PHIUS+ 2018 & Monitored Data

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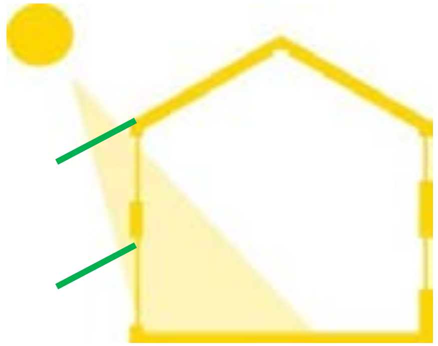
Lisa White – Lisa@passivehouse.us

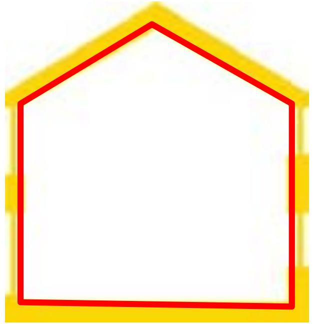
PASSIVE BUILDING PRINCIPLES

Thermal Control | **Radiation Control** | **Air Control**

CONTINUOUS
INSULATION



OPTIMIZED
WINDOWS
& SOLAR
GAINS



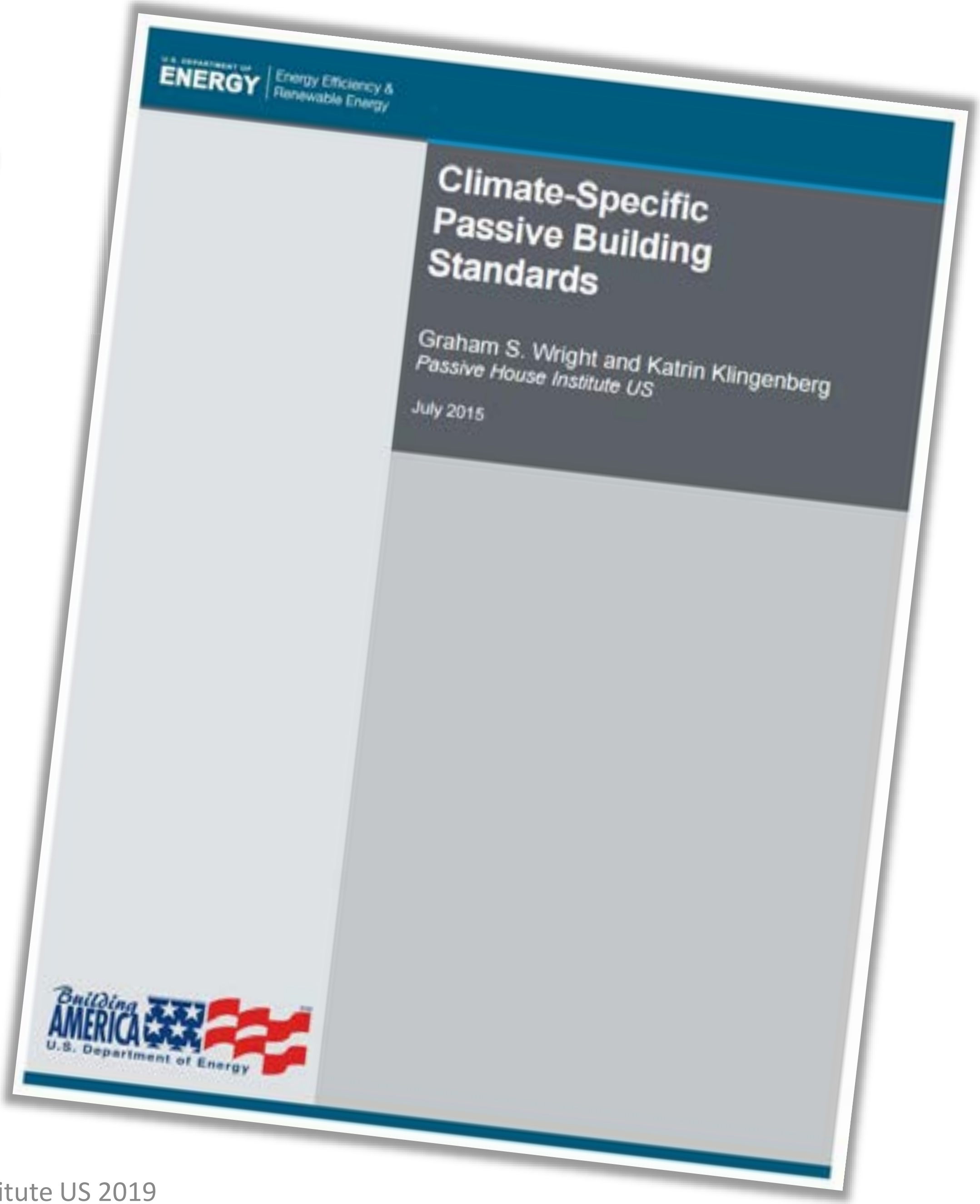
AIR-TIGHT
CONSTRUCTION

BALANCED
VENTILATION
WITH HEAT
RECOVERY

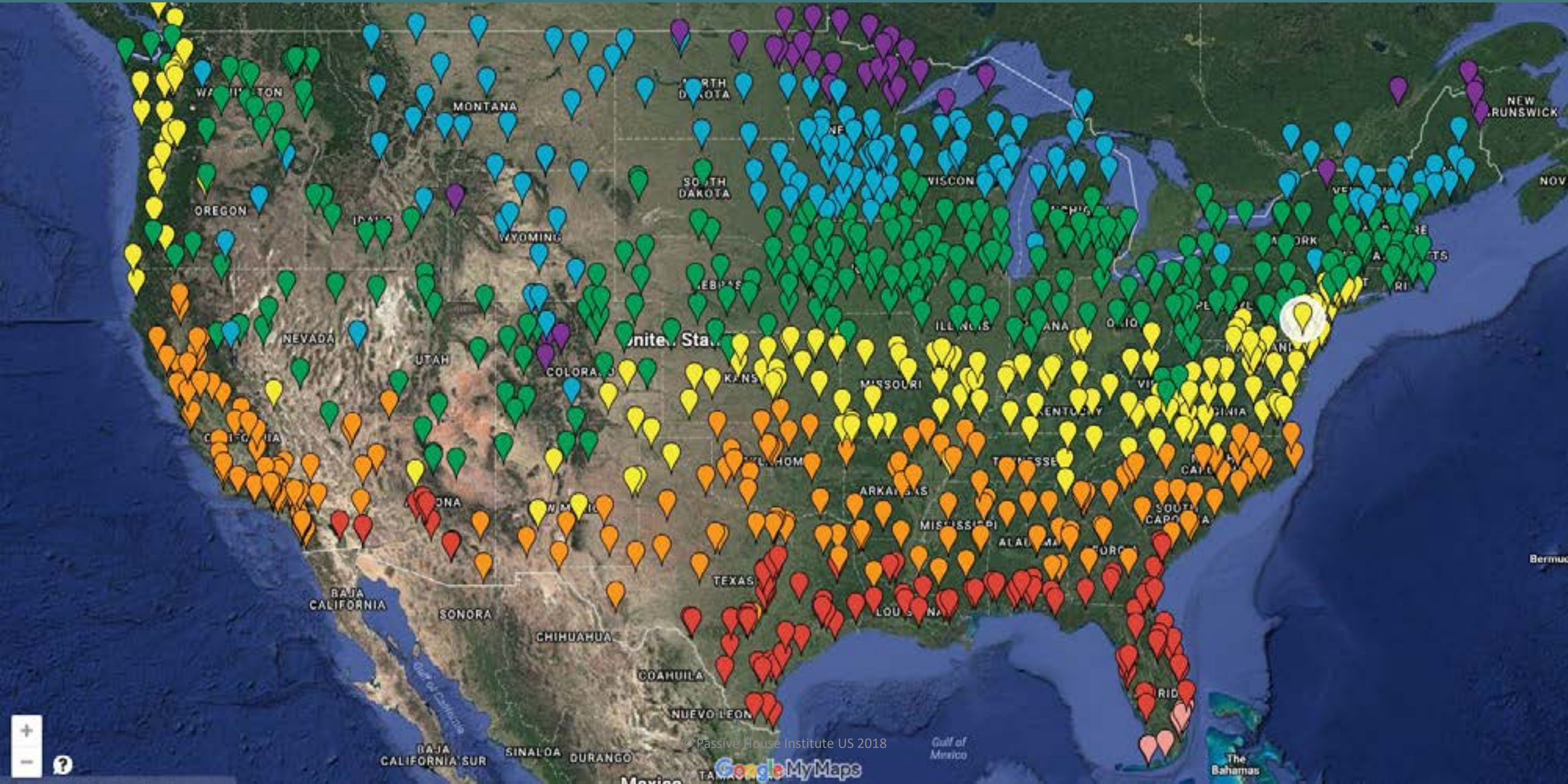
MINIMIZED
MECHANICAL
SYSTEMS

PHIUS+2015

A *performance* based **passive building standard** with *prescriptive* requirements.

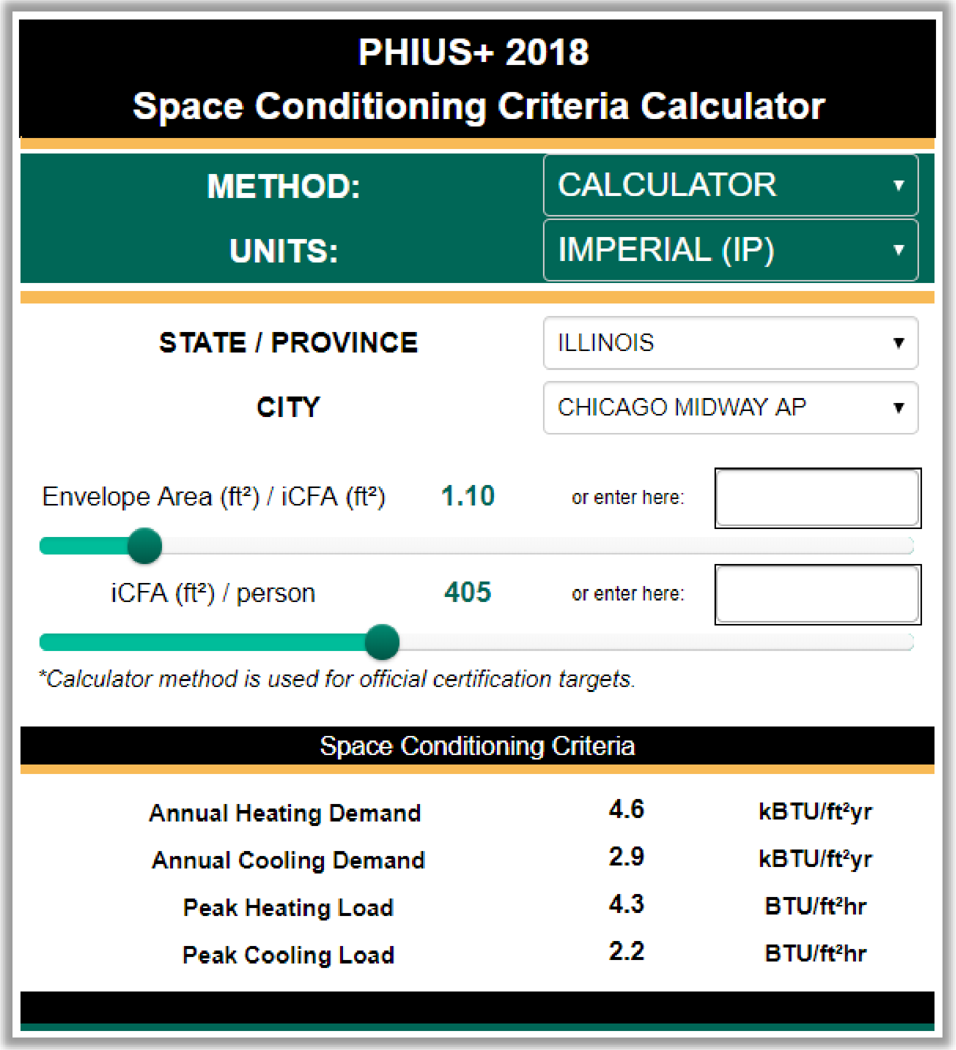


TARGETS for 1000+ CLIMATES



PHIUS+2018

A *performance* based ***passive building standard*** with *prescriptive* requirements.



MAIN CERTIFICATION REQUIREMENTS

REQUEIEMTNS FOR ALL PHIUS+ CERTIFICATIONS

SPACE CONDITIONING TARGETS

- Based on cost optimization analysis
- Vary based on climate, occupant density, and envelope/floor area ratio

AIR-TIGHTNESS

- 0.06 CFM50/ft2 envelope area
- Required limit set based on building durability. Pass/Fail.

ON-SITE QUALITY ASSURANCE TESTING/INSPECTION

- Ensure quality for elements not reflected in energy modeling
- Required for all projects

VARIES

NET SOURCE ENERGY TARGET

- Used instead of site energy as a better proxy for carbon emissions
- Target and renewable energy offsets vary based on program version

SPACE CONDITIONING TARGETS

Annual Demand [kBTU/yr.ft^2]: Space conditioning energy consumed over the course of the year, delivered by the equipment to the space.

Annual Heating Demand ≤ A (kBTU/ft2.yr)
Annual Cooling Demand ≤ B (kBTU/ft2.yr)

Peak Load [BTU/hr.ft^2]: Space conditioning requirement during the peak climate conditions (average over the worst 24 hours). Determines the size of the mechanical system.

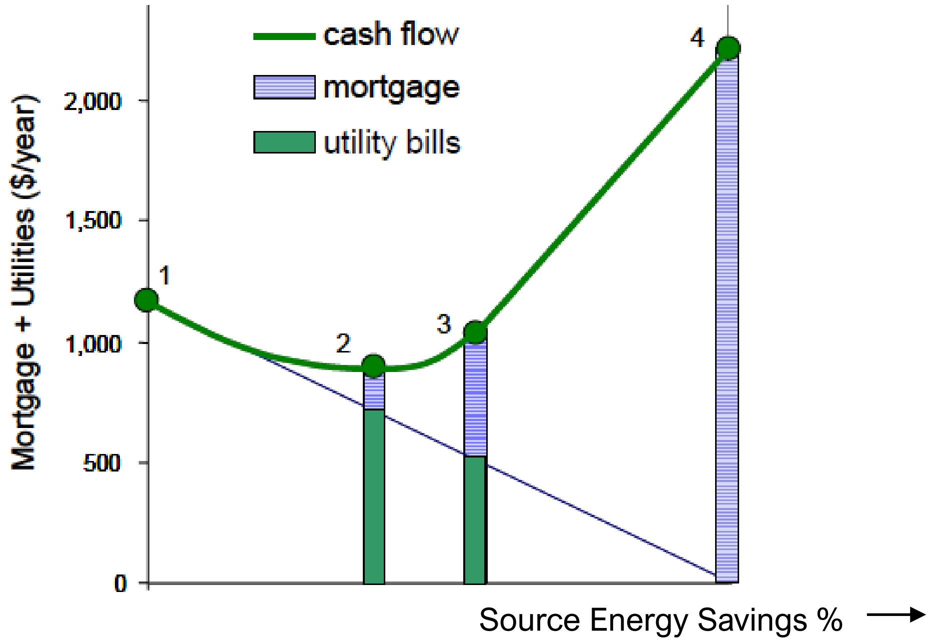
Peak Heating Load ≤ C (BTU/ft2.hr)
Peak Cooling Load ≤ D (BTU/ft2.hr)

MUST MEET ALL 4! Different advantages for each:

- Low ***annual demand*** saves energy and operating cost
- Low ***peak loads*** ensure comfort, resilience, and reduce mechanical system size

METHODOLOGY

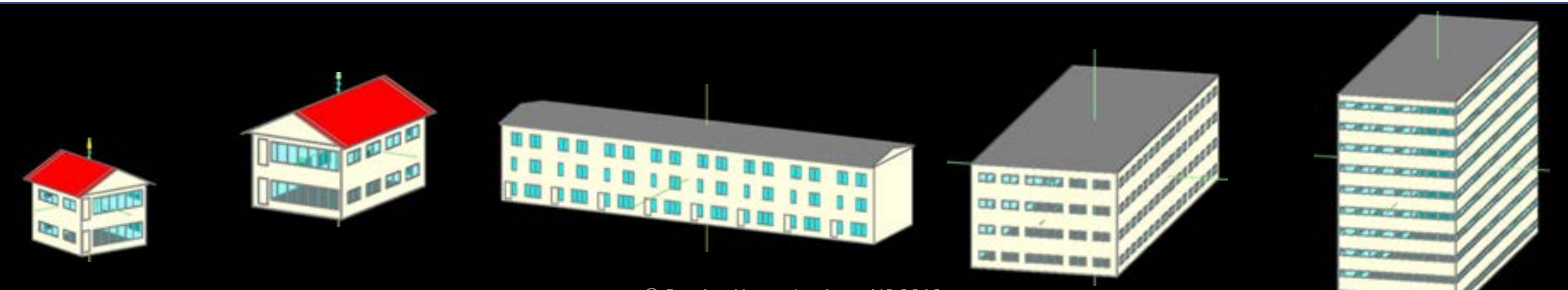
Setting Cost Competitive Space Conditioning Criteria



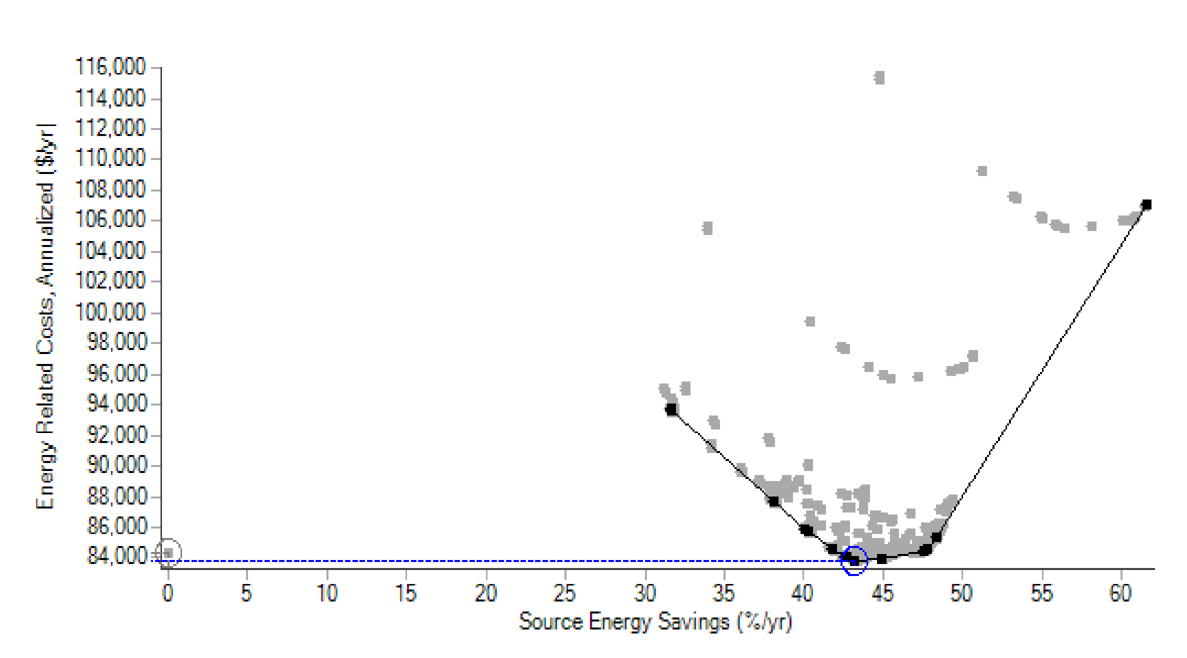
NREL BEopt optimizes upgrade package.

