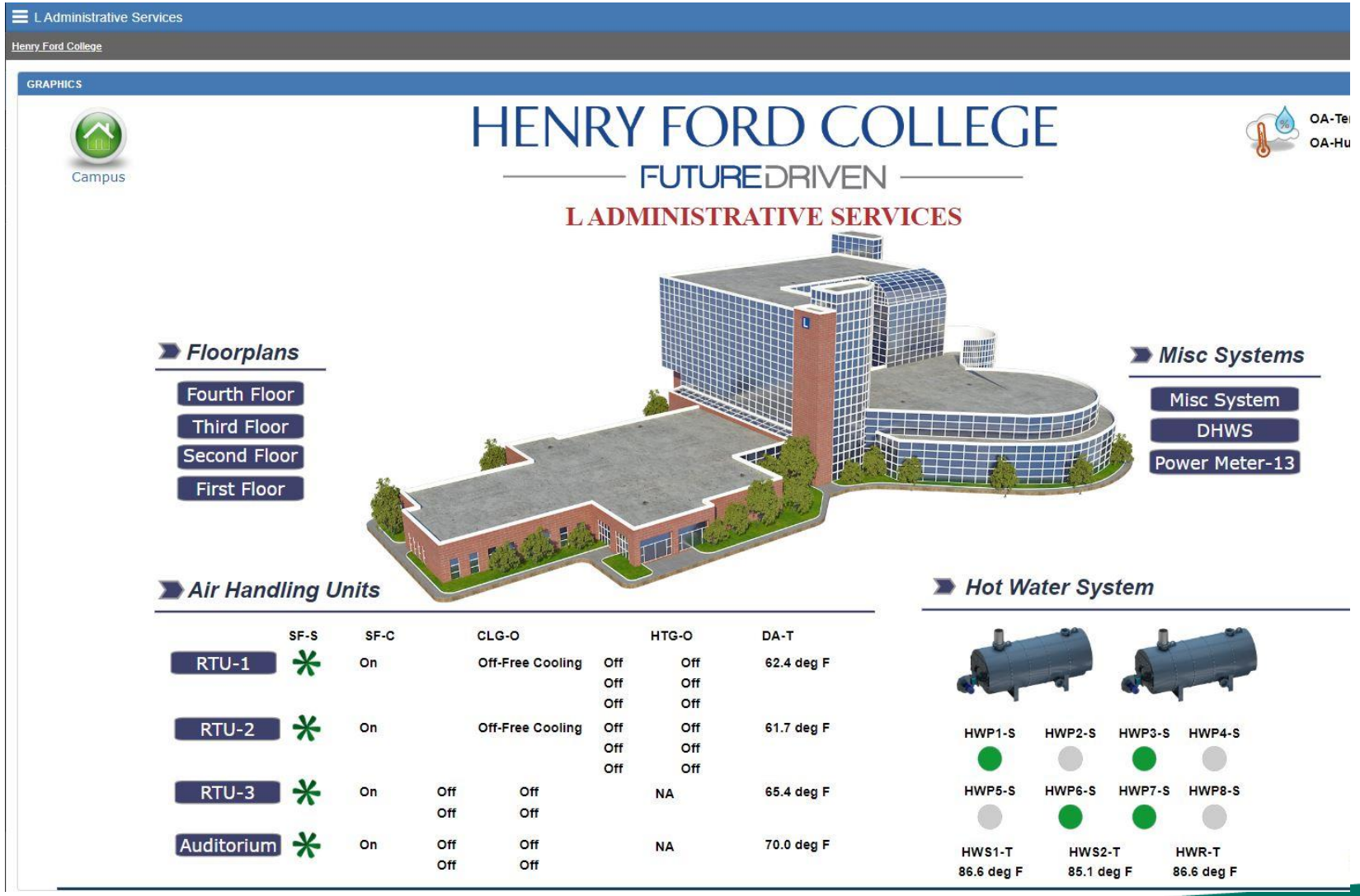
intelli-building

1

Name	Description	VOCs	VOC High Alarm	PM 2.5	PM 2.5 High Alarm	Ambient Light
IAQ-103	L1 Heart Gear Up Area Room 103	820 ppb	750 ppb	2.5 ug/m³	35.0 ug/m³	1 ftcd
IAQ-108	ECC Room 108	1390 ppb	750 ppb	1.8 ug/m³	35.0 ug/m³	2 ftcd
IAQ-133	Kitchen Servery Room 133	0 ppb	750 ppb	0.0 ug/m³	35.0 ug/m³	0 ftcd
IAQ-135	Community Hall Room 135	0 ppb	750 ppb	0.0 ug/m³	35.0 ug/m³	0 ftcd
IAQ-157	Daycare Room 157	1173 ppb	750 ppb	1.1 ug/m³	35.0 ug/m³	2 ftcd
IAQ-175	L1 Welcome Wall Area Room 175	125 ppb	750 ppb	2.2 ug/m³	35.0 ug/m³	0 ftcd
IAQ-201	K-1 Village Room 201	65 ppb	750 ppb	1.2 ug/m³	35.0 ug/m³	6 ftcd
IAQ-214	K-1 Gear Up Room 214	180 ppb	750 ppb	1.5 ug/m³	35.0 ug/m³	1 ftcd
IAQ-223	North Entry Gear Up Room 223	62 ppb	750 ppb	1.5 ug/m³	35.0 ug/m³	3 ftcd
IAQ-229	2-3 Learning Zone Room 229	0 ppb	750 ppb	0.0 ug/m³	35.0 ug/m³	0 ftcd
IAQ-236	4-5 Learning Zone Room 236	0 ppb	750 ppb	0.0 ug/m³	35.0 ug/m³	0 ftcd
