Decarbonizing Affordable Multifamily Housing: All-in REALIZE Retrofits & Zero Over Time

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Agenda

- REALIZE Overview
- Zero Over Time
- Concepts In Practice
- 1,000 Apartment Challenge
REALIZE Overview
To address the climate crisis, buildings must be:

- Low embodied carbon
- Efficient and properly ventilated
- All electric with low GWP refrigerants
- Grid interactive
- Powered by renewable energy

- Construct all new buildings to a zero-carbon standard
- Ensure all appliance sales are electric, efficient and grid-interactive
- Retrofit 4% buildings stock/year (4M/year in US alone) – 4x current rate
REALIZE aims to accelerate building decarbonization by developing affordable streamlined solutions that make buildings healthier for people and the planet.
A Service Analogy
REALIZE Theory of Change

STANDARDIZED RETROFIT PACKAGES + STREAMLINED & STANDARDIZED FINANCING + AGGREGATED DEMAND = SCALABLE SOLUTIONS
Standardize Retrofit Packages

Prefabricated wall panel including high-performance windows and doors

High-performance roof system including integrated solar

Integrated mechanicals including domestic hot water, heating, cooling, and ventilation, with controls and option for smart inverter and energy storage

All-electric appliances
Integrated Mechanical Systems

ERV with Boost | Heating/Cooling | Economizer | Central DHW
Requires 1 30A, 115V connection plus central plant electrical
Envelope Systems

Stick-frame solution
- 2-4 lb/sqft
- Non-structural
- Windows and doors not integrated (rough opening connections prefabbed)
- Streamlined scan → CAD → CAM process

Masonry solution
- 8-12 lb/sqft
- Structural
- Windows and doors integrated
- Streamlined scan → CAD → CAM process

Roof solution
- Insulated metal roof panels
- 2-3 lb/sqft
- Streamlined scan → CAD → CAM process
Streamline and Standardize Financing

First solve the incremental cost gap

$30,000 - $60,000 per apartment

- Industrialized Construction
- Industry Learning Curve
- Carbon Credits
- Underwrite Deeper Energy Savings
- Direct Subsidy

Incremental Cost

Today
Post Major Portfolio Decarb (e.g. NYCHA)
Aggregate Demand

RetrofitNY Pledge
4,395 Buildings
404,485 units

REALIZE CA Pledge
35,598 units

REALIZE MA 1,000 Apartment Challenge
starting construction 2023

Pathway to Scaling Zero Carbon Retrofits
Regional REALIZE Program Vision

DEMAND PIPELINE

ZERO OVER TIME TOOL

STANDARDIZED RETROFIT PACKAGE
MINIMAL DISRUPTION
FINANCING SOLUTION
PERFORMANCE GUARANTEE
INCLUSIVE ECONOMY

REALIZE | DATE
Zero Over Time
ZERO OVER TIME TOOL

DEMAND AGGREGATION AND

1. Retrofit Packages
   based on typology & climate zone

2. Portfolio Energy Optimization
   Physics Based Analytics

3. Optimized timing
   with trigger events

4. Financing
   Discounted Cash Flow Model
PEO evaluated a large portfolio of federal buildings in Canada.

- Collect reasonably comprehensive data on each portfolio asset
- Analyze historical performance to establish a baseline
- Generate multiple project scenarios for each property
ZOT Component 3

Trigger Events

Your Portfolio
- Building #1
- Building #2
- Building #3
- Building #4

2021 2022 2023 2024 2025

Equipment Upgrades & Replacements

2030 2029 2028 2027 2026

Major Rehabs & Tenant Improvements

2031 2032 2033 2034 2035

Acquisitions & Sales

Capital Events
Discounted Cash Flow Model

Present value of a project, modeled if done in different years.