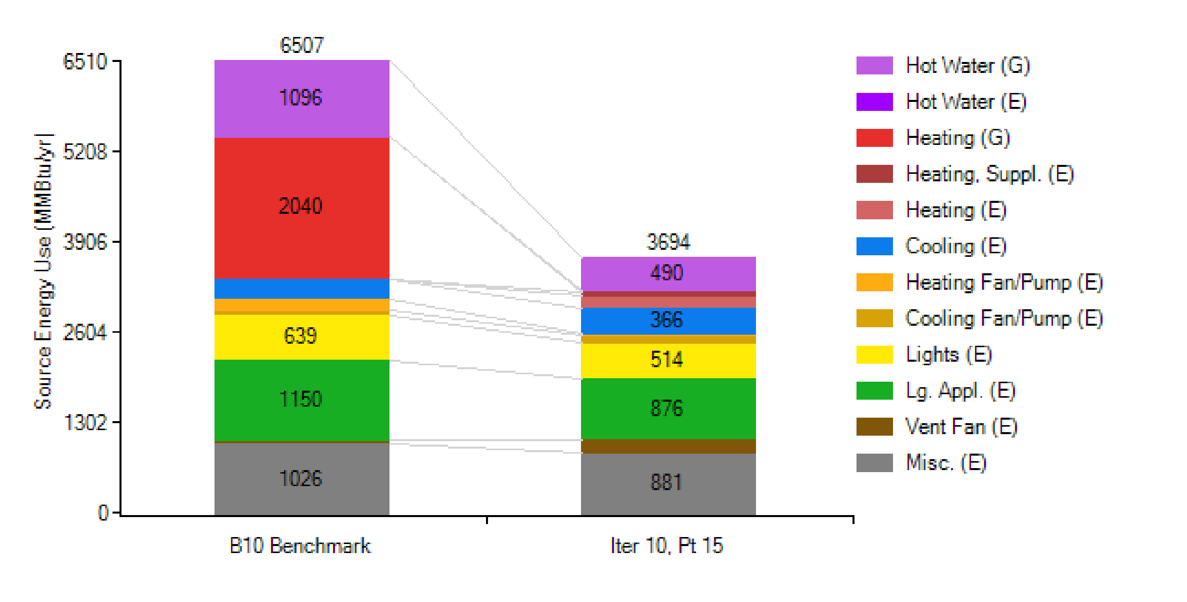
<u>Factors:</u>
Climate
Building Size
Occupant Density

<u>Forced Constraints:</u>
Air-sealing (meet PHIUS+ target)
Window performance (comfort & low loads)



Cost optimal sweet-spot for investment in conservation





SPACE CONDITIONING TARGETS

VARY BASED ON
BUILDING SIZE AND **OCCUPANT DENSITY**

PHIUS+ 2018
Space Conditioning Criteria Calculator

METHOD:	CALCULATOR
UNITS:	IMPERIAL (IP)
STATE / PROVINCE	ILLINOIS
CITY	CHICAGO MIDWAY AP

Envelope Area (ft²) / iCFA (ft²)	2.50	or enter here:
iCFA (ft²) / person	405	or enter here:

**Calculator method is used for official certification targets.*

Space Conditioning Criteria

Annual Heating Demand	7.7	kBTU/ft²yr
Annual Cooling Demand	4.3	kBTU/ft²yr
Peak Heating Load	6.2	BTU/ft²hr
Peak Cooling Load	3.1	BTU/ft²hr

PHIUS+ 2018
Space Conditioning Criteria Calculator

METHOD:	CALCULATOR
UNITS:	IMPERIAL (IP)
STATE / PROVINCE	ILLINOIS
CITY	CHICAGO MIDWAY AP

Envelope Area (ft²) / iCFA (ft²)	1.10	or enter here:
iCFA (ft²) / person	405	or enter here:

**Calculator method is used for official certification targets.*

Space Conditioning Criteria

Annual Heating Demand	4.6	kBTU/ft²yr
Annual Cooling Demand	2.9	kBTU/ft²yr
Peak Heating Load	4.3	BTU/ft²hr
Peak Cooling Load	2.2	BTU/ft²hr

SPACE CONDITIONING TARGETS

VARY BASED ON
BUILDING SIZE AND OCCUPANT DENSITY

PHIUS+ 2018
Space Conditioning Criteria Calculator

METHOD:	CALCULATOR
UNITS:	IMPERIAL (IP)
STATE / PROVINCE	ILLINOIS
CITY	CHICAGO OHARE INTL AP

Envelope Area (ft²) / iCFA (ft²)	1.10	or enter here:	
iCFA (ft²) / person	500	or enter here:	

**Calculator method is used for official certification targets.*

Space Conditioning Criteria		
Annual Heating Demand	4.8	kBTU/ft²yr
Annual Cooling Demand	3.0	kBTU/ft²yr
Peak Heating Load	3.6	BTU/ft²hr
Peak Cooling Load	2.2	BTU/ft²hr

PHIUS+ 2018
Space Conditioning Criteria Calculator

METHOD:	CALCULATOR
UNITS:	IMPERIAL (IP)
STATE / PROVINCE	ILLINOIS
CITY	CHICAGO OHARE INTL AP

Envelope Area (ft²) / iCFA (ft²)	1.10	or enter here:	
iCFA (ft²) / person	250	or enter here:	

**Calculator method is used for official certification targets.*

Space Conditioning Criteria		
Annual Heating Demand	4.8	kBTU/ft²yr
Annual Cooling Demand	4.6	kBTU/ft²yr
Peak Heating Load	4.2	BTU/ft²hr
Peak Cooling Load	2.5	BTU/ft²hr

AIR-TIGHTNESS

Passing test results (pressurization & depressurization) required for certification.

0.060 CFM_{50}/ft^2 envelope area*
0.080 CFM_{75}/ft^2 envelope area

For buildings 5+ stories of non-combustible construction **0.080 CFM_{50}/ft^2 envelope or **0.110 CFM_{75}/ft^2** envelope.*

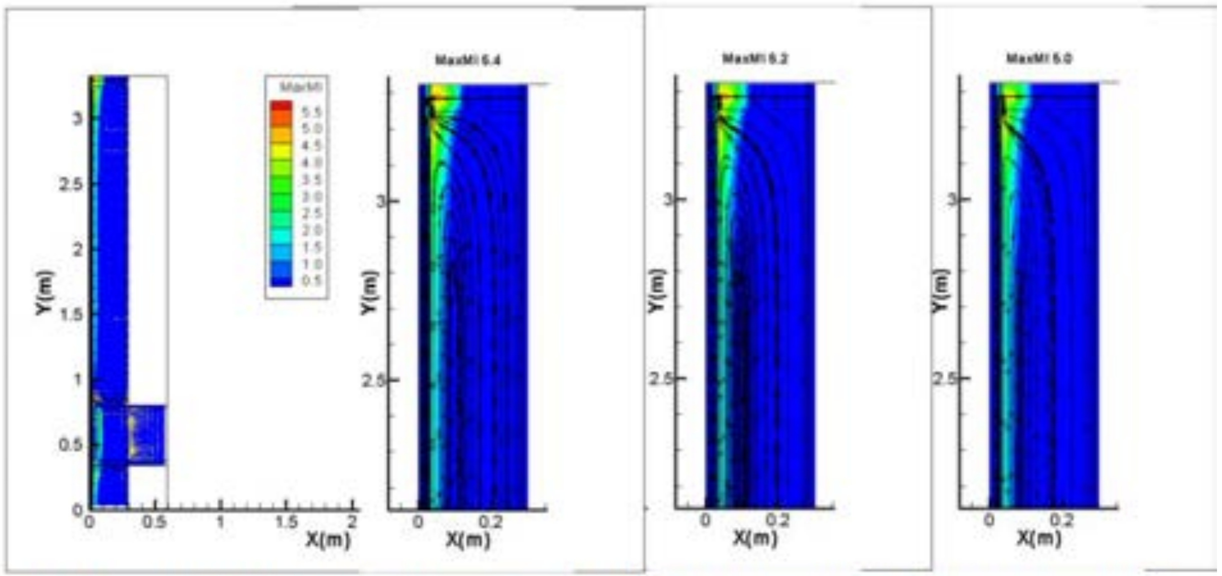
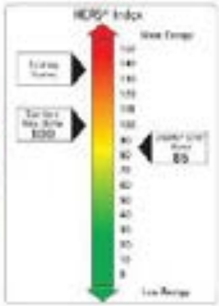


Figure 10. Predicted Mold Index at air tightness ratings 0.01, 0.02 and 0.04 cfm/sqft (left to right). Whole assembly for maximum mold index. Houston, TX.

ON-SITE QUALITY ASSURANCE TESTING/INSPECTION

- Built on US recognized systems (DOE, EPA IAP, RESNET)
- 3rd Party inspection process
- Multiple site visits
- Blower door testing
- Ventilation system balancing/commissioning
- Insulation inspection

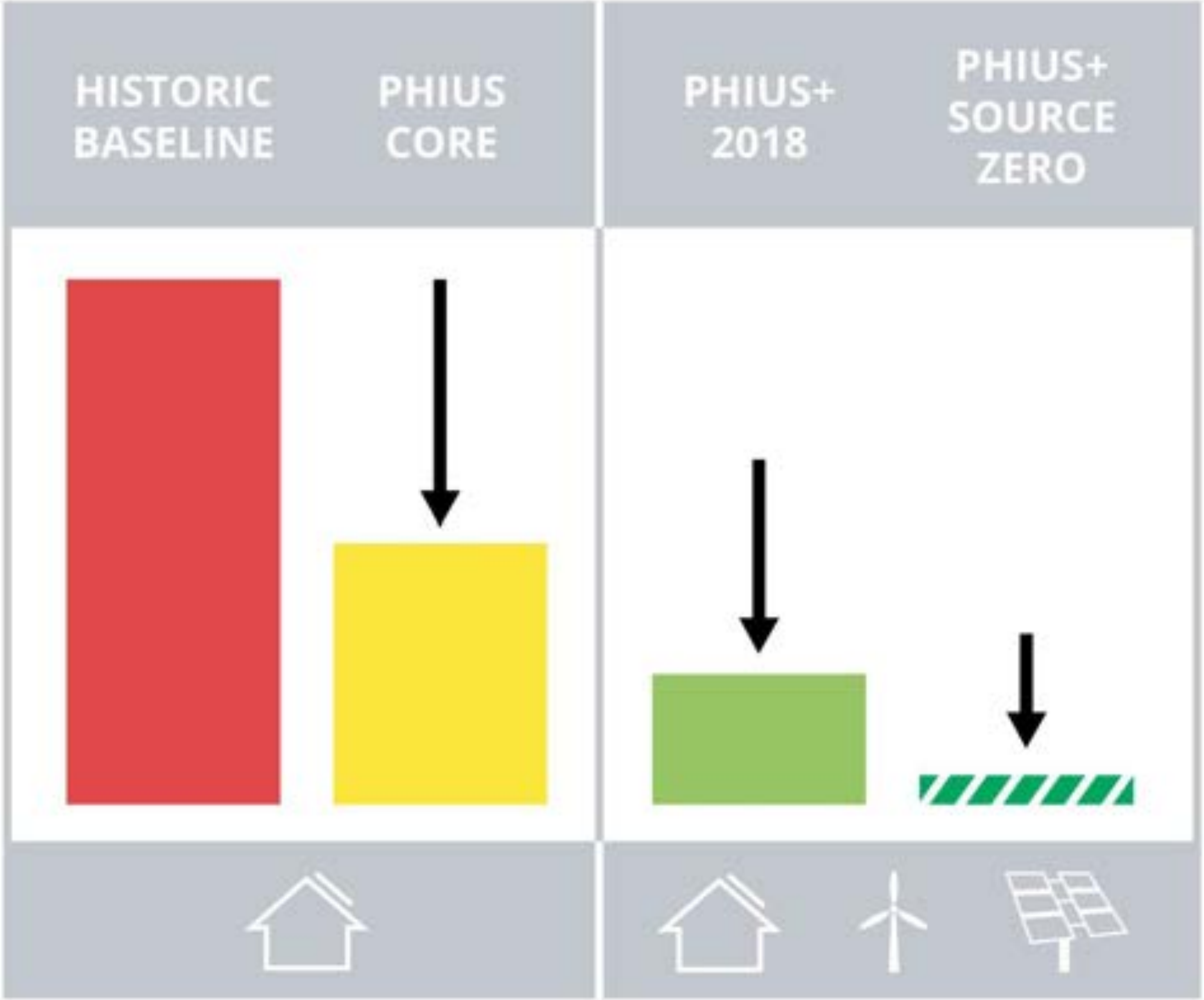
Critical for success. Provides assurance that the built product is what was planned.



DOE HIGH PERFORMANCE STAIRCASE

IECC 2009	IECC 2012	ENERGY STAR v3	ENERGY STAR v3.1	ZERH	PHIUS PHIUS+	PHIUS+ SourceZero
						Source Zero Renewable Energy System
					Balanced Ventilation HRV/ERV	Balanced Ventilation HRV/ERV
				SOLAR READY Depends on climate	SOLAR READY ALWAYS	SOLAR READY ALWAYS
				Eff. Comps. & H2O Distrib	Eff. Comps. & H_2O Distrib	Eff. Comps. & H_2O Distrib
				EPA Indoor airPLUS	EPA Indoor airPLUS	EPA Indoor airPLUS
				Ducts in Condit. Space	Ducts in Condit. Space	Ducts in Condit. Space
		HVAC QI w/WHV	HVAC QI w/WHV	HVAC QI w/WHV	Micro-load HVAC QI	Micro-load HVAC QI
		Water Management	Water Management	Water Management	Water Management	Water Management
		Independent Verification	Independent Verification	Independent Verification	Independent Verification	Independent Verification
IECC 2009 Enclosure	IECC 2012 Enclosure	IECC 2009 Enclosure	IECC 2012 Enclosure	IECC 2012/15 Encl./ES Win.	Ultra-Efficient Enclosure	Ultra-Efficient Enclosure
HERS 85-90	HERS 70-80	HERS 65-75	HERS 55-65	HERS 48-55	HERS 35-45	HERS < 0

NET SOURCE ENERGY



SOURCE ENERGY OFFSETS

For PHIUS+ 2018 and Source Zero, all of the following renewables are recognized as offsets:

Type	*Offset Factor (C_{RE})* *
On-Site Photovoltaic Array	1
Directly Owned Off-Site Renewable	1
Community Renewable Energy	1
Virtual Power Purchase Agreements (PPA)	1
Green-E Certified Renewable Energy Certificates (RECs)	0.2

1 kWh of renewable energy generated offsets ***2.8** kWh/**1.96** (US/Canada) at the source when the offset factor is 1.

PHIUS+ SOURCE ZERO

Building must generate as much energy as it uses on an annual, source-energy basis.

Net Source Energy Target: ***0!***

For an all electric building → Site Zero = Source Zero

CERTIFICATION BASED ON MODELED USE

WUFI® Passive modeling software

TWO PART CERTIFICATION:
PRE-CERTIFICATION: Design Stage
FINAL CERTIFICATION: On-Site QA

OTHER REQUIREMENTS

PHIUS WINDOW COMFORT & CONDENSATION RISK ASSESSMENT

PHIUS
Passive House Institute US

Project Name	SAMPLE
Project #	SAMPLE
State	MASSACHUSETTS
City	BOSTON LOGAN INT ARPT
ASHRAE 99% Design Temperature [°F]	13.4

http://ashrae-meteo.info/

PHIUS+ Climate Data

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ambient Temp (°F)	26.6	31.1	38.8	47.5	58.8	66.0	74.1	71.1	64.6	54.0	43.3	36.0
Dewpoint (°F)	13.8	17.4	24.6	35.1	47.1	54.1	60.6	61.0	53.2	41.7	33.4	23.0

CONDENSATION RISK

ISO 13788 Calculation for Low Thermal Inertia Elements

Is this a Heating Climate?	TRUE
Use simple method for indoor humidity?	TRUE
High occupancy?	TRUE
U-value of window frame/glass [BTU/hr.ft^2.F]	0.4
Safety Factor	15%

Interior Surface Temperature of window frame/glass [°F]	49.4
Risk of condensation on interior surface acceptable?	YES
Critical fRsi	0.64
Critical Month	JAN
Critical CRF Rating	64

COMFORT REQUIREMENTS

Applies to all projects.

Windows > 10' in height and above have the same required U-value.

Window Vertical Height (ft) - Use slider	7.0
Required Whole Window U-value [BTU/hr.ft^2.F]	0.24

OTHER REQUIREMENTS

Moisture Control in Assemblies

Must follow prescriptive requirements

OR

Pass by simulation in WUFI Pro.

Appendix B – Moisture Control Guidelines

Excerpted from Straube (2012). [42]

3.4.1 Vapor Control Recommendations

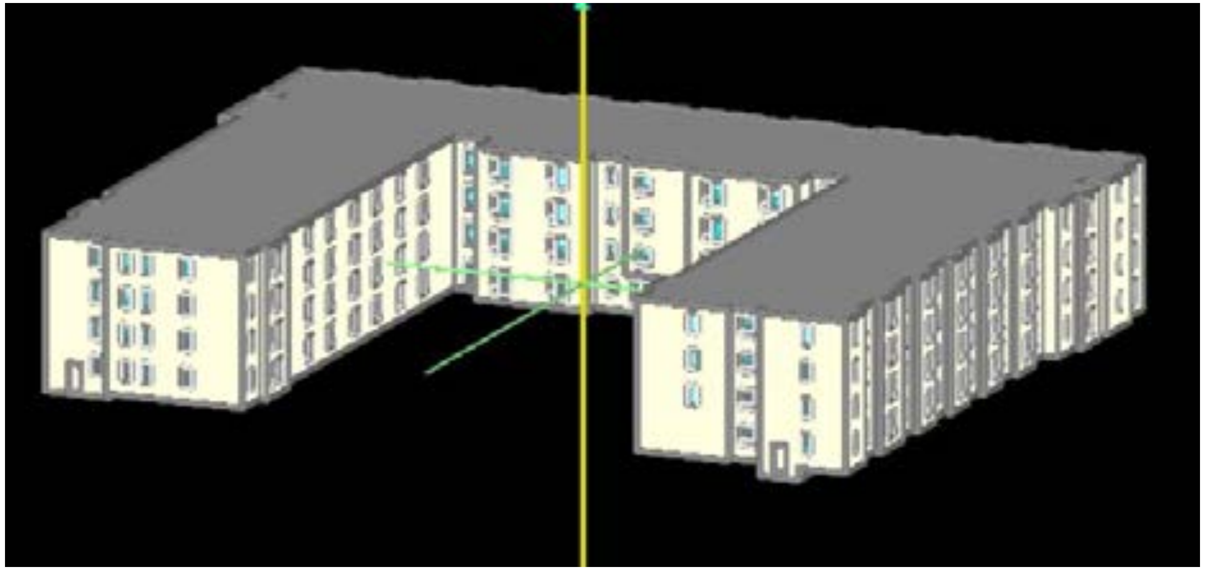
Different types of assemblies have different vapor control requirements. Although the requirements can be developed through rational engineering analysis, a simplified summary of recommendations, many from the "I" codes, is presented below.

PHIUS+ 2018 FEASIBILITY

Orchards at Orenco II & 124th & Ash

Units: 58
Bedrooms: 72
iCFA: 46,150 sf

Units: 175
Bedrooms: 103
iCFA: 98,700 sf



PHIUS+ 2018 FEASIBILITY

Packaged combinations that would work to achieve PHIUS+ 2018 performance targets. Not prescriptive.

