Electrifying Our Small Building Stock: Lessons from The Field

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Building Energy NYC
September 26, 2019

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Clean Heating & Cooling Building Energy NYC

September 26, 2019

Scott Smith

Why is the Topic of Clean Heating & Cooling Relevant to NY State

- HVAC accounts for around **a third** of NY carbon emissions.
- "**Beneficial Electrification**": **Heat Pumps** can help decarbonize the heating and cooling sector by:

1. Cooling at greater efficiency than air-conditioning (thus reducing summer peak)
2. Replacing fossil heating with heat pump heating, resulting in:
    - Increased grid utilization in the winter months
    - Significant carbon savings even at current grid carbon intensity
    - Further carbon savings in future as power generation decarbonizes further
    - Energy bill savings in homes heated with fuel oil and propane
    - Increased health benefits with no carbon monoxide produced on site

Barriers to Clean Heating and Cooling Adoption

- **High first costs and insufficient return on the additional investment above the cost of a regular heating & cooling system**
- **Low fossil fuel costs**
- **Limited training available for installers, designers, architects, and engineers**
- **Lack of consumer knowledge and awareness**
- **Lack of affordable financing solutions**

CH&C Programs

- **Air Source Heat Pumps (ASHP) Program [PON 3635 $10.95M]**
  - NYSERDA is providing up to $10.95 million in incentives to participating installers for the installation of program qualified ASHP systems in residential sites to include single-family and multifamily buildings through 2019. Incentives, provided on a first-come, first-served basis, include those that may be retained by the Participating Installer as well as incentives for Whole-House Solution ASHP Systems that will be paid to the Participating Installer but must be credited to site owners.
  - 250+ Participating Installers
- **Ground Source Heat Pumps (GSHP) Rebate Program [PON 3620 $26.5M]**
  - Offers $15 million to support the installation of ground source heat pump systems at residential, commercial, institutional, and industrial buildings. Funding is available only to eligible designers and installers of renewable heating and cooling systems that have been approved by NYSERDA through June 2019.
  - 68 Participating installers
- **Clean Heating & Cooling Communities Campaigns [PON 4114 / $2.5 Million available in third round, $8 Million total investment]**
  - Support for communities to increase customer awareness of CH&C technologies, reduce installed costs, and jump-start the market by implementing multi-year campaigns consisting of community-based outreach and education focused on CH&C.
  - Retained consultant to provide technical assistance to communities
- **Geothermal Clean Energy Challenge [$3.5 Million Available]**
  - NYSERDA and NYPA will identify the best candidates for large, multi-building geothermal ground-source heat pump installations by providing free technical assistance and financial support. Open only to qualified colleges and universities, K-12 schools, State and local governments, and hospitals in New York State.

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CH&C Programs Launched since June 2017 cont.

- **Cooperative Advertising and Training for CH&C Partners [PON 3694 / $2 Million]**
  - NYSERDA has made $2 million available to support advertising, special promotions and/or events, including training, for eligible HVAC technologies. Incentives up to 50 percent of the total cost for educational and marketing promotion opportunities to eligible participants, such as HVAC manufacturers, HVAC distributors/vendors and HVAC installers participating in PON 3653: Air-Source Heat Pump Program, PON 3620: Ground-Source Heat Pump Rebate or Renewable Heat New York
- **NEXTGEN HVAC Technology Challenges [PON 3519 / $15 Million Available in 4 Rounds]**
  - Several heat pump related categories
- **Financing Solutions**
  - Conduct financial solutions market research for CH&C technologies (focus in financing and investing)
  - Federal tax credit of 30% residential and 10% commercial for geothermal installations reinstated
  - Green Jobs Green NY Loan Program available to eligible GSHP and ASHP Installers
- **Marketing & Outreach**
  - Developing clean heating & cooling messaging with marketing consultants KSV
  - Developing customer targeting tool to identify high potential customers

Clean Heating and Cooling Community Campaigns

- Funding for local outreach, education, and bulk procurement for clean heating and cooling (CH&C) technologies:
  - Ground Source Heat Pumps
  - Air Source Heat Pumps
  - Solar Thermal
  - High-Efficiency, Low-Emission Biomass
- Increase consumer education and awareness of CH&C technologies
- Reduce purchase and installation costs
- Grow the CH&C workforce
- Increase participation of low- to moderate-income (LMI) households

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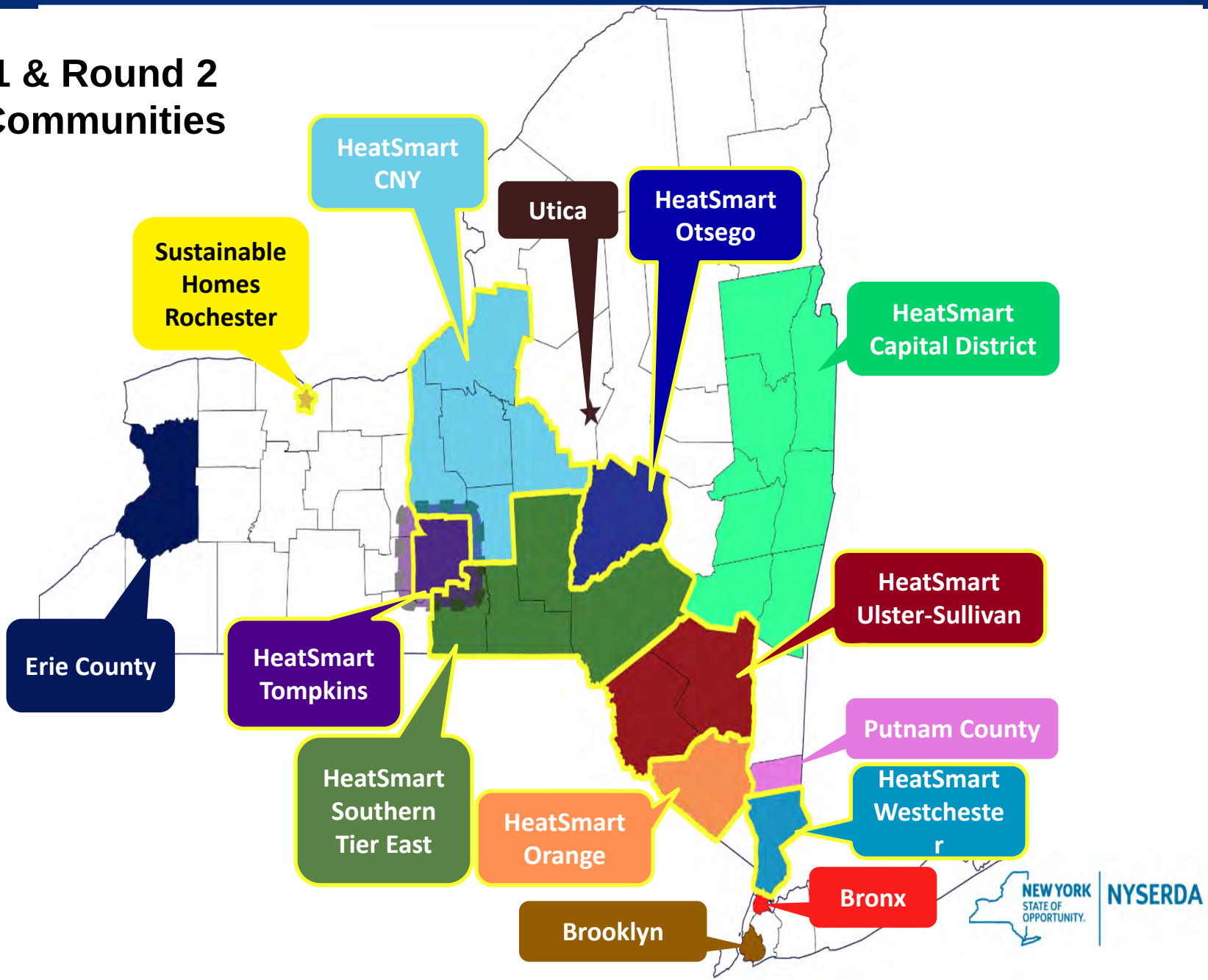
Round 1 & Round 2 CH&C Communities



Performance Validation and Demonstration Projects

- Ground Source Heat Pumps
  - ~50 existing residential systems statewide
  - ~45 additional residential systems on Long Island
- Air Source Heat Pumps
  - 20 residential replacements in Brooklyn and Queens
  - 20 residential displacements in the Hudson Valley

Performance Validation and Demonstration Projects

- Air Source Heat Pumps (Cont.)
  - 5 residential air to water systems in Tompkins County
  - 5 residential low capacity gas furnace/ASHP hybrids in Central NY
  - 2 VRF systems
    - One commercial in Westchester
    - One Multifamily building in NYC

Performance Validation and Demonstration Projects

- Goals:
  - Determine what information the market needs on technical and economic performance
  - Collect performance information that can be communicated accurately and confidently
  - Disseminate the information to the market and make data available to create change

Thank You

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New York City's Building Electrification Goals & Small Homes

Mayor's Office of Sustainability

NYC's Roadmap to Carbon Neutrality

70% Of citywide emissions come from the energy used in buildings

40% Of citywide emissions come from on-site fossil fuel use in buildings

At least:

100% Of buildings will need to complete a deep energy retrofit

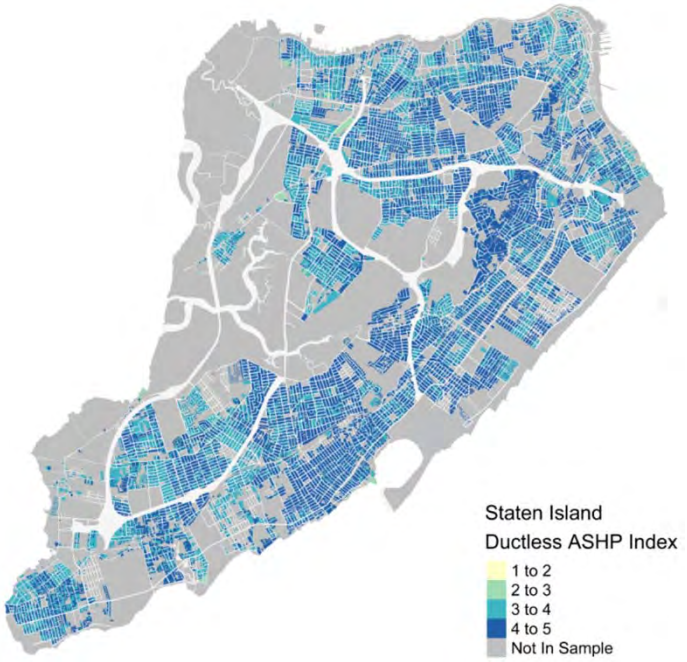
50-60% Of buildings must convert to high efficiency electric heat pumps

90%+ Of buildings must electrify hot water systems

Electrification Focus on Small Buildings

- NYC has **> 800,000** small residential buildings, which account for nearly 20% of building GHG emissions.
- **176,000 small residential buildings** across NYC identified as good candidates for ASHP installations.
- **Contractor research** identified that demand needed to reach 2050 goals will surpass installer supply by 2020.
- **Customer Market Research** completed to identify motivators, barriers, and best messaging channels.

Potential ASHP candidates in Staten Island



Ongoing and Upcoming Initiatives

- **Contractor-based Outreach and Assistance program** to accelerate ASHP retrofits in small residential homes

- **Standardizing ASHP Contractor QA/QC requirements**
  - Working group with NYSERDA, Con Ed, & National Grid with support from TRC
  - To be enforced by utility & statewide incentive programs, as well as upcoming City programs

- **Equitable Workforce Development**
  - Project with the Building Electrification Initiative (BEI) to:
    - Explore how to increase MWBE participation
    - Build a growing pipeline of HVAC contractors

