A New Frontier: Electrification in Multifamily Housing

Wednesday, May 19, 2021
2pm – 3:15pm ET
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#DOE
Today’s Presenters

- Jordan Dentz | The Levy Partnership
- Andrew McNamara | Bright Power
- Julie Klump | Partnership of Affordable Housing
- Rory Christian | New York City Housing Authority
- Edwin Mendez | New York City Housing Authority
AIR SOURCE HEAT PUMP DEMONSTRATION

- NYSERDA funded
- 20 Sites in NYC metro
- 1-3 family owner-occupied + rental
- Gas and oil
- Boilers + window AC
- Old buildings, minimal insulation
- Understand and demonstrate viability, costs and savings
SCOPE

• Full load replacement + weatherization
• NEEP-listed air source cold climate heat pumps
• 3-4 outdoor with 6-12 zones
• Mostly wall mounted fan coils
• Reasons for purchase: increase home value, “central” cooling, solve poor heat distribution
COSTS

- $10,000 to $50,000 project cost
- Up to $8,000 in incentives/discounts/rebates
### SAVINGS

Energy cost impact: +/-$1,500

<table>
<thead>
<tr>
<th>Site</th>
<th>old fuel</th>
<th>Site MMBTU savings</th>
<th>Savings lbs. CO2 emissions</th>
<th>$avings of HP only</th>
<th>$avings entire</th>
<th>COP accounting for env</th>
<th>COP raw</th>
<th>Reduced existing system use by</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>oil</td>
<td>223</td>
<td>36,368</td>
<td>$ (572)</td>
<td>$ 2,250</td>
<td>1.8</td>
<td>2.6</td>
<td>72%</td>
</tr>
<tr>
<td>5</td>
<td>gas</td>
<td>179</td>
<td>20,668</td>
<td>$ (746)</td>
<td>$ 485</td>
<td>2.0</td>
<td>3.2</td>
<td>70%</td>
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<tr>
<td>10</td>
<td>oil</td>
<td>228</td>
<td>37,151</td>
<td>$ (759)</td>
<td>$ 2,049</td>
<td>2.0</td>
<td>2.6</td>
<td>81%</td>
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<tr>
<td>12 owner</td>
<td>gas</td>
<td>31</td>
<td>3,522</td>
<td>$ (673)</td>
<td>$ (331)</td>
<td>0.7</td>
<td>1.7</td>
<td>89%</td>
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<tr>
<td>12 tenant</td>
<td>gas</td>
<td>31</td>
<td>3,535</td>
<td>$ (326)</td>
<td>$ (155)</td>
<td>1.4</td>
<td>2.1</td>
<td>84%</td>
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<tr>
<td>14</td>
<td>Oil</td>
<td>226</td>
<td>36,740</td>
<td>$ 1,470</td>
<td>$ 3,078</td>
<td>2.3</td>
<td>3.2</td>
<td>100%</td>
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<tr>
<td>19</td>
<td>oil</td>
<td>176</td>
<td>28,642</td>
<td>$ 975</td>
<td>$ 975</td>
<td>2.3</td>
<td>2.3</td>
<td>100%</td>
</tr>
<tr>
<td>21</td>
<td>Gas</td>
<td>20</td>
<td>2,223</td>
<td>$ (1,190)</td>
<td>$ (973)</td>
<td>0.4</td>
<td>0.9</td>
<td>20%</td>
</tr>
<tr>
<td>23</td>
<td>oil</td>
<td>105</td>
<td>17,125</td>
<td>$ 225</td>
<td>$ 1,489</td>
<td>2.0</td>
<td>3.6</td>
<td>100%</td>
</tr>
<tr>
<td>25</td>
<td>Gas</td>
<td>103</td>
<td>11,886</td>
<td>$ (429)</td>
<td>$ (162)</td>
<td>2.0</td>
<td>2.4</td>
<td>100%</td>
</tr>
<tr>
<td>39</td>
<td>Oil</td>
<td>50</td>
<td>8,076</td>
<td>$ (113)</td>
<td>$ (113)</td>
<td>1.8</td>
<td>1.8</td>
<td>100%</td>
</tr>
<tr>
<td>45</td>
<td>Oil</td>
<td>93</td>
<td>15,116</td>
<td>$ (434)</td>
<td>$ 572</td>
<td>1.5</td>
<td>2.6</td>
<td>100%</td>
</tr>
<tr>
<td>46</td>
<td>Gas</td>
<td>16</td>
<td>1,734</td>
<td>$ (1,571)</td>
<td>$ (1,571)</td>
<td>0.5</td>
<td>0.5</td>
<td>21%</td>
</tr>
<tr>
<td>AVG</td>
<td>0</td>
<td>88</td>
<td>12,882</td>
<td>$ (114)</td>
<td>$ 584</td>
<td>1.6</td>
<td>2.3</td>
<td>80%</td>
</tr>
<tr>
<td>AVG Oil (7)</td>
<td>Oil</td>
<td>157</td>
<td>25,603</td>
<td>$ 493</td>
<td>$ 1,471</td>
<td>2.0</td>
<td>2.7</td>
<td>93%</td>
</tr>
<tr>
<td>Avg Gas (6)</td>
<td>Gas</td>
<td>63</td>
<td>7,261</td>
<td>$ (822)</td>
<td>$ (451)</td>
<td>1.2</td>
<td>1.8</td>
<td>64%</td>
</tr>
</tbody>
</table>
SPACE HEATING HEAT PUMP TAXONOMY

