GETTING TO zero

Thank you to our Getting to Zero sponsors who make these educational opportunities possible:

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Center for Sustainable Landscapes | Pittsburgh, PA *Photo: Paul G. Wiegman*

nbi new buildings institute

Getting to Zero: Building Case Study Jam

March 25, 2021

2

Efficiency delivered.

NBI is responding to increasing urgency to reduce carbon emissions and increased demand for improved energy performance of new and existing buildings.

NBI's Theory of Market Change:

Our Program Areas

(1) Building & Program Innovation

(2) Zero Energy Leadership & Market Development

(3) Advancing Codes & Policy

3

Frick Environmental Center | Pittsburgh, PA *Photo:Ed Massey*

Today's panel:

Matthew Welker
Director, Sustainability Metrics and Operations
The American Institute of Architects

Dan Luddy
Engineer - Building Analysis and Modeling
PAE Consulting Engineers

Bill Maclay
Principal
Maclay Architects

Roger Chang
Engineering Leader
DLR Group

Tracy Steward
Principal
CMTA

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AIA 2030 COMMITMENT

Matthew Welker, Assoc. AIA
matthewwelker@aia.org

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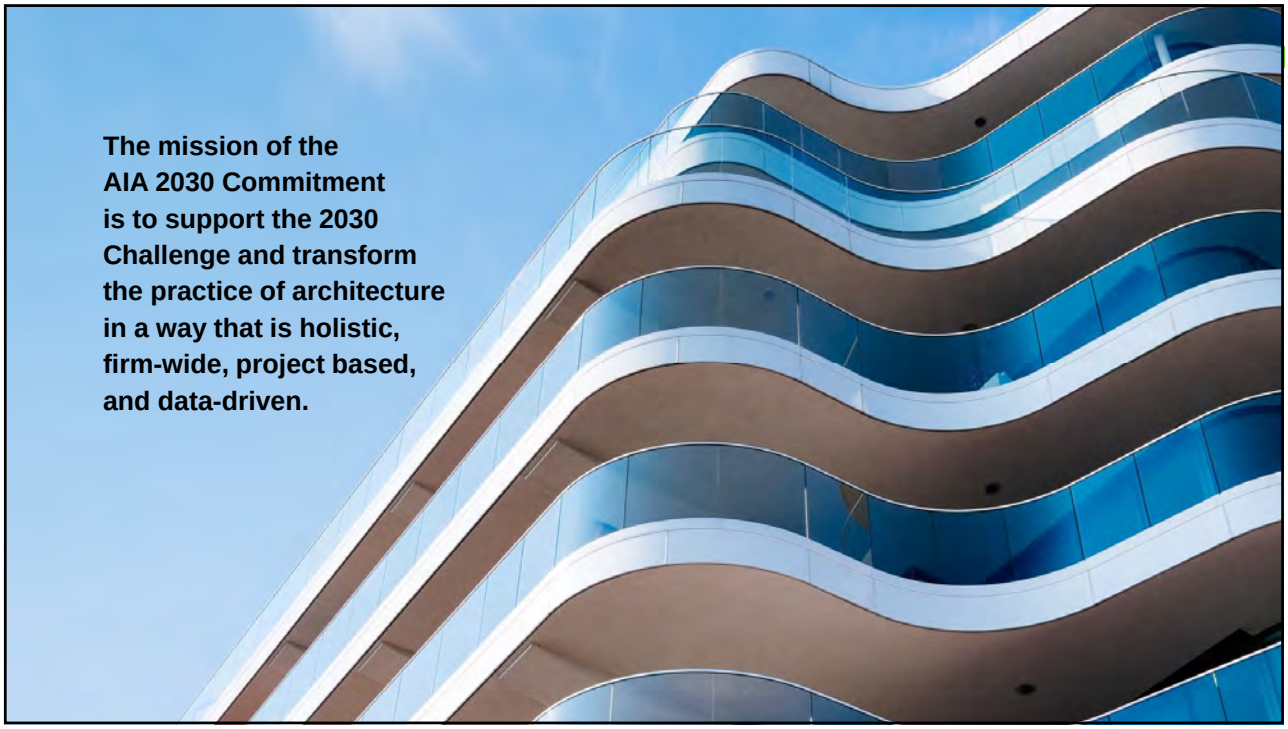

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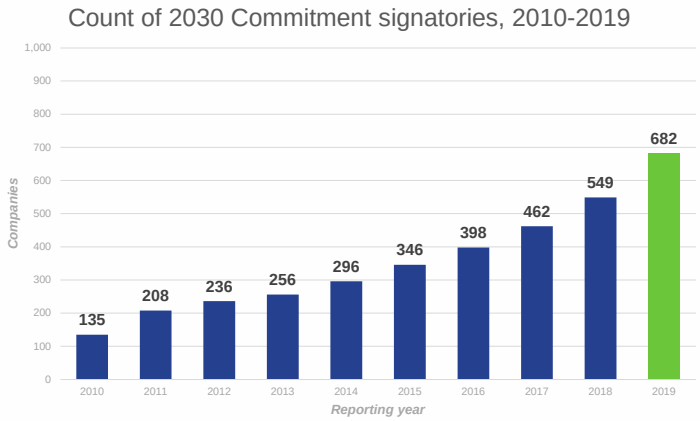
AIA 2030 COMMITMENT

Ten years strong, participation continues to grow each year.

We need more architects, engineers, consultants, and owners working toward our carbon-neutral goals.



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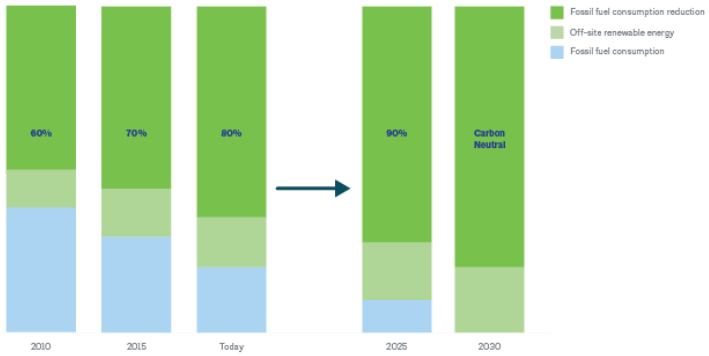
AIA 2030 COMMITMENT

Participants prioritize energy performance as they work toward carbon neutral buildings, developments and major renovations by 2030.



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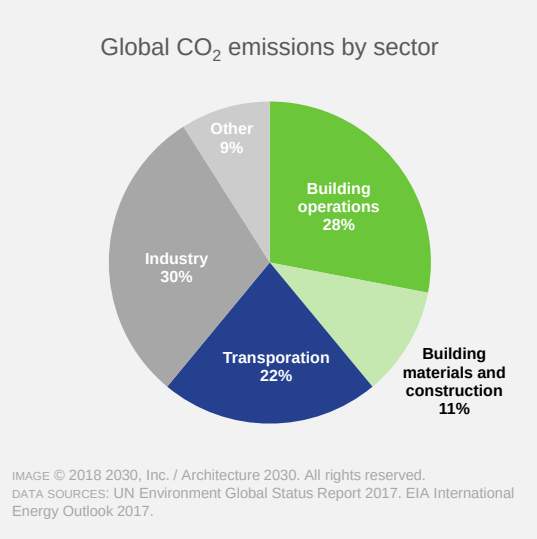
AIA 2030 COMMITMENT

Building operations are responsible for about 30% of greenhouse gas (GHG) emissions globally.

In some cities, building operations account for more than 70% of GHG emissions.

Embodied carbon emissions from (core and shell) materials and construction are estimated to be another 11% of GHG emissions globally.



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AIA 2030 COMMITMENT

1 Sign the Commitment letter

2 Create a Sustainability Action Plan

3 Endeavor to meet 2030 targets

4 Report all projects in the DDx

5 Review and update your Sustainability Action Plan

10

AIA 2030 COMMITMENT

In 2019, 2030 Commitment projects predicted an annual overall energy savings equivalent to avoiding 20.2 million MT CO2e.

That's the same as removing 4.4 million cars from the road for one year.

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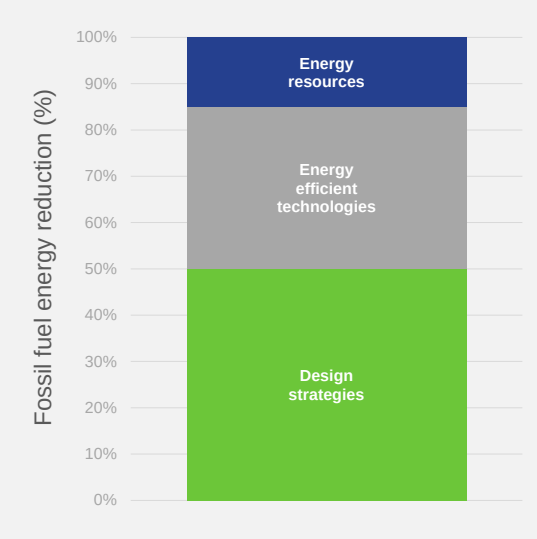
AIA 2030 COMMITMENT

Design strategies have the greatest impact on building energy use.

Architects have the greatest impact on design strategies early in the design process.



12

AIA 2030 COMMITMENT

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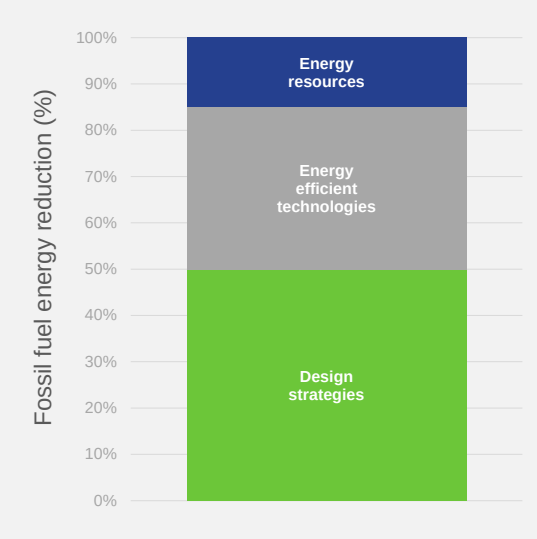

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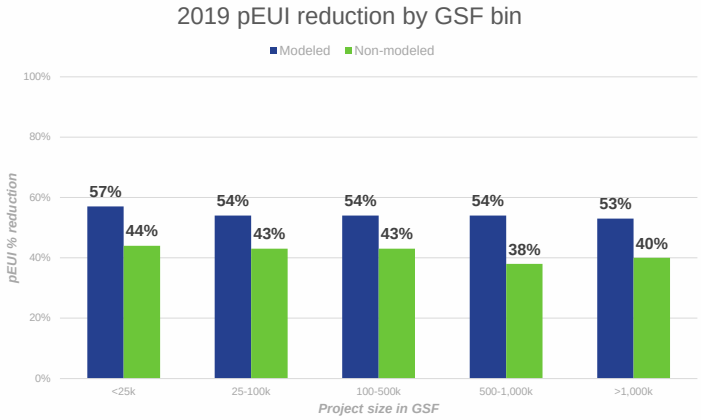
AIA 2030 COMMITMENT

Modeled projects consistently report higher savings, regardless of size.



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AIA 2030 COMMITMENT

"It is of paramount importance that buildings be built and renovated to consume less energy, and, wherever possible, buildings should produce clean energy to put back into the energy grid."

- JULIE HIROMOTO, AIA

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Learn more at aia.org/2030Commitment

Or send questions to us directly **2030Commitment@aia.org**.

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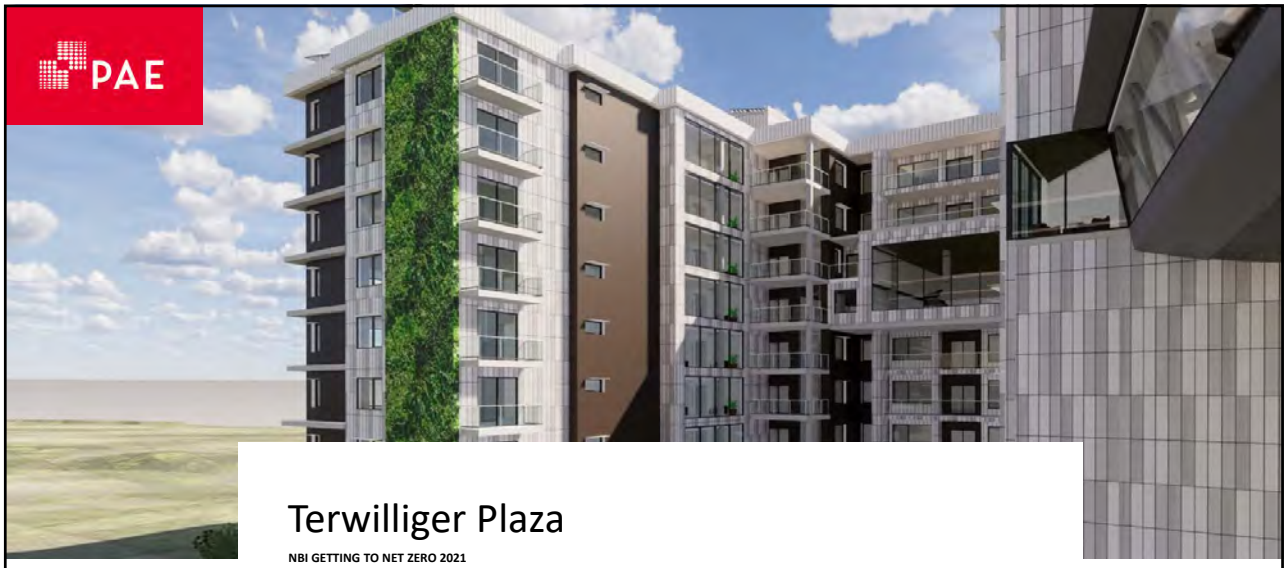

Terwilliger Plaza

NBI GETTING TO NET ZERO 2021

March 25, 2021
Presented by PAE

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Parkview at Terwilliger Plaza

- High rise senior living in Portland, OR
- 10 story, 250,000 ft^2
- Targeting PHIUS+ 2018 certification

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SECTION 1

Goal Setting and Stakeholder Buy-in Journey

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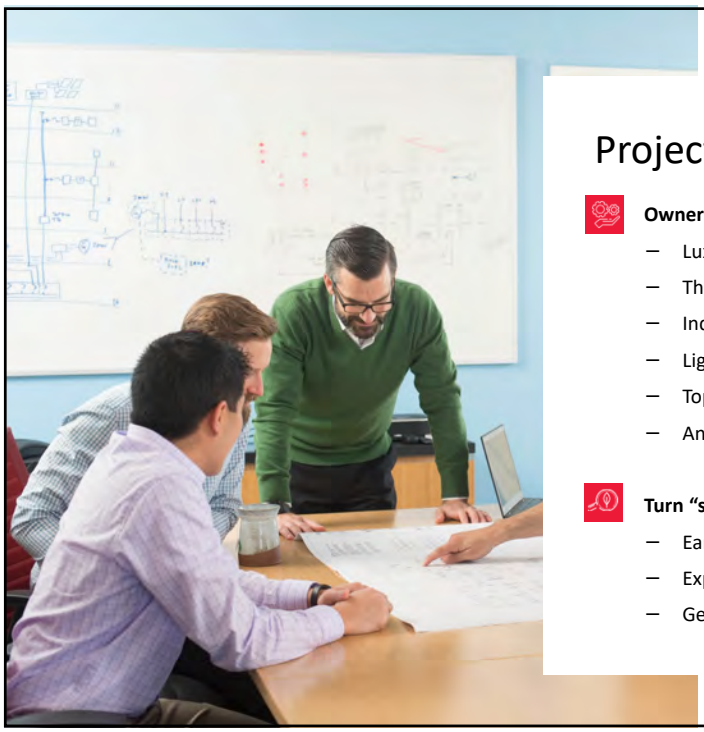

Project Goals

Owner's requirements

- Luxury apartments with amenities
- Thermal comfort
- Indoor air quality
- Lighting levels
- Top of the line appliances
- Answers to Community Board

Turn "sustainability" into measurable goals

- Early energy/water analysis
- Explore certifications
- Get "buy-in" from all team members

