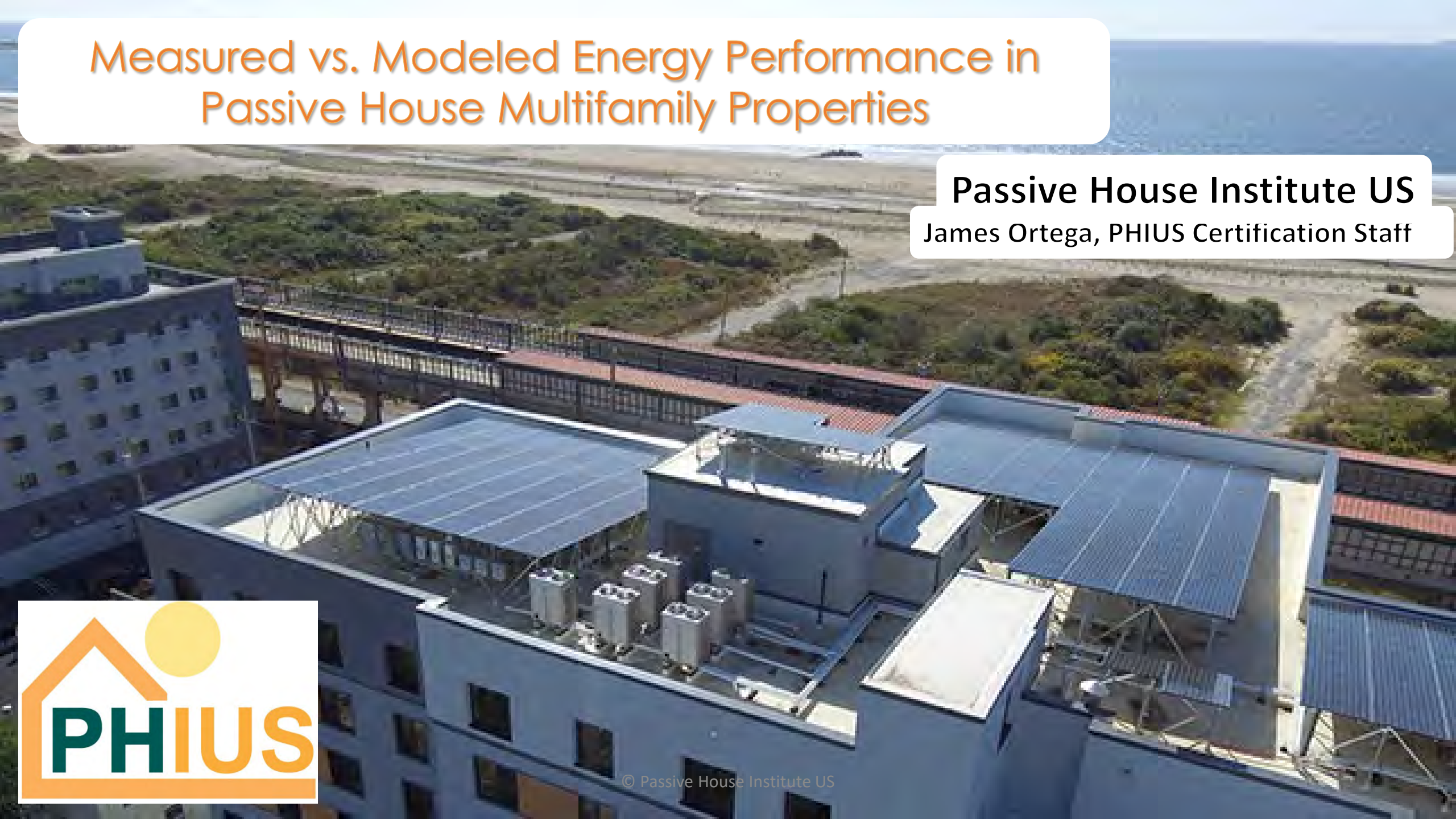
Measured vs. Modeled Energy Performance in Passive House Multifamily Properties



Passive House Institute US

James Ortega, PHIUS Certification Staff

AGENDA

1. Background
    1. Motivation for monitoring
    2. Potential Factors
2. Four Multifamily Projects - Monitored Data Analysis:
    1. Building Rundown
    2. Data Rundown
    3. Monitored vs Modeled
3. Lessons Learned

IMPORTANCE OF MONITORING

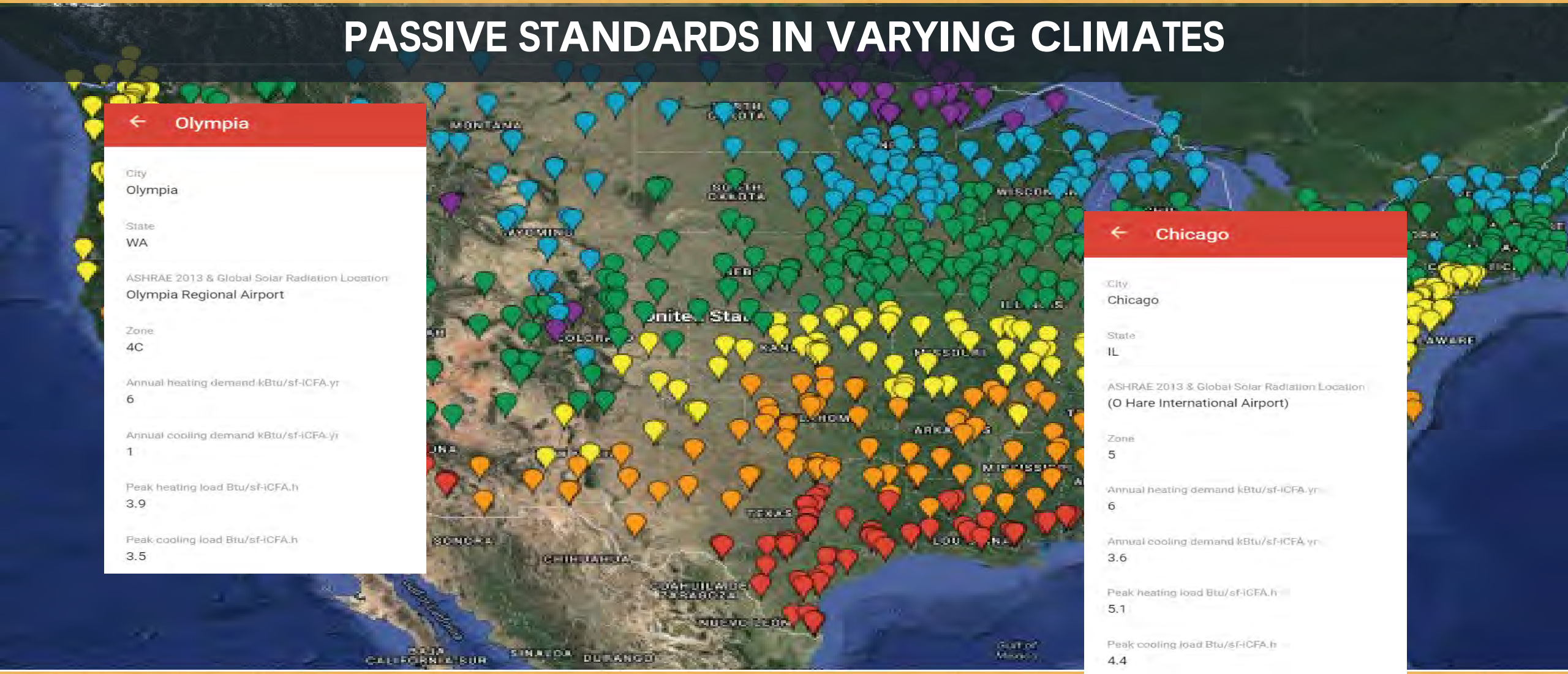
- PHIUS+ Certification is based on design – need to verify actual performance
- Realize & quantify savings
- Troubleshoot issues
- Adjust modeling protocol to improve predicted values
- Shape incentives from local jurisdictions & rating systems

POTENTIAL FACTORS AFFECTING DIFFERENCES BETWEEN MODELED AND MONITORED

- Varying heating setpoint above/below 68F (winter)
- Varying cooling setpoint above/below 77F (summer)
- Climatic differences between measured year and ‘typical year’ used for modeling
- Varying number of occupants from modeled assumption (BR+1)
- Occupant behavior (work from home, kids vs adults, lifestyle, habits)
- Equipment tested efficiency varying from real performance
- System/Operator Error

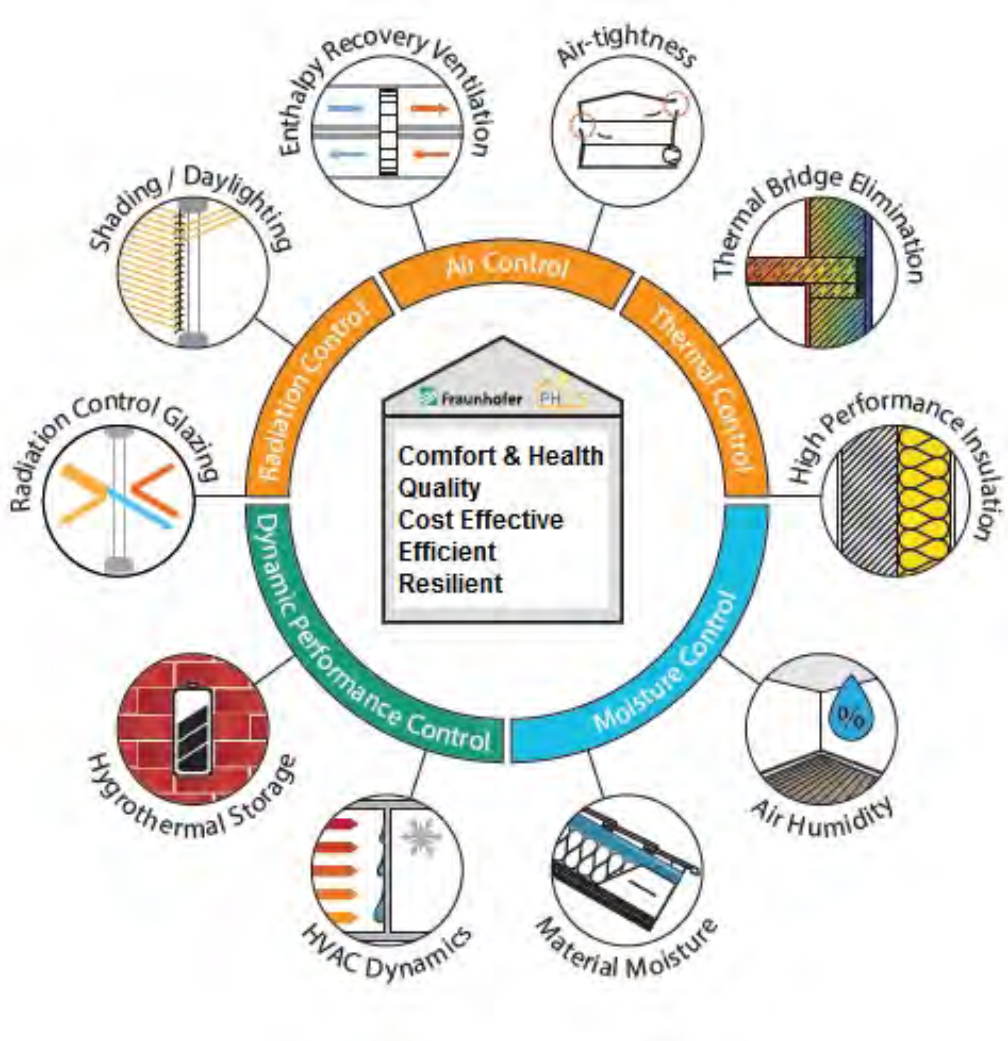
CLIMATE SPECIFIC METRICS

PASSIVE STANDARDS IN VARYING CLIMATES



CERTIFICATION PROTOCOL

	PHIUS+ 2015
Internal Heat Gains (Residential)	Varies Calculated
Square Footage	Interior Conditioned Floor Area (iCFA)
Occupancy	# Bedrooms + 1
Residential Lighting	80% RESNET Lighting Assumptions
Residential Miscelleneous Electric Loads (MELS)	80% RESNET MELS Assumptions
Source Electric Energy Factor	3.16 kWh/kWh (US Average)



*Assumes one light on per person at a time
**Reference: 25” color TV consumes 150W/hr

TERMINOLOGY

Demands, Peaks, Site & Primary Energy

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

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.

Site Energy [kWh/person.yr] OR [kBTU/yr.ft^2]: Total energy consumed over the course of the year, including space conditioning, hot water, plug loads, lighting, appliances, systems, etc. (Excludes electrical vehicle charging energy, and ligthing energy specific to vehicle parking areas)
*No requirement for PHIUS+ Certification

Source (Primary) Energy [kWh/person.yr] OR [kBTU/yr.ft^2]: Site energy as described above, multiplied by the source/primary energy factor for the specific fuel type used.
Ex: Electricity has a PE factor of 3.16 kWh/kWh (generation at the source vs use on site)

Four Case Studies




	Uptown Lofts	***Bayside Anchor***	***Village Center***	***Beach Green Dunes***
Location	Pittsburgh, PA	Portland, ME	Brewer, ME	Far Rockaway, NY
Square Footage (Gross)	25,000 ft^2	38,800 ft^2	54,900 ft^2	107,800 ft^2
Number of Units	24	45	48	101
Modeled Occupancy	48	72	131	254
Actual Occupancy	24	?	?	?
PHIUS+ Project #	1188	1343	1279	1311

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Uptown Lofts

Pittsburgh, PA

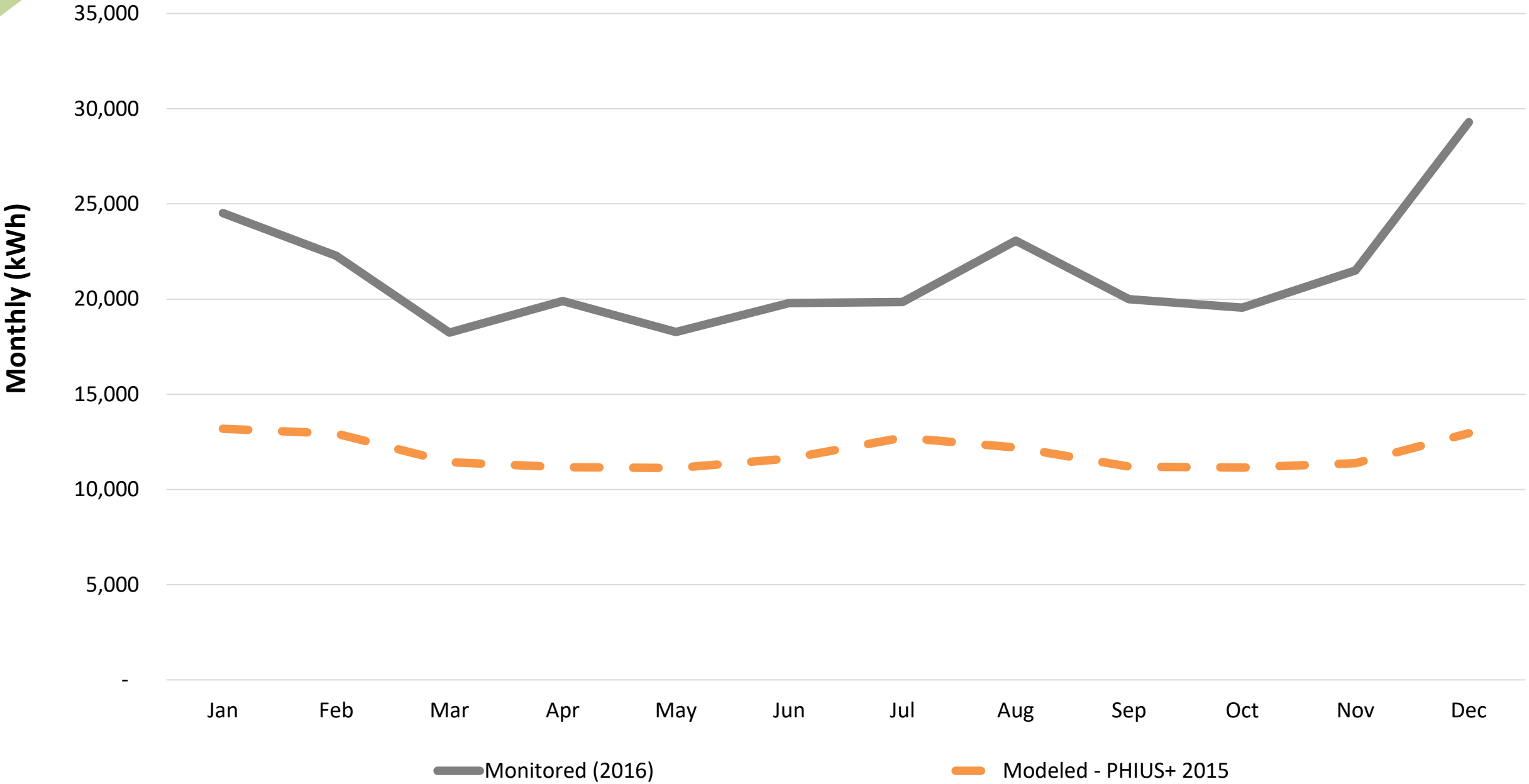
24 units

25,000 ft^2

Things to keep in mind

- Site Energy analyzed
- All electricity monitored together (includes all HVAC, hot water usage, lighting and MELs)
- Heat pumps (heating/cooling) in apartments
- Direct Electric baseboards in common stairs
- HRV
- Direct Electric WH

Site Energy: Monitored vs Modeled



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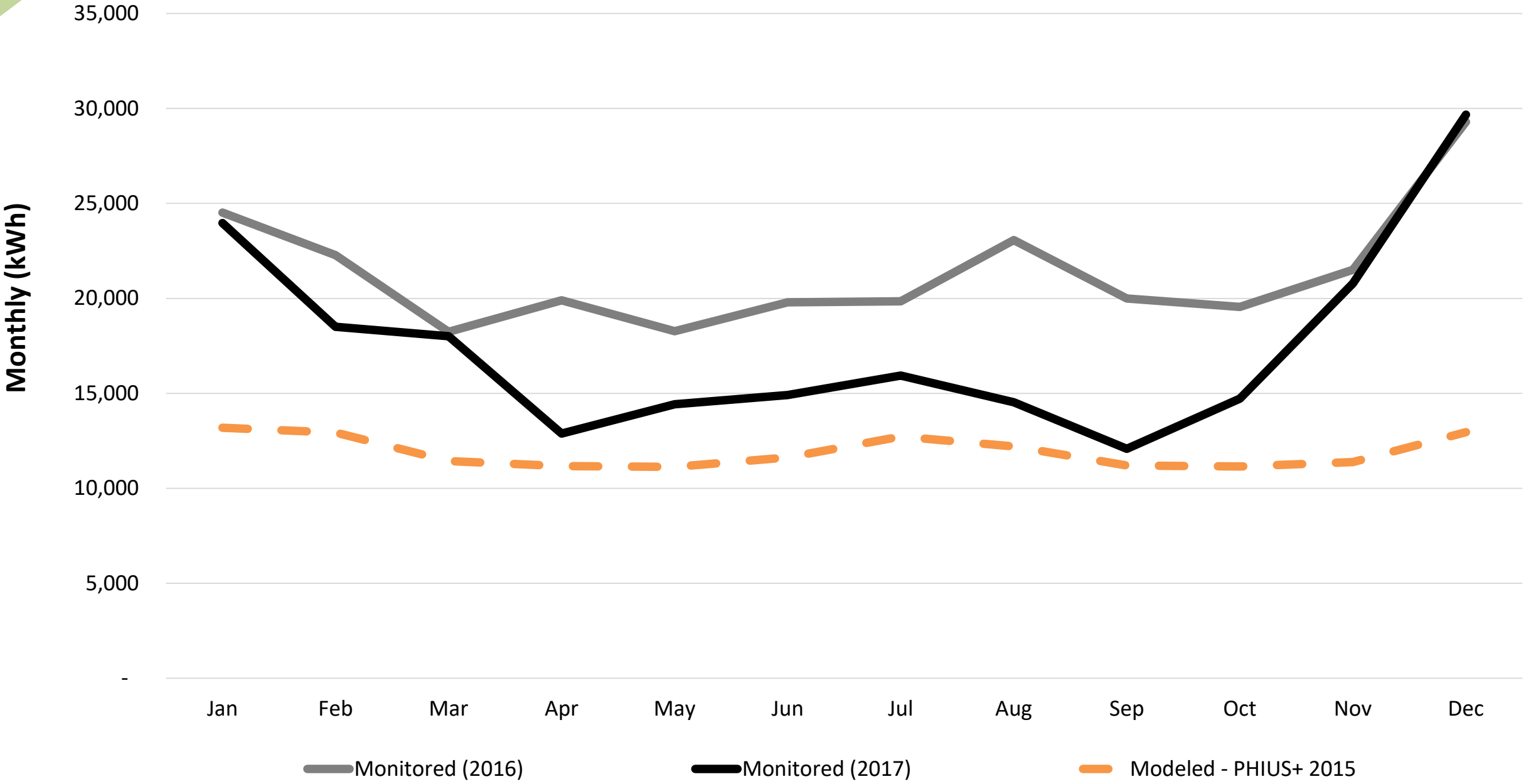