IAQ-245	MS Science/Kitchen Room 245	170 ppb	750 ppb	1.4 ug/m³	35.0 ug/m³	1 ftcd
IAQ-256	Music/Art Ecotone Room 256	25 ppb	750 ppb	2.1 ug/m³	35.0 ug/m³	0 ftcd
IAQ-290-1	MS Circulation Room 290	0 ppb	750 ppb	0.0 ug/m³	35.0 ug/m³	0 ftcd

IAQ sensors at Academy for Global Citizenship

Building Management Systems



BAUMANN CONSULTING

BMS Trending

- Remote monitoring and verification
- Access constraints due to scheduling and security

STAFF VERSION

School Calendar 2024-2025

New staff start: July 1st, 2024 | Existing staff start August 5th, 2023 | Staff Hours: 7:30am - 3:55pm

FD	First Day of School for Students	V*	Vacation or National Holiday
PD	Professional Development for All Staff	ET	End of Semester
PD	Professional Development for New Staff	RC	Report Cards Sent Home - Students Attend
NS	*No School for Students & Teaching Staff*	C	Conferences - Students Not in Attendance

FALL BREAK	WINTER BREAK	WELLNESS BREAK	SPRING BREAK
Oct 14th - 18th	*Dec 23rd - Jan 3rd*	*Feb 10th - 14th*	*March 25th - 28th*