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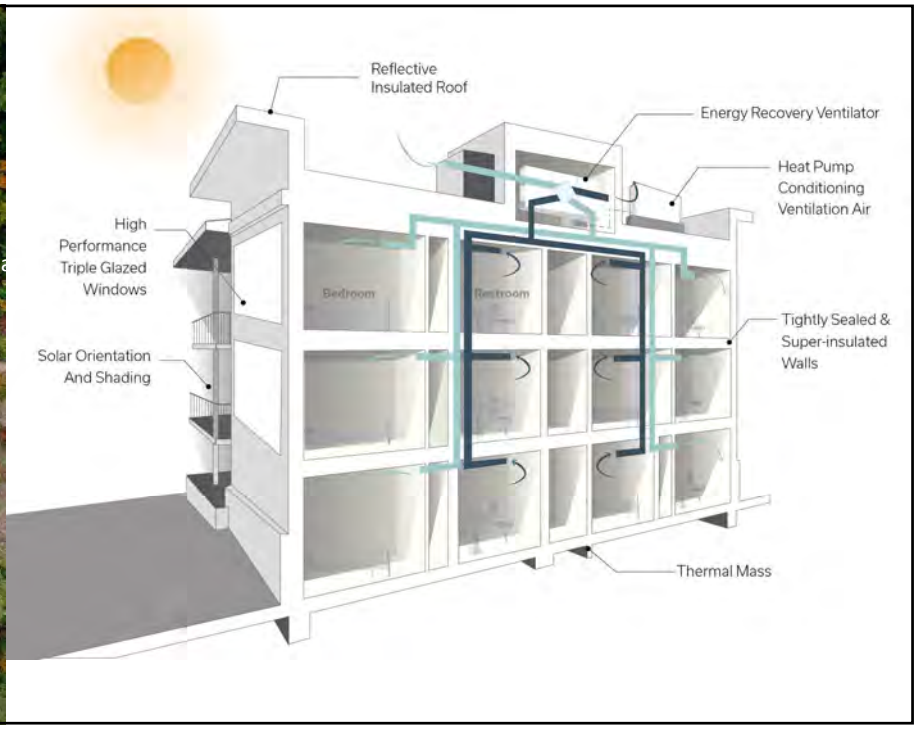
Sustainability Targets

Passive House
- Superinsulation
- Tight air sealing
- Continuous filtered ventila w/ heat recovery

No fossil fuels
- Heat pump heating
- Electric appliances

Architecture 2030 Energy Target
- Combined EUI 10 kBtu/ft^2/year



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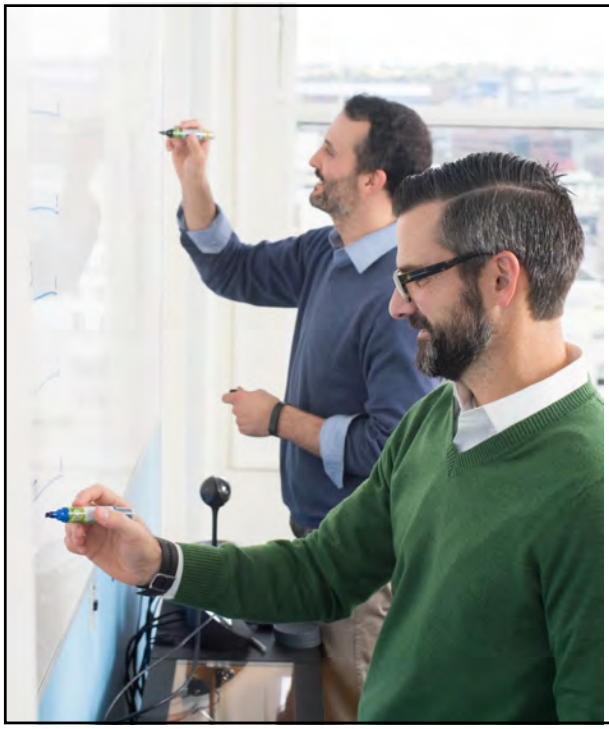

SECTION 2

Data-driven Design and Lessons-learned

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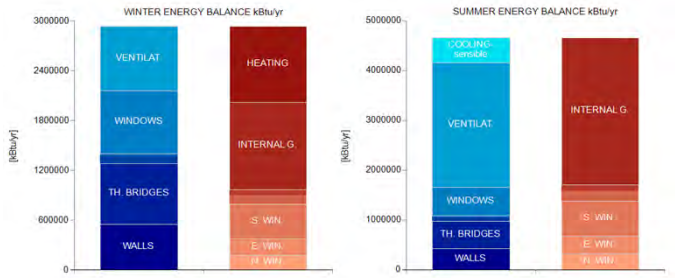
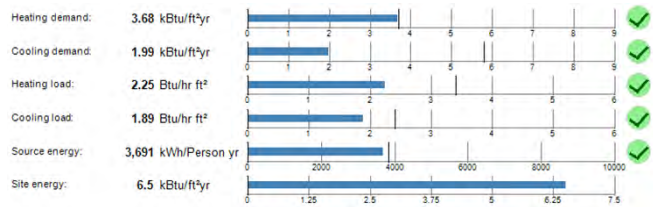
Early Design Analysis





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30 Year Life Cost Analysis Assumptions

30 year
analysis period

3 %
discount rate
(does not include inflation)

5 % **utility rate** (based on DOE calculator)

20-23 yrs
HVAC & Water Heater Lives assumed
1 replacement analyzed for all options in the 30 yr cycle

40 yrs
Opaque Envelope Life assumed
no replacement analyzed in the 30 yr cycle.

25-30 years
Glazing Life assumed
1 replacement in analyzed the 30 yr cycle

Maintenance costs

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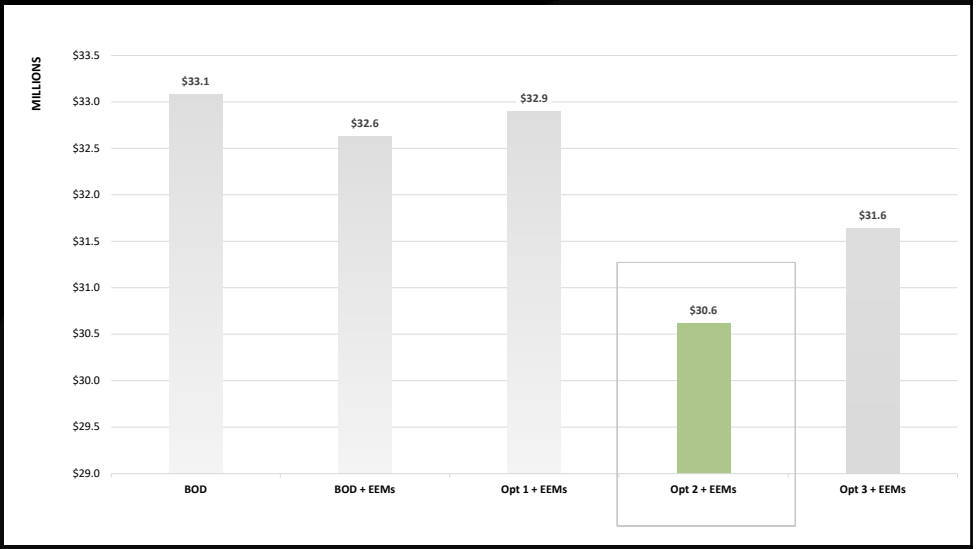
30 Year Life Cost Analysis



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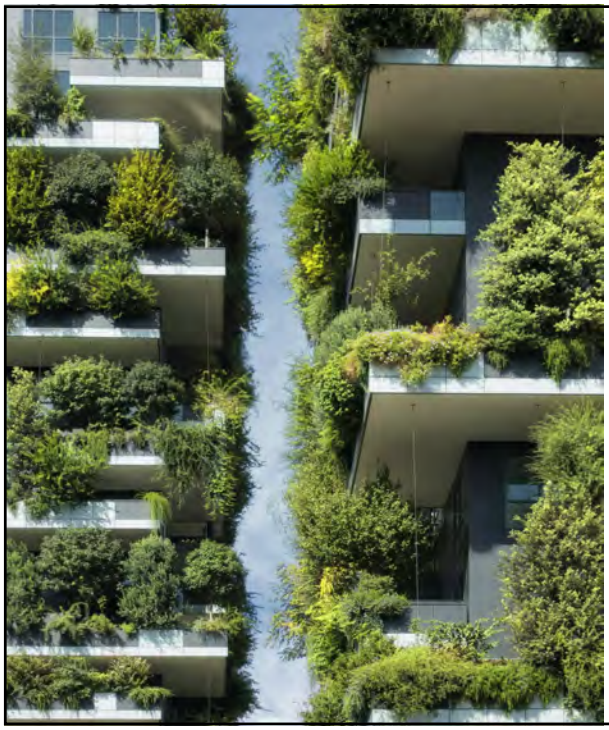

SECTION 3

Envelope Details

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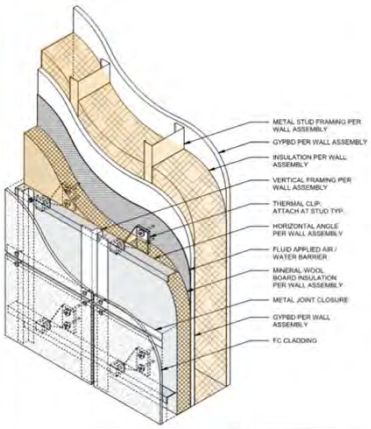
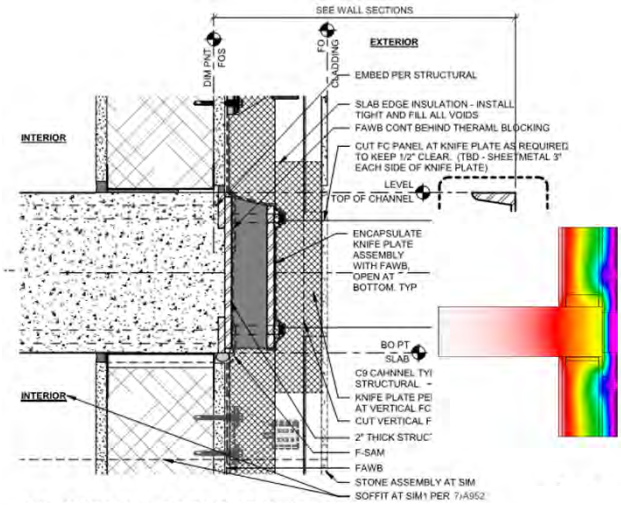
Envelope Details

ENVELOPE OPTIMIZATION



Thermal bridging analysis



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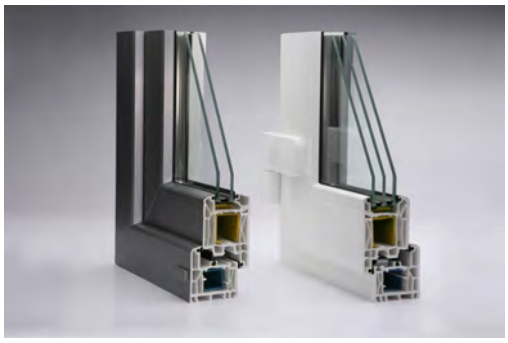
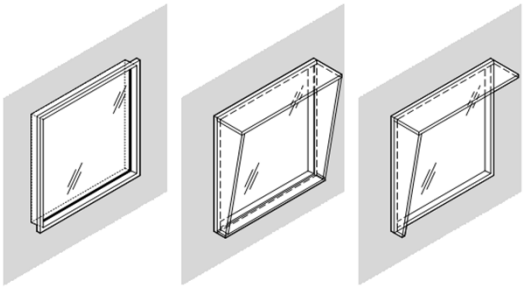
Envelope Details



WINDOW PERFORMANCE



SHADING OPTIMIZATION

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SECTION 4

Systems Design

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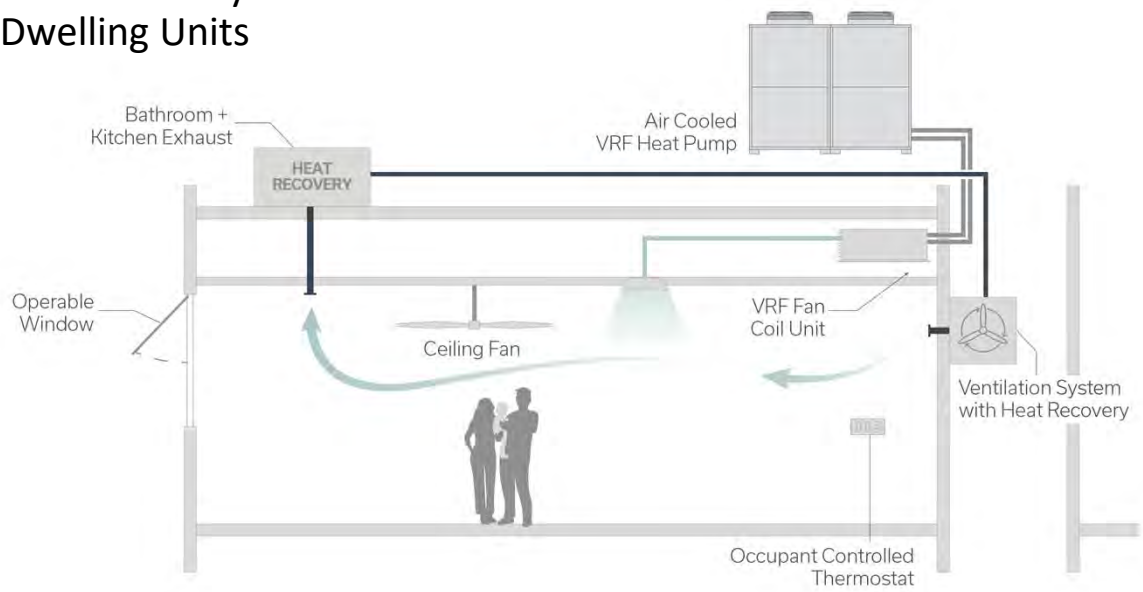
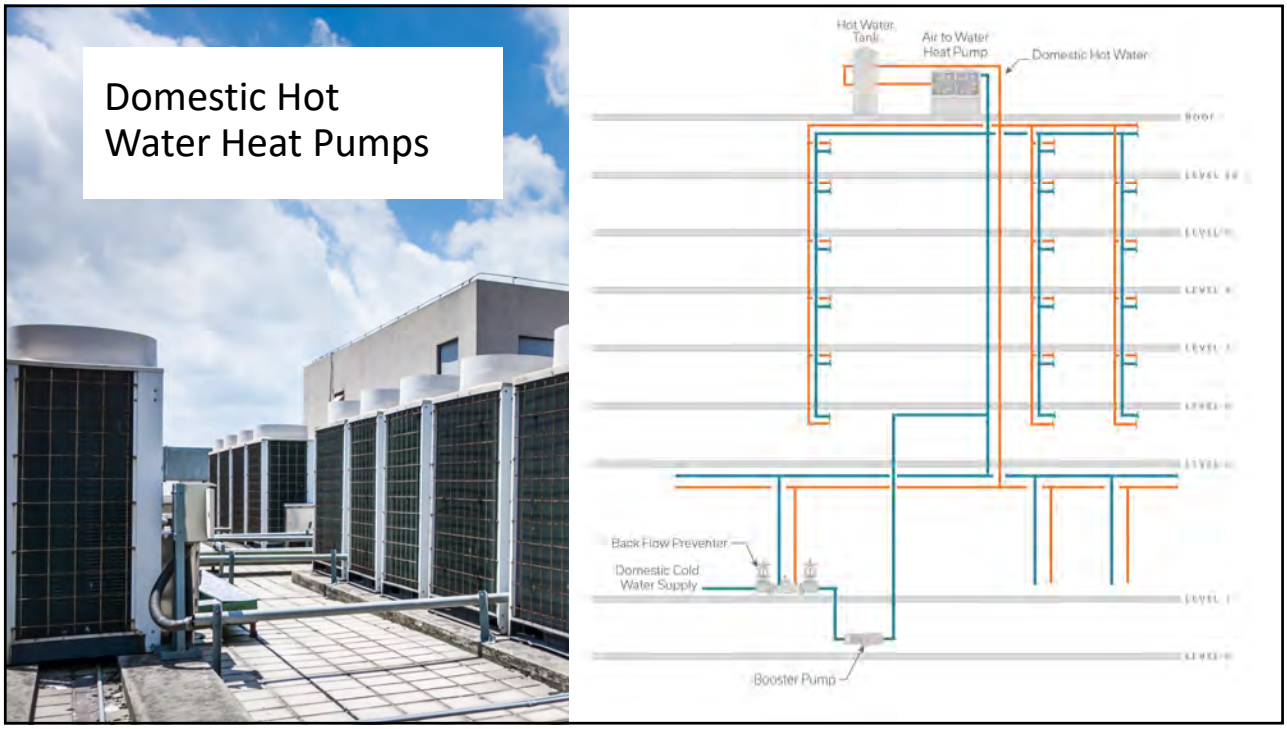
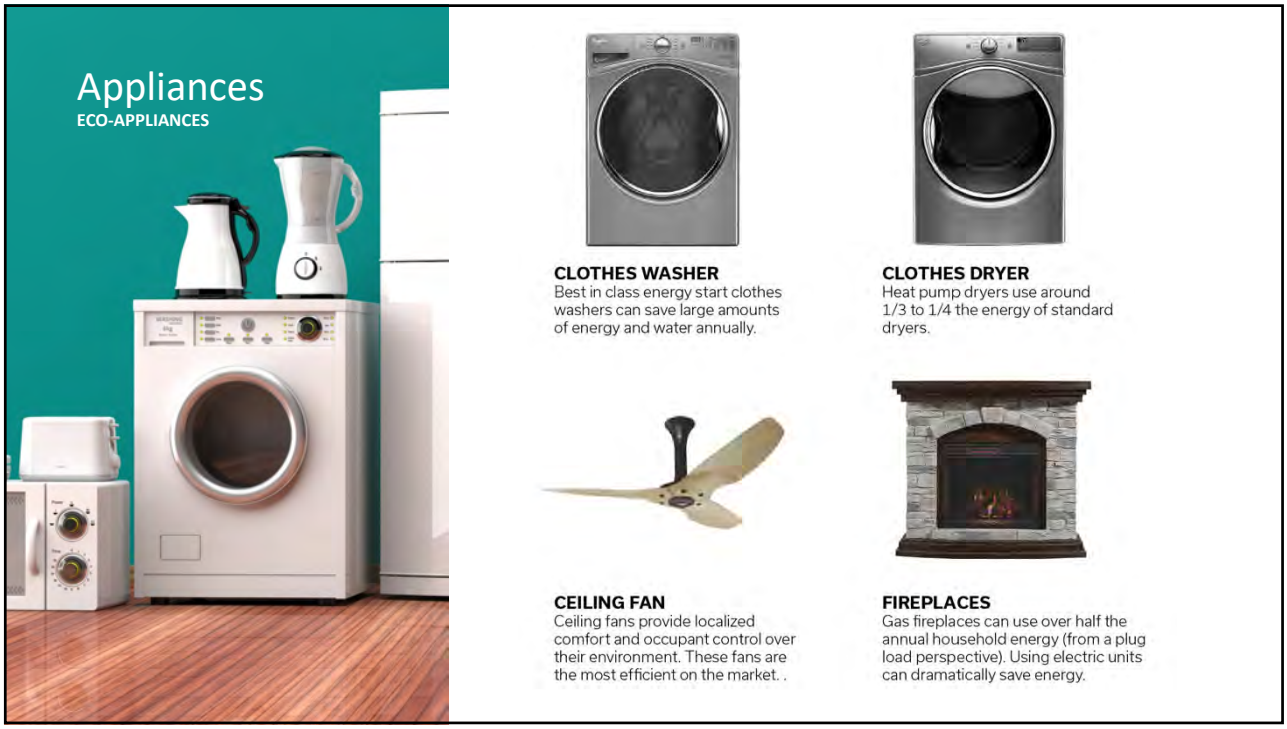
Mechanical Systems for Dwelling Units



