BUILDINGENERGY NYC

What We Have Learned from Many Built Multifamily Passive Houses

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Northeast Sustainable Energy Association (NESEA)
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Course Objectives

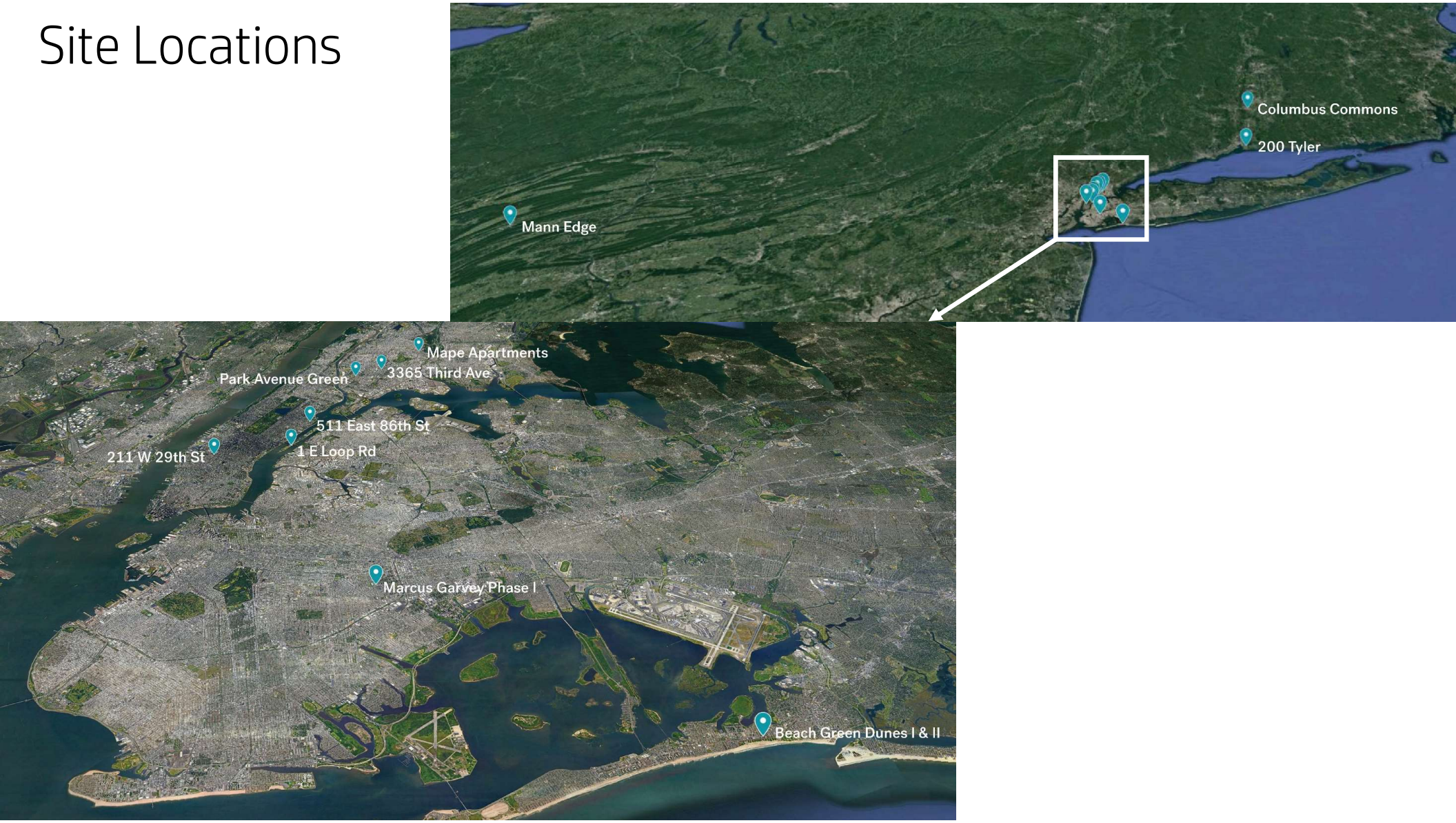
Curtis + Ginsberg Architects has completed 5 multifamily Passive House buildings, with two more in construction and six more in design. Steven Winter Associates has completed over 20 Passive House buildings, with 15 more in construction and 30+ more in design. We have collaborated on many of these projects. By reviewing variations in the systems, we can draw conclusions about what works best for:

- structure, envelope
- ventilation strategy
- heating and cooling systems
- On-site generation
- Residents
- Owners
- We will present the details of at least 6 buildings, what we have learned, and how they are performing to help develop best practices.

Learning Objective

1. Lean about the performance of many different multifamily Passive House buildings.
2. Learn about tenant and operator feedback on Passive houses.
3. Lean about mechanical systems in Passive House buildings and the pros and cons of each.
4. Learn about different Passive House Envelope Systems and the pros and cons of each.

Site Locations



Data

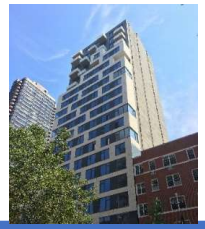




	BGDII	BGDI	3365	Mapes	Park Ave. Green	MG Phase I
Location	NYC	NYC	NYC	NYC	NYC	NYC
SF-Gross	121,433	108,979	51,954	33,473	163,743	92,754
# of Stories	8	8	8	6	15	7
Units	127	101	30	30	154	96
Floor area / Unit	685	809	982	703	809	672
Common Area	34,484	27,245	17,518	12,418	39,227	28,230

Data






	200 TYLER	211 W 29th	511 E 86th Street	Columbus Commons	Cornell	Mann Edge
Location	CT	NYC	NYC	CT	NYC	PA
SF-Gross	93,791	65,000	140,000	110,612	266,964	44,718
# of Stories	3	23	22	8	26	4
Units	70	55	140	80	352	34
Floor area / Unit	634	523	583	1,079	465	1,139
Common Area	32,125	9005	26,670	24,269	103,297	5,987

Structures and Facades

Exterior Wall

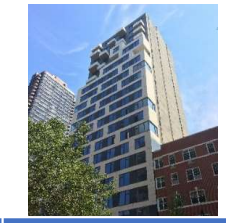




	BGDII	BGDI	3365	Mapes	Park Ave. Green	MG Phase I
Solid	R = 26.72	R = 23.65	R=29.84	R=29.64	R = 27.3	R = 15.60
Windows	U = 0.24	U = 0.22	U=0.12	U=0.17	U = 0.17	U = .29
Roof	R = 30	R = 26	R=40	R=35	R = 50	R = 30
Air Infiltration	**0.1 CFM75/ft2**	0.096 **CFM75/ft2**	0.1 **CFM75/ft2**	0.107 **CFM75/ft2**	0.04 **CFM75/ft2**	NA

Exterior Wall






	200 TYLER (historic)	211 W 29th	511 E 86th Street	Columbus Commons	Cornell	Mann Edge
Solid	R-10.9*	R-33	R-26	R-34	R-19	R-26
Windows	U - 0.50*	U-0.14	U-0.15	U-0.28	U-0.25	U-0.18
Roof	R-42	R-36	R-26	R-31	R-50	R-54
Air Infiltration	0.23 cfm75/ft2	0.06 cfm75/ft2	0.10 cfm75/ft2	0.10 cfm75/ft2	0.04 cfm75/ft2	0.07 cfm75/ft2

Structures & Facades

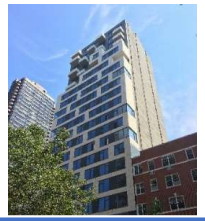




	BGDII	BGDI	3365	Mapes	Park Ave. Green	MG Phase I
Structure	Block and Insulation	ICF	ICF	Block and Insulation	Poured in Place / CMU wall	Poured in Place / Stud
Insulation	XPS/EPS/Spray Foam	ICF	ICF	Polyiso & GPS	XPS /Polyiso Aerated concrete block	Polyiso
Fenestration	UPVC	UPVC	UPVC	UPVC	UPVC	UPVC
Thermal Break Strategies	Structural Fiberglass Thermally Broken Wing Nut Brick Ties	Custom Relieving angle Embed	Febreek Thermal Break at Relieving Angle	Fero Clip	Structural Thermal Isolation blocks	Hohmann& Barnard TBS for relieving angle.

Structures & Facades






	200 TYLER	211 W 29th	511 E 86th Street	Columbus Commons	Cornell	Mann Edge
Structure	Solid masonry	Concrete/AAC block	Concrete/AAC block	Wood frame construction	Concrete + mega panel	Wood frame construction
Insulation	3.5” ccsf interior	5” ext MW + 1.5 int	1) 3”ext MW + 4” int MW 2) 2.25” Rigid EIFs + 2.5”int MW	3” eps ext + R-19 FG batts interior	11” & 7” MW - varies	2” XPS ext + R21 cell interior
Fenestration	Double pane, metal frame	Triple pane, metal	Triple pane, metal	Triple pane, UPVC	Triple pane, metal	Triple pane, UPVC
Thermal Break Strategies	Custom window surround	AAC block + thermal pads	AAC block + thermal pads	Wood frame – good details	Knightwall clip system, Shock	Wood frame – good details

HVAC Systems

Mechanical Systems





	BGDII	BGDI	3365	Mapes	Park Ave. Green	MG Phase I
Heating / Cooling	Ground Source Heat Pumps	VRF	VRF	Window AC / Hydronic	VRF	Ground Source Heat Pumps
Ventilation	Central ERV's	Unitized ERV's	Unitized ERV's	Central ERV's	Unitized ERV's	Central ERV
Hot Water	Gas Fired	Co-Gen/ Gas Fired	Gas Fired	Gas Fired	Co-Gen/ Gas Fired	Ground Source Heat Pumps

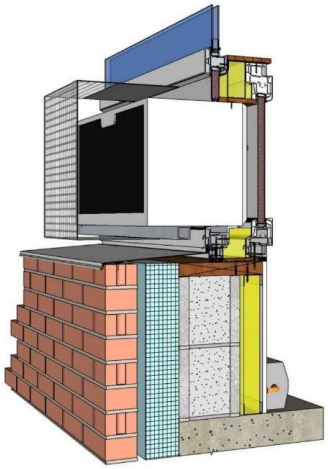
Mechanical Systems






	200 TYLER	211 W 29th	511 E 86th Street	Columbus Commons	Cornell	Mann Edge
Heating / Cooling	VRF	VRF	VRF	Mini-splits	VRF	Mini-splits
Ventilation	Central ERVs	Central ERVs	Central ERVs	Unit ERVs	Central ERVs	Unit ERVs
Hot Water	Gas fired	Gas fired	Gas fired	Gas fired central	Gas fired	Gas fired central