Thank You

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DOWNSTATE AIR SOURCE HEAT PUMP DEMONSTRATION

THE LEVY PARTNERSHIP
CENTSIBLE HOUSE
FRONTIER ENERGY

September 26, 2019

The Levy Partnership

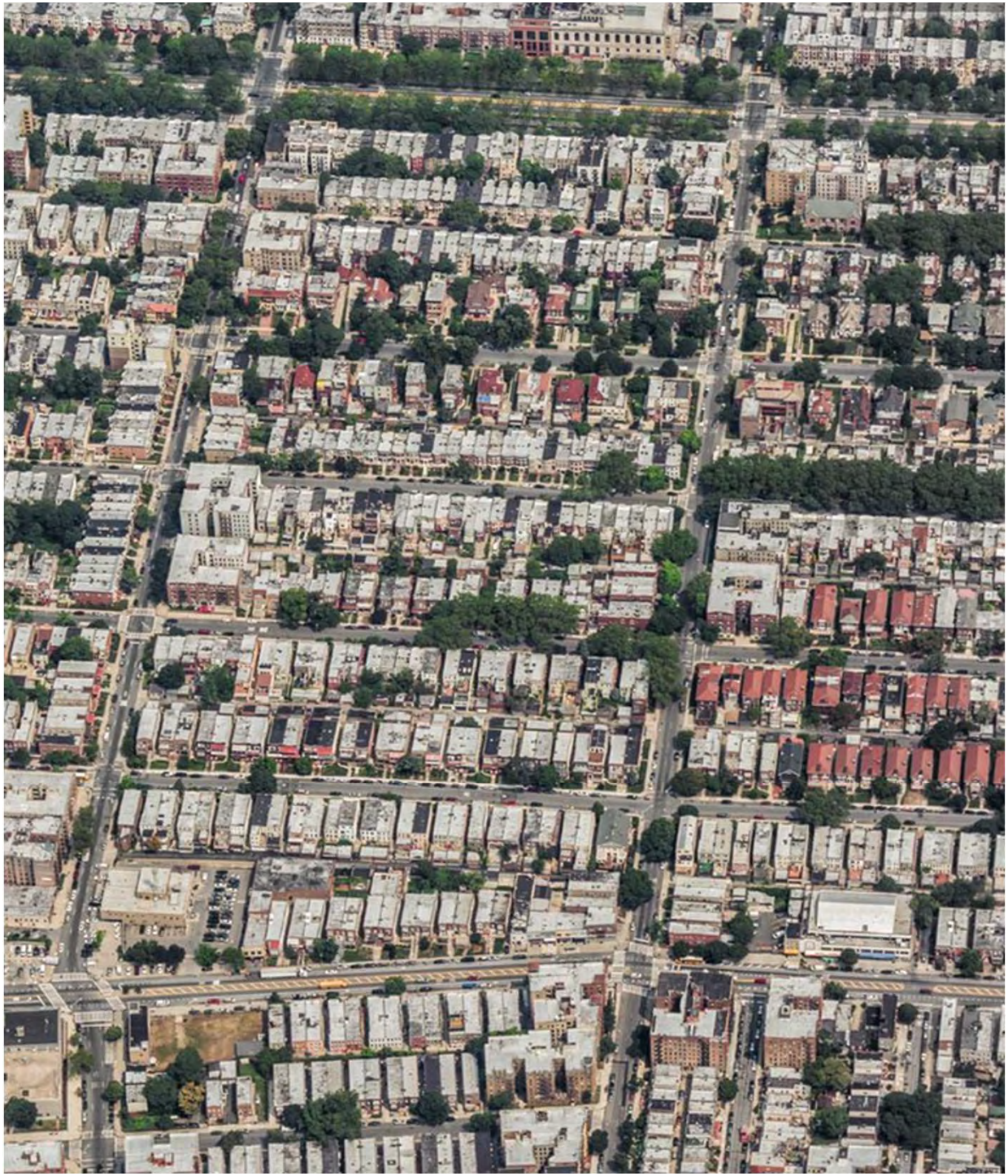
FRONTIER energy

Overview

- 20 Sites
- Brooklyn, Queens, Bronx, Yonkers, Long Island

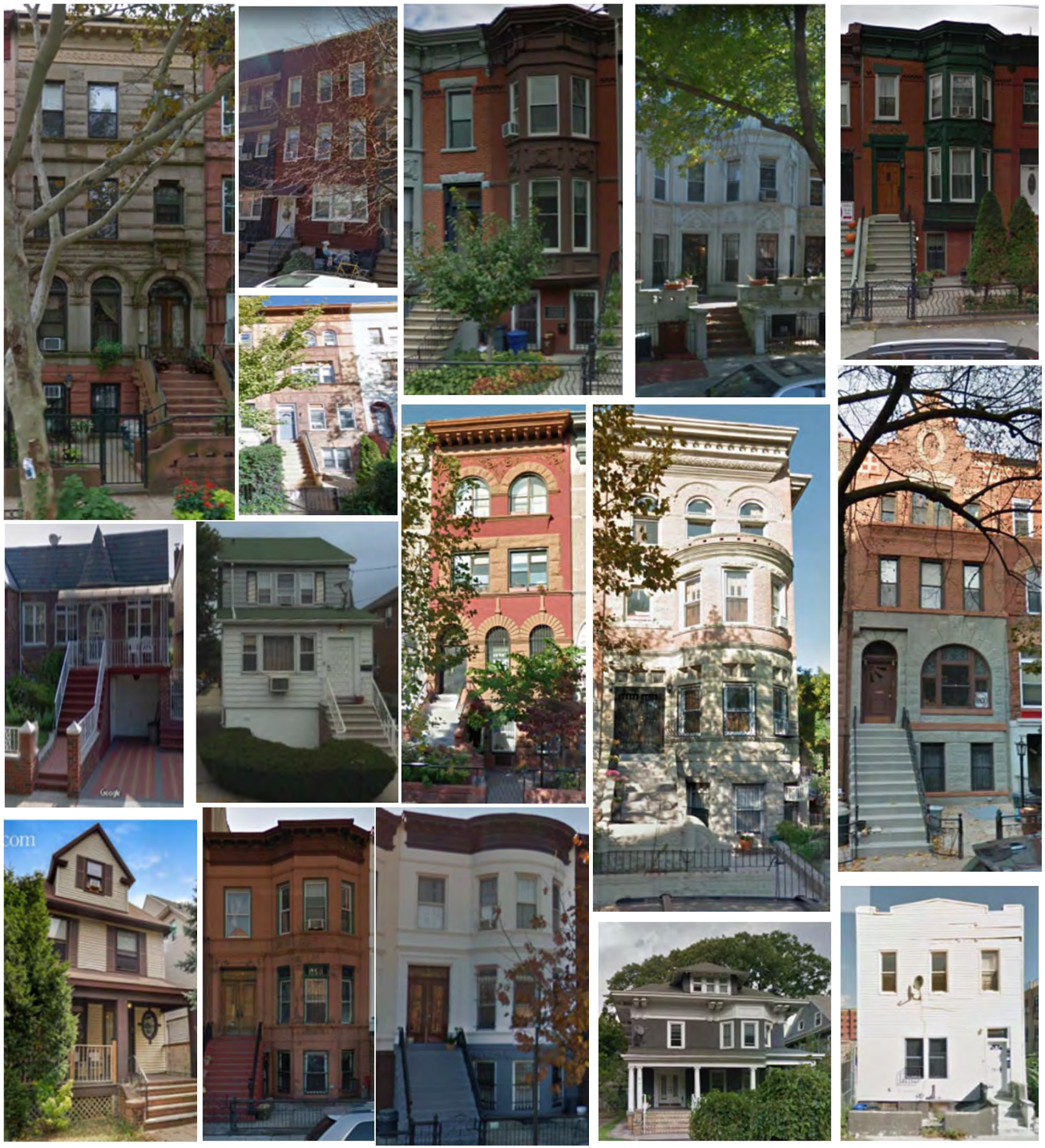
Goals:

- Understand and demonstrate viability costs and savings
- Increase awareness, and confidence
- Market exposure
- Provide resources for NYSERDA to promote benefits



Sites

- 1-3 family buildings
- Owner-occupied with rental units
- Tight urban lots
- Most masonry attached; some wood frame SFD
- Gas and oil
- Boilers with window ACs
- Old buildings, minimal insulation



Retrofit Scope

- Full boiler replacement
- Some weatherization

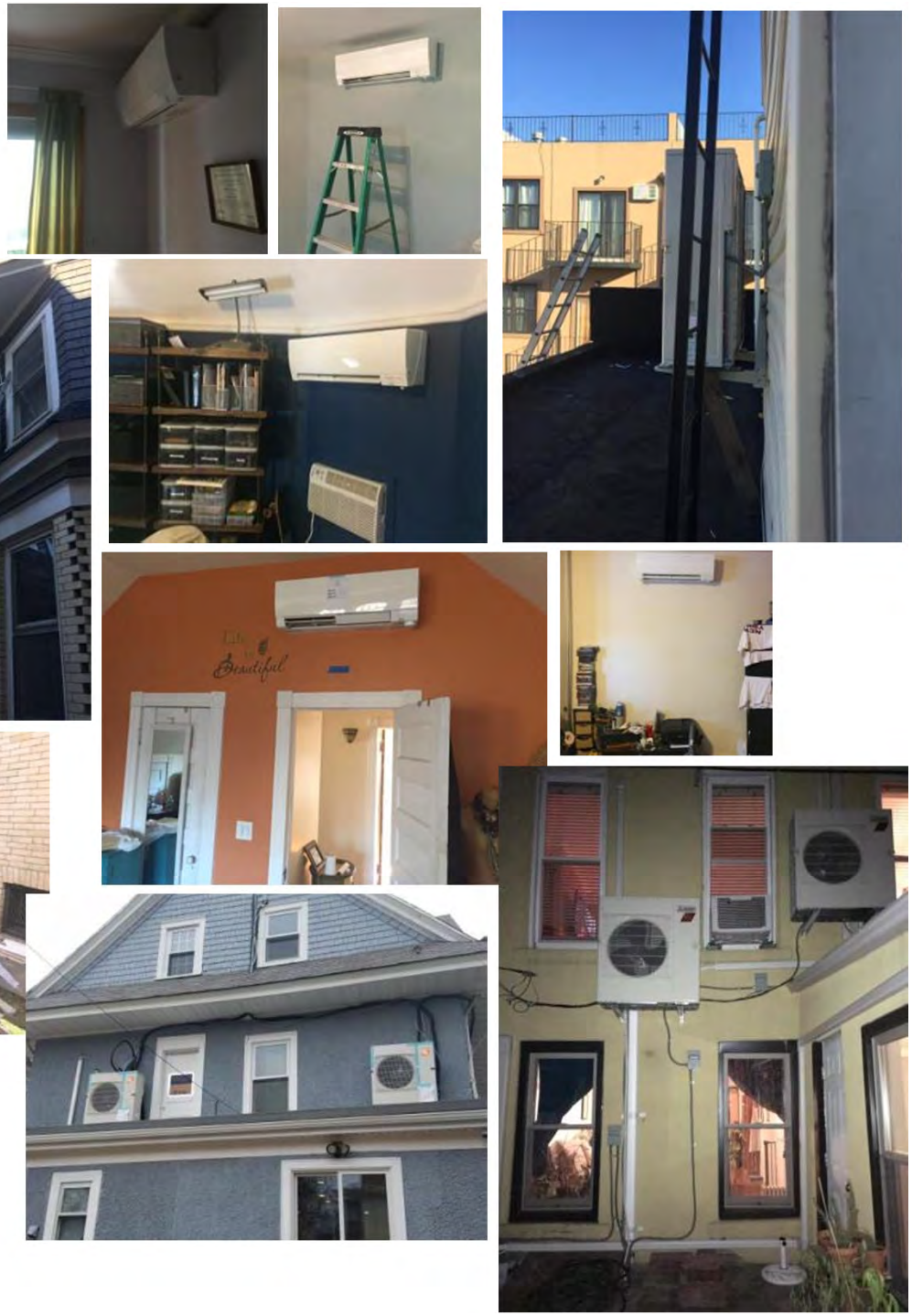
Site Status

- 20 sites installed
- 12 sites have one year data
- 8 sites data pending

Equipment

- Cold climate (NEEP listed)
- 3-4 condensing units
- 6-12 air handlers
- Wall mounted multi-splits
- A few ducted units
- Mostly Mitsubishi/Fujitsu equipment

Mitsubishi	Fujitsu
Outdoor unit	Outdoor unit
MXZ3C24NAHZ	AOU12RLS3H
MXZ4C36NAHZ	AOU18RLXFZH
MXZ3C30NAHZ	AOU24RLXFZH
MXZ5C42NAHZ	AOU36RLXFZH
MXZ4C36NAHZ	AOU36RLAVM
Indoor units	Indoor units
MSZFH06NA	ASU7RLP1
MSZFH09NA	ASU9RLP1
MSZFH12NA	ASU12RLP1
MSZFH15NA	ASU18RLP1



SITE 10

Envelope Improvements

Envelope Improvement	Details
Air Sealing	Reduce overall air leakage of heated area from 1.75 ACH to 1.25ACH.
Rim Joist	Upgrade 180 square feet of existing rim joist to 2” High Density Foam, 1.5” Wood, 0.5” Wood Siding, R-15
Second floor attic insulation	Upgrade 320 square feet of existing ceiling to Gyp Bd, 2x6 16” OC, 6” cellulose, R-19

