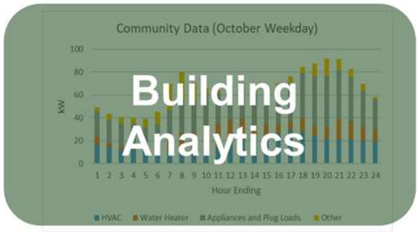
Buildings Program @ EPRI

Strategic focus on **building decarbonization** leveraging efficiency, flexibility, renewables and electrification as tools to achieve a <u>customer centric, low carbon, affordable</u> energy system



Alabama Power 'Smart Neighborhood' looks to the future

Updated Jun 4, 2018; Posted May 23, 2018

Decarbonization in affordable housing communities

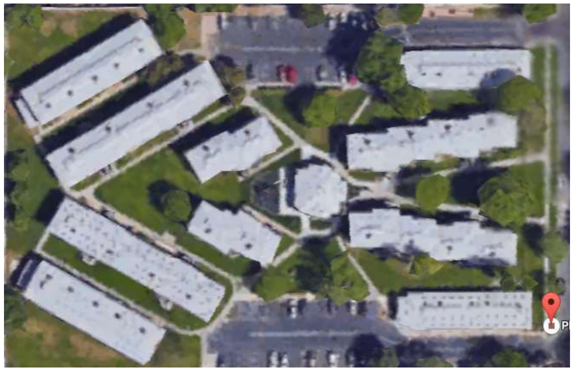
Understand ZNE + Electrification in infill settings (LINC)

All Electric Zero Carbon new construction affordable housing

Understanding behavioral load shapes + ZNE/electrification in LIMF communities

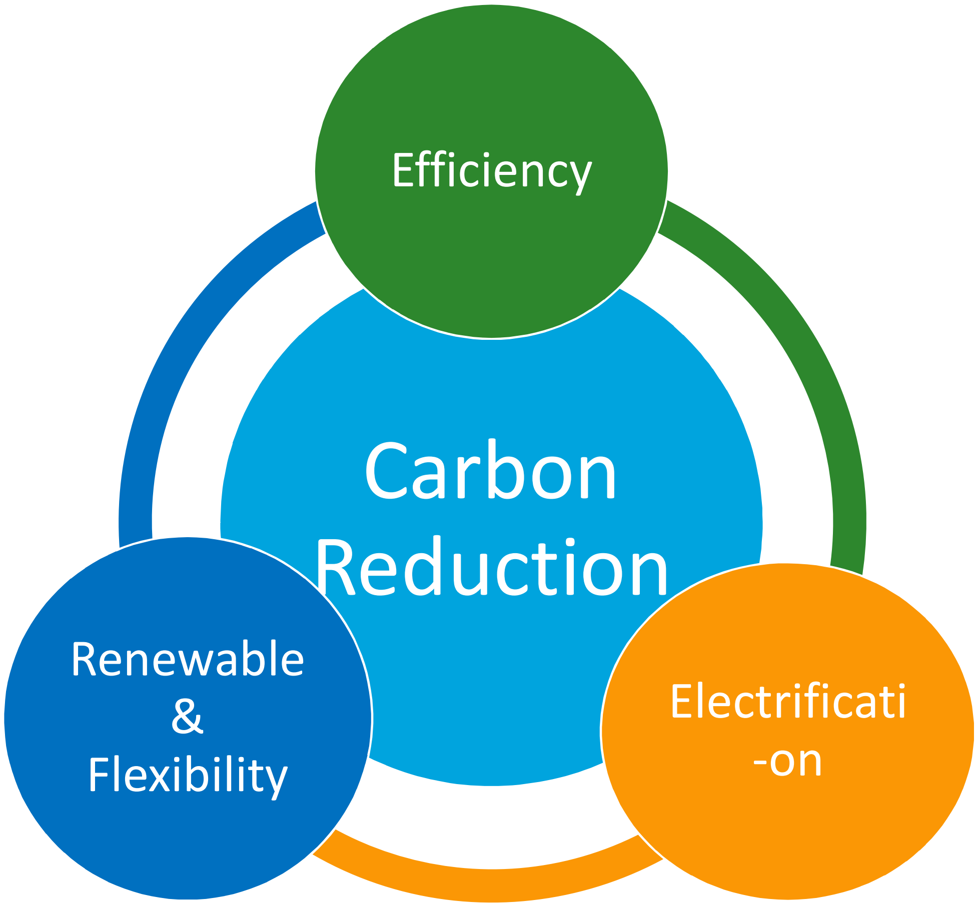
Heat Pump retrofits in existing multifamily housing