Low Temp Hydronic/Window AC

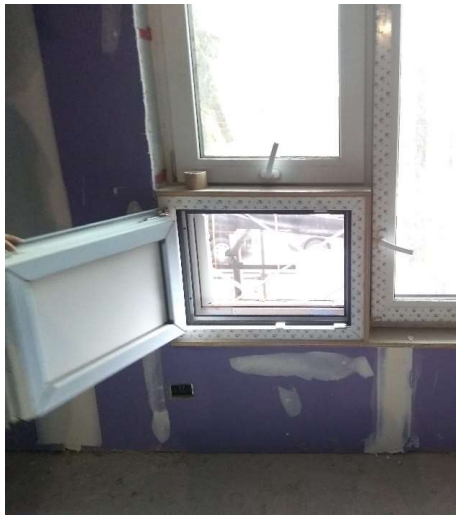


MAPES AVENUE APARTMENTS

Design

+ Can be designed for gas today and electric tomorrow, or for hybrid operations
+ Flexibility in terminal units (floor units, ceiling mounted, vertical units in cabinets)
+ Heat recovery for DHW possible
- Simultaneous heating-cooling options are more limited

Hydronic Heating and Window AC



Performance

+ Boiler/radiator sizing better matched to load
+ Heat recovery option allows for simultaneous heating and cooling
- Pumping power for hydronic can be high
- Least efficient cooling option

Design

+ Less riser and ceiling space
- Need rigorous system to prevent air leakage through window A/C during winter months

Maintenance Operation

+ Cooling on tenant meter
+ Lower coolant leakage
+ Occupants can turn on cooling whenever they want

Co-Gen

Combined Heat and Power

- Provide emergency power
- Utilize Generated Heat for domestic hot wall
- Reduces demand of domestic hot water heater
- Creates carbon.

Energy Consumption / Generation

Solar Arrays



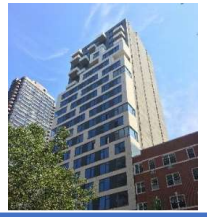


	BGDII	BGDI	3365	Mapes	Park Ave. Green	MG Phase I
Size (ft2)	10,200	8,000	2,300	n/a	1,615	n/a
Capacity (kW)*	≈ 180	≈ 144	41.3	n/a	34	n/a
Potential Output (kWh)	78,000 yr 1, 155,000 yr 2	120,000	52,838	n/a	44,648	n/a
Issues	Invertors not properly connected yr 1	n/a	n/a	n/a	n/a	n/a

* Approximated based on array area x 18W/ft2

Solar Arrays






	200 TYLER	211 W 29th	511 E 86th Street	Columbus Commons	Cornell	Mann Edge
Size (ft2)	5,977	TBD	n/a	n/a	n/a	n/a
Capacity (kW)*	94	Not installed to date	n/a	n/a	n/a	n/a
Potential Output (kWh)	113,902	n/a	n/a	n/a	n/a	n/a
Actual Output	93,797	n/a	n/a	n/a	n/a	n/a
% Difference	18%	n/a	n/a	n/a	n/a	n/a

Notes on the Following Data & Graphs

- Only using monthly data at this time – take breakouts of heating, cooling and baseload w/ a HUGE GRAIN of SALT, more detailed analysis to come
- Tenant data not available at this time for:
  - 200 Tyler
  - 3365 Third
  - Columbus Commons
  - Park Avenue Green
  - Mapes
  - 3361 Third
- Estimates from models was used for tenant lighting, appliances and plugs

Notes on the Following Data & Graphs

- Most projects have Heating/Cooling and DHW including in the house meter
- Exceptions are Mann Edge (PA) and Columbus Commons (CT) - mini-splits
- DHW is central gas recirc in all cases except MGI which has no available utility data at this time

Site Energy Consumption [kBtu/yr · ft^2]

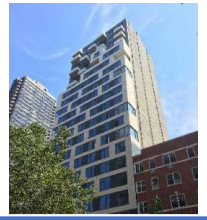




	BGDII	BGDI	3365	Mapes	Park Ave. Green	MG Phase I
Heating	1.8	2.0	17.82	TBD	6.2	TBD
Cooling	0.9	1.7	1.76	TBD	2.1	TBD
DHW	15.5	14.8	6.55	TBD	26.5 (13.3)	TBD
Lighting & Plug Loads	15.6	15.8	15.11	TBD	12.4	TBD
Totals	33.8	34.2	41.24	39.1	47.1 (40.6)	26.81
NYC Rating	A / 100	A / 99	A / 98	NR	B / 84	NA

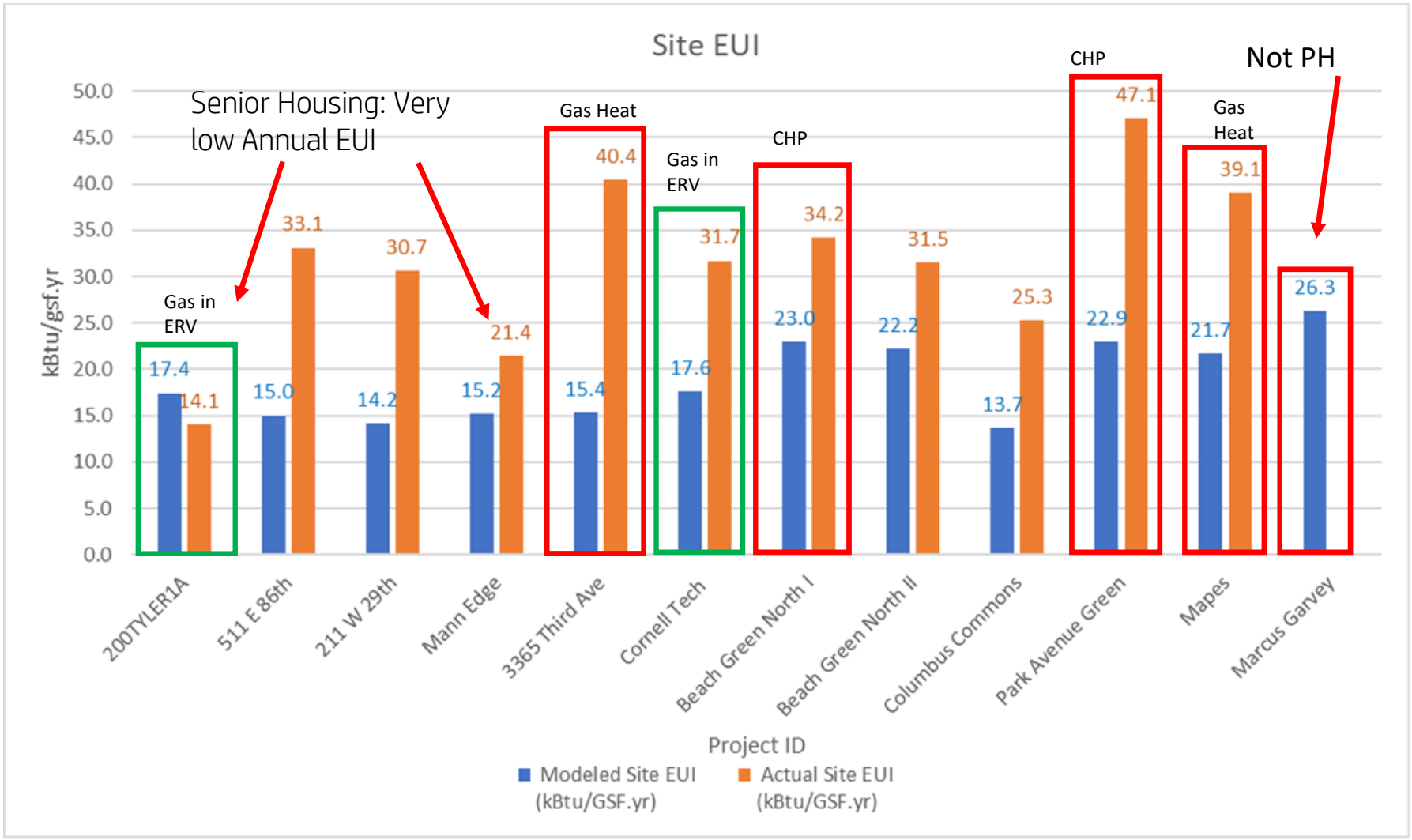
Site Energy Consumption [kBtu/yr · ft^2]