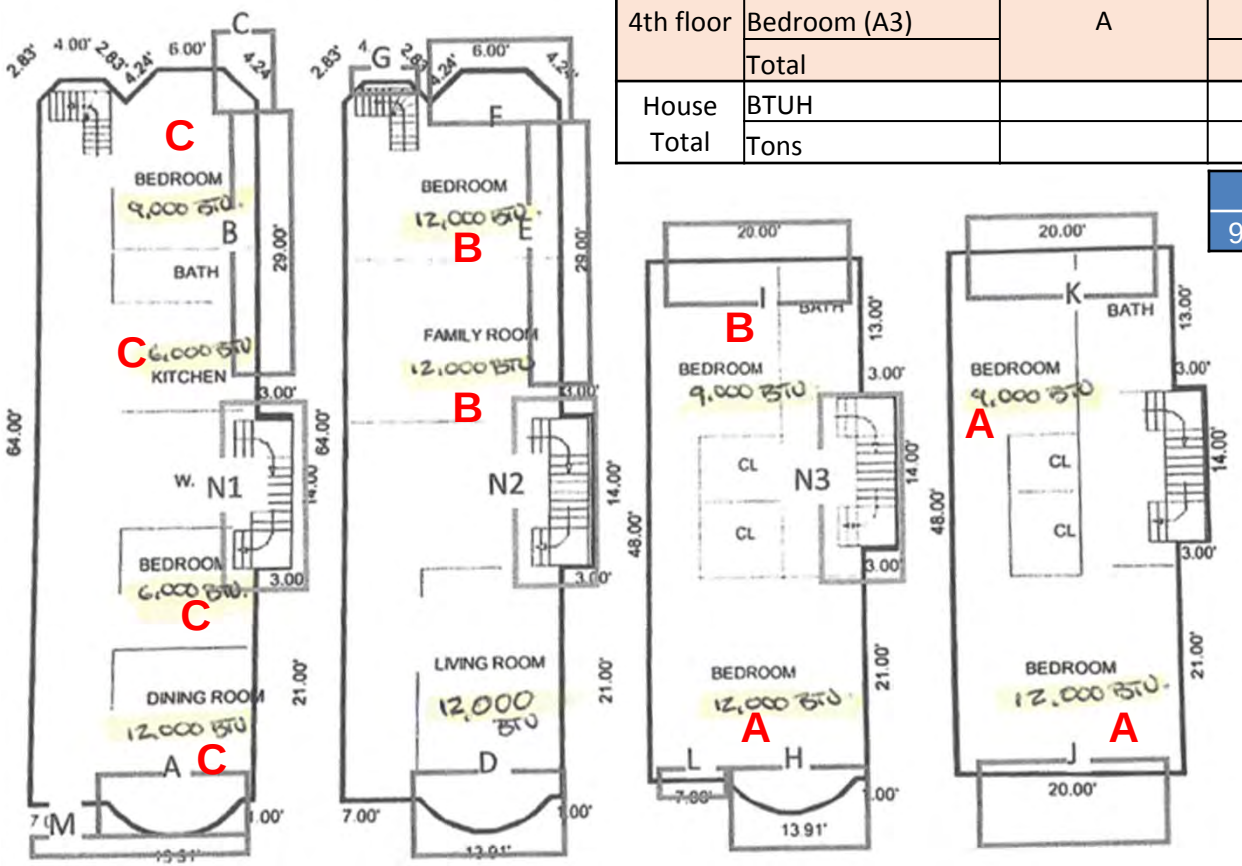
Costs

Item	Cost
Heat pump equipment (10 zones)	15,000
Heat pump labor	20,783
Total heat pump	35,783
Cost per ton	4,647
Cost per zone	3,578
Envelope materials + labor	10,736
Total job	**46,519**

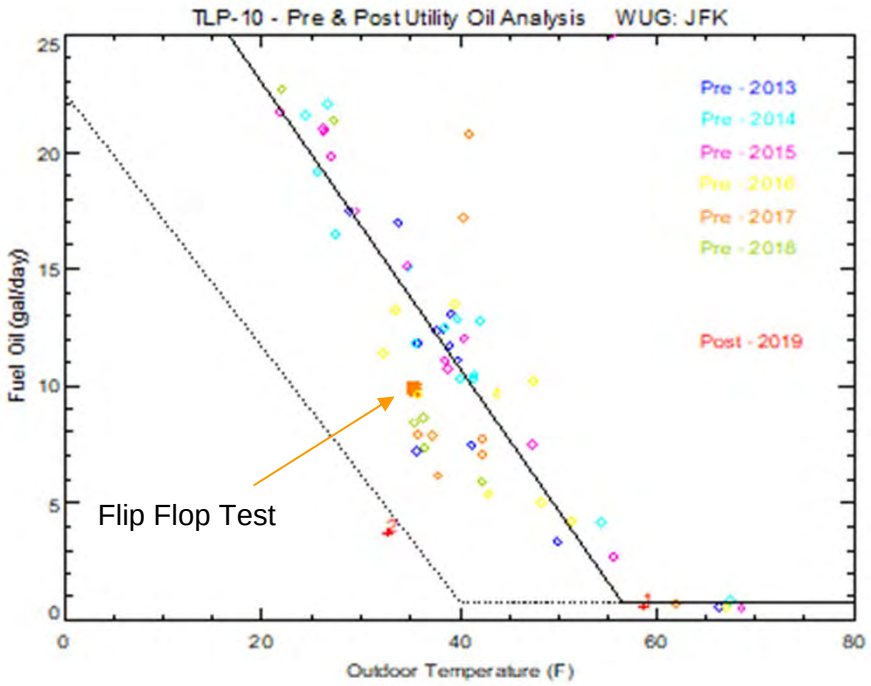
SITE 10

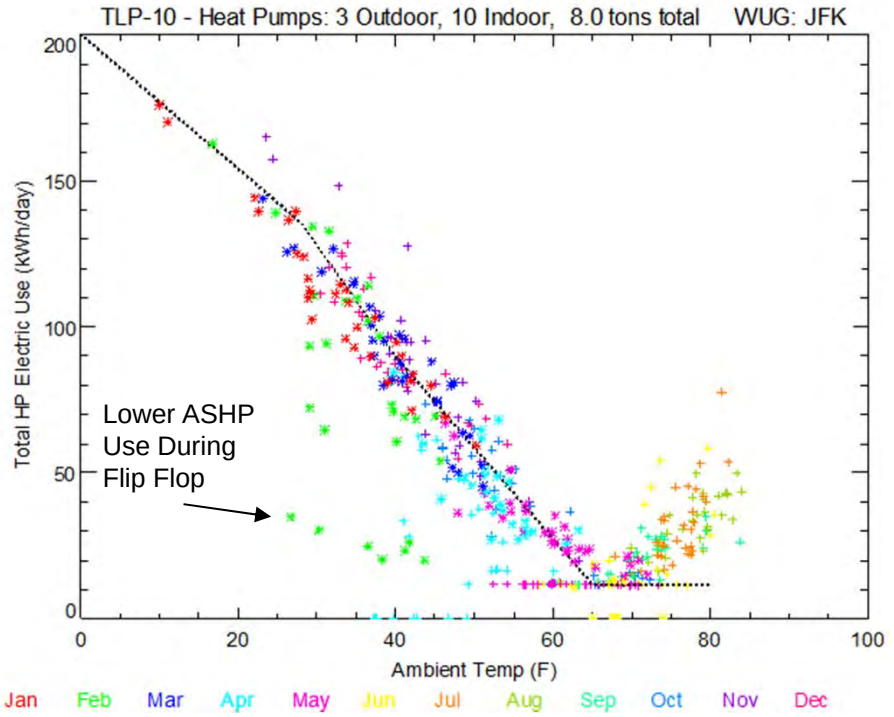
		Equipment Selection					
		Outdoor unit			Indoor units		
Floor	Room	Model	Cooling	Heating	Model	Cooling	Heating
1st floor	Living Room (C1)	MXZ-4C36NAHZ C			MSZ-FH12NA	12,000	10,900
	Bedroom (C2)				MSZ-FH06NA	6,000	8,700
	Kitchen (C3)				MSZ-FH06NA	6,000	8,700
	Back Bedroom (C4)				MSZ-FH09NA	9,000	10,900
	Total		**36,000**	**45,000**	**total**	**33,000**	**39,200**
2nd floor	Dining/Kitchen (B1)	MXZ-3C30NAHZ B			MSZ-FH15NA	15,000	12,900
	Back Bedroom (B2)				MSZ-FH12NA	9,000	7,900
3rd Floor	Bedroom (B3)				MSZ-FH09NA	9,000	7,900
	Total		**28,400**	**28,600**	**total**	**33,000**	**28,700**
3rd Floor	Front Bedoom (A1)	MXZ-3C30NAHZ A			MSZ-FH12NA	12,000	13,600
4th floor	Front Bedroom (A2)				MSZ-FH12NA	12,000	13,600
	Bedroom (A3)				MSZ-FH09NA	9,000	10,900
	Total		**28,400**	**28,600**	**total**	**33,000**	**38,100**
House Total	BTUH		92,800	102,200		99,000	106,000
	Tons		7.7	8.5		8.3	8.8

Loads	
93,273	110,633

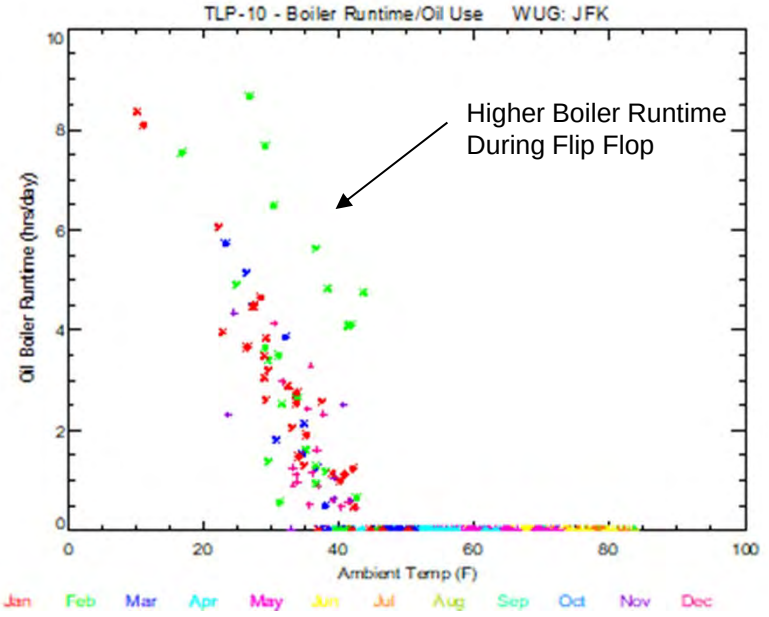


SITE 10



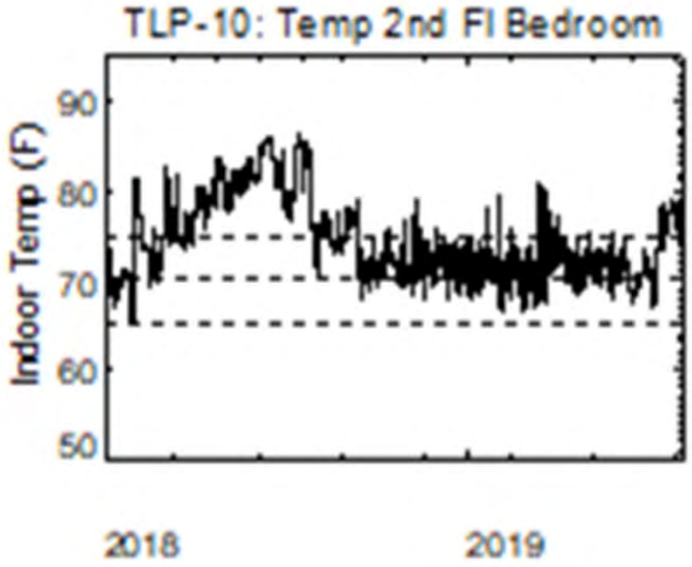


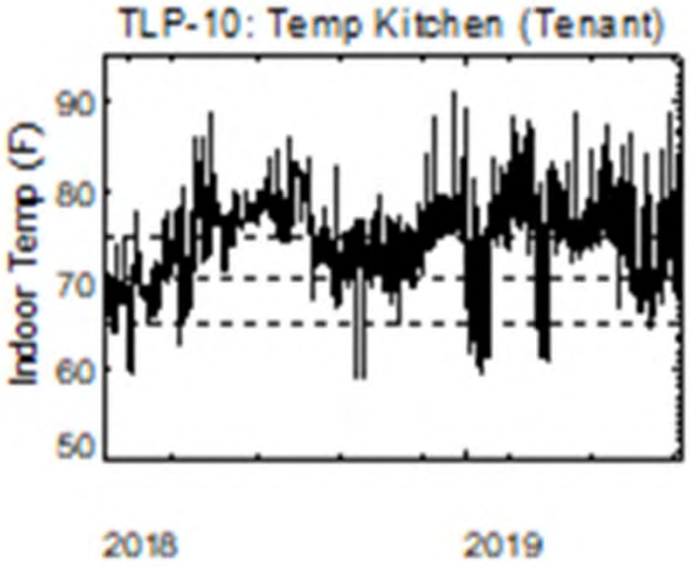
Heating season only (space and water heating)	PRE	POST	Savings
Costs	$8,237	$5,987	$2,250
Oil (Gal/yr) $3.60/gal	2,288	613	1,480.7
Electric (kWh/yr) $0.21/kwh		18,955	(18,955)
Implied COP accounting for envelope	2.0		

