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:
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.

Today’s panelists:

Atalia Howe
Manager
The Community Preservation Corporation

Paul Torcellini
Principal Engineer
Commercial Buildings Research Group
NREL

Maya Gantley
Project Manager
Association for Energy Affordability Inc.

Waleed AlGhamdi
Consultant

The David and Lucile Packard Foundation Headquarters | Los Altos, CA Photo: Jeremy Bittermann
ABOUT CPC

MISSION-DRIVEN SINCE 1974

CPC believes housing is central to transforming underserved neighborhoods into thriving and vibrant communities.

CPC is a nonprofit affordable housing and community revitalization finance company providing flexible capital solutions, fresh thinking and a collaborative approach to the complex issues facing communities.

CPC’s belief is that private capital can be the solution to scaling energy efficiency by incorporating better building upgrades and practices into the first mortgage process by underwriting actual operating expenses and savings.

Since 2015, CPC has financed over 8,200 units of environmentally sustainable housing.

Learn More: communityp.com
CPC provides a full suite of products to finance multifamily housing. Our team of experts work hand-in-hand with our borrowers to provide a level of personalized service that is second to none.

**CONSTRUCTION LENDING**
We will simultaneously commit a construction loan and a long-term permanent mortgage, which can be committed up to 24 months in advance. This includes lending for the acquisition/refinancing and rehabilitation of multifamily occupied properties, gut renovation of vacant buildings into multifamily properties, and new construction of multifamily properties.

**PERMANENT FINANCING**
CPC has a full suite of permanent lending products uniquely tailored to fit multifamily mortgage needs. From acquisition to refinancing, our team of dedicated experts work with borrowers to find the most competitive terms and rates.

**EQUITY INVESTING**
CPC is a long-term, cash-flow oriented investor, and our investment strategy and hold period align with the goal of creating and preserving good-quality, well-managed affordable housing. We partner with local owner-operators with strong teams and market knowledge, who share our investment philosophy.

---

**CPC: UNCOMMON EXPERTISE. UNMATCHED IMPACT.**

- **INVESTMENT**
  - $11 billion of private & public capital invested in the Northeast Region

- **PHYSICAL**
  - Over 195,000 residential units financed

- **SOCIAL**
  - Over 965,000 people provided with high quality, stable housing

- **ECONOMIC**
  - Stimulated the creation of over 115,000 jobs via construction lending
• CPC is a carbon neutral company, aligning with the New York City and State carbon reduction goals, as well as international frameworks.

• Developed CPC VeriFi, an online software application that calculates potential utility savings and helps owners explore financing options for multifamily building upgrades.

• Developed the Underwriting Efficiency guide to provide lenders, public partners and owners with a resource to finance energy and water efficiency measures as part of a first mortgage.
  ▪ CPC recently launched a supplement to the original guide with a focus on high-performance energy efficiency practices for new construction (ex. Passive House, NZE).

• CPC is a RetrofitNY financing partner. RetrofitNY, a NYSERDA initiative, is working to bring a large number of affordable housing units to or near net-zero energy use by 2025.

• Member of NYSERDA’s Carbon Neutral Buildings Roadmap Technical Advisory Group.

• CPC continues to explore new financing incentives and original loan offerings that add value to the market and support the adoption of increased environmental and economic sustainability.

Guide Overview
This guide is designed for multiple stakeholders within the multifamily ecosystem. It tackles the basics of high-performance design and how those design decisions can affect lifecycle performance, value, risk, and overall asset health.

› WHAT IS A HIGH-PERFORMANCE BUILDING?

› GROWING INTEREST IN HIGH-PERFORMANCE BUILDINGS

› BUILDING LIFECYCLE
  • FINANCE AND BUILD
  • OPERATE AND MAINTAIN
  • APPRAISE AND RESELL

› BUILDING FOR THE FUTURE

https://communityp.com/thought-leadership/sustainability/financing-high-performance/
Zero Energy Building (ZEB) Definition

An energy-efficient building, where on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy.
Energy Balance Boundary

Delivered Energy
Renewable and nonrenewable

On-site Renewables:
- Building Needs
- Heating
- Cooling
- Ventilation
- DHW
- Lighting
- Plug Loads
- Processes

Exports Energy: Renewable

Energy transfer within boundary
Energy transfer entering or leaving boundary

Source: Paul Torcellini/Marjorie Schott/NREL

Meeting the energy requirements

Site energy use intensity targets to meet the available rooftop PV annual energy production (75% roof PV, 2 floors)

Site EUI (kBtu/ft^2/yr)

Assumptions:
- 75% of Roof area available for PV
- 2 floor MF building

This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy.