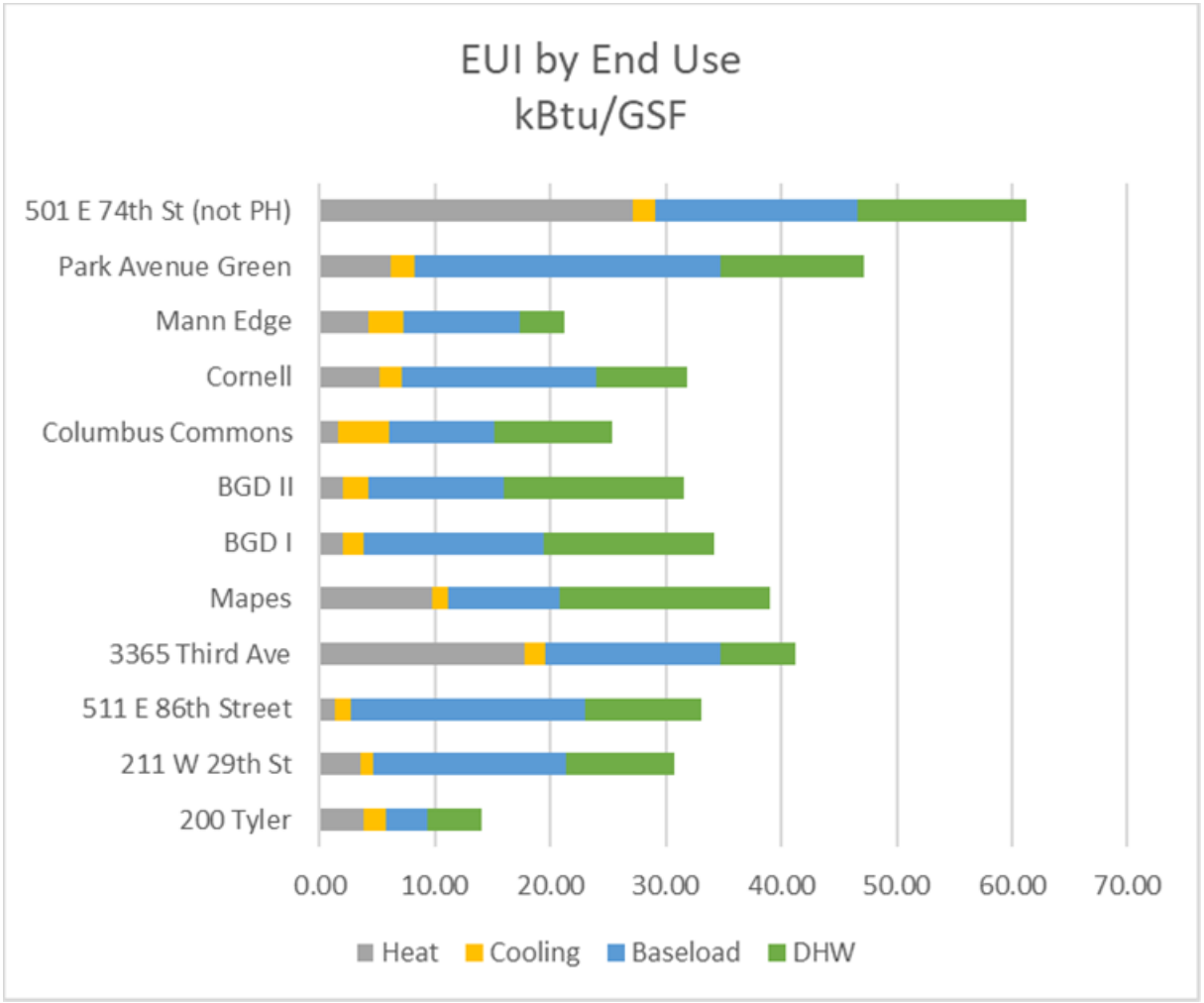



	200 TYLER	211 W 29th	511 E 86th Street	Columbus Commons	Cornell	Mann Edge
Heating	3.85	3.57	1.36	1.64	5.2	4.26
Cooling	1.91	1.09	1.39	4.38	1.9	2.97
DHW	4.73	9.4	10.04	9.1	7.8	3.84
Lighting & Plug Loads	3.60	16.63	20.03	10.2	16.94	10.14
Totals	14.09	30.69	33.10	25.32	31.8	21.2
NYC Rating	NA	B / 79	NR	NA	A / 99	NA