Electric Heat Pumps

Ground Source Heat Pumps

Air Source Heat Pumps

Packaged systems

Split systems

Individual systems

Central systems

PTHP

Vertical

Mini-split

Multi-split

VRF

Water loop
Why heat pumps?

- BENEFICIAL ELECTRIFICATION
- CAN MEET FULL HEATING AND COOLING DEMAND
- EFFICIENT
- RELIABLE, COMFORTABLE, QUIET, ETC.
- MANY SUPPLIERS AND CHOICES
Why not heat pumps?

- Electrical service
- Labor costs
- Intrusive for existing residents
- Design and other soft costs
- Refrigerant lines for retrofit
- Refrigerant leak potential
- Location of outdoor units
- Roof space for PV
- ASHRAE 15
The heat pump with no outdoor unit
Ephoca – HPAC 2.0

- No outdoor unit
- Minimal distribution during installation
- No field refrigerant connections
- No ASHRAE 15 issues
- Possibilities for phased retrofit
- Reduced wall opening: 2 @ 8” dia.
Ephoca – HPAC 2.0 - Window Integration
Ephoca – HPAC 2.0 - Installed Cost

1 BEDROOM APARTMENT - 650 FT²

$1,000 | DEMO
$6,000 | EQUIPMENT COST ($3,000 EACH)
$2,000 | LABOR AND MISC. MATERIALS
$1,000 | DESIGN, PERMIT, FEES
($2,400) | NYS CLEAN HEAT INCENTIVE (PENDING)

TOTAL = $7,600/apt  ~$11.70/SF
The mini-split that slides into a PTAC Sleeve
## Sample apartment – 15yr PTAC cost comparison

<table>
<thead>
<tr>
<th></th>
<th>NPV</th>
<th>Installed cost</th>
<th>Yr 1 energy cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fujitsu EZ-Fit</td>
<td>$15,457</td>
<td>$4,200</td>
<td>$773</td>
</tr>
<tr>
<td>PTAC</td>
<td>$33,286</td>
<td>$1,000</td>
<td>$2,217</td>
</tr>
<tr>
<td>PTHP</td>
<td>$29,105</td>
<td>$1,100</td>
<td>$1,923</td>
</tr>
<tr>
<td>High efficiency PHTP</td>
<td>$26,494</td>
<td>$1,300</td>
<td>$1,730</td>
</tr>
<tr>
<td>Gas PTAC</td>
<td>$13,932</td>
<td>$1,000</td>
<td>$888</td>
</tr>
</tbody>
</table>

3% discount rate; not factoring in potential LL97 penalties
The heat pump that plugs into your hydronic distribution system
Aermec NRK/WWB