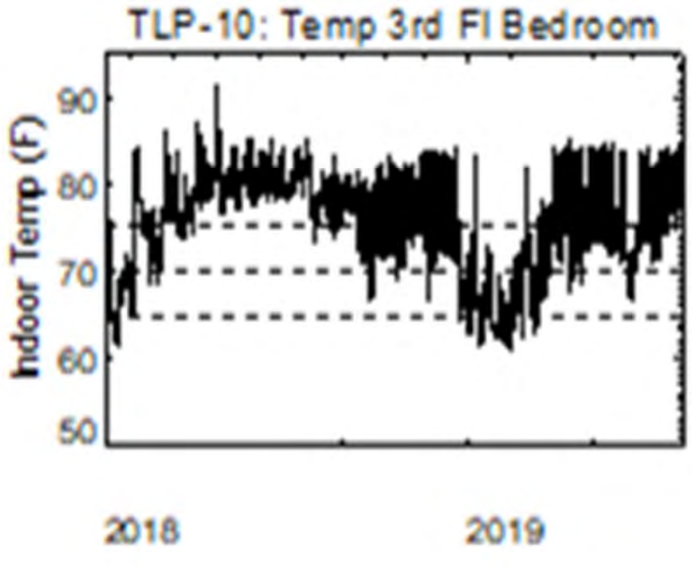


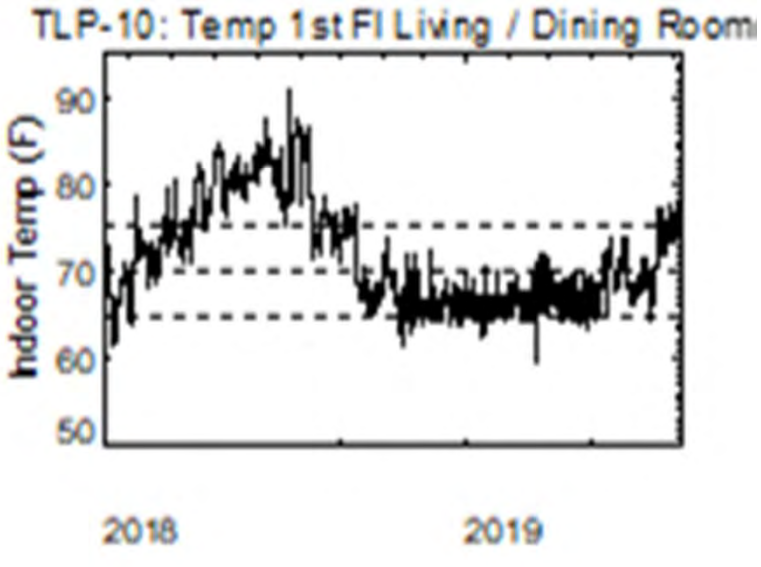
SITE 10

Indoor Space Temperatures









SITE 12

Envelope Improvements

Envelope Improvement	Details
Exterior wall insulation	Upgrade 1,160 sqft, from interior, to Gyp Bd, 2x4 16” OC, 3.5” cellulose, 0.75” wood, 4” brick, R-13
Air sealing	Reduce overall air leakage of the heated area from 5,789 CFM50 to 4,300 CFM50

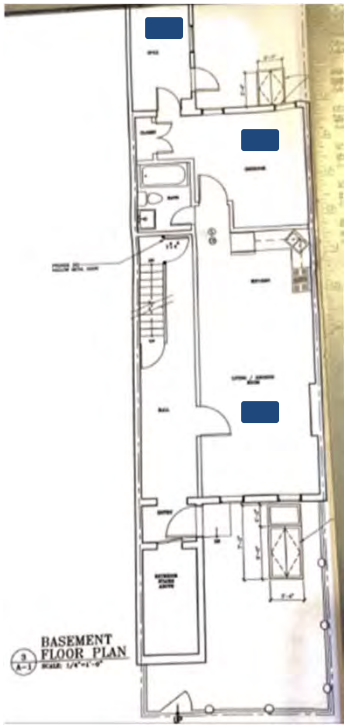
Costs

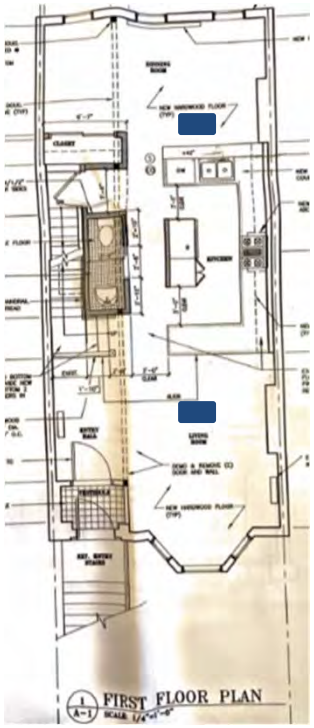
Item	Cost
Heat pump equipment (8 zones)	12,687
Heat pump labor	24,443
Total heat pump	37,130
Cost per ton	4,271
Cost per zone	3,523
Envelope materials + labor	18,943
Total job	47,130

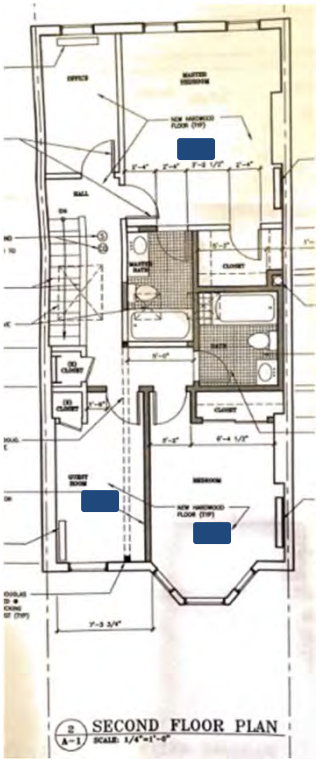
SITE 12

	Cooling	Heating
Capacity	78,800	82,200
Calculated	75,623	74,167

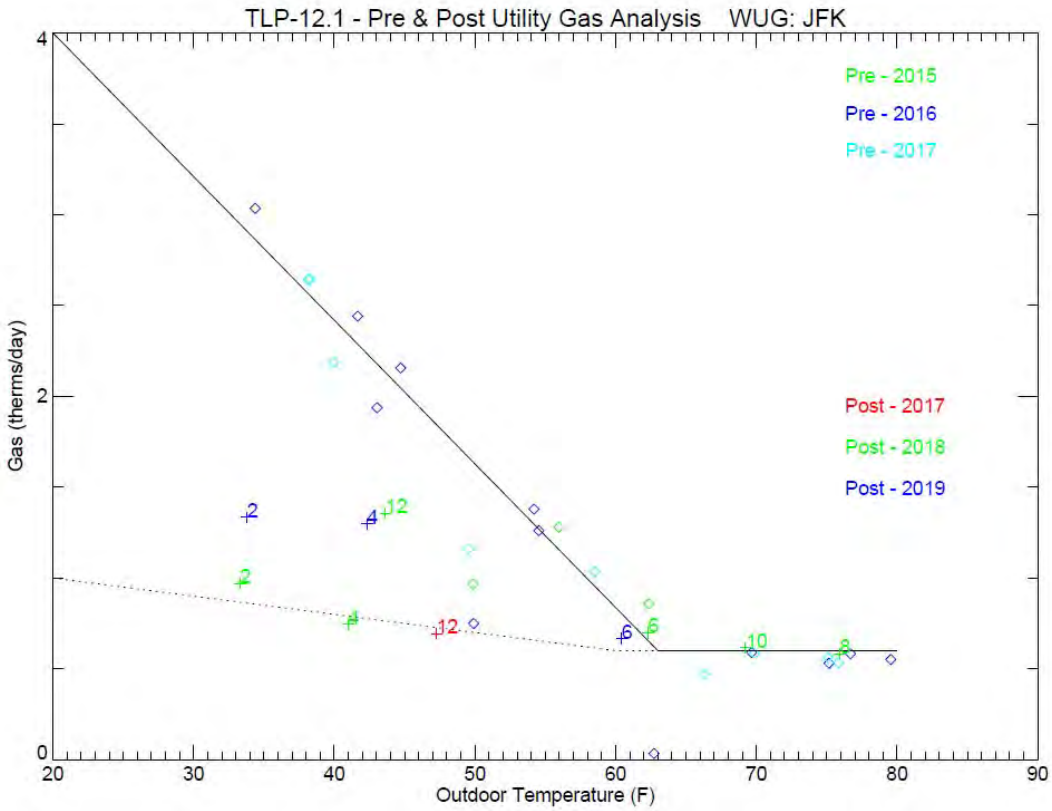
		Outdoor unit			Indoor units		
Floor	***Room***	***Model***	***Cooling***	***Heating***	***Model***	***Cooling***	***Heating***
Ground floor	Living Room	MXZ-5C30NAHZ			MSZ-FH12NA	12,000	13,600
	Main Bedroom				MSZ-FH09NA	9,000	10,900
	Baby Bedroom				MSZ-FH06NA	6,000	8,700
	total		28,400	28,600	**Indoor unit total**	**27,000**	**33,200**
2nd	Kitchen-Dining	MXZ-3C24NAHZ2			MSZ-FH15NA	15,000	18,000
	Front Room 2				MSZ-FH09NA	9,000	10,900
	total		**22,000**	**25,000**	**Indoor unit total**	**24,000**	**28,900**
3rd	Front Room 1	MXZ-4C30NAHZ			MSZ-FH06NA	6,000	8,700
	Office				MSZ-FH06NA	6,000	8,700
	Back Room+Bathroom				MSZ-FH12NA	12,000	13,600
	total		**28,400**	**28,600**	**Indoor unit total**	**24,000**	**31,000**

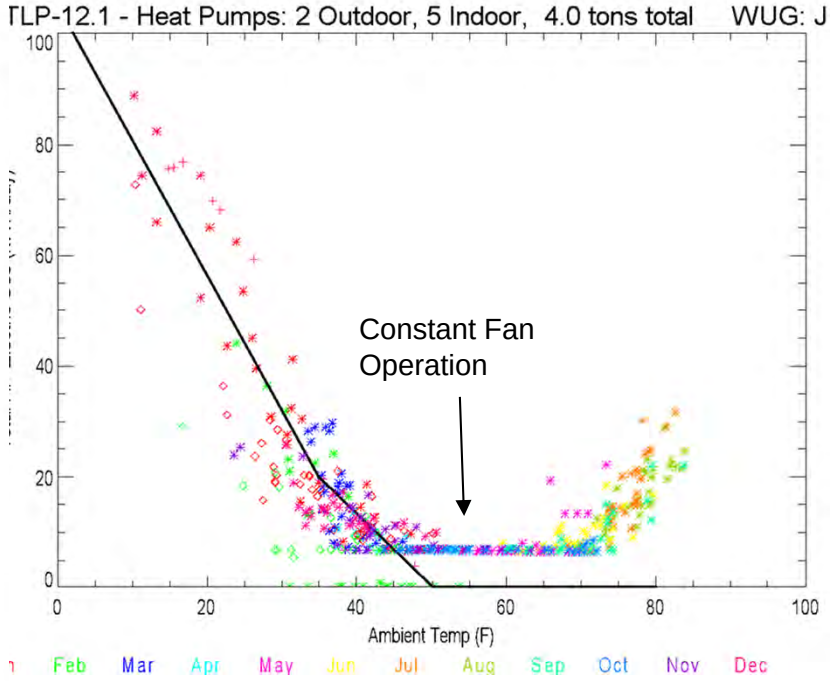






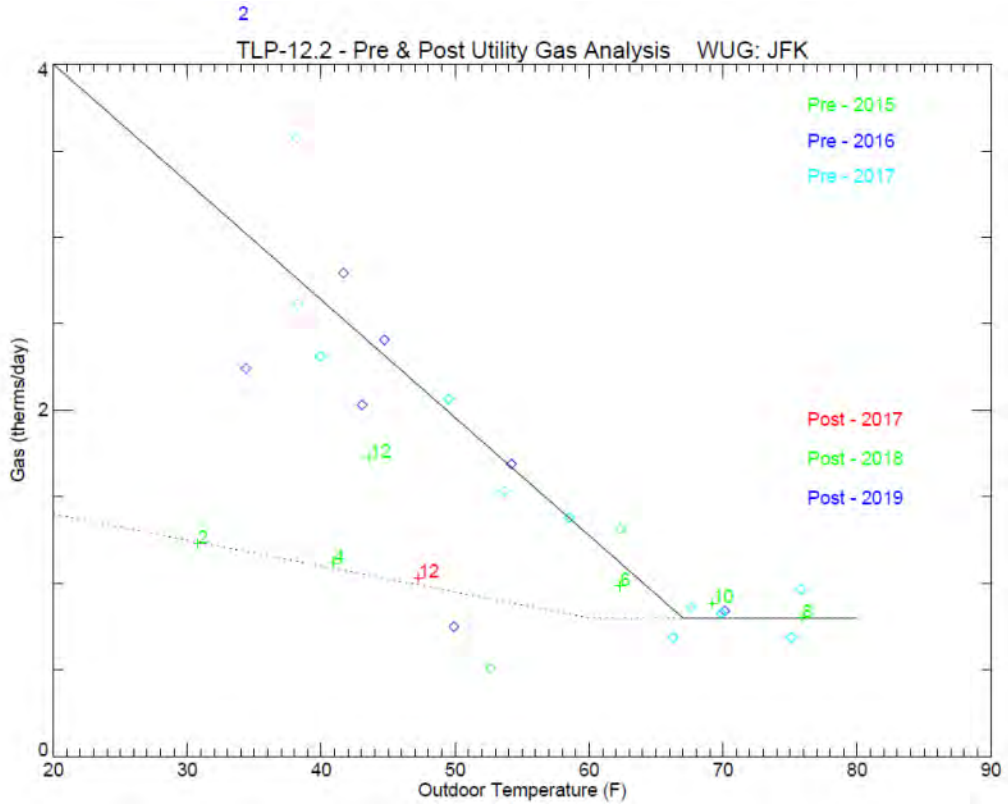
SITE 12 - OWNER

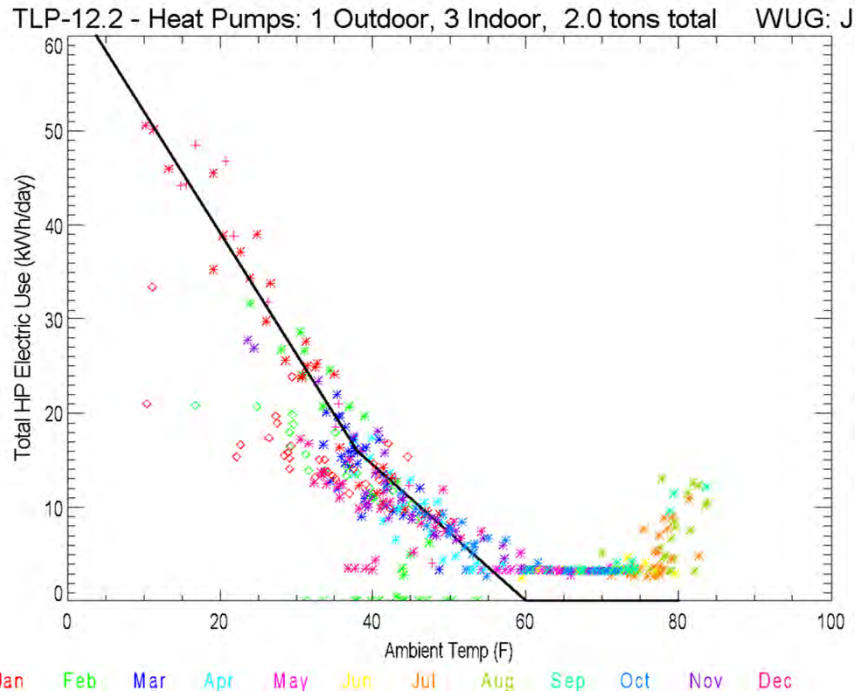




Heating season only (space and water heating)	PRE	POST	Savings
Costs	$942	$1,274	$(331)
Gas (therms/yr) ($1.79/therm)	567	205	321
Electric (kWh/yr) ($0.21/kWh)		4,319	(4,319)
Implied COP	0.7		