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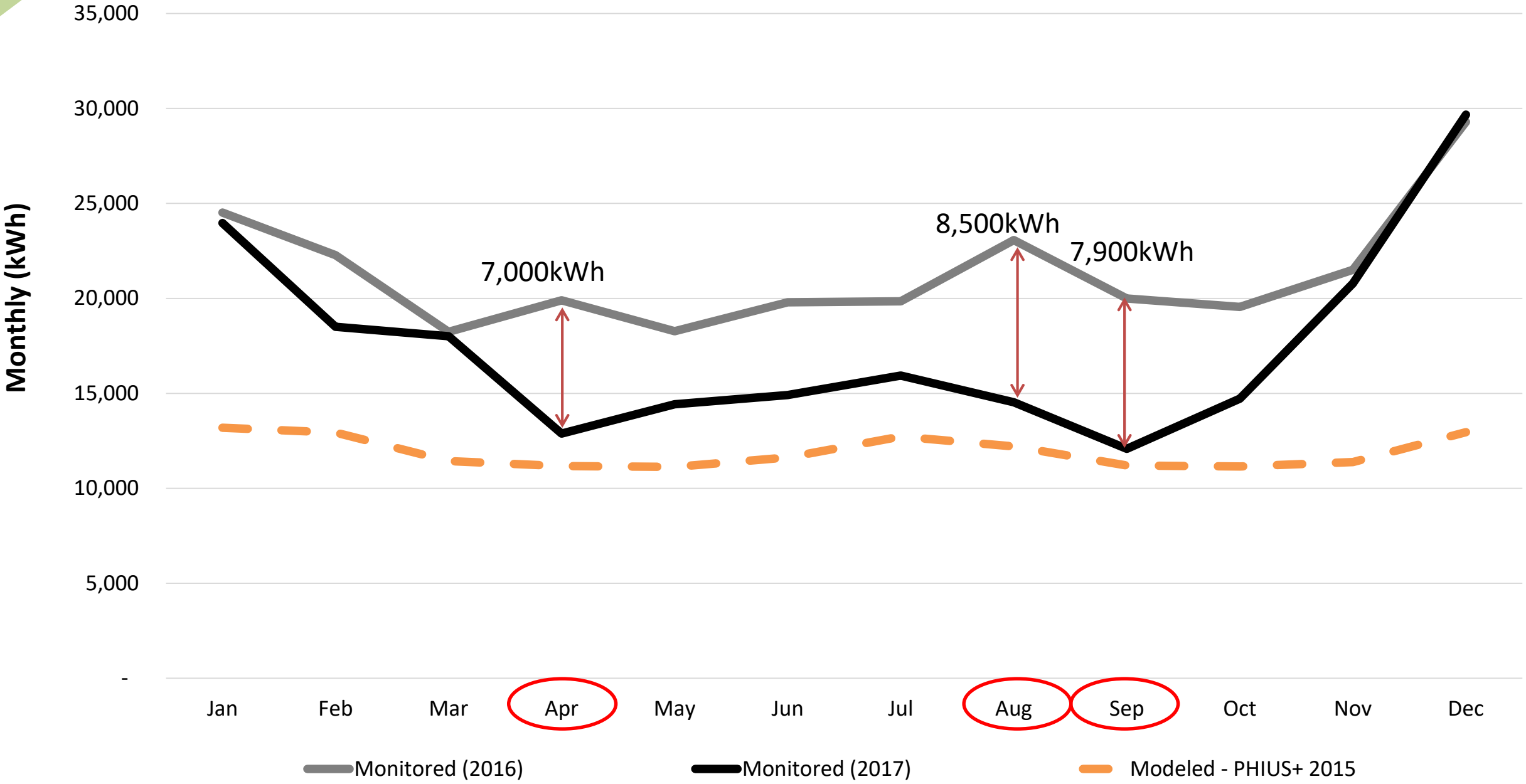
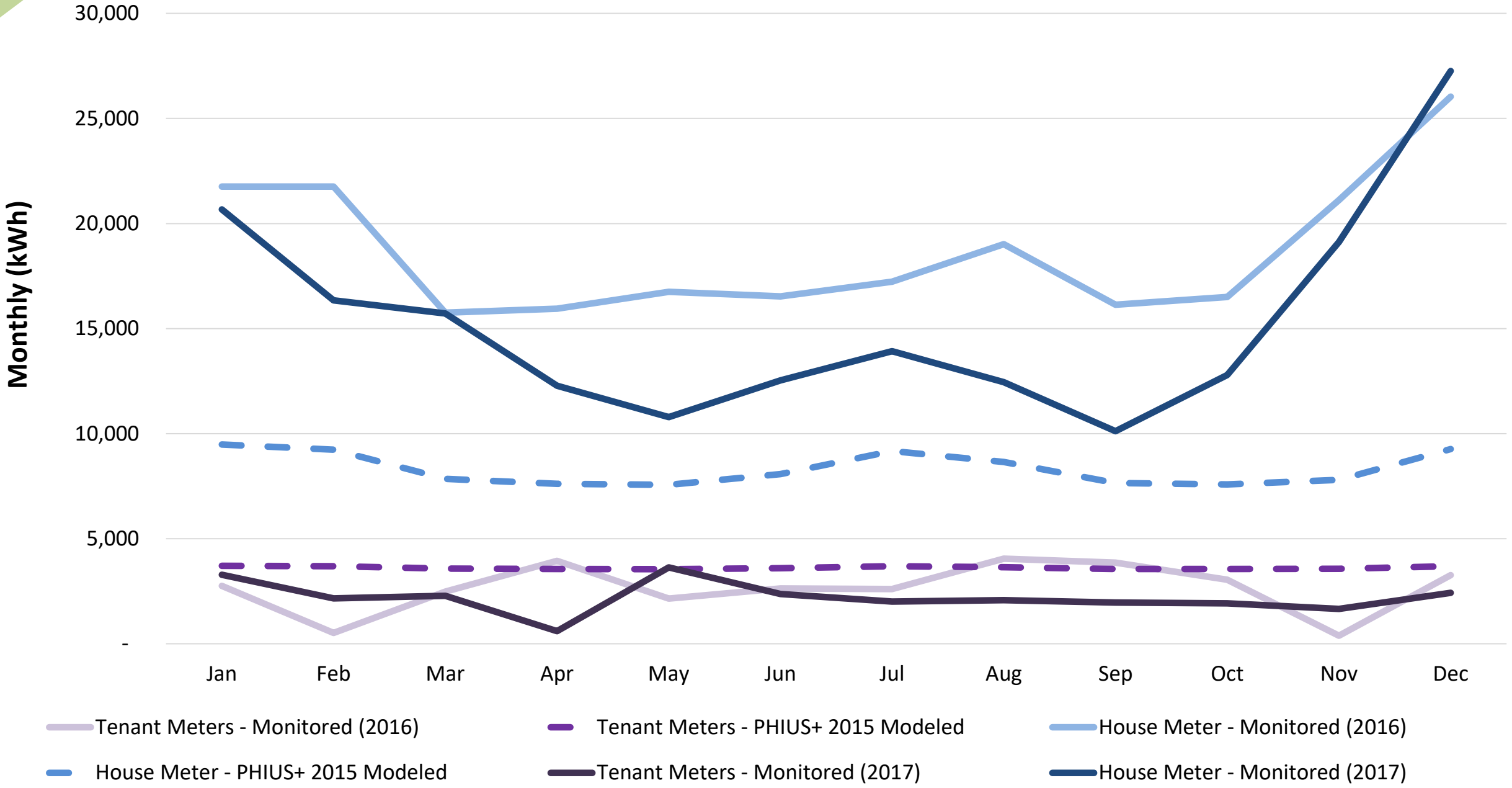


Two Meters

- Tenant Meter: Unit Plug loads/electricity, Unit Lighting & Fans for Heating/Cooling
- House Meter: Hallway/Stairwell/Exterior Lighting, 1st Floor Office Plug Loads, Laundry, Heat Pumps, Hot water tanks, all Ventilation

Site Energy: Monitored vs Modeled



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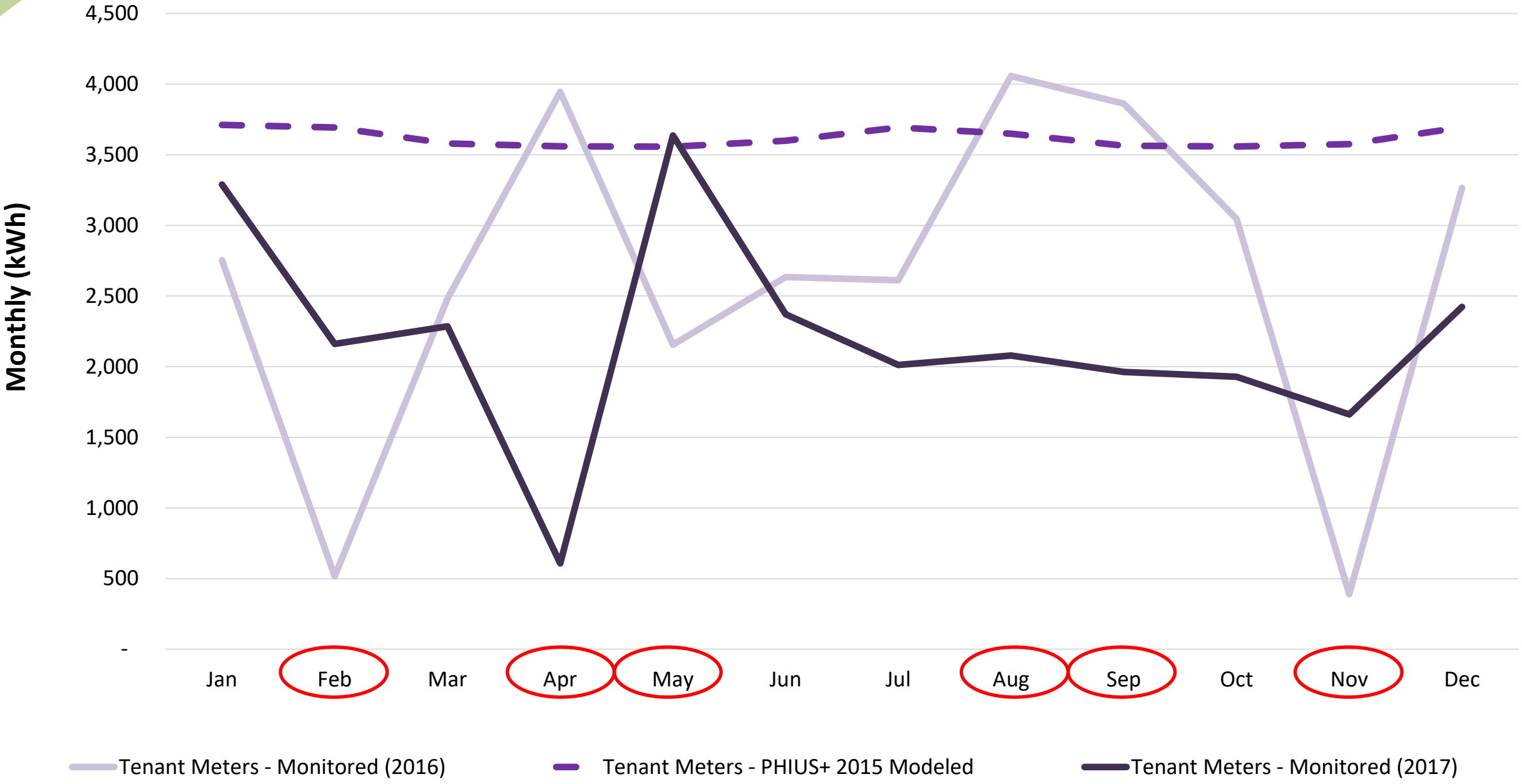

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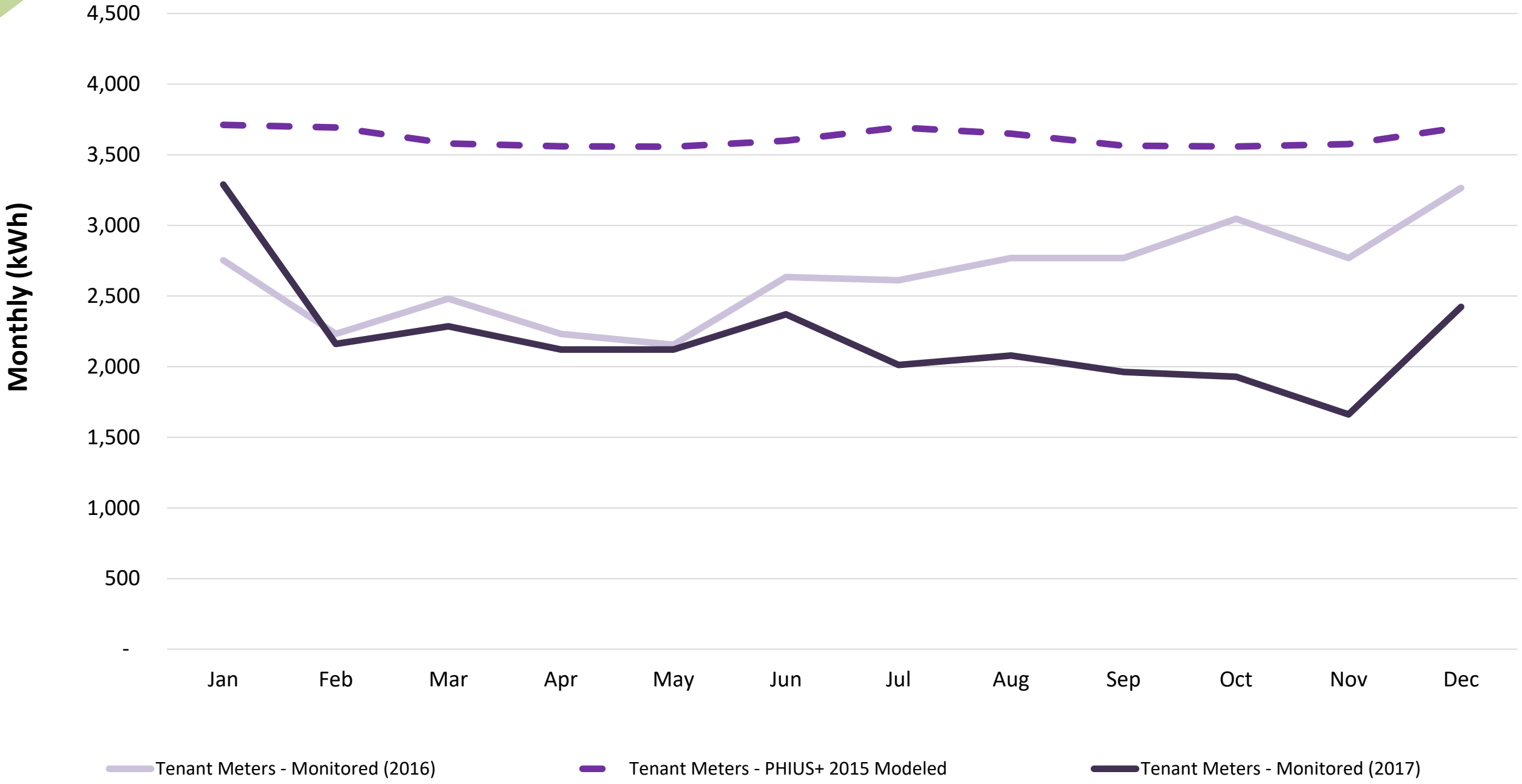

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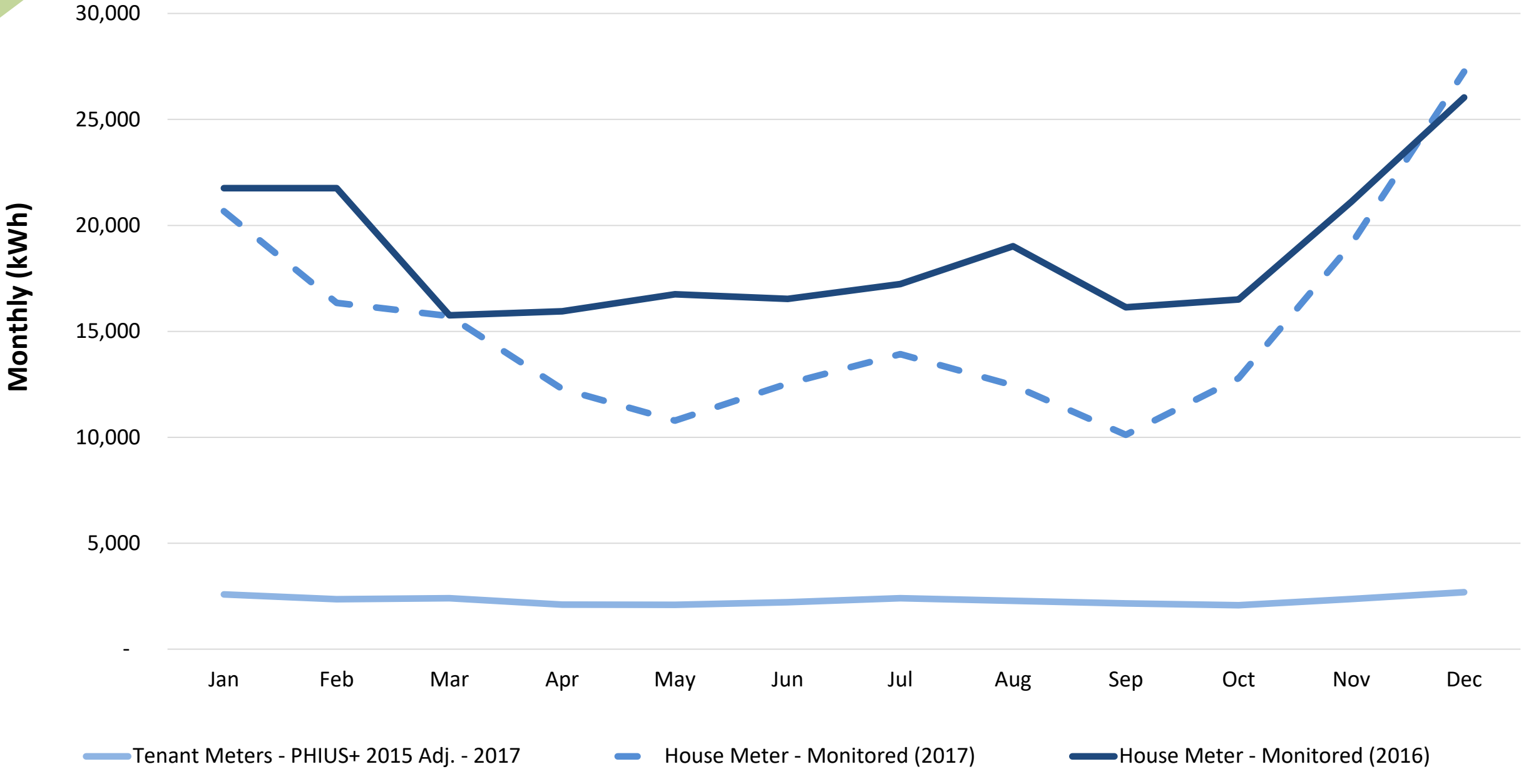

