PARK DISTRICT
of OAK PARK

NET ZERO FACILITIES

Case study on the Carroll Center Addition & Renovation

Net Zero Tips & Learned Experiences

PARK DISTRICT
of OAK PARK

CARROLL CENTER ADDITION & RENOVATION

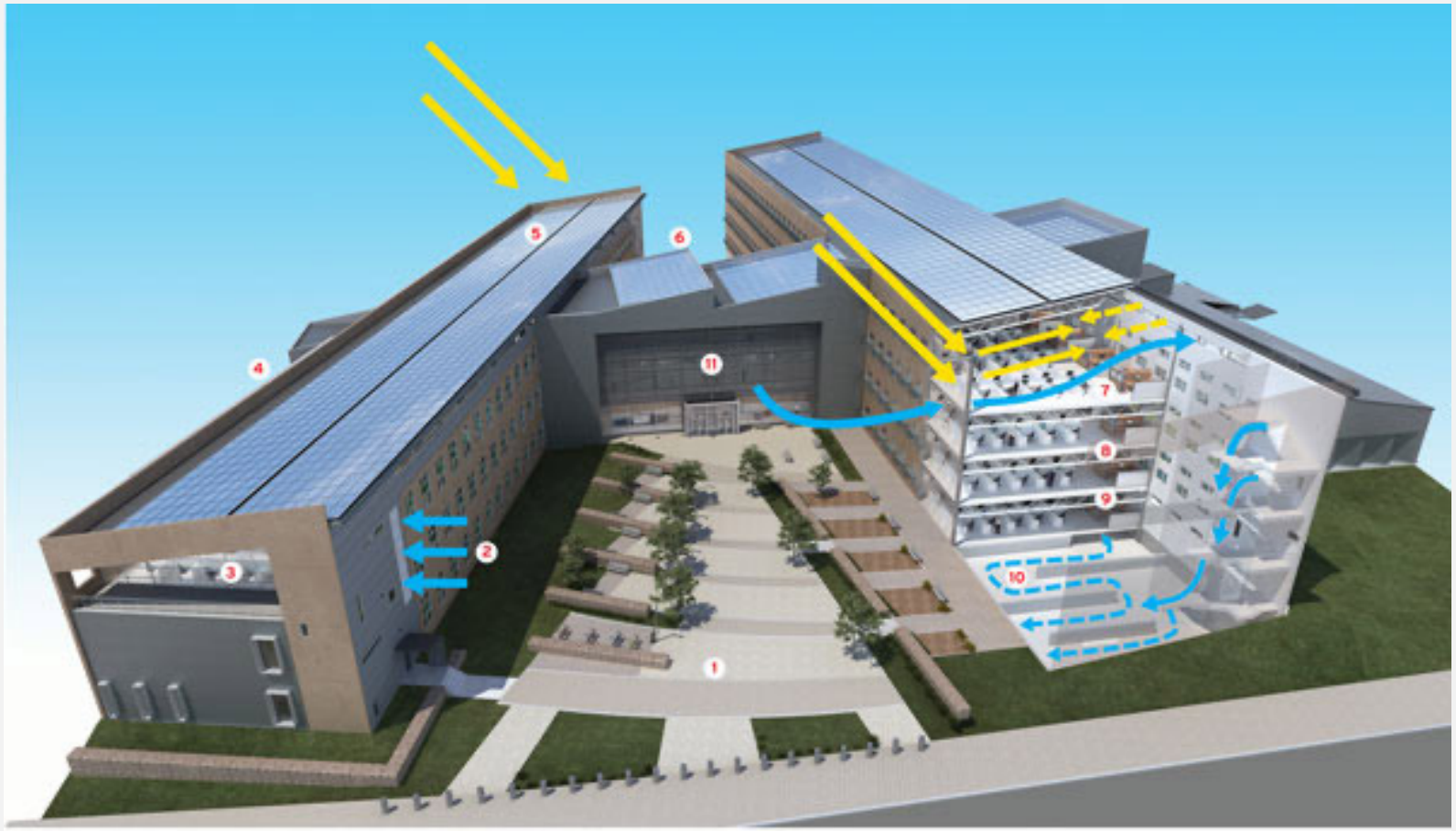
- Saved 100 year old facility and added on new programming space
- Well thought out design (Layout, daylighting, solar exposure)
- PHUIS + Source Zero Design
- Received Grant funding for additional costs

PRE- DESIGN PHASE

- Project Inception
  - Do Your Homework
  - Board Discussions
  - Define Net Zero for Your Organization
  - Start with Zero – Choose Certification Path
  - Design & Engineering Team Selection
  - Contractor Selection/Approach

DESIGN PHASE

- Building Design & Net Zero Integration
- Energy Modeling
- EUI Targets
- On-Site Solar Design
- Electrification & Battery Storage

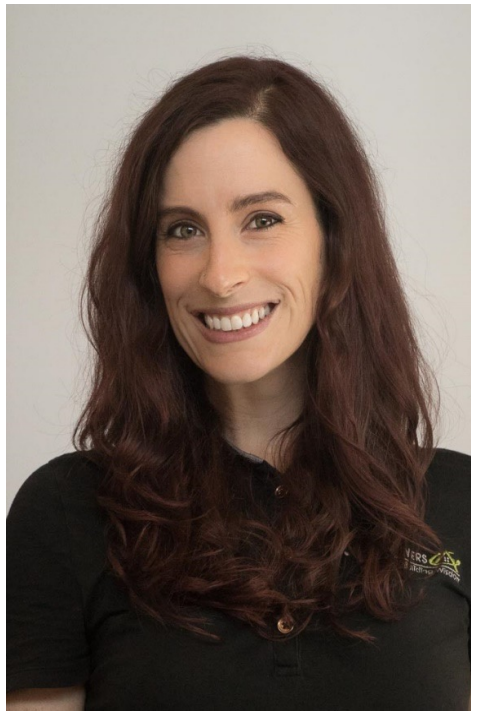


CUT-AWAY PERSPECTIVE

phius con
CHICAGO 2022

Lessons Learned from Commercial Phius Verifiers

phius con
CHICAGO 2022



Lindsey Elton
President/Partner, Eco Achievers

HERS Rater, BPI BA/BE Specialist
ENERGY STAR v3 / ESMFNC
LEED for Homes Green Rater
EGC Consultant, NGBS Verifier
Certified Passive House Consultant
PHIUS+ MF Verifier and Rater

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Detroit, MI 48201

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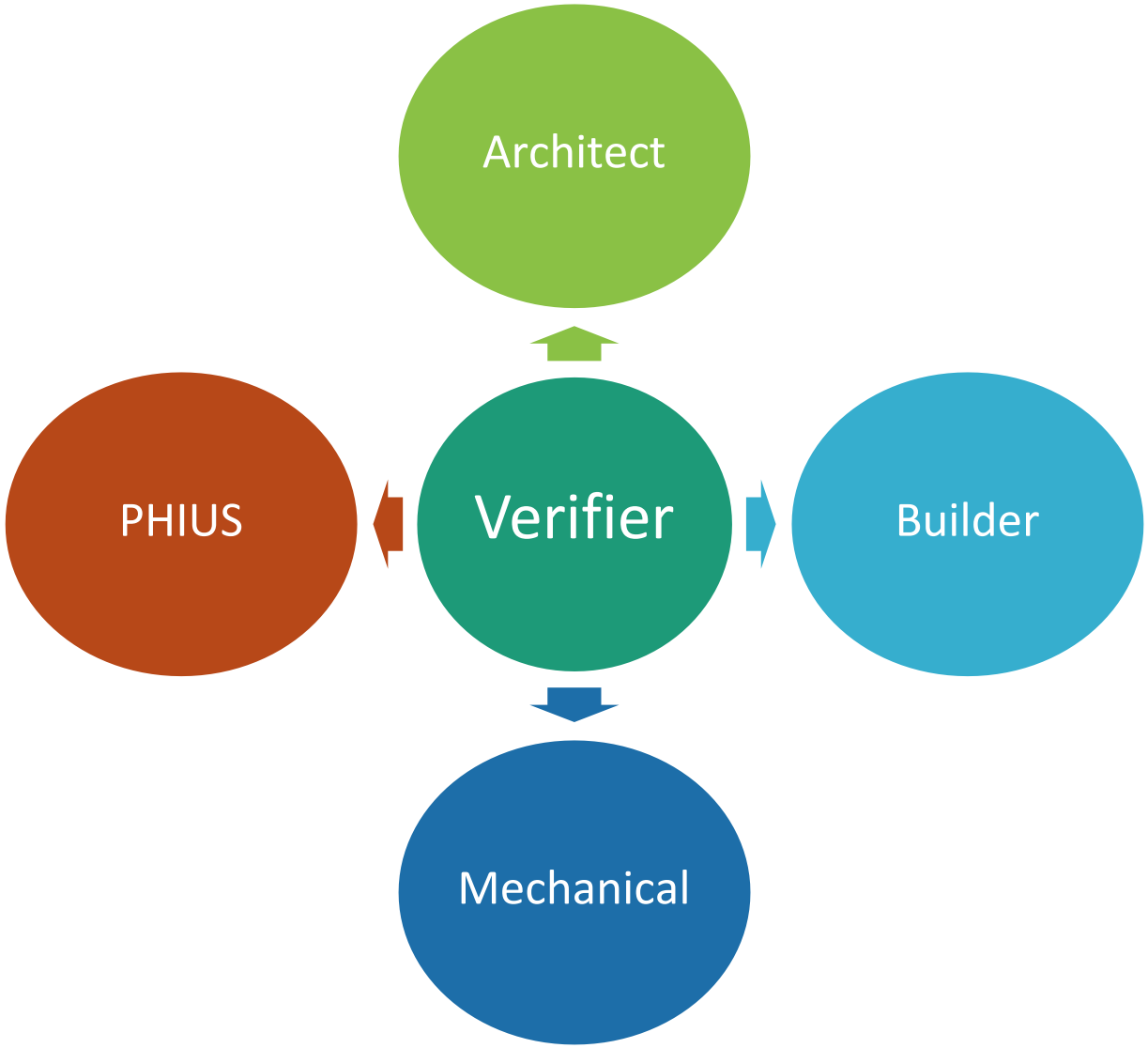
ECO ACHIEVERS
Building Wisdom

What to Expect...