NREL | 13

NREL | 14
Advanced Energy Design Guides

Six 30% Guides published (2004-2008)
Highway Lodging, K-12 Schools, Small Hospitals and Healthcare Facilities, Small Office Buildings, Small Retail Buildings, Small Warehouses and Self Storage

Five 50% Guides published (2009-2013)
Grocery Stores, K-12 Schools, Large Hospitals, Small to Medium Office Buildings, Medium to Big Box Retail Buildings

Two Zero Energy Guides Published (2018-current)
K-12 Schools
Small/Medium Offices
Multifamily (expected late Fall 2020)

As of October 5, 2020
All versions (13 total)
658,508 downloaded
26,582 distributed in print
685,090 total
171,367 registrants account for free AEDG downloads

ZE
K-12: 11,292 copies (January 2018)
SMO: 5,610 copies (June 2019)

• Industry partnership with top professional organizations and DOE, with oversight and constant validation process with industry experts
• Specialized volunteer experts on the Project Committee for each guide, representing the different professional organizations
• Supported by and leveraging DOE’s national laboratory research, energy simulation, and technical analysis

Zero Energy Trends

Resources:
Advanced Energy Design Guide for Achieving Zero Energy

• Design guidance by building type and climate zone
• Supported by case studies and energy modeling
• Developed by leading industry experts
• Looked to for beyond energy code

More information: https://www.ashrae.org/technical-resources/aedgs
Advanced Energy Design Guides

- Definitions and process
- Solution sets by climate zone; mix of prescriptive and performance-based approaches
- Guidance on specific strategies, whole-building integration approaches, additional considerations when using new technologies in field
- Recommended energy targets
- Examples of buildings with performance data showing that techniques work and that targets are achievable

Multiple Audiences for the AEDG

- Building Owners
- Architects
- Engineers
## Guide Organization

Chapter 1 – Introduction

Chapter 2 – Rationale for Zero Energy

Chapter 3 – Keys to Success

Chapter 4 – Building Simulation

Chapter 5 – How to Strategies

## How-To Strategies

<table>
<thead>
<tr>
<th>Strategy Type</th>
<th>#Tips</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building and site planning (BP)</td>
<td>23</td>
<td>Site selection and building orientation</td>
</tr>
<tr>
<td>Envelope (EN)</td>
<td>64</td>
<td>Air leakage control, thermal mass, insulation levels</td>
</tr>
<tr>
<td>Daylighting (DL)</td>
<td>18</td>
<td>Daylighting and view impact on occupants/residents</td>
</tr>
<tr>
<td>Electric lighting (EL)</td>
<td>32</td>
<td>Light-emitting Diode (LED)/Solid-State Lighting (SSL), Control strategies</td>
</tr>
<tr>
<td>Plug load management (PL)</td>
<td>7</td>
<td>Policy, controls, monitor usage</td>
</tr>
<tr>
<td>Service water heating (WH)</td>
<td>8</td>
<td>Efficiency, controls, heat recovery</td>
</tr>
<tr>
<td>HVAC (HV)</td>
<td>37</td>
<td>Distributed generation, system selection, DCV</td>
</tr>
<tr>
<td>Renewable energy (RE)</td>
<td>12</td>
<td>Sizing, storage, metering, rates</td>
</tr>
</tbody>
</table>
Modeling Floor Plan

Site EUI Targets by Climate Zone
Unit Mix; Density Matters

Performance Requirements for Water Source Heat Pump Equipment

**SYSTEM C – FOUR PIPE HYDRONIC SYSTEMS**
- Air-source heat pump chiller efficiency
  - < 150 tons; 11.5 EER; 15 IPLV @ AHRI Conditions
  - < 150 tons; 15 EER; 18 NPLV @ 55°F Chilled Water
- Heating Efficiency
  - ≥ 3.5 COP @ 45°F On 110°F Hot Water Sump
- Compressor capacity control
- VSD compressor
- Water circulation pumps
  - VSD and NEMA premium efficiency <20W/gpm at design
- Terminal Fan
  - ECM fans and <0.38 W/cfm at design
- Boiler Efficiency (only as back up heating)
  - Condensing boiler, ≥94% efficiency