		Orchards II - PHIUS+ 2018					124th & Ash - PHIUS+ 2018				
LOCATION		**LOS ANGELES**	**NYC**	**PORTLAND**	**CHICAGO**	**MINNEAPOLIS**	**LOS ANGELES**	**NYC**	**PORTLAND**	**CHICAGO**	**MINNEAPOLIS**
CLIMATE ZONE		**3**	**4A**	**4C**	**5**	**6**	**3**	**4A**	**4C**	**5**	**6**
ROOF (R-Value)		35	70	60	70	70	30	70	60	70	70
WALLS (R-Value)		20	35	30	35	40	25	35	30	35	35
SLAB (R-Value)		1	15	4	10	20	2	10	10	10	20
WINDOWS	U-VALUE	0.33	0.167	0.25	0.2	0.167	0.3	0.28	0.28	0.26	0.23
	SHGC	0.3	0.3	0.3	0.3	0.3	0.35	0.35	0.35	0.35	0.35
ERV Recovery Efficiency		70%	80%	70%	80%	80%	80%	80%	80%	80%	80%
COMMON LIGHTS (10% REDUCTION)		-	x	-	x	x	-	-	-	-	-
PV		33,000	69,000	65,000	81,000	87,000	140,000	220,000	220,000	280,000	320,000
Array Size (kW)		20	55	60	65	70	90	175	200	225	255