30


Domestic Hot
Water Heat Pumps
Hot Water
Tank
Air to Water
Heat Pump
Domestic Hot Water
Roof
Back Flow Preventer
Domestic Cold
Water Supply
Booster Pump

31


Appliances
ECO-APPLIANCES
CLOTHES WASHER
Best in class energy start clothes washers can save large amounts of energy and water annually.
CLOTHES DRYER
Heat pump dryers use around 1/3 to 1/4 the energy of standard dryers.
CEILING FAN
Ceiling fans provide localized comfort and occupant control over their environment. These fans are the most efficient on the market. .
FIREPLACES
Gas fireplaces can use over half the annual household energy (from a plug load perspective). Using electric units can dramatically save energy.

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Appliances
ECO-KITCHEN
KITCHEN COOKTOP
Induction cooktops dramatically out perform gas and electric options.
RANGE COOKTOP
Induction cooktops out perform gas and electric options.
MICROWAVE
Microwaves can save significant amounts of energy when correctly sized for homes.
DISHWASHER
These washing machines reduce both water and energy use.
REFRIGERATOR
Using a smaller refrigerator helps save space in units and large amounts of energy.
GARBAGE DISPOSAL
High efficiency and reliable disposals reduce maintenance hassles.

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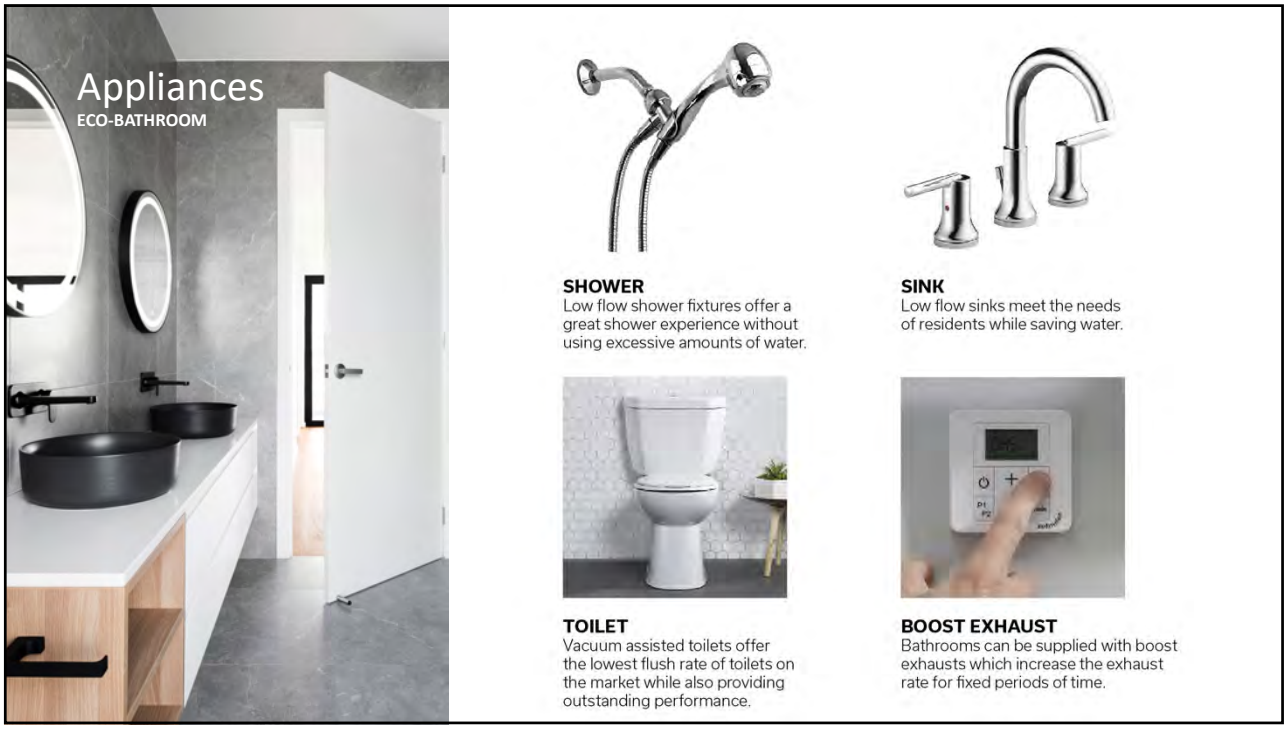
Appliances
ECO-BATHROOM
SHOWER
Low flow shower fixtures offer a great shower experience without using excessive amounts of water.
SINK
Low flow sinks meet the needs of residents while saving water.
TOILET
Vacuum assisted toilets offer the lowest flush rate of toilets on the market while also providing outstanding performance.
BOOST EXHAUST
Bathrooms can be supplied with boost exhausts which increase the exhaust rate for fixed periods of time.

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SECTION 5

Renewable Energy

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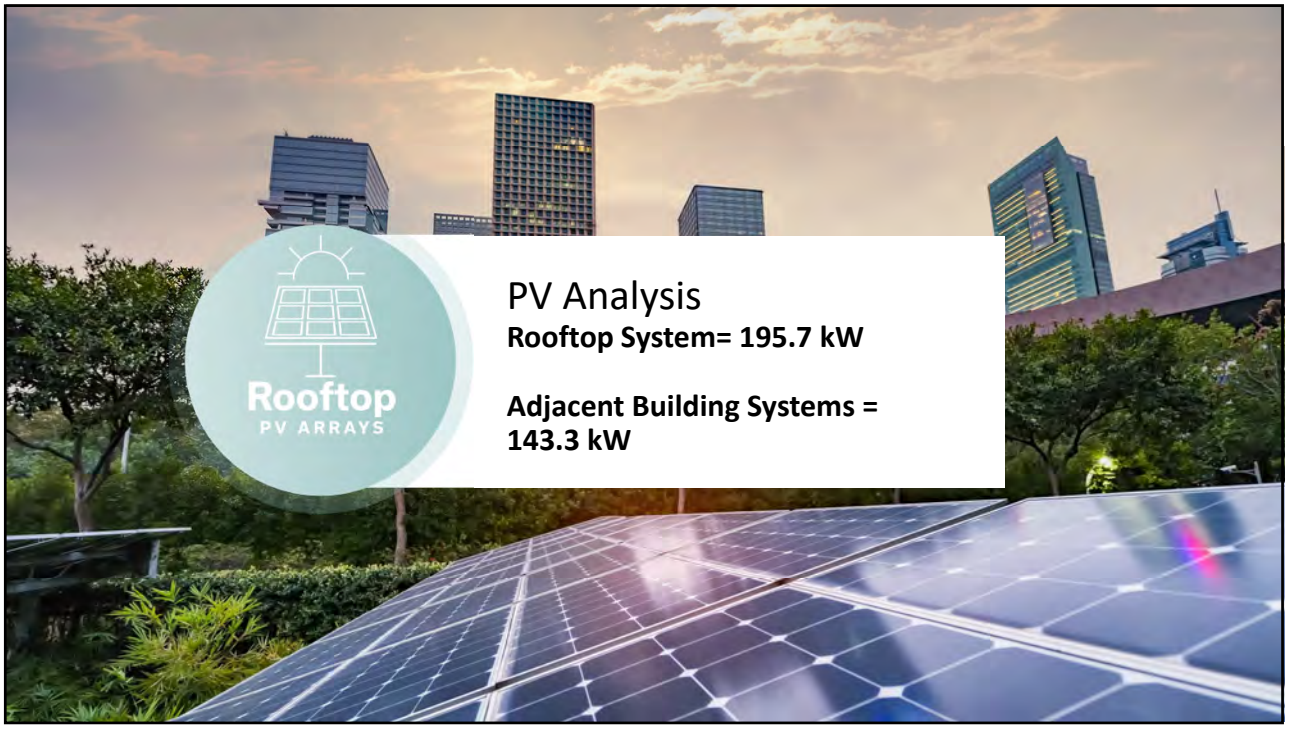

PV Analysis

Rooftop System= 195.7 kW

Adjacent Building Systems = 143.3 kW

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SECTION 6

Wrap-up

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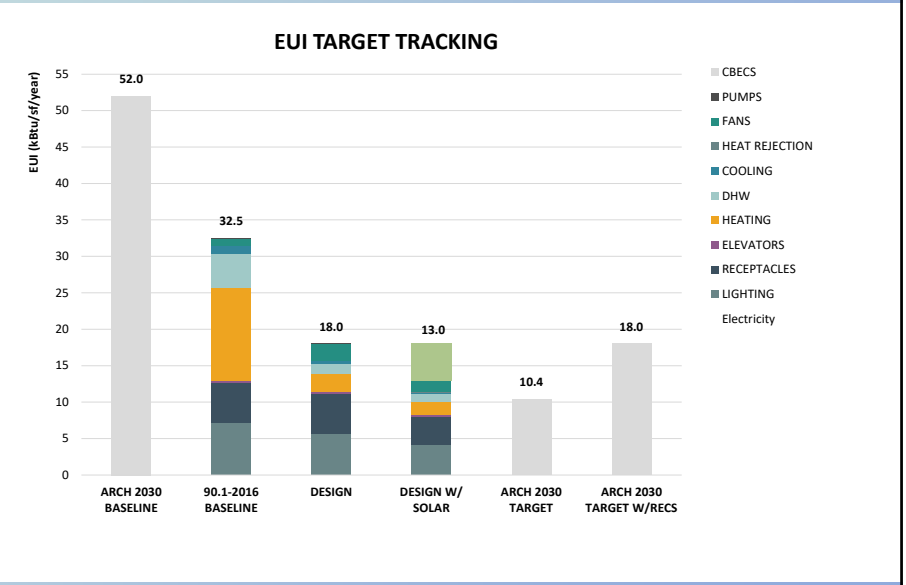
EUI - Energy Use Index

ESTIMATED ENERGY USE



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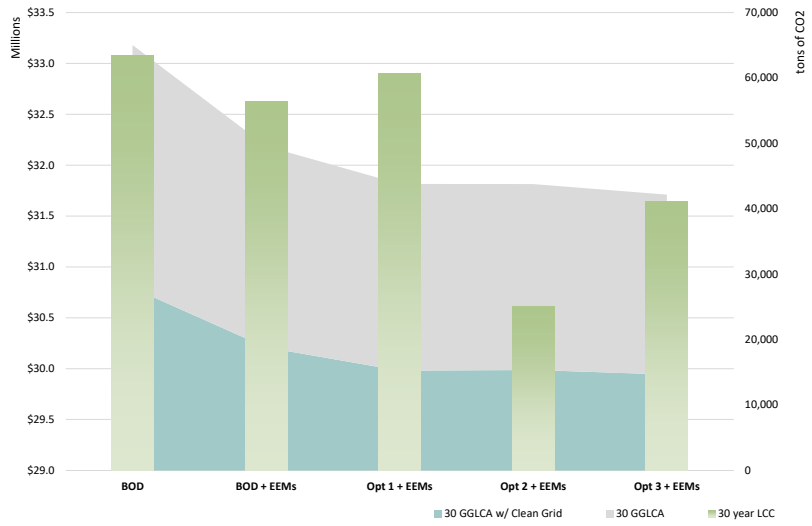
30 YEAR

Greenhouse Gas Emissions



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Key Takeaways

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Creating a better environment

Dan Luddy PE, BEMP, CPHC, LEED AP
ASSOCIATE

dan.luddy@pae-engineers.com
206-413-7268

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Existing Food Service EUI:
207-418 kBtu/sf/yr
Average 267 kBtu/sf/yr

Typical NZE EUI:
15-25 kBtu/sf/yr

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CHOICES IN SUSTAINABILITY

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NZE Food Service Strategy

Base EUI (15-25) +

Reduced Food Service Process Load EUI =

NZE Food Service EUI ≤

Renewable Energy

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NZE Food Service Process

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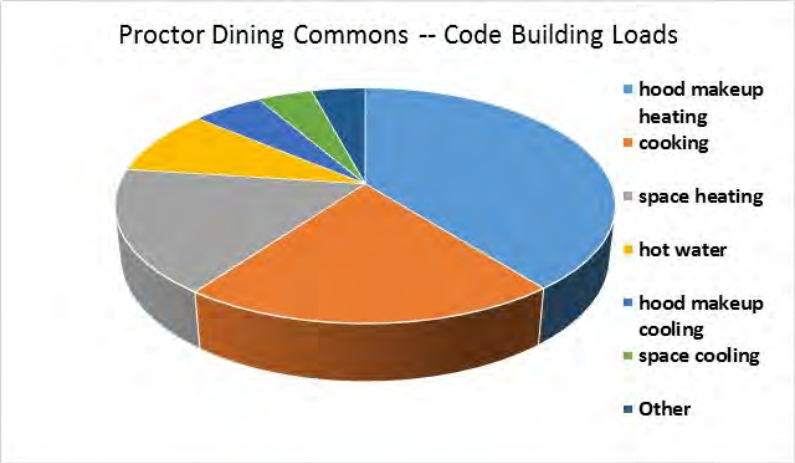
NZE Food Service Process