SITE 12 - TENANT

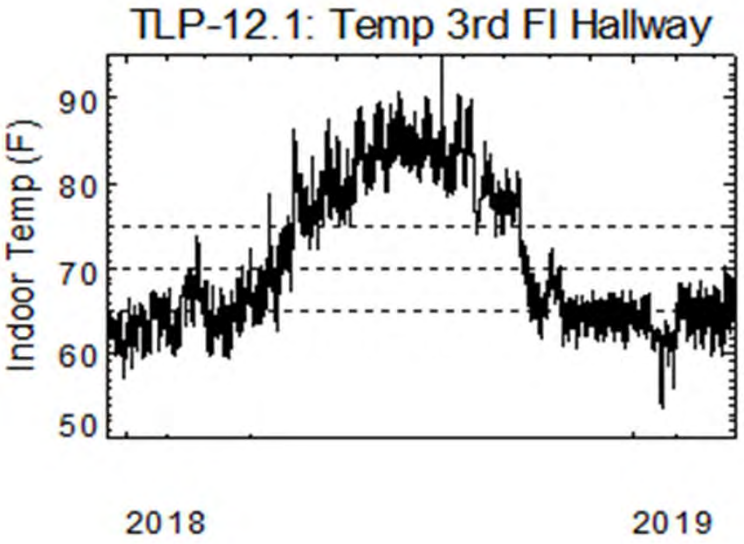


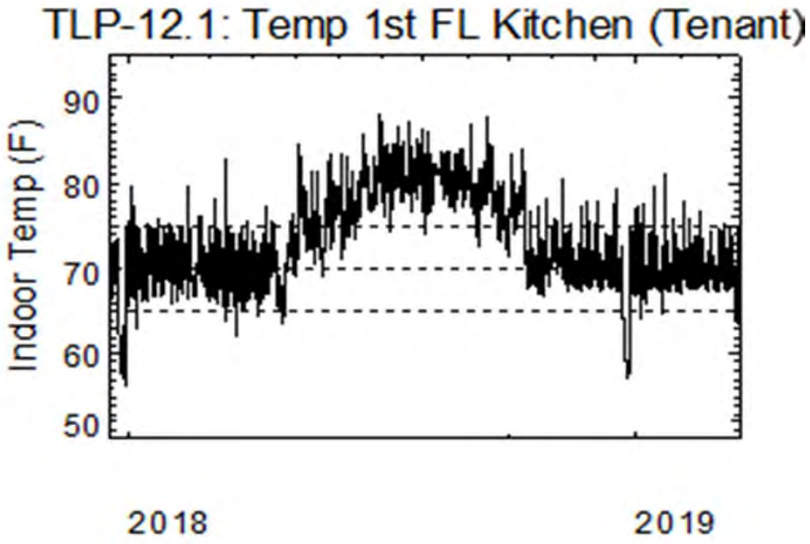


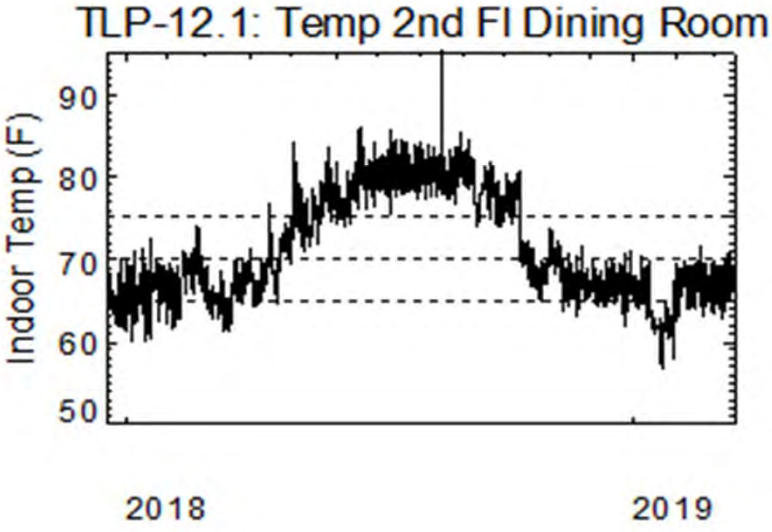
Heating season only (space and water heating)	PRE	POST	Savings
Costs	$1,071	$1,397	$(326)
Gas (therms/yr) ($1.79/therm)	598.5	280	319
Electric (kWh/yr) ($0.20/kWh)		3,454	(3,454)
Implied COP	1.4		

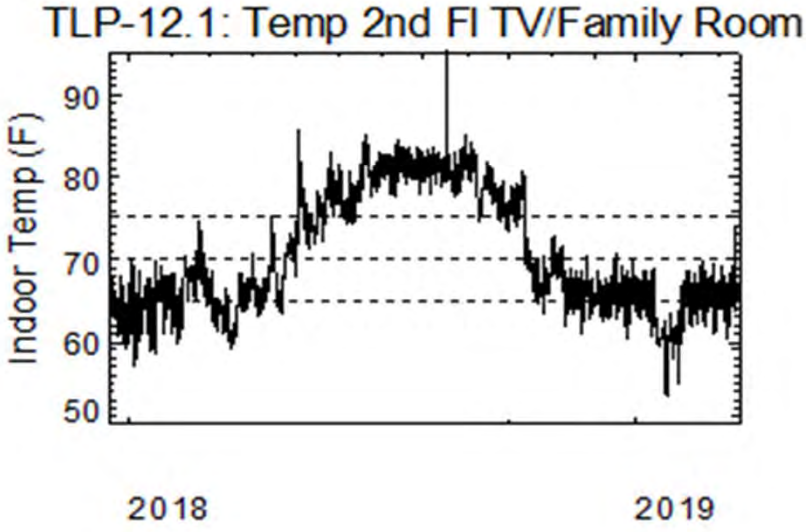
SITE 12

Indoor Space Temperatures





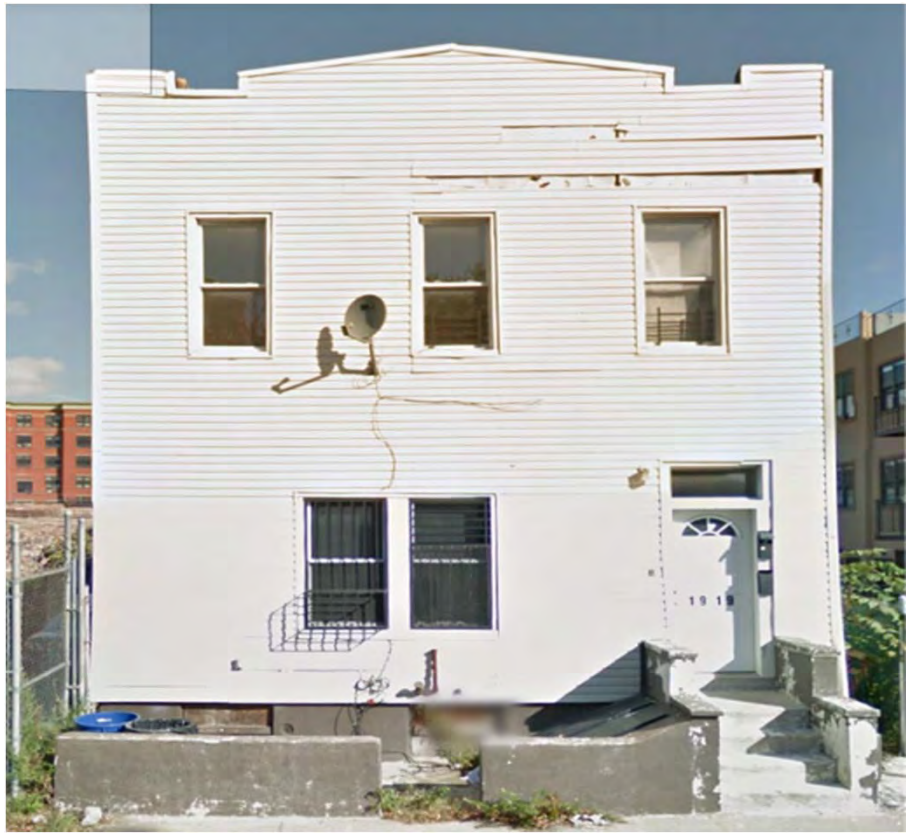




SITE 19

Envelope Improvements

Envelope Improvement	Details
Air sealing	Reduce overall air leakage of heated area from 4,742 CFM50 to 3,000 CFM50
Rim Joist Insulation	Rim joist upgrade, 122 sq ft, 2” high density foam, 1.5” wood, 0.5” wood, siding, R15

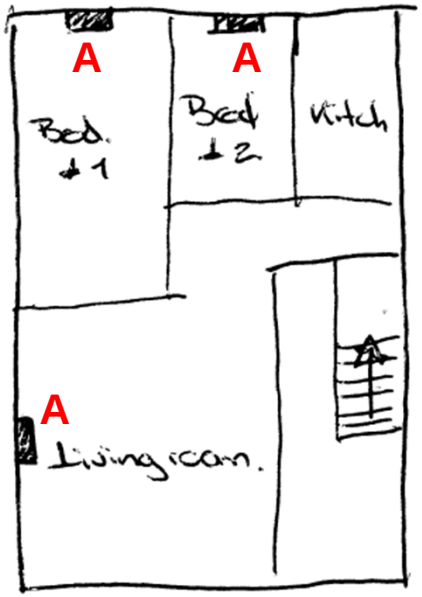


Costs

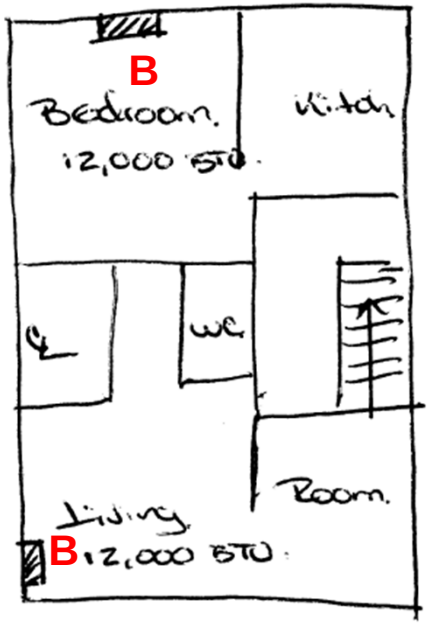
Item	Cost
Heat pump equipment (5 zones)	12,083
Heat pump labor	7,917
Total heat pump	20,000
Cost per ton	4,762
Cost per zone	4,000
Envelope materials + labor	0
Total job	20,000

SITE 19

		RHVAC sizing calcs		Outdoor unit			Indoor units		
Floor	Room	Cooling	Heating	Model	Cooling	Heating	Model	Cooling	Heating
1st	Living Room			MXZ-3C24NAHZ			MSZ-FH06NA	6,000	8,700
	Back bedroom 1						MSZ-FH06NA	6,000	8,700
	Back bedroom 2						MSZ-FH06NA	6,000	8,700
	Total	15,367	23,415		22,000	25,000	indoor unit total	18,000	26,100
2nd	Front Bedrooms			MXZ-3C30NAHZ			MSZ-FH12NA	12,000	13,600
	Back Bedroom						MSZ-FH12NA	12,000	13,600
	Total	22,307	30,197		28,400	28,600	indoor unit total	24,000	27,200
Total	Btu	37,674	53,612		50,400	53,600		42,000	53,300
	Tons	3.1	4.5		4.2	4.5		3.5	4.4