Source: NYCEEC
# Examples of Measures

<table>
<thead>
<tr>
<th>Category</th>
<th>Measures</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demand Flexibility</strong></td>
<td></td>
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<tr>
<td>Battery storage</td>
<td>Either maximize kW shed/shifted or IRR</td>
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<tr>
<td>Central ice storage</td>
<td>Ice storage</td>
<td></td>
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<tr>
<td>Light dimming</td>
<td>Shed measure, not shifting load.</td>
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<tr>
<td>Staging heating and cooling coils</td>
<td>Stage coils and cycling fans to reduce peak demand every month</td>
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<tr>
<td>Peak demand curtailment-Temperature setback</td>
<td>Setback temperatures in appropriate zones to reduce demand during TOU times or peak demand events</td>
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<tr>
<td><strong>Energy Efficiency</strong></td>
<td></td>
<td></td>
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<tr>
<td>Improved thermal envelope – Roof and wall insulation</td>
<td>Within each measure, there are several different scenarios with different R-values (e.g. R20, R30 and R40) and different types of insulations</td>
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<tr>
<td>Roof membrane</td>
<td>Dark or Light roof membrane</td>
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<tr>
<td>Improved fenestration</td>
<td>Replacing current windows (curtain walls, load windows and storefront windows) with high performance windows; Adding window films</td>
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<tr>
<td>Unitized wall panels</td>
<td>REALIZE style pre-fabricated insulated panels on the exterior of the building</td>
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<tr>
<td>Exterior door upgrades</td>
<td>Door air-curtains, revolving doors and fast acting dock doors to reduce infiltration</td>
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<tr>
<td>HVAC upgrades</td>
<td>Where applicable adding VFDs, high efficiency motors and pumps, energy recovery, economizer control, demand-controlled ventilation, and heat recovery</td>
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<tr>
<td>Smart Thermostat</td>
<td>Installing smart thermostats in apartments (non-BMS)</td>
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<tr>
<td>LED lighting upgrades</td>
<td>LED lamp retrofit; LED fixture upgrade with integrated sensors</td>
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<tr>
<td>Ceiling fans</td>
<td>Increased temperature setpoints while maintain comfort by increased air velocity using BAS integrated ceiling fans</td>
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<tr>
<td><strong>Electrification</strong></td>
<td></td>
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<tr>
<td>Heat pumps</td>
<td>Replace natural gas boilers for heating and DHW with GSHP, ASHP, VRFs or distributed WSHP where applicable</td>
<td></td>
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<tr>
<td>REALIZE Pods</td>
<td>Pre-fabricated heating and cooling pods installed in each apartment. Central heat pumps supplies DHW and neutral water to in-unit Pods</td>
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<tr>
<td><strong>Renewable Energy</strong></td>
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<tr>
<td>Rooftop PV</td>
<td>New PV array or augment existing PV array with more capacity</td>
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<tr>
<td><strong>Plug Loads</strong></td>
<td>Install high efficiency refrigerators, dish washer, in-unit washer/dryer where applicable</td>
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Concepts in Practice
WinnCompanies Overview

- WinnCompanies is a 50-year-old mixed income multifamily property developer, owner, and manager
- Employs more than 3,500 team members
- Manages 121 Million square feet, including housing, condos, commercial, retail, and parking;
- Provides homes to 330,000 residents;
- Has created or preserved more than 15,000 units of mixed-income housing across the Mid-Atlantic and Northeast
- A Commitment to Sustainability has been one of 8 Guiding Principles for over a decade.
Eva White Apartments, Boston

- REALIZE-MA Case Study
- DOE Advanced Building Construction
- Key Partners:
  - Castle Square Tenant Organization
  - Boston Housing Authority
  - Reisen Design Associates
  - Petersen Engineering Inc.
Eva White Apartments, Boston
Existing Conditions
Existing Conditions
“Business as Usual” Rehab

- **Moderate, Occupied Rehab**
  - Capital Needs Assessment
  - Critical Repairs
  - No Energy Performance Requirements

- **Scope of Work:**
  - Kitchen reno: flooring, cabinets, appliances, lighting, paint
  - Bathroom reno: flooring, vanity, plumbing fixtures, lighting, paint
  - Common area finishes
  - In-kind HVAC upgrades: condensing boilers, MAU, exhaust fans
  - Roof replacement
  - Window replacement
  - Misc. structural repairs to parapet, brick & concrete
Eva White Apartments: REALIZE