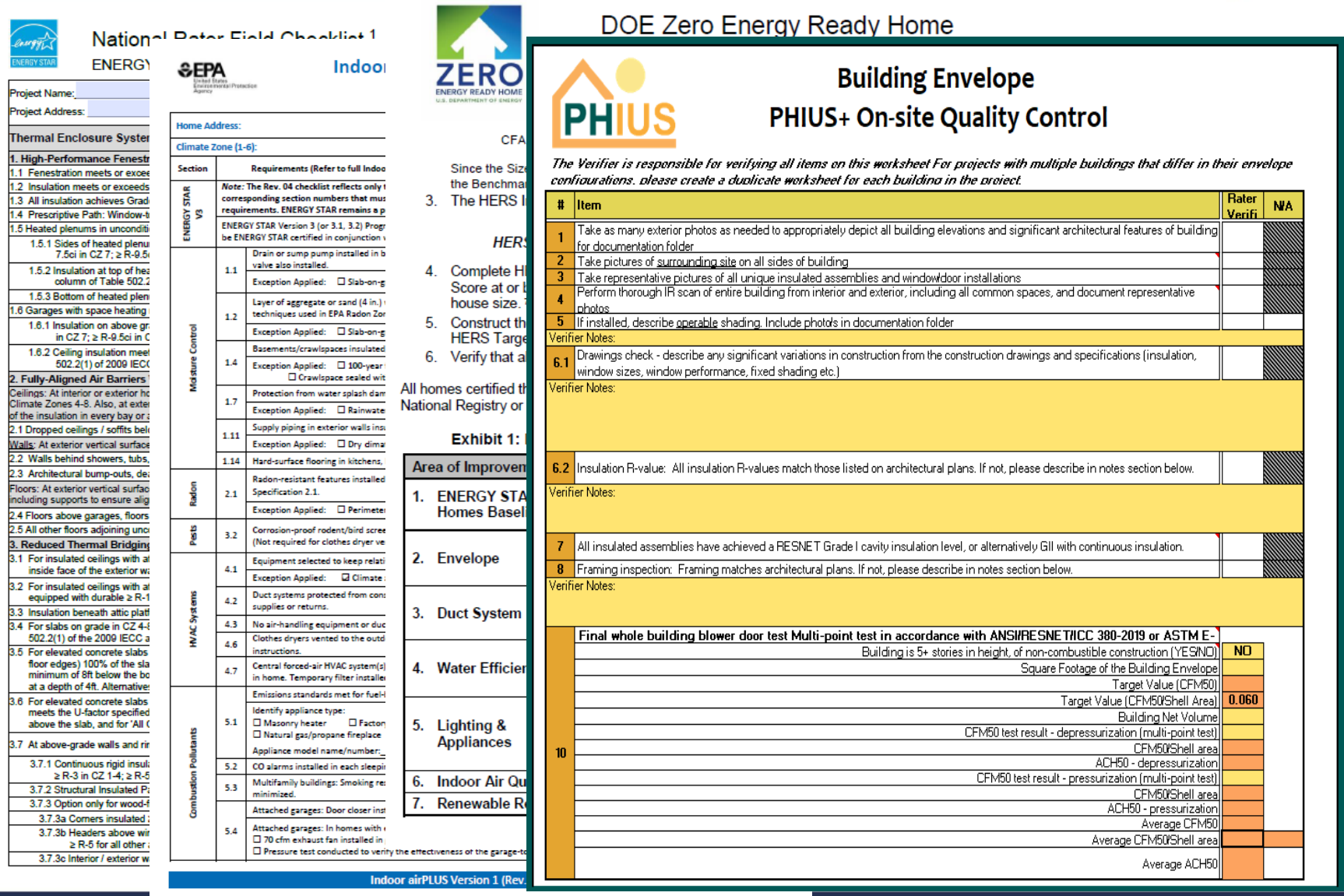
... When you're expecting a Phius Commercial Certification.

Third Party Verification



Phius 2021, Commercial Path

- Compliance with:
  - ENERGY STAR MF New Construction
  - Modified Indoor airPLUS
  - Modified Zero Energy Ready Homes
- Completion of Phius Commercial QA Workbook
- Blower Door Threshold
  - .06 cfm/sf enclosure



National Rater Field Checklist 1

ENERGY

Project Name:

Project Address:

Thermal Enclosure Syste

1. High-Performance Fenestr

1.1 Fenestration meets or exce

1.2 Insulation meets or exceeds

1.3 All insulation achieves Grad

1.4 Prescriptive Path: Window-t

1.5 Heated plenums in unconditi

1.5.1 Sides of heated plenu 7.5ci in CZ 7; ≥ R-9.5

1.5.2 Insulation at top of hea column of Table 502.2

1.5.3 Bottom of heated plen

1.6 Garages with space heating

1.6.1 Insulation on above gr in CZ 7; ≥ R-9.5ci in C

1.6.2 Ceiling insulation meet 502.2(1) of 2009 IEC

2. Fully-Aligned Air Barriers

Ceilings: At interior or exterior ho Climate Zones 4-8. Also, at exte of the insulation in every bay or

2.1 Dropped ceilings / soffits bel

Walls: At exterior vertical surface

2.2 Walls behind showers, tubs,

2.3 Architectural bump-outs, de

Floors: At exterior vertical surfac including supports to ensure alig

2.4 Floors above garages, floors

2.5 All other floors adjoining unc

3. Reduced Thermal Bridging

3.1 For insulated ceilings with a inside face of the exterior w

3.2 For insulated ceilings with a equipped with durable ≥ R-1

3.3 Insulation beneath attic platf

3.4 For slabs on grade in CZ 4- 502.2(1) of the 2009 IECC a

3.5 For elevated concrete slabs floor edges) 100% of the sla minimum of 8ft below the bo at a depth of 4ft. Alternative

3.6 For elevated concrete slabs meets the U-factor specified above the slab, and for 'All

3.7 At above-grade walls and rir

3.7.1 Continuous rigid insul ≥ R-3 in CZ 1-4; ≥ R-5

3.7.2 Structural Insulated P

3.7.3 Option only for wood-f

3.7.3a Corners insulated

3.7.3b Headers above wir ≥ R-5 for all other

3.7.3c Interior / exterior w

EPA

Indoo

Home Address:

Climate Zone (1-6):

Section		Requirements (Refer to full Indoo
ENERGY STAR V3		Note: The Rev. 04 checklist reflects only corresponding section numbers that mus requirements. ENERGY STAR remains a p
		ENERGY STAR Version 3 (or 3.1, 3.2) Progr be ENERGY STAR certified in conjunction
Moisture Control	1.1	Drain or sump pump installed in b valve also installed.
		Exception Applied: ☐ Slab-on-g
	1.2	Layer of aggregate or sand (4 in.) techniques used in EPA Radon Zor
		Exception Applied: ☐ Slab-on-g
	1.4	Basements/crawlspaces insulated
		Exception Applied: ☐ 100-year ☐ Crawlspace sealed wit
	1.7	Protection from water splash dam
		Exception Applied: ☐ Rainwate
	1.11	Supply piping in exterior walls ins
		Exception Applied: ☐ Dry climat
	1.14	Hard-surface flooring in kitchens,
Radon	2.1	Radon-resistant features installed Specification 2.1.
		Exception Applied: ☐ Perimete
Pests	3.2	Corrosion-proof rodent/bird scree (Not required for clothes dryer ve
HVAC Systems	4.1	Equipment selected to keep relati
		Exception Applied: ☑ Climate
	4.2	Duct systems protected from con supplies or returns.
	4.3	No air-handling equipment or duc
	4.6	Clothes dryers vented to the outd instructions.
	4.7	Central forced-air HVAC system(s) in home. Temporary filter installe
Combustion Pollutants	5.1	Emissions standards met for fuel-
		Identify appliance type: ☐ Masonry heater ☐ Facton ☐ Natural gas/propane fireplace
		Appliance model name/number:
	5.2	CO alarms installed in each sleepi
	5.3	Multifamily buildings: Smoking re minimized.
	5.4	Attached garages: Door closer ins
		Attached garages: In homes with ☐ 70 cfm exhaust fan installed in ☐ Pressure test conducted to verify the effectiveness of the garage-to

Indoor airPLUS Version 1 (Rev.

ZERO ENERGY READY HOME U.S. DEPARTMENT OF ENERGY

CFA

Since the Siz the Benchma

3. The HERS I

HERS

4. Complete H Score at or b house size.

5. Construct th HERS Targe

6. Verify that a

All homes certified th National Registry or

Exhibit 1:

Area of Improven
1. ENERGY STA Homes Basel
2. Envelope
3. Duct System
4. Water Efficier
5. Lighting & Appliances
6. Indoor Air Qu
7. Renewable R

DOE Zero Energy Ready Home

PHIUS

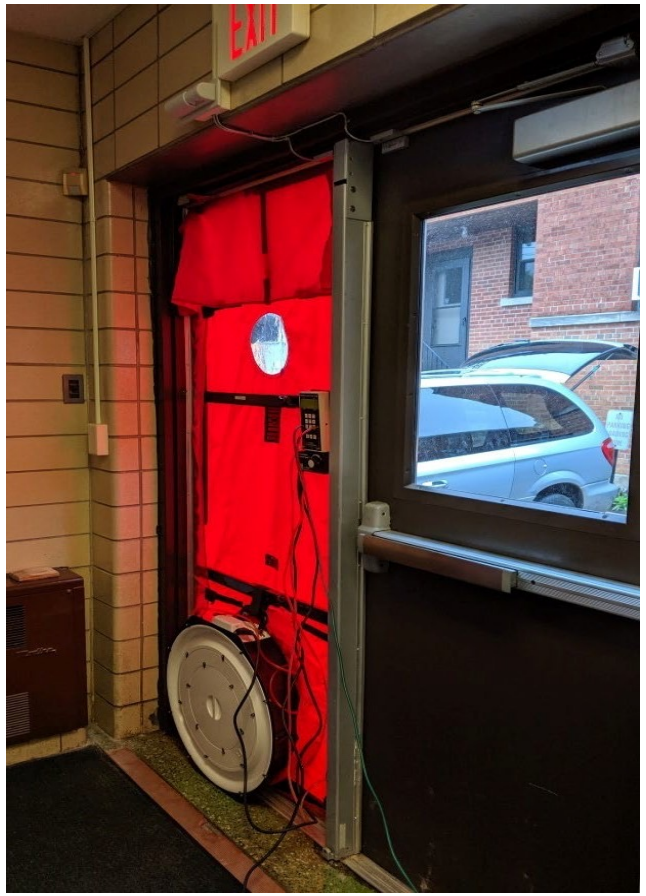
Building Envelope
PHIUS+ On-site Quality Control

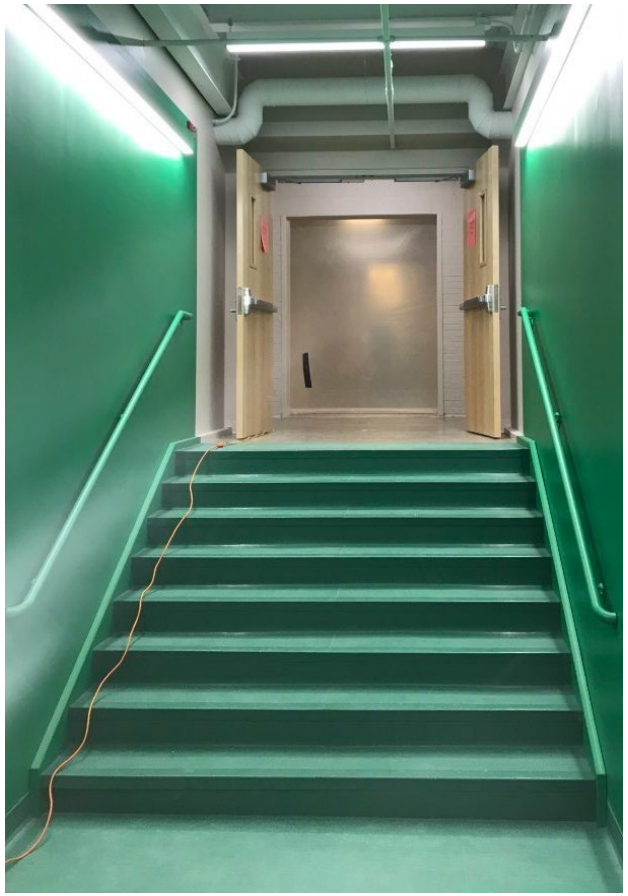
The Verifier is responsible for verifying all items on this worksheet For projects with multiple buildings that differ in their envelope configurations, please create a duplicate worksheet for each building in the project.