July 2024

M	T	W	T	F
1	2	3	4*	5
8	9	10	11	12
15	16	17	18	19
22	23	24	25	26
29	30	31		

August 2024

M	T	W	T	F
			1	2
5	6	7	8	9
PU	13	14	15	16
19	20	21	22	23
26	27	28	29	30

September 2024

M	T	W	T	F
2*	3	4	5	6
9	10	11	12	13
16	17	18	19	20
23	24	25	26	27
30				

November 2024

M	T	W	T	F
				1
4	5*	6	7	8
11	12	13	14	15
18	19	20	21	22
25	26	27	28*	29

December 2024

M	T	W	T	F
2	3	4	5	6
9	10	11	12	13
16	17	18	19	20
23	24	25*	26	27
30	31			

January 2025

M	T	W	T	F
		1*	2	3
6	7	8	9	10
13	14	15	16	17
20*	21	22	23	24
27	28	29	30	31

March 2025

M	T	W	T	F
3	4	5	6	7
10	11	12	13	14
17	18	19	20	21
24	25	26	27	28
31				

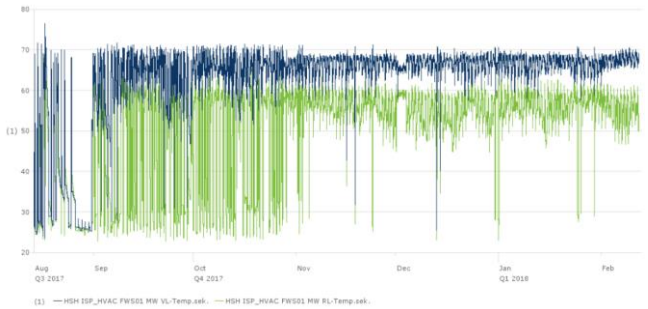
April 2025

M	T	W	T	F
	1	2	3	4
7	8	9	10	C
14	15	16	17	18
21	22	23	24	25
28	29	30		

May 2025

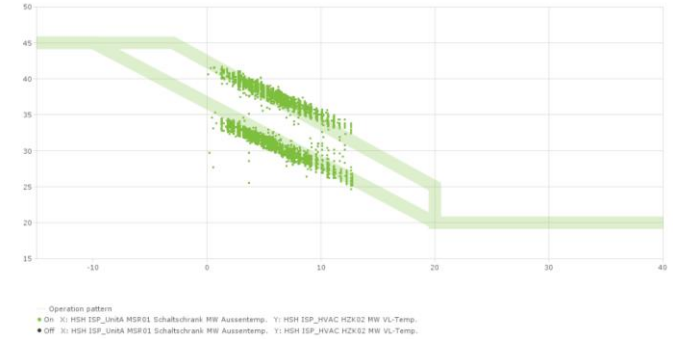
M	T	W	T	F
			1	2
5	6	7	8	9
12	13	14	15	16
19	20	21	22	23
26*	27	28	29	30

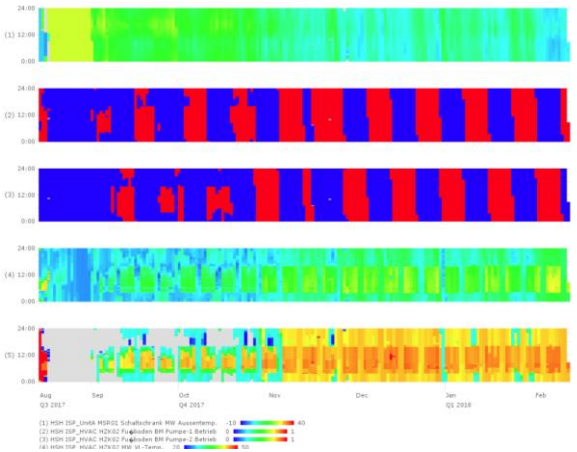
Building Automation System - Trending



Data Visualization

Operation Patterns





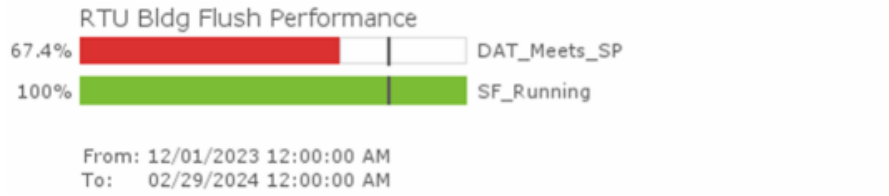
Data Analysis

Operation Improvements

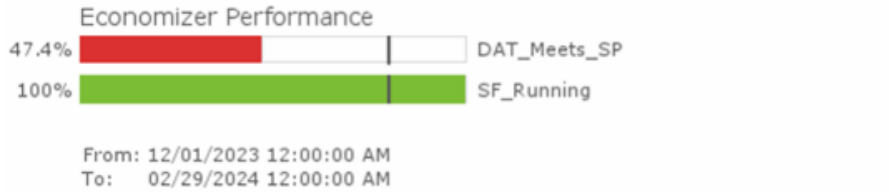
- Verification of Control Sequences
- Reduction Energy Consumption and Operating Costs
- Improvement of Thermal Comfort / Reduction of Occupant Complaints
- Detection and Prevention of Component Failures
- Ongoing Performance Monitoring