Calculate Loads



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CHOICES IN SUSTAINABILITY

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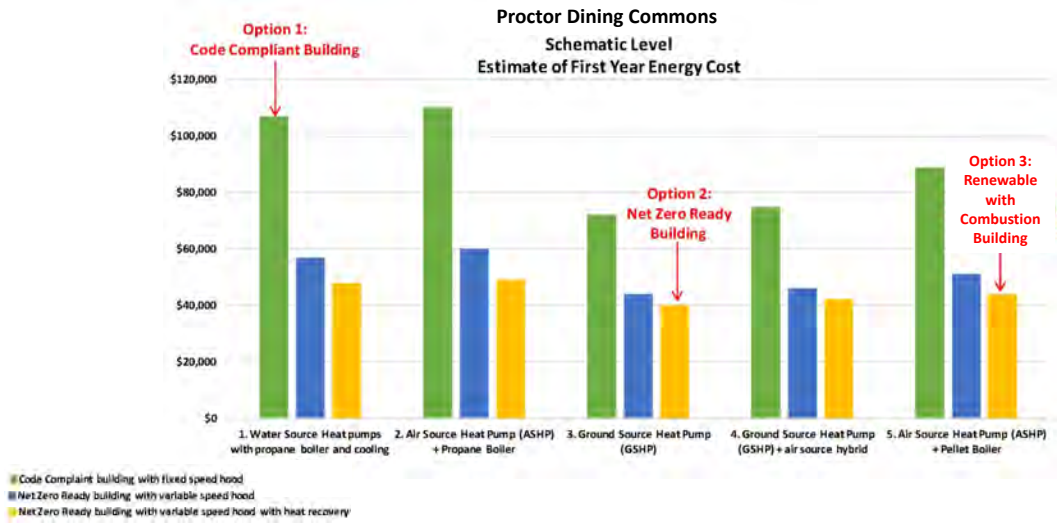
NZE Food Service Process

Energy Modeling



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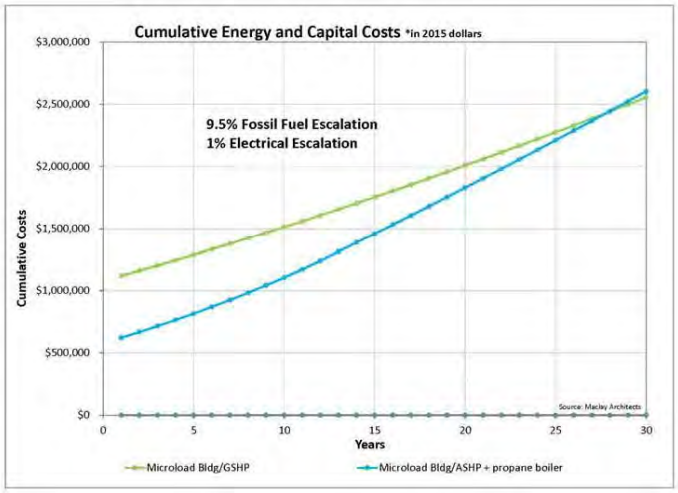
NZE Food Service Process

Financial Analysis



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NZE Food Service Process

Carbon Impact

EQUIVALENT CO2 EMISSIONS

= 4 TIMES ANNUALLY

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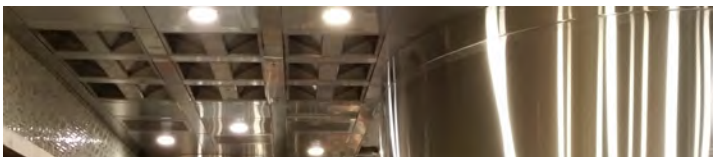
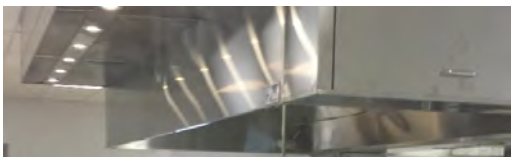
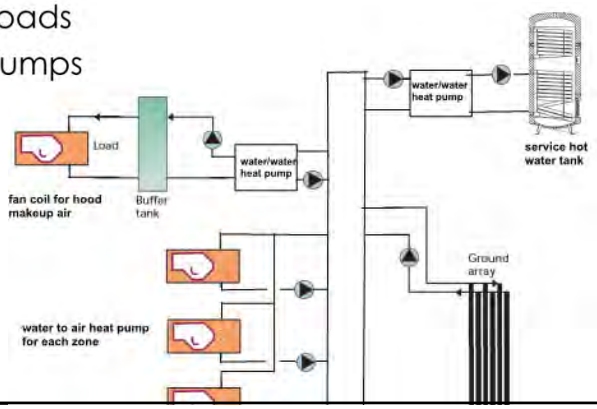




Implementing NZE Strategy

All Electric Kitchen
Reduced Ventilation Loads
Ground Source Heat Pumps



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Implementing NZE Strategy

All Electric Kitchen

Reduced Ventilation Loads

Ground Source Heat Pumps

Solar – but not all on roof tops

Educating Users

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Proctor EUI = 85

Pizza Oven is 5 EUI

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Achievable
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CHOICES IN SUSTAINABILITY
New Net Zero

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Affordable
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New Net Zero

54


Fire Roasted
Cauliflower
Healthy
MaclayArchitects
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New Net Zero

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Beautiful
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New Net Zero

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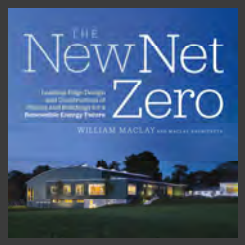

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Waitsfield, VT

www.maclayarchitects.com

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DLR Group

A Net Zero Energy Dining Journey

New Buildings Institute
March Case Study Jam

Swarthmore College
Dining and Community Commons Project
March 25, 2021
Roger Chang, PE, FASHRAE

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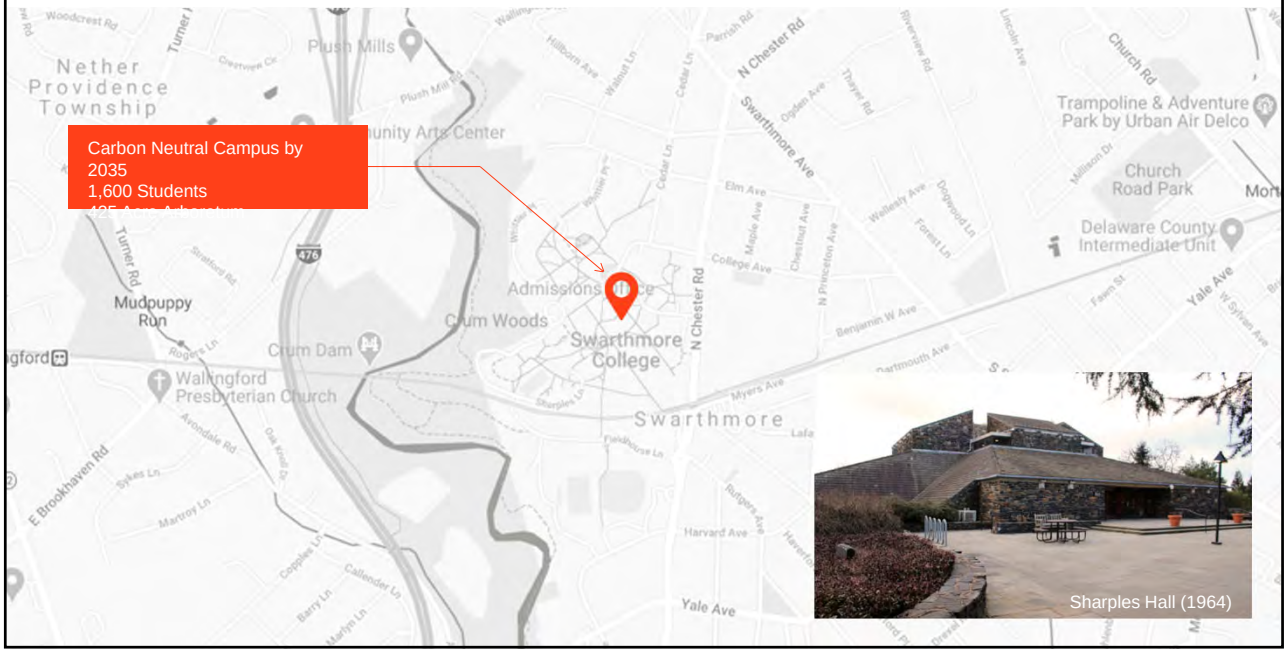
Road to Zero



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Campus Engagement

Dining Advisory Committee

Student Housing Committee

Resident Assistants

Sustainability Office

GA's

Defining Net Zero Goals

BUILDING + CAMPUS ENGINEERING

Participants

Steering Committee
Swarthmore College

Programmatic Committee
Swarthmore College

Design + Sustainability Teams
DLR Group

FOOD SERVICE - SUSTAINABLE GOALS

Participants

Food Service Project Managers
Swarthmore College

Design + Sustainability Teams
DLR Group

PRESIDENT'S STAFF

Participants

Valerie Smith
President Swarthmore College

President's Staff
Swarthmore College

Design + Sustainability Teams
DLR Group

CAMPUS ENGAGEMENT

Participants

Steering Committee
Swarthmore College

Programmatic Committee
Swarthmore College

Design + Sustainability Teams
DLR Group

LIFE CYCLE COST/ CARBON SHADOW PRICE

Participants

Steering Committee
Swarthmore College

Programmatic Committee
Swarthmore College

Design + Sustainability Teams
DLR Group

VALUES OF OUR SUSTAINABILITY COMMITMENT Participants

Steering Committee
Swarthmore College

Programmatic Committee
Swarthmore College

Design + Sustainability Teams
DLR Group

CAMPUS ORGANIZATIONS + GROUPS

Participants

Modern Languages
Swarthmore College

Honors Group
Swarthmore College

Biology Group
Swarthmore College

Maker-Space
Swarthmore College

Design + Sustainability Teams
DLR Group

WORKSHOP WRAP-UP

Participants

Steering Committee
Swarthmore College

DLR Group
Core Design + Sustainability Teams

FACULTY + STAFF OPEN SESSION

Participants

Faculty + Staff
Swarthmore College

Steering Committee
Swarthmore College

Programmatic Committee
Swarthmore College

DLR Group
Core Design + Sustainability Teams

INSIDE OUT

Participants

Building Operations + Maintenance Teams
Swarthmore College

Design + Sustainability Teams
DLR Group

ZERO NET ENERGY

Participants

Steering Committee
Swarthmore College

Programmatic Committee
Swarthmore College

Design + Sustainability Teams
DLR Group

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Overarching Goals & Values

Modern Dining
- Wellness
- Diversity

Community
- Inclusive
- Quaker Values
- Fun/ Socialize

Sustainability
- Global Impact
- Connections
- Safe Space
- Comfort
- Balance
- Natural
- Beauty

Functionality
- Flexible/ Functional
- Collaborative

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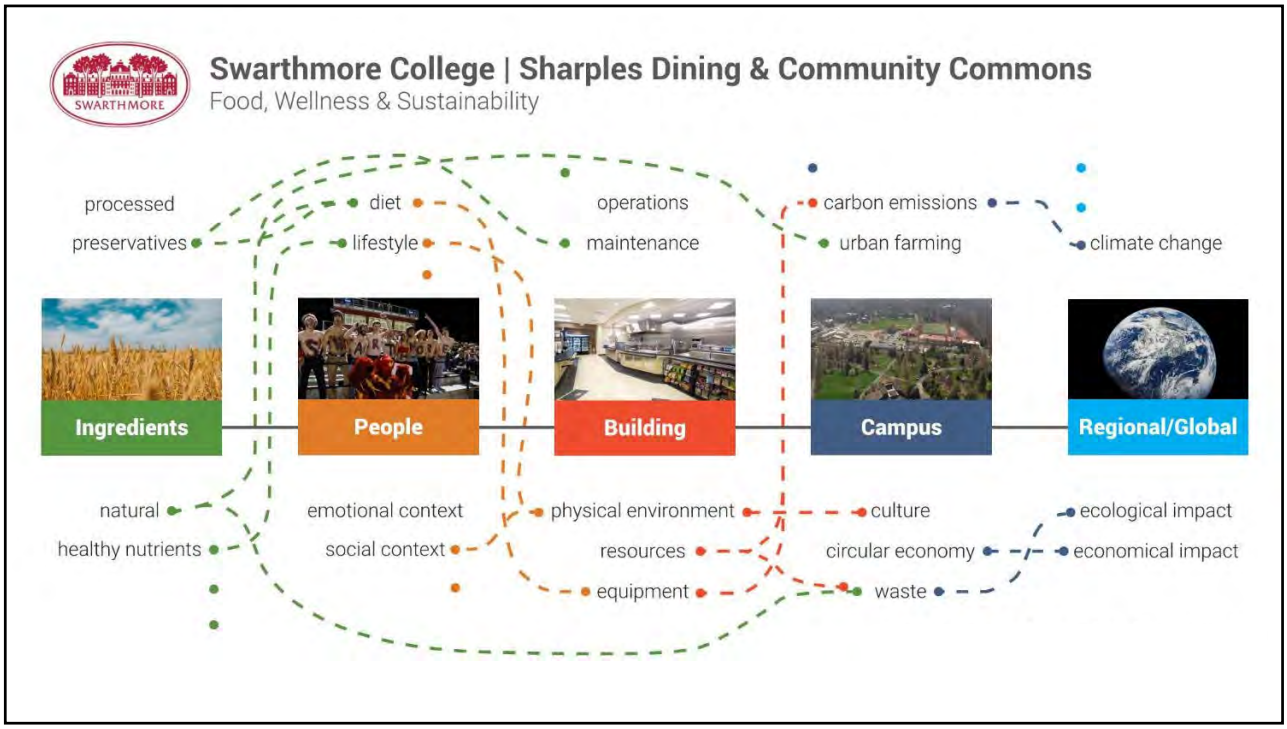

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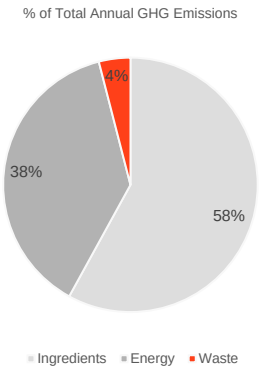
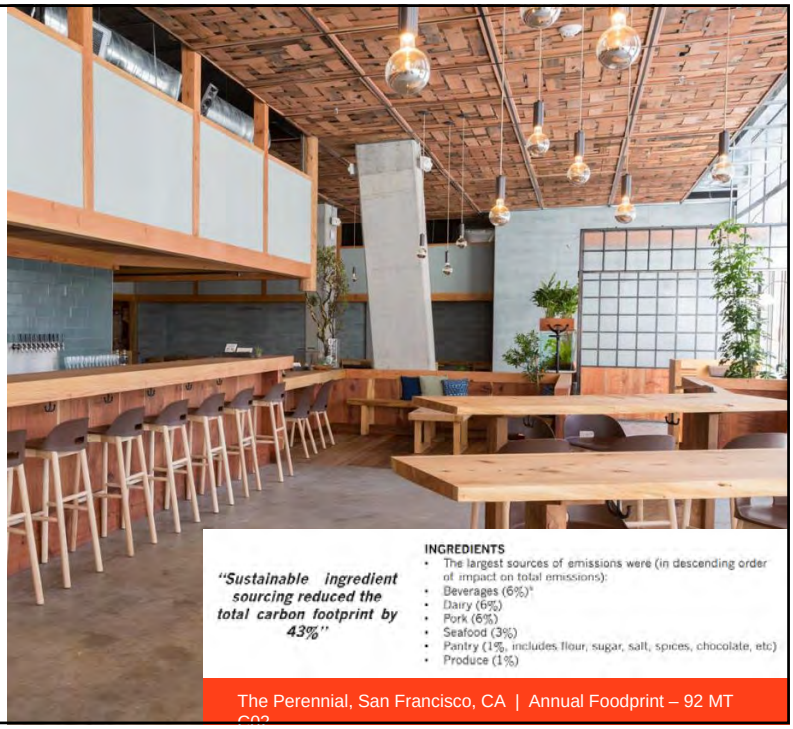
Zero FOODprint





"Sustainable ingredient sourcing reduced the total carbon footprint by 43%"

INGREDIENTS

- The largest sources of emissions were (in descending order of impact on total emissions):
- Beverages (6%)*
- Dairy (6%)
- Pork (6%)
- Seafood (3%)
- Pantry (1%, includes flour, sugar, salt, spices, chocolate, etc)
- Produce (1%)