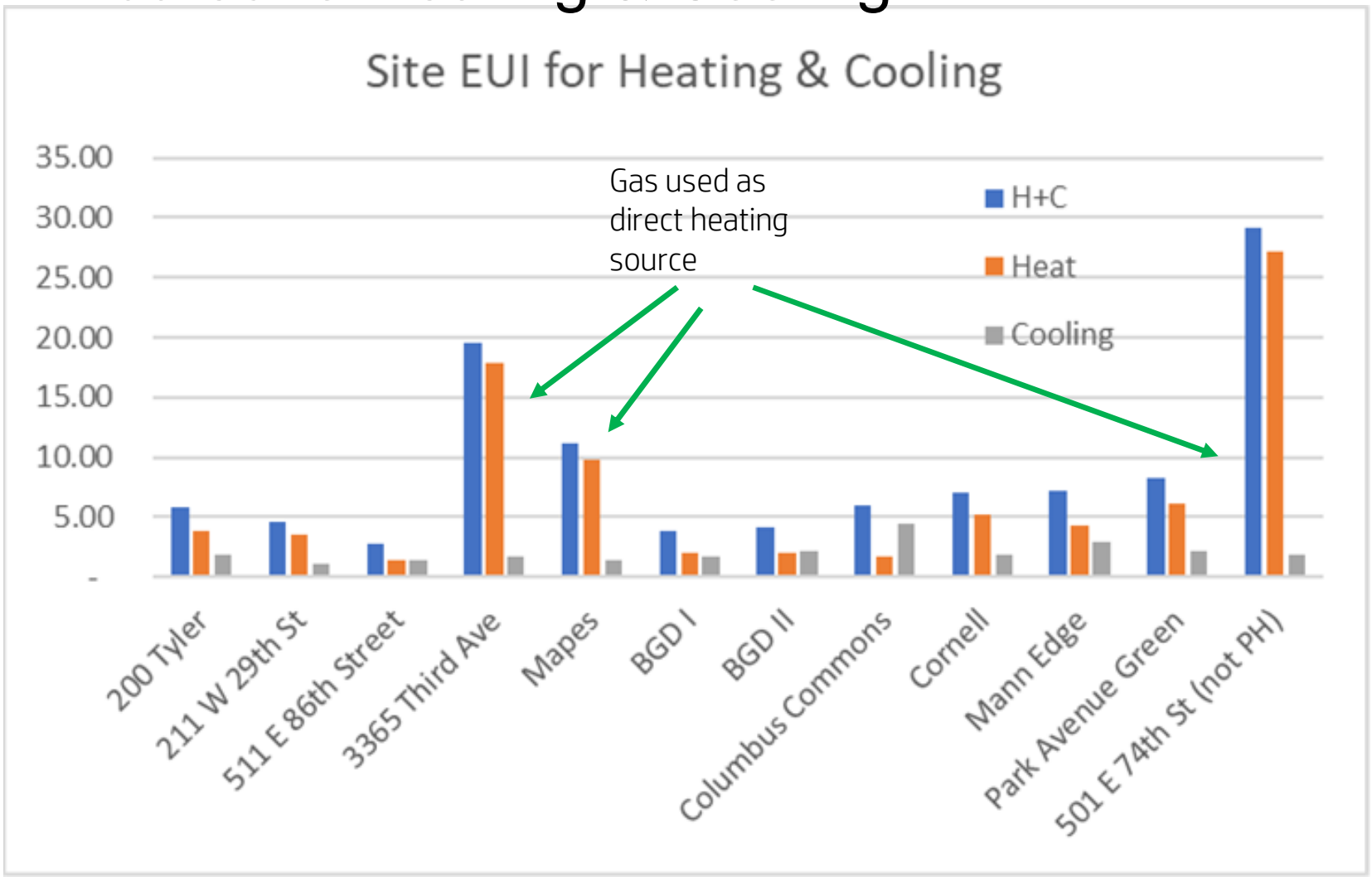
Predicted vs. Actual Site EUI



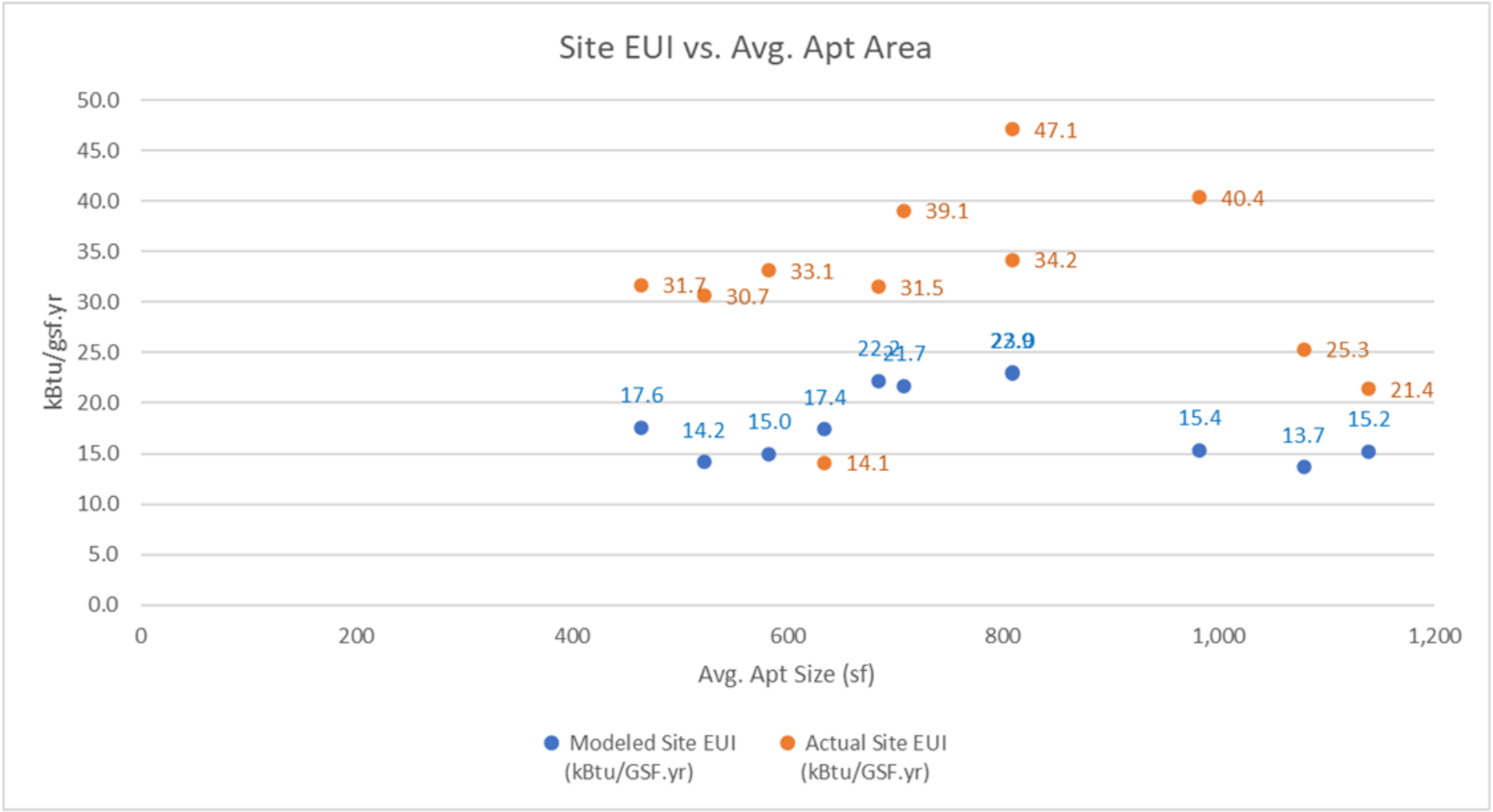
EUI by End Use



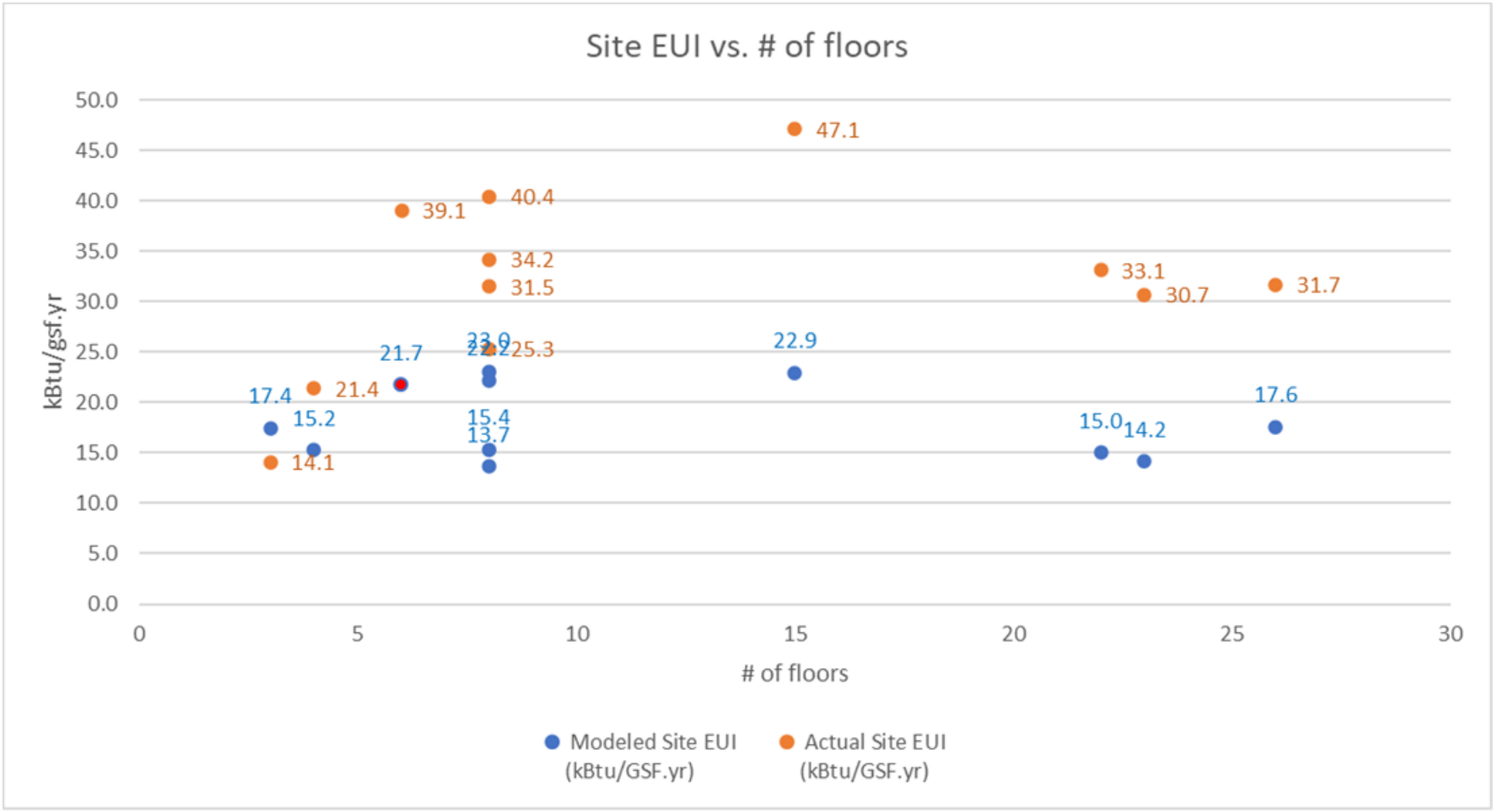
EUI Attributed to Heating & Cooling



EUI vs. Average Apartment GSF

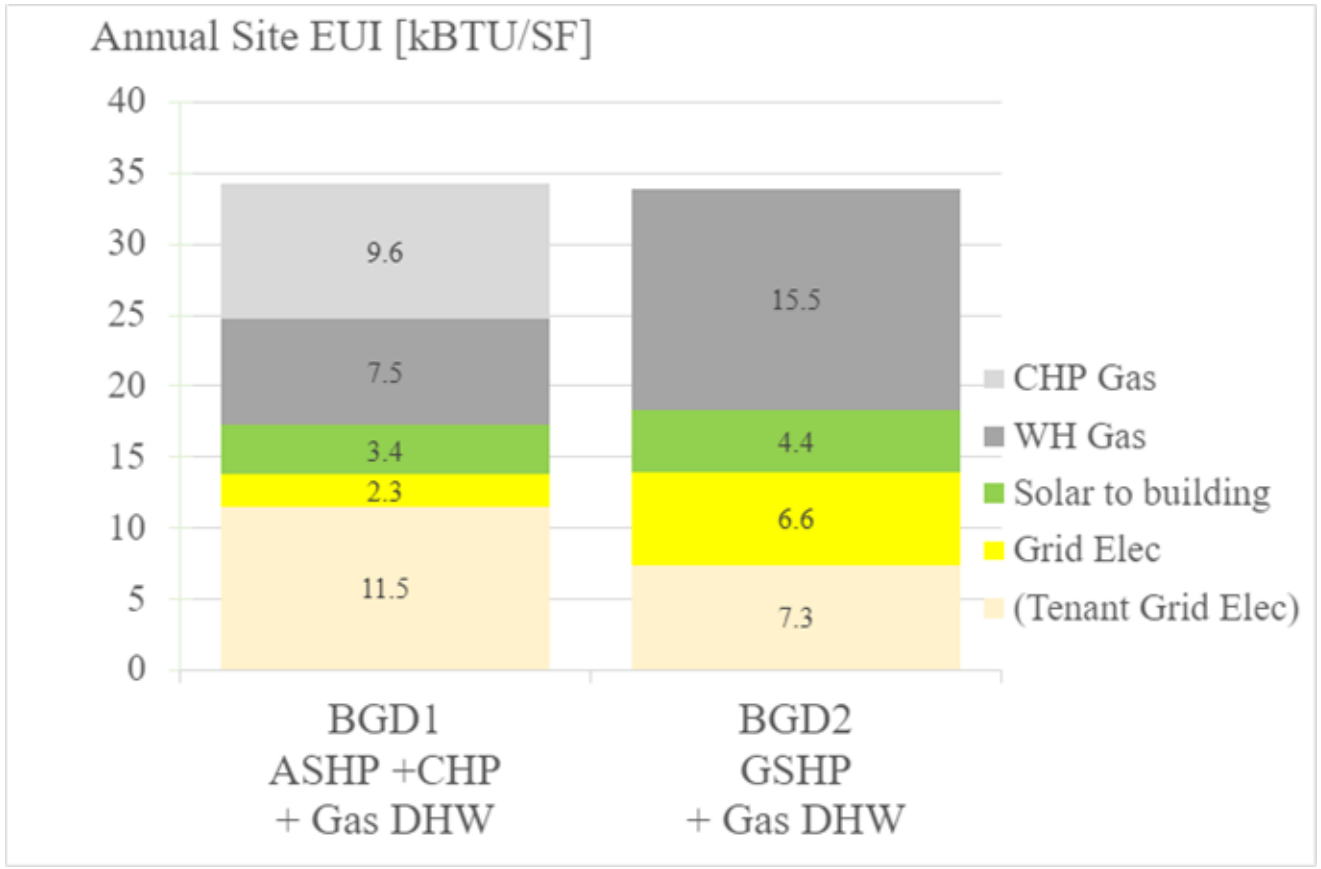


EUI vs. Number of Stories

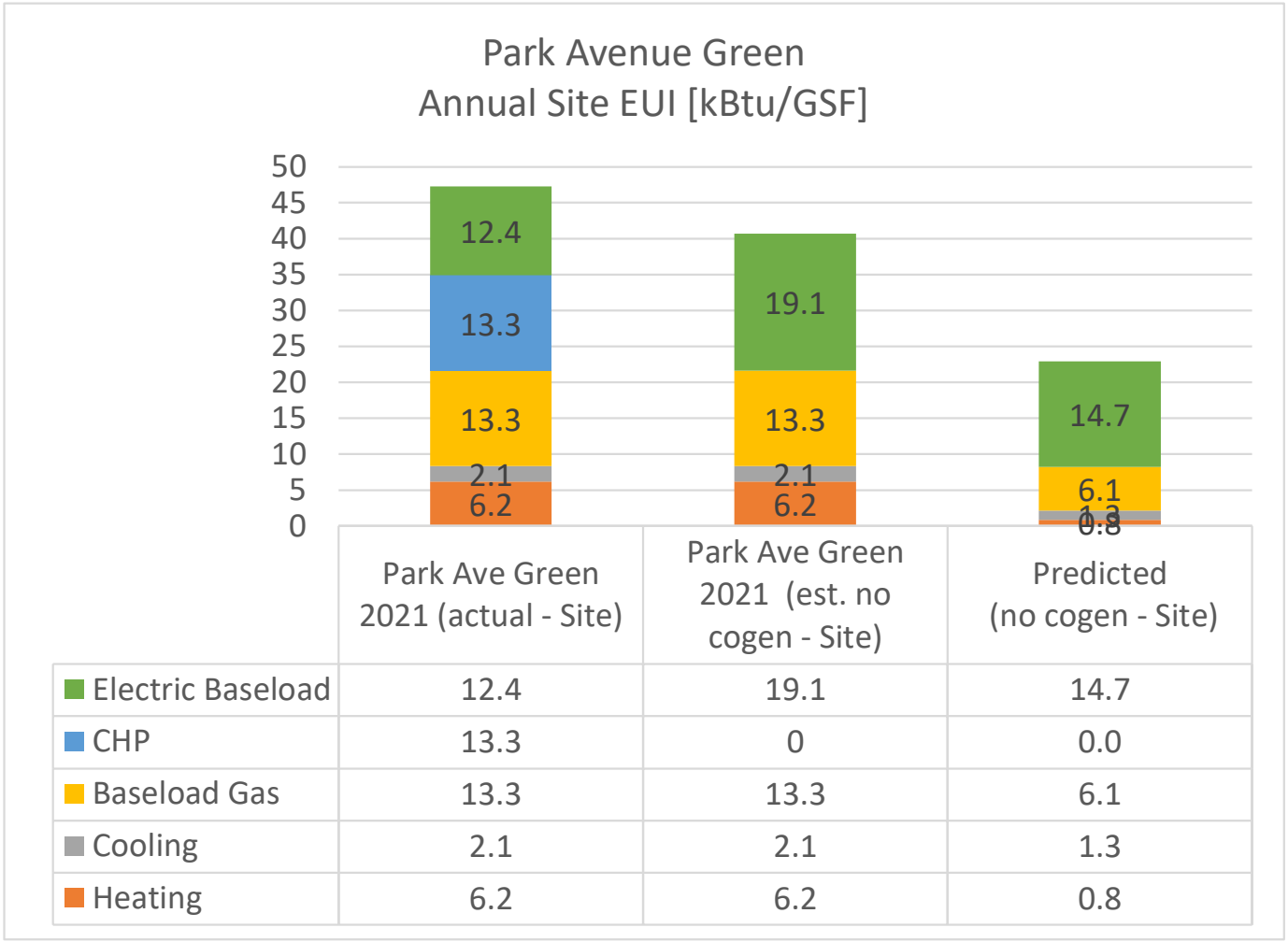


Site EUI Comparison: CHP vs no CHP

- Major differences
  - CHP
  - Solar PV array size
  - # of apartments

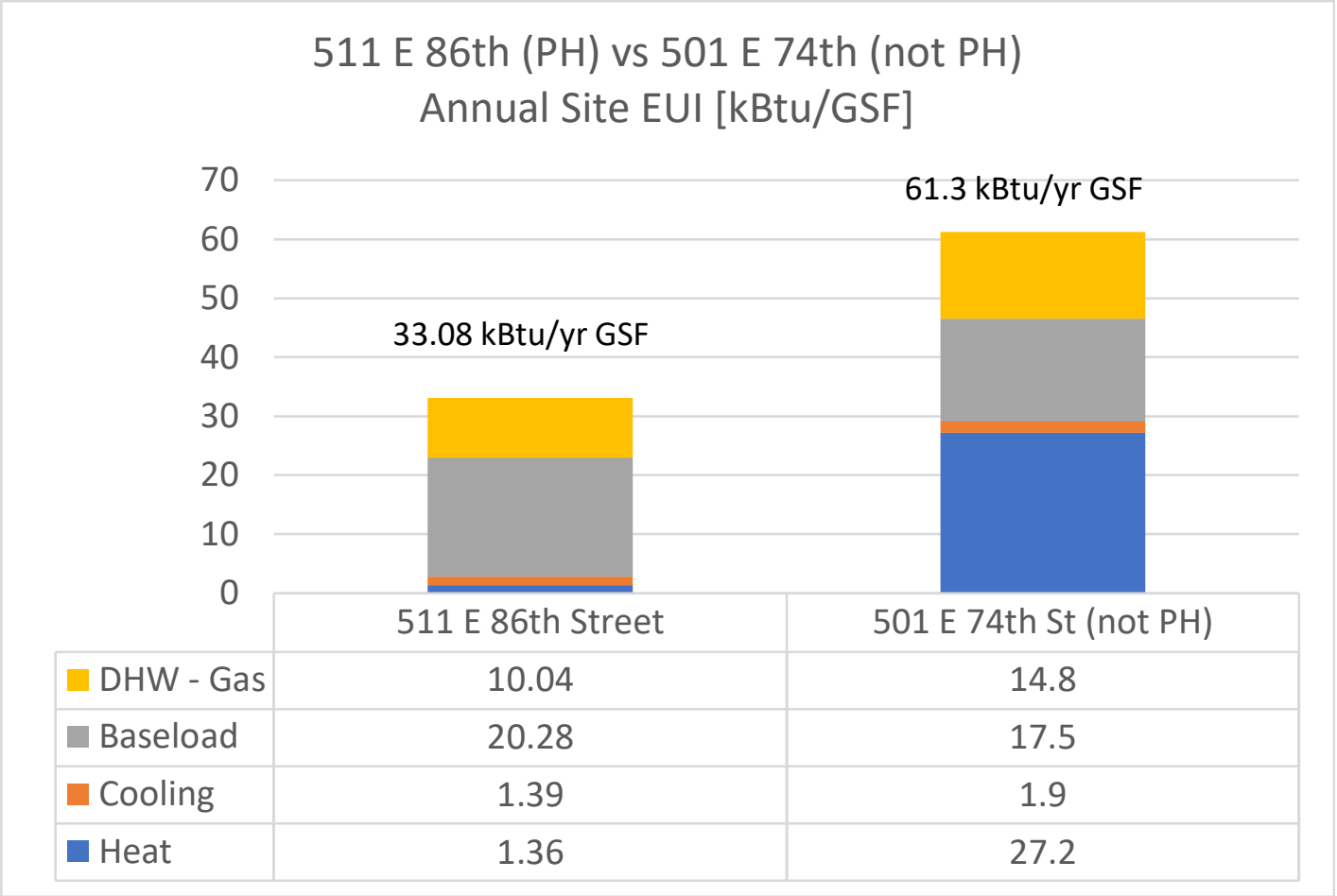