Monitoring Based Cx

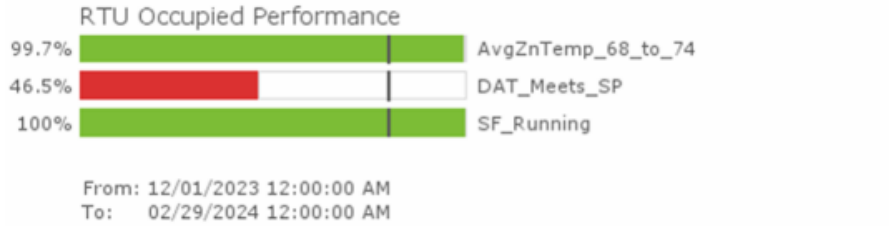
Bldg Flush Performance Analysis



Economizer Performance Analysis



Occupied Performance Analysis

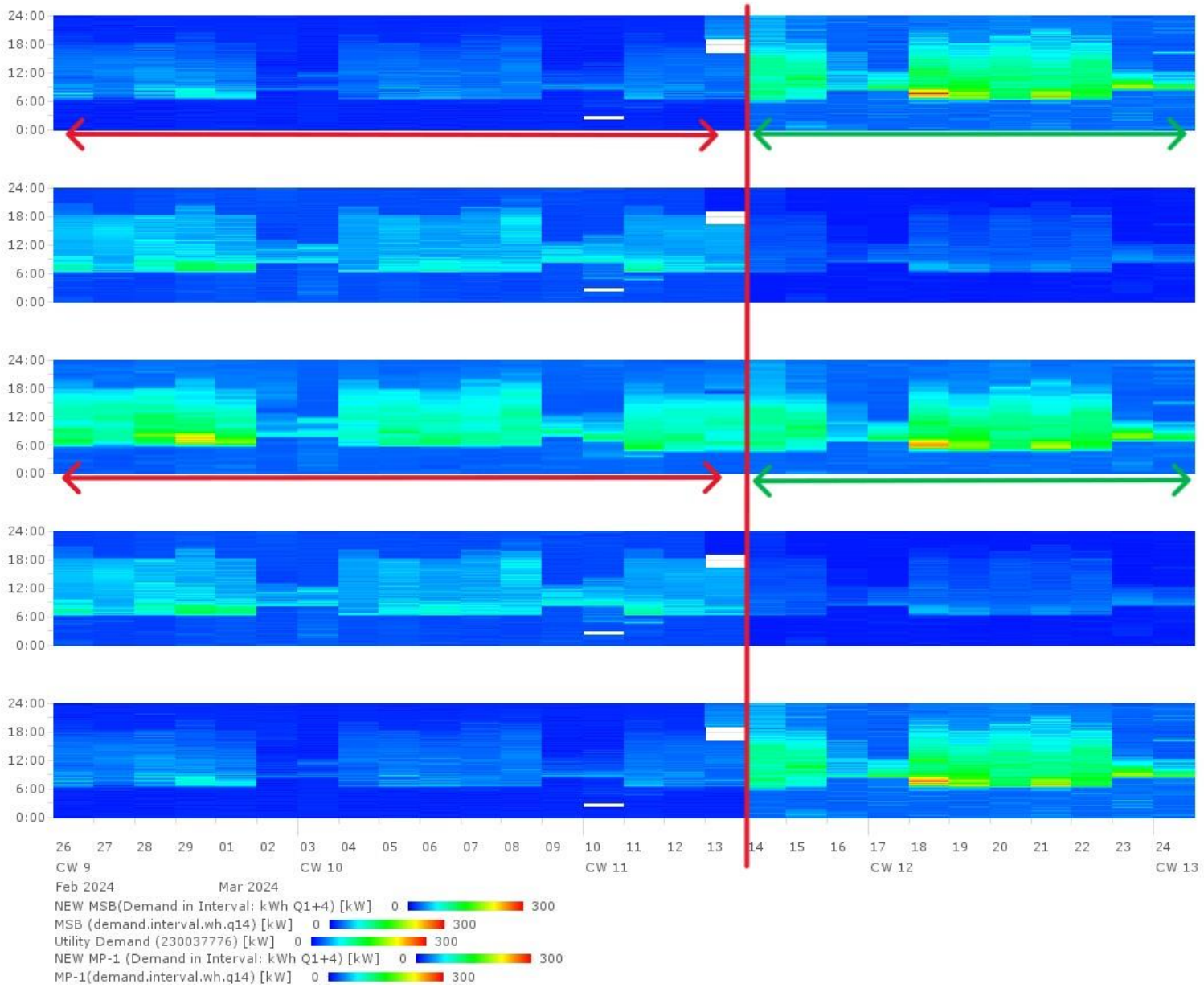


RTU Supply Air Temperature vs Setpoint (DEC - FEB)

BAUMANN CONSULTING

Solar Photovoltaic Arrays

Verification Issues



BAUMANN CONSULTING

Owner Education

What is this book?

Congratulations on moving into your new building! The Heartland Community College Agriculture Complex building has been in development in various forms since the college completed its latest master planning effort in 2020. The design and construction teams are thrilled to welcome you to the state of Illinois' first native-Net Zero college campus building.

The Net Zero Building User Manual provides end users and occupants of the building with a simple, quick, and easy guide to the everyday functions of the building in order to ensure a safe and healthy work environment, while complementing the efficient operation of the building to the full potential provided by the design.

This document is split into three parts.

- Part 1, the User Guide, will focus on information relating to the management of people and how they interact with the building.
- Part 2, the Building Manual, will focus on information that is relevant to building operations and facilities management.
- Part 3, the Glossary and Index, is intended to be a repository for terms and definitions used throughout the book, as well as an educational resource for users.

With the gap that often exists between the design concept and the operators' understanding of how the building works, this User Guide and Building Manual offers the opportunity to close this gap, and in doing so reduce excessive energy use and increased maintenance costs, while meeting the building's Net Zero goals.