ORCHARDS AT ORENCO I

Hillsboro, OR

57 units

54,700 ft^2

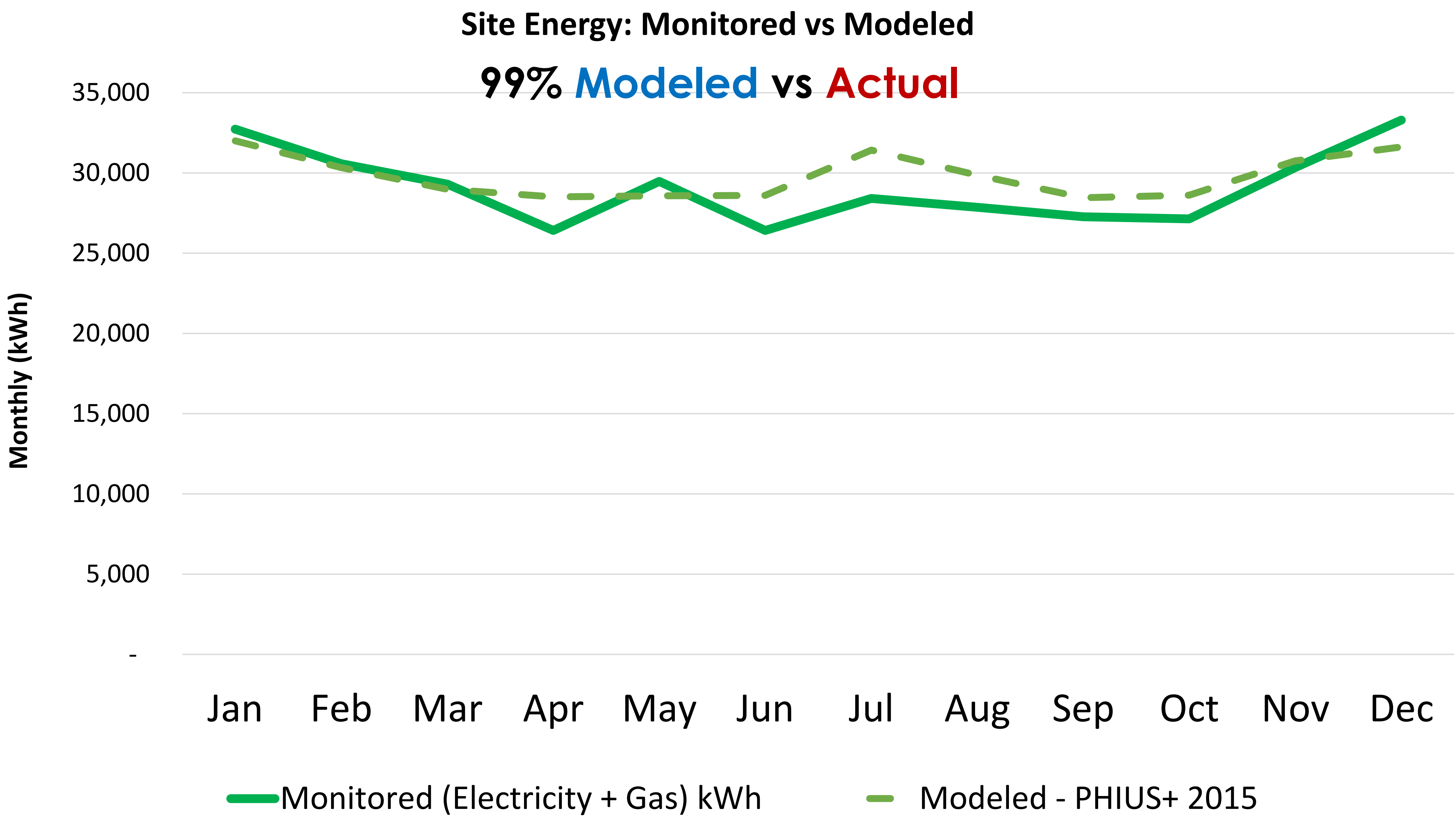
Central HVAC

ERVs w/Ducted Heat+Cool

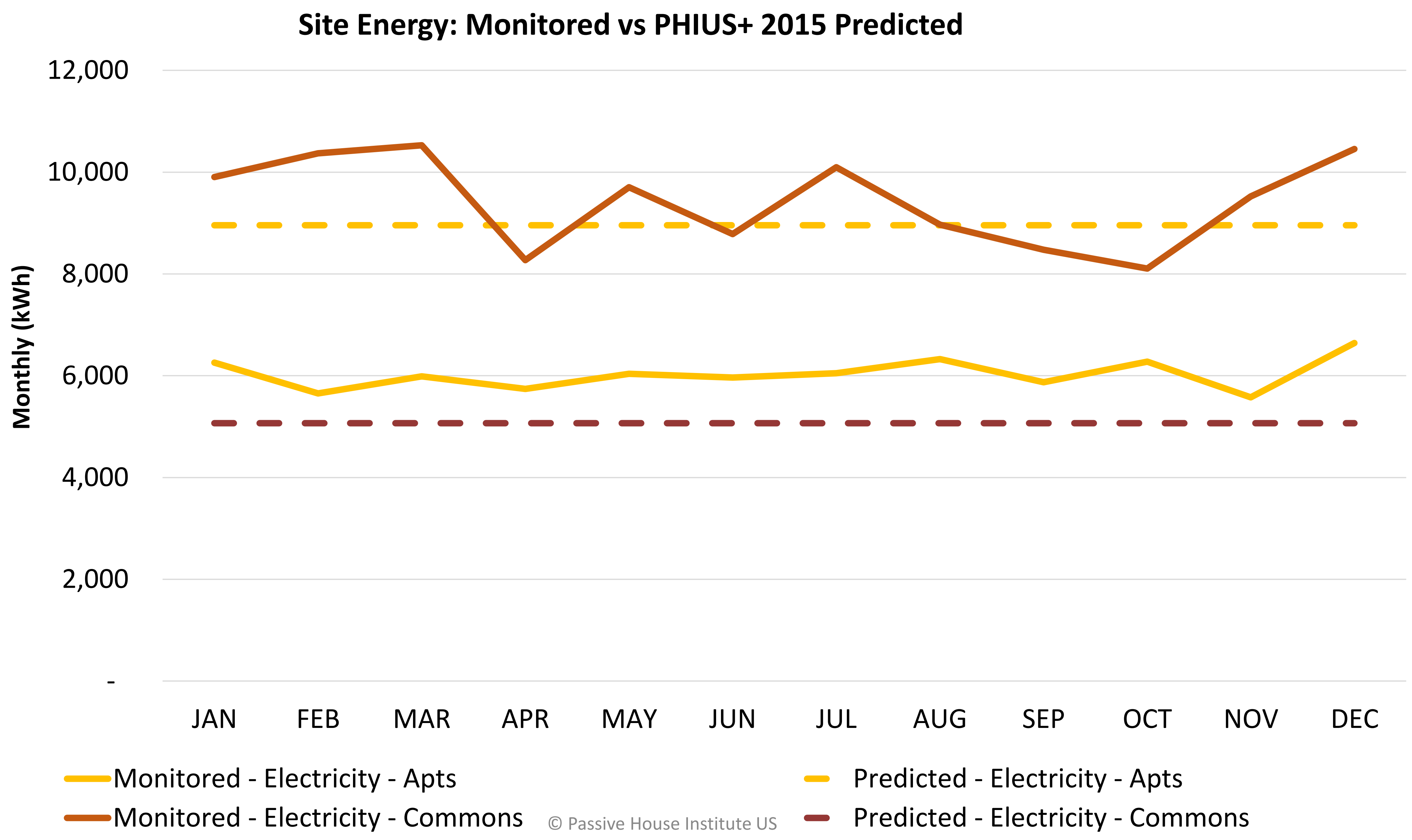
Gas Water Heating

Unit Meter & Common Meter

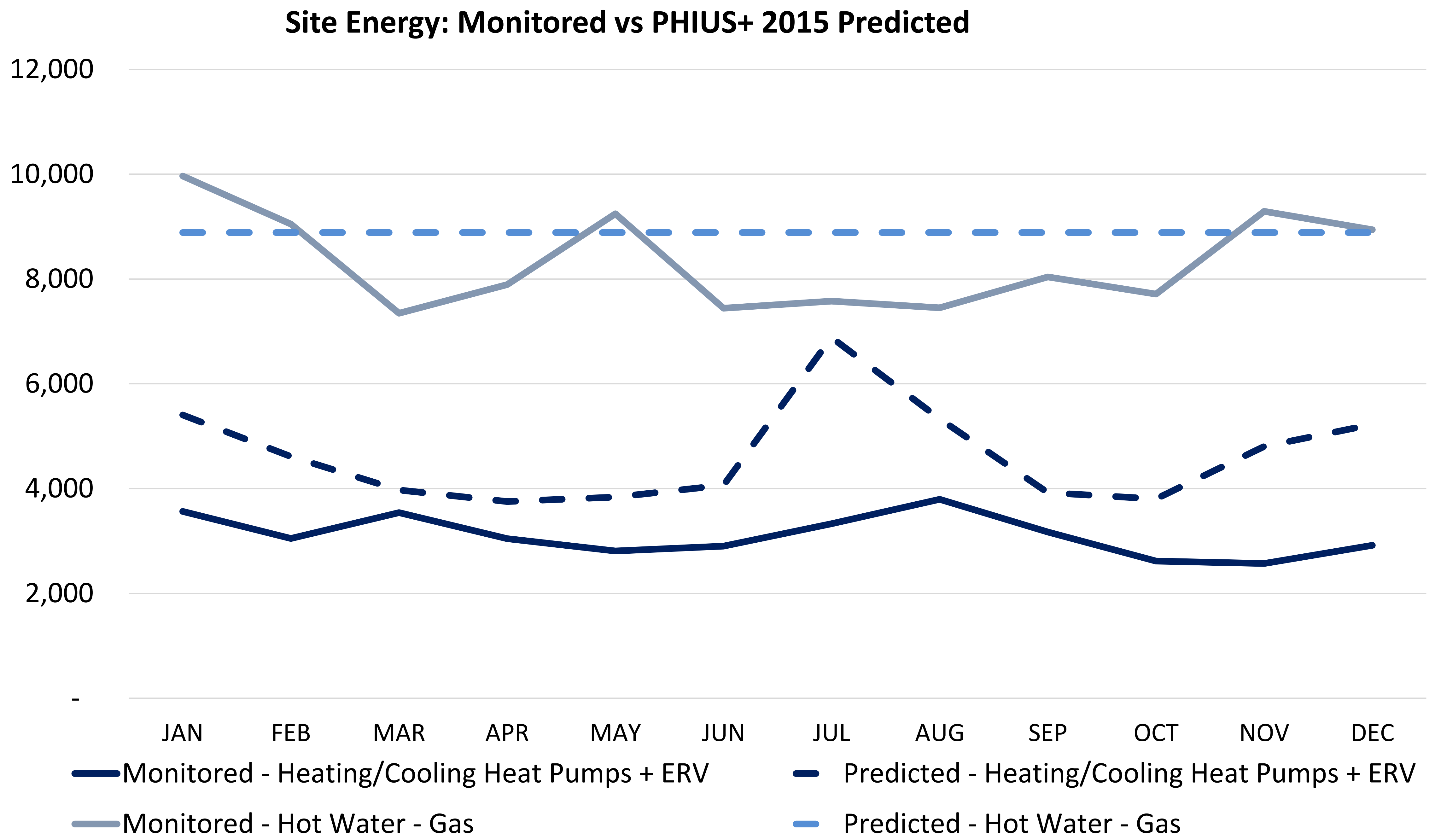
ORCHARDS AT ORENCO I



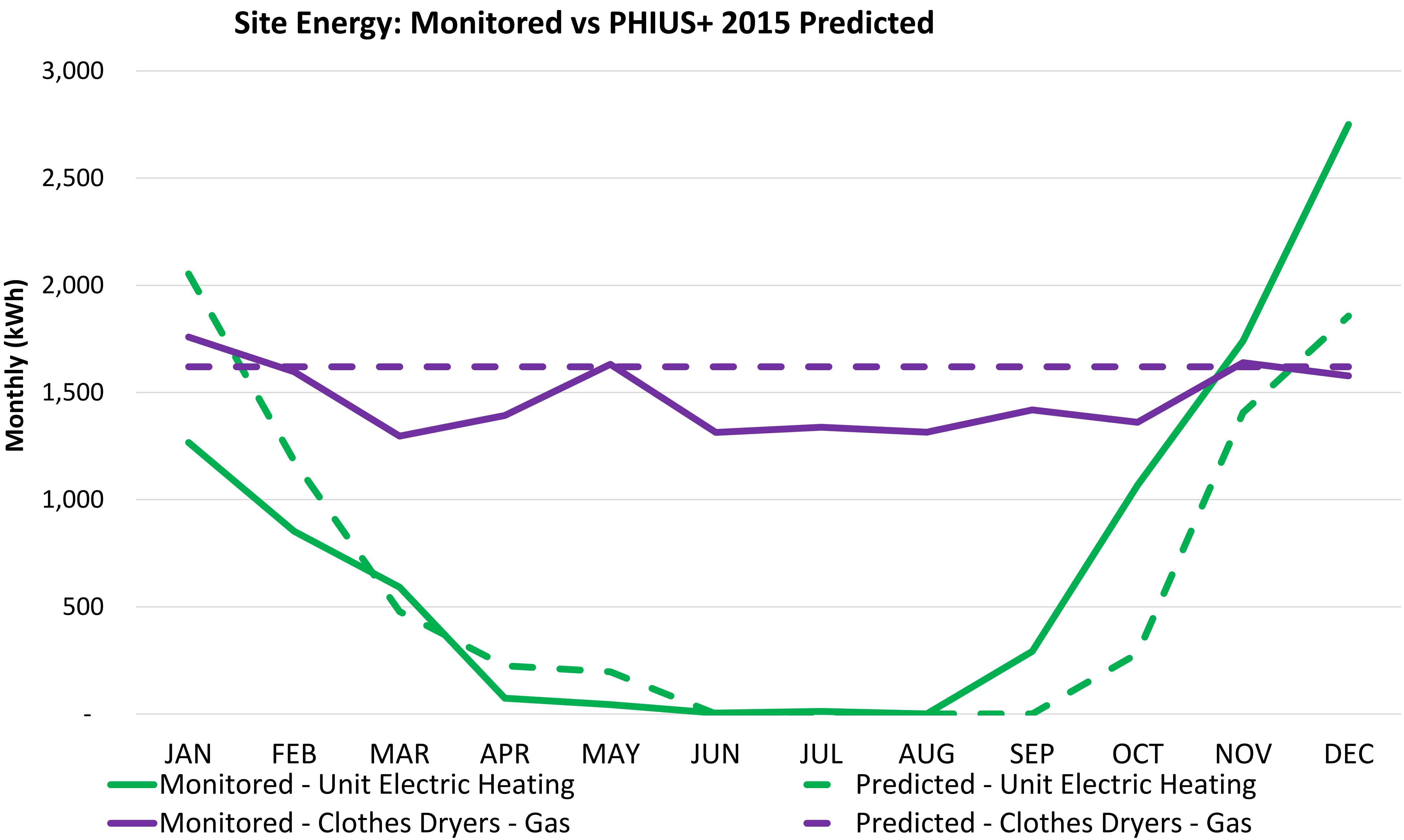
ORCHARDS AT ORENCO I



ORCHARDS AT ORENCO I



ORCHARDS AT ORENCO I



STELLAR APARTMENTS

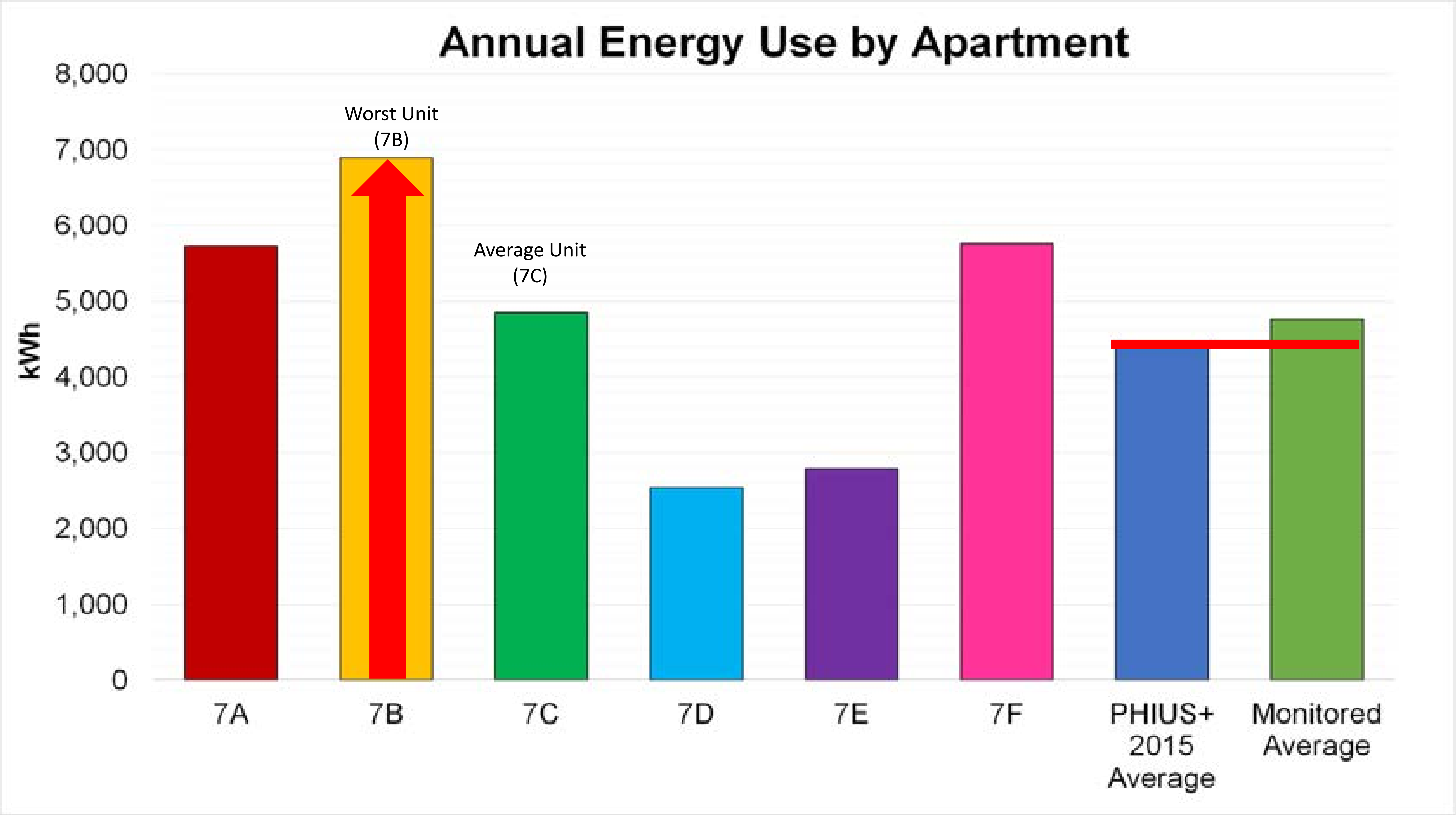
Eugene, OR

6 units

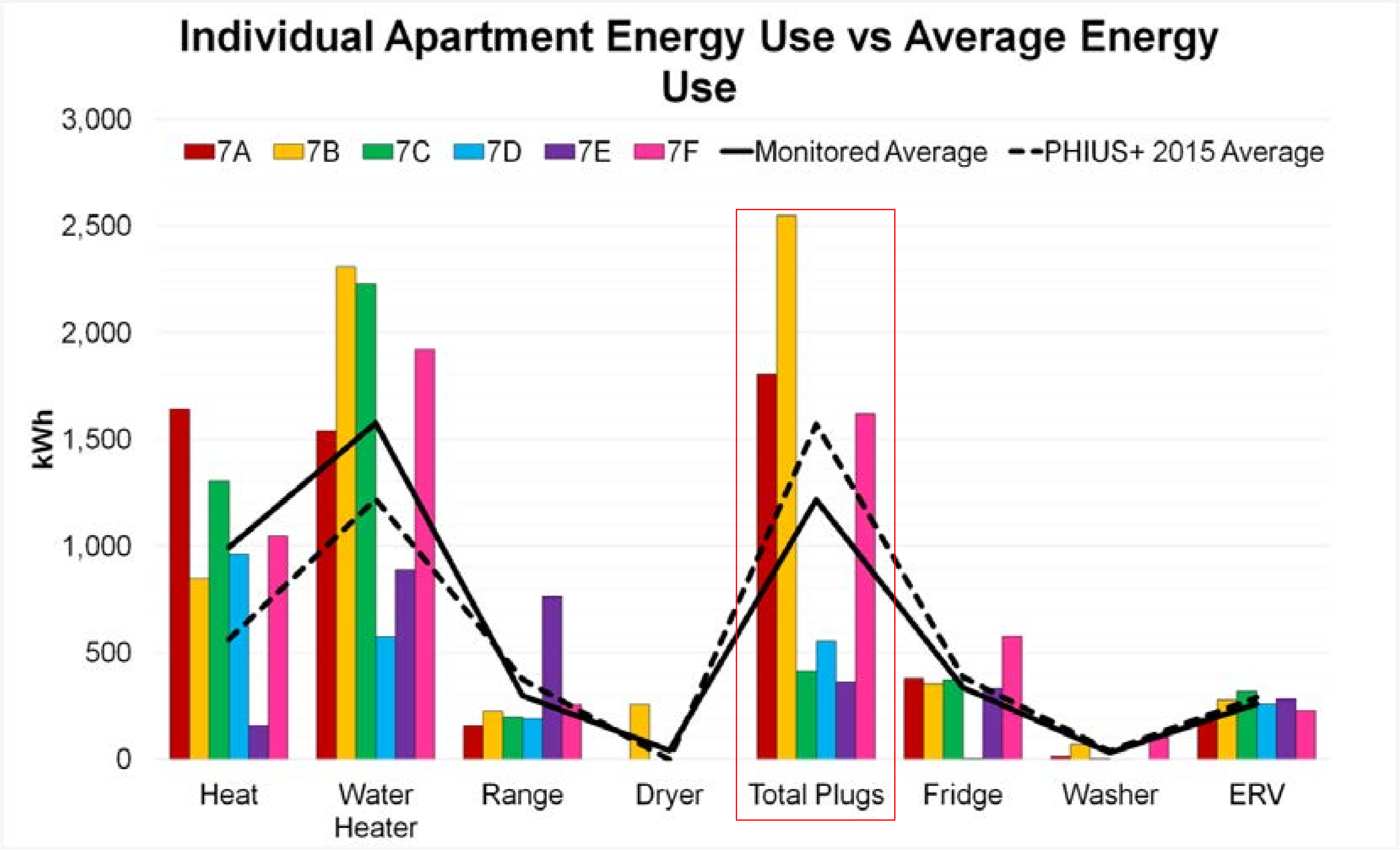
5,488 ft^2

- 8 Meters per unit
- No common spaces
- Electric Heating
- No Cooling
- Heat Pump Water Heaters in outdoor mech closet

STELLAR APARTMENTS



STELLAR APARTMENTS



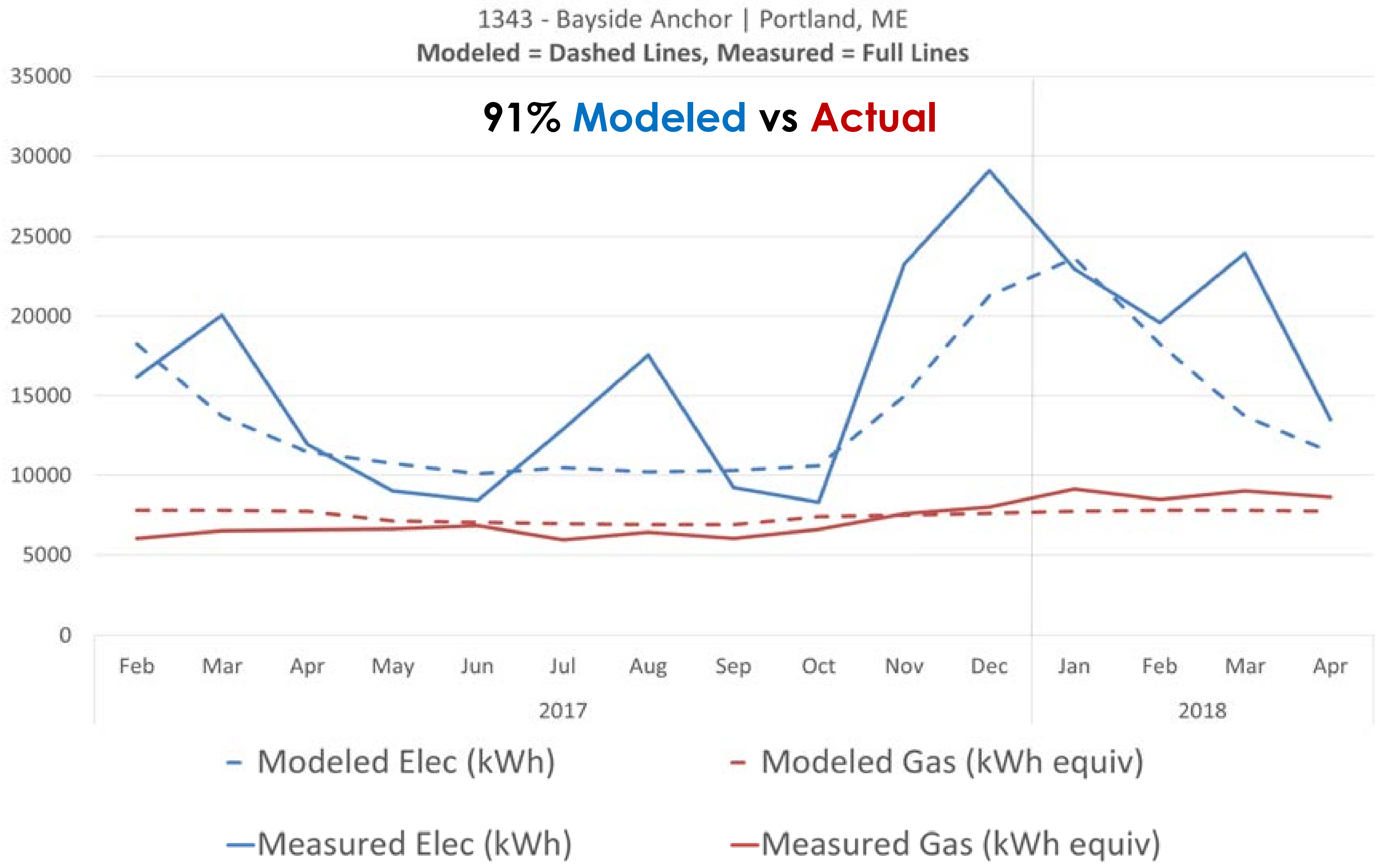
BAYSIDE ANCHOR

Portland, ME

45 Units
36,161 ft^2

Electric heating, no cooling
Gas Water Heating
Gas Exhaust Dryers
All other electric

BAYSIDE ANCHOR



Beach Green Dunes

Far Rockaway, NY

101 units

107,800 ft^2

Central VRF
In-Unit ERVs
Gas Water Heating
Central Laundry
CHP

BEACH GREEN DUNES

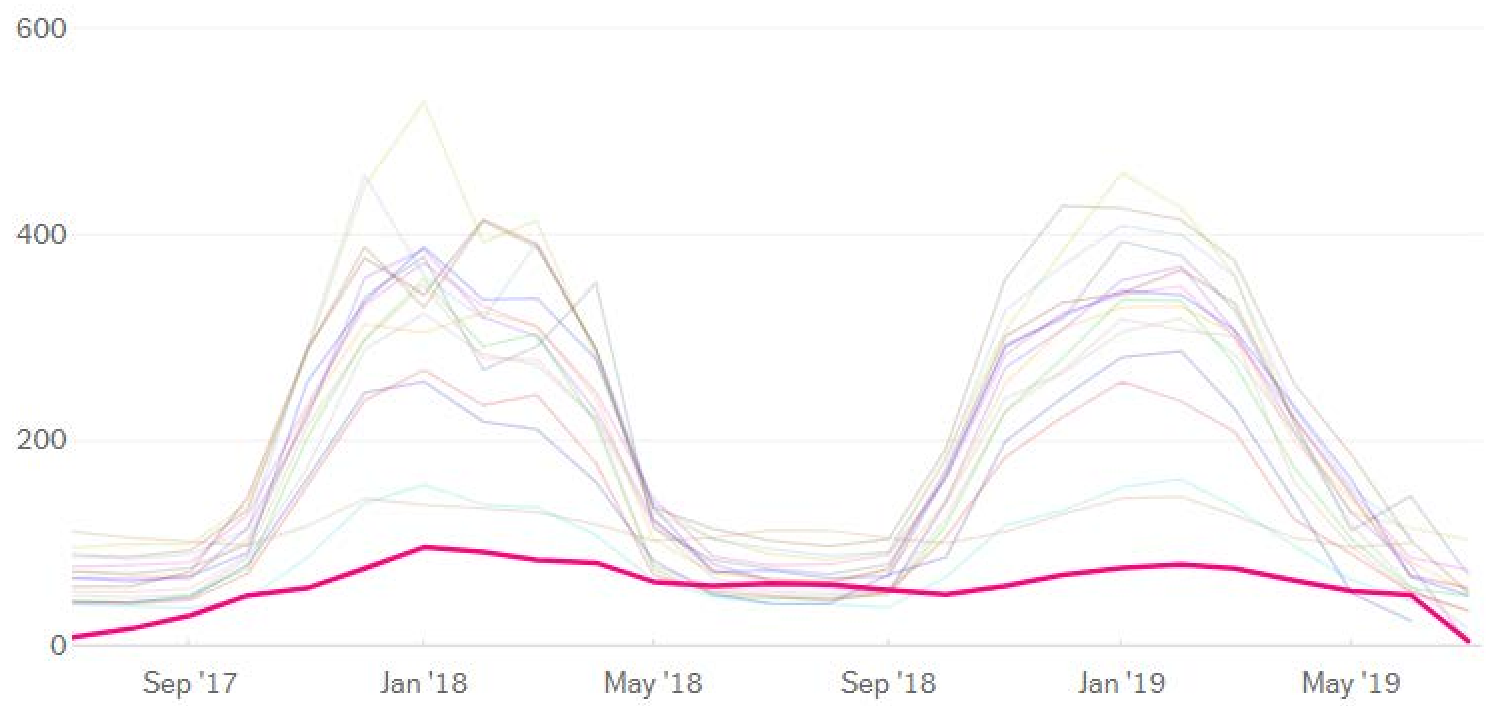
Total energy use in **Btu per square foot**

Name	Full-Year Sum
43-06 63rd St	91.8k*
Flushing Steam Buildin...	85.8k*
140-74 34th Avenue	84.8k*
138-49 Barclay Avenue	77.6k*
95-11 64th Rd	75k
28 Gilchrest Rd	74.2k*
141-28 84th Drive	73.7k*
Austin St	70.5k*
113th St	69.1k*
99-22 67th Rd	63k*
Kew Gardens	61.7k*
140-26 Franklin Avenue	60.5k*
9 Chelsea Place	50.9k*
193-04 Horace Harding	48.9k*
90-11 160th St	41.7k
65-54 Austin St	32.7k
BGN	22.6k*