**SYSTEM B – WATER SOURCE HEAT PUMP (WSHP)**
- WSHP with Boiler/Closed Circuit Cooler
  - WSHP Cooling Efficiency
    - >18.2 EER at 86°F entering water temperature
  - WSHP Heating Efficiency
    - >5.4 COP at 68°F entering water temperature
  - Terminal Fan
    - ECM fans and <0.38 W/cfm at design
  - Compressor capacity control
    - VSD compressor
  - Water circulation pumps
    - VSD and NEMA premium efficiency <20W/gpm at design
  - Cooling tower/cooling tower
    - VSD on fans
  - Boiler efficiency
    - Condensing boiler, ≥94% efficiency (include measures to maintain part load efficiency)

**Ground Source Heat Pump (GSHP)**
- GSHP Cooling Efficiency
  - >22 EER at 99°F entering water temperature
  - GSHP Heating Efficiency
    - >5 COP at 50°F entering water temperature
  - Terminal Fan
    - ECM fans and <0.38 W/cfm at design
  - Compressor capacity control
    - VSD compressor
  - Water circulation pumps
    - VSD and NEMA premium efficiency <20W/gpm at design

**Water Source Variable Refrigerant Flow**
- Cooling Efficiency
  - ≥20 EER at 86°F entering water temperature
  - WSHP Heating Efficiency
    - ≥6.0 COP at 68°F entering water temperature
  - Terminal Fan
    - ECM fans and <0.38 W/cfm at design
  - Compressor capacity control
    - VSD compressor
  - Water circulation pumps
    - VSD and NEMA premium efficiency <20W/gpm at design
Case Study: Batik Apartments

- Central heat pump water heating system
- Energy recovery ventilators in all amenity spaces
- Ductless heat pumps
- Beyond Code envelope insulation
- Low-flow plumbing fixtures
- Seattle, WA
- EUI = 16.5

AEDG’s are FREE

All the AEDGs and supplemental documentation is available at: [www.ashrae.org/aedg](http://www.ashrae.org/aedg)

Multifamily Guide will be out in January.

AIA, USGBC, and ASHRAE now have on-line training on the AEDGs
Envelope: Thermal Bridging

- Continuous air barrier
- Envelope and daylighting
What Does Zero Carbon Mean in Practice?

1. **Reduce** energy demand

2. **Use** all-electric systems

3. **Offset** with on-site renewables

Design Challenges and Considerations

- **Electrical Panel Upgrades** in Existing Buildings
  - Improve building envelope to reduce HVAC size
  - Load Monitoring
- **Upfront Cost** - Contractor knowledge
- **Maintenance Costs** - education
- **Success**: Engaged Owners and Contractors
Case Study: Wasco, CA

• Built it 1996
• 36 units, 44,000 sq.ft.
• ASHRAE CA 3B Hot-Dry

Scope of Work

• Comprehensive LED Upgrade
• Low-Flow Showerheads and Aerators
• Energy Star Washing Machines and Refrigerators
• Attic Air Sealing and Insulation
• Dual Pane Windows
• Ductwork Aerosealing
• In-Unit Heat Pump Water Heaters (electrification)
• Inverter Driven Heat Pumps (electrification)
• 110kW Solar Array (93% allocated to resident bills)

1. Reduce energy demand

2. Use all-electric systems

3. Offset with on-site renewables
Scope: Envelope Improvement

- Attic Insulation
- Aeroseal Duct Sealing

Scope: HVAC Electrification

Before

After
Design Considerations for In-Unit HPWH

- Heat pumps produce cool air when running
- This air can go straight to conditioned space
  - Kitchen closet
- To avoid complaints, better to:
  - Locate at exterior wall – air exchange to outside
  - Duct intake and exhaust
  - Use split system (heat pump is remote)