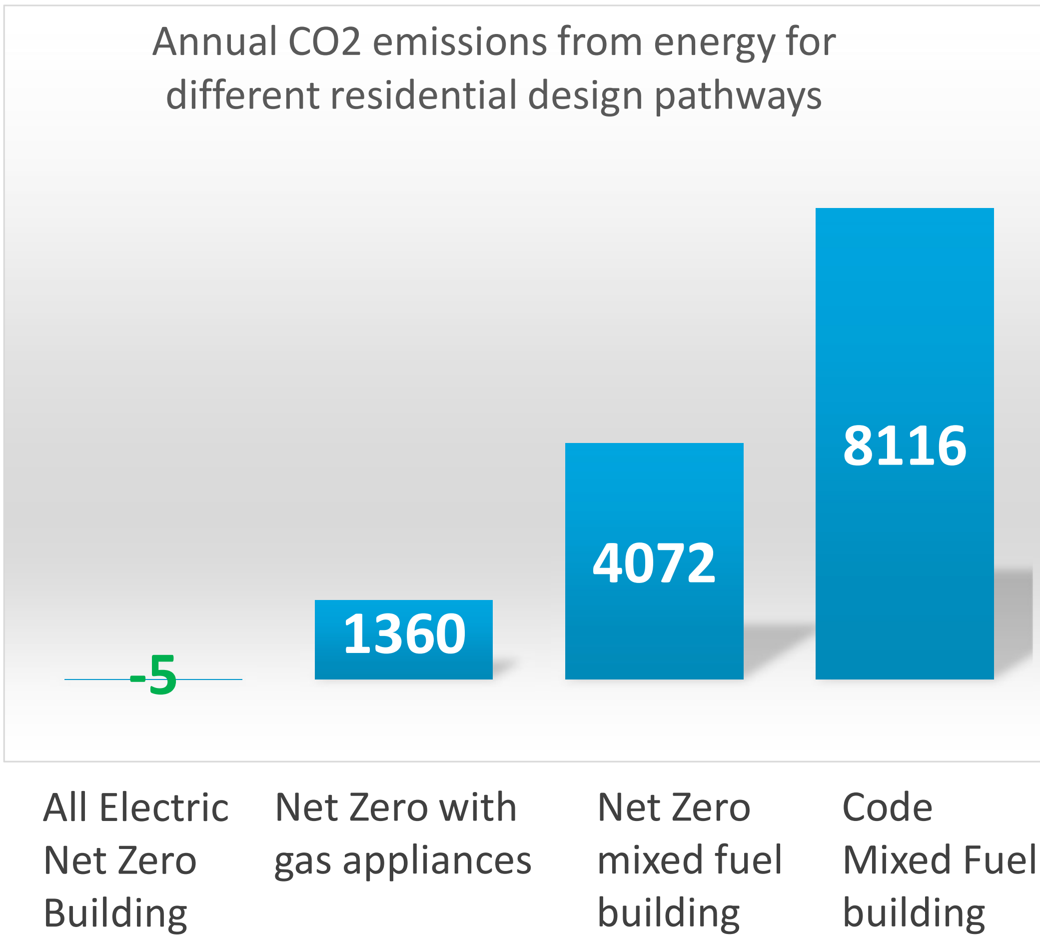
Mixed fuel + renewable retrofits



Electrification ZNE retrofit in 50-yr old community

Building Decarbonization Pathways





WinnCompanies

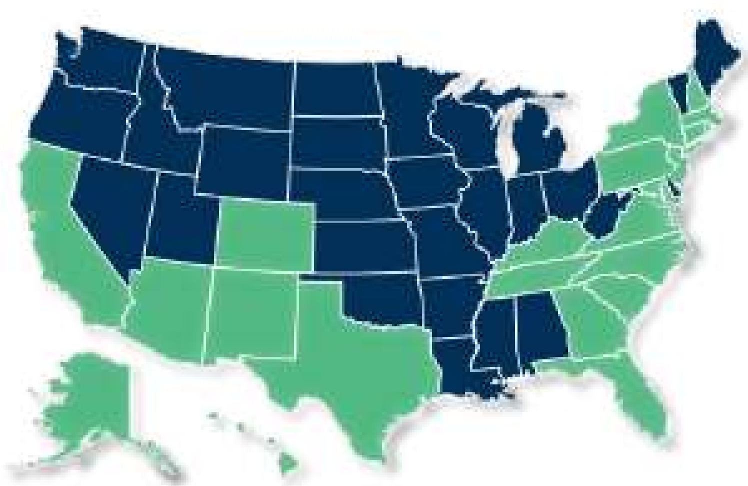
Decarbonizing Affordable Multifamily Housing

Christina McPike

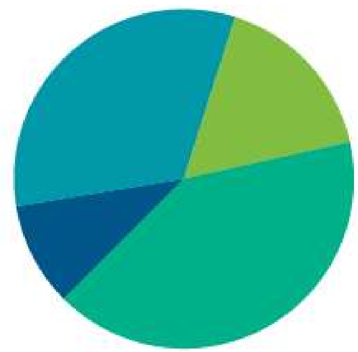
Director Energy and Sustainability

WinnCompanies Overview

WHERE WE OPERATE



COMMUNITY TYPES WE MANAGE



	Total units managed	101,887	
■	Market rate	9,374	9%
■	LIHTC	36,653	36%
■	Other subsidized	15,406	15%
■	Privatized military	40,454	40%

We manage 615 communities nationwide and own 107 of those, totaling 13,709 units

WinnCompanies
Development | Residential | Military

1st Major Hurdle – this is a real email!