Air to Water Heat Pump with Water to Water Heat Pump Booster

A matched set of components to deliver high temp heating hot water
Aermec NRK/WWB

- Existing buildings with high temp hot water distribution or new construction
- Existing hydronic fan coils
- Domestic hot water
- $15-$30/SF
The heat pump that pops into your window
Treau

- Over-the-window-sill
- Inverter heat pump
- User-installable
- Plugs into standard wall outlet like a window AC unit
- Does not block the window
- Preliminary $500 to $2,000, depending on features
### Example Building Analysis

<table>
<thead>
<tr>
<th></th>
<th>Space Heating</th>
<th>Space Cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Annual Energy Usage</td>
<td>17,598 Therms/yr</td>
<td>32,482 kWh/yr</td>
</tr>
<tr>
<td>Existing Annual Emissions</td>
<td>102.8 tCO2e</td>
<td></td>
</tr>
<tr>
<td>Electricity Rate</td>
<td>$0.21/kWh</td>
<td></td>
</tr>
<tr>
<td>Gas rate</td>
<td>$1.08/therm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Assumed Efficiency</strong></th>
<th>Ephoca HPAC 2.0</th>
<th>Fujitsu EZ Fit</th>
<th>Aermec NRK/WWB*</th>
<th>Treau</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Projected Annual Energy Usage</strong></td>
<td>170,608 kWh/yr</td>
<td>140,941 kWh/yr</td>
<td>196,218 kWh/yr</td>
<td>122,139 kWh/yr</td>
</tr>
<tr>
<td><strong>Projected Annual Emissions</strong></td>
<td>49.3 tCO2e</td>
<td>40.7 tCO2e</td>
<td>47.3 tCO2e</td>
<td>35.3 tCO2e</td>
</tr>
<tr>
<td><strong>Total Site EUI Savings</strong></td>
<td>32.6 kBtu/sf/yr</td>
<td>35.1 kBtu/sf/yr</td>
<td>30.4 kBtu/sf/yr</td>
<td>36.8 kBtu/sf/yr</td>
</tr>
<tr>
<td><strong>Total Annual Emission Savings</strong></td>
<td>53.5 tCO2e</td>
<td>62.1 tCO2e</td>
<td>46.1 tCO2e</td>
<td>67.6 tCO2e</td>
</tr>
<tr>
<td><strong>Annual Energy Savings</strong></td>
<td>-$9,921/yr</td>
<td>-$3,831/yr</td>
<td>-$15,177/yr</td>
<td>$28/yr</td>
</tr>
<tr>
<td><strong>Estimated Installed Cost per SF</strong></td>
<td>$13.00/SF</td>
<td>$15.00/SF</td>
<td>$20.00/SF</td>
<td>$10.00/SF</td>
</tr>
</tbody>
</table>

*Heating savings only*
Ice Air and Freidrich

- Space heating down to -5°F and below
- Variable Refrigerant Flow
- R-410a Refrigerant
- Seleve and vertical configurations
THANK YOU

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Bright Power

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A New Frontier: Electrification in Multifamily Housing

Andrew McNamara
Executive Vice President of Operations, California

BRIGHT POWER
Bright Power

Energy and water management services for real estate owners, investors, and operators.

Installs upgrades that improve building performance and resident comfort while decreasing operating costs.

Founded in 2004 & works in 50 states

Offices in New York City & Oakland

Employs over 150+ experts
Our Model

**FIND**
- Energy Scorecards
  - Data collection
  - Benchmarking
  - Portfolio Energy Needs Prioritization
  - Energy procurement review

**FIX**
- Retrofit:
  - Comprehensive auditing
  - Incentive analysis
  - Design and Implementation
  - Commissioning
  - O&M improvement

**FOLLOW**
- Energy Scorecards
  - Verify Savings
  - Monitoring and Alerts
  - Compliance
- MOBIUS
  - Continuous Commissioning

**INVESTMENT PROJECTS**
- Solar Power
- Onsite Cogeneration
- Fuel Conversion
- HVAC
- Lighting
- Building Envelope
Perspectives

How quickly can HPWH’s scale up to meet carbon saving goals?