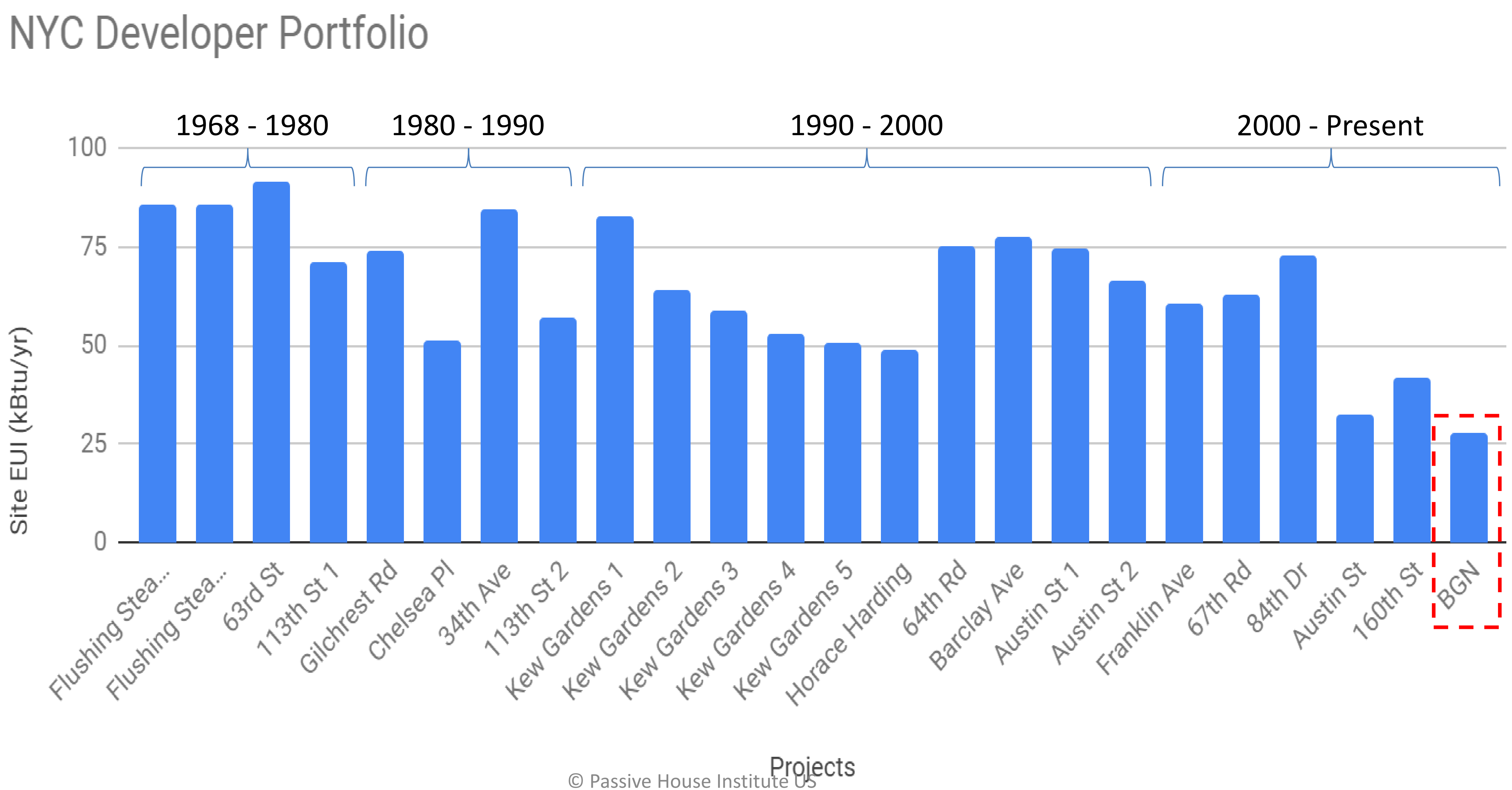
Detailed data per month

You are currently viewing the last 2 years of data only

Zoom out

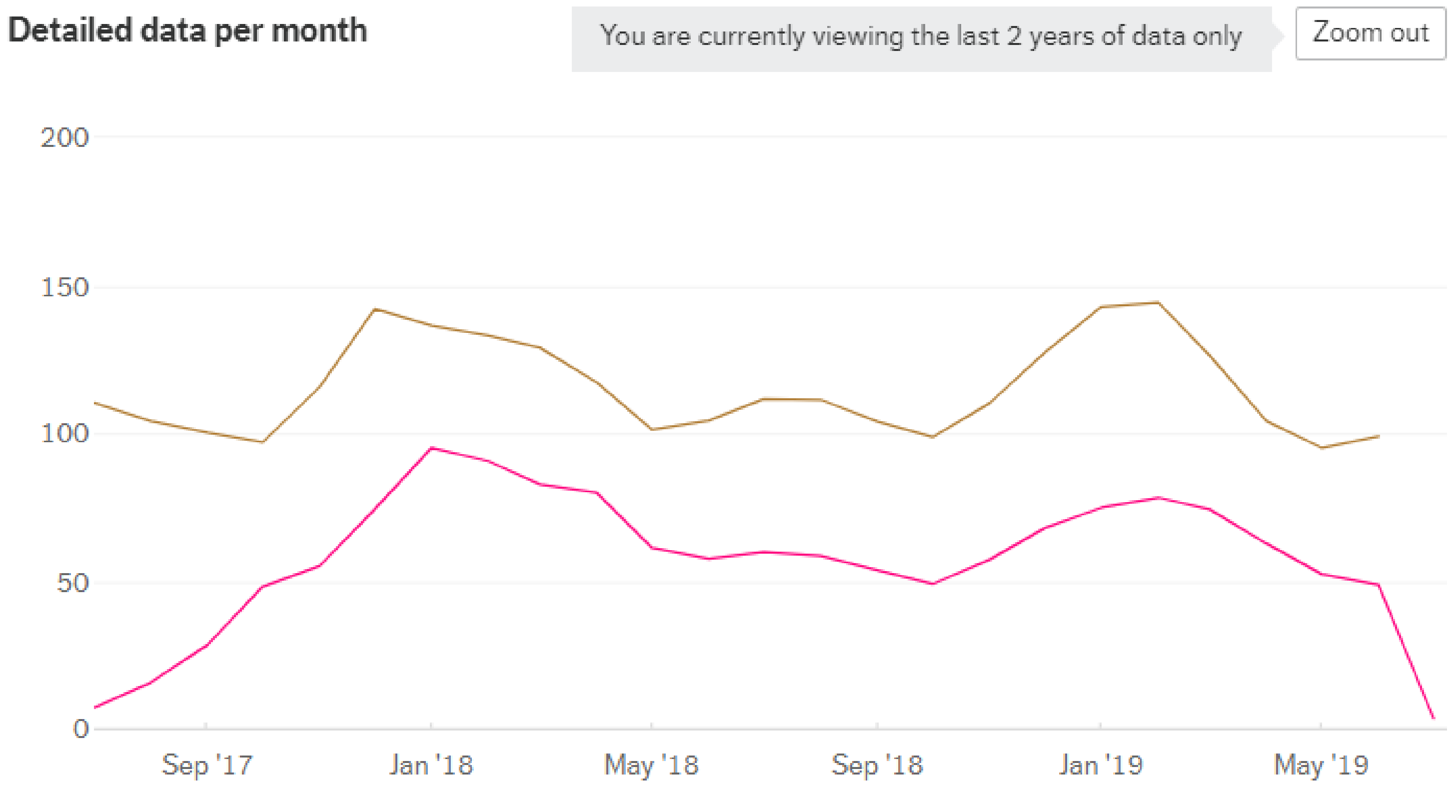


BEACH GREEN DUNES



BEACH GREEN DUNES

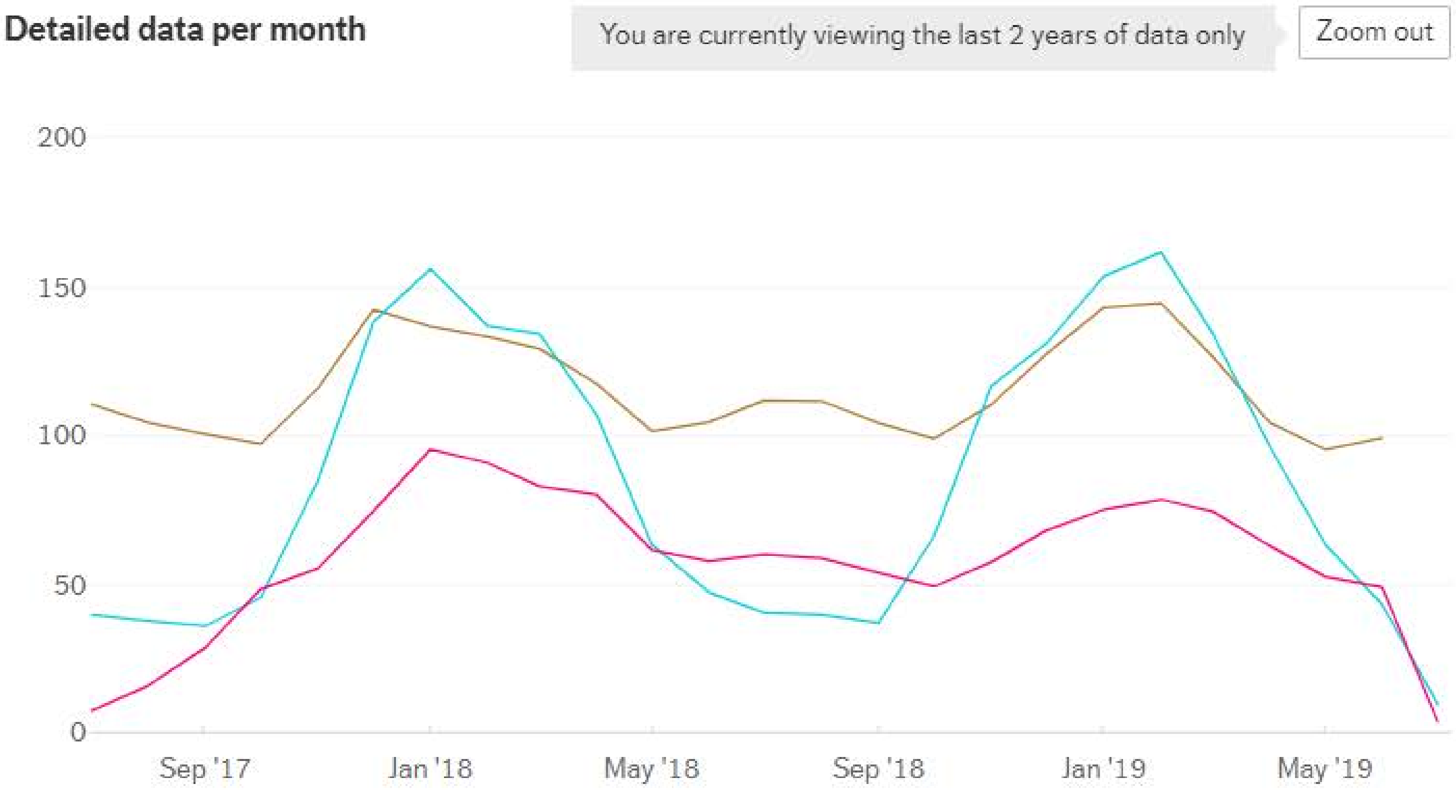
Name	Full-Year Sum	
140-74 34th Avenue	84.8k*	
138-49 Barclay Avenue	77.6k*	
95-11 64th Rd	75k	
28 Gilchrest Rd	74.2k*	
141-28 84th Drive	73.7k*	
Austin St	70.5k*	
113th St	69.1k*	
99-22 67th Rd	63k*	
Kew Gardens	61.7k*	
140-26 Franklin Avenue	60.5k*	
9 Chelsea Place	50.9k*	
193-04 Horace Harding	48.9k*	
90-11 160th St	41.7k	✓
65-54 Austin St	32.7k	
BGN	22.6k*	✓



Differences
Ventilation & Airtightness

BEACH GREEN DUNES

Name	Full-Year Sum	
140-74 34th Avenue	84.8k*	☐
138-49 Barclay Avenue	77.6k*	☐
95-11 64th Rd	75k	☐
28 Gilchrest Rd	74.2k*	☐
141-28 84th Drive	73.7k*	☐
Austin St	70.5k*	☐
113th St	69.1k*	☐
99-22 67th Rd	63k*	☐
Kew Gardens	61.7k*	☐
140-26 Franklin Avenue	60.5k*	☐
9 Chelsea Place	50.9k*	☐
193-04 Horace Harding	48.9k*	☐
90-11 160th St	41.7k	✓
65-54 Austin St	32.7k	✓
BGN	22.6k*	✓