The Perennial, San Francisco, CA | Annual Foodprint – 92 MT CO2

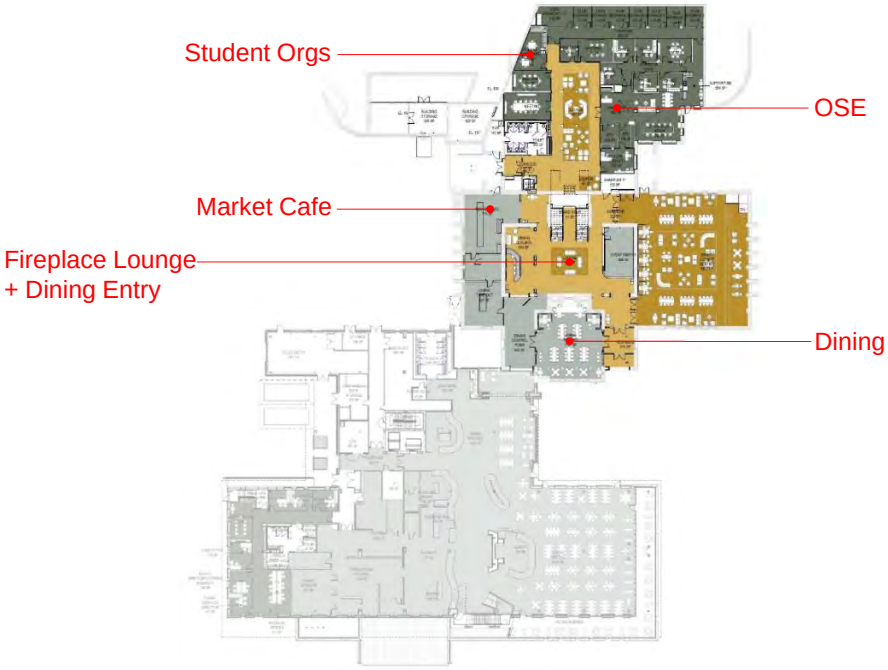
64

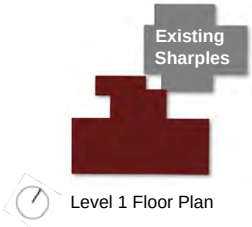
Biophilic Design Summit

65

66

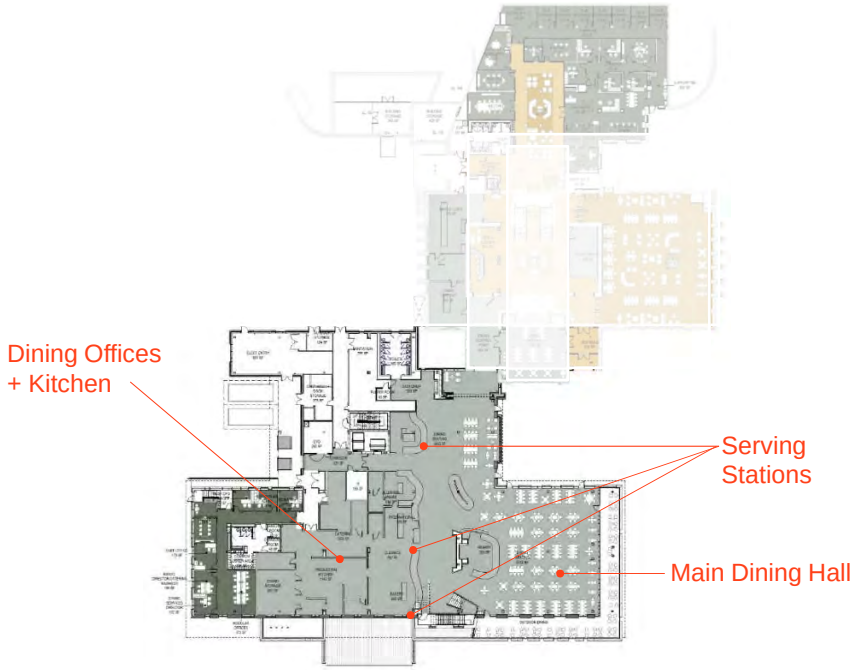
Nourish
Social
Support

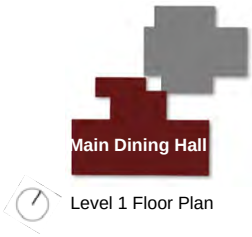




67

Nourish
Social
Support

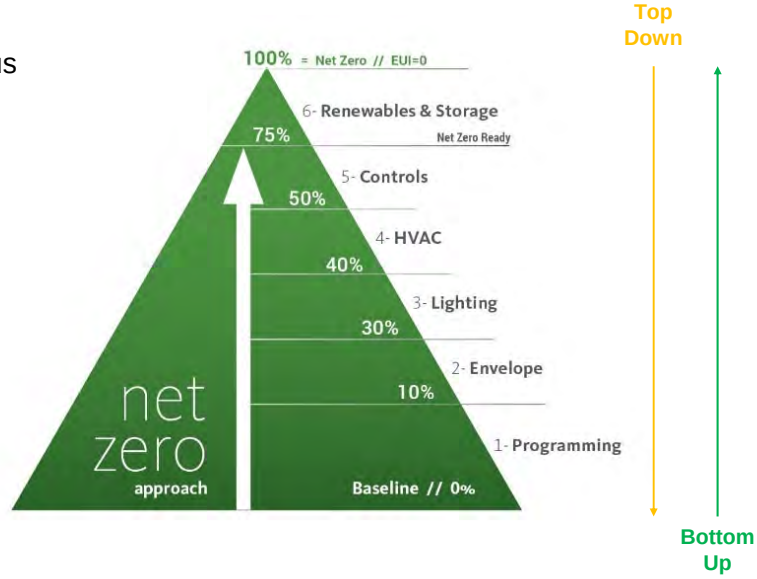




68

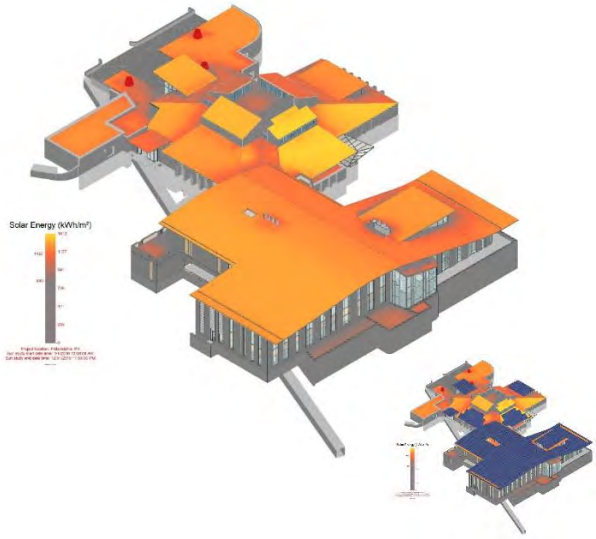
ZNE Feasibility Process

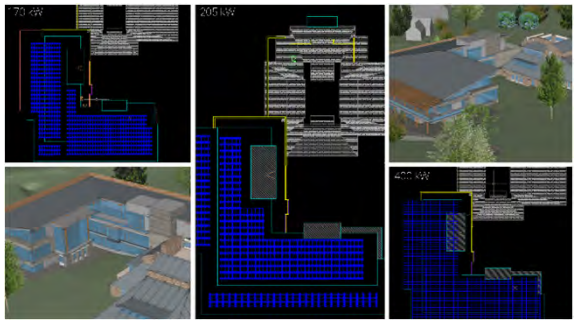
- Renewables – 400 kW + campus
- Electrification – kitchen process
- Centralized geothermal plant
- Advanced control – airflow
- Airside energy recovery
- Radiant floor system
- Lighting – 50% reduction
- Enhanced enclosure / structure
- Right-sized program



69

Solar Rooftop Design

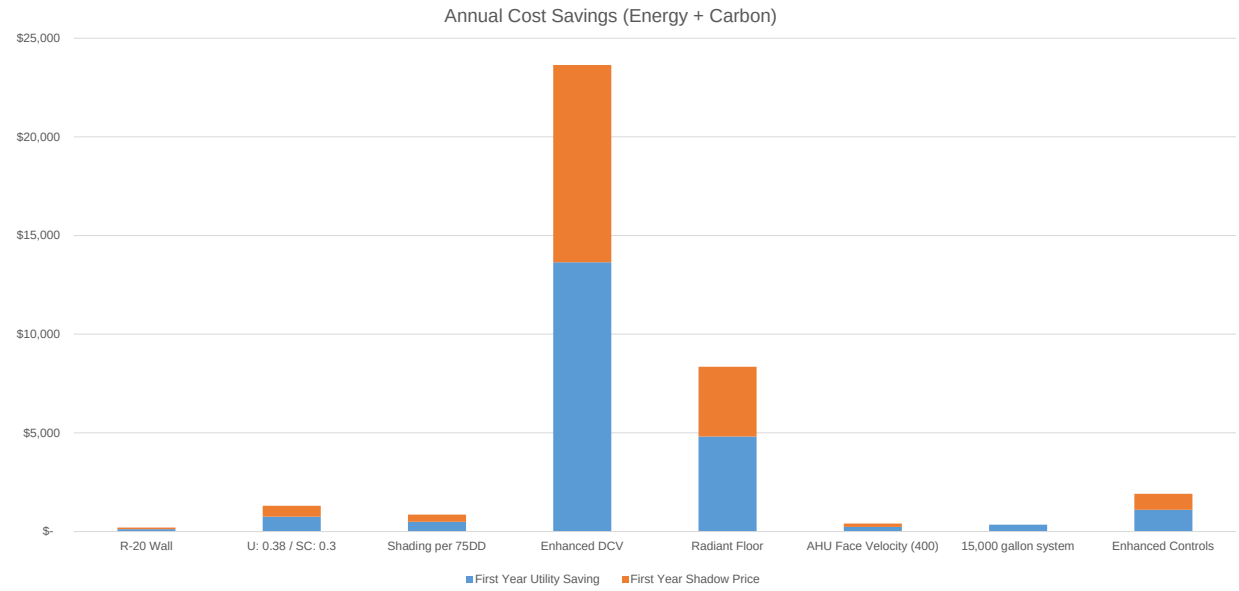




Early PV Study

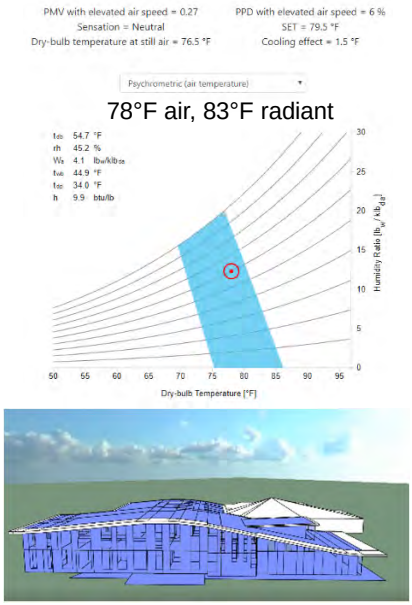
70

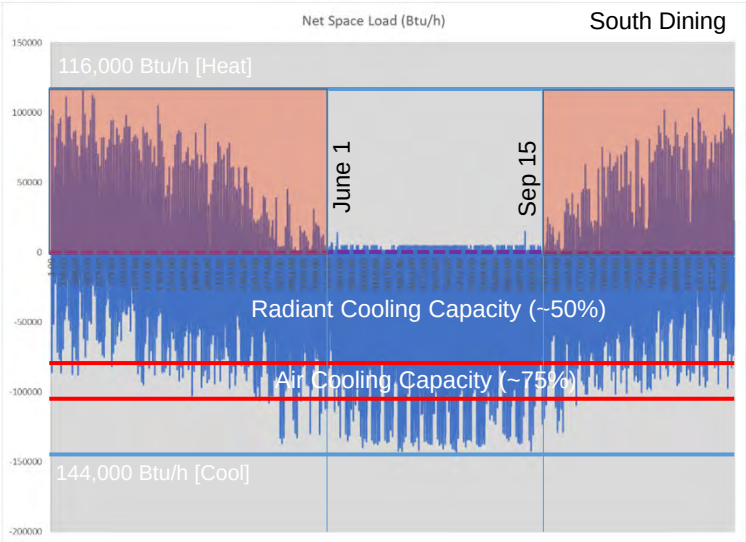
Life Cycle Cost Analysis - $50/ton Carbon Shadow Price



71

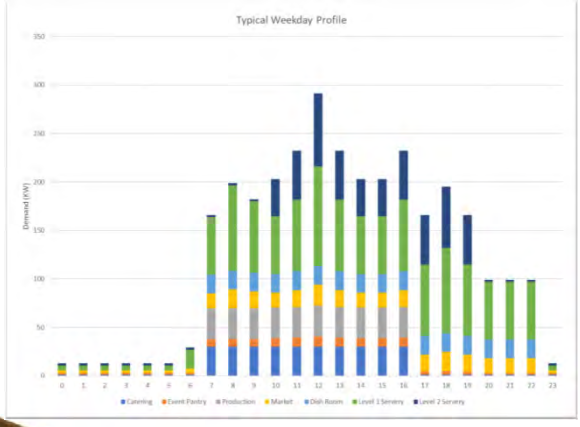
Radiant Systems



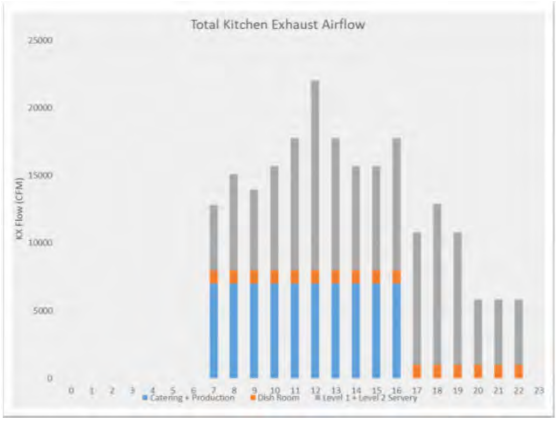


72

Demand Profiles



Electric Demand

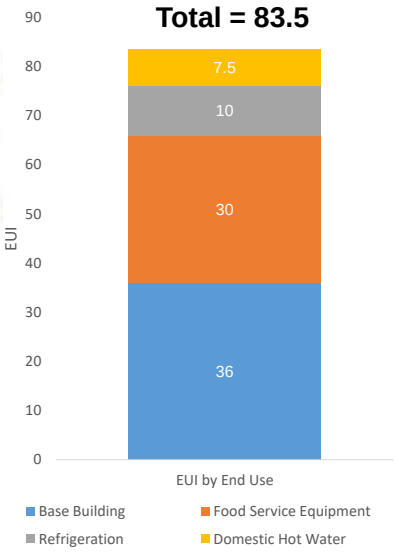


Exhaust Airflow

73

Energy Target

Academic Year	Days	Meals per day	Total Academic Year Meals	kWh per day	Total kWh
Weekdays	180	2650	477,000	3,087	555,618
Weekend days	30	1855	55,650	2,371	71,127
Totals			532,650		626,745
Current kWh/Meal Estimate >>>>>>>					1.177