Will HPWHs work for my property? Are HPWH’s a worthwhile investment?

How do we ensure reliability of HPWH systems? Should I invest in building a business reliant on policy & incentives?
### Technologies for Electrification

<table>
<thead>
<tr>
<th>Uses</th>
<th>Gas Equipment</th>
<th>All-Electric Alternatives*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Heating</td>
<td>• Natural Gas Boiler</td>
<td>• <strong>Heat Pump Water Heaters</strong></td>
</tr>
<tr>
<td></td>
<td>• Gas Tankless Water Heater</td>
<td>• Electric Tankless Water Heater</td>
</tr>
<tr>
<td>Space Heating</td>
<td>• Gas Boiler</td>
<td>• <strong>Heat Pump Water Heaters</strong></td>
</tr>
<tr>
<td></td>
<td>• Steam Boiler</td>
<td>• Electric Resistance Heating</td>
</tr>
<tr>
<td>Cooking</td>
<td>Gas Stoves/Ovens</td>
<td>• Induction Stoves/Ovens</td>
</tr>
<tr>
<td>Clothes Dryers</td>
<td>Gas Clothes Dryers</td>
<td>• Electric Clothes Dryers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• <strong>Heat Pump Clothes Dryers</strong></td>
</tr>
<tr>
<td>Pools and Hot Tubs</td>
<td>Gas Pool Heaters</td>
<td>• <strong>Heat Pump Pool Heaters</strong></td>
</tr>
</tbody>
</table>

* not an exhaustive list

**Heat Pumps** are a key technology for full electrification!
<table>
<thead>
<tr>
<th>Application</th>
<th>System Type</th>
<th>Available Products/Form Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Single Family Integrated Tank (50-80 gal)</td>
<td>![Images]</td>
</tr>
<tr>
<td></td>
<td>Split</td>
<td>![Images]</td>
</tr>
<tr>
<td>Commercial</td>
<td>Low-Rise Integrated Tank (120 gal)</td>
<td>![Images]</td>
</tr>
<tr>
<td></td>
<td>Residential Manifolded</td>
<td>![Images]</td>
</tr>
<tr>
<td>Hi-Rise</td>
<td>Large Split</td>
<td>![Images]</td>
</tr>
</tbody>
</table>
Timeline of Central HPWH Multifamily Retrofit Installations

2004
- Bright Power founded

2015
- Bright Power’s CA office opens

2019
- Commercial
  - Jonathan Rose Companies
  - 155 br
  - Hybrid
- Commercial
  - TNDC
  - 245 & 129 br
  - Hybrid, Monitored

2020
- Residential
  - 103 br
  - HPWH only
- Commercial
  - Jonathan Rose Companies
  - 102 & 157 br
  - Hybrid, Monitored

1,614 Bedrooms served across 16 Properties
Bright Power Central HPWH Classifications

Central HPWH Systems

1st Gen
- Residential
- HPWH Only
- Hybrid

2nd Gen
- Commercial
- HPWH Only
- Hybrid

Sanden
Colmac / Nyle
2017 Heat Pump Installation
Heat Pump Installs: Sanden

- 7 affordable multifamily properties
- 36-151 units each
- Sanden Heat Pumps
- Work funded by LIWP
Technical Specs

Sanden Heat Pumps:
• 4.5 COP rated (at 45 degree inlet water temp and 60 degree ambient temp)
• Compressor is segregated from tank

Recirculation Control:
• Enovative AutoHot system

Tanks
• High storage volume
• Design for stratification
Equipment Selection

Context: Multifamily Retrofit

Equipment Selection:
- Sanden Gen3 - 15,400 BTUh per Sanden Heat Pump; 83 gals per tank
- Single Pass; CO2 refrigerant
- Separate Tank/Condenser
- Manifold design: up to 13 HPs in parallel
- High nameplate eff’y: 4.5 COP / 3.4 EF.
Compressors & Tanks Being Installed in Basement
Compressors Installed in Breezeway Near Boiler Room
Inlet Water Temperature vs. COP