#	Item	Rater Verifi	N/A
1	Take as many exterior photos as needed to appropriately depict all building elevations and significant architectural features of building for documentation folder		
2	Take pictures of surrounding site on all sides of building		
3	Take representative pictures of all unique insulated assemblies and window/door installations		
4	Perform thorough IR scan of entire building from interior and exterior, including all common spaces, and document representative photos		
5	If installed, describe operable shading. Include photo/s in documentation folder		
Verifier Notes:			
6.1	Drawings check - describe any significant variations in construction from the construction drawings and specifications (insulation, window sizes, window performance, fixed shading etc.)		
Verifier Notes:			
6.2	Insulation R-value: All insulation R-values match those listed on architectural plans. If not, please describe in notes section below.		
Verifier Notes:			
7	All insulated assemblies have achieved a RESNET Grade I cavity insulation level, or alternatively GII with continuous insulation.		
8	Framing inspection: Framing matches architectural plans. If not, please describe in notes section below.		
Verifier Notes:			

10	Final whole building blower door test Multi-point test in accordance with ANSI/RESNET/ICC 380-2019 or ASTM E-	
	Building is 5+ stories in height, of non-combustible construction (YES/NO)	NO
	Square Footage of the Building Envelope	
	Target Value (CFM50)	
	Target Value (CFM50/Shell Area)	0.060
	Building Net Volume	
	CFM50 test result - depressurization (multi-point test)	
	CFM50/Shell area	
	ACH50 - depressurization	
	CFM50 test result - pressurization (multi-point test)	
	CFM50/Shell area	
	ACH50 - pressurization	
	Average CFM50	
	Average CFM50/Shell area	
	Average ACH50	

Air Leakage: Isolating Structures





Air Leakage: Isolating Existing Assemblies

We’re testing the addition. But how do you control…

Air Leakage: Done Right

Air Leakage: Mechanicals

phius con CHICAGO 2022

Ventilation System Programming

- Identify continuously running systems – truly continuous (24 hours) vs occupied/ non-occupied modes (i.e. system that shuts down after hours)
- Impact on WUFI + need to have motorized dampers

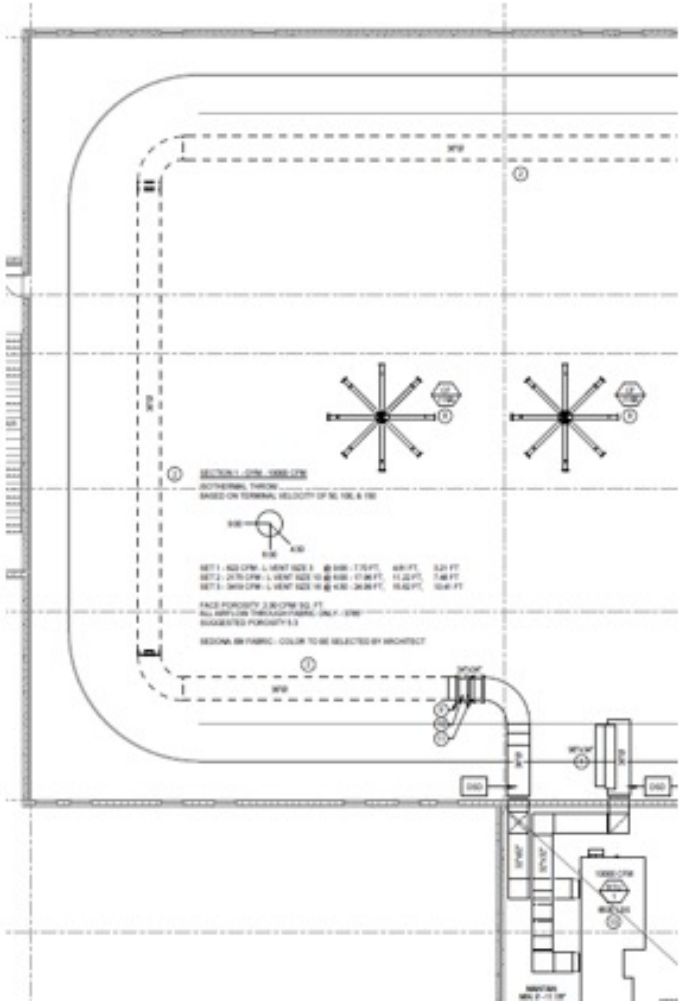
Air Leakage: Mechanicals

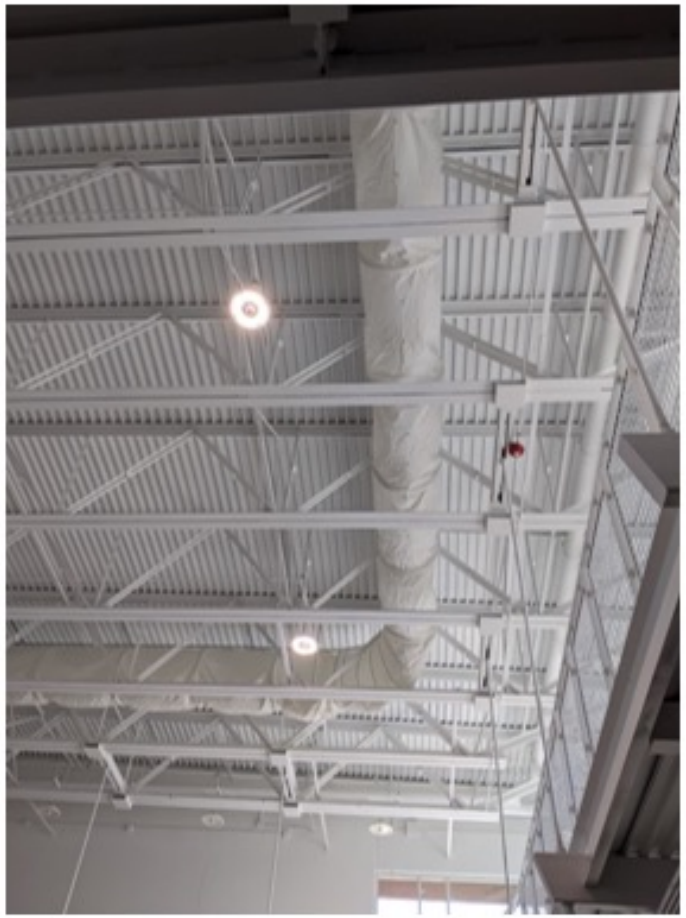
Multiple DOAS Units =

Multiple locations for air leakage at the unit.

And then that happened...

Mechanicals: Duct Sox





Mechanicals: TAB

phius con CHICAGO 2022

TAB COMPLIANCE: PRETTY STRAIGHT FORWARD, RIGHT?

Top 5ish Take Homes

Air barriers: pay attention to assembly transitions. That's often where things fall apart.

Build in extra wiggle room for durability vs WUFI blower door testing in your model. This may save you.

Sequencing matters. Talk through schedules to ensure Verifier can see key air barrier/air sealing components.

Get an A.S.S. – an air sealing specialist, that is. Identify someone on the project (likely from the GC team) to be in charge of everything air sealing and air barrier related, on a daily basis.

Be cautious about combined space conditioning + ventilation. Phius likes controlled systems and the TAB verification protocol follows suit.

Discuss TAB verification up, with the contractor, so they know the full process – thresholds, equipment, locations, etc. – ahead of time.

East Building Addition
Lincolnshire, IL
Net Zero Certified – ILFI 2021
LEED Platinum NC 2009 Certified
First Verified NZE Building in Illinois
Occupied August 2019
56,800 SF
Classroom Addition including Science Labs

Exceptions:

- Use of existing natural gas emergency power system
- Scale Jumping for PVs on adjacent building due to Rooftop Urban Agriculture

Wight

Stevenson High School


Window to Wall Ratio – 43%

Transparency as a Design Driver; + Daylighting - Energy

Transparency through and through

Rooftop Greenhouse and Urban Ag Installation; Not Your Typical Roof

2 Living Walls, Energy Impacts?

VRF: 6 Condensing units, 97 tons total, IEER range from 22 to 22.9. (The mechanical room is heated to 45F in winter with electric unit heater to prevent freezing and make sure the condensing units work efficiently in winter.)

DOAS : 75 Ton DX Cooling with 11.8 EER, 302 kW Electric heat coil

VAV: (VAV is used to distribute OA from DOAS, no heating or cooling coils.)

ERV: With a total effectiveness of 74% sensible and 62% latent.