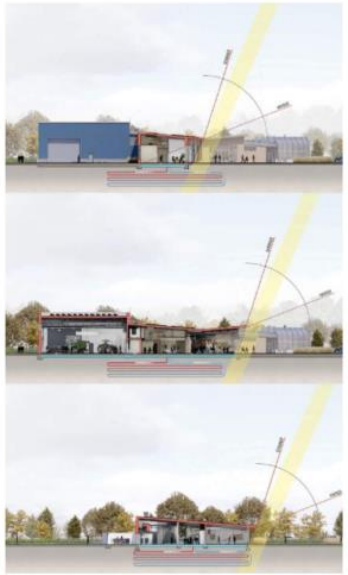


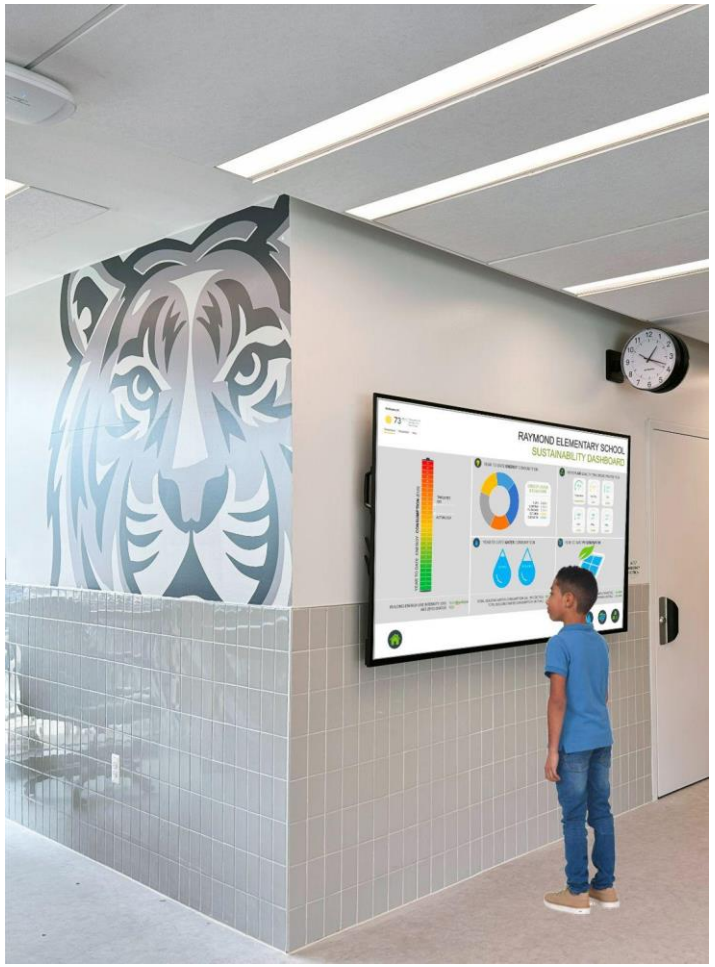
TABLE OF CONTENTS