- Higher inlet temp = lower COP
- Tank Stratification = higher COP
- Recirculation = less stratification = lower COP

<table>
<thead>
<tr>
<th>Inlet Water Temperature</th>
<th>Unit COP</th>
</tr>
</thead>
<tbody>
<tr>
<td>°F</td>
<td>°C</td>
</tr>
<tr>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>68</td>
<td>20</td>
</tr>
<tr>
<td>86</td>
<td>30</td>
</tr>
<tr>
<td>104</td>
<td>40</td>
</tr>
</tbody>
</table>

Based on Ambient Temperature of 44.6°F or 7°C
### Annual Operating Costs

<table>
<thead>
<tr>
<th>Project</th>
<th>Modeled Annual Weighted COP</th>
<th>‘Measured’ Annual Weighted COP</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project A</td>
<td>3.65</td>
<td>2.46</td>
<td>-33%</td>
</tr>
<tr>
<td>Project B</td>
<td>3.86</td>
<td>2.18</td>
<td>-43%</td>
</tr>
</tbody>
</table>

Current % HPWH Contribution

Designed % HPWH Contribution
- Crossover Flow + Recirc Imbalance
- Recirc pump turned to constant operation
- Heat Pump tanks destratify
- Return water temp rises; heat pump COP falls
Lessons Learned

1. The Technology Works!
2. Heat Pumps are not Boilers
   • Significant applications engineering is required to do retrofits right
3. Potential to give technology a black eye is real
   • Heat Pumps = Cold showers is not association we want
   • 2 core culprits:
     1. Crossover Flow
     2. Recirc Distribution Imbalance (i.e. no balancing valves and/or reverse return)
Lessons Learned

4. Demand shifting opportunities are an opportunity in hybrid plants
   • Heat pumps function as baseload, operating 80-95% of time

5. Electrical capacity is an issue at some properties.

6. Hybrid systems are the preferred option for reliability & cost effectiveness.
   • Certain installations will have the heat pumps providing most of the load, with a gas water heater as a backup system.
2019 Heat Pump Installation:
Jonathan Rose Companies’ Casa Panorama Panorama
Equipment Selection

**Context:** Multifamily Retrofit

**Equipment Selection:**
- Colmac HPA15- ~250,000 BTU/h per Hour (~17x Sanden)
- Single Pass
- Integrated Tank/Condenser
- Non-Manifold design
- COP ~4.0 in typical design conditions
- Designed to cover ~90% annual DHW load
Colmac

Crane Lift in Panorama City, CA
Colmac + Buffer Tanks Installed
Colmac + Buffer Tanks Installed

Re-using existing boiler and tank as “gas peaker” plant
Colmac System Schematic Design

Colmac HPA15 with Natural Gas backup

Single Heat Pump (not manifolded)

Existing DHW system acts as “gas peaker” plant

Project Funded by LIWP
Path to DHW Electrification:

1. Single Family: Heat pumps now (@ end of life)
2. Multifamily
   1. **Hybrid in short term** (~3 years). Why?
      • ~90% of gas offset for ~40-60% of the **cost**
      • **Reliable** DHW – avoid the black eye
      • **Learn** to address DHW Distribution in “safe” environment
   2. **All electric**
      • Now: in “goldilocks” properties
      • Medium term (~5 yrs) for end of life replacements
Path to DHW Electrification: Hybrid Model

Internal Combustion Engine | Hybrid-Electric | Electric

Gas | Hybrid | Electric
Bright Power HPWH Installed Cost Comparison

![Graph showing cost per bedroom for HPWH systems with and without hybrid options.](image-url)
How do I get started?

1. **Get your feet wet.** Plan your first projects now and build best practices.

2. **Identify partners.** Look for a design-build approach for retrofits.

3. **Retrofits: Utilize incentives** to yield strong returns.

4. **New Construction: Avoiding natural gas connection costs** can help your economic case.
Thank you!

Andrew McNamara
Executive Vice President of Operations, California
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Julie Klump
Preservation of Affordable Housing

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How and Why Electrify?