Eight years ago I thought VRFs were going to become the primary heating/cooling system in our area, this is no longer my belief. After installing many VRF systems (large and small). I do not recommend using a them. Below are some of the projects we have encountered issues on:

Large residential --
- The electric bill in these residences was 3x higher than the gas bill during heating months

Elderly Housing --
- The DX coil froze and split during cold weather leaving multiple residents without heat
- Electric bills were 3x higher than expected per design – this caused the management to believe there was something wrong with the system and we had to do a second factory start-up with the same results

Nursing Home –
- The compressor control boards shorted out on multiple compressors during a large snow storm leaving approximately 45 units without heat – Manufacturer paid approx. $100,000 to replace boards and compressors throughout the winter. The owner wanted to remove the entire system and install water source heat pumps.

Hotel
- First heating season – the condensers filled with snow shorting out control boards resulting in 20-30 rooms without heat and approx. $11,000 in replacement boards
- Second heating season – January 2018 snowstorm – condensers were filled with snow again resulting in no heat in 15-20 rooms resulting in an additional $10,000 in repairs

Assisted Living --
- January 2018 snowstorm – condensers from phase I (2015) and recent phase (2017) were not working resulting in many units with no heat

These systems typically go down during snow / ice storms making it very difficult to troubleshoot and service the systems.

Talk about an upward hill battle!

WinnCompanies
Development | Residential | Military

Hamilton Canal Parcels 8&9

- New construction, 118 mixed income units, Lowell, MA
- Ducted ASHP's for heating & cooling in each unit, central gas DHW plant.
- MassCEC Grant: $195,167
- Passive House Operating Savings: $18,000

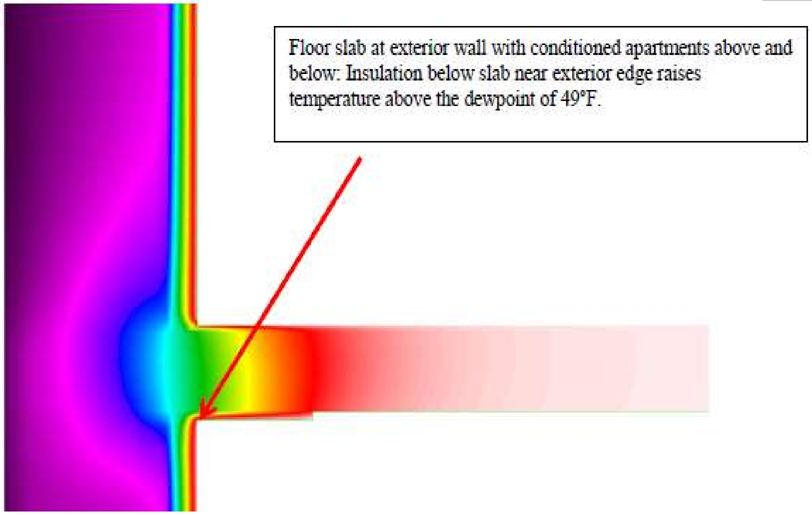
Model	Electricity Consumption (kWh)	Natural Gas Consumption (Therms)	Total Energy Consumption (kBtu)	Meets ENERGY STAR	Meets PHIUS+2015
ES Baseline	560,150	6,296	2,595,180	Yes	No
PH Proposed	465,673	6,587	2,304,522	Yes	Yes
PH+PV Proposed	435,673	6,587	2,202,168	Yes	Yes

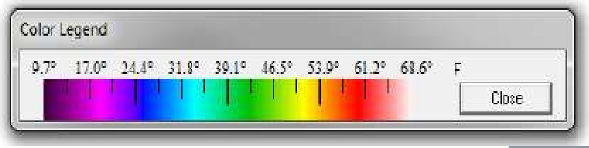
Table 1: Energy Modeling Results Summary

WinnCompanies
Development | Residential | Military

EnerPHit at The Tyler, East Haven CT

- Historic adaptive reuse, 70 elderly units
- **Why?**
  - CHFA added 3 points to QAP for Passive House
  - PHI's preferred PHPP Model → Electric VRF to reduce pump and fan energy
- **How?**
  - Lots of modeling & coordination
  - SHPO approval
  - EnerPHit with certain (historic) waivers
- **Status:**
  - 50% complete
  - Fingers crossed re: operating cost