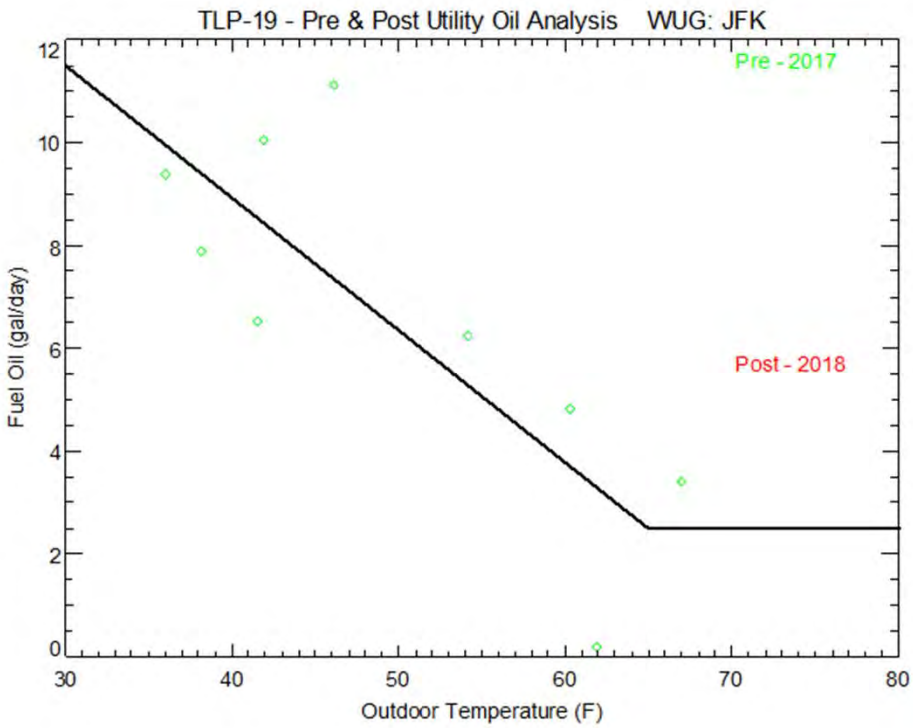


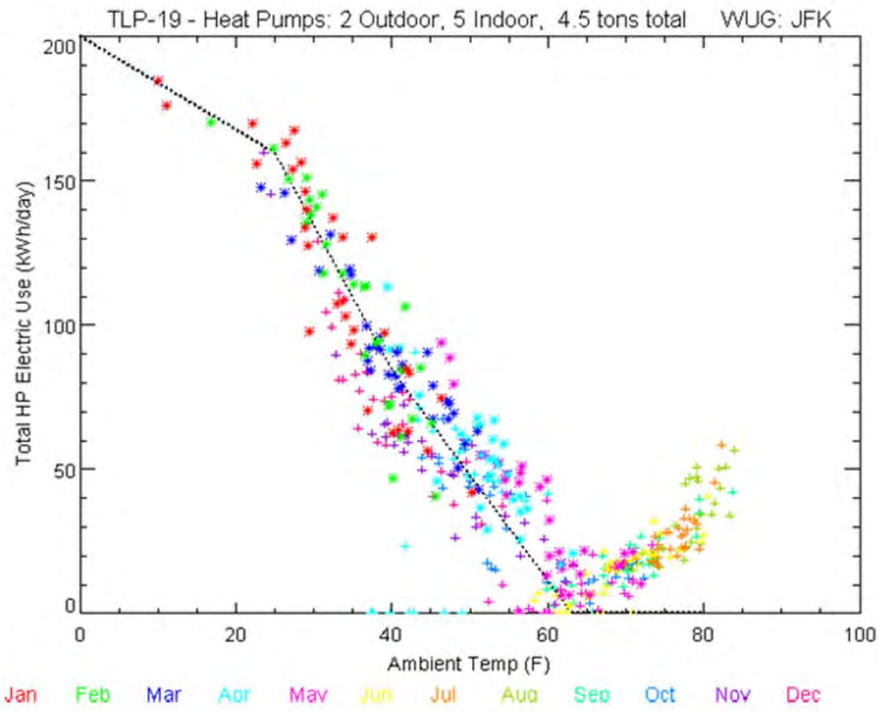
1st Floor



2nd Floor

SITE 19



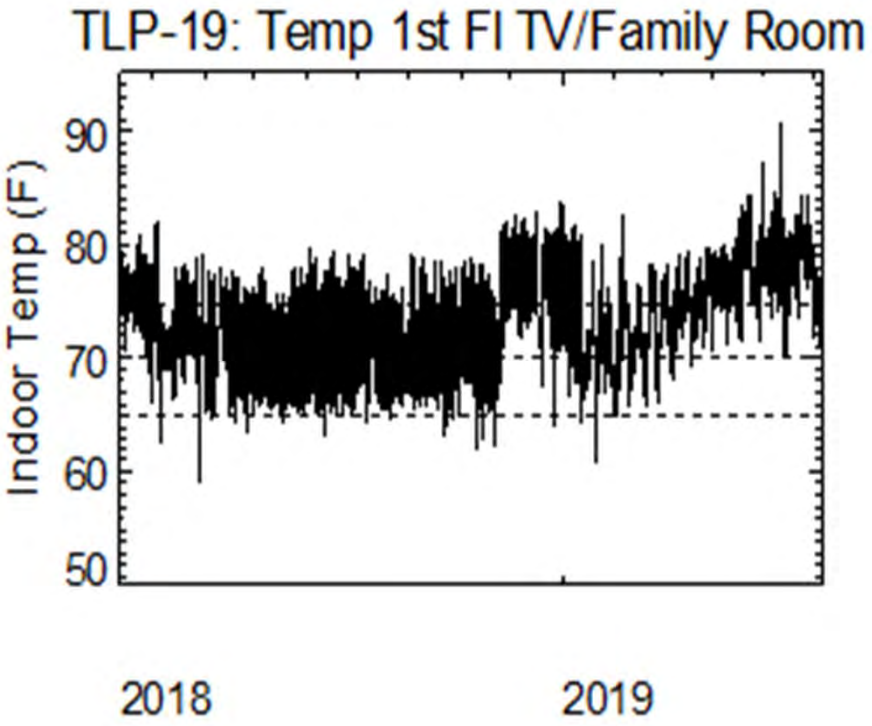


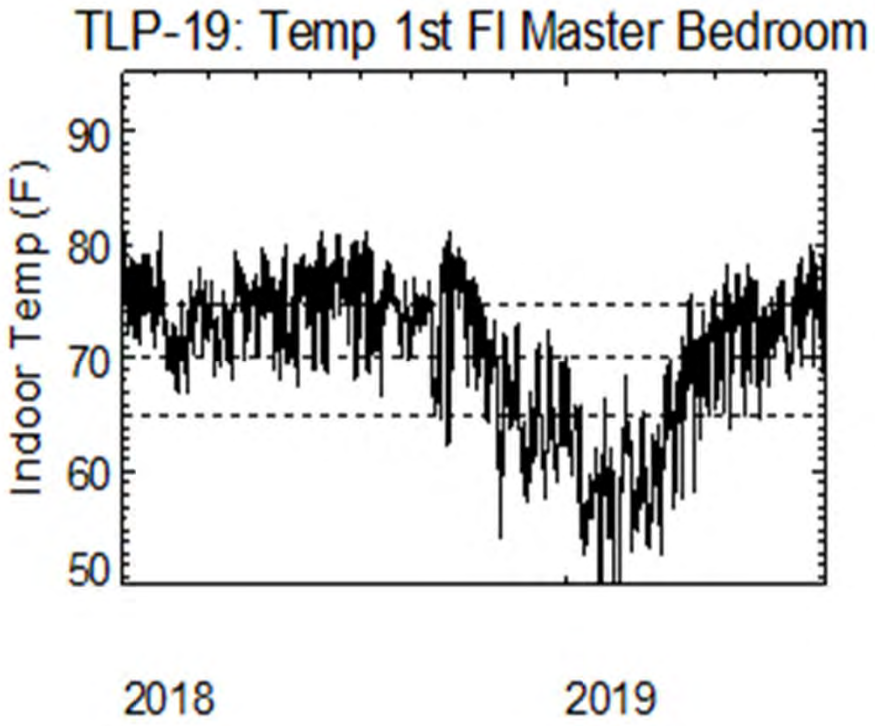
There was no post-retrofit oil use as indicated above. However, post-retrofit oil use was included in the analysis to account for DHW use. An electric DHW tank was installed at the time of the ASHP installation.

Heating season only (space and water heating)	PRE	POST	Savings
Costs	$7,165	$6,190	$1,299
Oil (Gal/yr) $3.60/gal	1,990	692	1,298
Electric (kWh/yr) $0.21/kwh		17,620	(17,620)
Implied COP	2.3		

SITE 19

Indoor Space Temperatures





The second floor apartment was not accessible at the time of monitoring equipment installation or data retrieval.