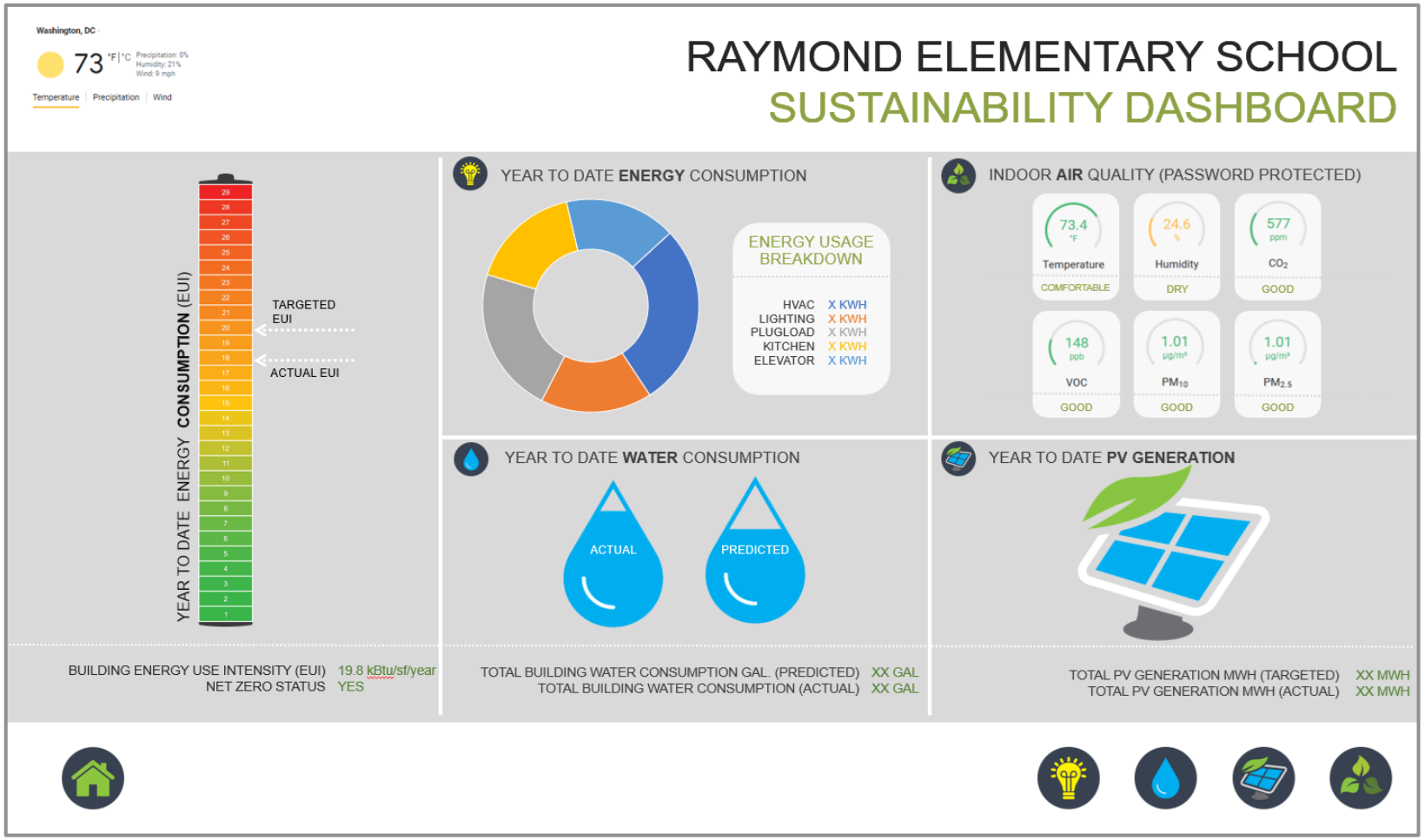
Net Zero Building User Manual created for Heartland Community College