Site EUI Comparison: CHP vs no CHP



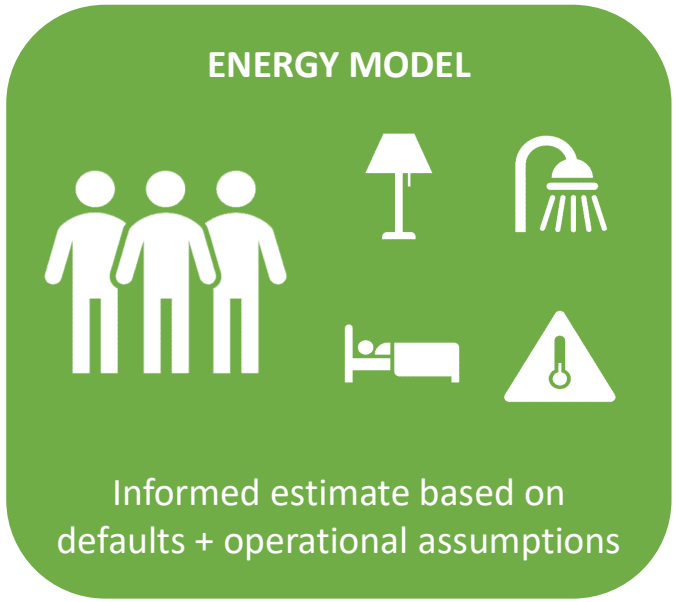
	Park Ave Green 2021 (actual - Site)	Park Ave Green 2021 (est. no cogen - Site)	Predicted (no cogen - Site)
Electric Baseload	12.4	19.1	14.7
CHP	13.3	0	0.0
Baseload Gas	13.3	13.3	6.1
Cooling	2.1	2.1	1.3
Heating	6.2	6.2	0.8

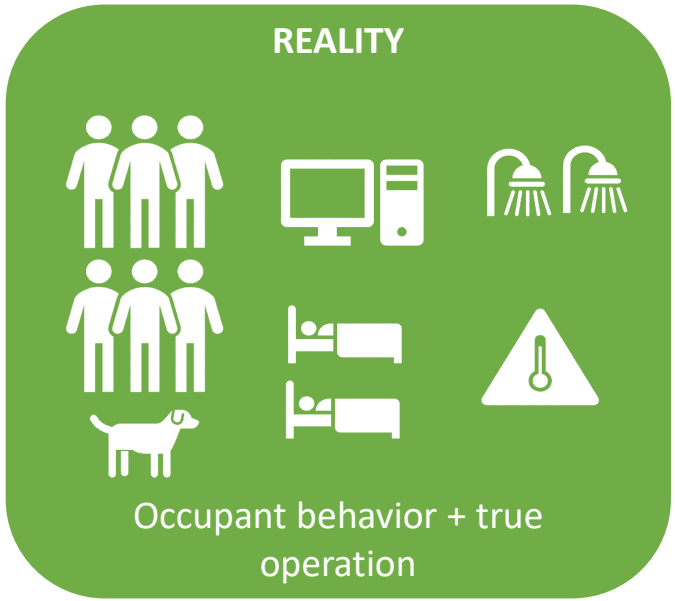
2021 PH vs. 2016 non-PH



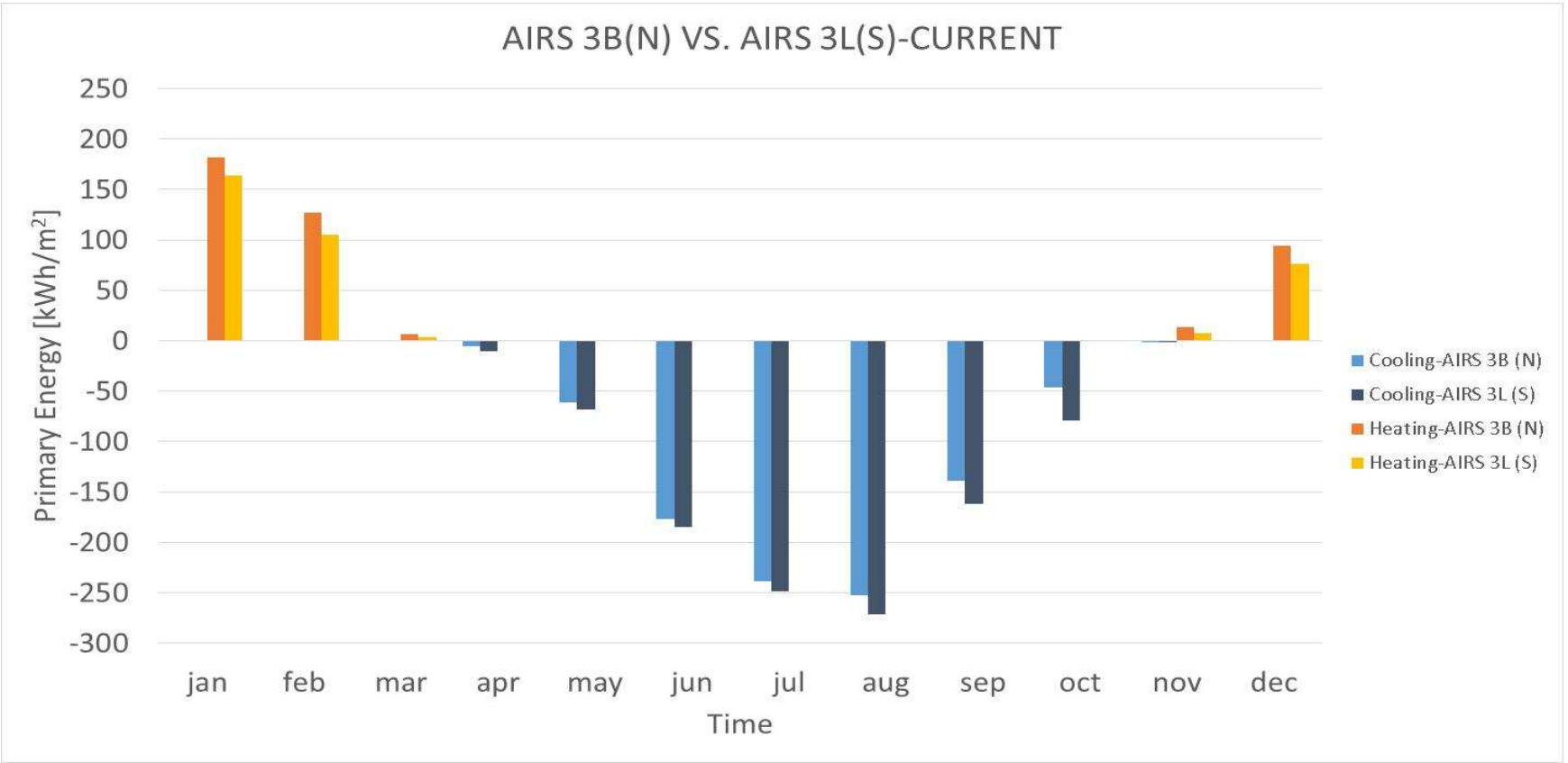
	511 E 86th Street	501 E 74th St (not PH)
DHW - Gas	10.04	14.8
Baseload	20.28	17.5
Cooling	1.39	1.9
Heat	1.36	27.2