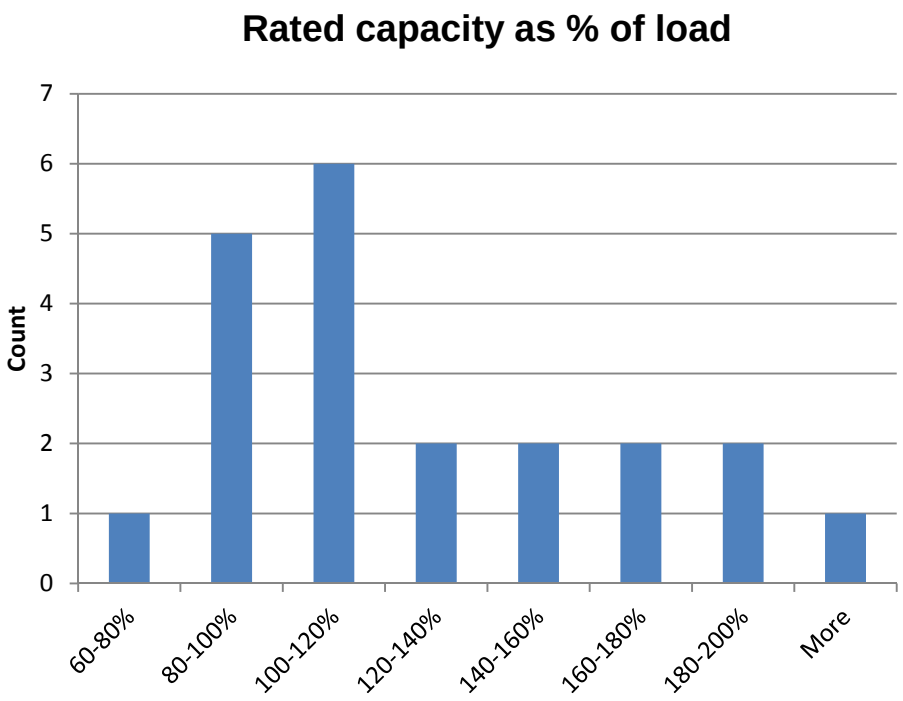
Installation Summary

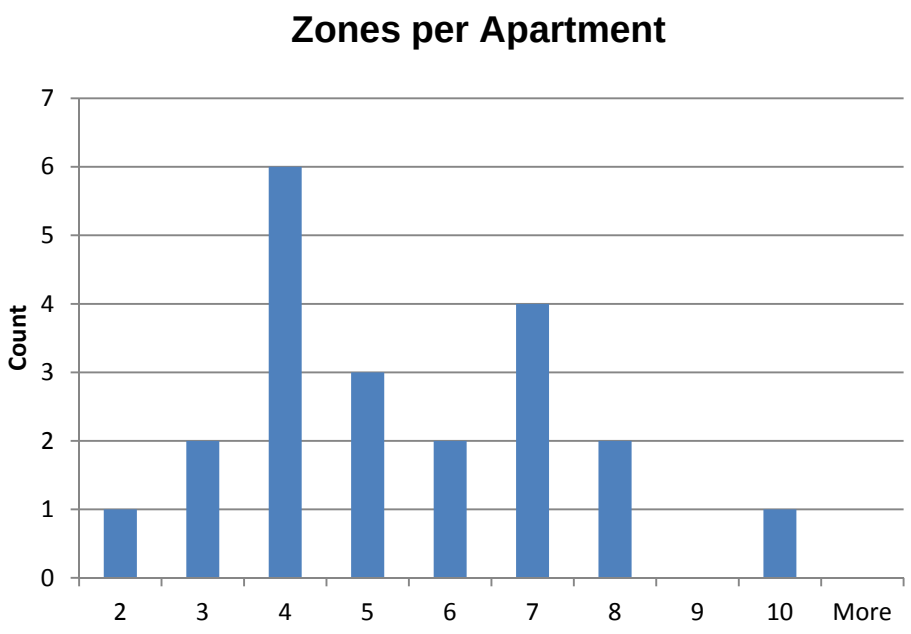
Site	Zones	Living Units	Heat pump equip. cost	Heat pump labor cost	Heat pump total cost	Weather-ization cost	Total cost	Heat pump total/zone	Heat pump total/ton	Zones per apt.	Htg load	Cap @ 47	Cap/ Load
1	6	1	$ 8,290	$ 15,610	$ 23,900	$ -	$ 23,900	$ 3,983	$ 4,686	6	42,998	61,400	143%
3	7	1	$ 11,156	$ 20,992	$ 32,148	$ 5,500	$ 37,648	$ 4,593	$ 5,358	7	99,462	78,600	79%
5	10	1	$ 18,024	$ 34,166	$ 52,190	$ 5,500	$ 57,690	$ 5,219	$ 8,698	10	80,226	78,600	98%
10	10	2	$ 15,000	$ 20,783	$ 35,783	$ 10,736	$ 46,519	$ 3,578	$ 4,647	5	110,633	102,200	92%
12	8	2	$ 12,687	$ 24,443	$ 37,130	$ 10,000	$ 47,130	$ 3,523	$ 4,271	4	74,167	82,200	111%
14	7	1	$ 13,530	$ 9,500	$ 23,030	$ 28,431	$ 51,461	$ 3,290	$ 3,715	7	76,224	75,000	98%
19	5	2	$ 12,083	$ 7,917	$ 20,000	$ -	$ 20,000	$ 4,000	$ 4,762	2.5	53,612	53,600	100%
21	4	2	$ 6,555	$ 11,319	$ 17,874	$ 5,500	$ 23,374	$ 4,469	$ 5,766	2	43,095	45,000	104%
23	7	1	$ 15,576	$ 6,000	$ 21,576	$ 13,596	$ 35,172	$ 3,082	$ 3,657	7	54,411	64,900	119%
25	8	1	$ 10,696	$ 11,304	$ 22,000	$ 7,350	$ 29,350	$ 2,750	$ 3,729	8	31,719	77,400	244%
31	7	1	$ 7,429	$ 15,571	$ 23,000	$ -	$ 23,000	$ 1,714	$ 2,500	7	41,397	64,200	155%
32	4	1	$ 5,682	$ 6,318	$ 12,000	$ 3,500	$ 15,500	$ 3,000	$ 4,138	4	20,009	39,341	197%
35	6	1	$ 10,200	$ 14,800	$ 25,000	$ 1,000	$ 26,000	$ 4,167	$ 5,208	6	45,252	54,000	119%
39	4	1	$ 4,903	$ 7,097	$ 12,000	$ -	$ 12,000	$ 2,000	$ 2,759	4	31,967	39,341	123%
40	3	1	$ 4,488	$ 7,512	$ 12,000	$ 9,750	$ 21,750	$ 4,000	$ 6,667	3	23,694	26,000	110%
41	4	1	$ 7,444	$ 6,000	$ 13,444	$ 14,327	$ 27,771	$ 3,361	$ 3,361	4	47,871	42,500	89%
42	4	1	$ 10,431	$ 8,000	$ 18,431	$ -	$ 18,431	$ 4,608	$ 4,608	4	45,320	48,000	106%
44	5	1	$ 7,000	$ 9,000	$ 16,000	$ -	$ 16,000	$ 3,200	$ 4,324	5	37,926	52,000	137%
45	11	3	$ 14,000	$ 10,000	$ 24,000	$ 10,000	$ 24,000	$ 2,182	$ 3,000	3.7	69,456	115,000	166%
46	8	1	$ 19,100	$ 8,900	$ 28,000	$ -	$ 28,000	$ 3,500	$ 4,000	8	53,864	96,000	178%
18	9	2	$ 15,243	$ 9,840	$ 25,083	$ 26,500	$ 51,583	$ 2,787	$ 3,420	4.5	51,660	95,000	184%
Avg	**6.5**	**1.3**	**$ 10,929**	**$ 12,622**	**$ 23,552**	**$ 7,223**	**$ 30,299**	**$ 3,476**	**$ 4,442**	**5.3**	**54,046**	**66,204**	**131%**

Installation Summary

	Average
Zones per site	6.5
Living units per site	1.3
Zones per apt.	5.3
Heat pump equip. cost per site	$10,929
Heat pump labor cost per site	$12,622
Heat pump total cost per site	$23,552
Weatherization cost per site	$7,223
Total cost per site	$30,299
Heat pump cost per zone	$3,476
Heat pump cost per ton	$4,442
Heating load (Btu/hr) per site	54,046
Rated heating capacity (Btu/hr) per site	66,204
Capacity/Load avg. of all sites	1.3

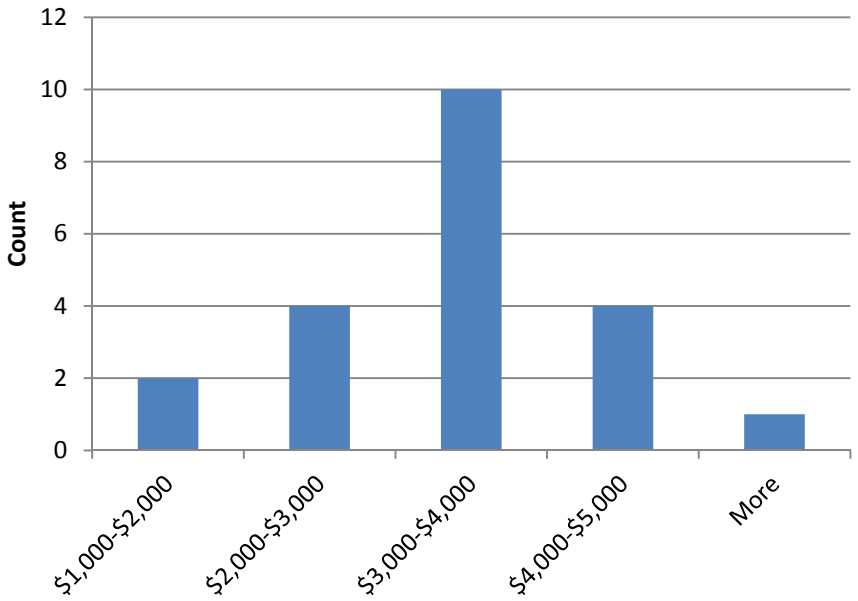
Capacity and zones



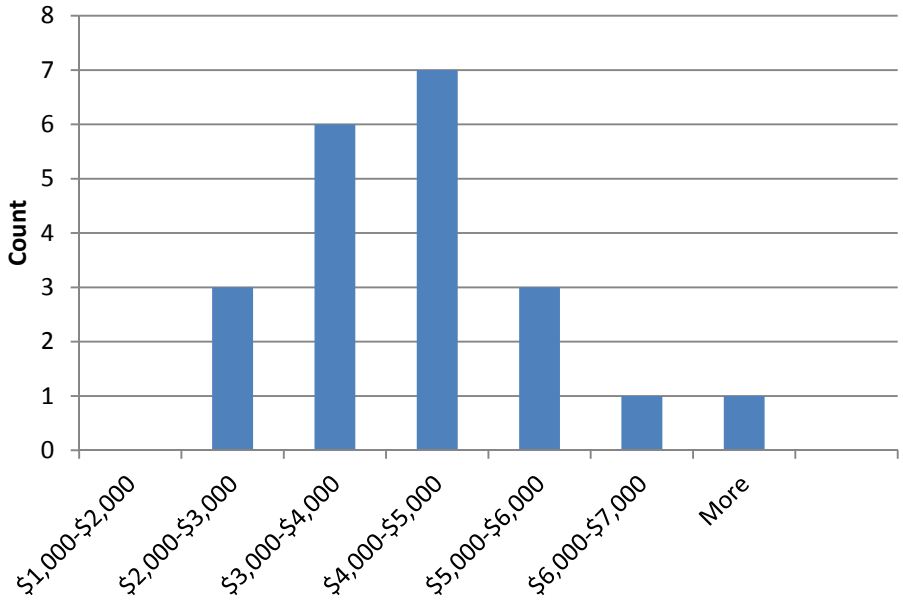


Costs

Cost per zone

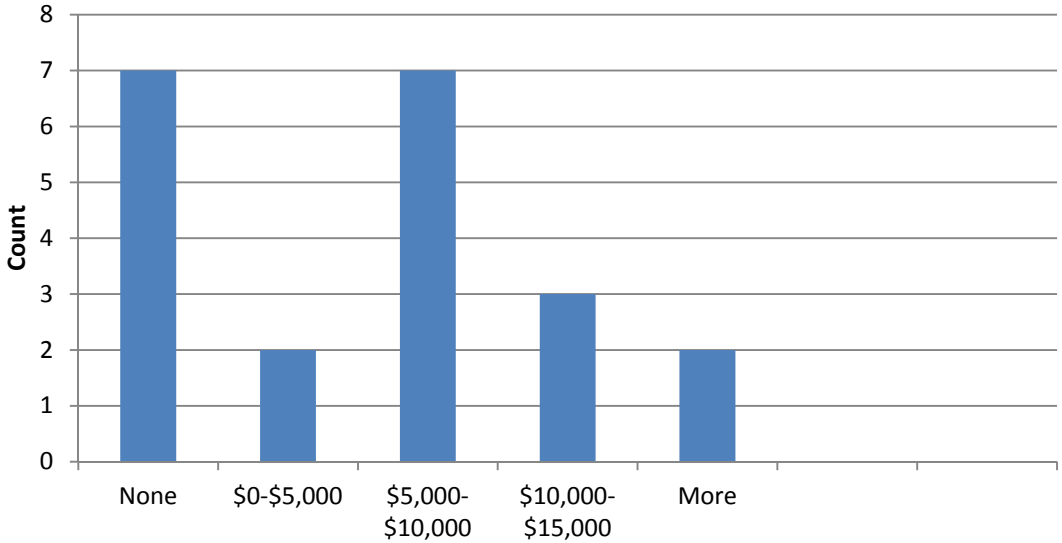


Cost per ton (nominal cooling)



- $10,000 to $50,000 project value
- Up to $8,000 in incentives/discounts/ rebates special to demo

Spent on weatherization



M&V Summary

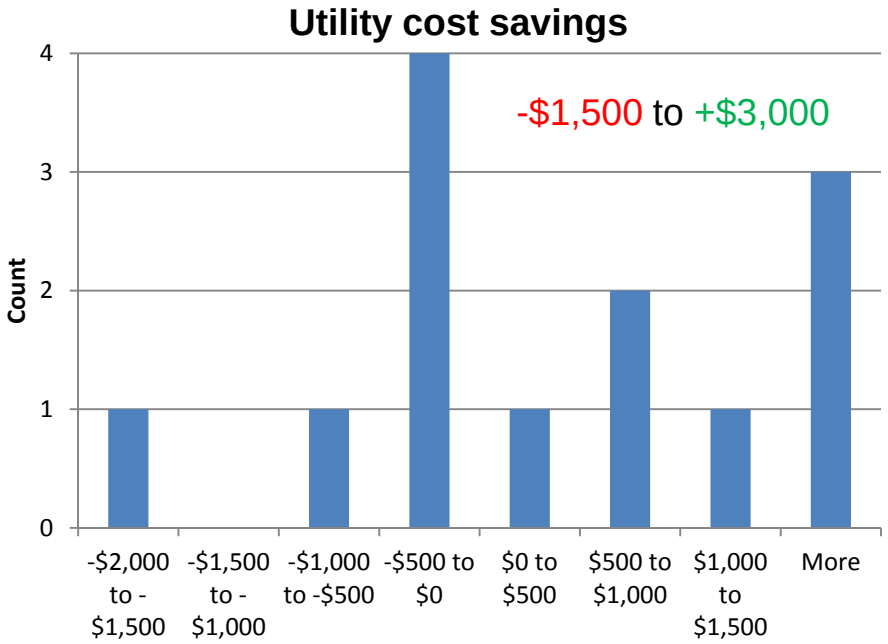
Site	old fuel	Site MMBTU savings	Savings lbs. CO2 emissions	$avings of HP only	$avings entire	COP accounting for env	COP raw	Reduced existing system use by
3	oil	223	29,242	$ 572	$ 2,250	1.8	2.6	72%
5	gas	179	15,579	$ (746)	$ 485	2.0	3.2	70%
10	oil	228	29,396	$ 759	$ 2,049	2.0	2.6	81%
12 owner	gas	31	1,865	$ (673)	$ (331)	0.7	1.7	89%
12 tenant	gas	31	2,210	$ (326)	$ (155)	1.4	2.1	84%
14	Oil	226	31,082	$ 1,470	$ 3,078	2.3	3.2	100%
19	oil	176	21,504	$ 975	$ 975	2.3	2.3	100%
21	Gas	20	(280)	$ (1,190)	$ (973)	0.4	0.9	20%
23	oil	105	14,591	$ 225	$ 1,489	2.0	3.6	100%
25	Gas	103	8,117	$ (429)	$ (162)	2.0	2.4	100%
39	Oil	50	5,321	$ (113)	$ (113)	1.8	1.8	100%
45	Oil	93	11,460	$ (434)	$ 572	1.5	2.6	100%
46	Gas	16	(1,768)	$ (1,571)	$ (1,571)	0.5	0.5	21%
AVG	**0**	**88**	**9,951**	**$ (114)**	**$ 584**	**1.6**	**2.3**	**80%**
AVG Oil (7)	**Oil**	**157**	**20,371**	**$ 493**	**$ 1,471**	**2.0**	**2.7**	**93%**
Avg Gas (6)	**Gas**	**63**	**4,287**	**$ (822)**	**$ (451)**	**1.2**	**1.8**	**64%**

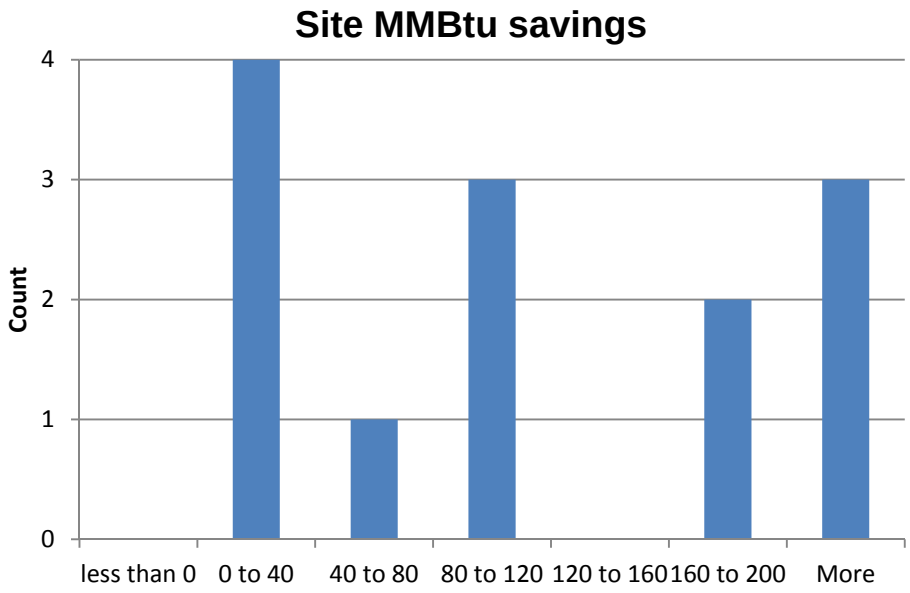
Low COP of sites 21 and 46 suspected due to behavioral changes – higher post-retrofit setpoint and/or under-heating pre-retrofit. Both sites barely reduced existing system use.