Dedicated **dehumidifier** on living wall : 8 ton DX Cooling

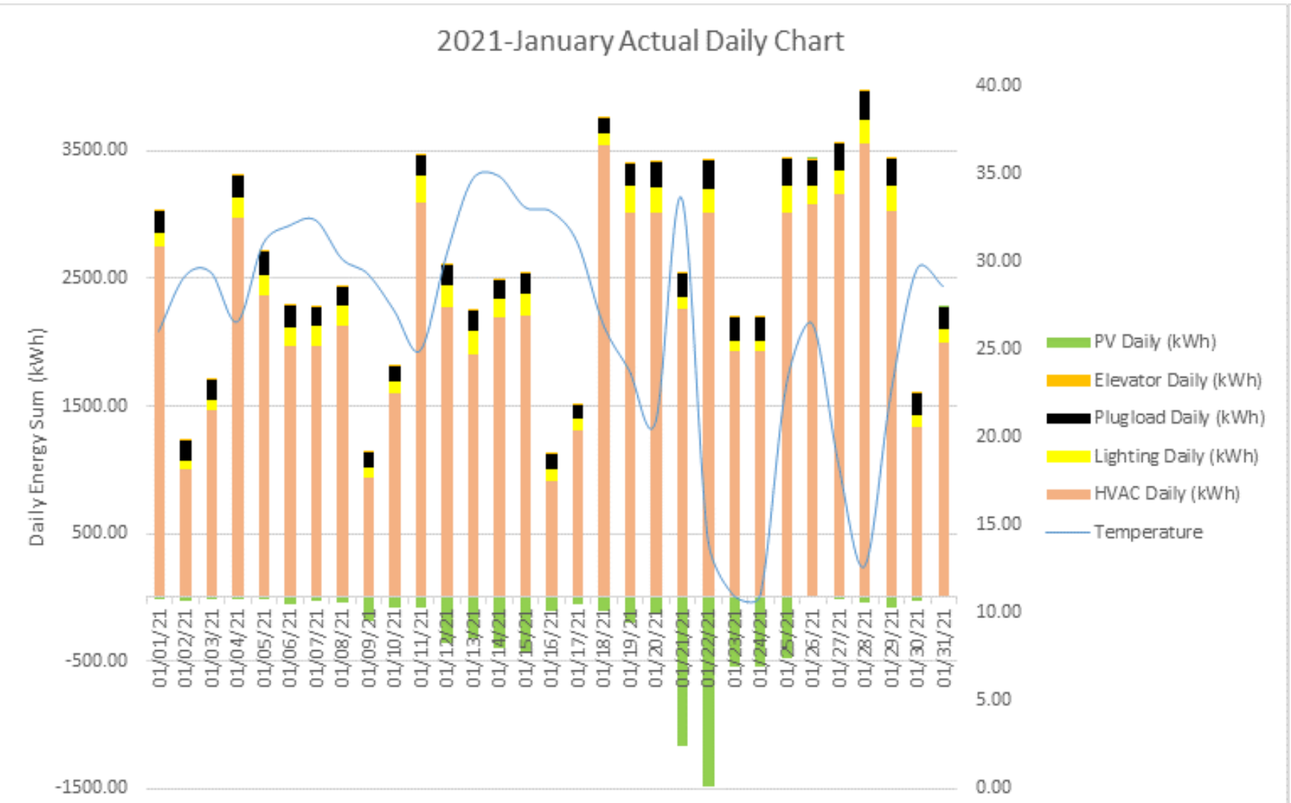
Water Heater for DHW 119 Gal, 30 kW

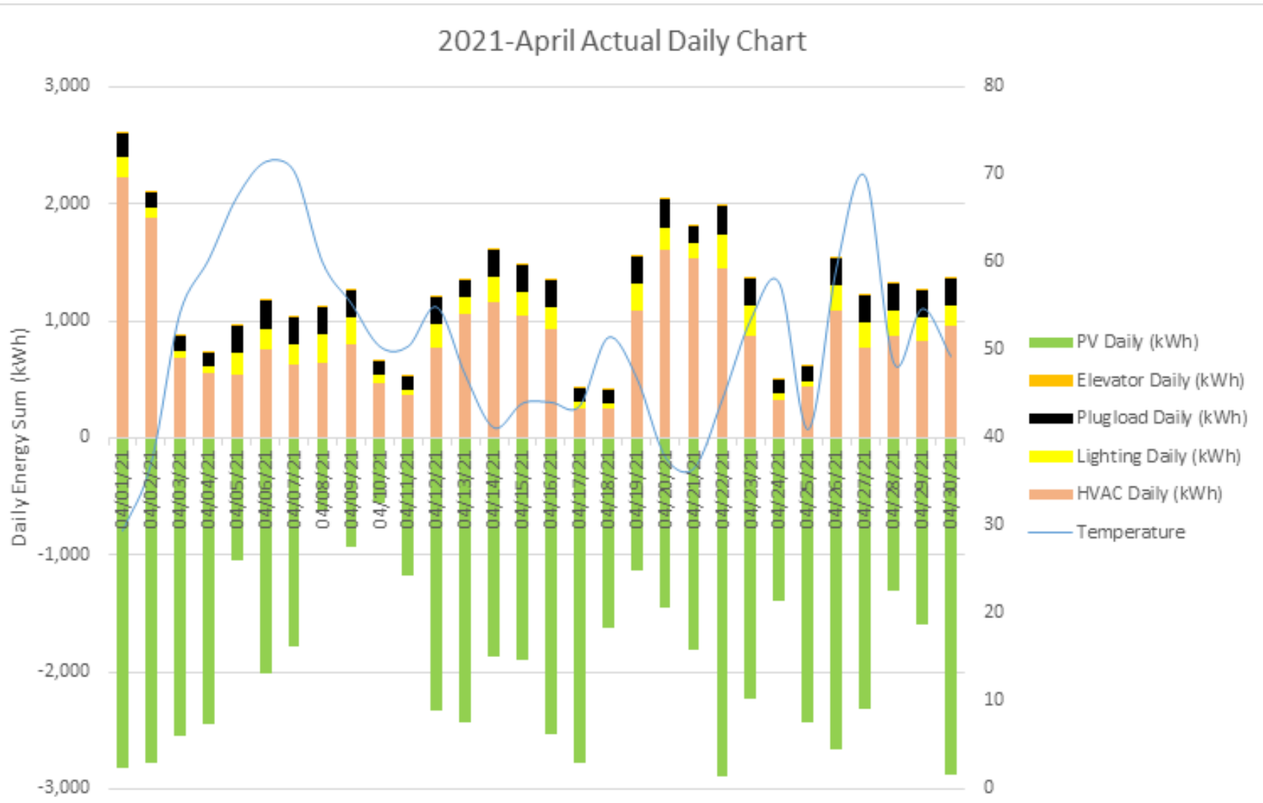
Misc – 1.8 kW **Hot Plates** in lieu of Bunson burners for Science Classrooms. Wired for 60 hot plates….

All Electric Mechanical System

- Conventional Building Commissioning is a point in time. Chasing Net Zero Energy requires continuous monitoring.
- These issues took time to investigate, understand and fix. All while the clock was ticking on the performance period.

Net Zero is a Journey AND a Destination

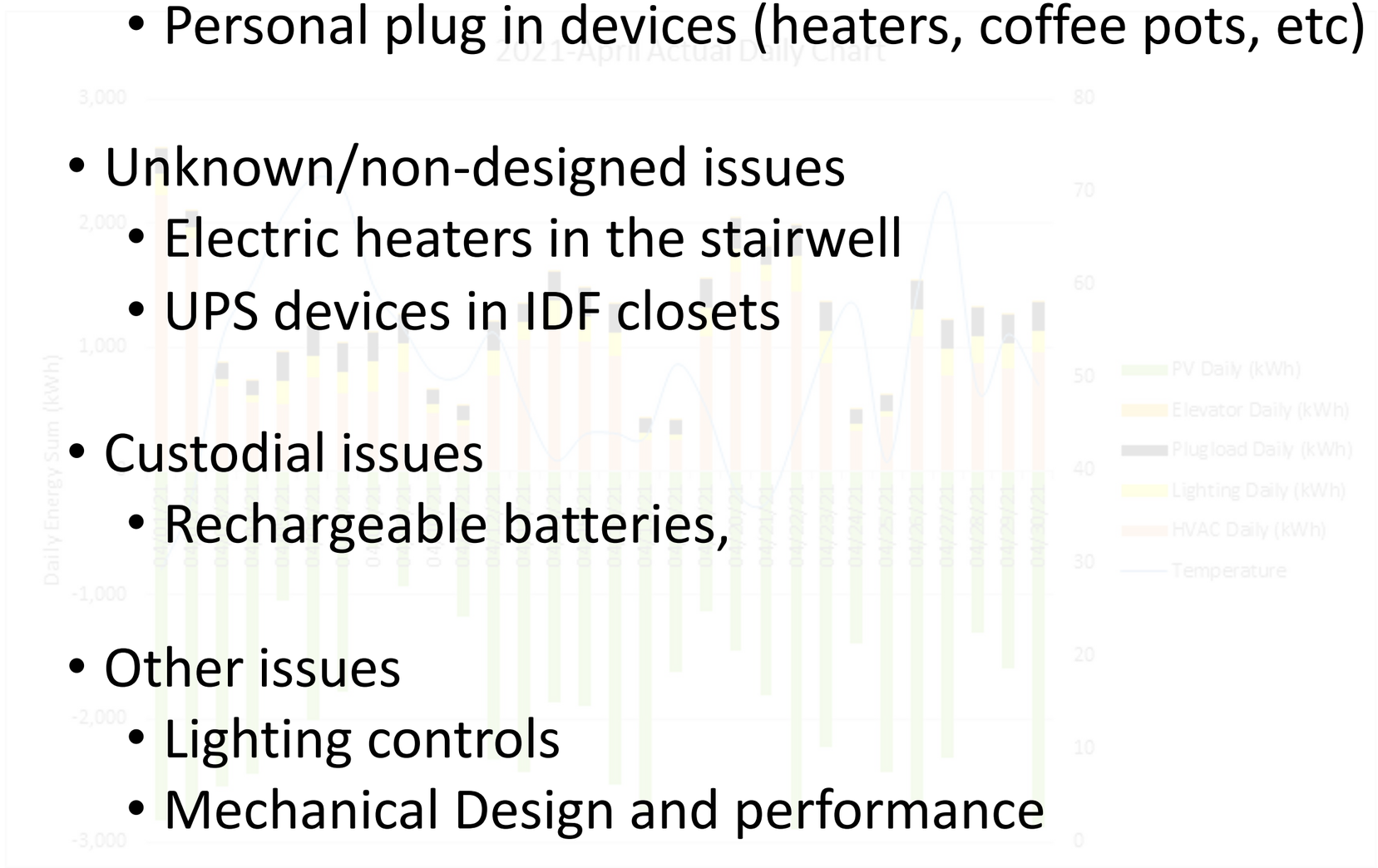




One Month’s Daily Performance Data

The constant struggle of monitoring

- Changing of behavior
  - Personal plug in devices (heaters, coffee pots, etc)
- Unknown/non-designed issues
  - Electric heaters in the stairwell
  - UPS devices in IDF closets
- Custodial issues
  - Rechargeable batteries,
- Other issues
  - Lighting controls
  - Mechanical Design and performance



Other Items to note

- Electricity provider
  - Ensure they know early on in the process
- BAS System
  - Are all meters and data loggers visible by your BAS
  - Add alarms from your energy source to BAS
- Monthly monitor meetings
  - What are the expectations of performance? (Before)
  - How is it operating? (During)
  - Is it still performing as designed? (After)

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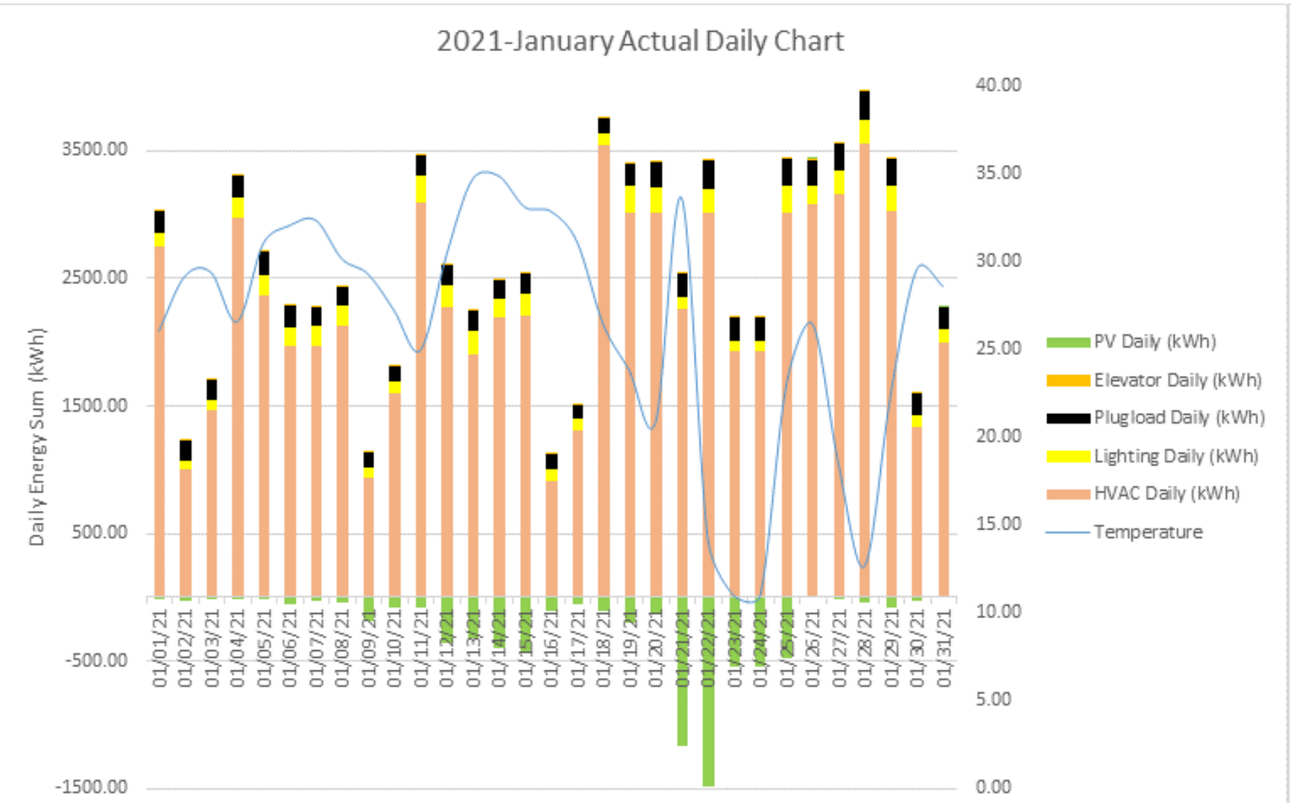