ENERGY USE: MODELLED VS. ACTUAL

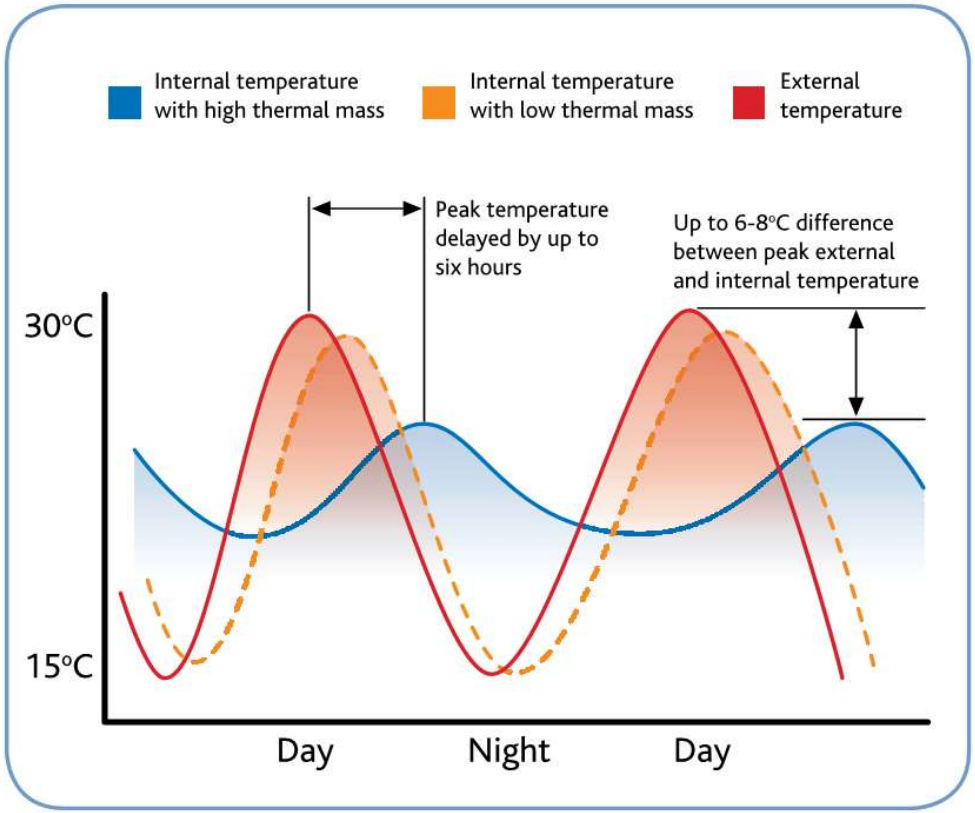




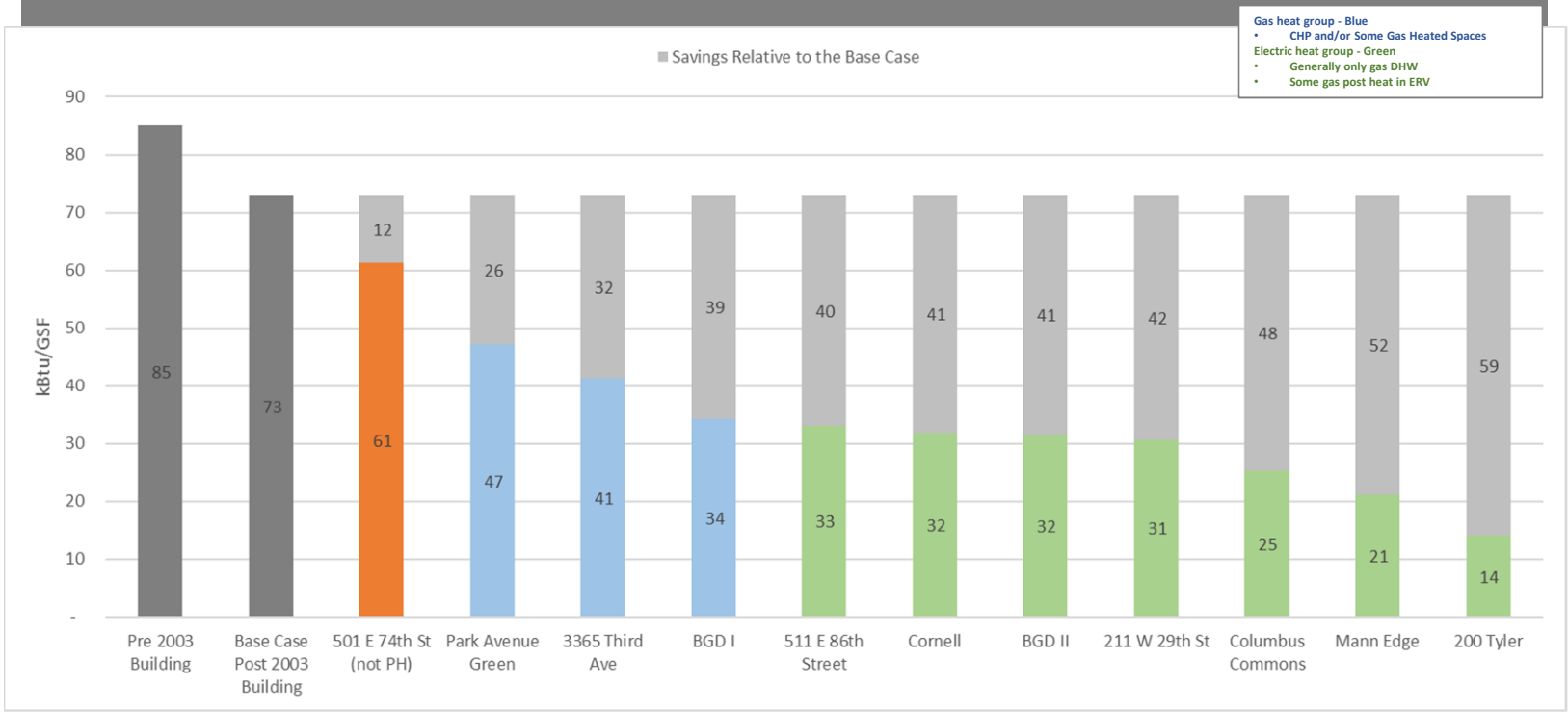
When do you heat / When do you cool?



Passive House Buildings are More Resilient

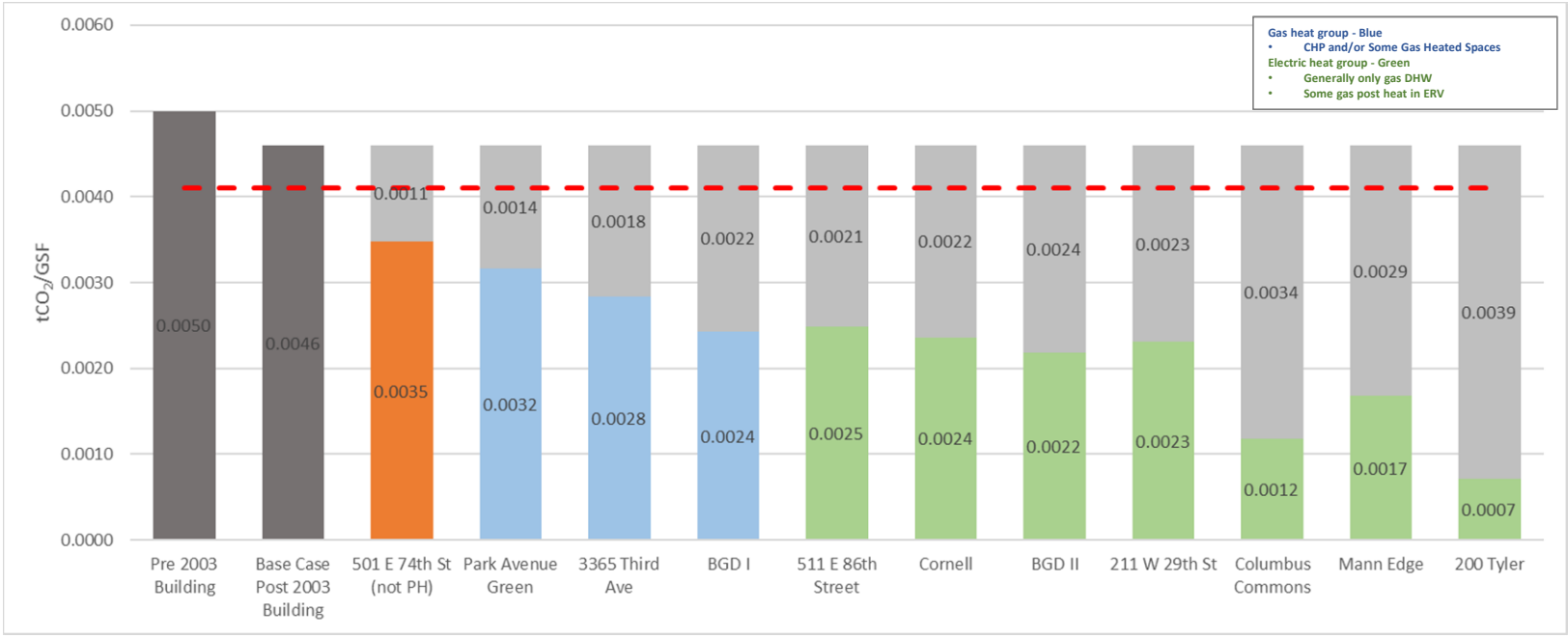


WHOLE BUILDING SITE EUI



1. Post 2003 Building sample is made up of NYC buildings with at least one full year of consumption data and includes approximately 94% buildings with gas heating, 6% with electric heating.
2. PH-1A & PH-1B have gas heating and hot water. The remaining projects have electric heating (VRF)
3. PH current target based on PHI standard 38 kBtu/sf/yr. Ranges from 20 (model) upper 20's-low 30s (25% gas + 75% electric fuel mix – typ. of gas DHW + elec heat) when building commissioned.