74

75

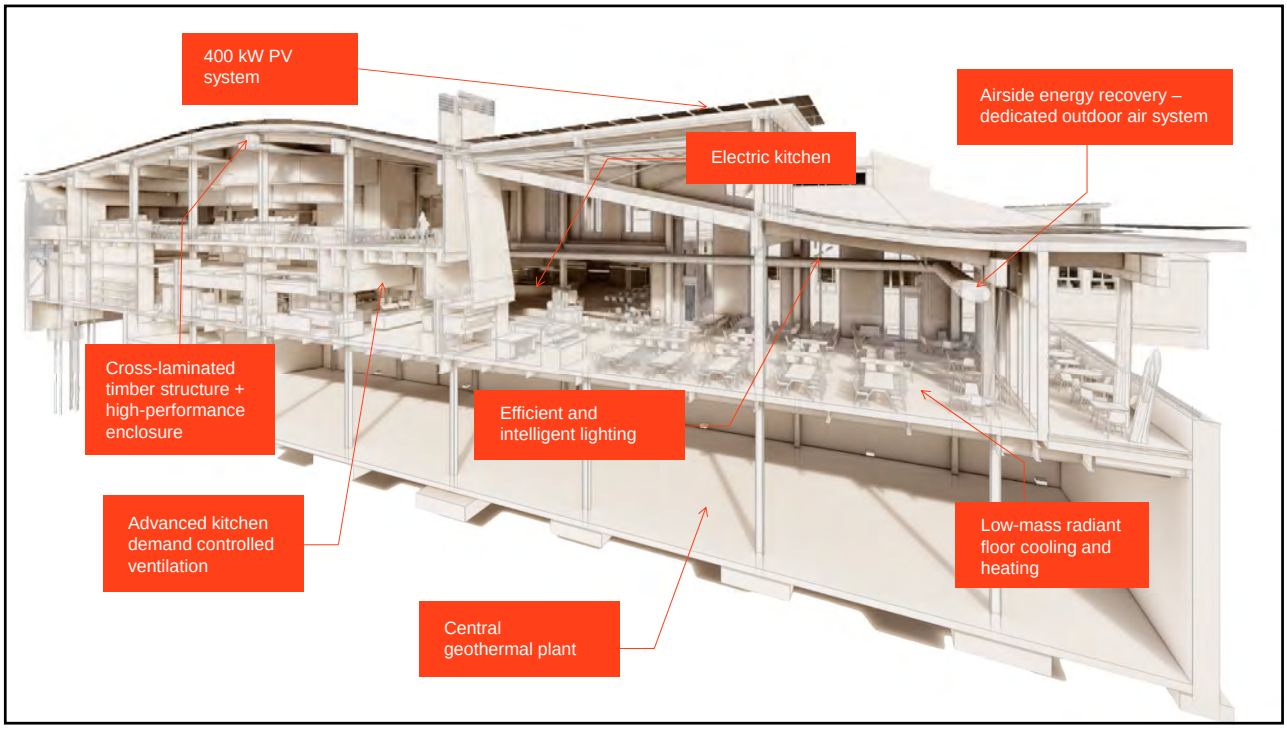
76

Main Dining Hall

77

Upper Dining + Lounge

78


400 kW PV system
Airside energy recovery – dedicated outdoor air system
Electric kitchen
Cross-laminated timber structure + high-performance enclosure
Efficient and intelligent lighting
Advanced kitchen demand controlled ventilation
Low-mass radiant floor cooling and heating
Central geothermal plant

79


January 2021 Update

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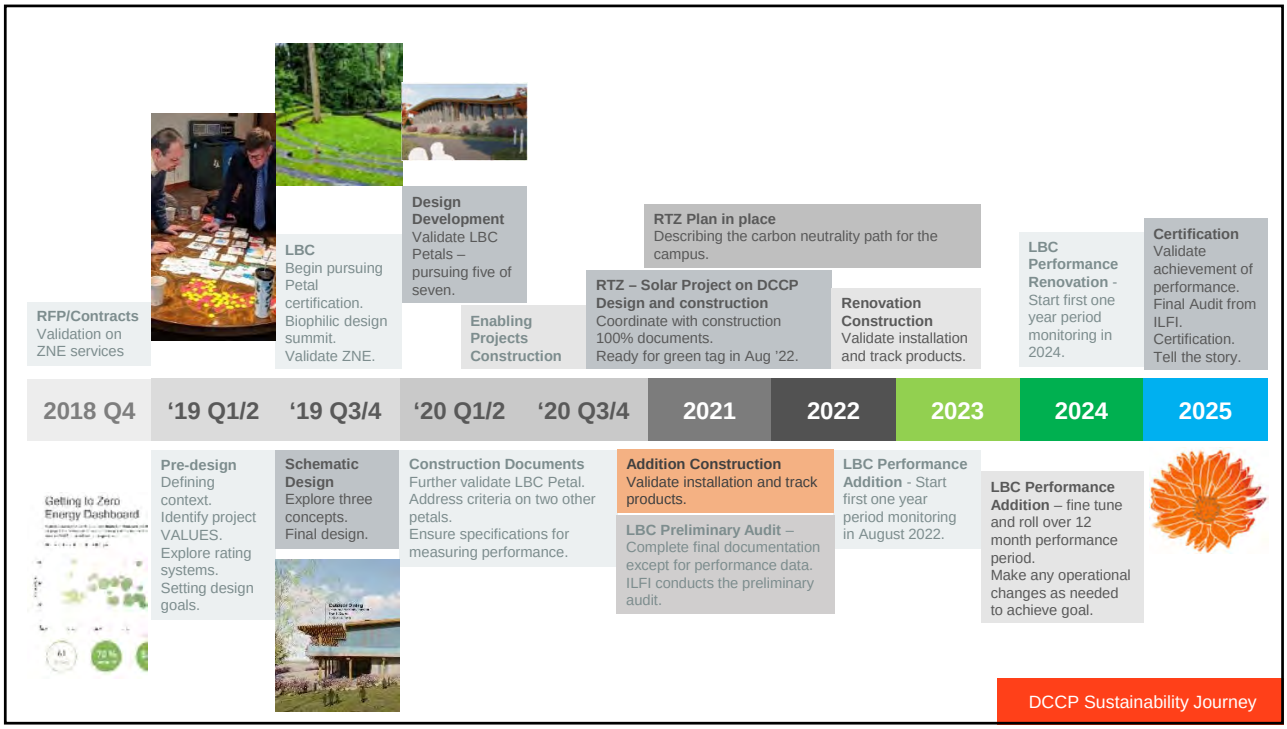


83

A Net Zero Energy Dining Journey

New Buildings Institute March Case Study Jam

Contact Info: Roger Chang – rchang@dlrgroup.com

SWARTHMORE

DLR Group

84

CMTA Inc.

Case-Study - NeoCity Academy: Florida's First Zero-Energy School

Tracy Steward

85

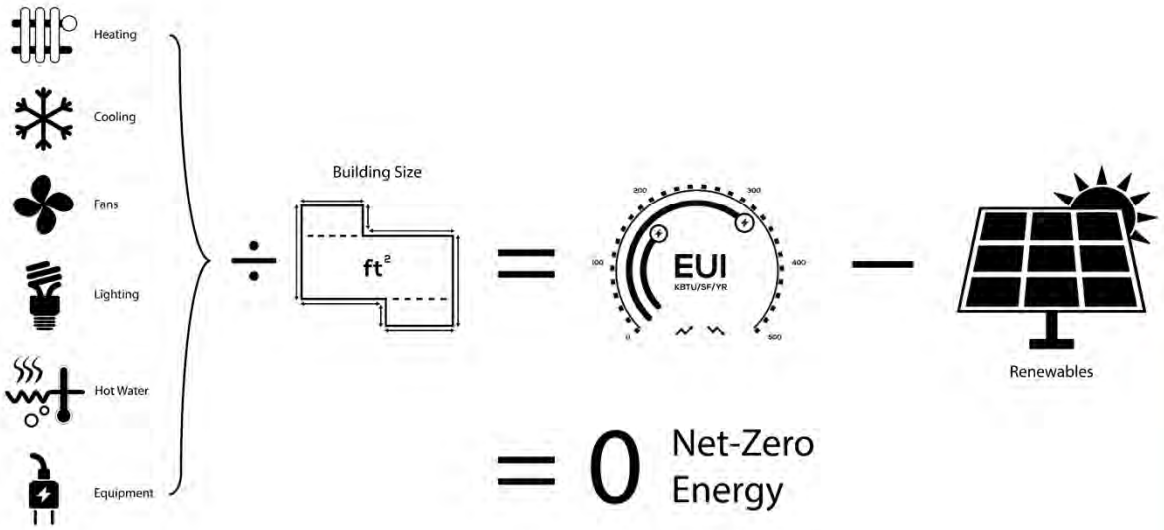
Energy Costs
If a 50% Reduction Goal Became Reality…

Florida Schools	Florida Schools
~$530,000,000	~$265,000,000
Osceola County	Osceola County
~$12,000,000	~$6,000,000

Office of Educational Facilities: Florida Department of Education

86

Zero Energy Philosophy:
…Then Consider Renewable Options



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NeoCity Academy
First Zero Energy School in Florida

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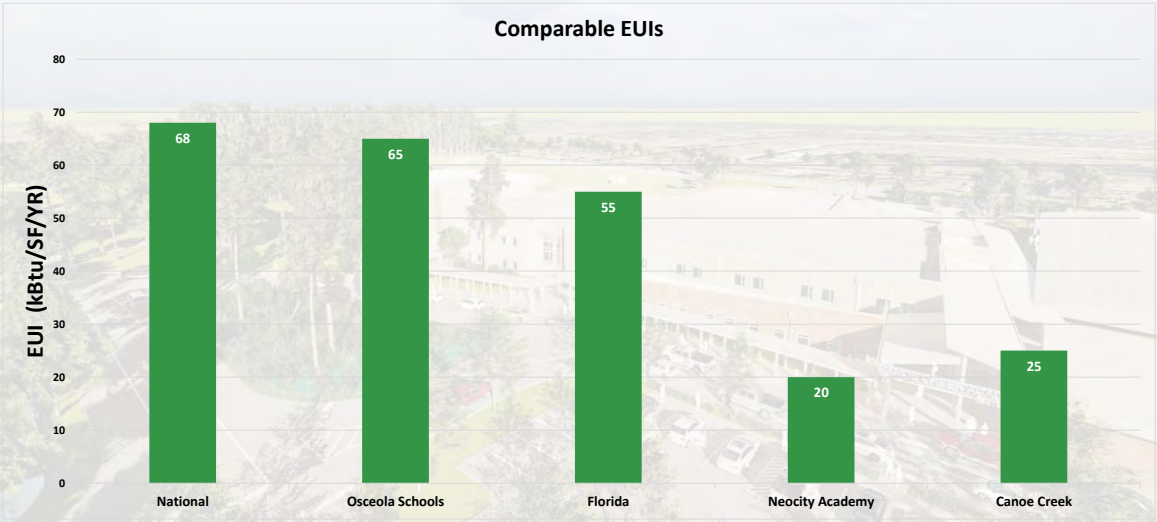
Drastic Energy Reduction

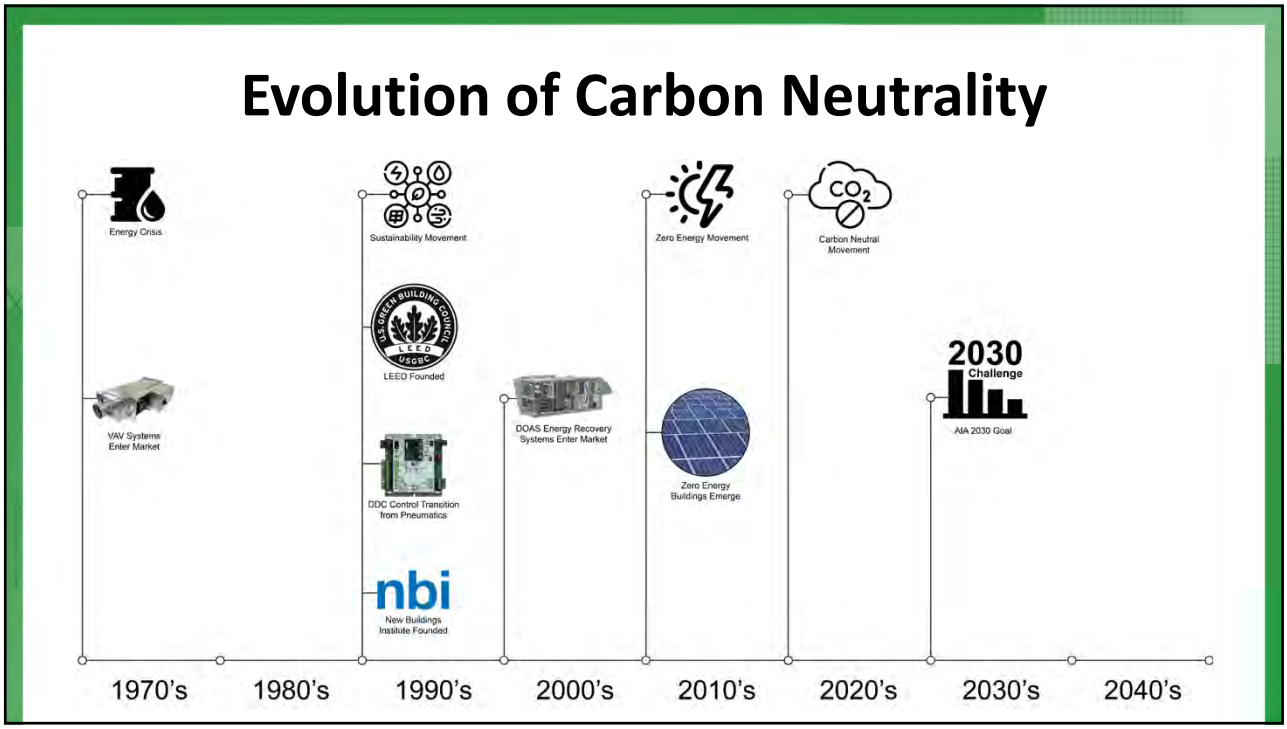


89

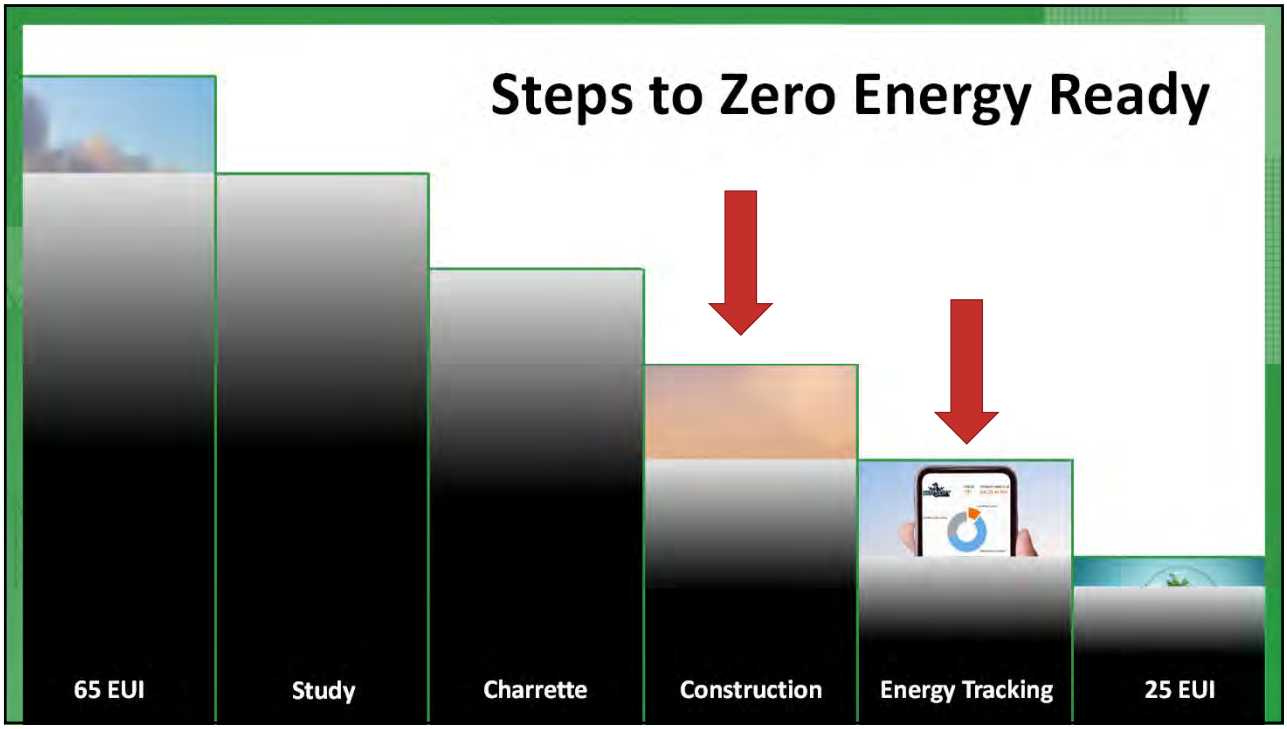
How Do We Achieve This Goal?