WEGOWISE

BUILDING ELECTRIC BILLS

YANMAR

LG VRF SYSTEM

TENANT ELECTRIC BILLS

PHOTOVOLTAICS

WEGOWISE

BUIL ING

ELEC RIC BILLS

YANMAR

V

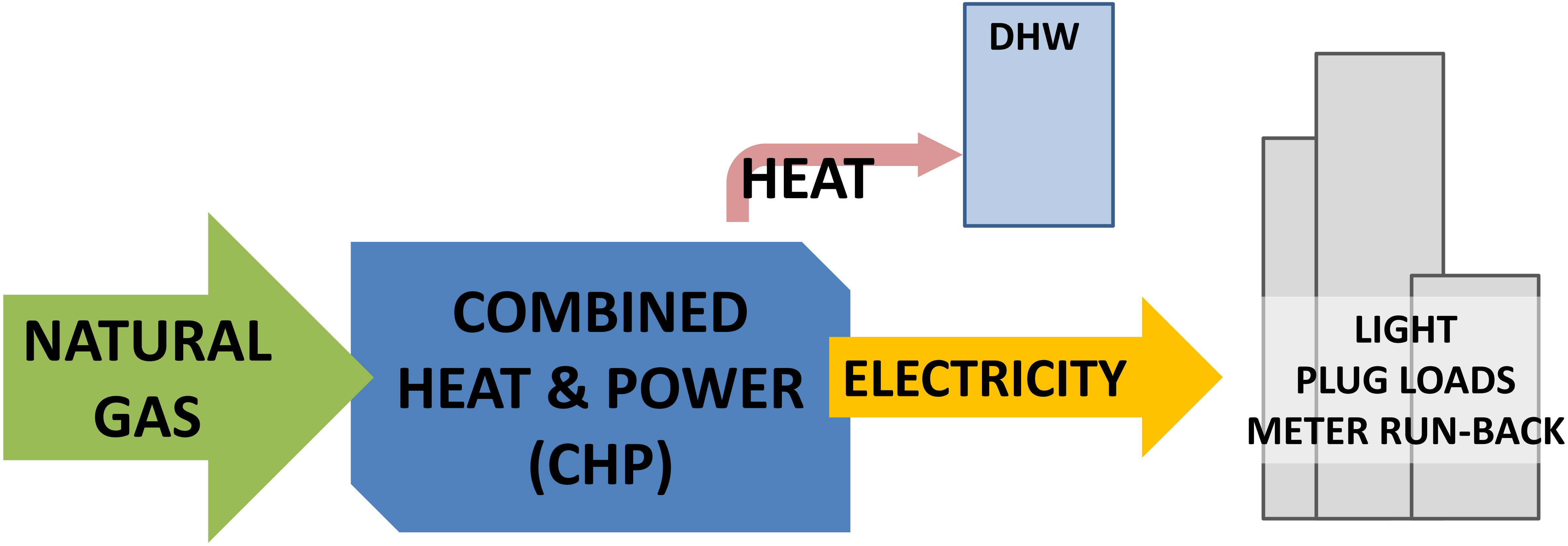
E N E

S

M

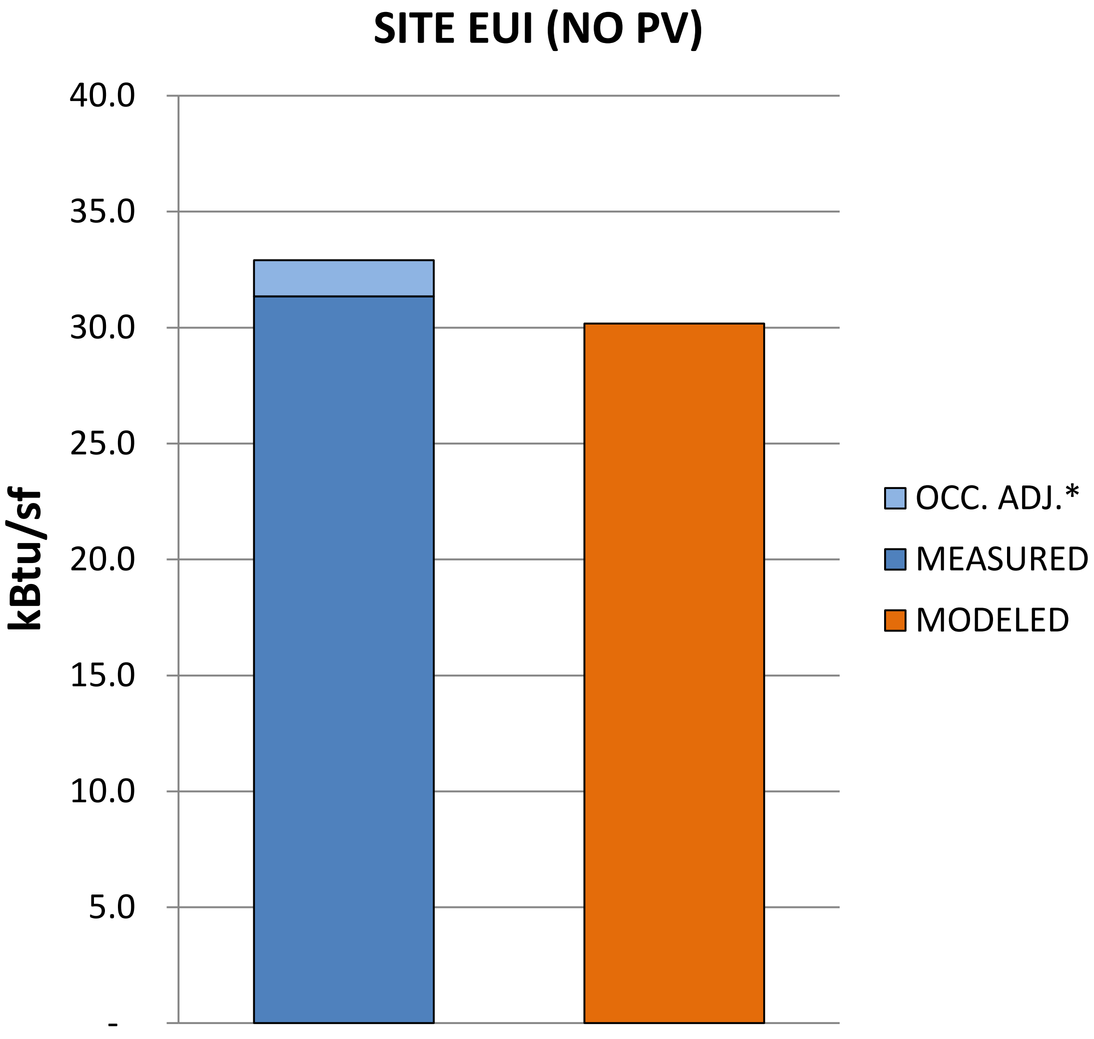
PHOTOVOLTAICS

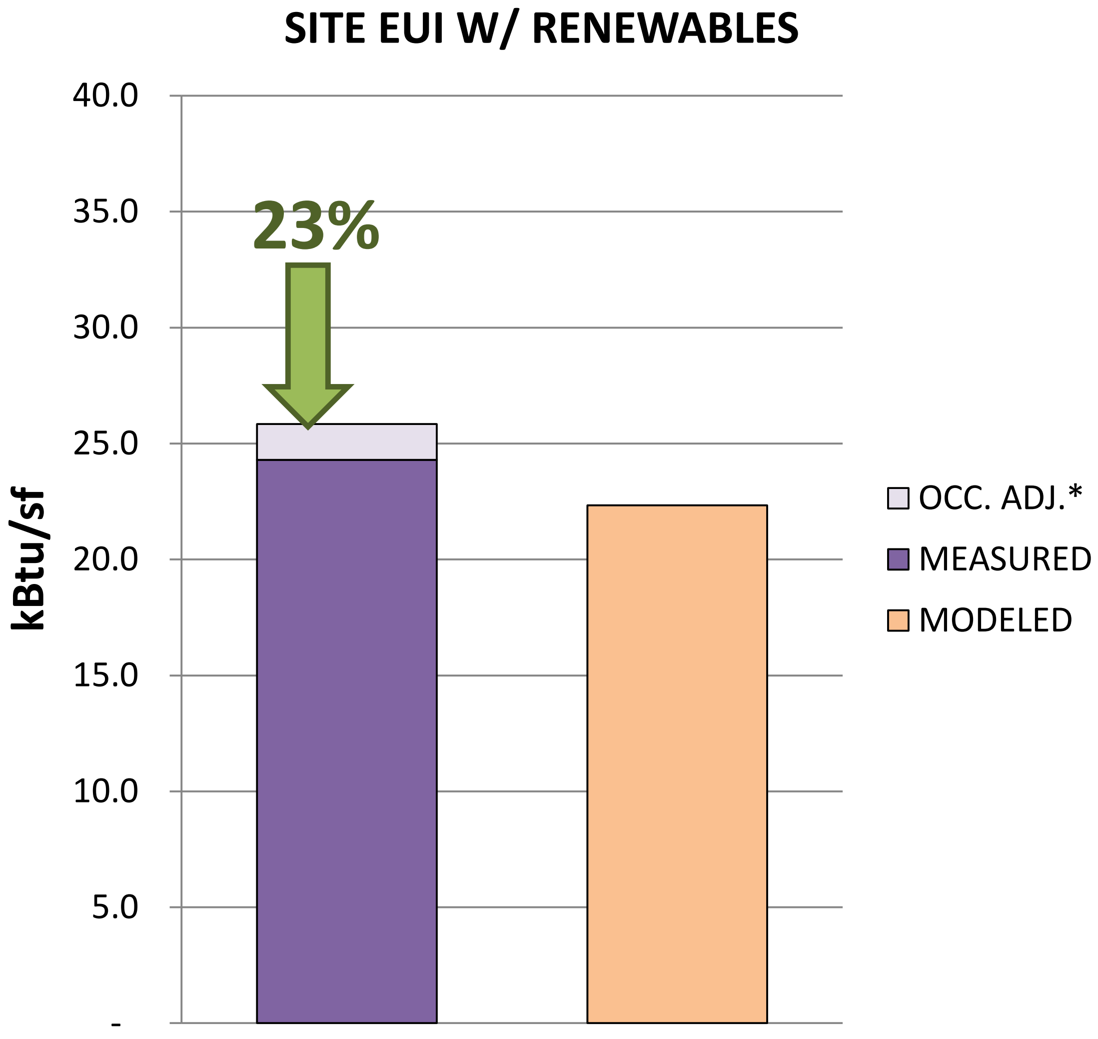
BEACH GREEN DUNES



BEACH GREEN DUNES

89% Modeled vs Actual





SINGLE FAMILY CASE STUDIES







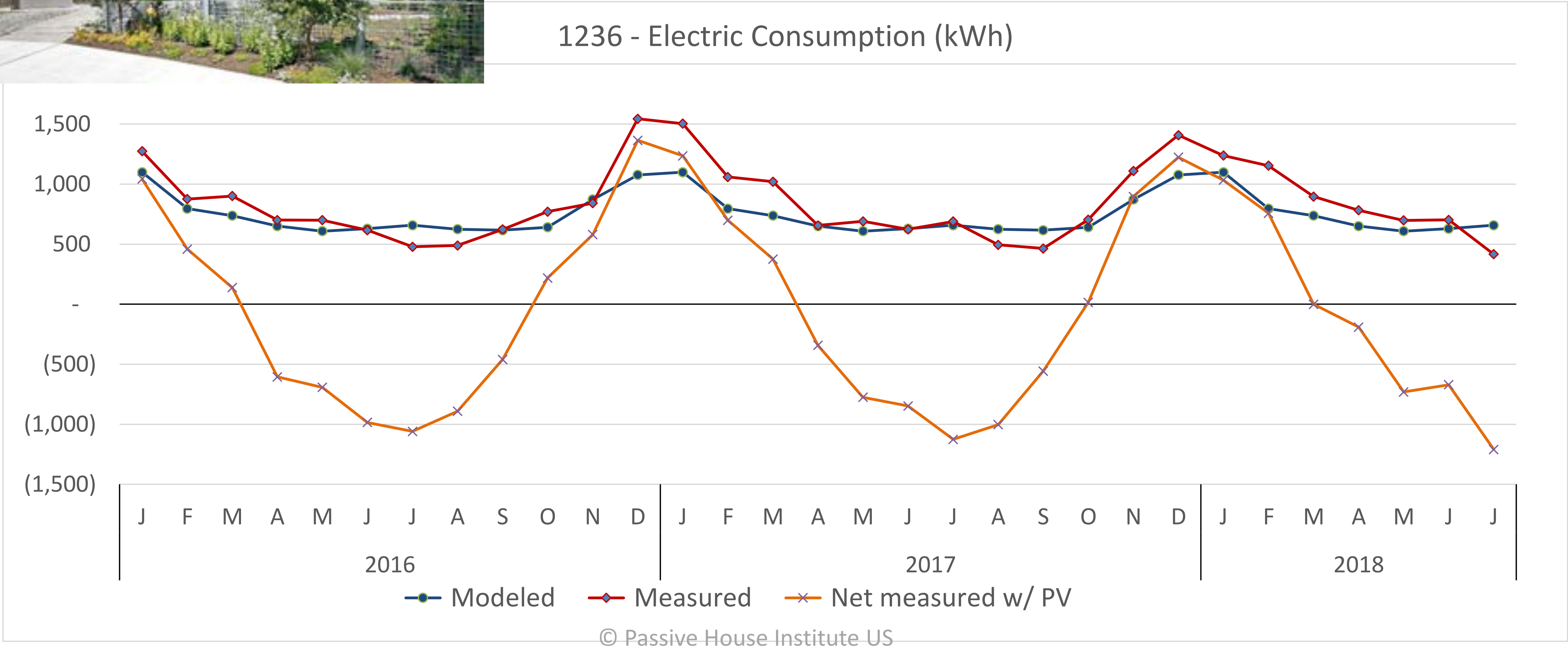




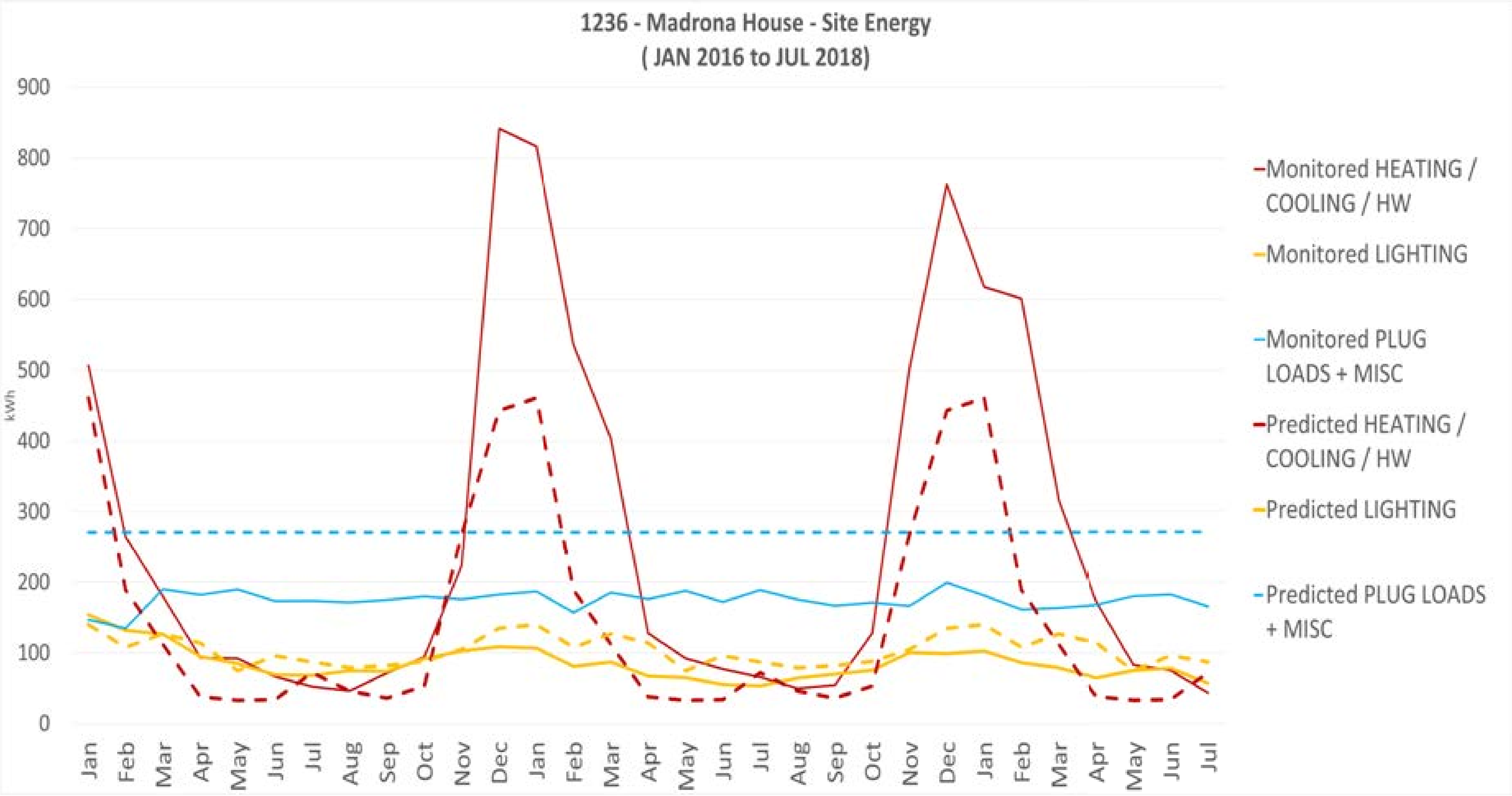
MADRONA

89% Modeled vs Actual

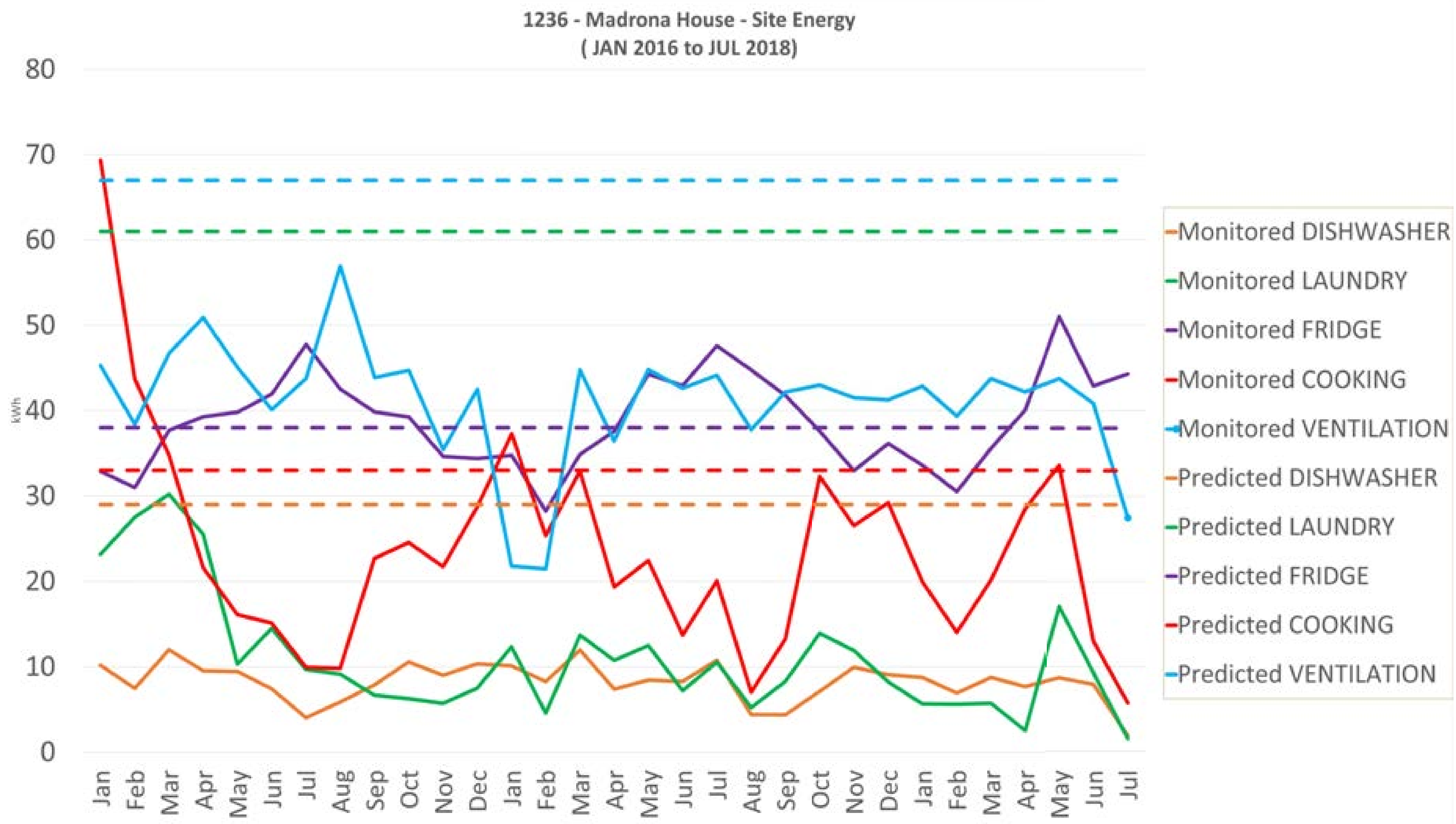
Type: Single family
Occupants: 4
Location: Seattle, WA
CPHC: Dan Whitmore



MADRONA


1236 - Madrona House - Site Energy
(JAN 2016 to JUL 2018)
900
800
700
600
500
400
300
200
100
0
kWh
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Monitored HEATING / COOLING / HW
Monitored LIGHTING
Monitored PLUG LOADS + MISC
Predicted HEATING / COOLING / HW
Predicted LIGHTING
Predicted PLUG LOADS + MISC

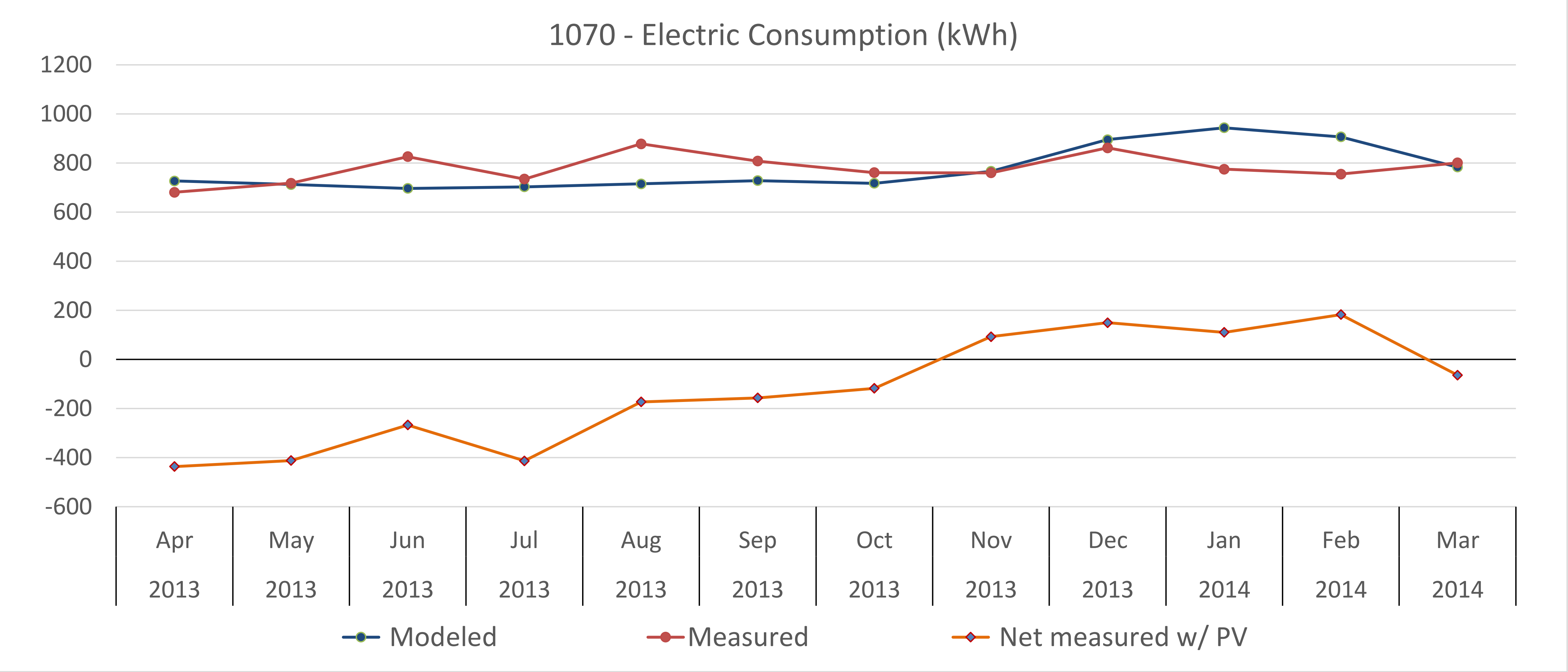
MADRONA


1236 - Madrona House - Site Energy
(JAN 2016 to JUL 2018)
80
70
60
50
40
30
20
10
0
kWh
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Monitored DISHWASHER
Monitored LAUNDRY
Monitored FRIDGE
Monitored COOKING
Monitored VENTILATION
Predicted DISHWASHER
Predicted LAUNDRY
Predicted FRIDGE
Predicted COOKING
Predicted VENTILATION

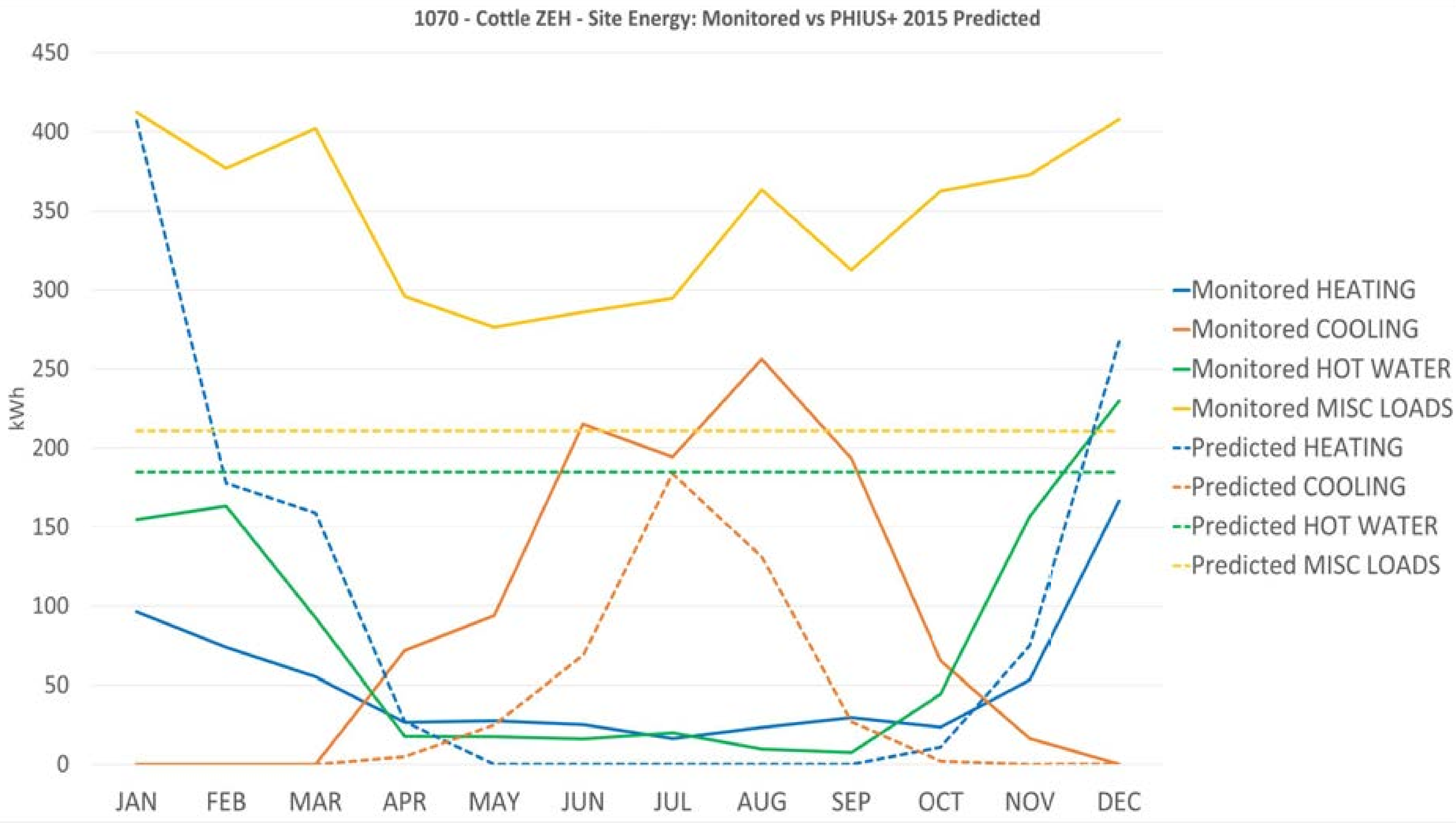
COTTLE ZEH

99% Modeled vs Actual

Type: Single family
Occupants: 3
Location: San Jose, CA
CPHC: Allen Gilliland

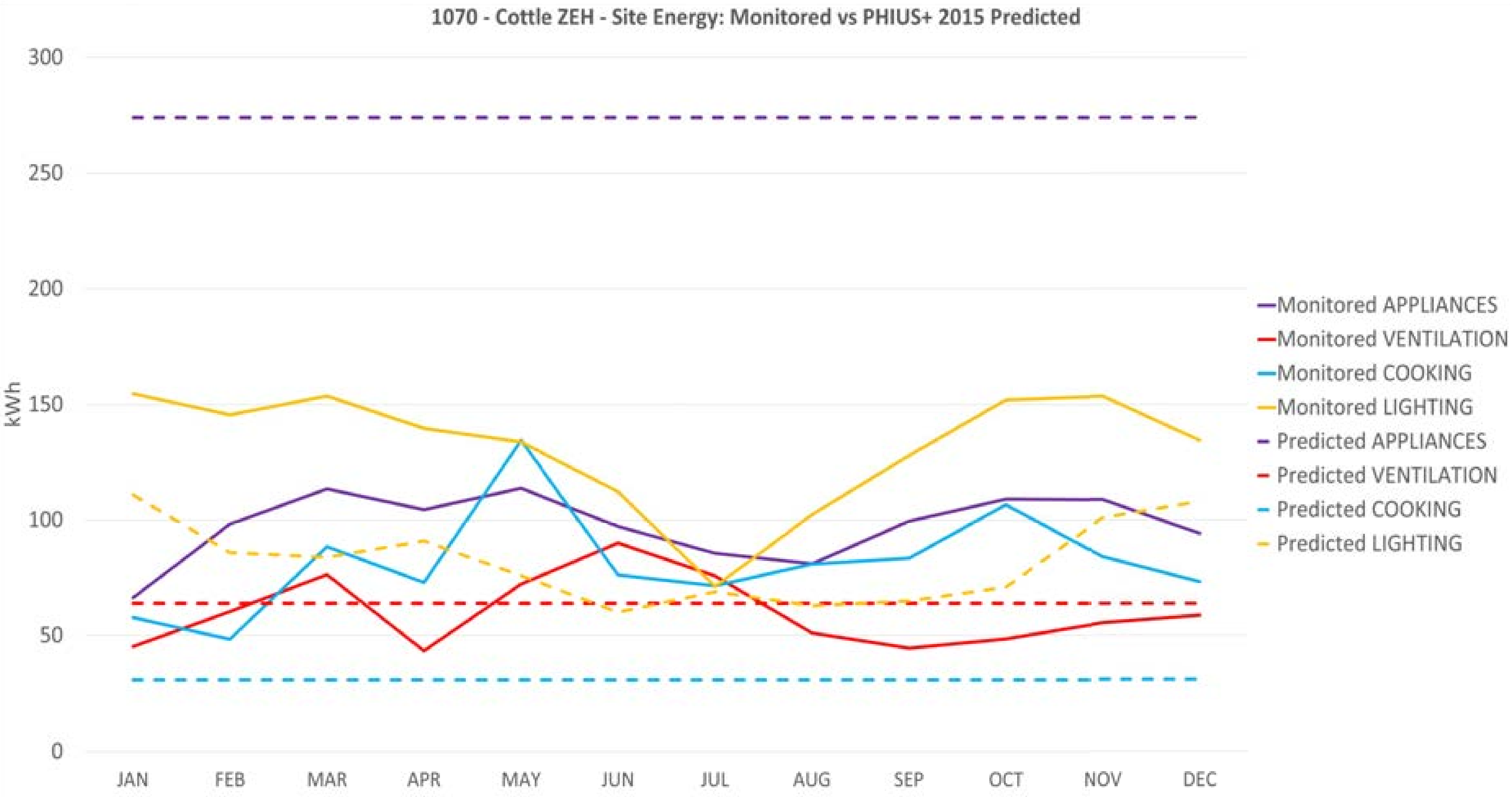


COTTLE ZEH



1070 - Cottle ZEH - Site Energy: Monitored vs PHIUS+ 2015 Predicted
450
400
350
300
250
200
150
100
50
0
kWh
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Monitored HEATING
Monitored COOLING
Monitored HOT WATER
Monitored MISC LOADS
Predicted HEATING
Predicted COOLING
Predicted HOT WATER
Predicted MISC LOADS