Owner AND Occupant Education

Teacher and building staff training at Raymond Elementary School

Maintaining Transparency





Sustainability dashboard at Raymond Elementary School

BAUMANN CONSULTING

Occupant Engagement

Form a “green team” of interested champions from the following groups to hold responsibility for achieving the net zero goal during the performance verification period

- Admin
- Facilities
- Students
- Teachers

Walk the site monthly, looking for changes to settings, setpoints, usage patterns, and plugged-in equipment; record all changes to discuss at next meeting with performance verification consultant/ongoing CxP

Schedule monthly calls with performance verification consultant/ongoing CxP

- Review past month’s energy performance compared to predictions

Schedule quarterly in-person reviews with performance verification consultant/ongoing CxP

- Review monitoring-based Cx findings & recommendations
- Schedule follow-up actions with green team’s facilities staff representatives

Conclusion

1. Commissioning is an integrative process which should be used throughout the entire lifecycle of a high performance building.
2. Shools are at the forefront of net zero energy certifications
3. Understand common building enclosure and MEP system approaches to achieving high performance in a building.
4. Learn how to leverage smart building technology to allow for remote verification in mission critical facilities where occupancy/access is a concern.
5. Learn the importance of user education when working in facilities with high performance goals.

BAUMANN
CONSULTING

Thank you!

www.baumann-us.com

Lessons learned from NZE MEP Cx Issues Logs

1. Properly specify & witness to ground-exchange borefield backfill and flush/fill operations to prevent ground loop flow issues…
2. Don’t forget to properly configure your hydronic appurtenances before plant equipment startup!
3. Ensure sensor accessibility for in-slab systems before they’re ordered
4. Double-check lockouts on economizers and ERVs
5. Investigate simultaneous heating and cooling conflicts between independent ventilation and space conditioning systems
6. Double-check refrigerant pipe lengths for uncommon refrigerant-based equipment, and specify filter/driers on refrigerant-based systems experiencing heavy use year-round
7. Get the vendor out when conducting FPTs for complex packaged equipment like DCKV
8. Functionally test a 100% sample of sensors controlling lighting, plugs, HVAC, and other smart devices
9. Perform an after-hours visit to make sure things behave the way they should at night
10. Double-check PV systems for reversed polarity and ground fault issues.

Lessons learned from NZE MEP Cx Issues Logs

1. Hold a kickoff meeting with all users including faculty, administration, support staff, and students to explain project goals, building systems, user responsibilities, and next steps
2. Form a green team to champion net zero energy performance during the performance period
3. Provide visible means for all building users to track energy performance as a habit
4. Establish communication protocol for building users to report comfort and energy issues to the green team
5. Calibrate the energy model at least quarterly based on weather and green team findings and observations regarding modified settings, setpoints, and usage patterns
6. Identify end-uses exceeding calibrated energy model predictions,
7. Use monitoring-based commissioning approach to identify potential causes for energy end-uses exceeding calibrated energy model breakdowns
8. Meet green team in person on a quarterly basis and remotely on a monthly basis to keep building performance on track during the performance period
9. Work with green team to implement and verify operational modifications, behavioral programs, and faulty system repairs
10. Submit building utility and renewable energy system production data for net zero verification!