1. Passive House
2. Retrofits
3. Salem Heights
WHERE WE ARE

Connecticut  257 units
Washington, D.C.  94 units
Florida  1,356 units
Illinois  2,155 units
Kentucky  41 units
Massachusetts  3,426 units
Maryland  100 units
Michigan  645 units
Missouri  1,538 units
New Hampshire  264 units
Ohio  1104 units
Rhode Island  1,007 units

TOTAL  11,987 units
Passive House Projects:

- 6 in design
- 1 under construction
- 100% Electric
- Gas DHW & Generator
- Gas DHW & Generator
- 100% Electric
- 100% Electric

100% Electric

Gas DHW & Generator
Passive House Projects:
6 in design
1 under construction

Passive House:
Ensures Robust Enclosure
Low Load Heating and Cooling Demand
All Electric Ventilation Systems
DHW?
Back-up Power (solar storage)

Barriers:
Cost of Gas versus Electric
Cost of Electric Back-up Power
Ideal Retrofits:
Update Enclosure (whenever new cladding is needed)
Convert to Electric Heating and Cooling Systems
All Electric Ventilation Systems
DHW?
Back-up Power (solar storage)?

Barriers:
Cost of Gas versus Electric
Converting to Electric Heat and Cooling w/out Enclosure
Salem Heights
283 Units Family
Salem, MA
Enclosure Details

- New Roof with Insulation
- New Metal Panel Cladding (with Armorwall)
- Existing Brick Cladding

Roof to Wall Detail

Exterior Wall Details
18 x 12" Intake Louver Above
18 x 12" Exhaust Louver Below
Rooftop

269.2 kW DC

South Wall

106.2 kW DC
How close are we?

Robust Enclosure
All Electric HVAC
Solar PV (Wall and Roof)
Attleboro, MA
2 Historic Properties
Robust Enclosure?
HVAC
Hybrid VRF
- All Electric
- Includes Booster for Heating
ERV
Enclosure
- Foam Injection at Masonry Walls
- Continuous Rigid at Wood
- “Good” Windows

VRF heat recovery outdoor unit
YNW air sourced (22–50kW)

Central controllers

Water piping providing simultaneous heating and cooling

2 refrigerant pipes

Hybrid Branch Controller (HBC)
8 or 16 pots

Indoor units
Up to 50 indoor units (12–14.0kW)

Remote controllers

R32
Thank you.

Jklump@poah.org
Rory Christian
New York City Housing Authority

Edwin Mendez
New York City Housing Authority

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NYCHA: Keystone of NYC’s Critical Housing Infrastructure

PUBLIC HOUSING REPRESENTS 7.8% OF RENTAL HOUSING STOCK IN NYC

NYCHA IS THE LARGEST LANDLORD IN THE CITY

*2017 NYC HOUSING AND VACANCY SURVEY

NYCHA CLIMATE MITIGATION ROADMAP
Meeting Local Law 97 through Energy Efficiency and Beneficial Electrification
LL97 Roadmap is the latest elaboration of the Sustainability Agenda released on Earth Day 2016.
Purpose of Publishing Long-term Plans

1. Creation of each document **builds consensus** within NYCHA
2. Putting these plans in writing is a first step towards **public accountability**
3. Creates a **shared basis** for the inevitable push-pull (public, interagency, interest groups, etc.) of the implementation phase.

Must be clear about:

- **Guiding principles**: values that have to survive negotiation
- **Underlying assumptions**: plan should change if these are proven wrong later
- **Desired outcomes**, to enable “there’s a better way to get there” conversations
- **Timeframe and pace**, to choose among competing options
Business as Usual Gets us to 2030…but not 2050

Figure E1. Impact of Fuel Efficiency Measures on GHG Intensity

NYCHA 2030 Goal: 5.1 mtCO2e/ksf
NYCHA 2050 Goal: 1.7 mtCO2e/ksf

Analysis by Steven Winter Associates
NYCHA’s Plan in 2 Parts

1. Address **heat and hot water**
   - Building enclosure: Load reduction
   - Mechanical Systems: Optimization and electrification

2. Reduce **in-unit energy consumption** and costs via thoughtful transition to electrical submetering and electrification of cooking.