COTTLE ZEH

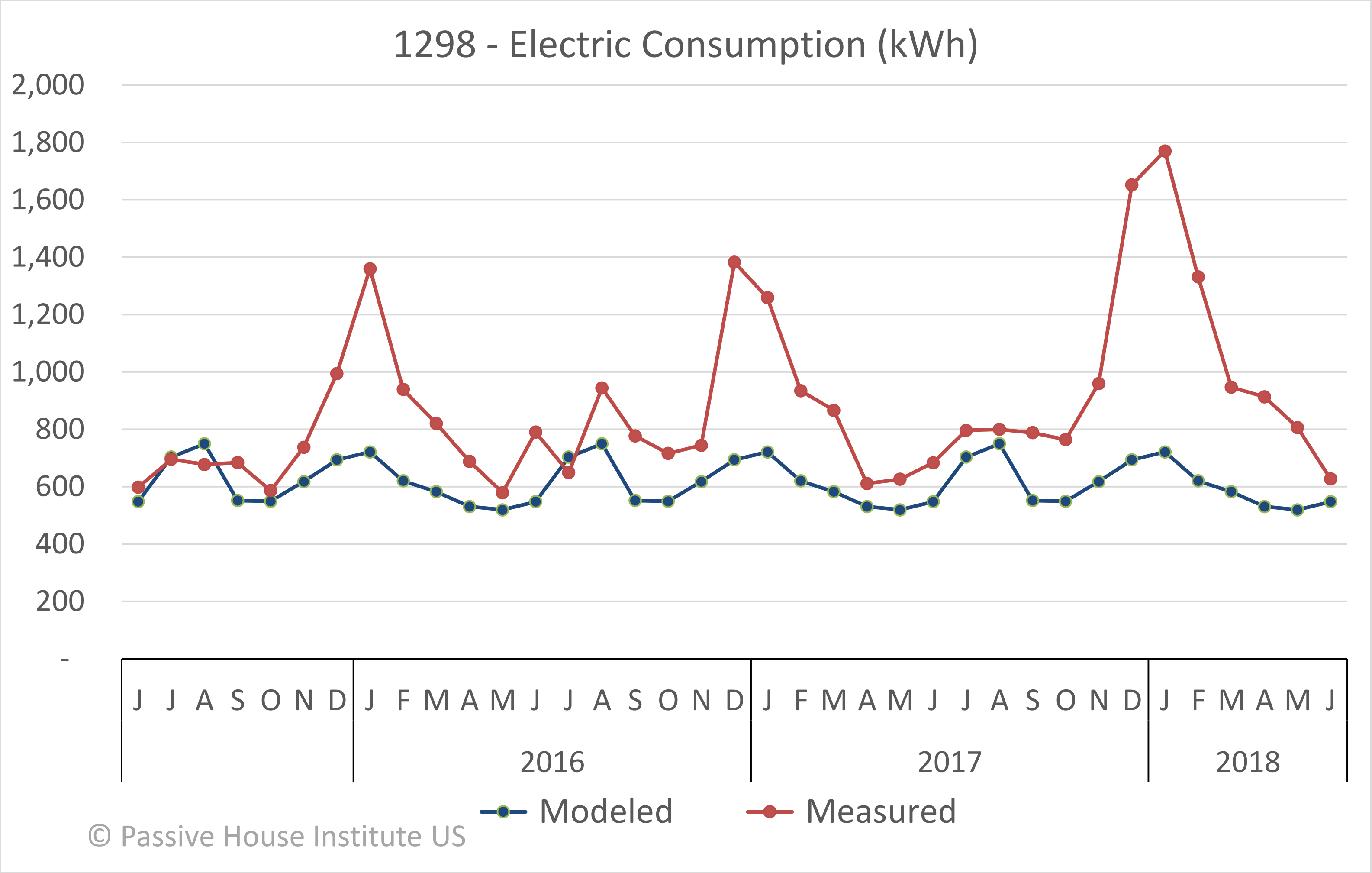


1070 - Cottle ZEH - Site Energy: Monitored vs PHIUS+ 2015 Predicted
kWh
300
250
200
150
100
50
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Monitored APPLIANCES
Monitored VENTILATION
Monitored COOKING
Monitored LIGHTING
Predicted APPLIANCES
Predicted VENTILATION
Predicted COOKING
Predicted LIGHTING

GEORGE RESIDENCE

70% Modeled vs Actual

Type: Single family
Occupants: 4
Location: Oak Park, IL
CPHC: Tom Bassett-Dilley

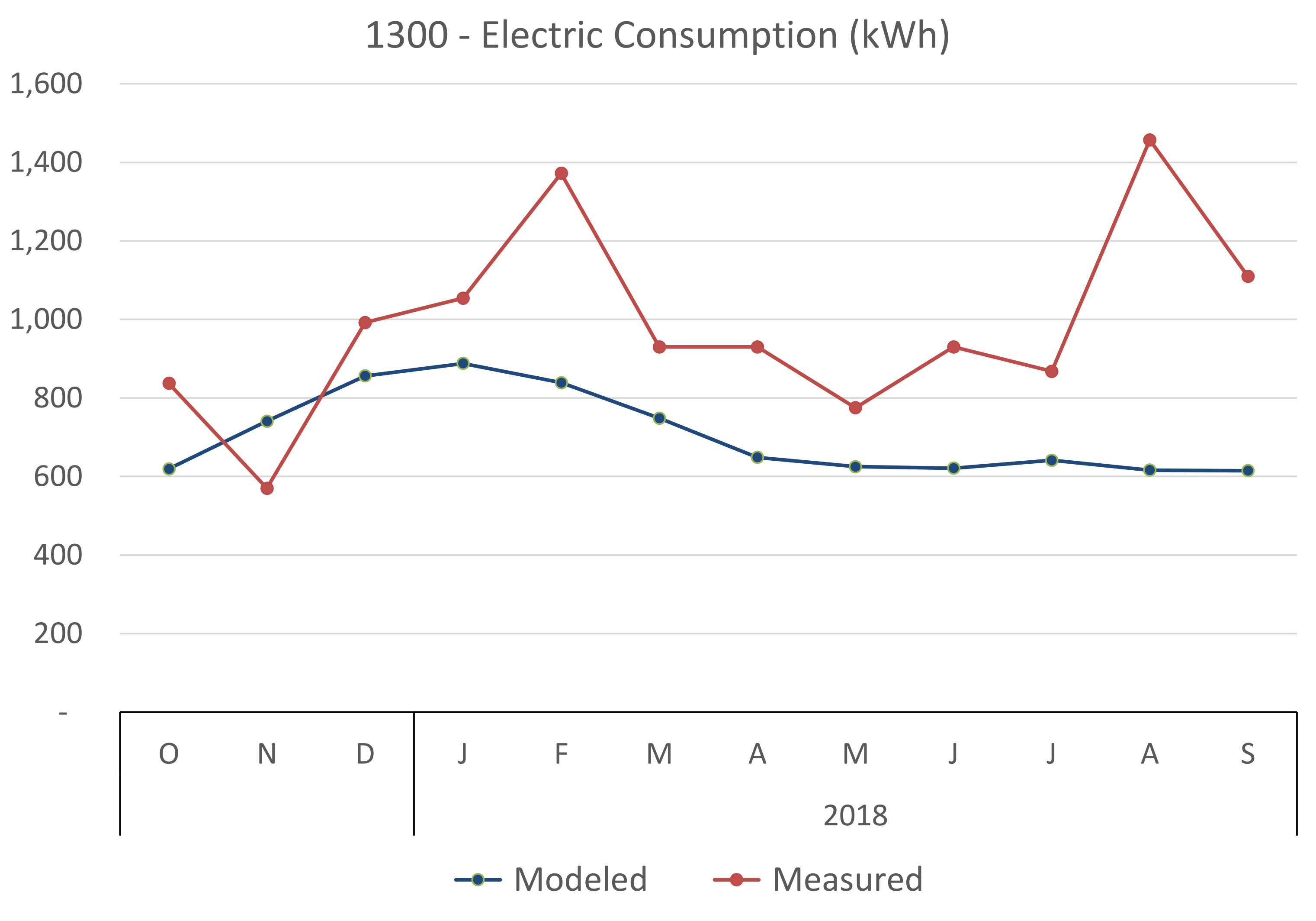


HPWH
Under-sized heat pump

BERKS / SOEDER

72% Modeled vs Actual

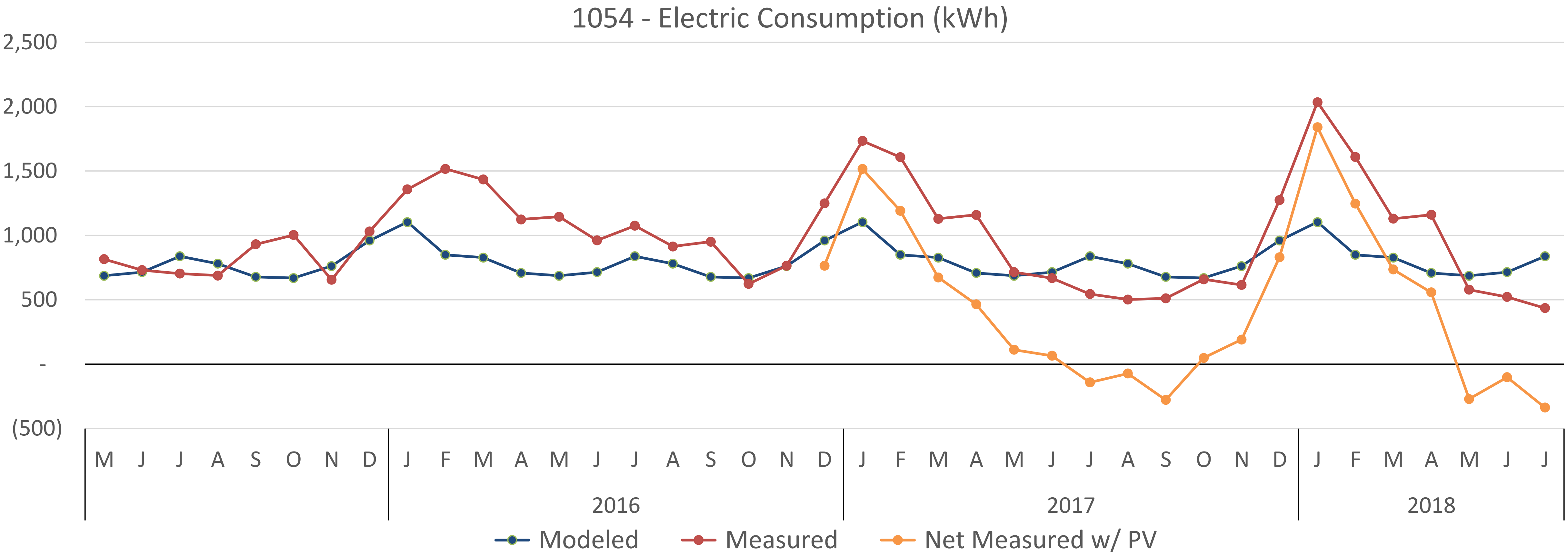
Type: Single family
Occupants: 6
Location: Scranton, PA
CPHC: Richard Pedranti



MOSKOWITZ PASSIVE HOUSE

Type: Single family
Occupants: 3
Location: Teaneck, NJ
CPHC: Christine Liaukus
Malka Van Bemmelen