Barriers and Opportunities

Barriers:

- Cold climate technology
- DHW system options
- **Energy savings vs. cost savings (particularly for retrofits)**

Opportunities & Trends:

- REALIZE Program
- Grid improvements (City of Boston Article 80)
- New revenue sources: demand response, solar + storage
- Smaller tonnage
- Policy & financing as a driver (QAP's, Passive House)

WinnCompanies
Development | Residential | Military

Thank you

Christina McPike
cmcpike@winnco.com

NEEP Electrification Symposium Northeast

August 8, 2019

Decarbonizing Affordable Multifamily Housing

Lessons Learned: Calculating Savings from Electrification

Ed Connelly, President, New Ecology, Inc.

New Ecology works nationally to bring the benefits of sustainable development to the community level, with a concerted emphasis on underserved populations.

A mission-driven non profit, we seek to make the built environment more efficient, healthy, durable, and resilient.

Who We Are

THIS IS MANIFESTED IN OUR CORE WORK TO:

- Research, test and implement new approaches to sustainability, resiliency, healthy environments and energy efficiency;
- Monitor, test, diagnose and solve operational and building performance issues on existing buildings;
- Help design, build, certify and operate new high performance buildings;
- Share our learnings with building professionals, contractors, government, financiers, owners and managers through education and training.

Understanding The Costs of Gas vs. Electricity

One therm of gas:	100,000 Btu	$1.20
One kWh of electricity:	3,412 Btu	$ .22
kWh in a 100,000 Btu:	29.3	$6.45 (5.4x)

Inputs:		
$/therm	$ 1.20	
$/kwh	$ 0.22	
Combustion system efficiency	74%	
Heating therms (billed)	66,108	therms
Calculations:		
Btus billed (gas burned)	6,610,800,000	Btu
Btus (delivered as space heat)	4,891,992,000	Btu
Convert delivered heat to kWh (/3412)	1,433,761	kWh
Outputs:		
Cost of **gas** heating load	$ 79,330	
Cost of **electric** heating load	$ 309,692	$ 103,230.78
Required electric coefficient of performance (COP) for electric costs to equal gas costs	3.9	
Electric is 3.9x more expensive than gas.		
Equipment		
Heat Pump COP	3	
Load Reduction Needed To Break Even	23%	

NEW ECOLOGY
Community-Based Sustainable Development

Controlling Operating Costs: The Need to Driving Down Loads

Actual Audit Example of Heating Loads

	Therms	
Current Usage		
Conduction	36,070	
Air Leakage	30,390	
Total heat loss	66,460	
Projected Savings:		
Roof insulation, air sealing & window rehab	6,780	
ERVs replace RTUs	8,538	
Total Savings:	15,318	23%

NEW ECOLOGY
Community-Based Sustainable Development

Scenarios

Run	Heating & Cooling	DHW	Ventilation	Envelope
1 (Baseline)	WSHPs, boilers, cooling tower	Central Tankless	Central ERV	Typical
2	WSHPs, boilers, cooling tower	Central Tankless	Individual ERVs	Typical
3	WSHPs, boilers, cooling tower	Central Tankless	Individual ERVs	Intermediate
4	WSHPs, boilers, cooling tower	Central Tankless	Individual ERVs	Passive House
5	Water-Cooled VRF	Central Tankless	Individual ERVs	Intermediate
6	Water-Cooled VRF	Central Tankless	Individual ERVs	Passive House
7	Air-Cooled VRF	Central Tankless	Individual ERVs	Intermediate
8	Air-Cooled VRF	Central Tankless	Individual ERVs	Passive House
9	Individual FCUs, Combi Boilers,DX	Combi Boilers	Individual ERVs	Typical
10	Individual FCUs, Combi Boilers,DX	Combi Boilers	Individual ERVs	Intermediate
11	Individual Furnace, DX	Individual Tankless Boilers	Individual ERVs	Typical
12	Individual Furnace, DX	Individual Tankless Boilers	Individual ERVs	Intermediate

First Cost

Run	Heating & Cooling	Envelope	First Cost	% Added First Cost
11	Individual Furnace, DX	Typical	$47,963,213	-3%
12	Individual Furnace, DX	Intermediate	$48,946,023	-1%
9	Individual FCUs, Combi Boilers,DX	Typical	$48,964,081	-1%
1 (Baseline)	WSHPs, boilers, cooling tower	Typical	$49,365,145	-
10	Individual FCUs, Combi Boilers,DX	Intermediate	$49,946,891	1%
7	Air-Cooled VRF	Intermediate	$50,235,190	2%
8	Air-Cooled VRF	Passive House	$50,382,511	2%
2	WSHPs, boilers, cooling tower	Typical	$50,752,575	3%
3	WSHPs, boilers, cooling tower	Intermediate	$51,735,385	5%
4	WSHPs, boilers, cooling tower	Passive House	$51,882,706	5%
5	Water-Cooled VRF	Intermediate	$52,007,246	5%
6	Water-Cooled VRF	Passive House	$52,154,567	6%