One Project at a Time

90


Evolution of Carbon Neutrality
Energy Crisis
VAV Systems Enter Market
Sustainability Movement
LEED Founded
DDC Control Transition from Pneumatics
nbi
New Buildings Institute Founded
DOAS Energy Recovery Systems Enter Market
Zero Energy Movement
Zero Energy Buildings Emerge
Carbon Neutral Movement
2030 Challenge
AIA 2030 Goal
1970's
1980's
1990's
2000's
2010's
2020's
2030's
2040's

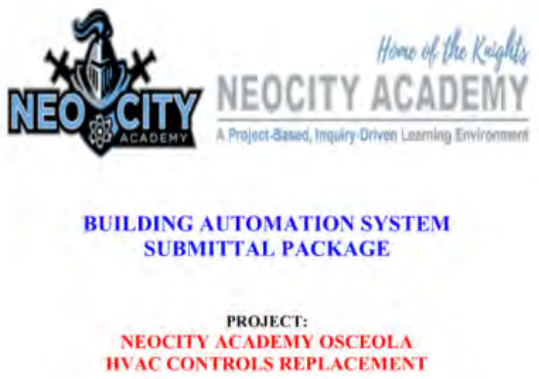
91


Steps to Zero Energy Ready
65 EUI
Study
Charrette
Construction
Energy Tracking
25 EUI

92

Control System

- Shop Drawing Review
- Schedule
- Preventing startup issues
- Schedules
- Trending



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Commissioning

- Functional Performance Testing

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Envelope -Performance Metrics

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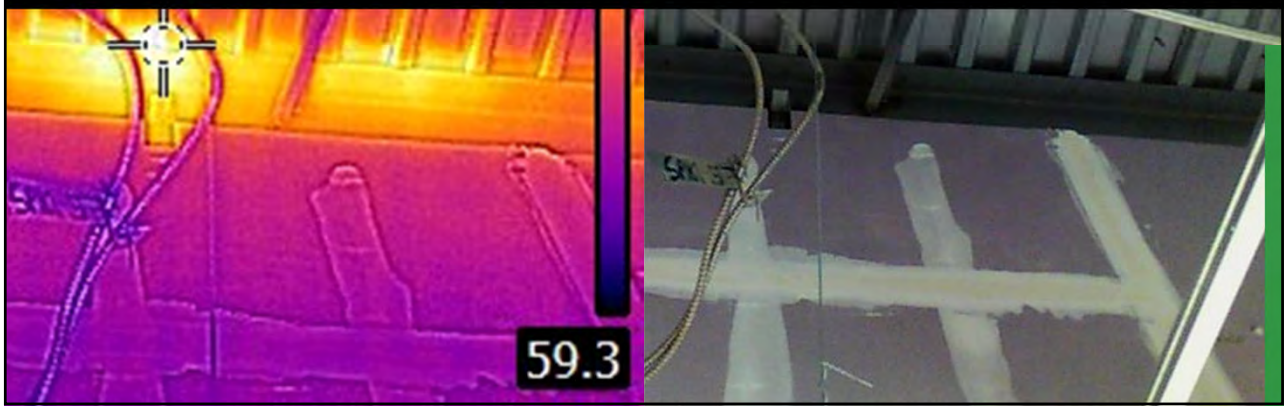
Thermal Imaging



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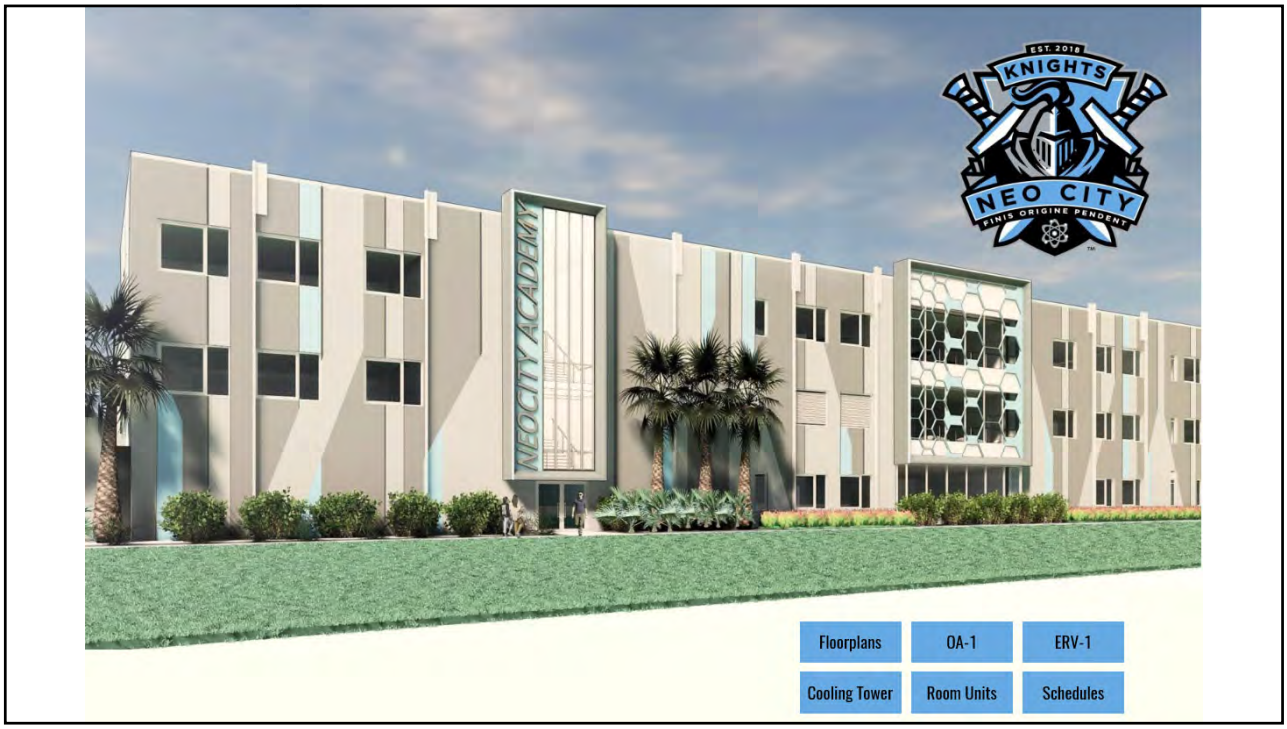
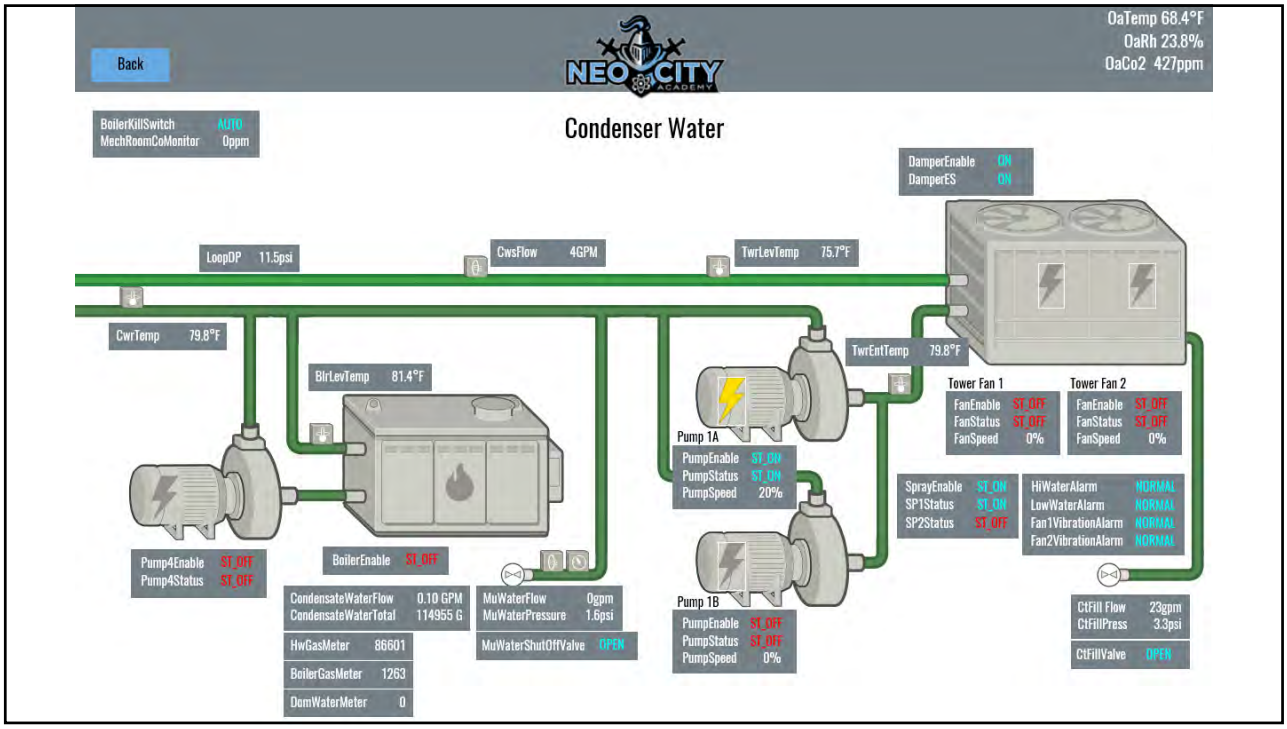
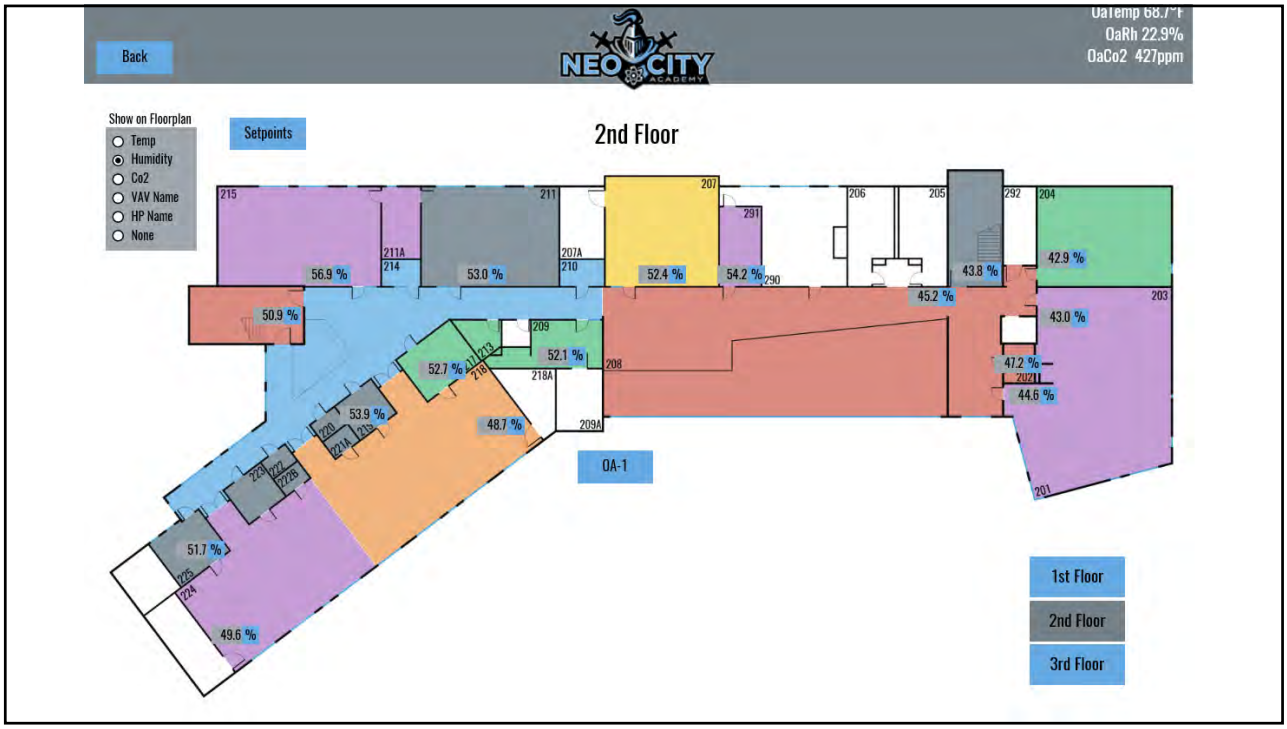

EST. 2018
KNIGHTS
NEO CITY
FINIS ORIGINE PENDENT
NEOCITY ACADEMY
Floorplans
OA-1
ERV-1
Cooling Tower
Room Units
Schedules

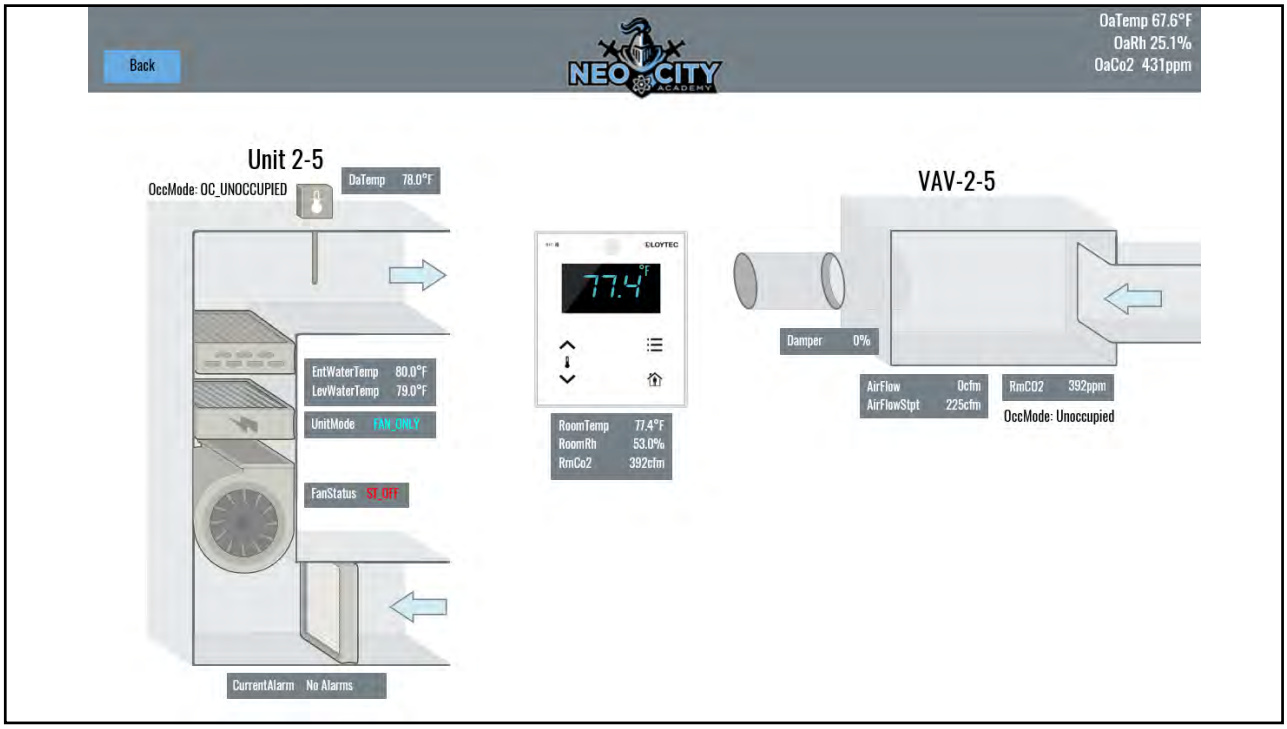
97


Back
NEO CITY ACADEMY
OaTemp 68.4°F
OaRh 23.8%
OaCo2 427ppm
Condenser Water
BoilerKillSwitch AUTO
MechRoomCoMonitor 0ppm
DamperEnable ON
DamperES ON
LoopDP 11.5psi
CwsFlow 4GPM
TwrLevTemp 75.7°F
CwrTemp 79.8°F
TwrEntTemp 79.8°F
BlrLevTemp 81.4°F
Tower Fan 1
FanEnable ST_OFF
FanStatus ST_OFF
FanSpeed 0%
Tower Fan 2
FanEnable ST_OFF
FanStatus ST_OFF
FanSpeed 0%
Pump 1A
PumpEnable ST_ON
PumpStatus ST_ON
PumpSpeed 20%
SprayEnable ST_ON
SP1Status ST_ON
SP2Status ST_OFF
HiWaterAlarm NORMAL
LowWaterAlarm NORMAL
Fan1VibrationAlarm NORMAL
Fan2VibrationAlarm NORMAL
Pump4Enable ST_OFF
Pump4Status ST_OFF
BoilerEnable ST_OFF
CondensateWaterFlow 0.10 GPM
CondensateWaterTotal 114955 G
HwGasMeter 86601
BoilerGasMeter 1263
DomWaterMeter 0
MuWaterFlow 0gpm
MuWaterPressure 1.6psi
MuWaterShutOffValve OPEN
Pump 1B
PumpEnable ST_OFF
PumpStatus ST_OFF
PumpSpeed 0%
CtFill Flow 23gpm
CtFillPress 3.3psi
CtFillValve OPEN

98


Back
NEO CITY ACADEMY
OaTemp 68.7°F
OaRh 22.9%
OaCo2 427ppm
Show on Floorplan
Temp
Humidity
Co2
VAV Name
HP Name
None
Setpoints
2nd Floor
56.9 %
53.0 %
52.4 %
54.2 %
43.8 %
42.9 %
45.2 %
50.9 %
43.0 %
52.7 %
52.1 %
47.2 %
44.6 %
53.9 %
48.7 %
51.7 %
49.6 %
OA-1
1st Floor
2nd Floor
3rd Floor

