#### A Technical Guide to Heat Pump Installation

Take a deep dive into heat pump installation during this step-by-step training, following a multifamily building's conversion to individual air source heat pumps in each apartment. Hosted by Building Energy Exchange, this webinar showcases the impact to cost, energy consumption, and energy savings of converting a 10-unit multifamily building in New York City to all-electric heating and cooling. Speakers will detail heat pump installation and design elements, operating procedures, and additional benefits of heat pumps compared to oil and gas-fired heating systems. They'll also address the importance of air sealing and the impact of heat pumps on the building's electrical system, and case-specific considerations.

#### **Moderator:**

Valerie Corbett, Account Manager, NYC Accelerator

#### **Speakers:**

Tom Sahagian, Project Originator and Manager Ian Shapiro, Founder, Taitem Engineering Lisa Harrison, Building Resident and Project Liaison

January 26, 2022 | 1 to 2:30 pm | 1.5 AIA LU|HSWs Building Energy Exchange | be-exchange.org



building energy exchange



#### BeeX January 26, 2022

Tom Sahagian, Lisa Harrison, Ian Shapiro



#### **Key Concepts**

- 1. #1 challenge is to eliminate refrigerant leaks; otherwise the whole exercise is a complete waste of time
- 2. To have a prayer of reaching 80 x 50, each heat pump must be directmetered or submetered
- 3. Keep the existing heating system in place as a future demand limiter
- 4. Do not assume you need an electrical upgrade
- 5. Airsealing is integral to the job, not an option
- 6. Do not assume gas-fired buildings are poor candidates for conversion

### Major Takeaways...

- 1. There is already a shortage of properly-trained heat pump techs
- 2. Someone knowledgeable must oversee the job
- 3. Every building is likely to have unexpected weirdness
- 4. "Set It and Forget It" may rhyme, but that does not mean it's a good idea
- 5. Drain condensate internally if you can
- 6. A maintenance contract may not provide much value
- 7. DHW remains a challenge, but is becoming easier

#### ...but there are plenty more

#### Results (with caveats)

Measured (mostly) Results UWS Heat Pump Conversion							
Spa	ace Hea	t Oil		Space Heat Heat Pumps			
From		10/1/19		From		10/1/20	
То		5/31/20		То		5/31/21	
HDD		4,393		HDD		4,326	
	3,132	gal			21,527	kWh	
\$	2.48	Avg. \$/gal			\$0.28	Avg. \$/kWh	
\$	7,767	Subtotal \$		\$	6,028	Subtotal \$	
\$	2,000	\$/yr Maint.		\$	3,000	\$/yr Maint.	
\$	9,767	Total \$/yr.		\$	9,028	Total \$/yr.	
\$	977	\$/apt/yr		\$	903	\$/Apt./Yr.	
Space Heat Electric Resistanc				Extra Cost of DHW			
	3,941	kWh			2.4	Old gal oil/day	
\$	894	Total \$			4.7	New gal oil/day	
Varies by apartment					242	days	
					557	Extra DHW oil gal.	
				\$	2.48	\$/gal	
				\$	1,380	Extra DHW \$/yr	

Energy Cost Savings Calculation \$								
Total			Total	Annual Savings				
\$ 10,662			\$ 10,408	\$	254			
		Cost	Reduction		2%			
Energy Savings Calculation MMBtu								
140,000	Btu/ gal		140,000	Btu/ gal				
438	MMBtu/ yr		78	MMBtu/ yr				
3,413	Btu/ kWh		3,413	Btu/ kWh				
13	MMBtu/ yr		73	MMBtu/ yr				
Total			Total					
452	MMBtu/ yr		151	MMBtu/ yr				
Annua	Savings, MM	% Energy Savings						
301			67%					

