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Getting to Zero: Building Case Study Jam
March 25, 2021
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

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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The mission of the AIA 2030 Commitment is to support the 2030 Challenge and transform the practice of architecture in a way that is holistic, firm-wide, project based, and data-driven.
Ten years strong, participation continues to grow each year.

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

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

Global CO₂ emissions by sector

IMAGE © 2018 2030, Inc. / Architecture 2030. All rights reserved.

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
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.

Design strategies have the greatest impact on building energy use.

Architects have the greatest impact on design strategies early in the design process.
Design strategies have the greatest impact on building energy use. Architects have the greatest impact on design strategies early in the design process.

Modeled projects consistently report higher savings, regardless of size.
“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

Learn more at aia.org/2030Commitment

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

March 25, 2021
Presented by PAE

Parkview at Terwilliger Plaza

- High rise senior living in Portland, OR
- 10 story, 250,000 ft²
- Targeting PHIUS+ 2018 certification
SECTION 1

Goal Setting and Stakeholder Buy-in Journey

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
Sustainability Targets

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

No fossil fuels
- Heat pump heating
- Electric appliances

Architecture 2030 Energy Target
- Combined EUI 10 kBtu/ft²/year

Data-driven Design and Lessons-learned
Early Design Analysis

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**
30 Year Life Cost Analysis

Envelop Details

SECTION 3
Envelop Details

ENVELOPE OPTIMIZATION

Thermal bridging analysis

Envelop Details

WINDOW PERFORMANCE

SHADING OPTIMIZATION
Mechanical Systems for Dwelling Units
Domestic Hot Water Heat Pumps

Appliances
ECO-APPLIANCES

CLOTHES WASHER
Best in class energy star 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.
**Appliances**

**ECO-KITCHEN**

**KITCHEN COOKTOP**
Induction cooktops dramatically outperform gas and electric options.

**RANGE COOKTOP**
Induction cooktops outperform 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.

---

**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.
**Renewable Energy**

**PV Analysis**
- **Rooftop System**: 195.7 kW
- **Adjacent Building Systems**: 143.3 kW
SECTION 6

Wrap-up

EUI - Energy Use Index

ESTIMATED ENERGY USE

EUI TARGET TRACKING

- CBECs
- PUMPS
- FANS
- HEAT REJECTION
- COOLING
- DHW
- HEATING
- ELEVATORS
- RECEPTACLES
- LIGHTING
- Electricity
Key Takeaways

- **Define Actionable Goals**
- **Use Early Analysis to Drive Decisions**
- **Buy-In from Owner and Design Team**
- **Sustainability Can Complement Other Design Goals**
Creating a better environment

Dan Luddy
PE, BEMP, CPAC, LEED AP
ASSOCIATE
dan.luddy@pae-engineers.com
206-413-7268

Is Net Zero Energy (NZE) Food Service Possible?

TAMING THE 900-POUND GORILLA

Proctor Dining Commons
250 Meals 3x Day (average)
Existing Food Service EUI: 207-418 kBtu/sf/yr
Average 267 kBtu/sf/yr

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

NZE Food Service Strategy
Base EUI (15-25) +
Reduced Food Service Process Load EUI =
NZE Food Service EUI ≤
Renewable Energy
NZE Food Service Process

Calculate Loads

Proctor Dining Commons -- Code Building Loads

- hood makeup heating
- cooking
- space heating
- hot water
- hood makeup cooling
- space cooling
- Other
**NZE Food Service Process**

**Energy Modeling**

Proctor Dining Commons
Schematic Level
Estimate of First Year Energy Cost

- Option 1: Code Compliant Building
- Option 2: Net Zero Ready Building
- Option 3: Renewable with Combustion Building

---

**NZE Food Service Process**

**Financial Analysis**

Cumulative Energy and Capital Costs (in 2005 dollars)

- 9.5% Fossil Fuel Escalation
- 1% Electrical Escalation

- Microbial biogas/SHP
- Microbial biogas/SHP + propane boiler
NZE Food Service Process
Carbon Impact

EQUIVALENT CO2 EMISSIONS

= 4 TIMES ANNUALLY

Implementing NZE Strategy
All Electric Kitchen
Reduced Ventilation Loads
Ground Source Heat Pumps
Implementing NZE Strategy
All Electric Kitchen
Reduced Ventilation Loads
Ground Source Heat Pumps
Solar – but not all on roof tops
Educating Users

Proctor EUI = 85
Pizza Oven is 5 EUI
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
Road to Zero

Carbon Neutral Campus by 2035
1,600 Students

505 students interviewed
Campus Engagement

Dining Advisory Committee
Student Housing Committee
Resident Assistants
Sustainability Office
GA's

Defining Net Zero Goals

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
Swarthmore College | Sharples Dining & Community Commons
Food, Wellness & Sustainability