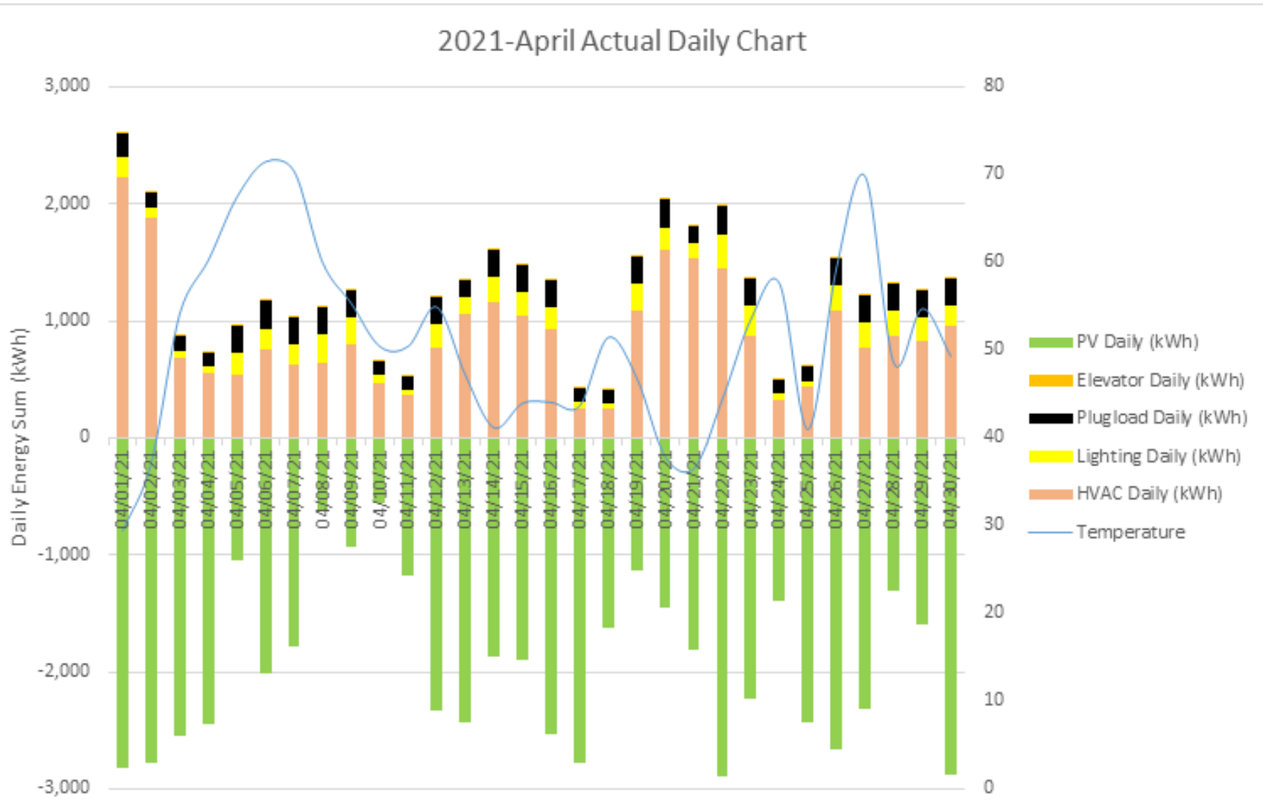

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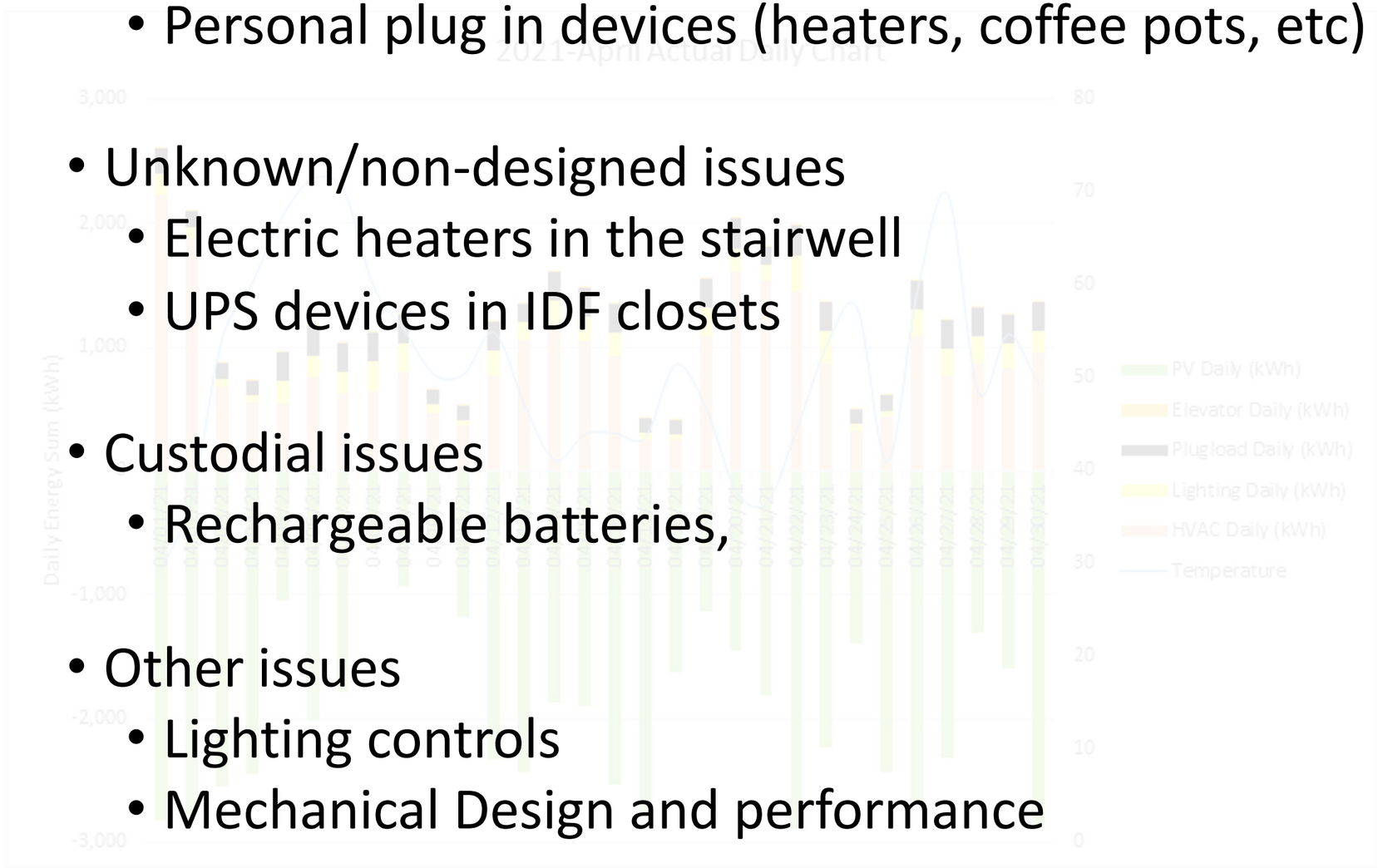

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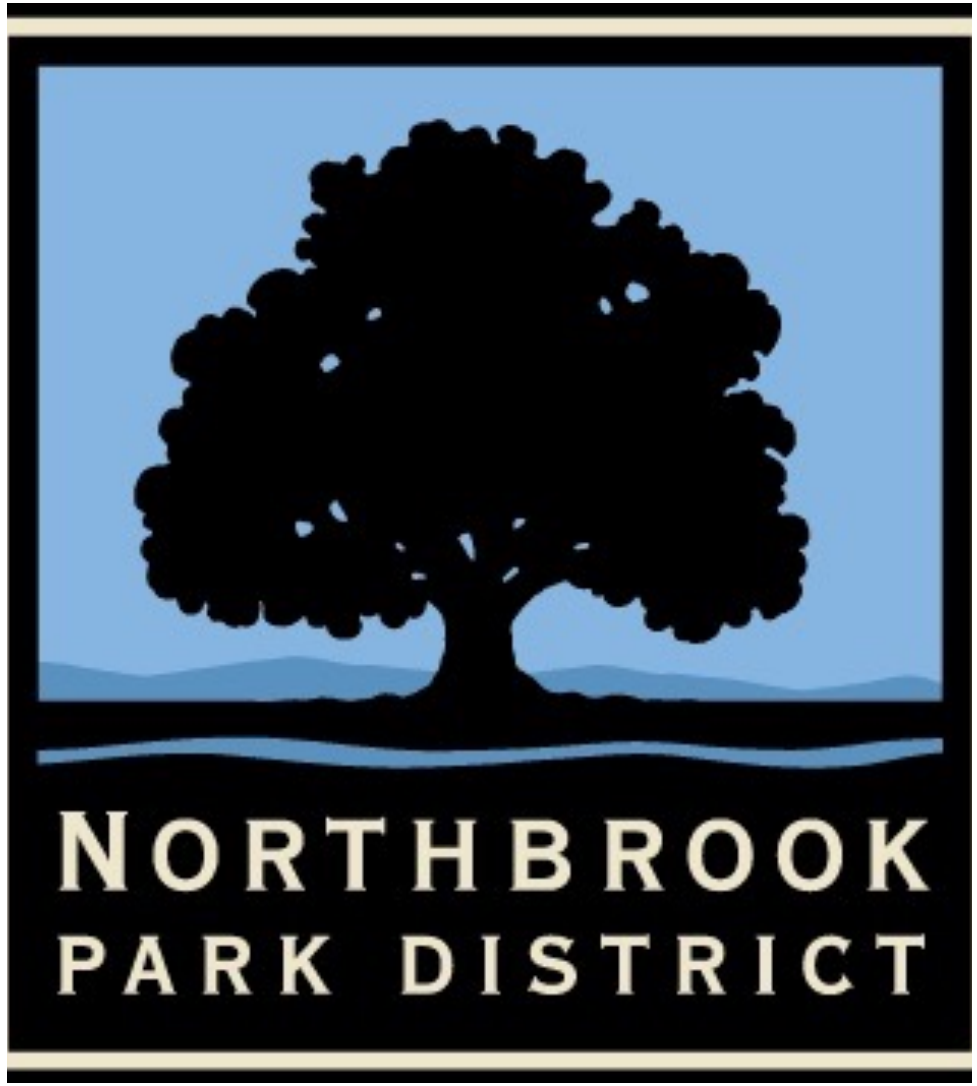


Techny Prairie Activity Center

Net Zero Verified

October 27, 2022

Techny Prairie Activity Center

- **44,200 sq ft**
- **High Efficiency MEP systems**
- **312 KW PV Array**
- **$1.78 M grant from ICECF**