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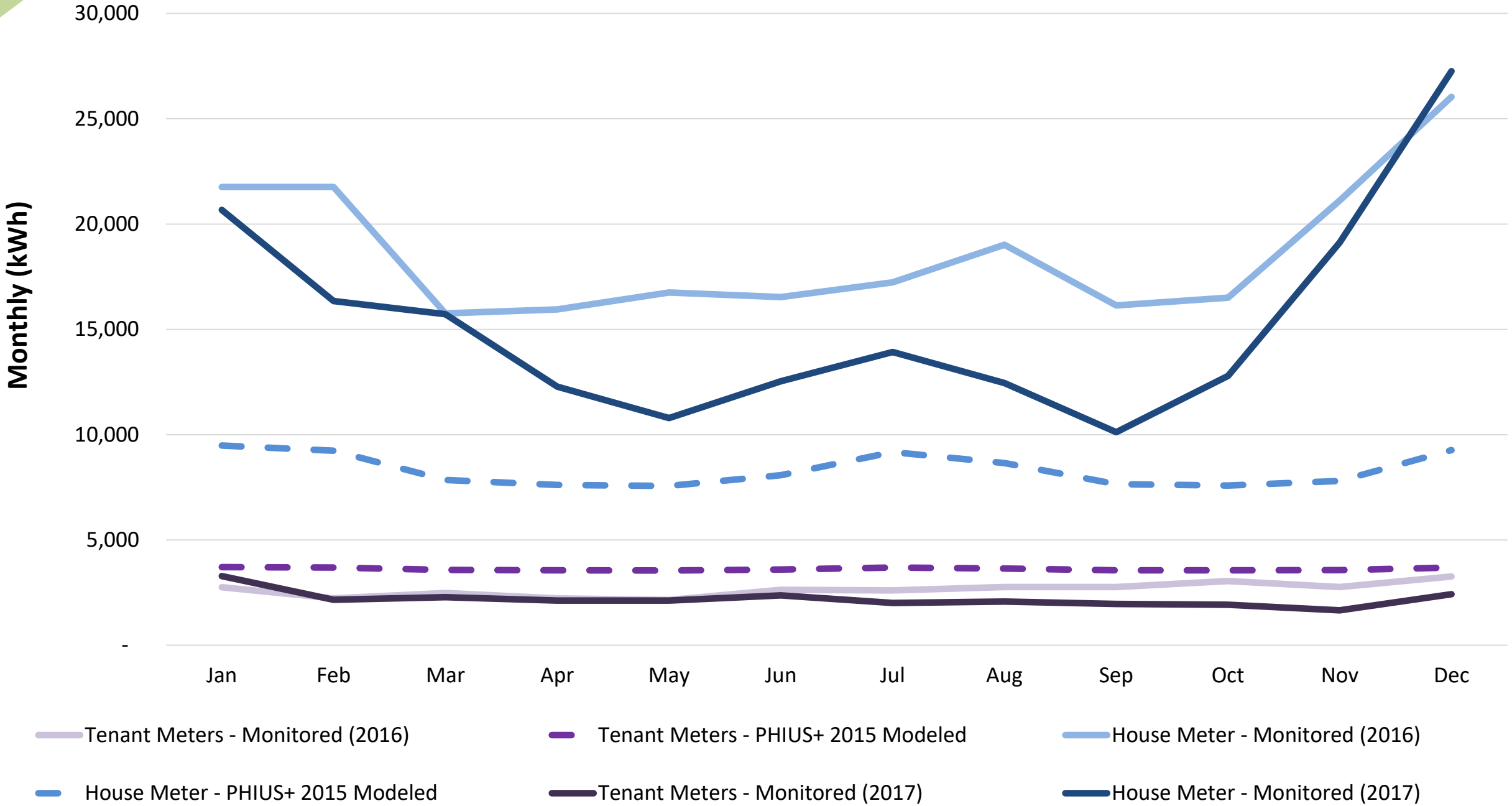
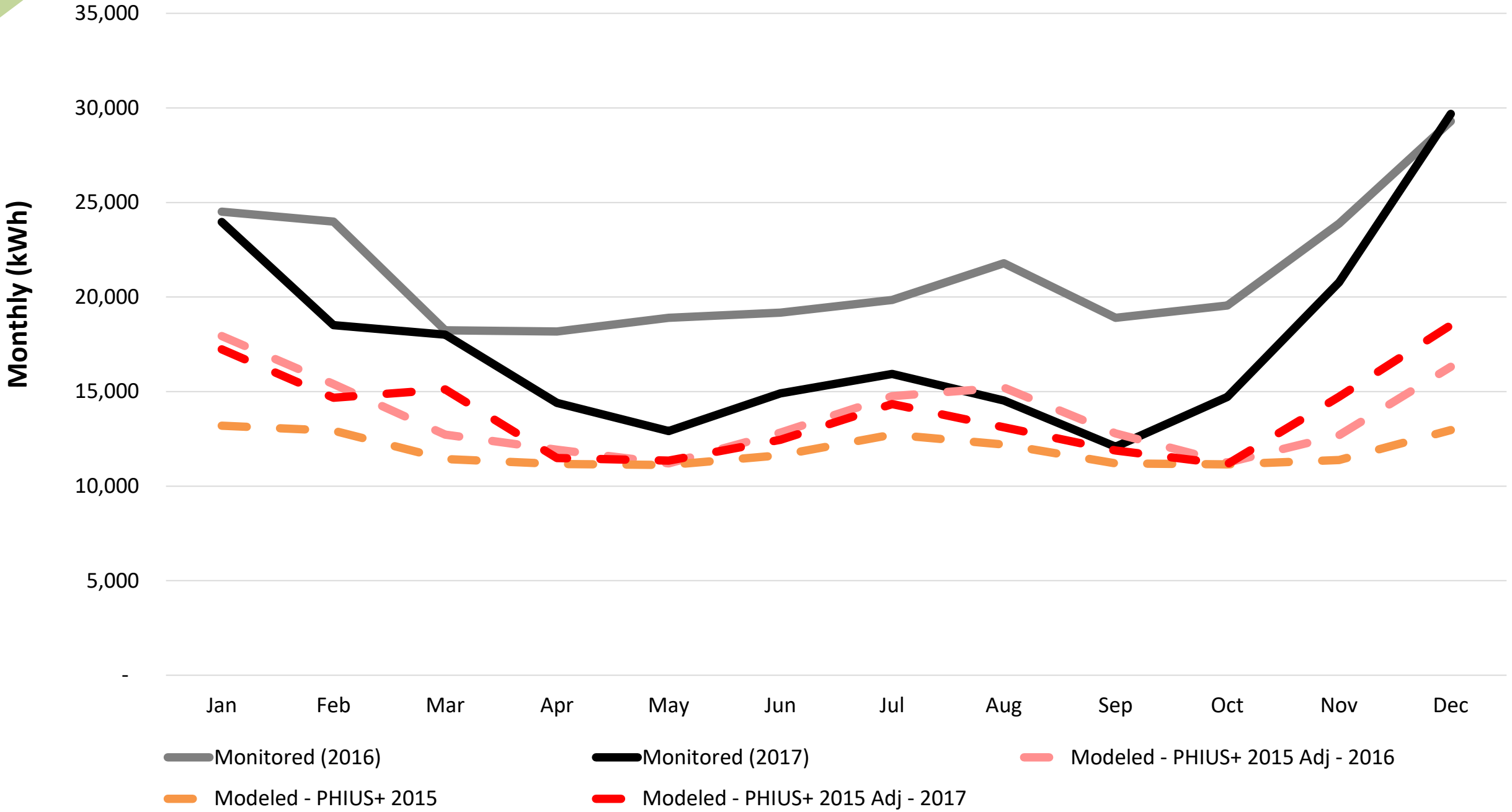


PHIUS+ 2015 – Adjusted Model

- Mean Temperatures Adjusted (2016 & 2017)
- Actual Occupancy
- Unit MELS/Lighting Reduced
- Thermostats set to 80F (Winter) 72F (Summer)
- Doubled Hot Water Usage
- Eliminated Summer Natural Ventilation
- Heat Pumps Malfunction? (2.7 COP to 1.5 COP)

Site Energy: Monitored vs Modeled



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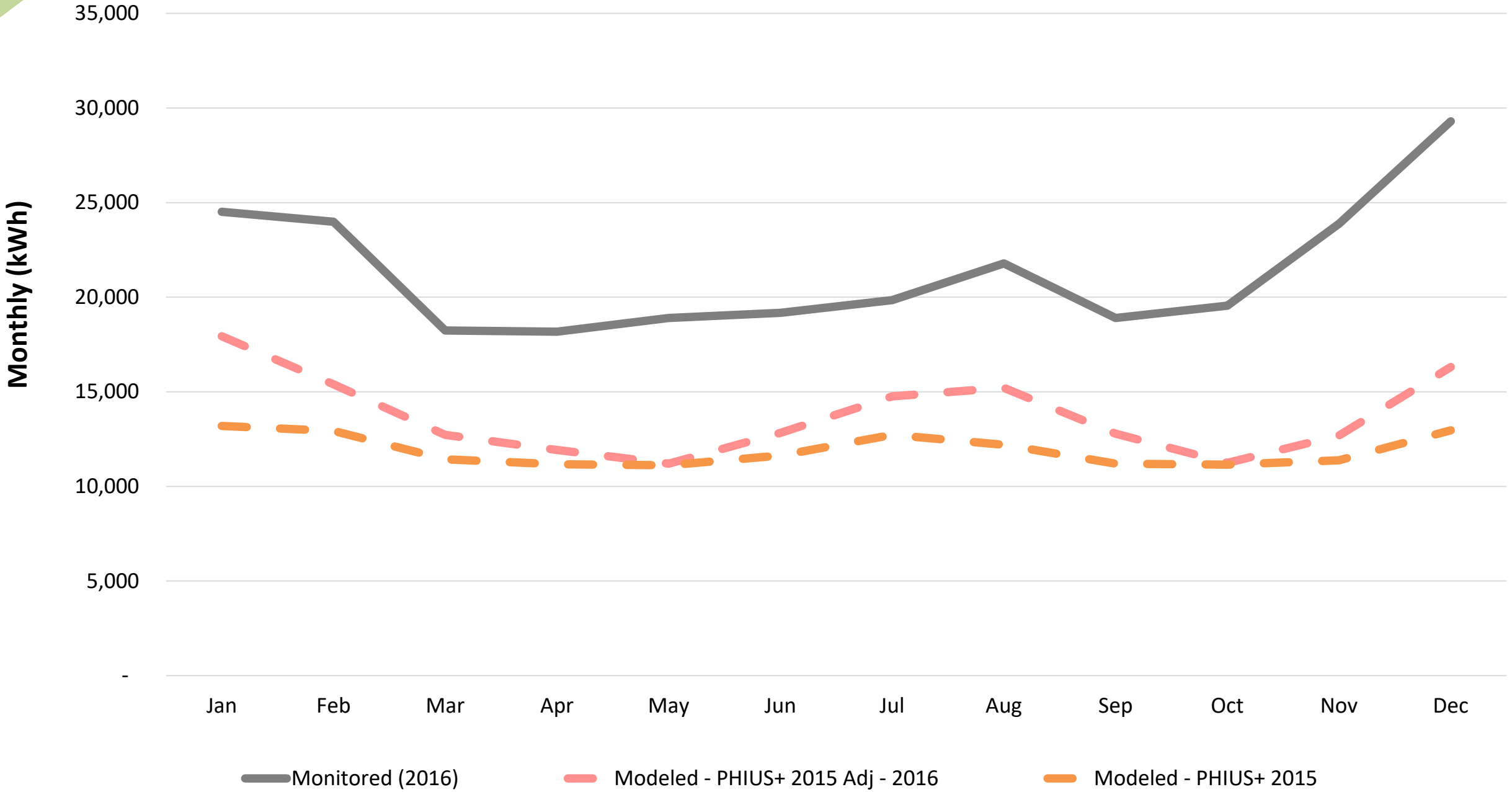

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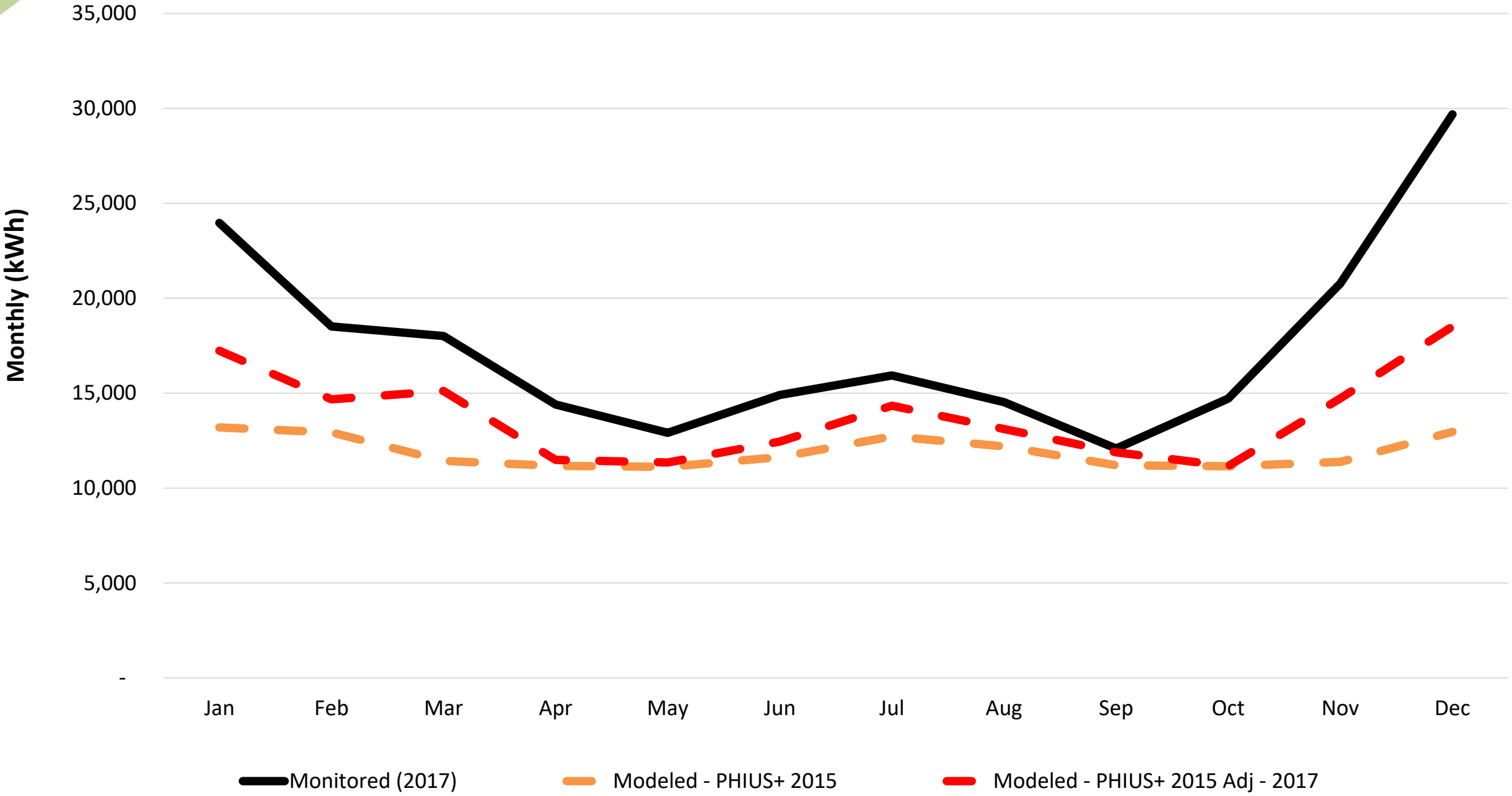

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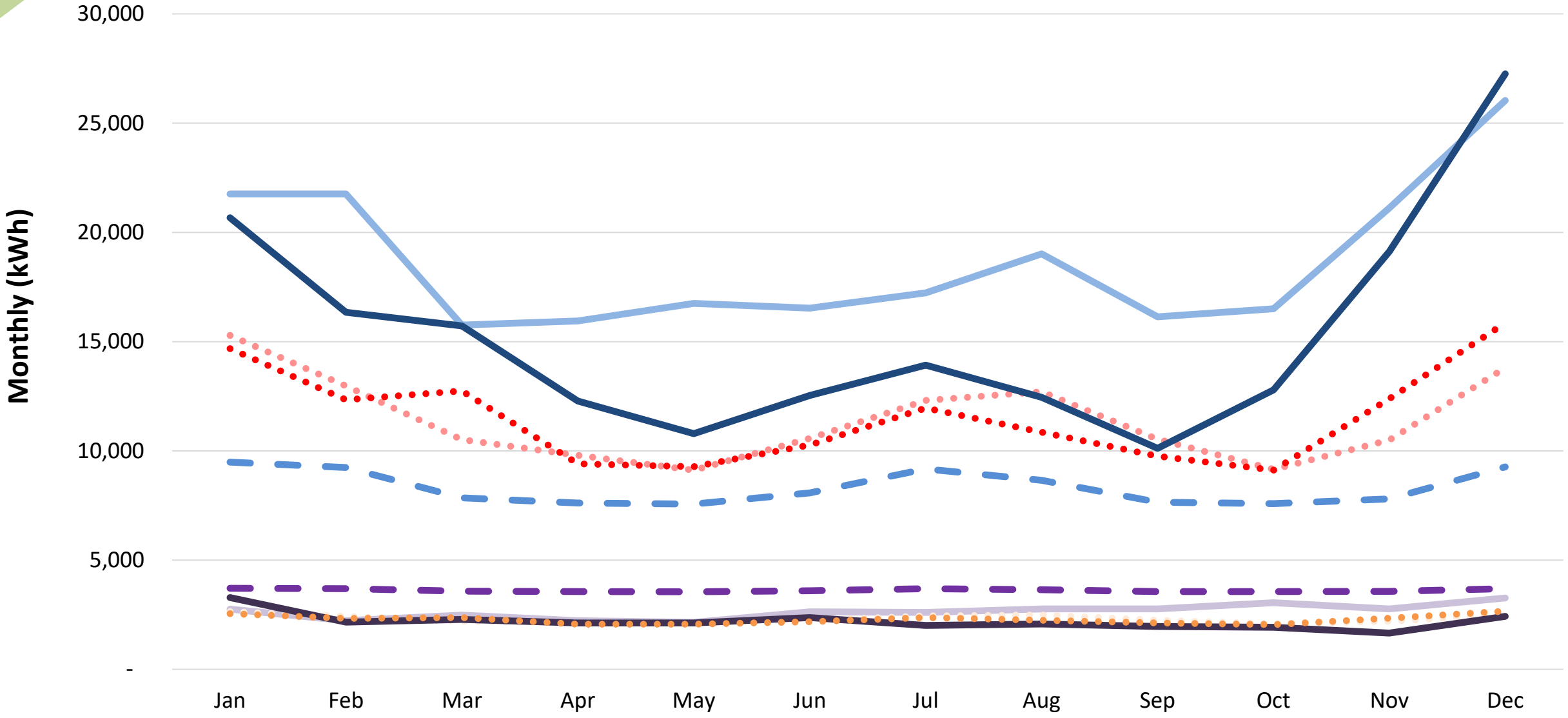

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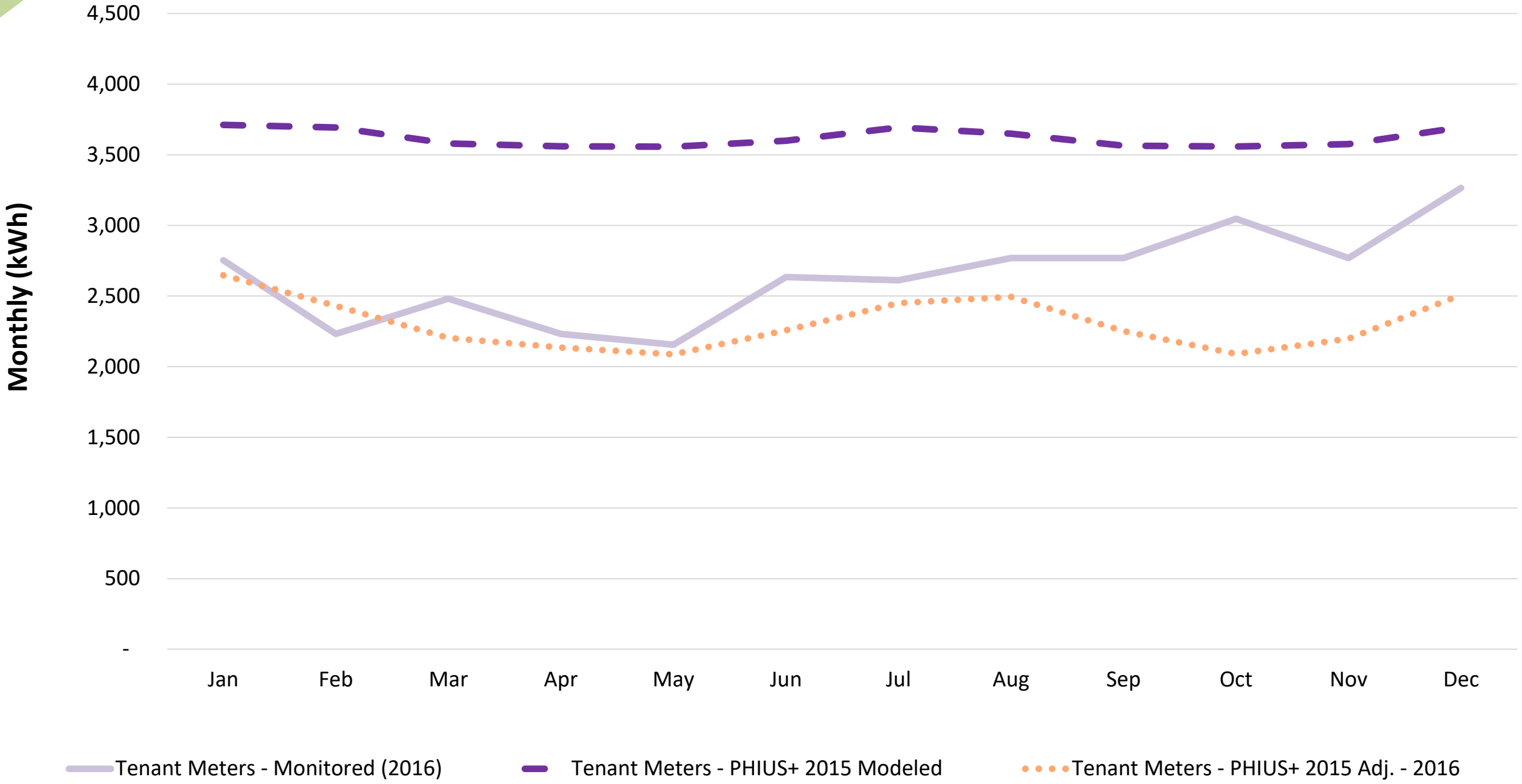