GHG Calculation tonnes equivalent CO2							
Space Heat	Space Heat Oil			Space Heat Heat Pumps			
Oil GHGs			Oil GHGs (less-efficient DHV				
164	lb/MMBtu		164	lb/MMBtu			
71,911	lbs/yr		12,780	lbs/yr			
32.6	tonnes/yr		5.8	tonnes/yr			
Electricity G	iHGs		Electricity GHGs				
0.289	kg/kWh*		0.289	kg/kWh*			
1,139	kg/yr		6,221	kg/yr			
1.14	tonnes/yr		6.2	tonnes/yr			
Total			Total				
33.8 tonnes/yr			12.0	tonnes/yr			
Annual Savings, Tons GHGs/year			% GHG Reduction				
21.8			64%				
*NYC 2019 GHG Inventory							

October 2021: Oil cost = \$3.45/gal; Residential gas cost = \$2.34/thm Assuming equal boiler efficiency, this gas cost is equivalent to \$3.28/gal

### **Alternative Endings**

			Better-		
		Estimated	case	New Cost	New GHG
Variable	Existing	Savings	Scenario	Savings	Reduction
\$/kwH	\$0.28	2%	\$0.26	6%	N/A
\$/gallon of oil	\$2.48	2%	\$3.45	20%	N/A
GHG/kWh	0.289	64%	0.384	N/A	58%
GHG/kWh	0.289	64%	0.192	N/A	71%
Btu/sq. ft./HDD	10	2%	15	28%	N/A

# Original system – central cast-iron, oil-fired 1-pipe steam boiler with tankless coil for domestic hot water (DHW)





#### New system – individual air-source heat pump (ASHP) in each apartment

Installed Outdoor Units (ODUs) In Three Locations: 1 -- Roof



#### 2. Rear Wall







### Indoor Units (IDUs)

#### Wall-mount

#### Floor-mount



Note: These are cold-climate heat pumps. There are no "backup" resistance electric heat elements

## **Design Issues**

### **Design Issues**

- How much capacity do we need?
- How many ODUs per apartment?
  - $\circ$  Where should they be located?
- How many IDUs per apartment?
  - Where should they be located?
  - Which type floor, ceiling or wall mount? Snazzy or standard?
- Which load is greater, cooling or heating?
- Will the basement pipes freeze once the boiler stops providing space heat?
- Will the common-area hallways be too cold?
- How and where should we drain the condensate?
- Where do we run the refrigerant linesets?
- Do we need to increase electrical capacity?
- What do we do about DHW?



#### Some people are aesthetically opposed to Line-Hide





#### Others are not





#### Some prefer a soffit to an exposed lineset or Line-Hide



## Installation Issues

#### Installation Issues



Wrong ODU Brackets

Wrong Condensate Pumps



Pressure test

Vacuum test

Pressure test

7/27/20 5:38 pm Starting pressure = 552 Temp = 91.0 Ending pressure = 550 Temp = 85.87/28/20 9:28 am Delta T = (91.0 - 85.8) \* 0.8 = 5.2 \* 0.8 = -4.2 degrees Delta P = -2 psi



#### Condensate leaks



Condensate Removal -- Original Plan





Uninsulated Refrigerant Lines;

Holes and Exposed Brick





#### Repair Attempt 1



#### Repair Attempt 2





Contractor explained that they did not have a fin-straightening tool

## **O&M** Issues

### Drips



### Wrong Way







### Condensate Pumps



## Airsealing

### Airsealing – Basement Window



### Airsealing – Basement Gym





### Airsealing -- Missed this one for an entire year



### Airsealing – Roof Door



#### Airsealing Doors – more difficult than you might think...



#### ...especially if the resident doesn't want any.



## **Electrical Issues**

### **Electrical Service**



#### Breaker Capacity Was Increased, But Not the Service Itself



#### Peak kW for the Entire Building During Cold Weather



## Weirdness

#### Weirdness 1-- Unexpected Air Leaks





#### Weirdness 2



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### Weirdness 3 – Airsealing re: Boiler Room





## The Future of Heat Pumps

#### The Future of Heat Pumps



#### Thank You!

#### Questions?

#### ts.conserve@gmail.com

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