EUI and Emissions

Run	Heating & Cooling	Envelope	Site EUI (kBtu/sf)	Annual Source GHG Emissions (mtCO2e)
6	Water-Cooled VRF	Passive House	22	182
4	WSHPs, boilers, cooling tower	Passive House	23	189
5	Water-Cooled VRF	Intermediate	24	199
8	Air-Cooled VRF	Passive House	24	212
10	Individual FCUs, Combi Boilers,DX	Intermediate	26	200
3	WSHPs, boilers, cooling tower	Intermediate	26	205
7	Air-Cooled VRF	Intermediate	26	232
12	Individual Furnace, DX	Intermediate	27	207
2	WSHPs, boilers, cooling tower	Typical	29	225
9	Individual FCUs, Combi Boilers,DX	Typical	30	223
11	Individual Furnace, DX	Typical	31	232
1 (Baseline)	WSHPs, boilers, cooling tower	Typical	33	251

Annual Utility Cost

Run	Heating & Cooling	Envelope	Annual Utility Cost	% Annual Utility Savings
10	Individual FCUs, Combi Boilers,DX	Intermediate	$95,176	19%
12	Individual Furnace, DX	Intermediate	$96,093	18%
6	Water-Cooled VRF	Passive House	$98,049	16%
4	WSHPs, boilers, cooling tower	Passive House	$99,518	15%
9	Individual FCUs, Combi Boilers,DX	Typical	$100,581	14%
3	WSHPs, boilers, cooling tower	Intermediate	$101,636	13%
11	Individual Furnace, DX	Typical	$101,835	13%
5	Water-Cooled VRF	Intermediate	$103,294	12%
2	WSHPs, boilers, cooling tower	Typical	$105,984	10%
1 (Baseline)	WSHPs, boilers, cooling tower	Typical	$117,232	-
8	Air-Cooled VRF	Passive House	$120,504	-3%
7	Air-Cooled VRF	Intermediate	$133,220	-14%

Lifecycle Cost

Run	Heating & Cooling	Envelope	Total Lifecycle Cost (NPV)	Simple Payback (years)
11	Individual Furnace, DX	Typical	$72,199,073	0
9	Individual FCUs, Combi Boilers,DX	Typical	$73,361,621	0
12	Individual Furnace, DX	Intermediate	$73,531,123	0
1 (Baseline)	WSHPs, boilers, cooling tower	Typical	$74,430,873	-
10	Individual FCUs, Combi Boilers,DX	Intermediate	$74,699,513	18
8	Air-Cooled VRF	Passive House	$76,040,544	Inf.
7	Air-Cooled VRF	Intermediate	$76,045,864	Inf.
2	WSHPs, boilers, cooling tower	Typical	$76,235,306	163
3	WSHPs, boilers, cooling tower	Intermediate	$77,681,475	209
4	WSHPs, boilers, cooling tower	Passive House	$77,859,399	196
5	Water-Cooled VRF	Intermediate	$78,105,552	262
6	Water-Cooled VRF	Passive House	$78,229,403	202

Carbon Charge ($45/mtCO2e)

Run	Heating & Cooling	Envelope	Total Lifecycle Cost (NPV)
11	Individual Furnace, DX	Typical	$72,511,991
12	Individual Furnace, DX	Intermediate	$73,662,591
9	Individual FCUs, Combi Boilers,DX	Typical	$73,809,922
1 (Baseline)	WSHPs, boilers, cooling tower	Typical	$74,770,170
10	Individual FCUs, Combi Boilers,DX	Intermediate	$74,968,995
7	Air-Cooled VRF	Intermediate	$76,326,712
8	Air-Cooled VRF	Passive House	$76,359,059
2	WSHPs, boilers, cooling tower	Typical	$76,628,613
3	WSHPs, boilers, cooling tower	Intermediate	$77,958,243
4	WSHPs, boilers, cooling tower	Passive House	$78,114,999
5	Water-Cooled VRF	Intermediate	$78,373,751
6	Water-Cooled VRF	Passive House	$78,475,134

Carbon Charge

Utility	Base Rate	Carbon Charge	Carbon Charge per Utility	Base Rate + Carbon Charge
Electricity	$0.21/kWh	$45/mtCOe	$0.01/kWh	$0.22/kWh
Natural Gas	$1.32/therm	$45/mtCOe	$0.27/therm	$1.59/therm