Scope: On-Site Solar PV
Resident Meter – Energy Savings

Realized Annual Energy Savings: **44%**

- **77%** gas
- **-12%** electricity

* Aggregated data provided by utilities via AB 802 pathway
Realized Annual **Cost** Savings (EE only): **18%** ($8,100/yr)
Projected Annual **Cost** Savings (with Solar): **68%** ($30,400/yr)

- **90% gas**
- **-25% electricity**
Lessons Learned and Takeaways

- **Electrical load** – evaluating existing buildings
  - Improve building envelope to reduce HVAC size
  - Load Monitoring
- Utility cost savings – **optimize rates** and use PV
  - Tenant education
- Retrofits: need **engaged owners and contractors**

Electrification is **viable now** for both new and existing buildings

---

Design Considerations: Central HPWH Systems

- **Large storage volumes** and **longer recovery time** compared to traditional gas storage water heating
- Heat pumps need **outside air**
- Good locations:
  - Garage or roof
  - Behind a building
- Bad locations:
  - Interior spaces
  - Tiny rooms
- Allocate space for storage
Thank you

Maya Gantley
Project Manager
Association for Energy Affordability (AEA)
mgantley@aea.us.org

Case Study:
SBP Residential:
Planning for Net Zero Energy, and
Getting There

Waleed AlGhamdi, AIA, CEM, BEMP, LEED AP BD+C
Associate Director, Smart City & Sustainability
ROSHN Real Estate
SBP Residential - Project Information

**Type:** Affordable Multifamily Housing

**Size:**
- 45,200 SF
- 3 Floors
- 50 Apartment (1BR+2BR)

**Location:** New Orleans, LA
- Climate Zone 2A, Hot Humid
SBP Residential - Project Information

Type: Affordable Multifamily Housing

Size:
- 45,200 SF
- 3 Floors
- 50 Apartment (1BR+2BR)

Location: New Orleans, LA
- Climate Zone 2A; Hot Humid
Orientation and Massing

Massing: Limited options due to city grid and site constraints.
Orientation: Helps maximize building self-shading and solar access.
LIMITED ROOF AREA = 14,900 SF

Parallel Exercise: Supply & Demand

WHAT IS THE LOWEST EUI POSSIBLE FOR A RESIDENTIAL BUILDING?

WHAT IS THE HIGHEST ENERGY OUTPUT POSSIBLE ON THIS ROOF?
Parallel Exercise: Supply & Demand

WHAT IS THE LOWEST EUI POSSIBLE FOR A RESIDENTIAL BUILDING?

15 [kBtu/SF/year]
According to published research

Regional Average EUI = 48 [kBtu/SF/year]
Energy Star EUI = 32 [kBtu/SF/year]
Early Simulations EUI = 17 [kBtu/SF/year]

WHAT IS THE HIGHEST ENERGY OUTPUT POSSIBLE ON THIS ROOF?

19 [kBtu/SF/year]
OR ~255,000 kWh annually (PVWatts)
Parallel Exercise: Supply & Demand

**WHAT IS THE LOWEST EUI POSSIBLE FOR A RESIDENTIAL BUILDING?**

15 \([\text{kBtu/SF/year}]\)

According to published research

**WHAT IS THE HIGHEST ENERGY OUTPUT POSSIBLE ON THIS ROOF?**

19 \([\text{kBtu/SF/year}]\)

OR ~255,000 kWh annually (PVWatts)

Regional Average EUI = 48 \([\text{kBtu/SF/year}]\)
Energy Star EUI = 32 \([\text{kBtu/SF/year}]\)
Early Simulations EUI = 17 \([\text{kBtu/SF/year}]\)

**THE GOAL?** DESIGN A BUILDING WITH AN EUI AT OR LOWER THAN THE AVAILABLE ANNUAL ENERGY OUTPUT
Simulation: A Balancing Act

Simulation: HVAC System Comparison

- EUI
  - Baseline: 24.7
  - HP SEER 15: 24.1 (2% lower)
  - HP SEER 17: 23.5 (5% lower)
  - VRF: 23.2 (6% lower)
  - VRF+DOAS+ERV: 22.9 (7% lower)
WHICH BUILDING SYSTEMS MATTER, THEN?!
Simulation: Energy Reduction (by individual measures)