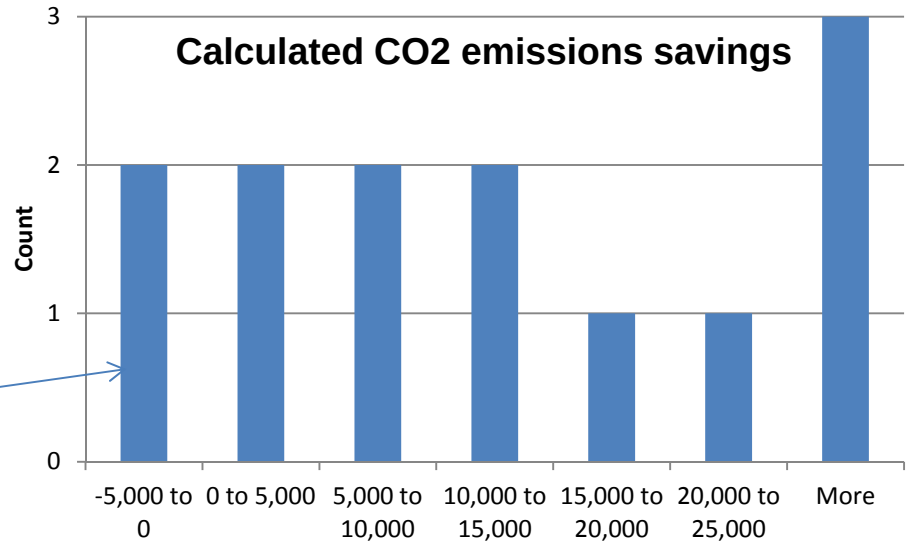
M&V Summary

	Avg	Avg Oil (7)	Avg Gas (6)
Old fuel	All	Oil	Gas
Site MMBTU savings	88	157	63
Savings lbs. CO2 emissions	9,951	20,371	4,287
$avings of HP only	$ (114)	$ 493	$ (822)
$avings entire	$ 584	$ 1,471	$ (451)
COP accounting for envelope	1.6	2.0	1.2
COP raw	2.3	2.7	1.8

Savings

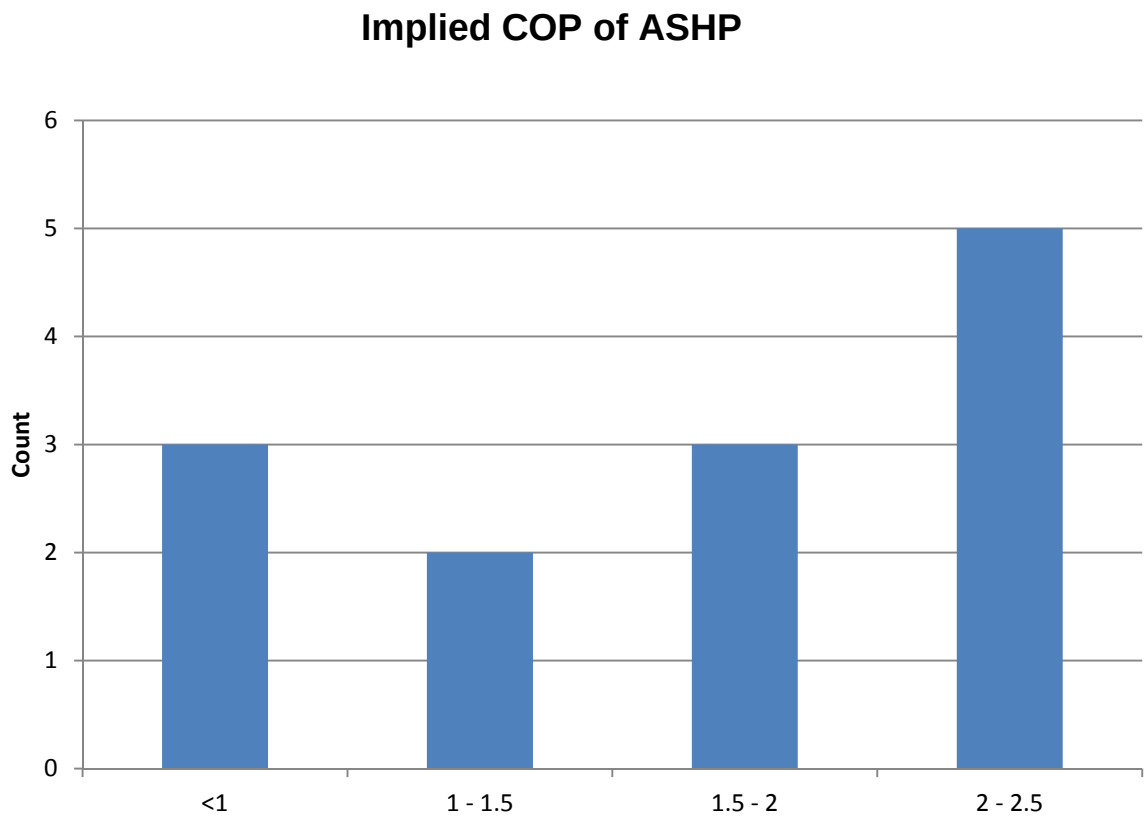






These were the bad COPs

COPs



Are the COPs a true reflection of the equipment performance, a result of behavioral changes, how much are they impacted by controls/settings, or some other reason?

If you leave it they will use it

Site	Reduced existing space heating system use by	Existing System Status
3	72%	In-Place
5	70%	In-Place
10	81%	In-Place
12.1	89%	In-Place
12.2	84%	In-Place
14	100%	Removed
19	100%	Removed
21	20%	In-Place
23	100%	In-Place
25	100%	Not Operational
32	100%	Removed
39	100%	In-Place
44	100%	Removed
45	100%	Removed
46	21%	In-Place

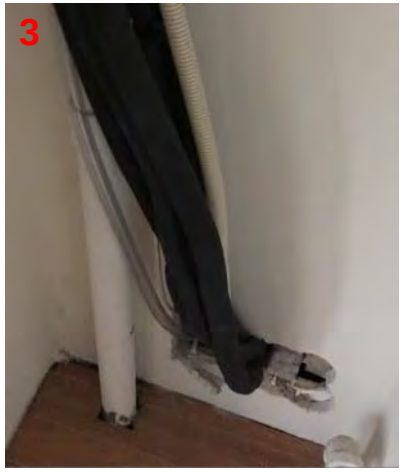
Could integrated controls have improved performance?

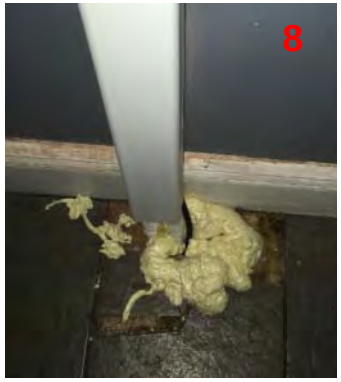
Cost effectiveness of envelope measures

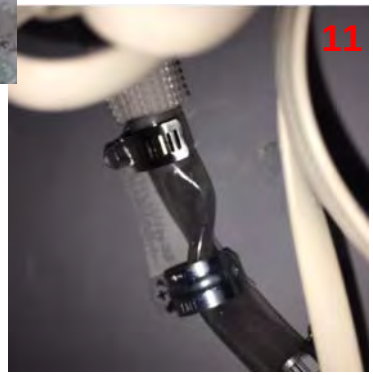
Site	Savings due to envelope measures	Cost of envelope measures	Payback (years)	ROI
3	$ 1,678	$ 5,500	3.3	31%
5	$ 1,231	$ 5,500	4.5	22%
10	$ 1,291	$ 10,736	8.3	12%
12 owner	$ 341	$ 10,000	19.5	12%
12 tenant	$ 171			
14	$ 1,608	$ 28,431	17.7	6%
19	$ -	$ -	N/A	N/A
21	$ 218	$ 5,500	25.3	4%
23	$ 1,264	$ 13,596	10.8	9%
25	$ 267	$ 7,350	27.5	4%
39	$ -	$ -	N/A	N/A
45	$ 1,006	$ 10,000	9.9	N/A
46	$ -	$ -	N/A	N/A
AVG	$ 698	$ 8,051	11.5	9%
AVG Oil (7)	$ 978	$ 9,752	10.0	10%
Avg Gas (5)	$ 371	$ 5,670	15.3	7%

Did the envelope improvements enable reduced heat pump sizing?

Installation Problems







Installation Problems

	Type of defect	Sites affected
Outdoor unit	Incorrect placement of condensers (stacking)	3
	Incorrect support/fastening of condensers (blocks, scrap wood)	3, 12, 21, 10
	Ground clearance of condensers	5, 21, 10
Condensate	Condensate tube drains to improper location	12, 10
	Condensate leak at evaporator	14, 10
	Condensate tubing – flex plastic instead of copper/PVC	3, 21, 10
Refrigerant Lines	Inadequate sealing of wall penetrations	5
	Line cover (or portion) missing	12
	Inadequate or missing refrigerant pipe insulation	5, 14
Other	Refrigerant leak	5, 3
	Damage to evaporator / lubricant leakage	12
	Noisy outdoor unit	10

Takeaways

- Comfort is major motivator
- Design details crucial (aesthetics of line sets) and impacts costs
- QA important
- Occupant education and expectations
- Weatherization underappreciated
- Right sizing possible, but small homes challenging
- Cooling and heating loads similar in attached homes
- If fossil fuel system left in place, good chance it will be used
- Use of multiple systems will increase energy consumption

Ongoing Questions

- What was the cause of low effective COPs?
- Did envelope improvements impact sizing?
- How would using single zone equipment impact costs, design, performance?
- Could integrated controls improve performance?

New Research

- What was the cause of low effective COPs?

New DOE research project to measure in-site performance of ccASHP – 10 sites sought

- Could integrated controls improve performance?

Maximizing the Effectiveness of Ductless Heat Pumps in Existing Homes by Demonstrating Integrated Controls – 12 sites sought


DRAFTS/PITCHERS
4/14 BUSCH
7/NO GUINNESS
7/25 GOOSE ISLAND IPA
7/25 VICTORY PRIMA PILSNER
7/25 DOWNEAST WHITE
7/25 SOUTHERN TIER HARVEST ALE
10 BUD-A-RITA FLIGHT
WINE
SAUV BLANC 7
CABERNET
FLORA SPARKLING ROSÉ CAN 7
BEER + SHOT
7 PBR + WELL SHOT
10 TECATE + MEZCAL + SANGRITA

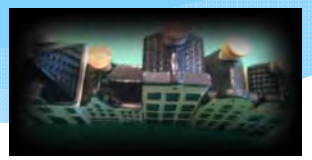
Jordan Dentz, The Levy Partnership, Inc.
jdentz@levypartnership.com

Julie Liu, Centsible House
julie@centsiblehouse.com

Thank You

Maximizing the Effectiveness of Ductless Heat Pumps in Existing Homes by Demonstrating Integrated Controls

Jordan Dentz, The Levy Partnership, Inc.
jdentz@levypartnership.com



Background

* Trend to install ASHP to supplement less efficient space conditioning systems
* Can provide as much as 75% of the space conditioning
* Evaluations suggest not reaching full potential
* NYSERDA and Mass Save integrated controls incentive programs

Hypothesis: Integrated controls can boost performance

Objectives

* Maximize heating load fulfilled by the heat pump
* Reduce energy cost
* Maintain comfort
* Maximum $500 incremental cost

Technical Solutions

* Forced air homes - similar to a two-stage thermostat
* Hydronic homes - may include individual radiator control and occupancy sensing or scheduling

Plan & Results

Plan

* Install at 12 sites
* Monitor 8-12 months
* Alternate operation every 2-4 weeks

Results

* Performance data
* Evaluate alternative control strategies
* Modeled impact for NY climates