Utility	Base Rate	Multiple	Base Rate + Carbon Charge	Multiple
Electricity	$0.062/kBtu	4.66x	$0.066/kBtu	4.15x
Natural Gas	$0.013/KBtu	1x	$0.016/KBtu	1x

Carbon Charge

Utility	Base Rate	Carbon Charge	Carbon Charge per Utility	Base Rate + Carbon Charge
Electricity	$0.21/kWh	$1,850/mtCOe	$0.61/kWh	$0.82/kWh
Natural Gas	$1.32/therm	$1,850/mtCOe	$10.98/therm	$12.30/therm

Utility	Base Rate	Multiple	Base Rate + Carbon Charge	Multiple
Electricity	$0.062/kBtu	4.66x	$0.123/kBtu	1.95x
Natural Gas	$0.013/Kbtu	1x	$0.240/Kbtu	1x

Thank You!

Edward Connelly
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www.newecology.org

Electrification Challenges in Affordable Multifamily Housing

Uncommon Expertise. Unmatched Impact.

cpc Community® Preservation Corporation

Community Preservation Corporation

MISSION-DRIVEN SINCE 1974

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

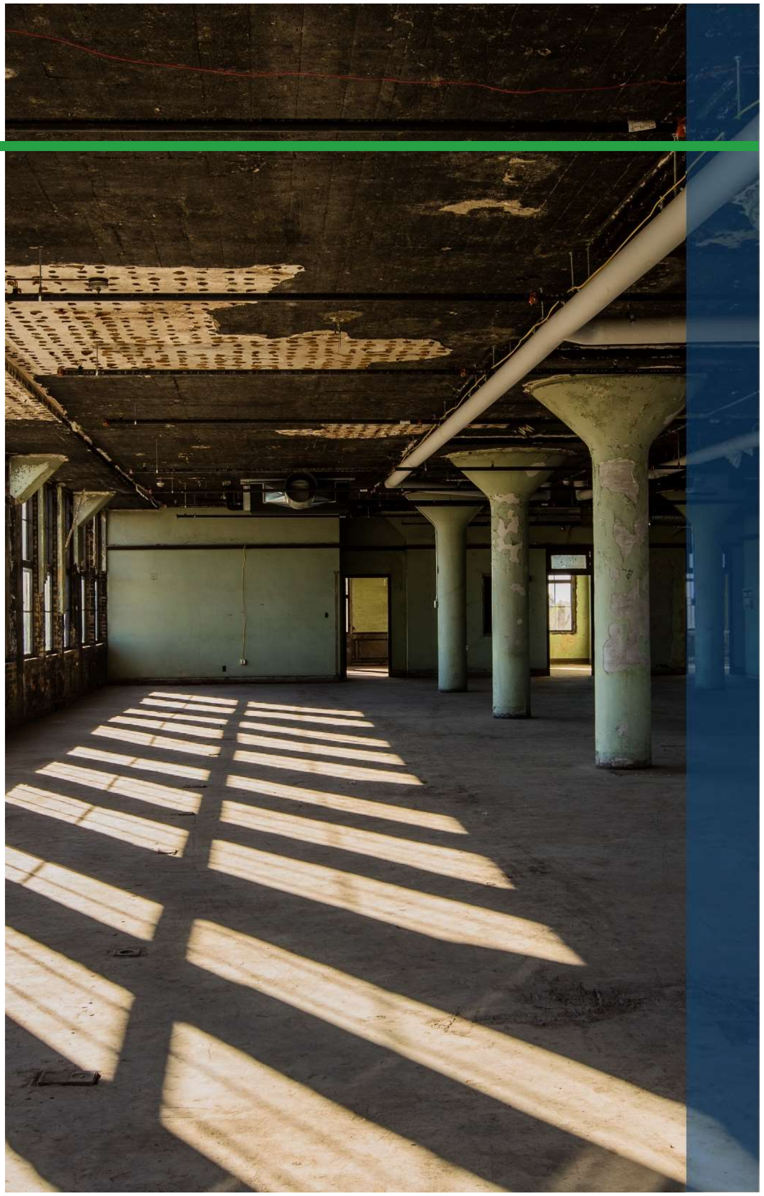
CPC is a nonprofit affordable housing and community revitalization finance company providing flexible capital solutions, fresh thinking and a collaborative approach to the complex issues facing communities. We are also committed to being Carbon Neutral.

Sustainability at CPC

The cost savings associated with energy-efficient measures and high-performance building practices play a key role in ensuring the long-term economic stability of affordable multifamily properties.