Both depend on NY State grid decarbonization
Many Paths to 80 x 50, Contingent upon Grid Decarbonization

Figure E2. Impact of Electrification Measures on GHG Intensity

<table>
<thead>
<tr>
<th>Year</th>
<th>Greenhouse Gas Emissions (tCO2e/ksf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005 Baseline</td>
<td>8.7</td>
</tr>
<tr>
<td>Reference Year 2017</td>
<td>7.9</td>
</tr>
<tr>
<td>Strategy 5 DHW Electrification</td>
<td>5.1 mtCO2e/ksf</td>
</tr>
<tr>
<td>Strategy 6 ASHP</td>
<td>1.7 mtCO2e/ksf</td>
</tr>
<tr>
<td>Strategy 1 &amp; 2 for Remainder</td>
<td></td>
</tr>
<tr>
<td>Carbon Free Electricity 2040</td>
<td></td>
</tr>
</tbody>
</table>

NYCHA 2030 Goal
NYCHA 2050 Goal

Analysis by Steven Winter Associates
### Scenario Retrofits

<table>
<thead>
<tr>
<th>Retrofits</th>
<th>Sc1 - Central Plant Replacement</th>
<th>Sc2 - Hydronic Boiler</th>
<th>Sc3 - hydronic Air Source HP</th>
<th>Sc4 - Packaged Terminal HP</th>
<th>Sc5 - VRF Heat Pumps</th>
<th>Sc6 - Hydronic Ground Source HP</th>
<th>Sc7 - Radiant Floor Heat &amp; POU DHW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Heat Retrofits</td>
<td>Replace central steam plant with condensing DHW; replace traps, vac tanks, distribution lines</td>
<td>Decentralize and install hydronic condensing natural gas fired boilers at each building for heat and DHW</td>
<td>Decentralize and install hydronic air/water heat pumps at each building for heat and DHW</td>
<td>Decentralize and install in-unit packaged terminal heat pumps in each building with air/water heat pumps for DHW</td>
<td>Decentralize and install in-unit VRF and air/water heat pumps in each building with heat pumps for DHW</td>
<td>Decentralize and install ground-source water loop heat pumps in each building for heat and DHW</td>
<td>Decentralize and install electric resistance heating elements below floor tiles</td>
</tr>
<tr>
<td>Space Cooling Retrofits</td>
<td>Existing window AC units remain unchanged</td>
<td>Existing window AC units are unchanged</td>
<td>Summer cooling provided by hydronic heat pump loop</td>
<td>Summer cooling provided by packaged terminal heat pumps</td>
<td>Summer cooling provided by VRF heat pumps</td>
<td>Summer cooling provided by geothermal system via hydronic loop</td>
<td>Existing window AC units are unchanged</td>
</tr>
<tr>
<td>HVAC Distribution System</td>
<td>Existing steam radiators, vertical and horizontal distribution remain</td>
<td>Fan coils or fin tube installed in dwelling units</td>
<td>Fan coils installed in dwelling units</td>
<td>Package terminal heat pumps in-unit</td>
<td>VRF fan coils or cassettes installed in dwelling units</td>
<td>Fan coils installed in dwelling units</td>
<td>Radiant floor heat</td>
</tr>
<tr>
<td>DHW Retrofits</td>
<td>Condensing DHW boilers installed at each building using existing piping networks</td>
<td>Condensing indirect-fired DHW at each building using existing piping networks</td>
<td>Air/water to water heat pumps at each building using existing piping networks for DHW</td>
<td>Air/water to water heat pumps at each building using existing piping networks for DHW</td>
<td>Air/water to water heat pumps at each building using existing piping networks for DHW</td>
<td>Ground source heat pumps at each building using existing piping networks for DHW</td>
<td>Point of Use electric DHW heaters in bathrooms and kitchens</td>
</tr>
</tbody>
</table>

### Common retrofits to all scenarios:
- **Windows replaced with energy efficient models.**
- **Exterior Insulation Finishing System (EIFS) wall cladding installed.**
- **Stovetops replaced with induction models.**