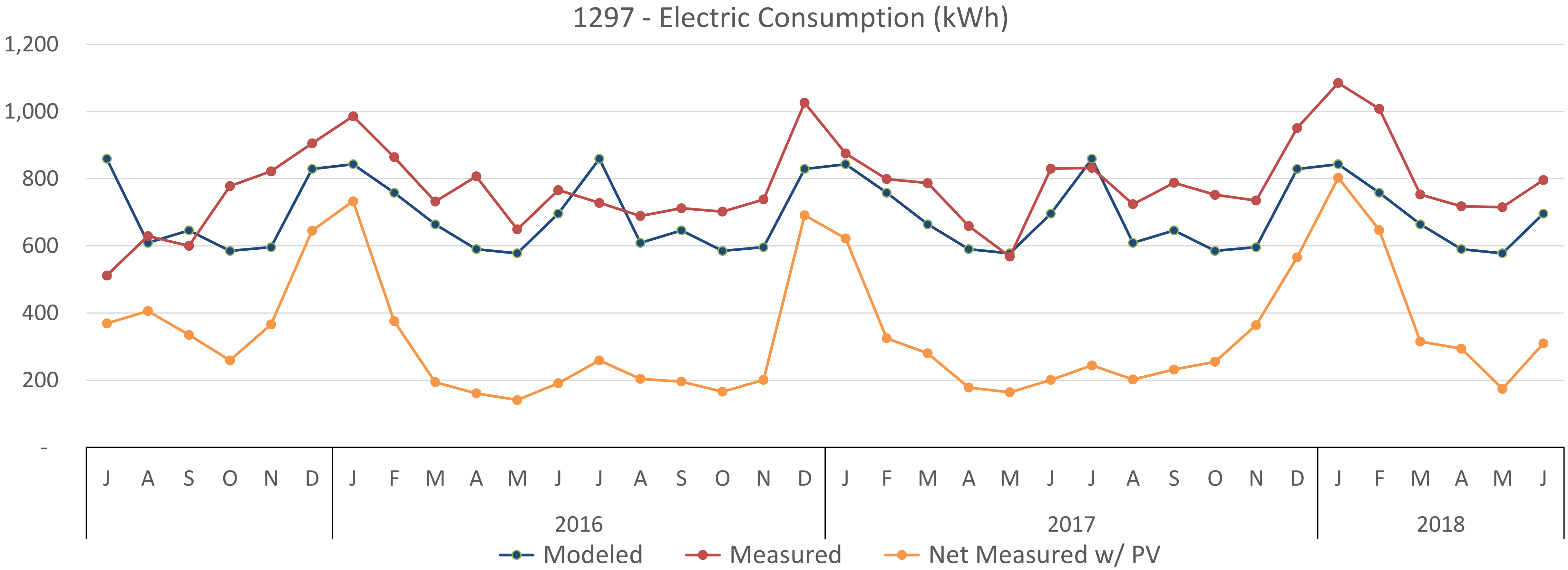
79% Modeled vs Actual



EAST LAWRENCE PH

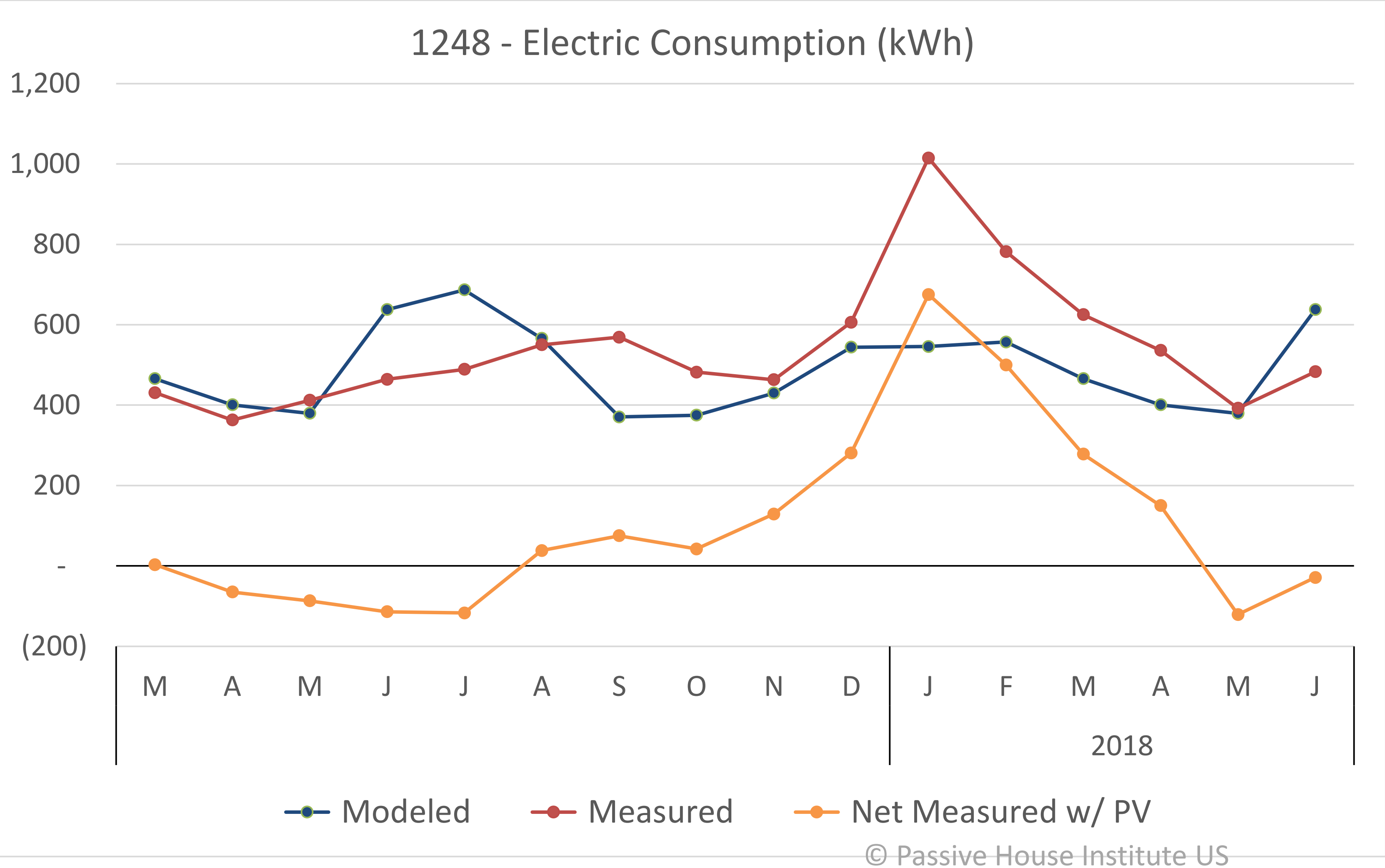
88% Modeled vs Actual

Type: Single family
Occupants: 3
Location: Lawrence, KS
CPHC: Ryan Abendroth



LOUGHRAN RESIDENCE

93% Modeled vs Actual

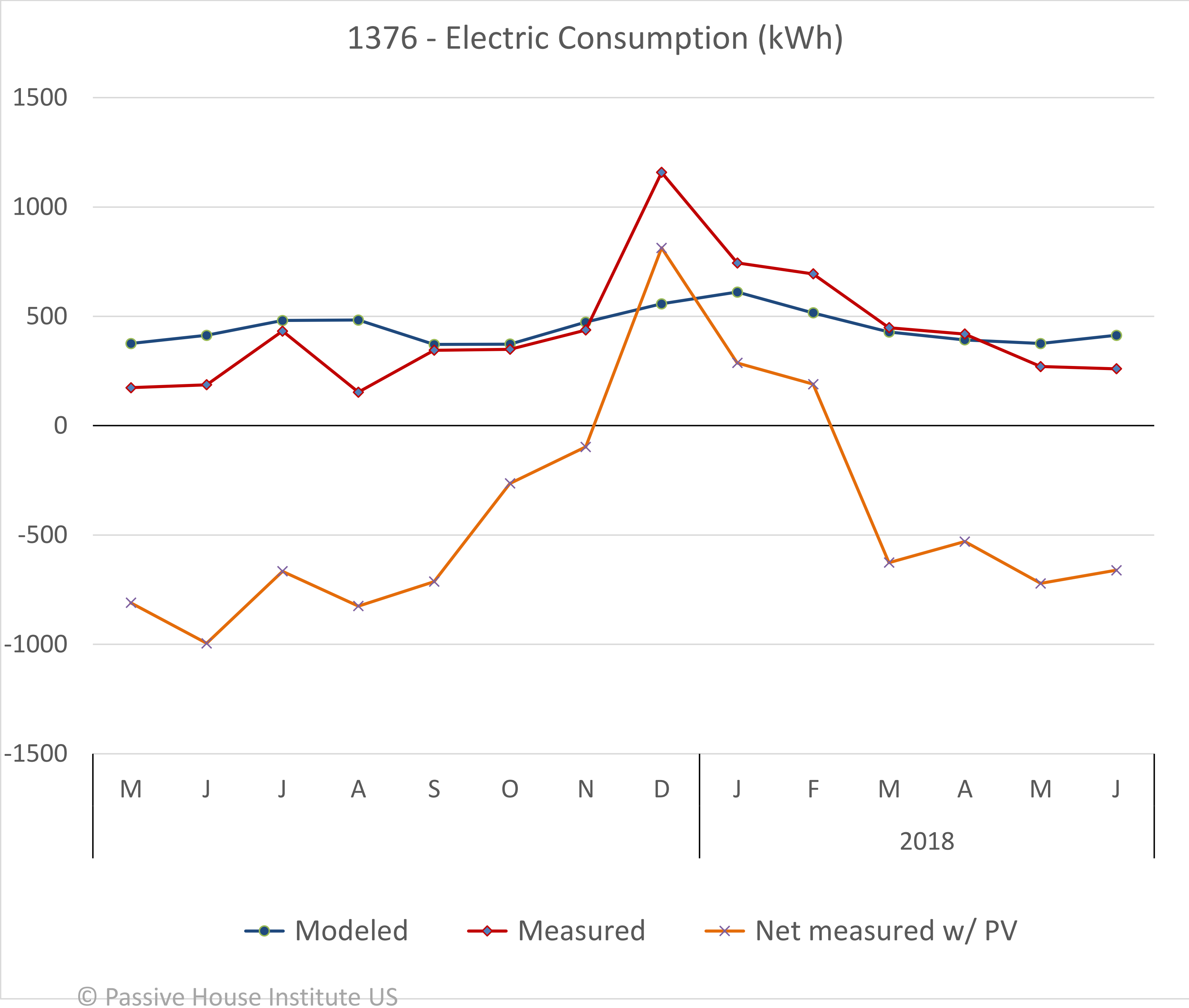


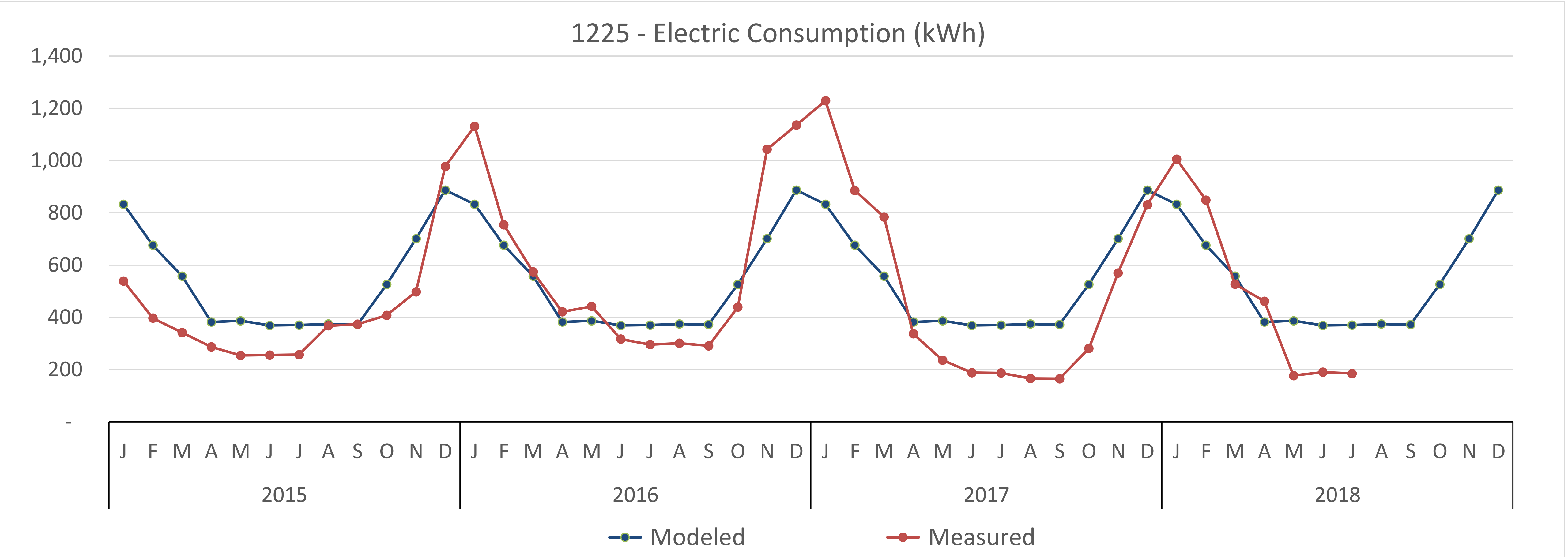
Type: Single family
Occupants: 4
Location: Illinois
CPHC: Ryan Abendroth

THE ROCKPILE

103% Modeled vs Actual

Type: Single family
Occupants: 2
Location: Dubuque, IA
CPHC: Shane Hoeper





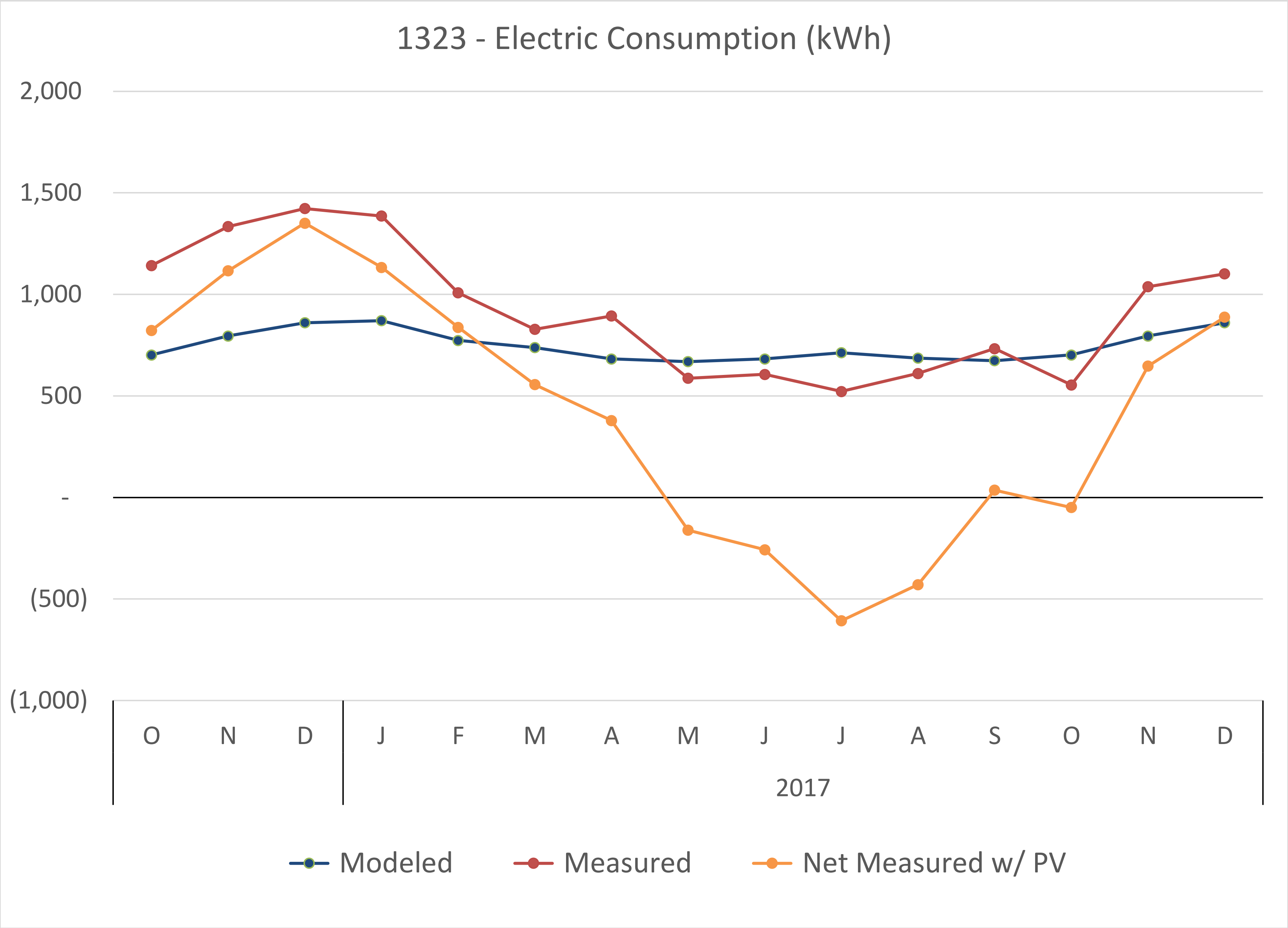
OWL HAVEN

107% Modeled vs Actual

Type: Single family
Occupants: 3
Location: Langley, WA
CPHC: Robert Moore

CHRISTIANSON

108% Modeled vs Actual

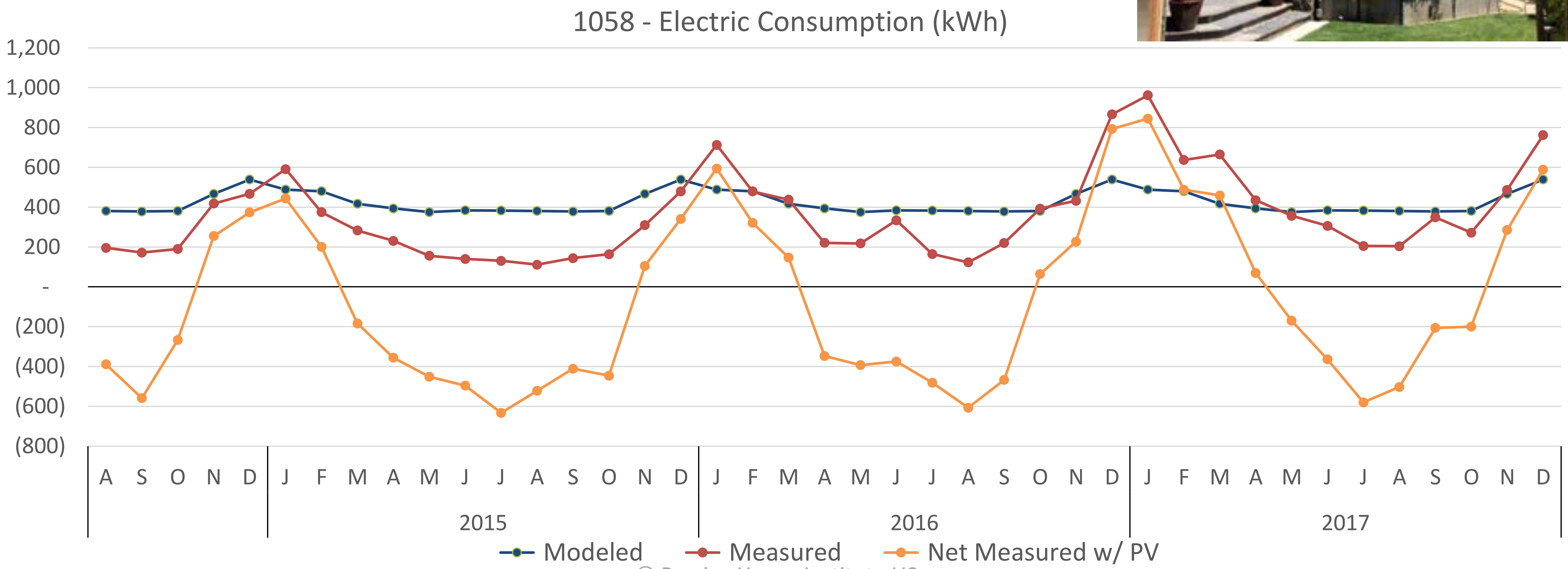


Type: Single family
Occupants: 5
Location: Corvallis, OR
CPHC: Jan Fillinger,
Win Swafford

Type: Single family
Occupants: 3
Location: Eugene, OR
CPHC: Win Swafford
Jan Fillinger

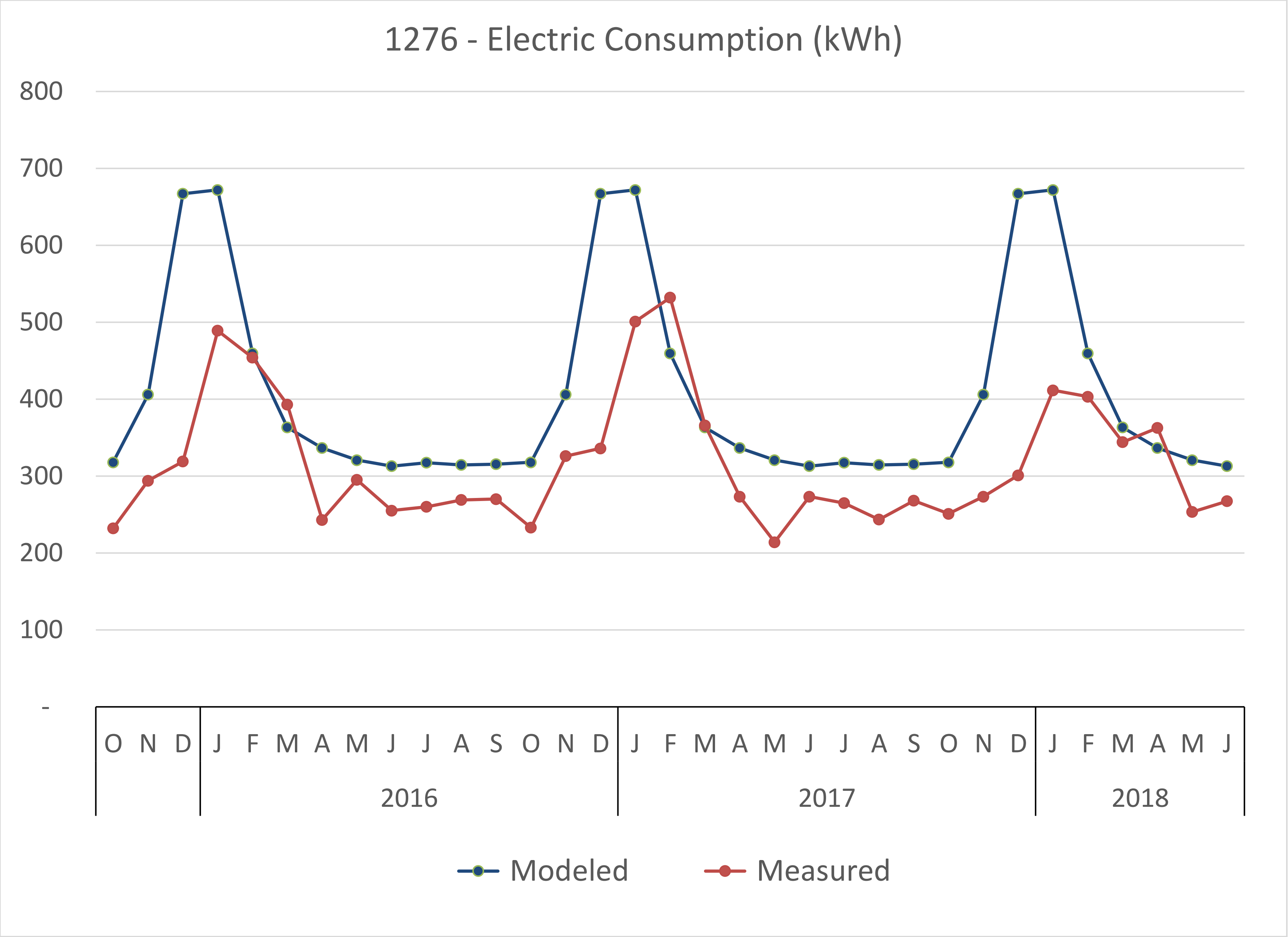
ORCHARD ST

116% Modeled vs Actual



ANCHOR BAY

128% Modeled vs Actual

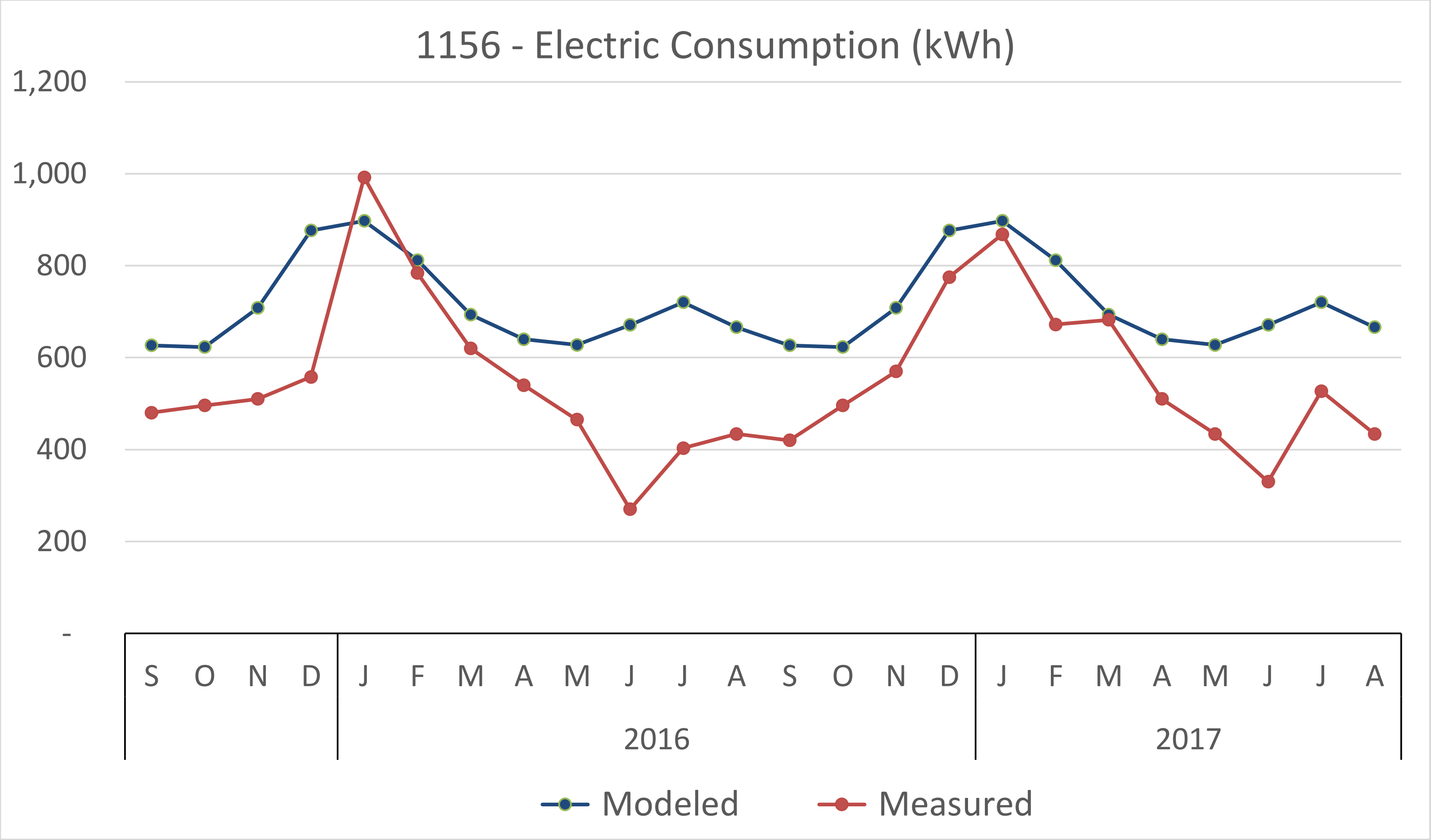


Type: Single family
Occupants: 4
Location: Gualala, CA
CPHC: Graham Irwin

KARPIAK MULHALL

130% Modeled vs Actual

Type: Single family
Occupants: 4
Location: Scranton, PA
CPHC: Richard Pedranti



93% Modeled vs Actual