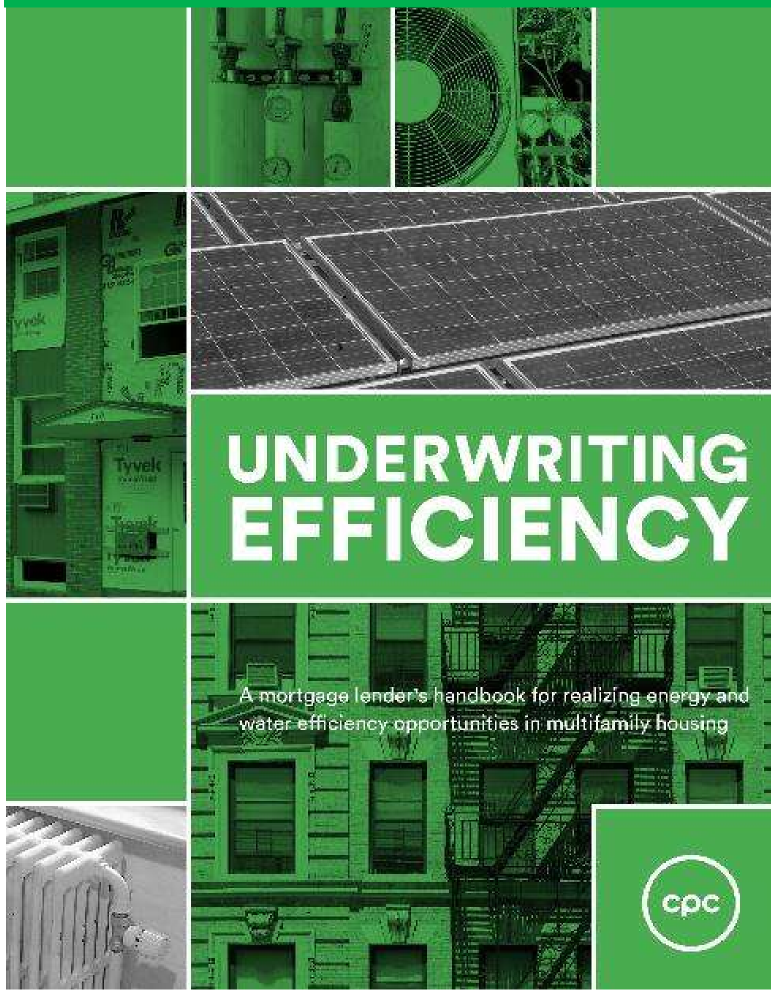
Lending & Originations

CPC Underwrites projected savings and/or building performance into the first mortgage economics to drive additional proceeds to pay for the work.



Adaptive Reuse
500 Seneca
Buffalo, NY

Monetize Savings to Pay for Work



A Practical Approach:

CPC developed the guide in 2017 to create an industry standard for how lenders, public partners and owners could approach monetizing and valuing the inclusion of energy efficiency in rehab of multi-family properties.

FY20 Goal:

CPC intends to create a supplement to the guide to educate the industry about Passive House and Net Zero construction methods and building performance in a new regulatory environment which is focusing on carbon reduction and electrification and moving off of fossil fuel.

Getting at the Challenge of Data

CPC VeriFi™

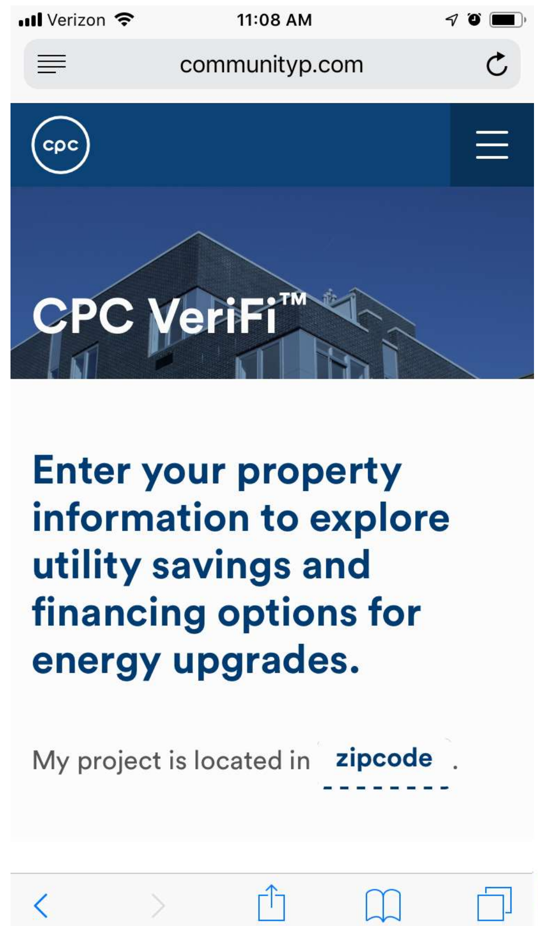
Using data collected from thousands of multifamily buildings, CPC VeriFi calculates opportunities for cost savings driven by energy and water upgrades and improvements.