- Code Baseline
- Building Shade
- R-30 Roof
- R-20 Walls
- WH SHGC-0.30, U-0.27
- Infiltration 0.40 CFM/SF
- Infiltration 0.25 CFM/SF
- LPD Reductions
- Lighting Controls
- HVAC Low Capacity
- Efficient Fans
- HVAC SEER 18
- Heat Pump DHW
- Low Flow Fixtures
- Energy Star Appliances
- ES Most Efficient Appl.
- Smaller ES Appl.
Zooming In: Appliances Profile

- Refrigerator: 35%
- Clothes Dryer: 35%
- Dishwasher: 19%
- Clothes Washer: 11%
### ENERGY SAVINGS BY APPLIANCE TYPE

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Baseline</th>
<th>ENERGY STAR</th>
<th>EDR Spec</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Refrigerator</strong></td>
<td>565</td>
<td>423</td>
<td>384</td>
</tr>
<tr>
<td></td>
<td>36%</td>
<td>24%</td>
<td>20%</td>
</tr>
<tr>
<td><strong>Dishwasher</strong></td>
<td>307</td>
<td>270</td>
<td>234</td>
</tr>
<tr>
<td></td>
<td>24%</td>
<td>20%</td>
<td>16%</td>
</tr>
<tr>
<td><strong>Clothes Washer</strong></td>
<td>170</td>
<td>124</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>47%</td>
<td>33%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Clothes Dryer</strong></td>
<td>597</td>
<td>317</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>74%</td>
<td>46%</td>
<td>23%</td>
</tr>
</tbody>
</table>
Measures & Return on Investment

<table>
<thead>
<tr>
<th>Measure</th>
<th>Total kWh Saved</th>
<th>Incremental Cost</th>
<th>KWh/$10k</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEER 17</td>
<td>15,870</td>
<td>$70,000</td>
<td>2.267</td>
</tr>
<tr>
<td>VRF &amp; Local Ventilation</td>
<td>20,391</td>
<td>$190,000</td>
<td>1.073</td>
</tr>
<tr>
<td>VRF &amp; DOAS+ERV</td>
<td>23,291</td>
<td>$300,000</td>
<td>0.776</td>
</tr>
<tr>
<td>Premium Appliances</td>
<td>52,489</td>
<td>$60,000</td>
<td>8.748</td>
</tr>
<tr>
<td>Heat Pump WH</td>
<td>75,444</td>
<td>$50,000</td>
<td>15.089</td>
</tr>
</tbody>
</table>

The Secret Sauce: Biggest Impact

1. Air Tightness
The Secret Sauce: Biggest Impact

1. Air Tightness

2. Heat Pump Water Heater

3. Ultra Efficient Appliances
But How Much Did it Cost?

### REGIONAL AVERAGE COST

<table>
<thead>
<tr>
<th>Low Rise</th>
<th>Stick-Frame</th>
<th>Multifamily Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td>$225 $/SF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Local Average]

### CONSTRUCTION COST

<table>
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<tr>
<th>Low Rise</th>
<th>Stick-Frame</th>
<th>Multifamily Residential</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$164 $/SF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Total Construction Cost]

27% Below Average

- Excluding Solar System = $153 $/SF
- Basic EnergyStar Design = $142 $/SF
But How Much Did it Cost?

**REGIONAL AVERAGE COST**

<table>
<thead>
<tr>
<th>Cost</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>225 $/SF</td>
<td>Low Rise Stick-Frame Multifamily Residential [Local Average]</td>
</tr>
</tbody>
</table>

**CONSTRUCTION COST**

<table>
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<tr>
<th>Cost</th>
<th>Description</th>
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<tbody>
<tr>
<td>164 $/SF</td>
<td>27% Below Average Excluding Solar System = 153 $/SF Basic EnergyStar Design = 142 $/SF</td>
</tr>
</tbody>
</table>

PREMIUM FOR NET ZERO READY BUILDING = 7%
PREMIUM FOR NET ZERO + RESILIENT BUILDING = 13%
How is the Building “Measuring” Up?

Modeled (Predicted) vs. Actual (Metered) Energy

- Modeled Energy
- Actual Energy
THANK YOU!

Q and A
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

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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.