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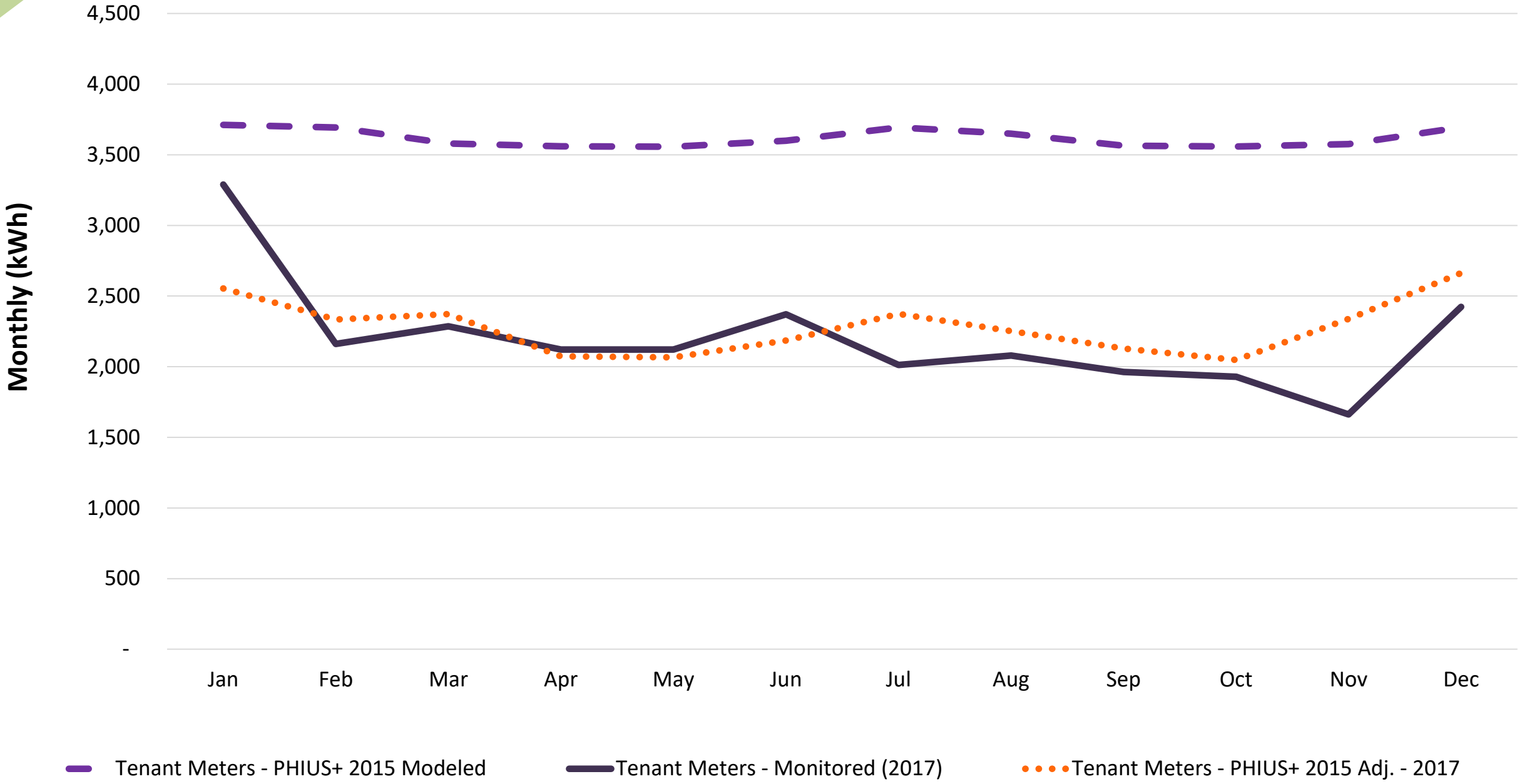

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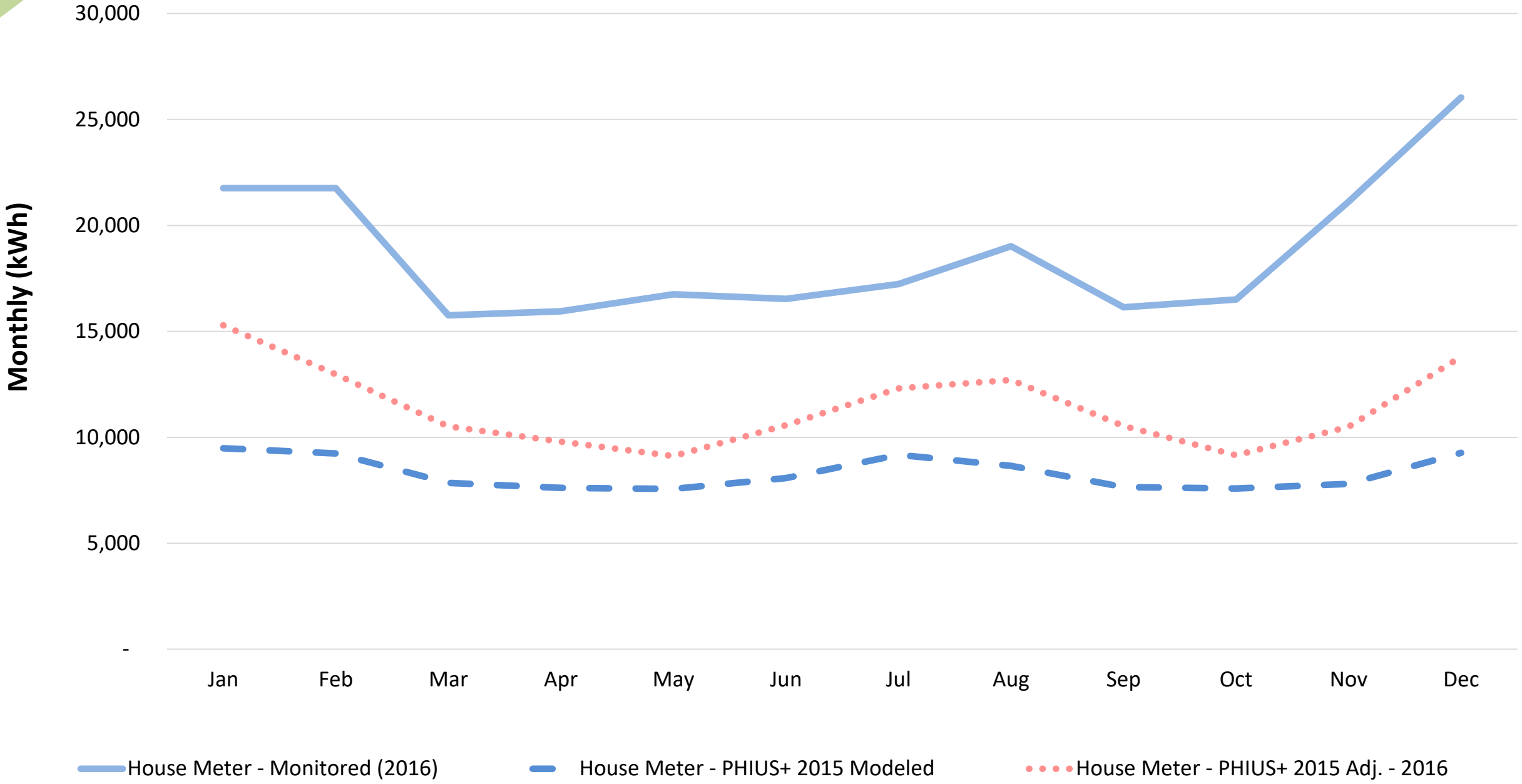

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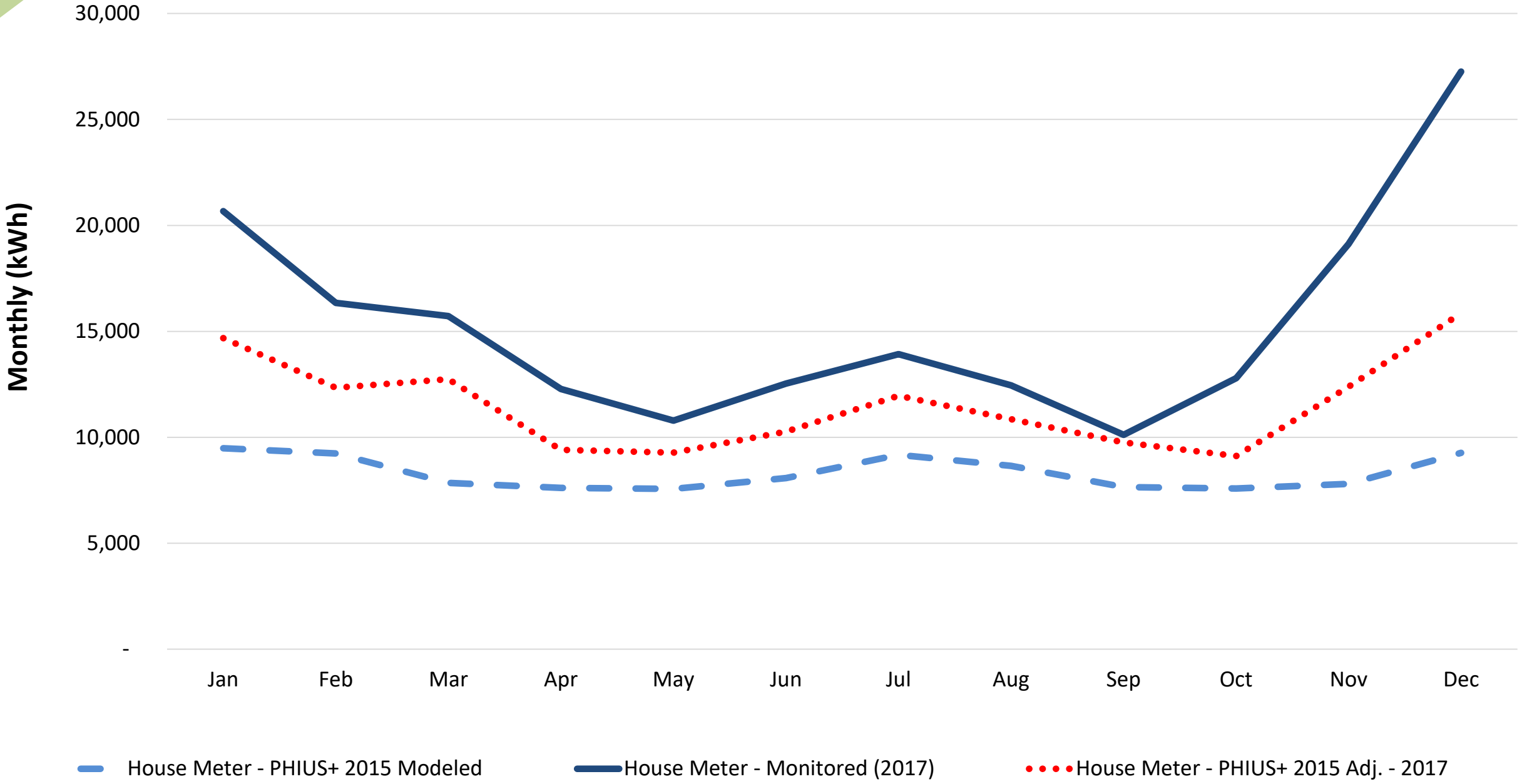
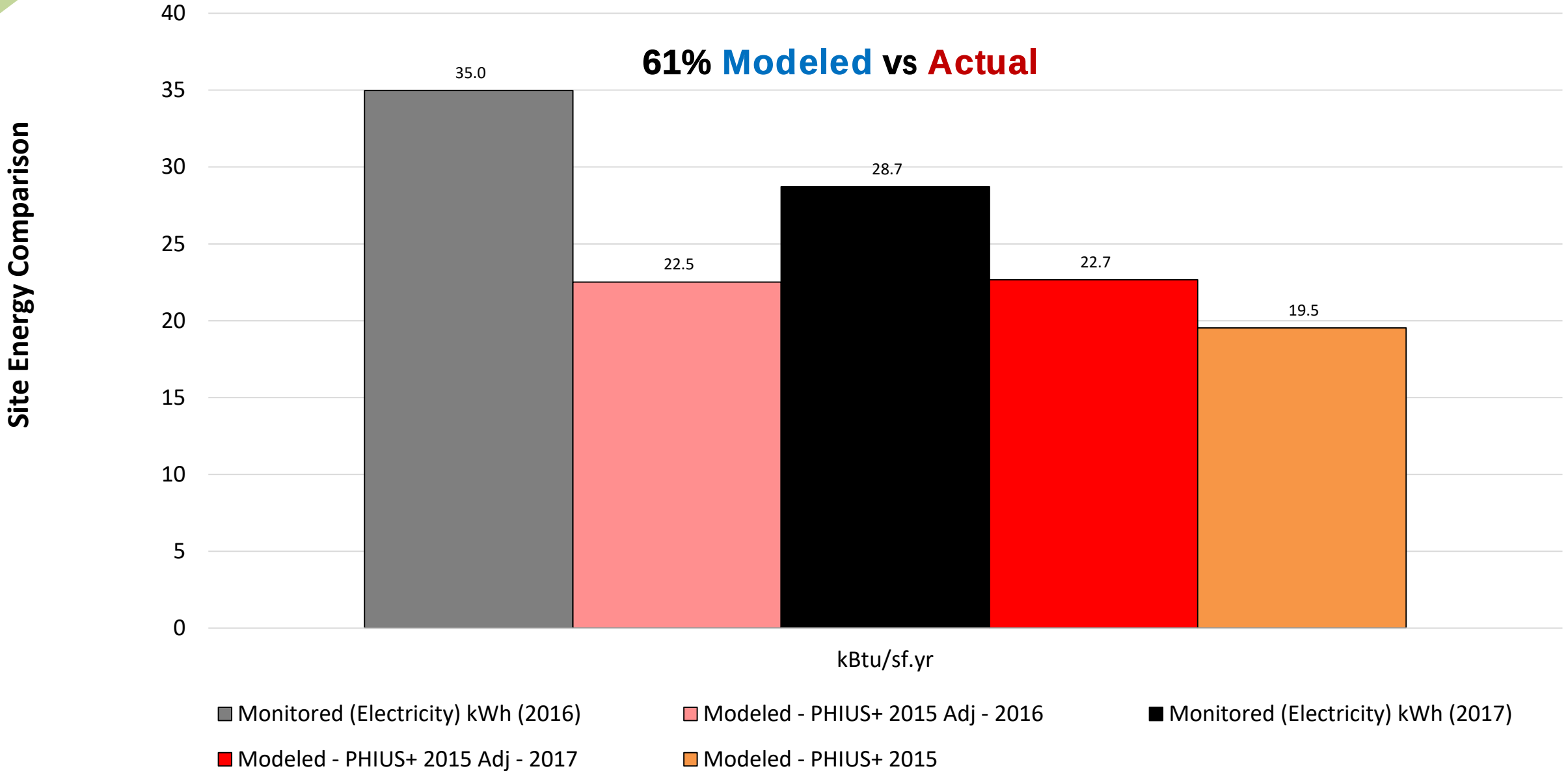


Site Energy: Monitored vs Adjusted Models



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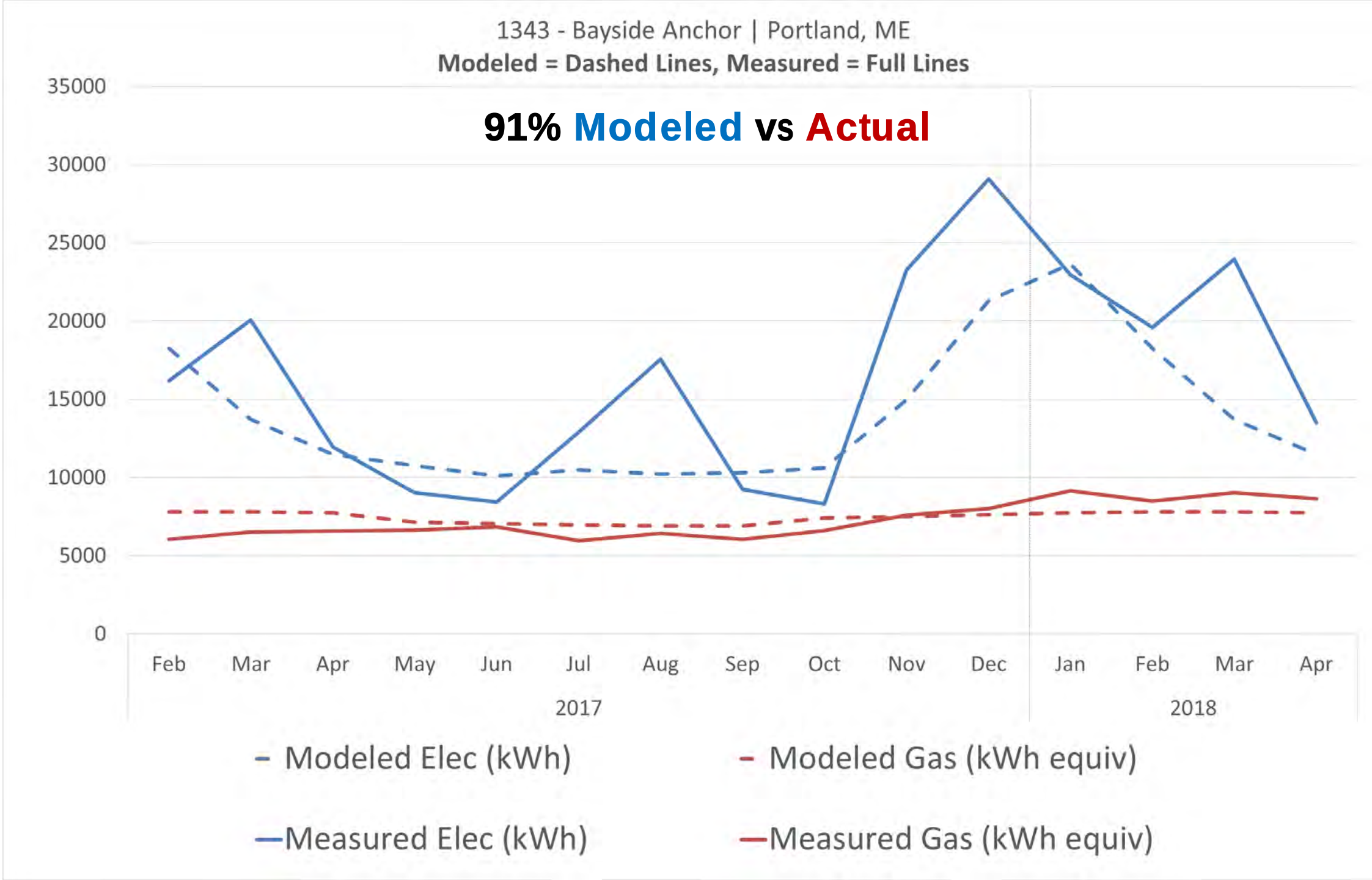
BAYSIDE ANCHOR

Portland, ME

45 Units
iCFA: 36,161 ft^2

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

BAYSIDE ANCHOR



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VILLAGE CENTER

Brewer, ME

48 Units

iCFA:

51,778 ft^2

Central Heating

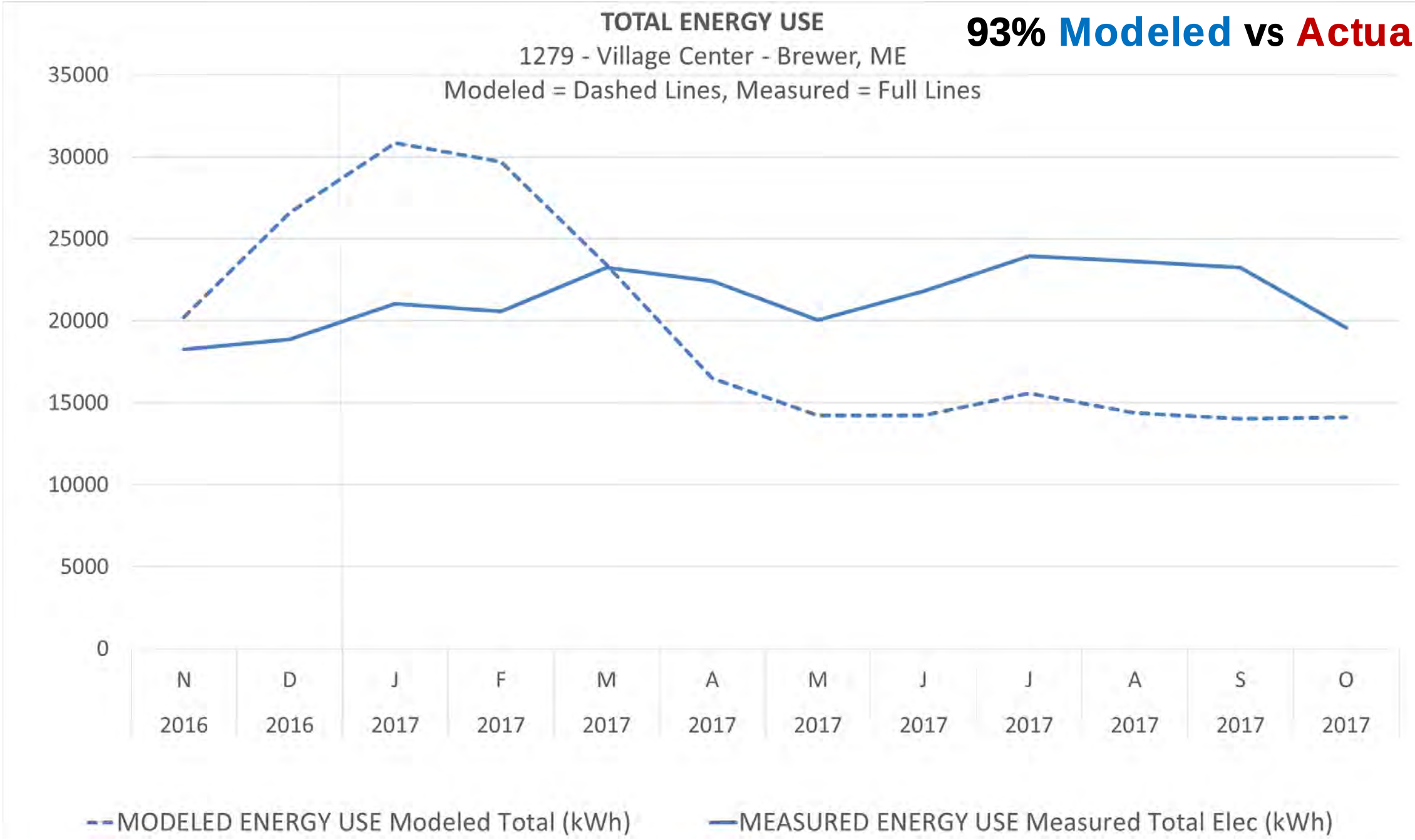
Individual Unit Cooling

Gas Water Heating

All other electric

VILLAGE CENTER

93% Modeled vs Actual



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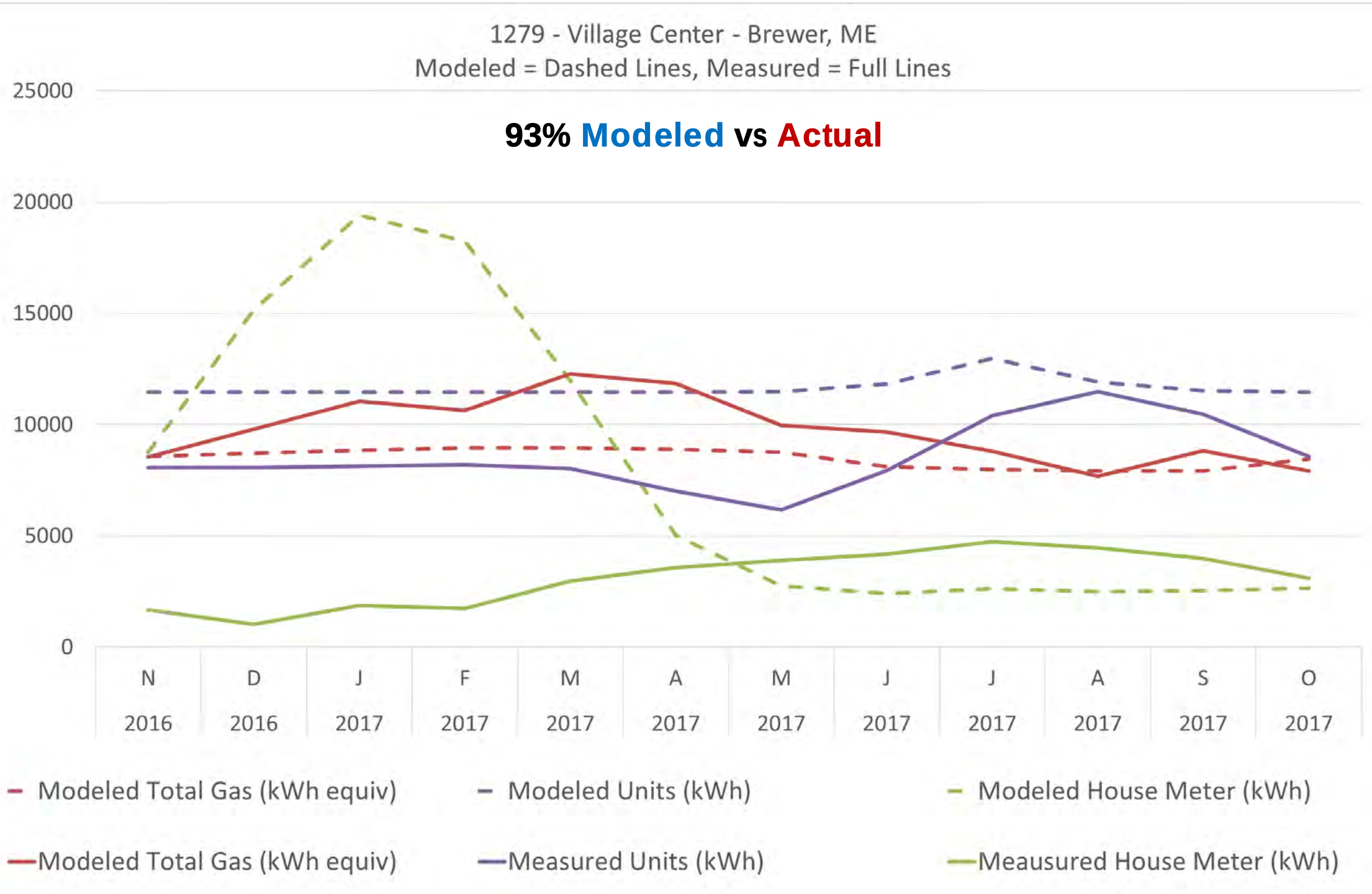

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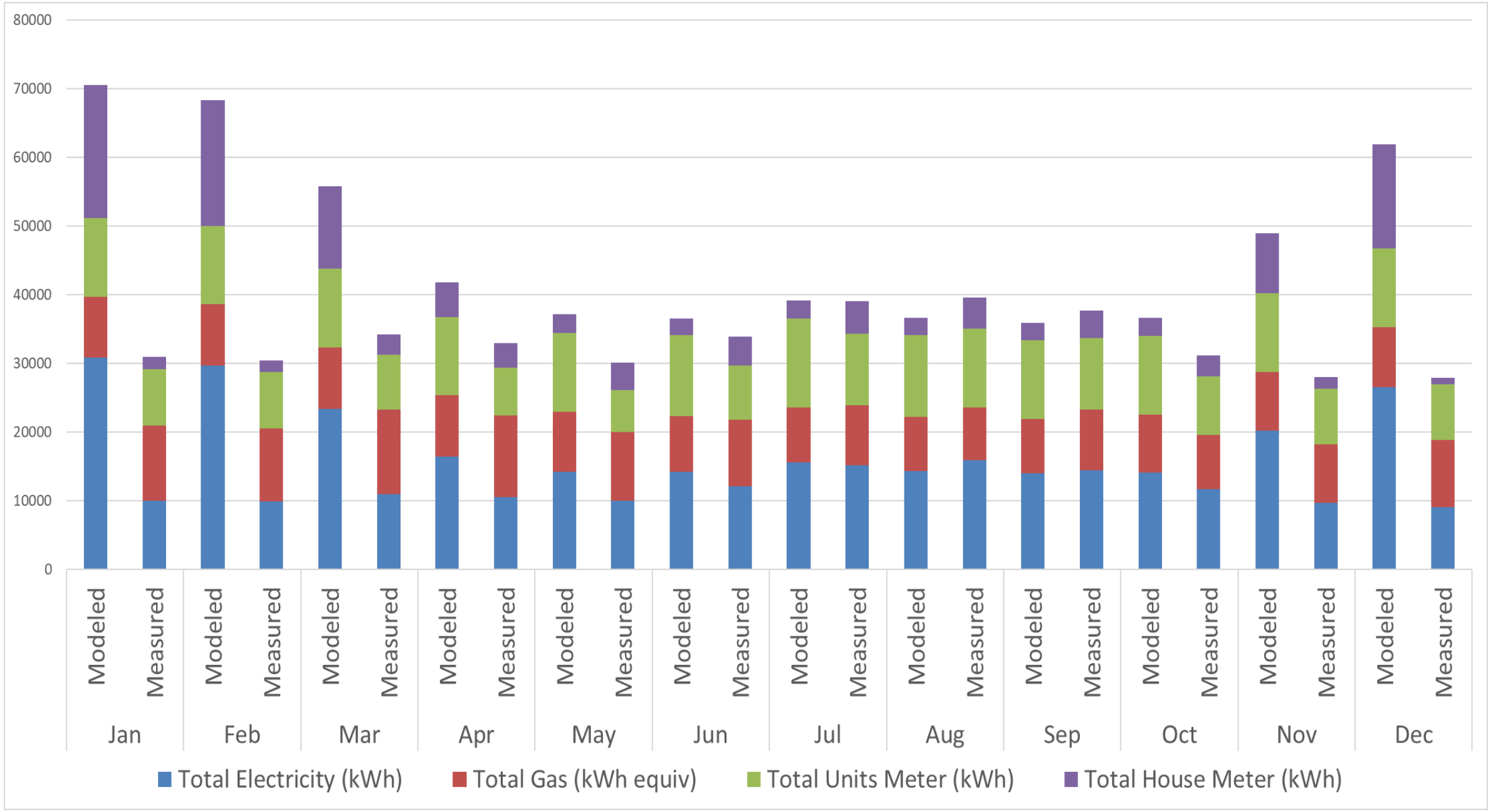

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Beach Green Dunes

Far Rockaway, NY

101 units

107,800 ft^2

Central VRF
In-Unit ERVs
Gas Water Heating
Central Laundry

WEGOWISE

BUILDING ELECTRIC BILLS

YANMAR

LG VRF SYSTEM

TENANT ELECTRIC BILLS

PHOTOVOLTAICS

WEGOWISE

BUIL ING

ELEC RIC BILLS

YANMAR

V

E N E

S

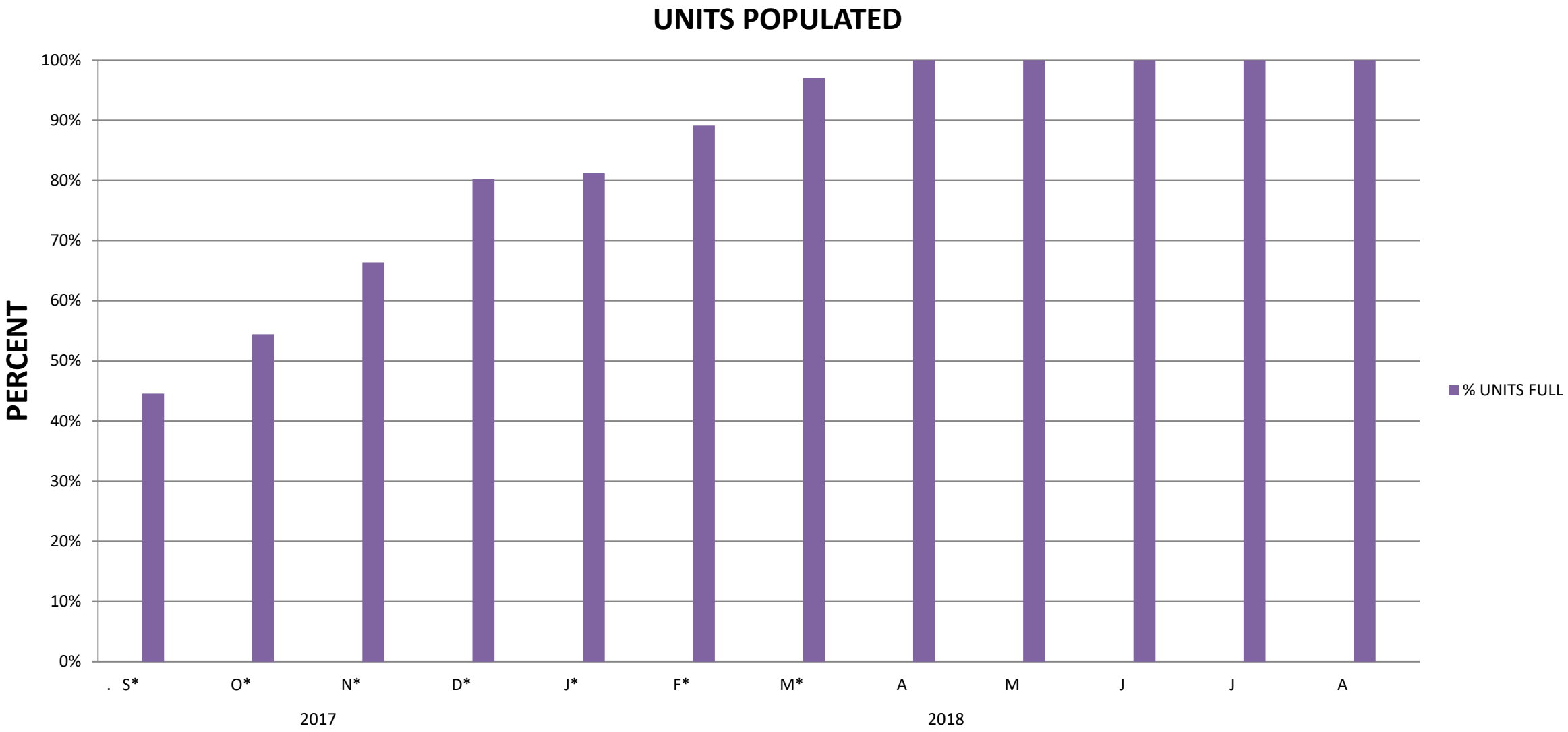
M

PHOTOVOLTAICS

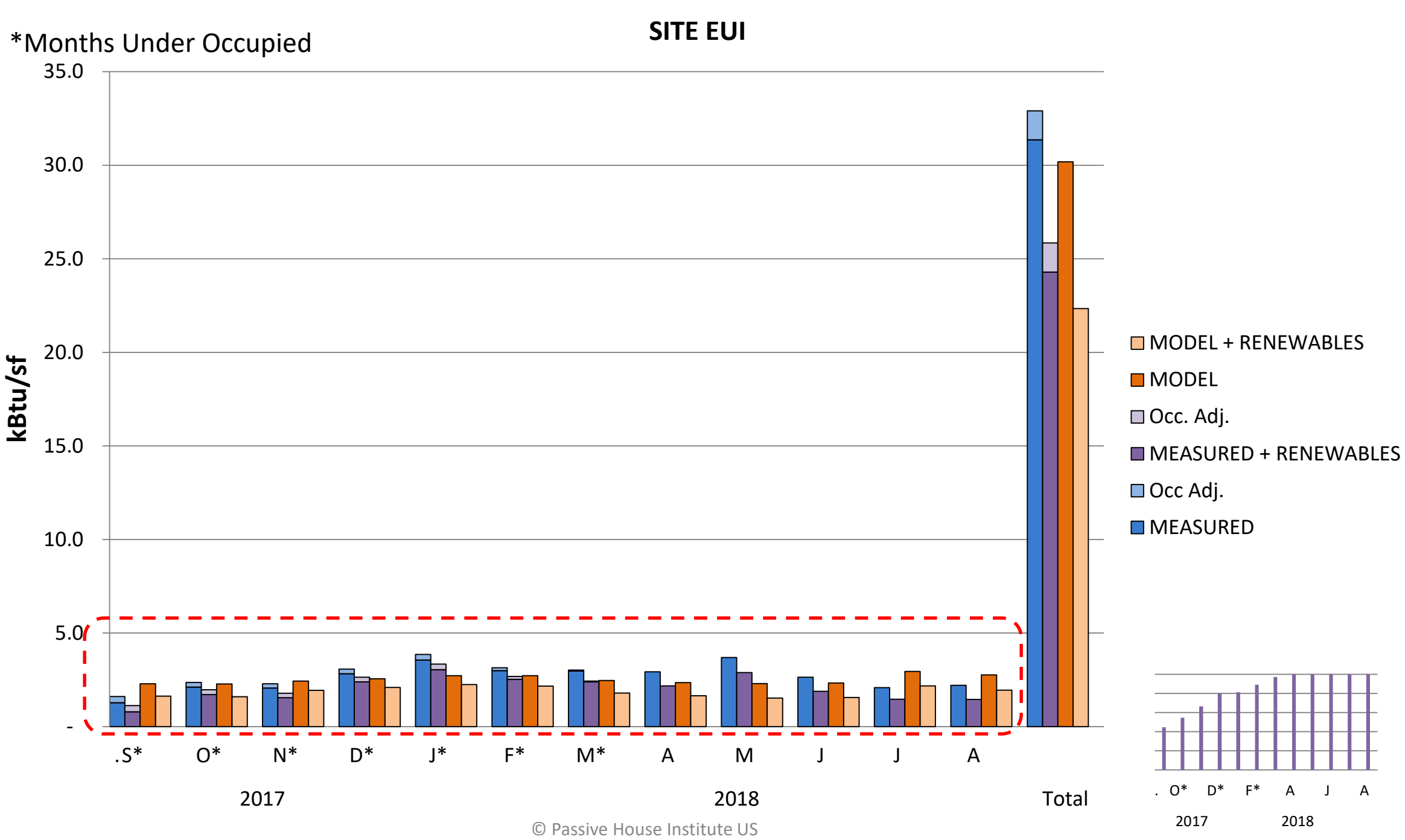
BEACH GREEN DUNES

*Months Under Occupied

84% Average Occupancy



BEACH GREEN DUNES



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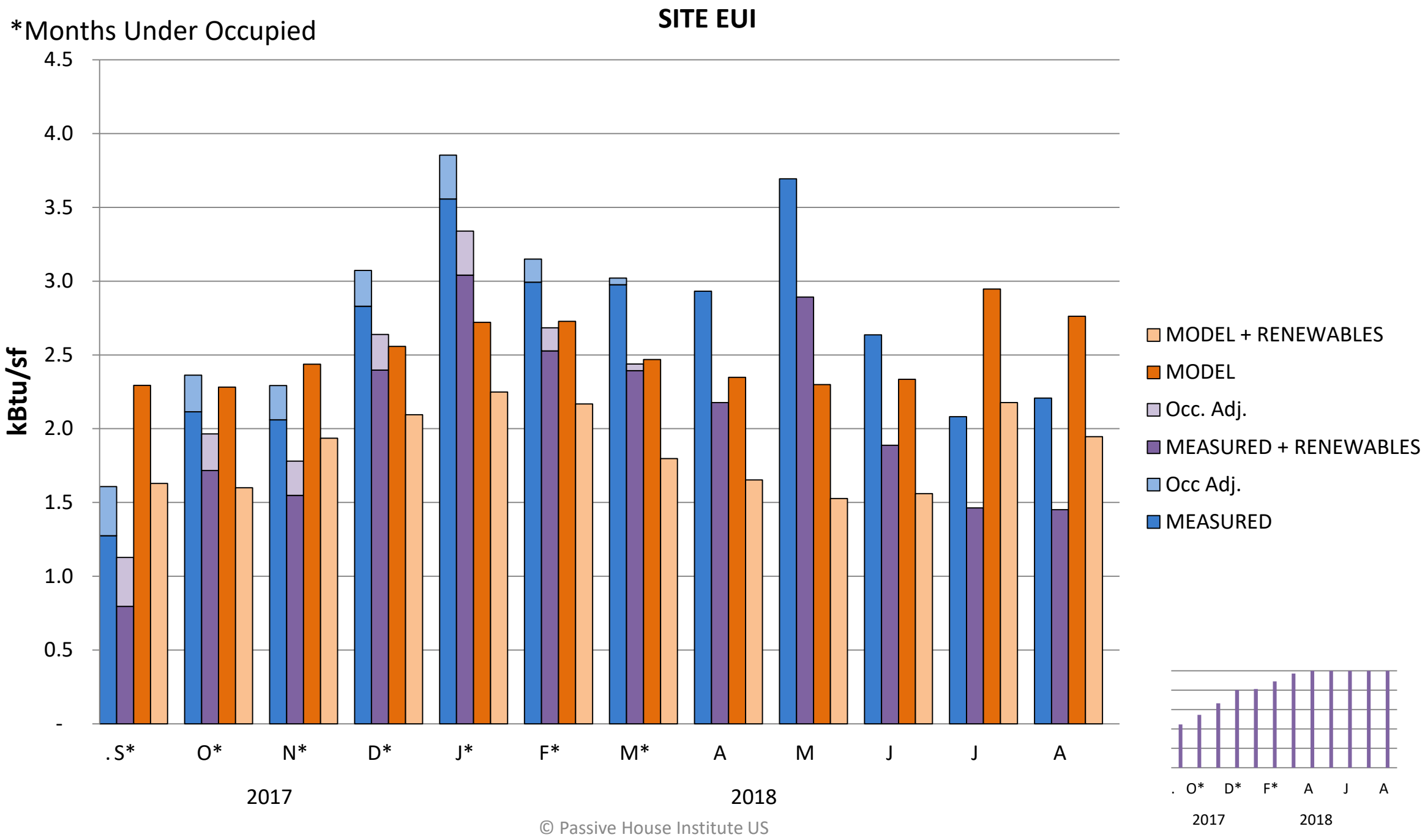

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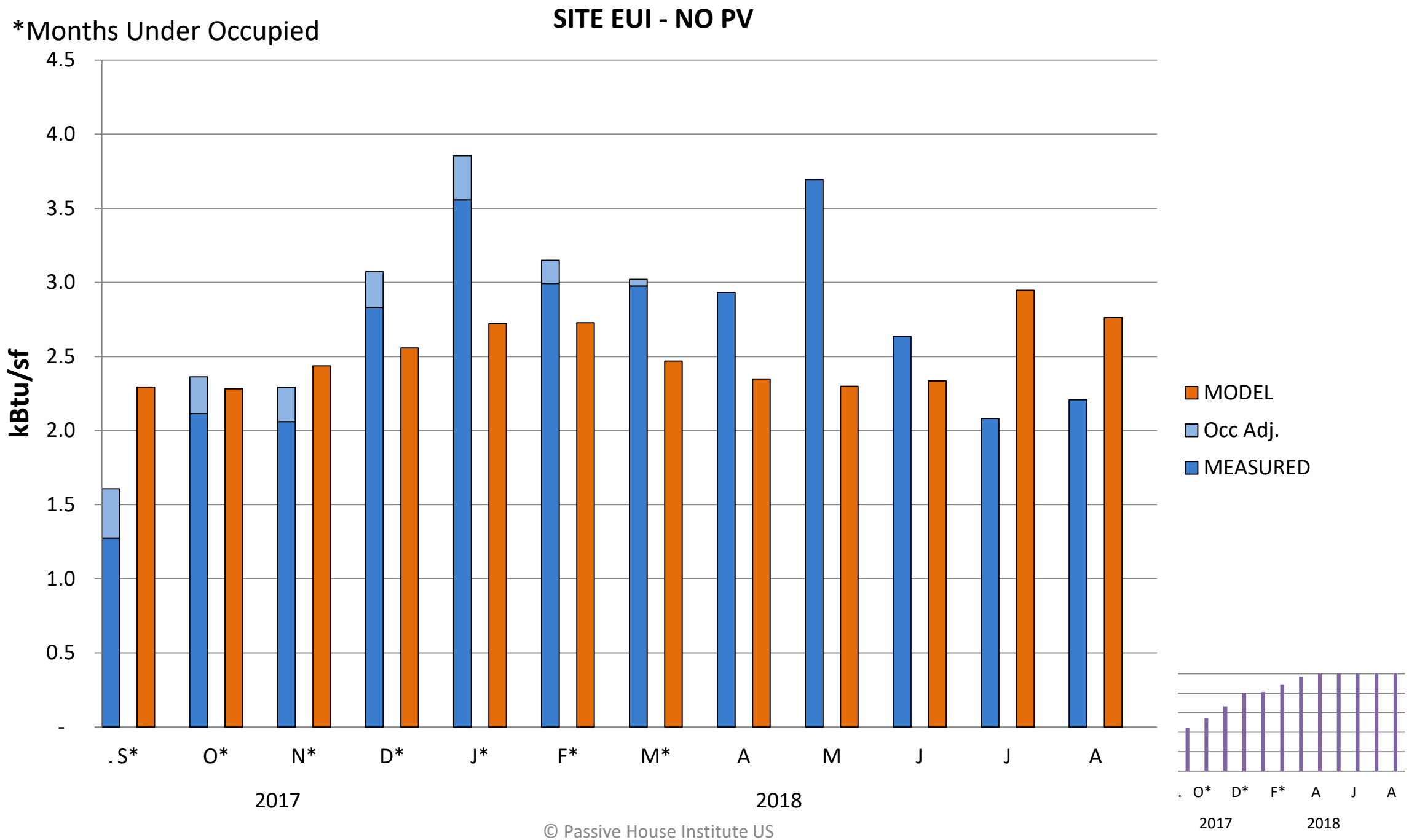