Flying Past Our Net Zero Goal

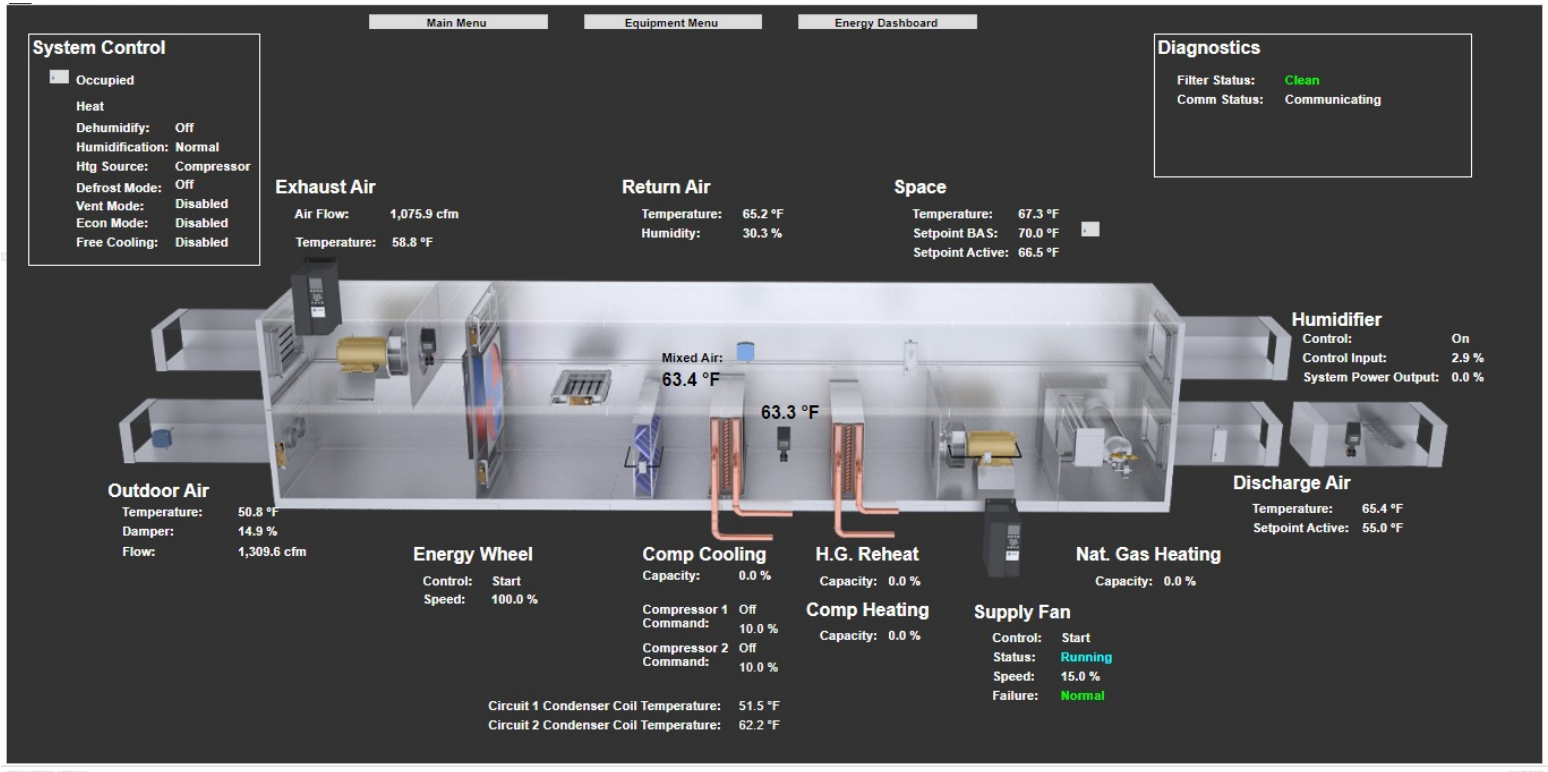
- **Commissioning**
- **Performance To Date**
- **Verification**
- **Net Energy Projections**

Commissioning

- **Started in December 2020**
- **Iterative process**
- **Data driven analysis**
- **System changes implemented**

HVAC System

- Performance
- Programming
- Scheduling
- Optimization



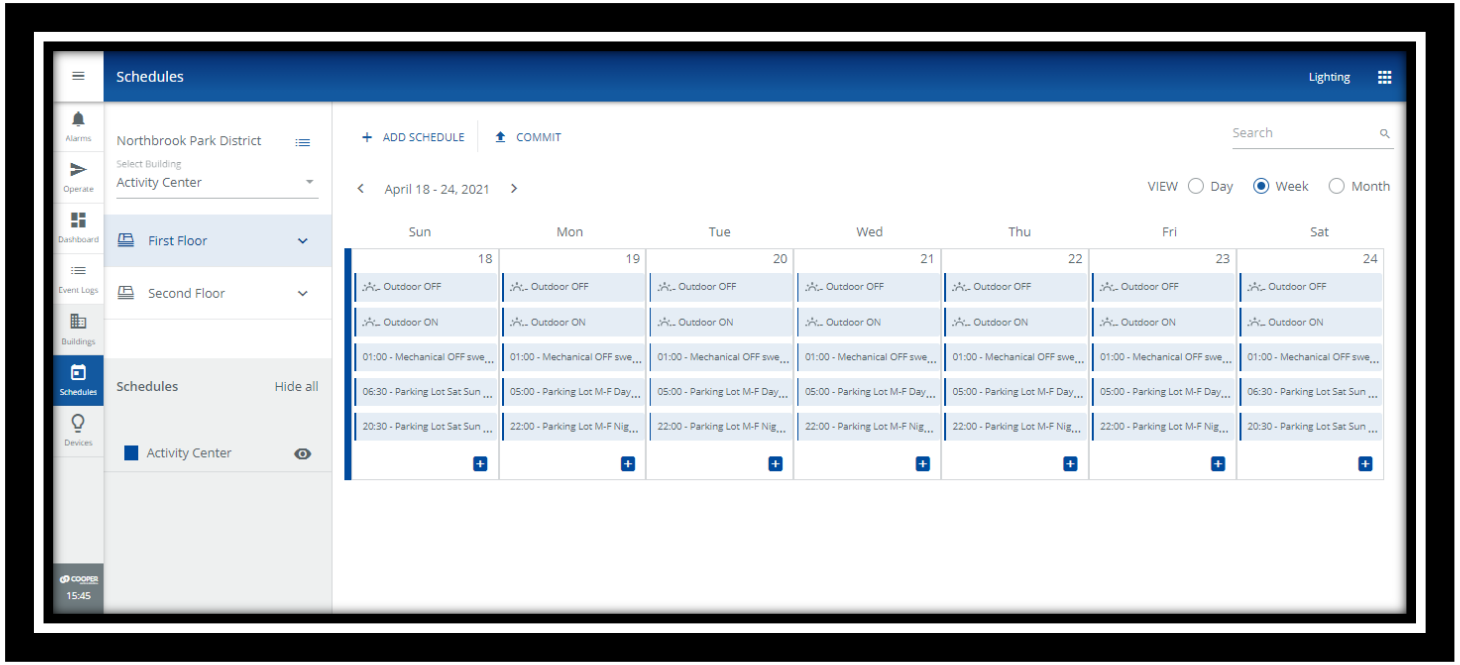
Photovoltaic System

- **Start-up March 4, 2021**
- **Monitoring**
- **Troubleshooting**
- **Data Analyzation**