WHOLE BUILDING GREENHOUSE GAS EMISSIONS: RELATIVE TO LL97 2030 TARGET

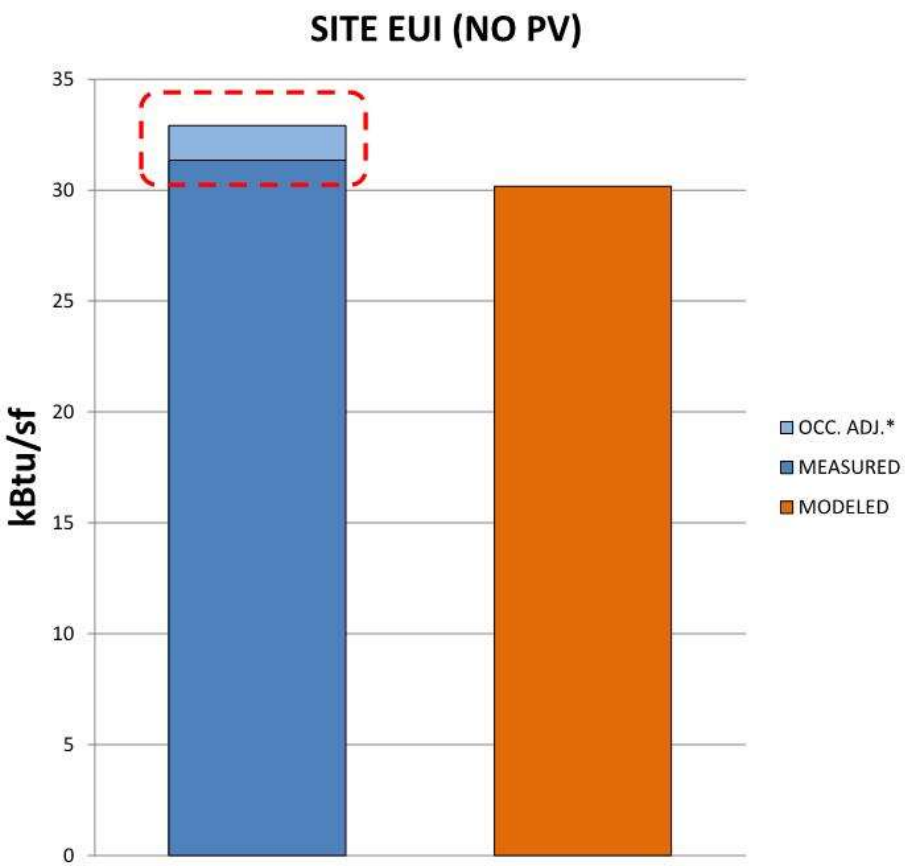


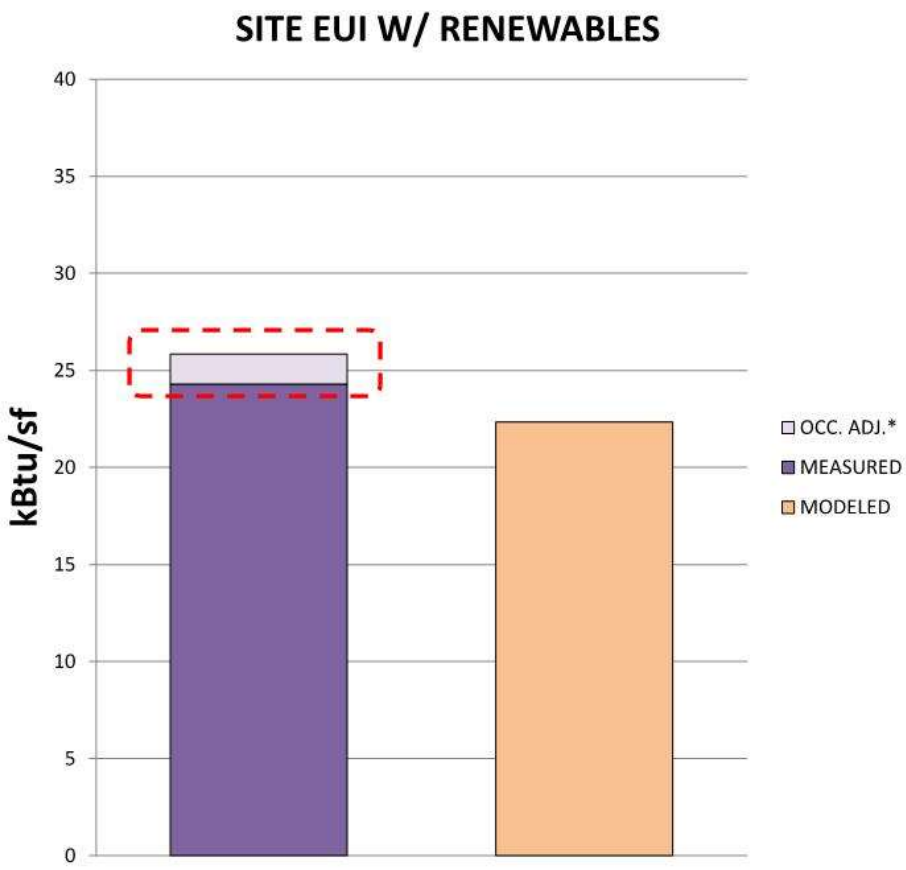
1. GHG emissions use 2024-2029 emissions coefficients outlined by Local Law 97 of NYC. Note that the emissions factors for 2030 have not yet been established. There is a strong likelihood that the combination of Indian Point closing and gains made as part of the CLCPA, the coefficient will be similar to the one set for 2024-2029.

Lessons Learned

BEACH GREEN DUNES

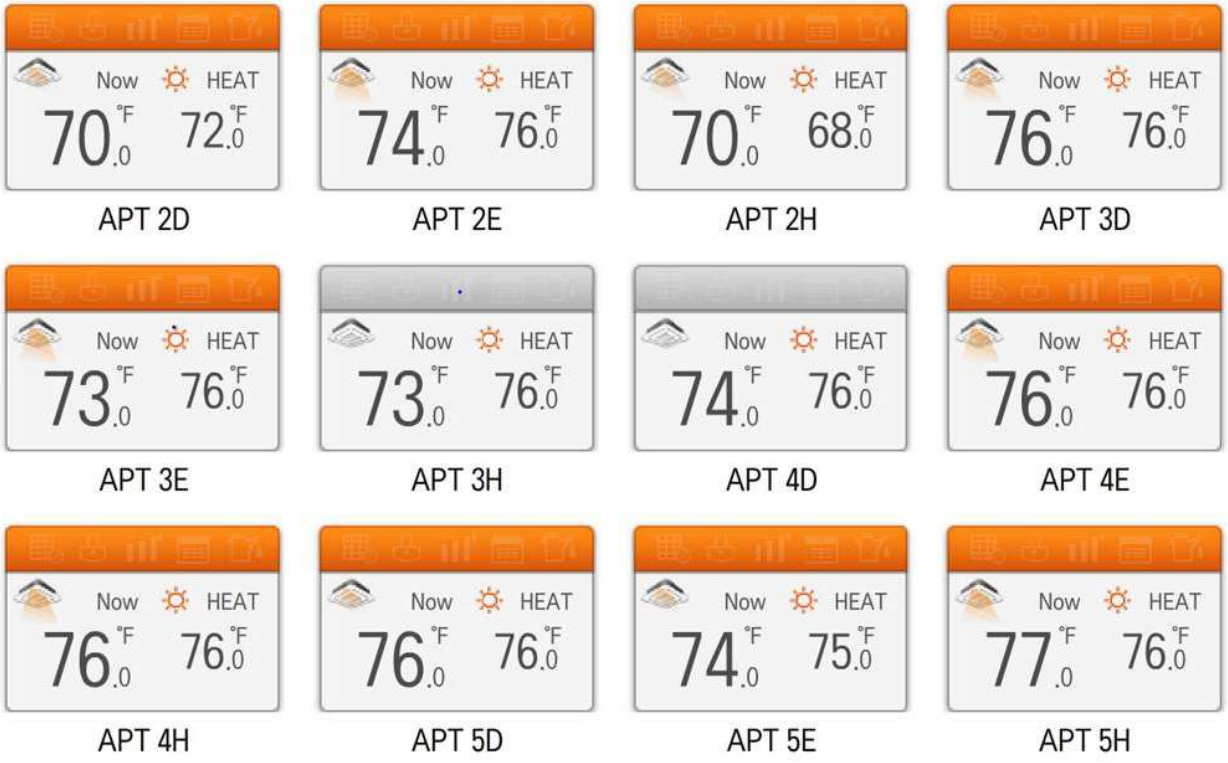
89% Modeled vs Actual





BGD-I

Why?
Thermostat Settings



BGD-I

Why?