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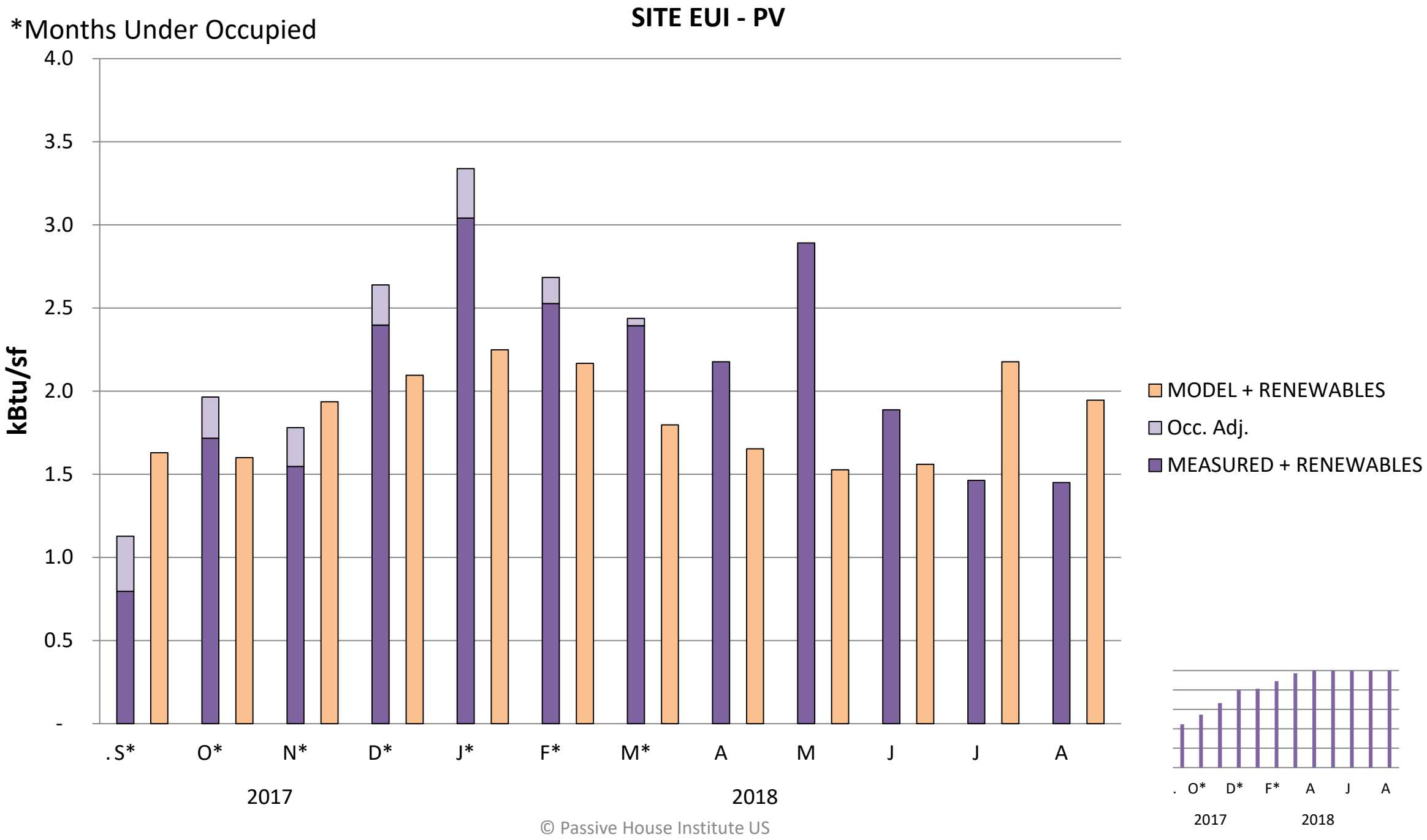


Beach Green Dunes

Far Rockaway, NY

101 units

107,800 ft^2

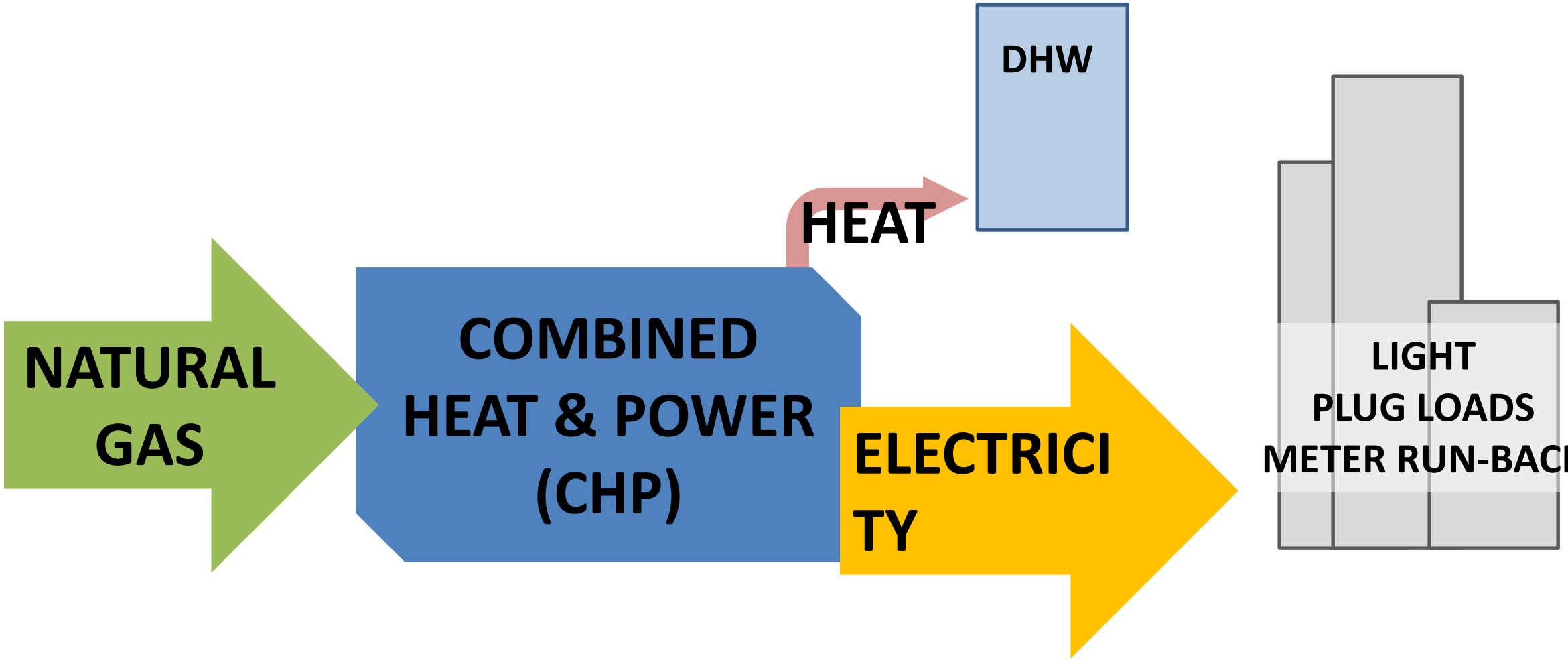
NATURAL GAS

COMBINED HEAT & POWER

DOMESTIC HOT WATER

DRYERS

BEACH GREEN DUNES



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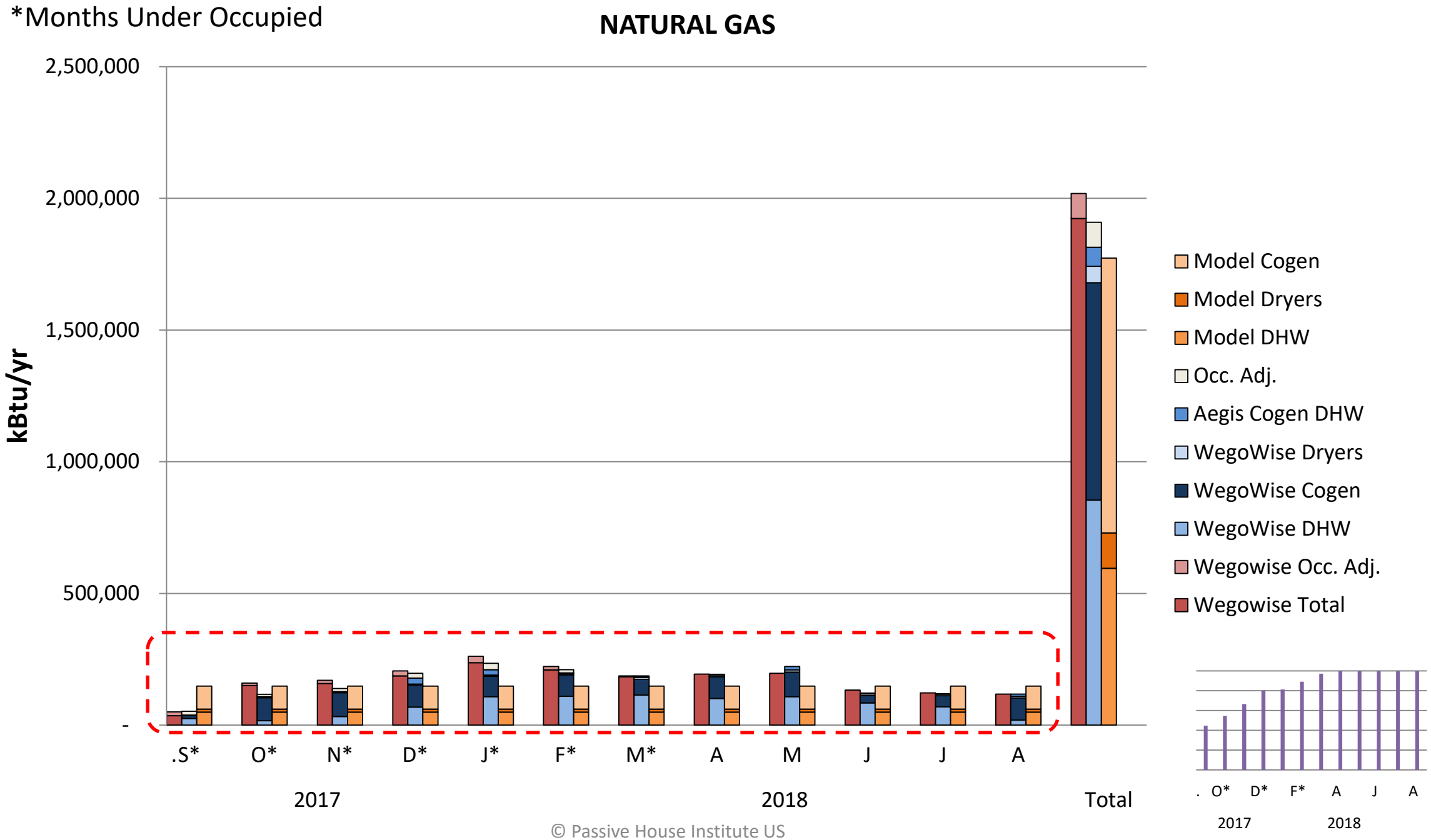

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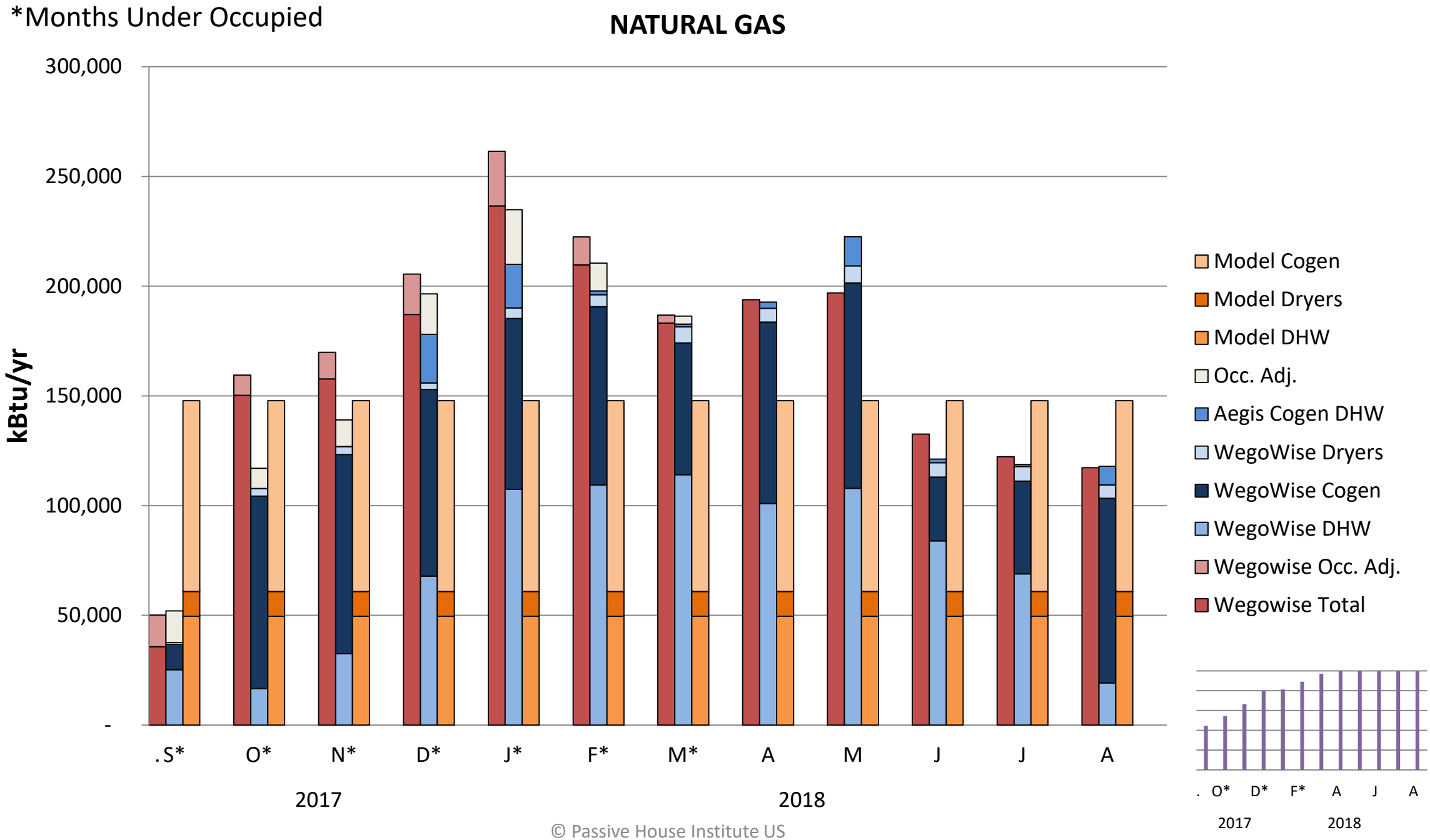

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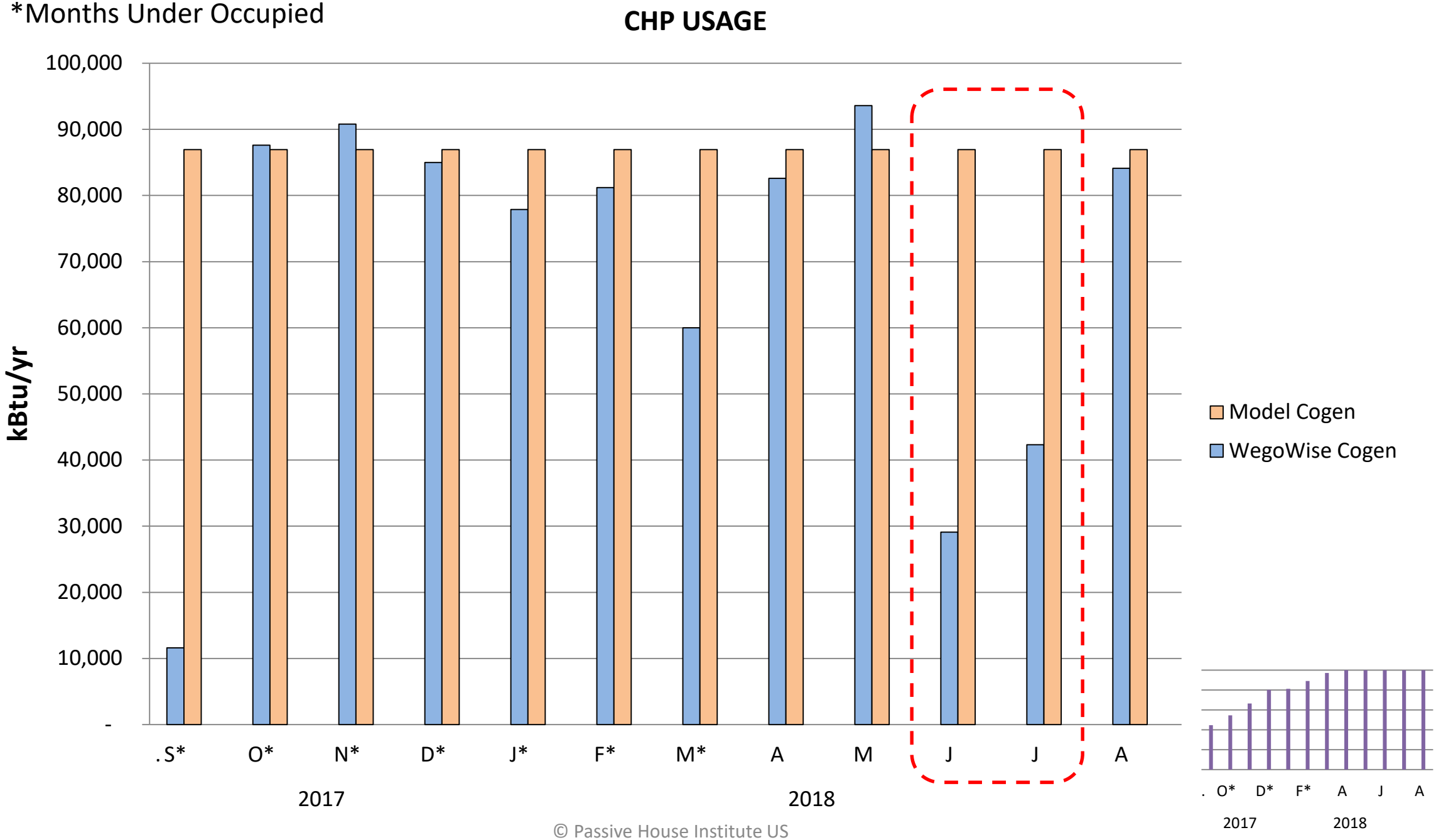

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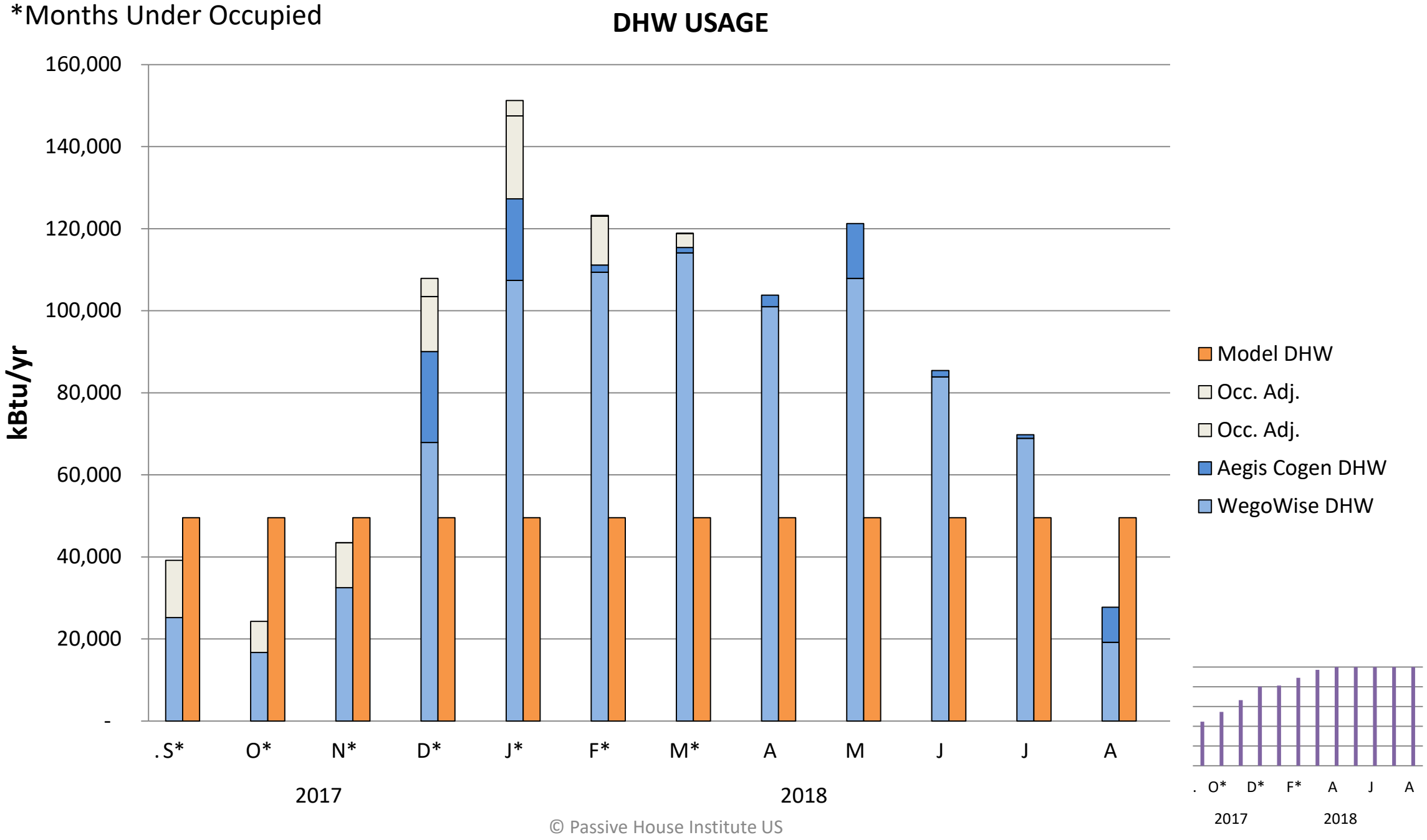