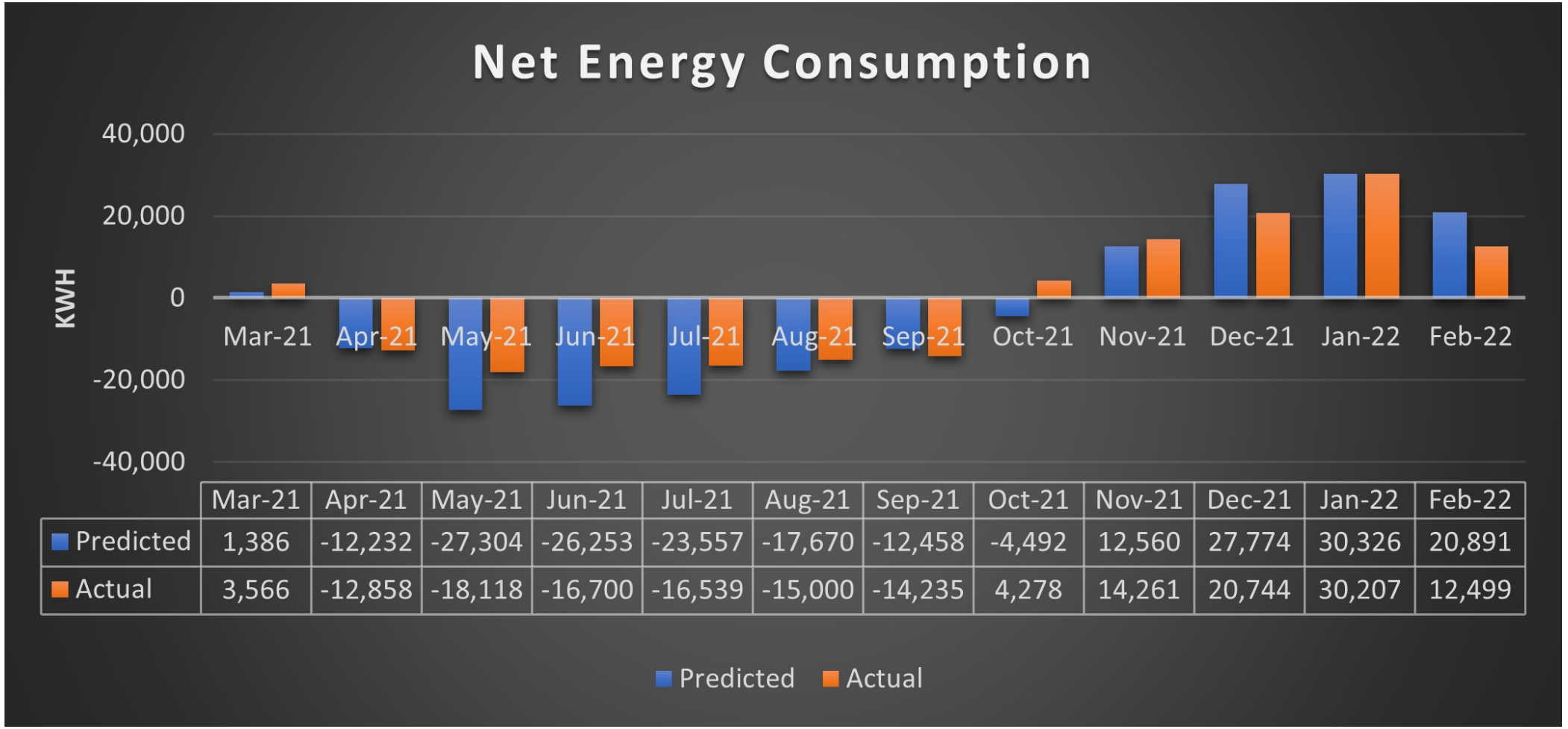
371,054 kWh Produced

Lighting System

- **Scheduling**
- **Daylighting**
- **Monitoring**
- **Settings Changes**



Building Performance



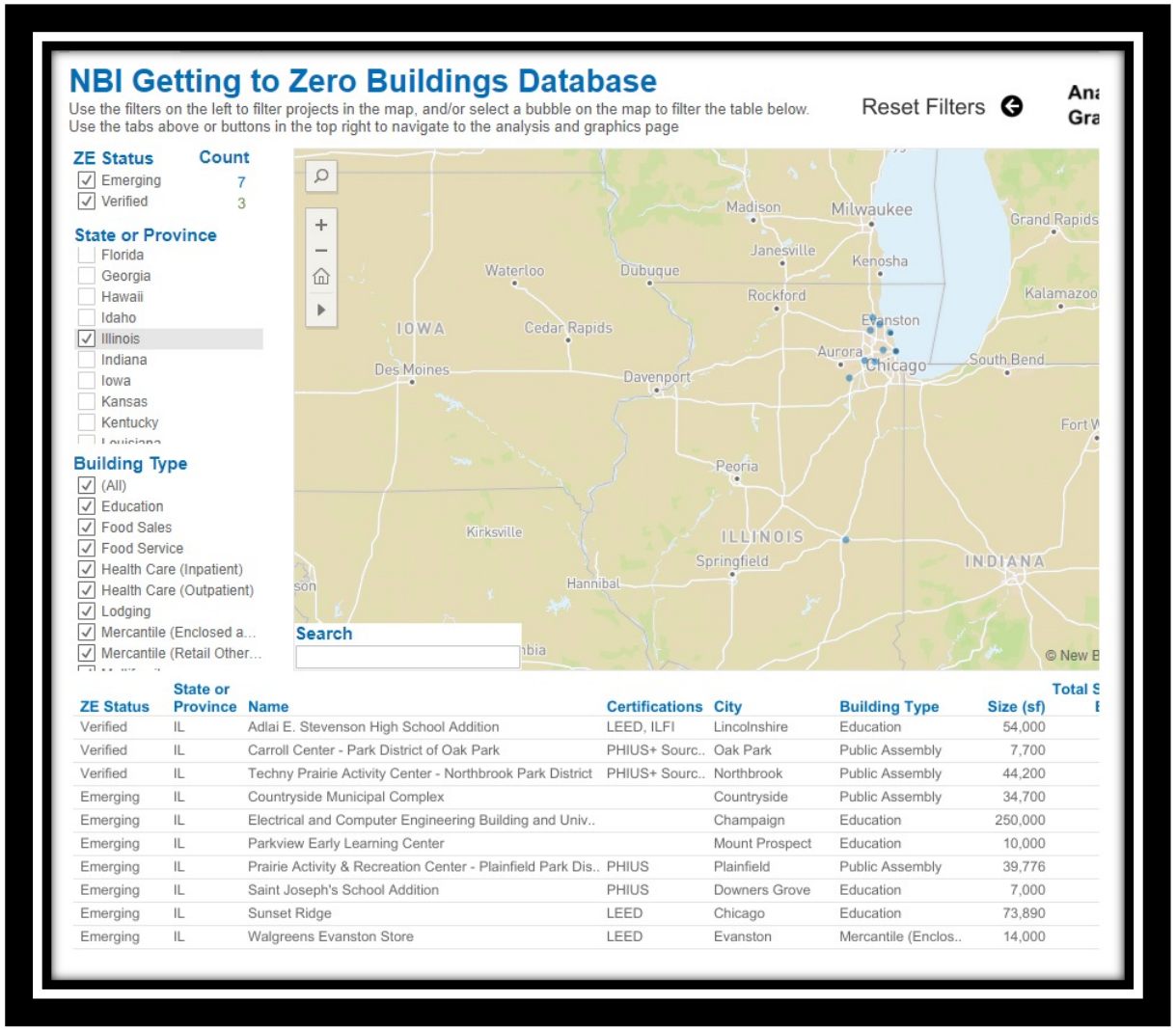
	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22
Predicted	1,386	-12,232	-27,304	-26,253	-23,557	-17,670	-12,458	-4,492	12,560	27,774	30,326	20,891
Actual	3,566	-12,858	-18,118	-16,700	-16,539	-15,000	-14,235	4,278	14,261	20,744	30,207	12,499

Steps to Achieving Net Zero

- **Monitoring**
- **Troubleshooting**
- **Forward Thinking**
- **Culture/Attitude**

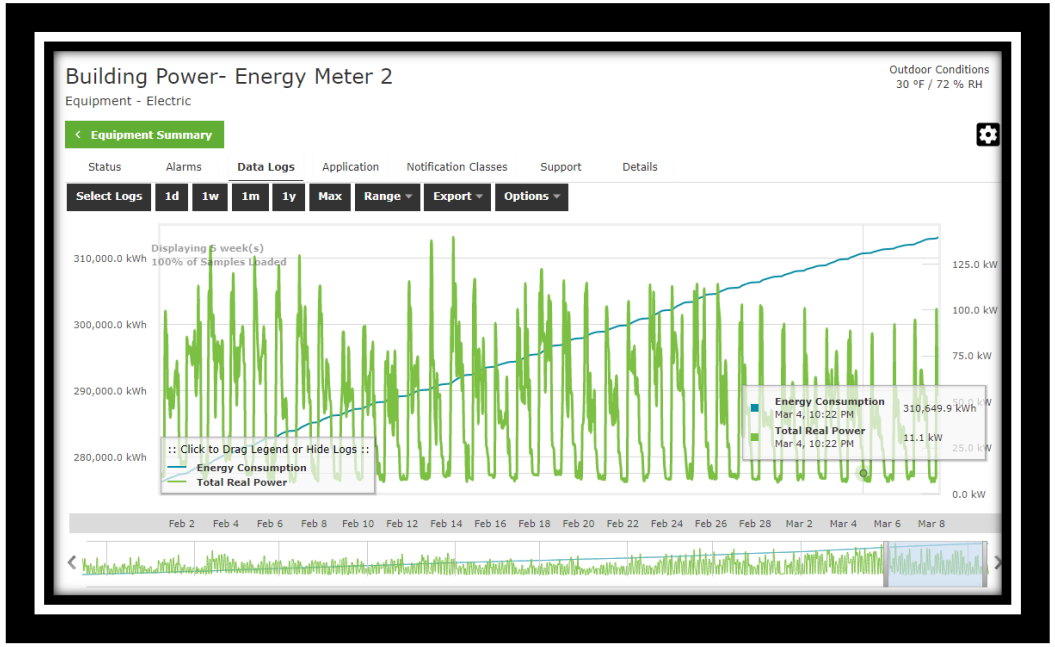
Verification

- ICECF Grant
  - Final Pay App
- NBI Verification
  - Verified on 3/14
- 3rd Verified Net Zero Building in IL



Net Energy Projections

- **March through June 2022 decreased energy consumption year over year by 15%**
- **March 2021 more gas consumption than December 2021 or February 2022**



Sustainably Net Zero!

Grants, Awards & Certifications

Illinois Clean Energy Community Foundation Grant
$1,776,770

Commonwealth Edison Energy Efficiency Program Grants
$31,650

Verified Net Zero facility
New Buildings Institute
(awarded March 2022)

Passive House and Source Zero Certified
Passive House Institute US (PHIUS)

PHIUS Commercial/Institutional Honorable Mention
2021 PHIUS Passive House Design Competition

2021 Illinois Net Zero Honor Roll Watch List
Illinois Green Alliance

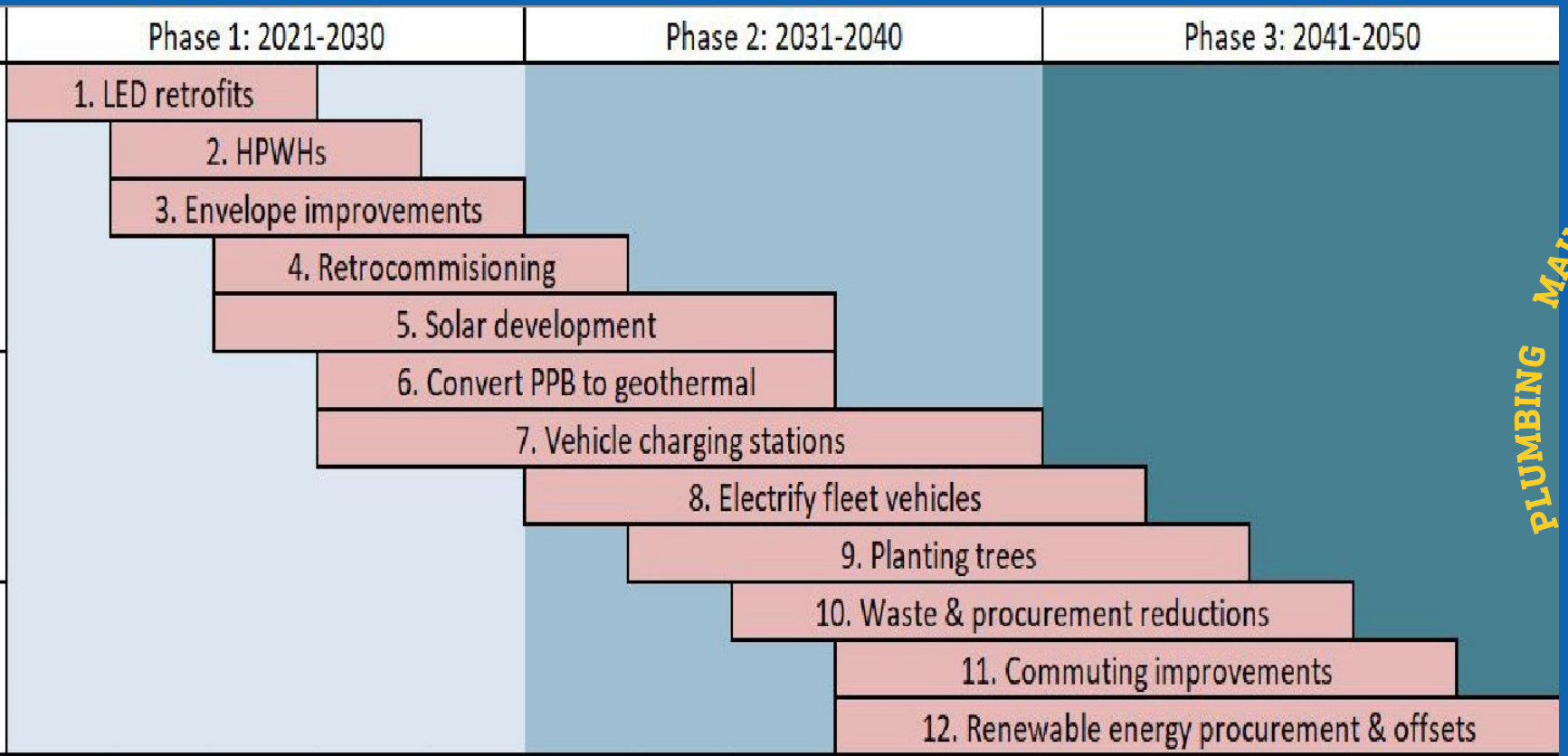
2021 Outstanding Park & Facility Award
Illinois Park and Recreation Association (IPRA)

Best of the Best Awards
2021 Best Green Practices Award
Illinois Association of Park Districts (IAPD)