Ingredients
- Processed
- Preservatives
- Diet
- Lifestyle

People
- Operations
- Maintenance

Building
- Physical Environment
- Resources
- Equipment

Campus
- Culture
- Circular Economy
- Waste

Regional/Global
- Ecological Impact
- Economical Impact
- Climate Change
- Urban Farming

% of Total Annual GHG Emissions

- Ingredients
- Energy
- Waste

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

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

Annual Cost Savings (Energy + Carbon)

- $25,000
- $20,000
- $15,000
- $10,000
- $5,000
- $0
- $-

R-20 Wall
U: 0.36 / SC: 0.3
Shading per TID (enhanced)
Enhanced DCV
Radiant Floor
AHU Face Velocity (400)
15,000 gallon system
Enhanced Controls

First Year Utility Saving
First Year Shadow Price

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

Radiant Systems

Net Space Load (Btu/h)

South Dining

116,000 Btu/h [Heat]
144,000 Btu/h [Cool]

July

Sep 15

Radiant Cooling Capacity (~50%)
Air Cooling Capacity (~75%)

78°F air, 83°F radiant
Demand Profiles

Electric Demand

Exhaust Airflow

Energy Target

<table>
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<th>Academic Year</th>
<th>Days</th>
<th>Meals per day</th>
<th>Total Academic Year Meals</th>
<th>kWh per day</th>
<th>Total kWh</th>
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<td>2650</td>
<td>477,000</td>
<td>3,087</td>
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<td>Weekend days</td>
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<td>1855</td>
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<td>2,371</td>
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<td>510</td>
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<td>532,650</td>
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<td>626,745</td>
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<td>Current kWh/Meal Estimate</td>
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Total = 83.5

EUI by End Use:
- Base Building
- Food Service Equipment
- Refrigeration
- Domestic Hot Water
Cross-laminated timber structure + high-performance enclosure

Advanced kitchen demand controlled ventilation

Efficient and intelligent lighting

Electric kitchen

Low-mass radiant floor cooling and heating

Central geothermal plant

Airs side energy recovery – dedicated outdoor air system

400 kW PV system

January 2021 Update
**A Net Zero Energy Dining Journey**  
**New Buildings Institute March Case Study Jam**

Contact Info: Roger Chang – rchang@dlrgroup.com
CMTA Inc.

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

Tracy Steward

Energy Costs
If a 50% Reduction Goal Became Reality...

Florida Schools
~$530,000,000

Florida Schools
~$265,000,000

Osceola County
~$12,000,000

Osceola County
~$6,000,000

Office of Educational Facilities: Florida Department of Education
Zero Energy Philosophy:
...Then Consider Renewable Options

Net-Zero Energy

NeoCity Academy
First Zero Energy School in Florida
Drastic Energy Reduction

Comparable EUIs

<table>
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<tr>
<th>EUI (kBtu/SF/YR)</th>
<th>National</th>
<th>Osceola Schools</th>
<th>Florida</th>
<th>Neocity Academy</th>
<th>Canoe Creek</th>
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<td>68</td>
<td>65</td>
<td>55</td>
<td>20</td>
<td>25</td>
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</tbody>
</table>

How Do We Achieve This Goal?

One Project at a Time
Evolution of Carbon Neutrality

Steps to Zero Energy Ready

65 EUI  Study  Charrette  Construction  Energy Tracking  25 EUI
Control System

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

Commissioning

• Functional Performance Testing
Envelope - Performance Metrics

Thermal Imaging

59.3
Live Data- Measure Success at the Meter

**What does this data mean?**
This data shows the total amount of energy used to operate the facility. This includes all energy required to heat, cool, and light the building, plus any equipment and appliances used in the building by individuals and any machinery in operation.

**Percent change from previous period:**
0.0%

Energy Consumption Transparency

**What does this data mean?**
This data shows the total amount of energy used to operate the facility. This includes all energy required to heat, cool, and light the building, plus any equipment and appliances used in the building by individuals and any machinery in operation.

**Percent change from previous period:**
-24.9%
Study Sub-metered Data

Energy Tracking to Reach Zero Energy
LOW-E COATING

The windows at NeoCity Academy are double insulated containing two layers of glass with a 5" 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 0.8, the glass used in this building has an emissivity of 0.02.

Low-E glass has a microscopically thin, transparent coating—thinner than a human hair—that reflects long-wave infrared energy (or heat) as well as ultraviolet 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.
Learning Objectives

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

1. Understand hidden challenges and roadblocks 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.
Q and A

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.
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/

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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](http://gettingtozeroforum.org/resource-hub)

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

One week. All net zero.

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

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Find out first!
Follow NBI on your favorite social media platform.

Find us online at:

ZeroEnergyBuildings
@zeroenergyblnds
New Buildings Institute

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.

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
Thank you!

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