Co-Gen

Valve

BGD-I

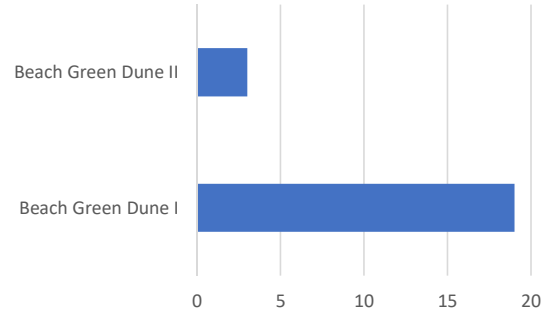
Super Interviews

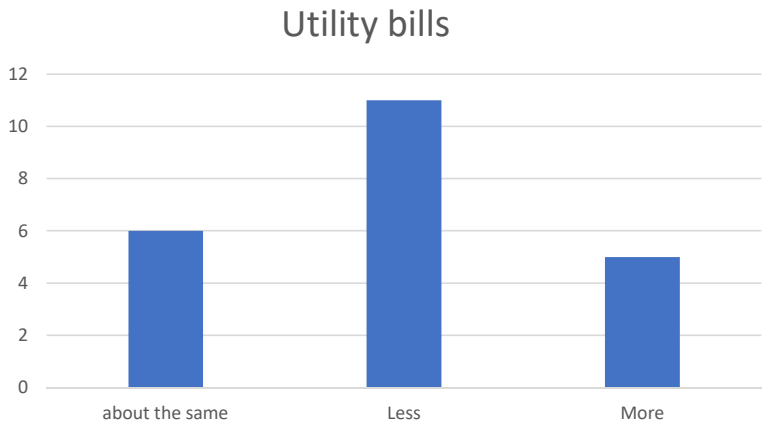
- Spoke with: Director of Property Management, Manager, Supers
- Heating/Cooling
  - Get technical support from HVAC vendors, didn't have additional training at turn over
  - Need more HVAC contractors trained on VRF
  - VRF setup is important – trouble shooting has been an issue
  - One unit down, takes down the entire loop in some systems
  - Key components that need inspection should not be behind walls
  - Setpoint limits in apartments cause complaints – 72 winter, 68 summer
  - Cooling is needed beyond turnover date of 10/1 and earlier than spring turnover

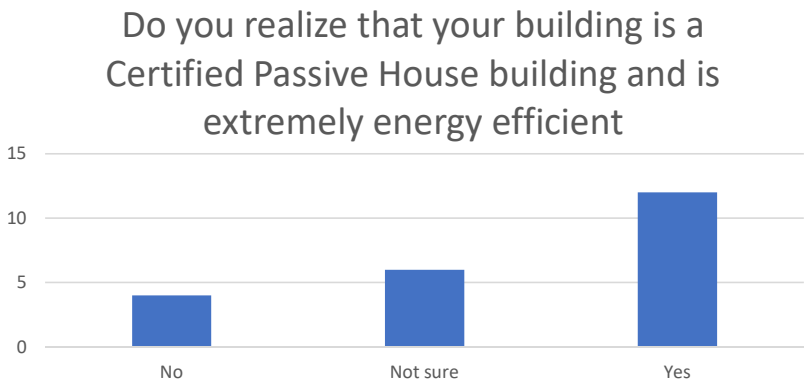
Super Interviews

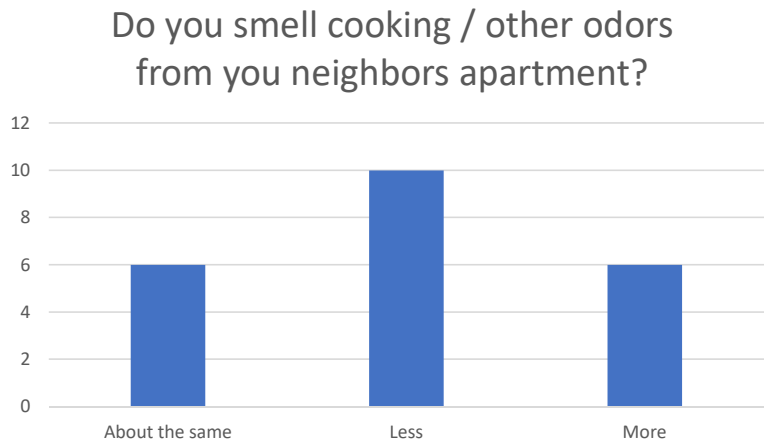
- Ventilation
  - For some: things are fine w/ filter changes, happen every 6 months, more if necessary
  - For others: never taught maintenance schedules, filters are often clogged
  - All projects: Supply air on ERVs in winter can be a source of complaint
  - In-unit ERVs: Occupants commonly turn them off, need more education of why they are important

Resident survey



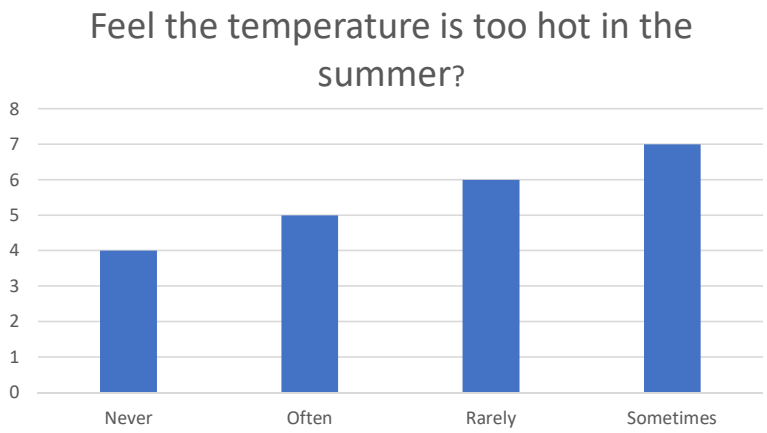


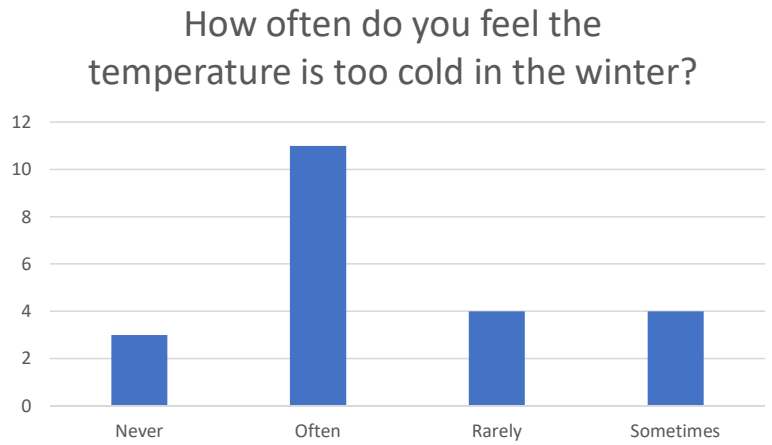


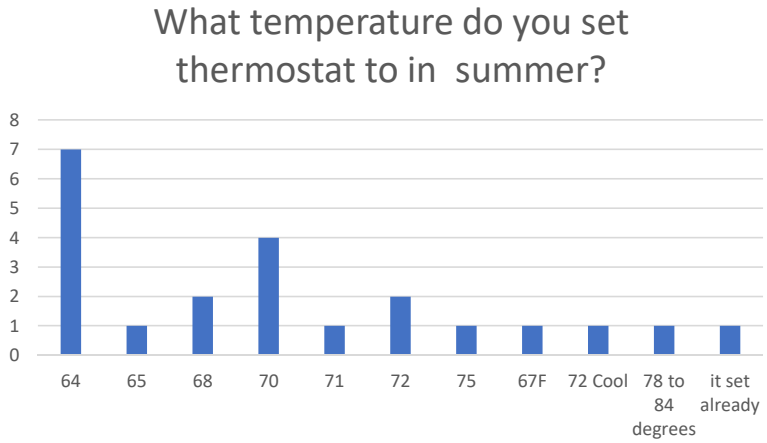


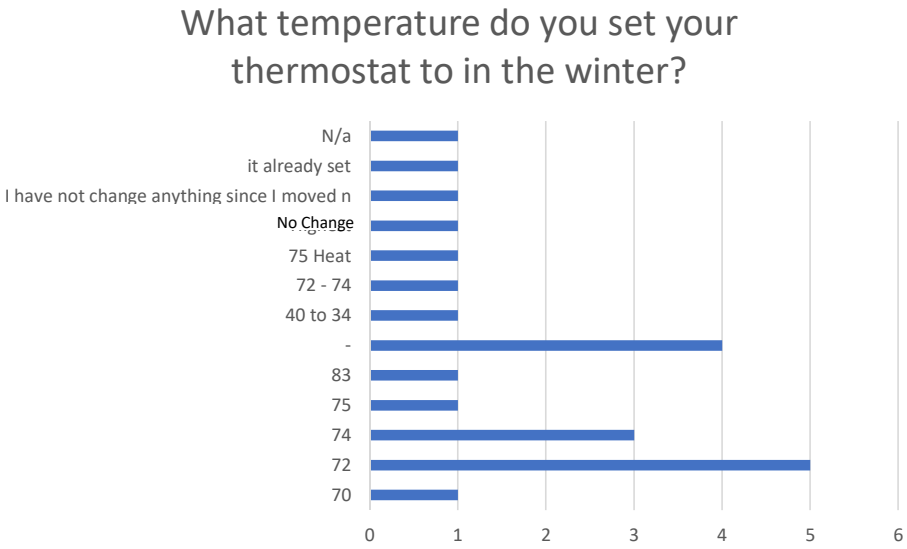
- BGD I had many more responses since they sent out electronically.
- Even with air sealing and ERV's there seem to be some smell issues.

Resident survey









- People like it very cold in the summer and hot in the winter. There needs to be an education campaign.

Conclusions

Conclusions:

- Many ways to meet Passive House and get similar results.
- ICF's have many advantages but need more sub contractors who want and know how to do.
- Operation and Maintenance is critical.
- Resident education is critical.
- Need to educate people about sweaters and short sleeve shirts etc.
- Senior behavior seems to have lower energy use.
- Cogen – design for DHW not electric load.
- Heating and Cooling are a small part of the load. So, spending a lot of money on those systems does not make sense but making buildings electric does.
- Waste Water / Ground Source heat pump recovery systems for hot water are the next frontier. Ground source, not Passive House has lowest EUI.
- Ground source may give greater resident comfort.
- Ground Source Heat pumps higher first cost and lower operating cost – slightly.
- Unitized vs. Centralized ERV, similar operation costs, different first costs, user and maintenance issues.
- Residents turn off unitized ERV's, again need education.
- Regulations often force decisions.

Thank You!

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