99


Back
NEO CITY ACADEMY
OaTemp 67.6°F
OaRh 25.1%
OaCo2 431ppm
Unit 2-5
OccMode: OC_UNOCCUPIED
DaTemp 78.0°F
EntWaterTemp 80.0°F
LevWaterTemp 79.0°F
UnitMode FAN_ONLY
FanStatus ST_OFF
CurrentAlarm No Alarms
77.4°F
RoomTemp 77.4°F
RoomRh 53.0%
RmCo2 392cfm
VAV-2-5
Damper 0%
AirFlow 0cfm
AirFlowStpt 225cfm
RmCO2 392ppm
OccMode: Unoccupied

100

Live Data- Measure Success at the Meter

101

Energy Consumption Transparency

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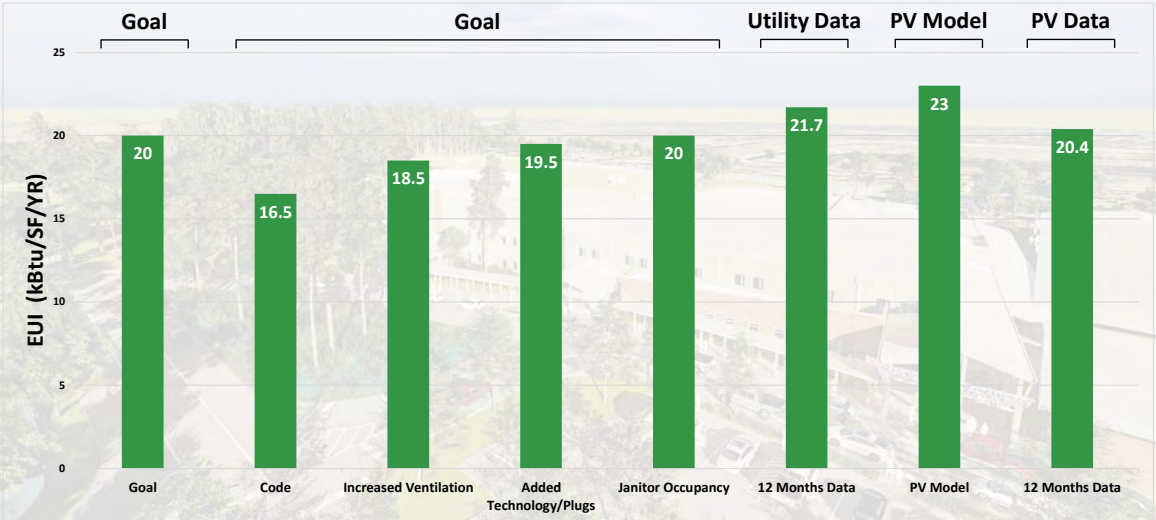
Study Sub-metered Data

103

Energy Tracking to Reach Zero Energy



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NEO CITY
INSIDE OUTSIDE
73°
MONDAY MARCH, 01
04:25:41 PM
LIGHTING MECHANICAL RECEPTACLES BUILDING SOLAR NET ENERGY
DAY WEEK MONTH YEAR
BUILDING DEMAND
43
kW
WHAT DOES THIS DATA MEAN?
PERCENT CHANGE
0.0 %
STRATUS

105


NEO CITY
EXTERIOR FRONT

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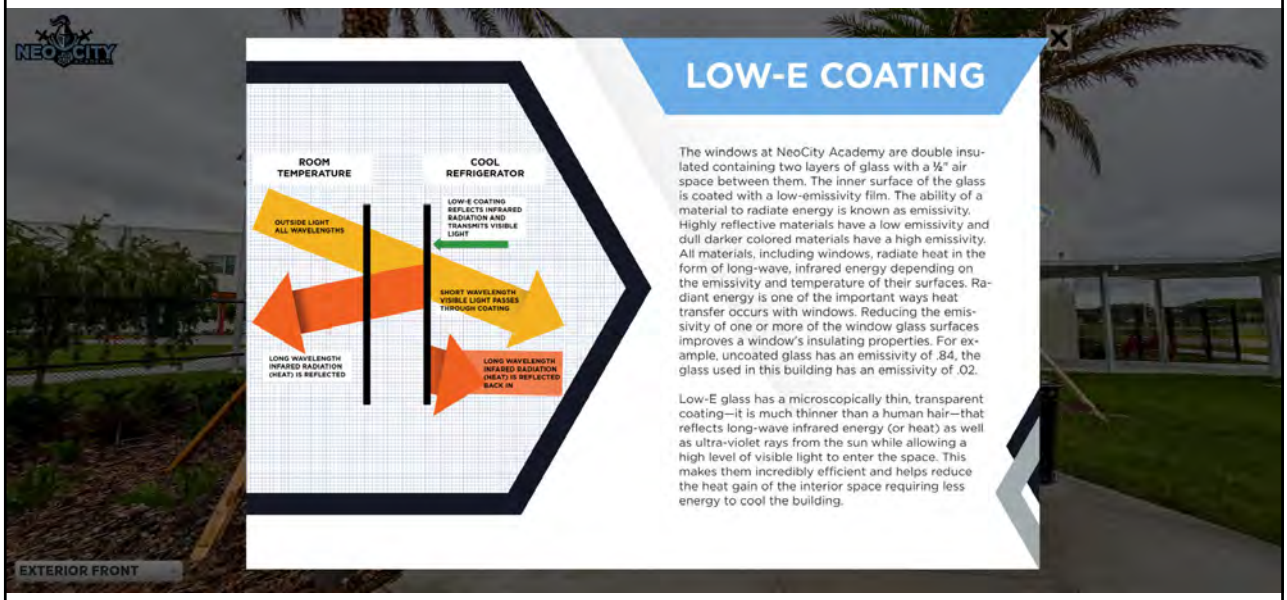
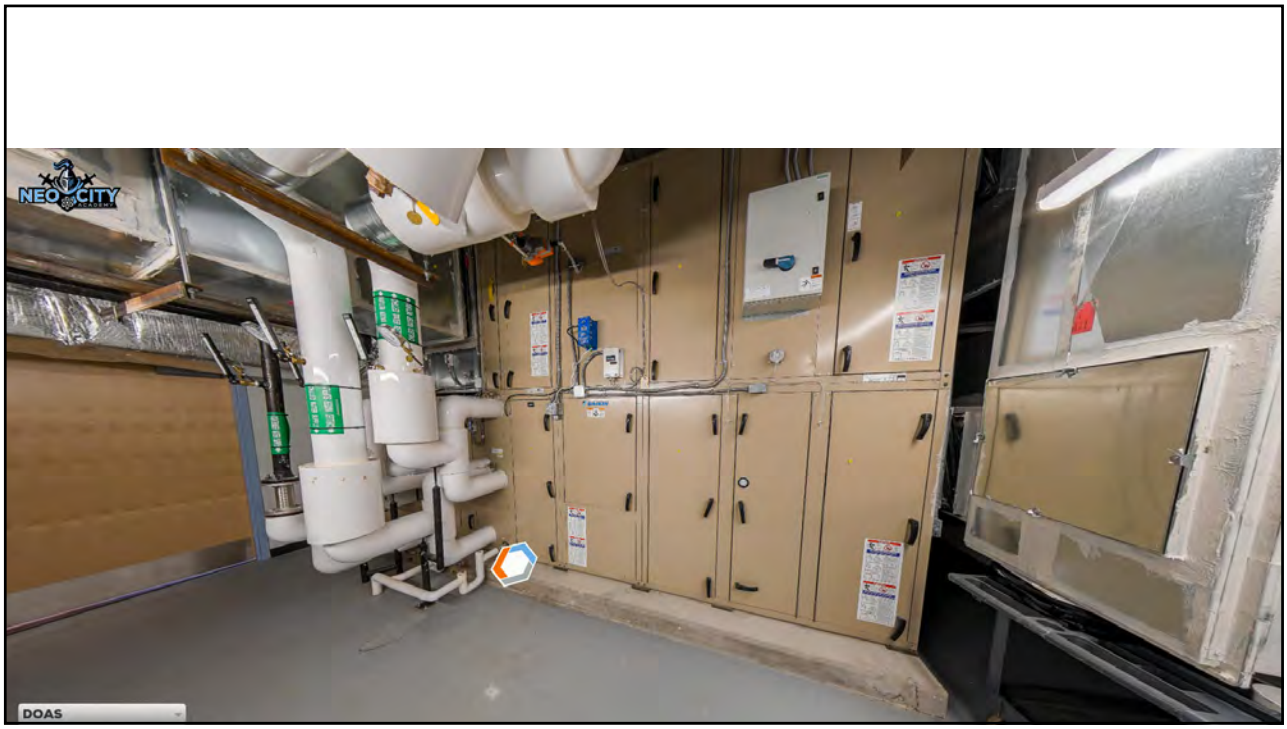

NEO CITY
LOW-E COATING
ROOM TEMPERATURE
COOL REFRIGERATOR
OUTSIDE LIGHT ALL WAVELENGTHS
LOW-E COATING REFLECTS INFRARED RADIATION AND TRANSMITS VISIBLE LIGHT
SHORT WAVELENGTH VISIBLE LIGHT PASSES THROUGH COATING
LONG WAVELENGTH INFARED RADIATION (HEAT) IS REFLECTED
LONG WAVELENGTH INFARED RADIATION (HEAT) IS REFLECTED BACK IN
The windows at NeoCity Academy are double insulated containing two layers of glass with a ½" air space between them. The inner surface of the glass is coated with a low-emissivity film. The ability of a material to radiate energy is known as emissivity. Highly reflective materials have a low emissivity and dull darker colored materials have a high emissivity. All materials, including windows, radiate heat in the form of long-wave, infrared energy depending on the emissivity and temperature of their surfaces. Radiant energy is one of the important ways heat transfer occurs with windows. Reducing the emissivity of one or more of the window glass surfaces improves a window's insulating properties. For example, uncoated glass has an emissivity of .84, the glass used in this building has an emissivity of .02.
Low-E glass has a microscopically thin, transparent coating—it is much thinner than a human hair—that reflects long-wave infrared energy (or heat) as well as ultra-violet rays from the sun while allowing a high level of visible light to enter the space. This makes them incredibly efficient and helps reduce the heat gain of the interior space requiring less energy to cool the building.
EXTERIOR FRONT

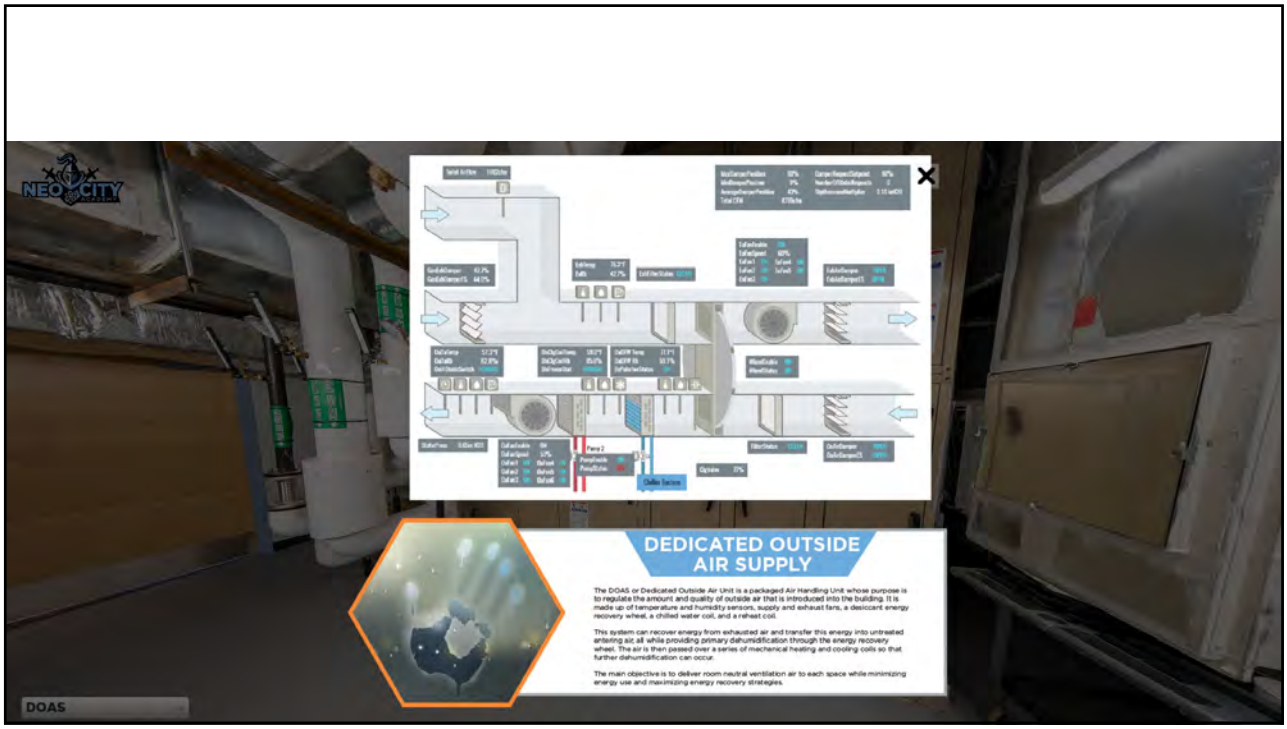
107


NEO CITY

108


NEO CITY
DOAS

109


NEO CITY
DEDICATED OUTSIDE AIR SUPPLY
The DOAS or Dedicated Outside Air Unit is a packaged Air Handling Unit whose purpose is to regulate the amount and quality of outside air that is introduced into the building. It is made up of temperature and humidity sensors, supply and exhaust fans, a desiccant energy recovery wheel, a chilled water coil, and a reheat coil.
This system can recover energy from exhausted air and transfer this energy into untreated entering air, all while providing primary dehumidification through the energy recovery wheel. The air is then passed over a series of mechanical heating and cooling coils so that further dehumidification can occur.
The main objective is to deliver room neutral ventilation air to each space while minimizing energy use and maximizing energy recovery strategies.
DOAS

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Learning Objectives

At the end of the this course, participants will be able to:

1. Understand hidden challenges and road-blocks to zero energy faced with control contractors and 3rd party functional performance testing.
2. Explain through project specific examples how access to the building automation coupled with a live energy dashboard are leveraged for zero energy success.
3. Demonstrate how dashboards have evolved from an energy displays to academic curriculum.

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Q and A

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Save the Date!

GETTING TO zero FORUM 2021

October 27-29, 2021
New York City

Join building and energy industry leaders at the premier global event dedicated to defining a low-energy, low-carbon future for the built environment.

nbi new buildings institute | RMI | NEW YORK STATE OF OPPORTUNITY. NYSERDA

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Join us for another webinar:

Getting to Zero: Grid-Integrated Buildings

Thursday, April 29, 2021

10:00 -11:30 AM PDT/ 1:00-2:30 PM EDT

Find links to register for these sessions at newbuildings.org/event/

nbi new buildings institute

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Access case studies, research, guidance, models and more

The **Getting to Zero Resource Hub** is an open-source collection of over 300 zero energy and zero carbon resources across six different topic areas:

Design & Development | Embodied Carbon | Codes & Policy | Local Governments Toolkit | Residential | Schools

gettingtozeroforum.org/resource-hub

GETTING TO zero | nbi new buildings institute

The Getting to Zero Resource Hub was developed and delivered by New Buildings Institute with ongoing support from our sponsors and partners.

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Find out first!

Follow NBI on your favorite social media platform.

ZeroEnergyBuildings

@zeroenergybldgs

New Buildings Institute

Find us online at:

nbi new buildings institute

www.newbuildings.org

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Net Zero Buildings Week

One week. All net zero.

Join us for **Net Zero Buidlings Week** and share resources for getting to zero energy and carbon neutral buildings.

Contact us for more information

connie@newbuildings.org

Net Zero Promotion Week is led by a network of building industry organizations to raise awareness and promote the benefits of net zero buildings for a clean energy future.

Join us! March 29 to April 2

Here's how it works:

1. Commit to promoting net zero related resources during the week of 3/29-4/2
2. Contact NBI for more info
3. Tease the week on your social media @handles and use #NetZeroNow and start to follow others on Twitter, LinkedIn, Facebook, etc.
4. Post your resources and share others' during the week

Net Zero NOW

For a better future

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Thank you!

You will receive an email tomorrow with links to the on-demand recording and a PDF of the slides.

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