Educating the Industry

- CPC Sustainability Department staff and Bright Power developers created a new resource to help owners identify areas to save by providing:
    - A scope of work to guide energy and water efficiency measures
    - Capital to finance simple, moderate, and substantial retrofits
    - Customized utility cost savings

FY20 Goal:

CPC Sustainability Department and Bright Power developers will collaborate to broaden the data base and rollout CPC Verifi 2.0 – An Underwriter's tool for projecting post rehab energy savings and performance with a goal of monetizing that value into additional first mortgage proceeds.



Carbon Reduction Challenges

More than 90% of the one million buildings that exist today in NYC will still exist in 2050

- Reducing carbon emissions and the use of fossil fuels in our built environment is a critical strategy for mitigating climate change and maintaining healthy, safe, and affordable communities.

- Electrification of buildings and renewable offsets are a public policy priority but don’t always make sense economically.

- Affordable Housing programs don’t have “extra” subsidy for carbon mitigation, their goal is affordability and they have limited public resources to maximize the number of affordable units that can be created to meet the overwhelming demand.

- If electrification does not make housing more affordable it will be very hard to get affordable housing developers, advocates and subsidy providers to prioritize it or even embrace it.

cpc

Retrofit to Carbon Neutral Case Studies

Uncommon Expertise. Unmatched Impact.

Community® Preservation Corporation

Westchester County Midrise

Property Basics

- Located in Tarrytown, Westchester, NY
- Built in 1969
- 103 units
- 1 building, 9-story mid-rise
- Includes an underground parking area, exposed parking lot, playground, laundry room, and basement community space

- <u>SCOPE OF WORK</u>
- **Insulation and air sealing: Re-clad with an exterior finishing system to insulate the building**
  - Cut heat loss through the walls by 85%
  - Fewer drafts and improved overall comfort
  - More even temperatures throughout building
- **Ventilation: Seal and balance the ventilation shafts. Replace rooftop units with a properly sized energy recovery ventilator (ERV) to recover some heat from exhaust and supply**
- **Lighting: Upgrade all lighting to LEDs**
- **Water: Install 1.1 gal/flush toilets and water leak detection equipment**
- **Renewables: Install approximately 200kW photovoltaic system over parking lot to offset a portion of electricity costs**

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Savings & Payback

	Business as Usual	EE Retrofit
Heating Index (BTU/SF/HDD)	12.6	6.3
Annual Energy Savings ($) Per Unit	-	$1,769
Total Annual Energy Savings ($)	-	$182,207
Carbon Emissions Reduction (Metric Tons)	-	**674**
Scope Cost Per Unit	$2,809	$17,647
Incremental Cost Over Business as Usual	-	$14,838
Payback Period	-	**8.4 years**

Economic Returns: IRR - 13%, Cash on Cash – 8.5%

Rochester Garden-Style Complex

Property Basics

- Located in Rochester, NY
- Built in 1962
- 184 units
- 11 buildings, garden style complex
- Gas heat

- <u>**WORK SCOPE**</u>
- **Insulation and air sealing: Re-clad with an exterior finishing system to insulate the building**
  - Cut heat loss through the walls by 85%
  - Fewer drafts and improved overall comfort
- **Ventilation: Seal and balance the ventilation shafts**
- **Heating: Replace atmospheric gas boilers and hot water heaters with sealed combustion furnaces and DHW heaters**
- **Water infiltration and moisture issues: Install gutters and leaders to address existing infiltration issues**
- **Appliances: Replace all refrigerators with new ENERGY STAR units**
- **Lighting: Upgrade all lighting to LEDs**
- **Water: Install low-flow fixtures and shower heads in all units**

cpc

Savings & Payback

	Business as Usual	EE Retrofit
Heating Index (BTU/SF/HDD)	17.7	6.0
Energy Usage Reduction	10-15%	66%
Annual Energy Savings ($) Per Unit	-	$677
Total Annual Energy Savings ($)	-	$124,568
Carbon Emissions Reduction (Metric Tons)	-	**1,551**

Scope Cost Per Unit	$3,383	$21,134
Incremental Cost Over Business as Usual	-	$17,751
Payback Period	-	**26.2 years**
Economic Returns: IRR – 11%, Cash on Cash 3%		

cpc

Take Aways:

- Economics and housing affordability will always be a priority to de-carbonization and electrification
- Electrification is a new concept in affordable housing and in order to be broadly adopted needs to make units more affordable
- Utility costs will drive the depth of the retrofit, expensive electricity will curb enthusiasm for electrification in the absence of mandates
- Maximizing underwriting isn’t always going to cover the cost of de-carbonization or electrification

Concern:

- Will there be enough electricity for electrification once Indian Point closes down?

Idea:

- Make Carbon Neutrality a condition of closing a loan

Thank You

- **Sadie McKeown, EVP Lending and Initiatives**
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