### Pros / Cons

| 2nd in lifecycle costs; no comfort improvement; requires ongoing maintenance for failing infrastructure; no permanent carbon reduction | Lowest lifecycle cost; eliminates steam infrastructure; adds comfort improvement for heat; No cooling; an investment in gas infrastructure instead of electrification; some carbon reduction but does not benefit from future greening electric grid without further conversion. | Eliminates steam infrastructure; comfort improvement for heat and cooling; deep carbon reduction from future greening electric grid; potential fuel switch redundancy. | 4th in lifecycle costs; layered with Sc2, maybe redundant costs. | 3rd in lifecycle costs; eliminates steam infrastructure; comfort improvement for heat and cooling; deep carbon reduction from future greening electric grid; simpler installation (may not require electric upgrades); but will require envelope penetrations or loss of operable window area. | Eliminates steam infrastructure; comfort improvement for heat and cooling; deep carbon reduction from future greening electric grid; lowest electric demand; 50 year life; 6th in lifecycle costs; not as modular if future loads reduce, requires many in-unit visits (e.g., envelope upgrades) | Eliminates steam infrastructure; comfort improvement for heat; Highest first cost; low efficiency compared to other electrification options |

NYCHA CLIMATE MITIGATION ROADMAP
Meeting Local Law 97 through Energy Efficiency and Beneficial Electrification
Scenario Retrofits
GHG Emissions (tCO2e per 1000sf)
Scenario Comparison to Emission Targets
Ocean Hill Apartments

Note: Electric grid is projected to be 100% green by 2040
Heating and Cooling Systems R&D
NYCHA is proposing to completely electrify all energy uses such as heating (and cooling), domestic hot water, and cooking at **1471 Watson Avenue located in Bronx, NY** by Fall of 2022.
Weatherization Toward Net Zero

Aiming for 80% reductions of total site energy

NYSERDA RetrofitNY Competition RFQL 4234
Scope of work:
• Panelized cladding
• Electrification (heat pumps for heating, cooling, ventilation and hot water)
• Improving aesthetics and resident comfort

Cladding at Baychester Houses
Bronx
• LL-11 façade
• Increased R-value
• Revitalized
Q & A

Submit Questions
www.slido.com event code #DOE
Additional Resources

Better Buildings Page: New York City Housing Authority
[Link](#)

Better Buildings Page: Preservation of Affordable Housing
[Link](#)

NYCHA Climate Mitigation Roadmap
[Link](#)
<table>
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<tr>
<th>Event</th>
<th>Date</th>
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<tbody>
<tr>
<td>Electrifying Our Buildings: Challenges and Solutions</td>
<td>June 8</td>
</tr>
<tr>
<td>Becoming ESPC-Ready</td>
<td>June 15</td>
</tr>
<tr>
<td>Boosting Industrial and Manufacturing Efficiency and Resiliency with CHP</td>
<td>June 17</td>
</tr>
<tr>
<td>Financing in Higher Education</td>
<td>June 22</td>
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<tr>
<td>What's Hot with Heat Pumps</td>
<td>June 29</td>
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<tr>
<td>Kick the Tires: Understanding the Role of R&amp;D in the Deployment of Building Energy Technologies</td>
<td>July 6</td>
</tr>
<tr>
<td>ESPC in the Express Lane: New Project Tracking Tools</td>
<td>July 13</td>
</tr>
<tr>
<td>Workplace Evolution: Supporting Occupant Health While Achieving Energy Efficiency</td>
<td>July 20</td>
</tr>
<tr>
<td>Energy-Saving Envelope Success Stories</td>
<td>July 27</td>
</tr>
<tr>
<td>Waste Reduction: Lessons Learned and What Comes Next</td>
<td>August 3</td>
</tr>
<tr>
<td>Visualize Your Energy Future with 'Slope': The State and Local Planning for Energy Platform</td>
<td>August 10</td>
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https://betterbuildingssolutioncenter.energy.gov/events-webinars
Additional Questions?

Please Contact Us

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