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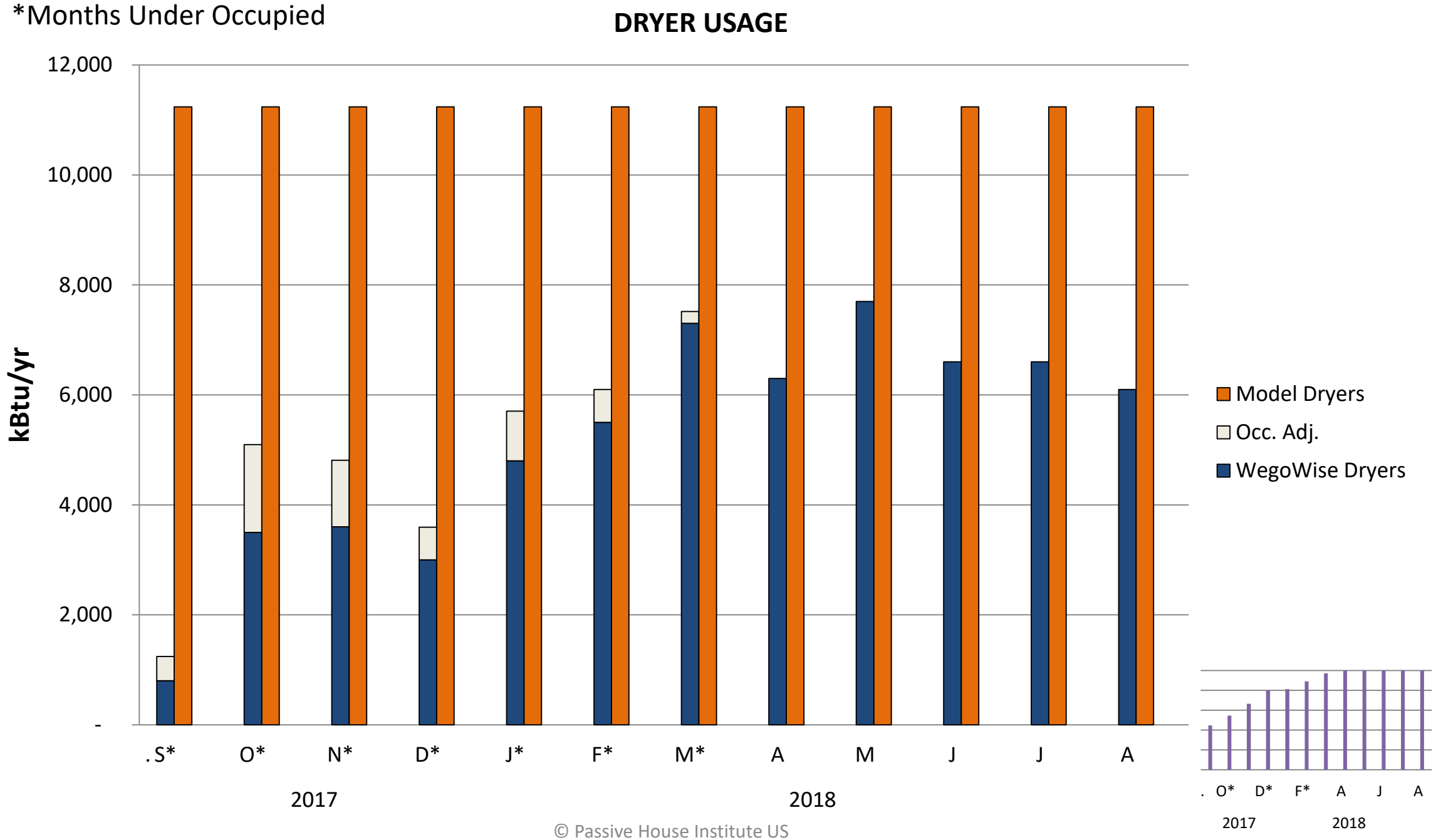


Beach Green Dunes

Far Rockaway, NY

101 units

107,800 ft^2

ELECTRICITY

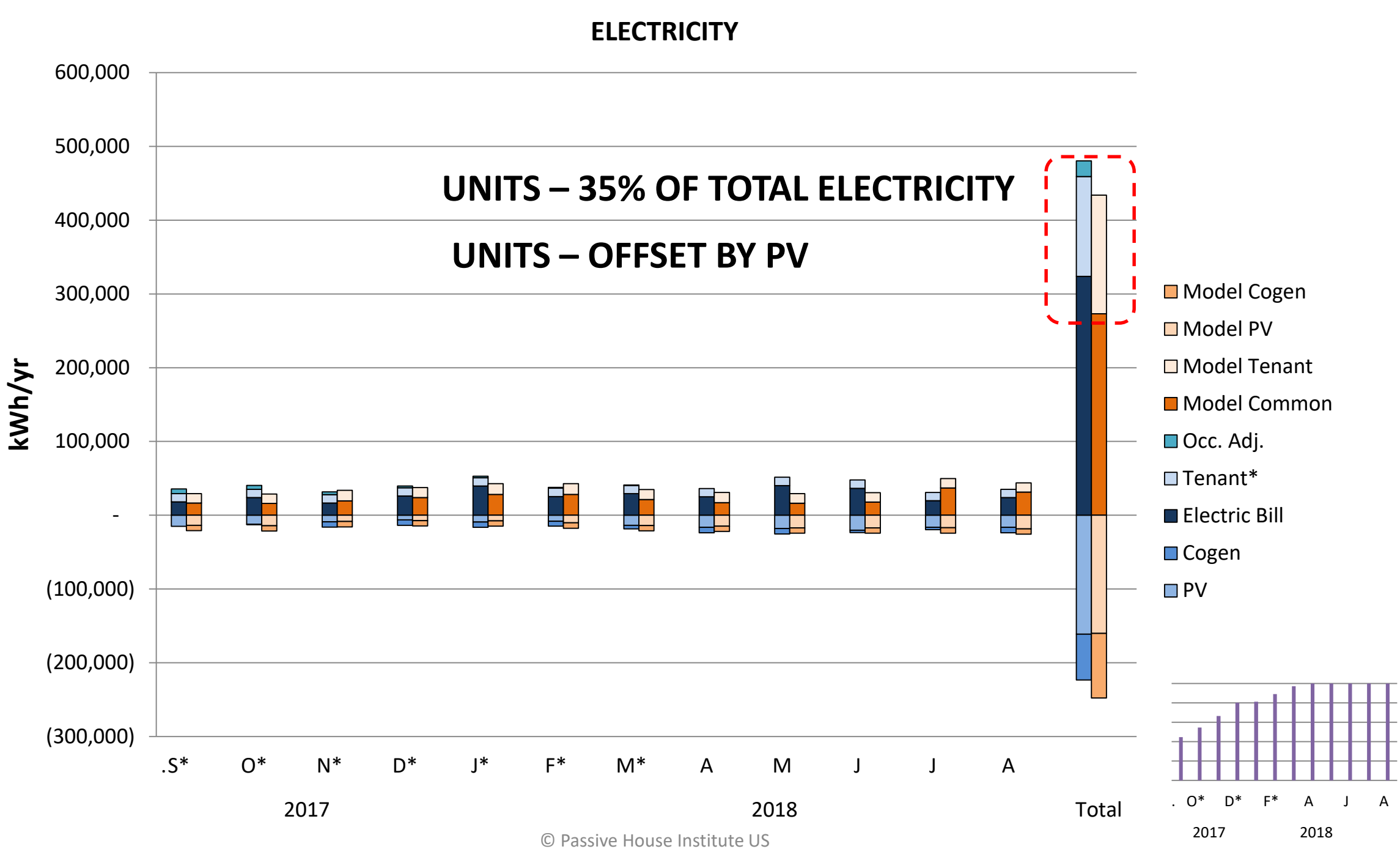
COMMON

VRF (HEAT/COOL)
COMMON LIGHTS
ELEVATORS
PUMPS
PV
FIRE ALARMS,
SECURITY, ETC..

TENANT

ERV
UNIT LIGHTS
UNIT PLUG LOADS /
APPLIANCES

BEACH GREEN DUNES



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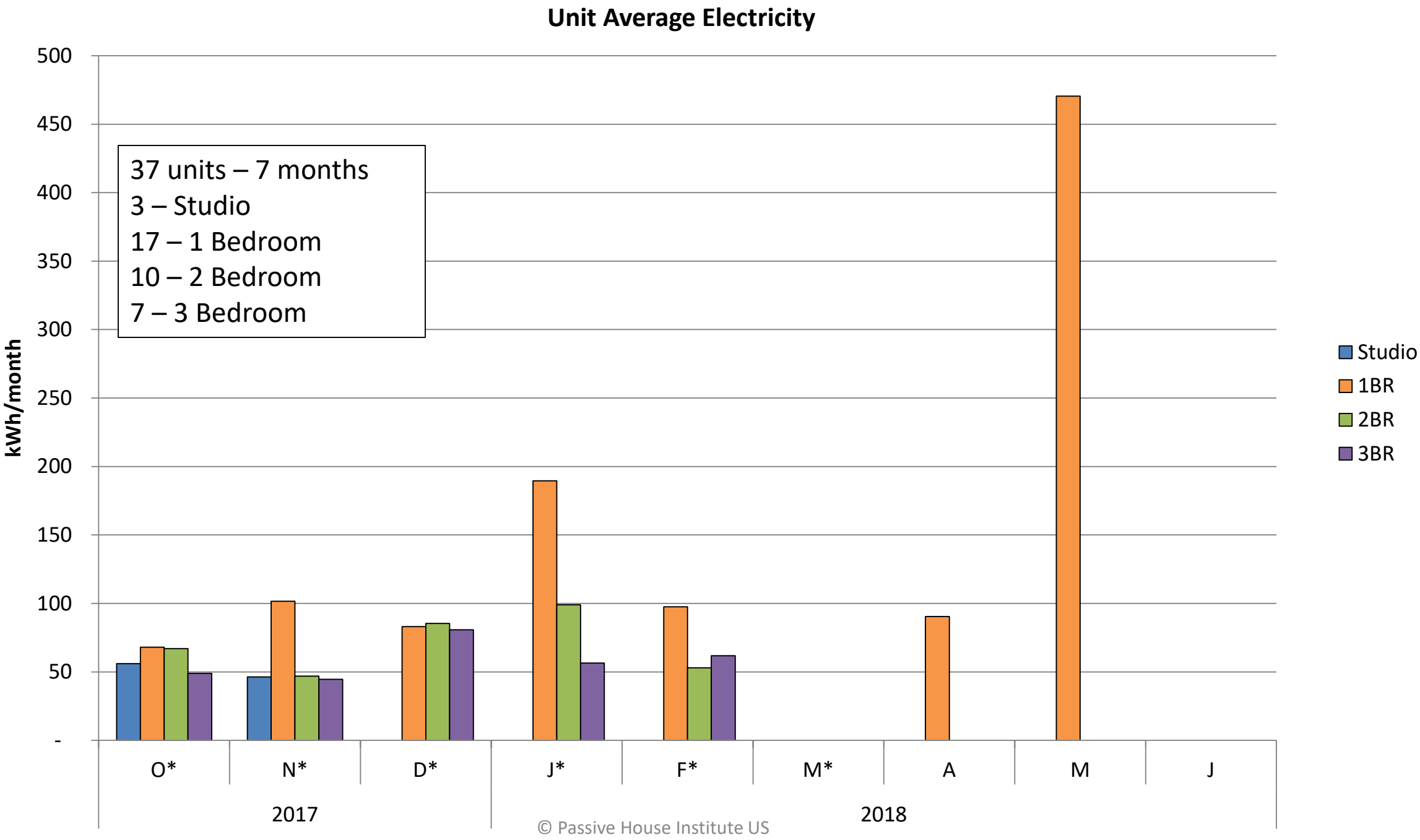

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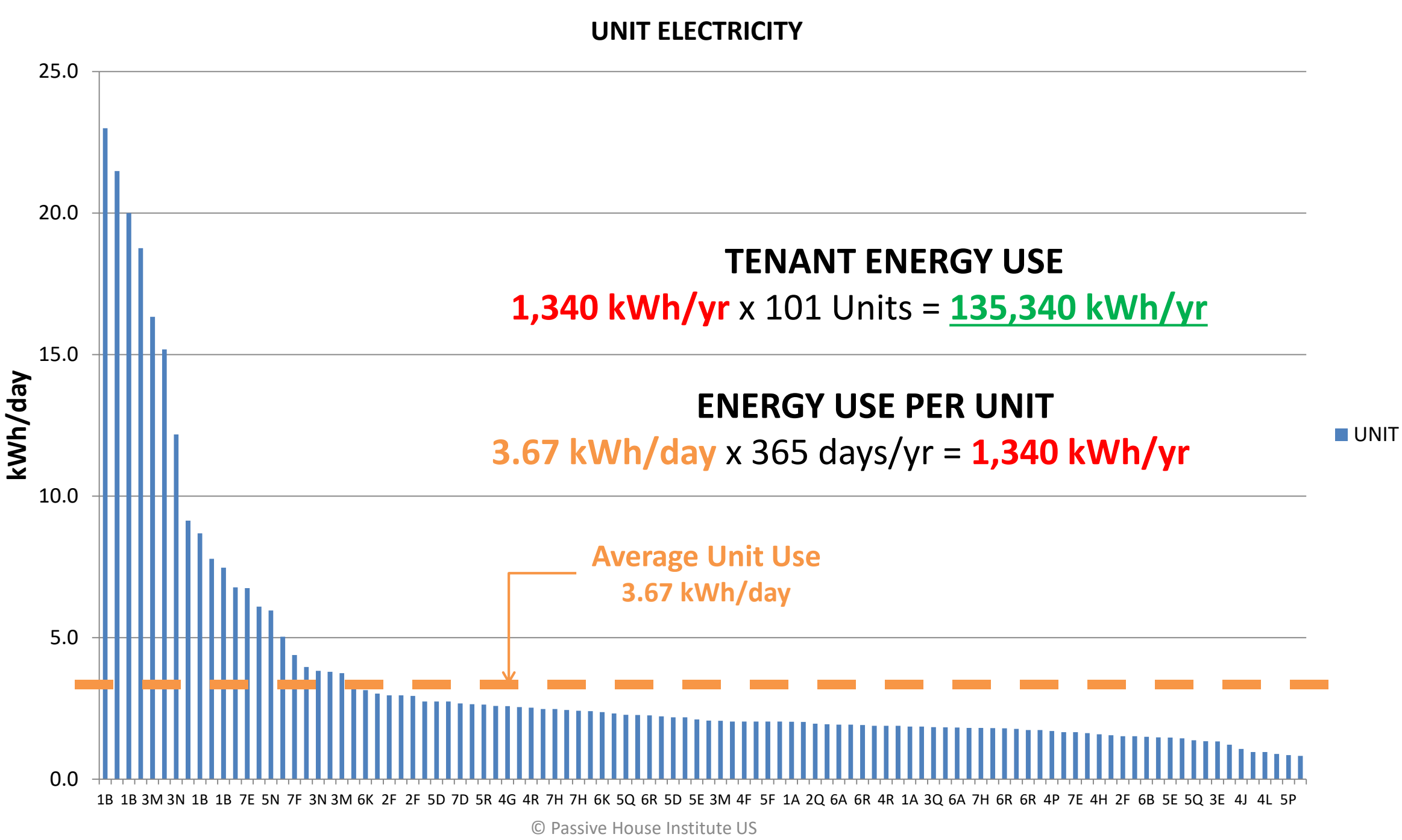
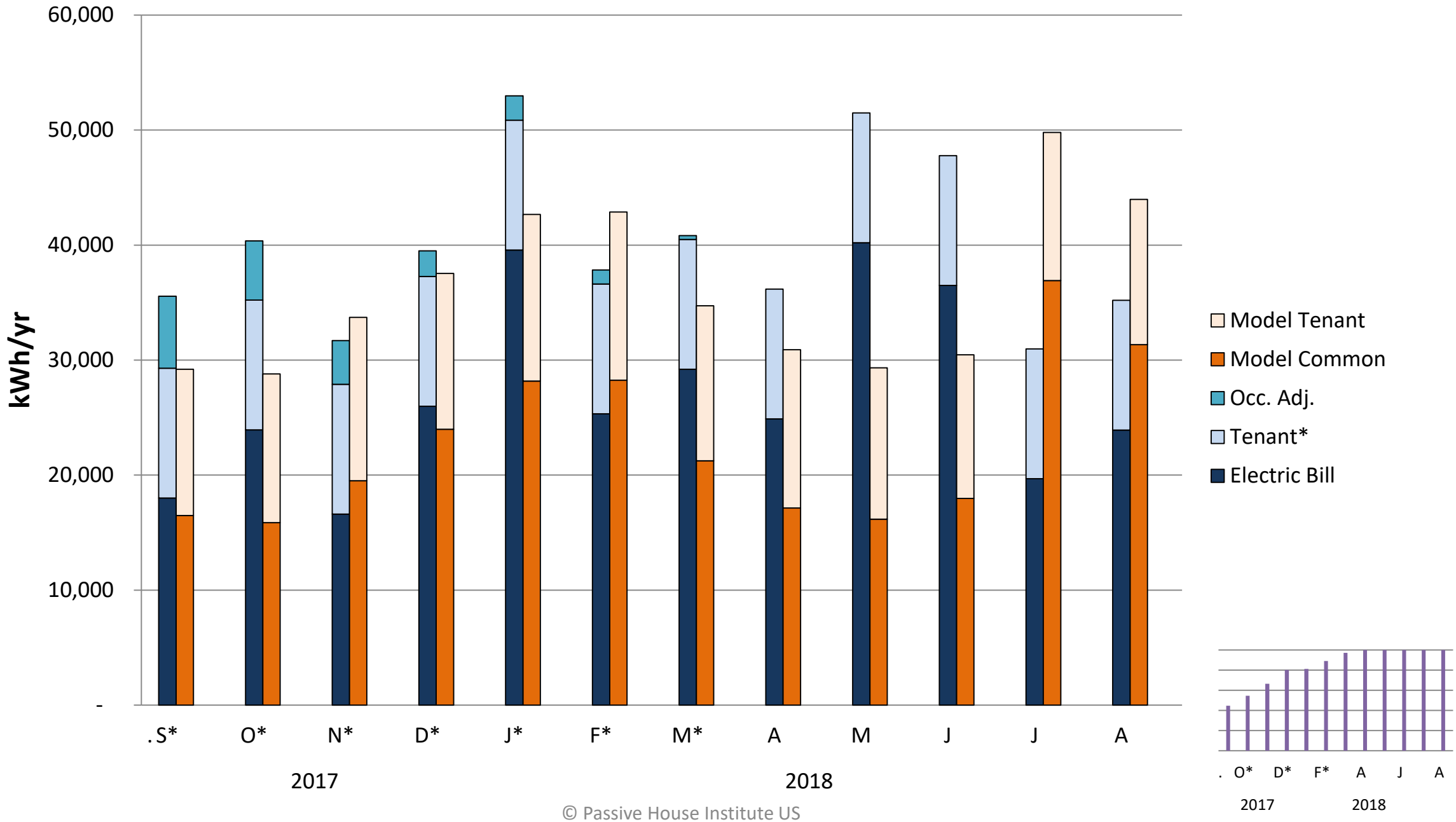