Performance Specs:
- R-25 Continuous Insulation
- R-40 Roof
- 0.20 ACH50
- Limited thermal bridging
- U-0.26 Windows
- Full Electrification

Modeled savings:
- 68% site energy savings
- EUI 96 → EUI 31
- $70k/year utility cost savings
Eva White Retrofit Package

Envelope: Prefabricated Wall Panel System

- R&D by Tremco → “Revitalite” System
  - Prefabricated, Lightweight, Structural, Insulated Façade
  - 6” thick, EPS or GPS core and EIFS finish
  - uPVC Amberline Window
  - Patented connection assembly
- Performance Testing Ongoing
  - Fire, thermal, air, water, structural
- Warranty & Insurance Discussions
Eva White Retrofit Package

HVAC: All Electric

- Standard systems
  - VRF, Mitsubishi Y-series
  - ERV, Annexair
  - HPWH, Mitsubishi QAHV
- Master metering required
- Central systems preferred for maintenance
- Utilizing new cavity space
Eva White DER

Reisen Design Associates
Eva White DER
• Leveraging existing rehab and capital needs can reduce incremental cost
  o BAU: $150k/unit
  o DER: $250k/unit
• New sources needed to support added costs
  o MassSave LEAN (ABCD Inc.)
  o Proportionally higher LIHTC equity
  o RAD/Section 18
• Customized vs. “Standardized”
  o Creativity, Demonstrations, and further R&D still needed
  o Learn as you go ➔ Integrated Design & Project Delivery
Scaling a New BAU

- How can we re-define the “BAU” rehab and capital planning process?
  - It costs more...
  - It’s harder to do...
- **REALIZE** and **ZOT Frameworks** offer solutions for building owners and policy makers
- Carrots & Sticks will continue being primary drivers
  - **Sticks:**
    - BERDO 2.0
    - Building Energy Performance Standard ("BEPS", Washington DC)
    - NYC Local Law 97
  - **Carrots:**
    - Energy Cost Savings (not enough)
    - Non-economic: aesthetics, comfort, etc. (not enough)
Taking Inventory

Boston Portfolio GHG Intensity

Multifamily Properties

kgCO2/sf

2025
2030
2035
2040
2045
Zero Over Time

- Subset of 29 Properties being evaluated across 6 states and 3 climate zones
  - Extensive and Ongoing Data Collection Process
- The buildings in scope include 4,526 units
- Average Energy Use Intensity of 68 kBTU/SF
  - Data requires further QA/QC
  - Tenant paid utilities often excluded

**PEO Analysis**

- 29 Properties
- 5.3 million Square Feet
- 100+ Measures & variations
- 3000+ Energy Simulations
Zero Over Time

Walden Square Apartments

Building Energy Consumption & Emissions Relative to HVAC System

- Water Source Heat Pump / Energy Recovery Ventilation
- Traditional HVAC

Site EUI (kBtu/ft²) vs. Greenhouse Gas Emissions (lbs CO2e/ft²)
Looking Ahead

- Strategic Planning
- Leverage capital needs and major recapitalization events
1000 Apartment Challenge
1,000 apartment challenge
1,000 deep energy retrofits under construction in Massachusetts by 2023
Market Transformation
15 – 20% energy savings

Standard Weatherization
50%+ energy savings
All electric
Grid Interactive
Renewables
Heat Recovery Ventilation
Low Embodied Carbon

15 – 20% energy savings

Standard Weatherization

Zero Carbon Retrofit
Energie Sprong – 50% Cost Compression in 5 Years
The ideal candidate building(s)

1) Scheduled for a **major rehab**
2) **Funds** allocated for major rehab
3) **Planned scope of work** (at least 3 of the following): new windows, roofs, mechanicals, new siding
4) **Simple architecture**
5) **Not historic or architecturally significant building**
1,000 Apartment Challenge

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Thank You

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