2021 Green Business of the Year Award
Village of Northbrook

Net Zero & Renewable Energy

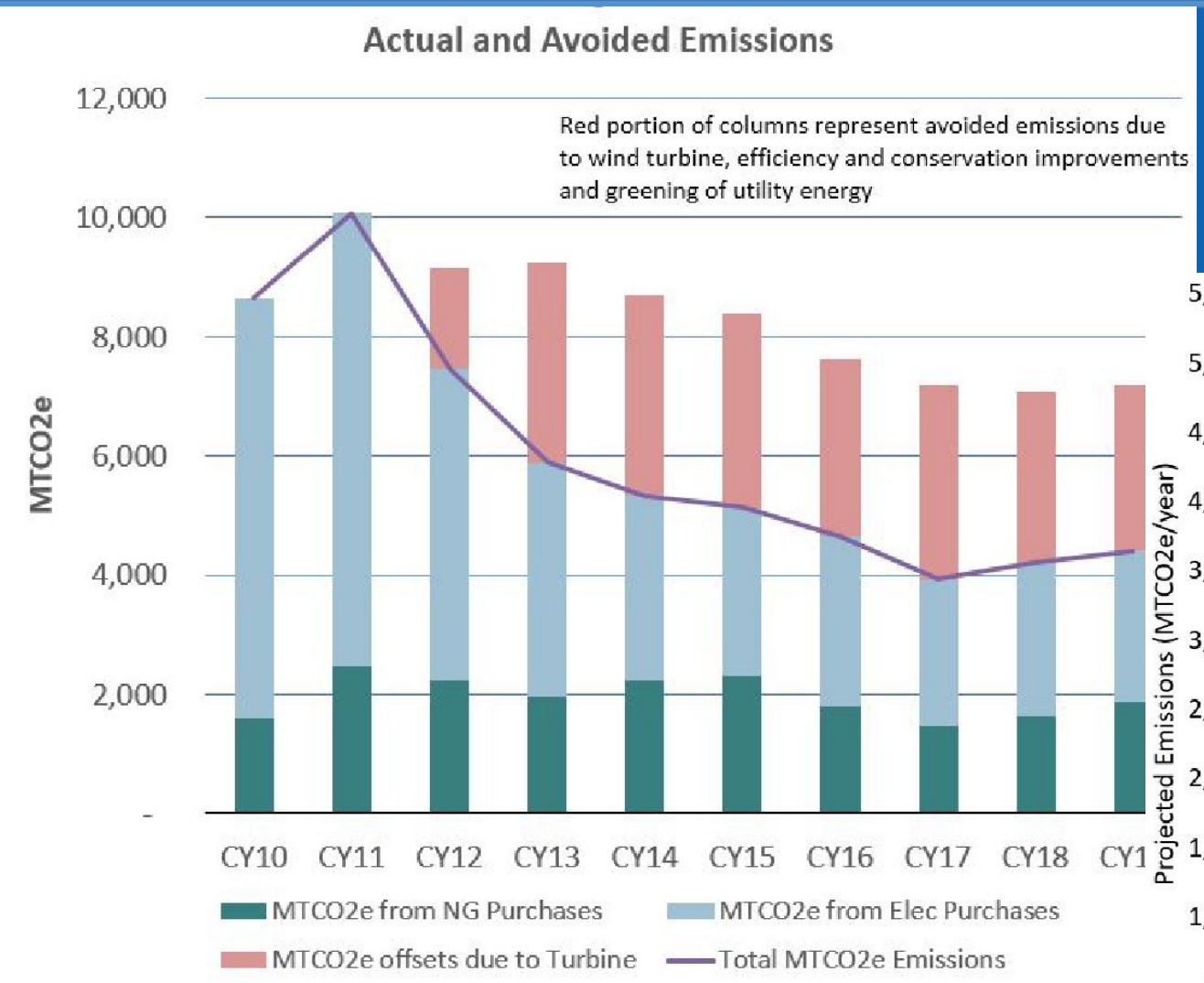
Heartland Community College Facilities department worked with SEDAC to create a Pathway to Net Zero in 2021 with a goal of a Net Zero campus by 2050

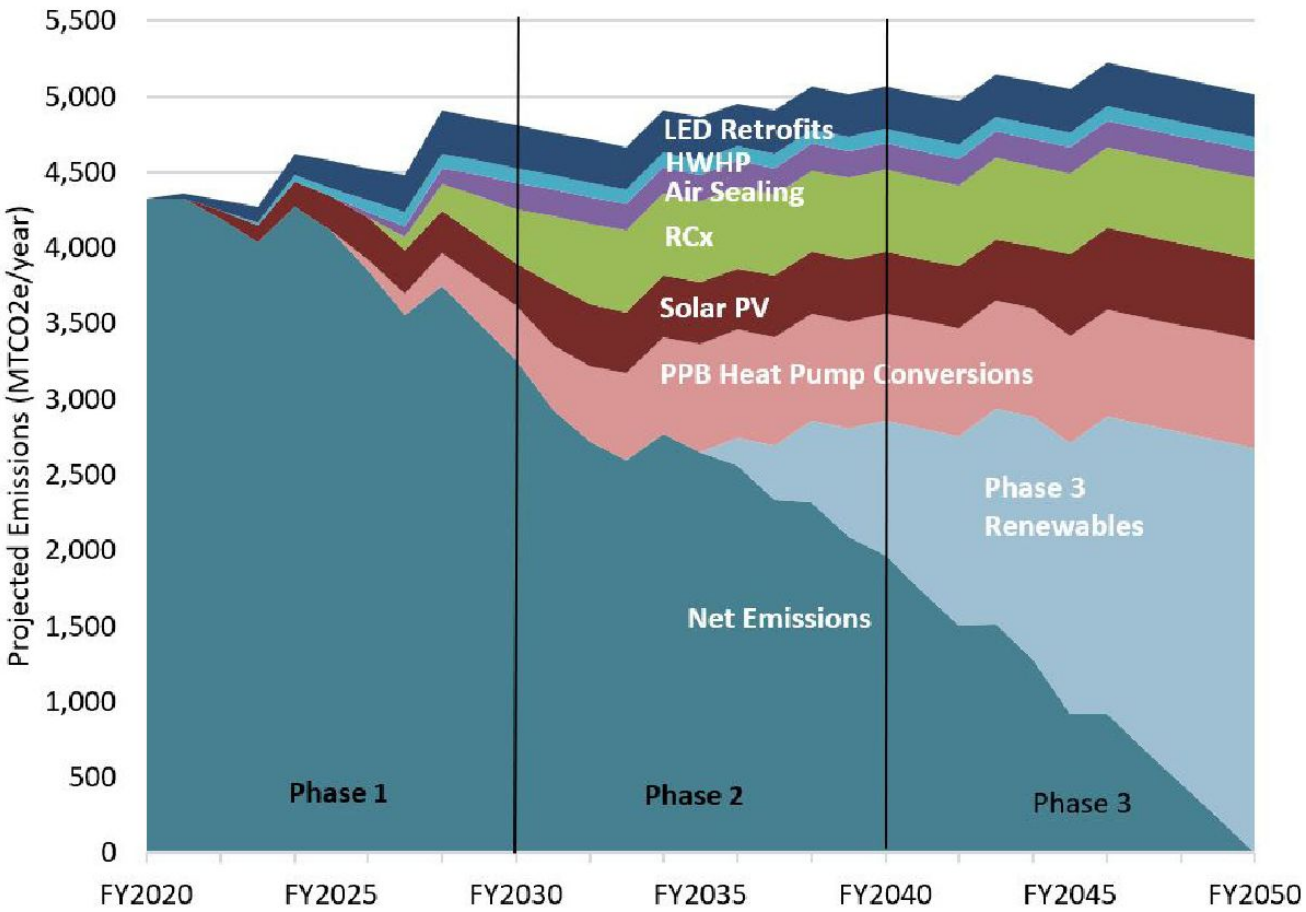


PLUMBING MAINTENANCE HVAC GROUNDS ELECTRICAL CUSTODIAL

FACILITIES

Net Zero & Renewable Energy





Net Zero & Renewable Energy

The Wind Turbine provides more than 40% of campus electrical needs

- We are selling back to the grid in the winter
  - Gas boilers are the campus heat source eight of our buildings
- We need additional electricity in the summer
  - Our campus has a big demand to offset our heat load
  - Chillers are used to supply cooling to the buildings
- We continue to convert lighting to LED & search for other ways to reduce our demand

Net Zero & Renewable Energy

The Wind Turbine has needs too…

Performance and maintenance contract

- Guaranteed energy performance of the turbine
  - Regular oil changes, lubrication, monitoring
- Reconcile usage data from supplier with our tracked data
- Regular monitoring of the system
  - Facilities staff checks the system weekly & whenever we see it still while others in the area are spinning

Net Zero & Renewable Energy

Aspects of acquiring a wind turbine:

- Contact the Illinois Department of Natural Resources early in this process to start your EcoCAT report
- Bat mitigation
  - We had a migratory study done to ensure minimal interference with migratory species
  - We had an ongoing body count
- During migration season the turbine will shut down if wind and lighting conditions are right

Net Zero & Renewable Energy

Aspects of owning a wind turbine:

- Data loss—we have dealt with different occurrences that resulted in loss of turbine data
- Down-time—if it is mechanical, it will inevitably break (and many people will call you about it)
- Lack of specialized staff—we rely on a third party contractor for repairs and maintenance

Net Zero & Renewable Energy

Geothermal Advantages:

- HCC workforce has experience with geo systems
- Two geothermal buildings went online in 2007: the Child Development Lab (CDL) and the Workforce Development Center (WDC)
  - We know how to troubleshoot geo-heat pumps
  - We take regular readings to ensure no leaks in the closed loops

Net Zero & Renewable Energy

Geothermal Advantages:

- Test all closed loops on a monthly basis (3rd party):
  - Look for chemical imbalance (leaks, bacteria, corrosion, scale)
- Our geothermal buildings do not add to the existing HVAC load on the physical plant
  - If we have to shut down campus wide HVAC for service, repair, or in an emergency, we are able to continue heating/cooling the CDL and WDC.

Net Zero & Renewable Energy

Geothermal Disadvantages:

- HCC has struggled at times to have a reliable 3rd party chemical contractor
- Buildings can struggle in extreme temps
  - A poor building envelope is a big issue that directly affects the design intent of the HVAC system
- If the geo-loop stops flowing, your entire building HVAC is down (but at least it isn't campus wide)
  - Leaks, pump failures, stuck valves or actuators, plugged filters

Net Zero & Renewable Energy

Solar is coming!

- HCC is building an Agriculture Complex
  - Net Zero plan includes solar on the roof (and geothermal wells for the HVAC)
- Looking into Solar PPA
  - Minimal upfront costs
  - Fixed rates
  - Not responsible for maintenance

Net Zero & Renewable Energy

Solar is the unknown…

- HCC Facilities has no experience with solar
  - Commissioning agents will monitor the Agriculture Complex for 18 months to streamline performance and ensure the building meets Net Zero (get performance guarantees!)
  - We are planning to learn the system during commissioning & through additional training, if needed
  - Close monitoring of the system may require the hiring of additional staff

Net Zero & Renewable Energy

Solar is concerning?

- Long lead times could complicate things
  - We have to hit performance goals
  - If something breaks--performance slips
  - If we cannot get a part for an extended period, the impact on our Net Zero goal could be substantial
- Long delays with some power suppliers to interconnect PV systems of any size
- Plan for spare equipment on hand to avoid repair delays