BEACH GREEN DUNES

COMMON + TENANT



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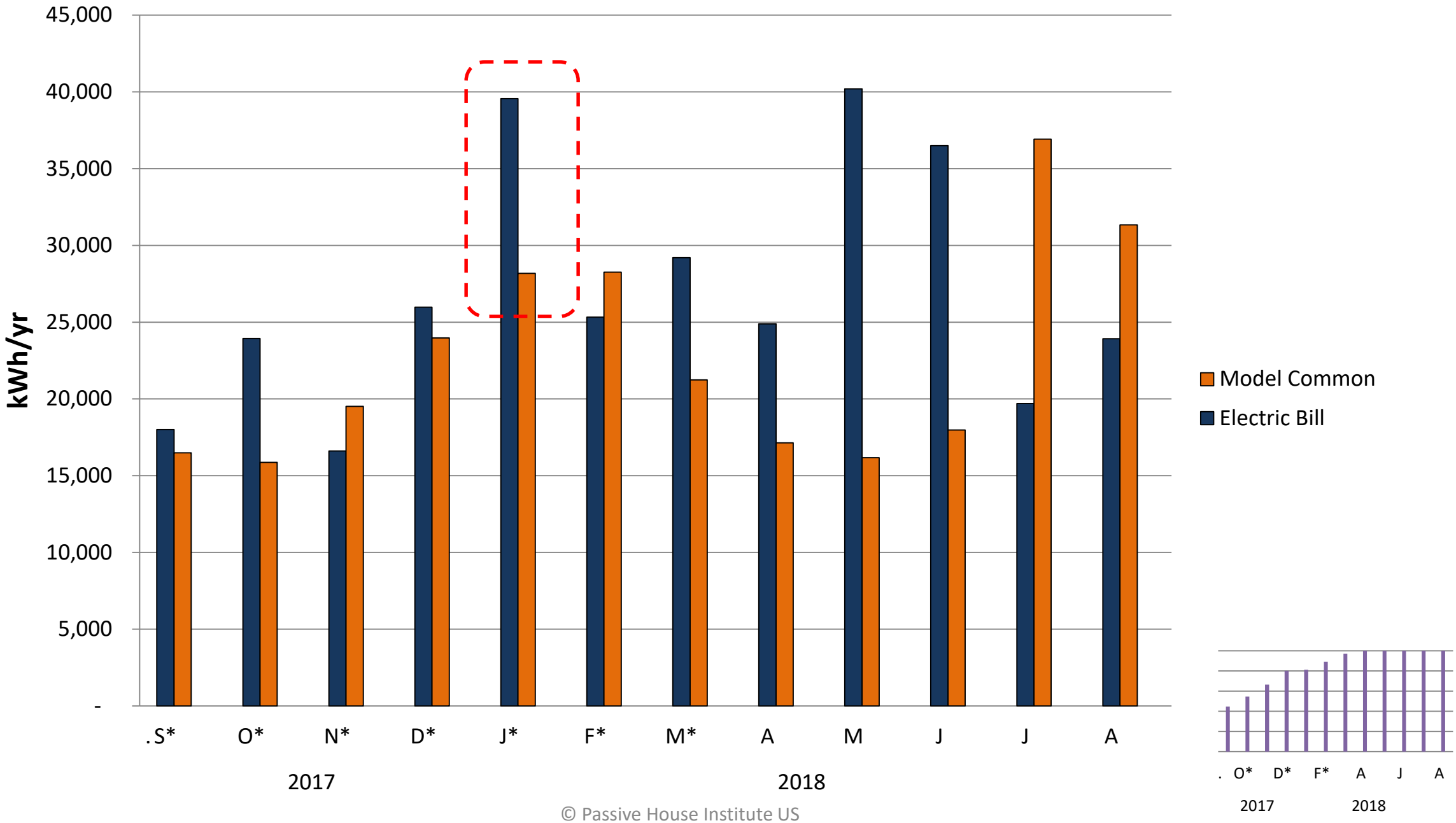
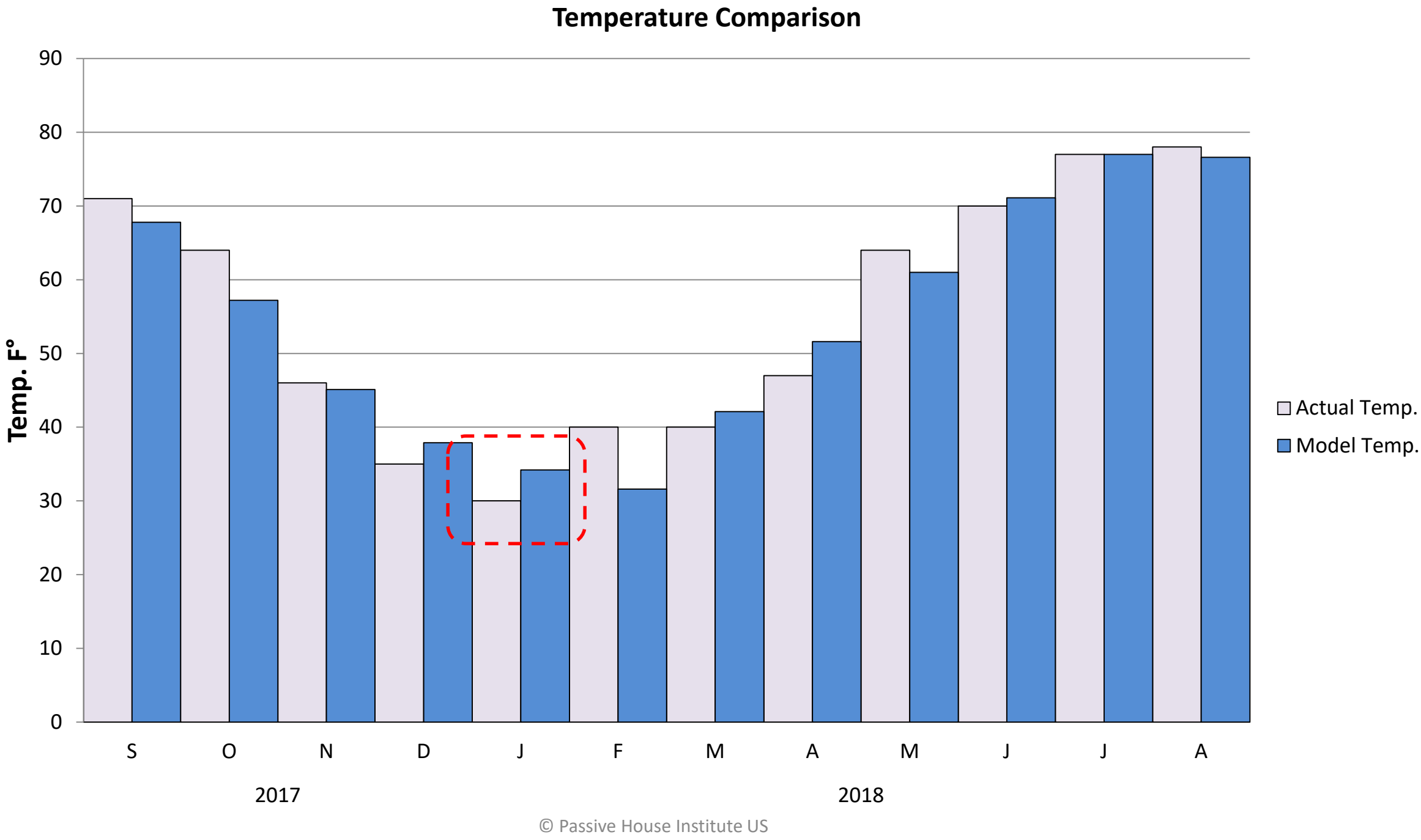
COMMON ELECTRICITY



BEACH GREEN DUNES



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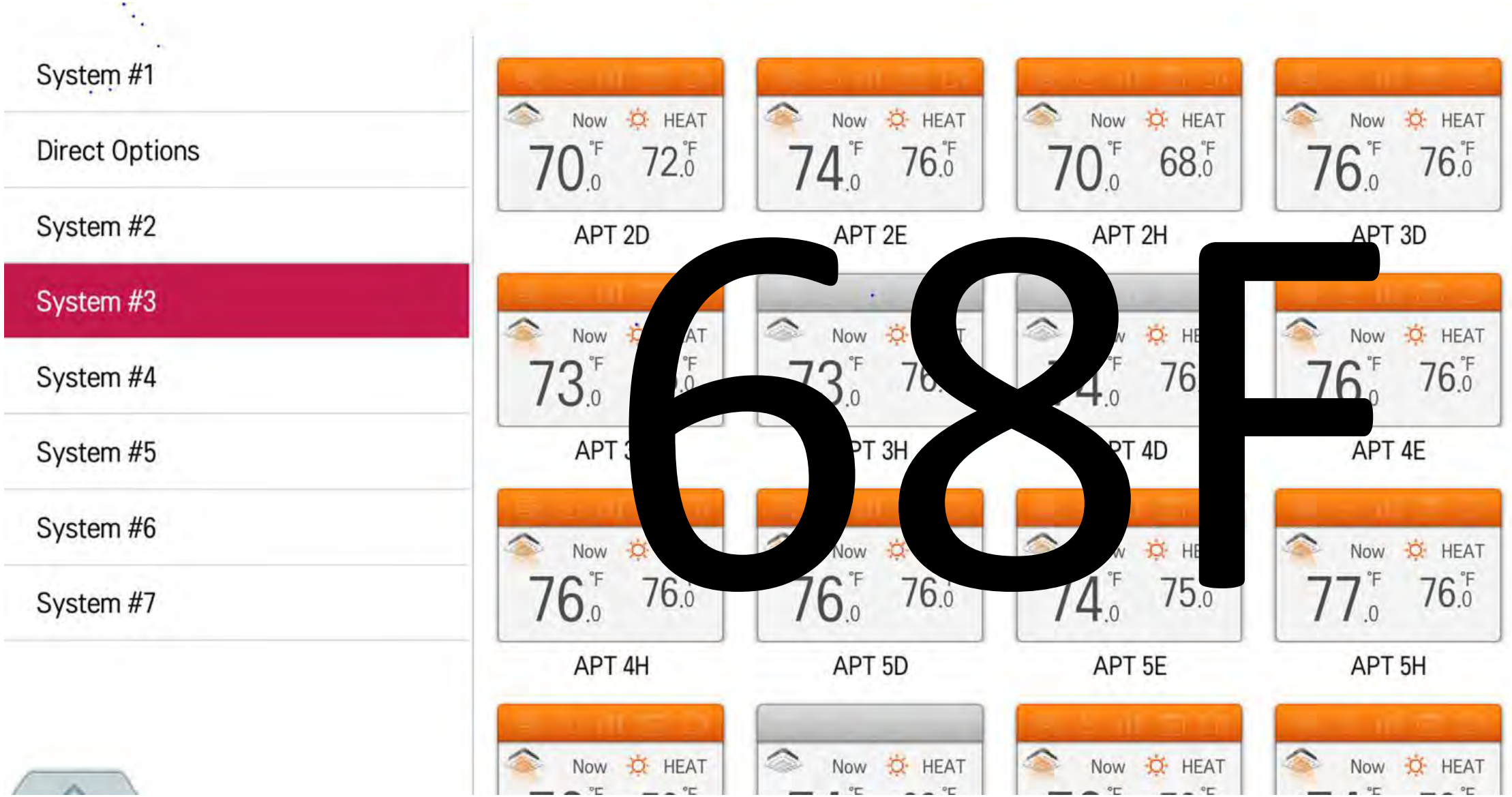

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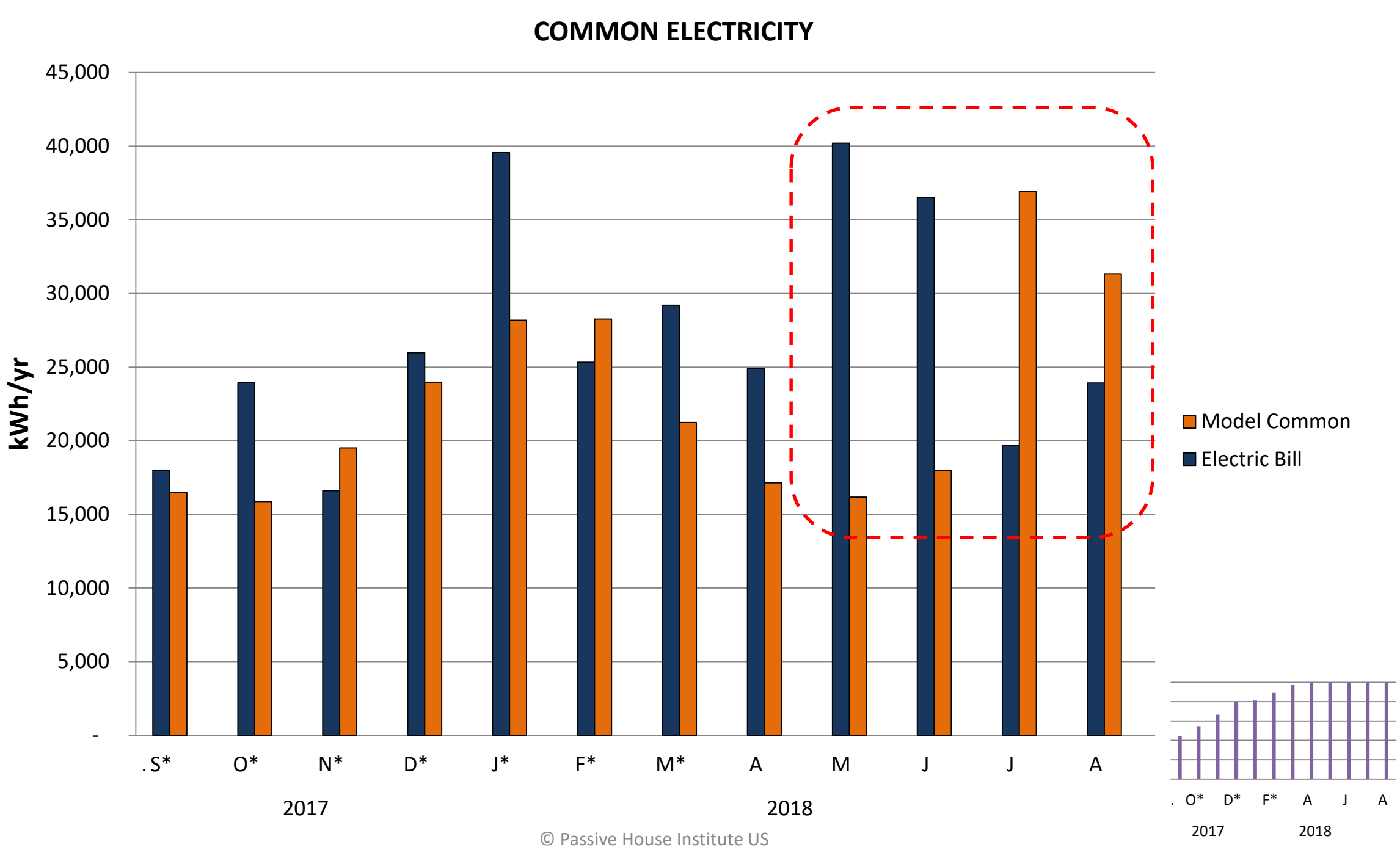

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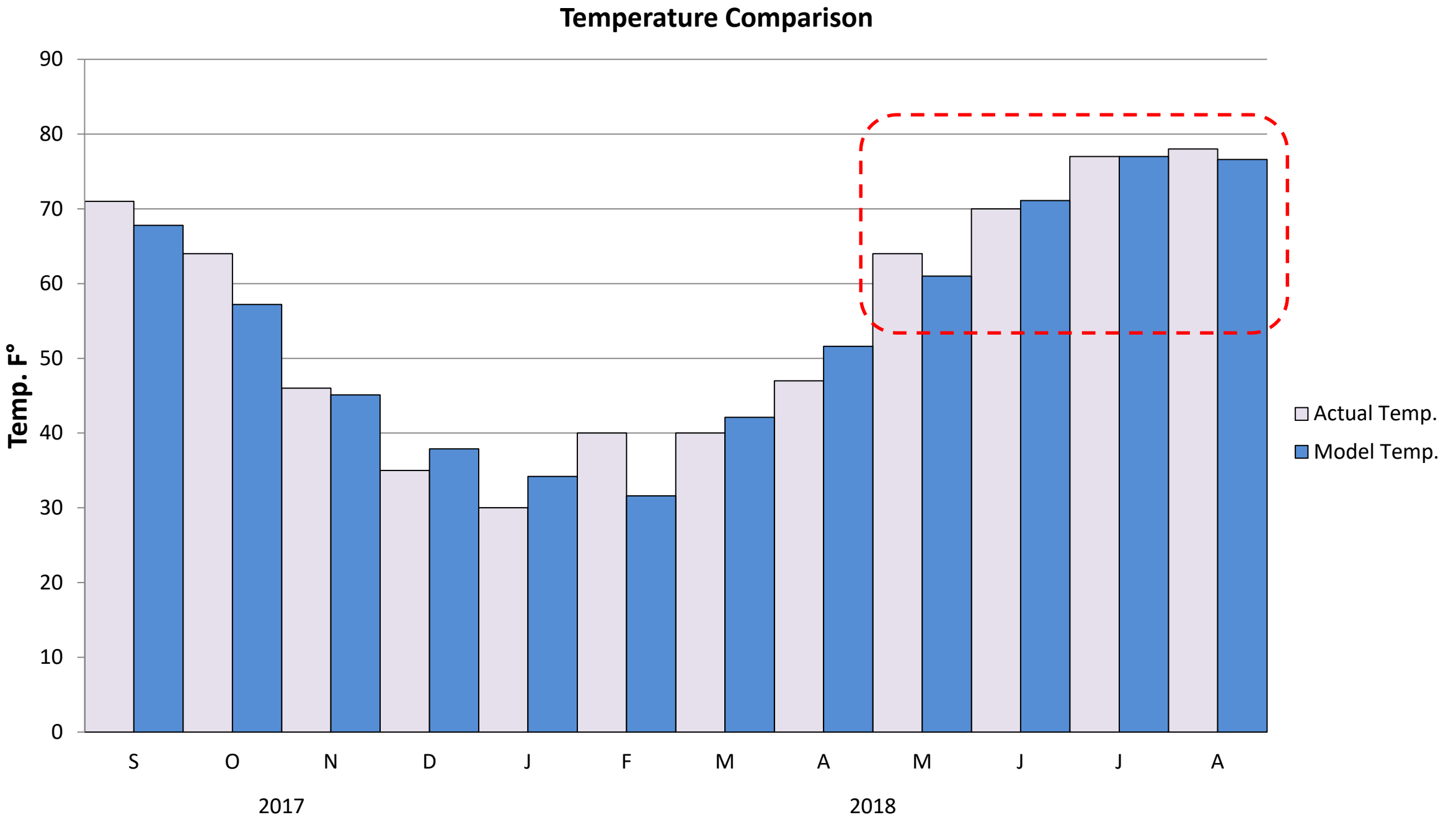
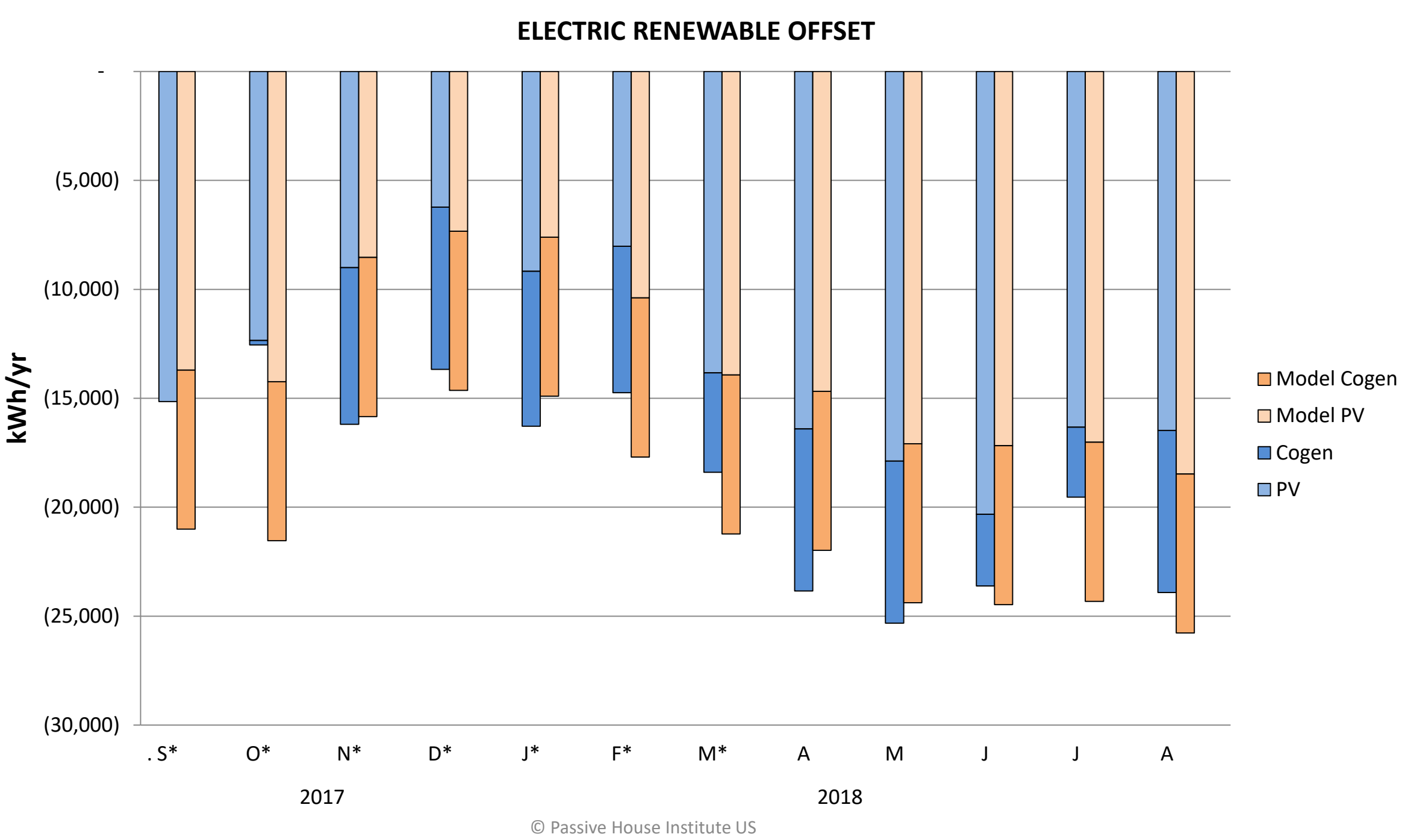


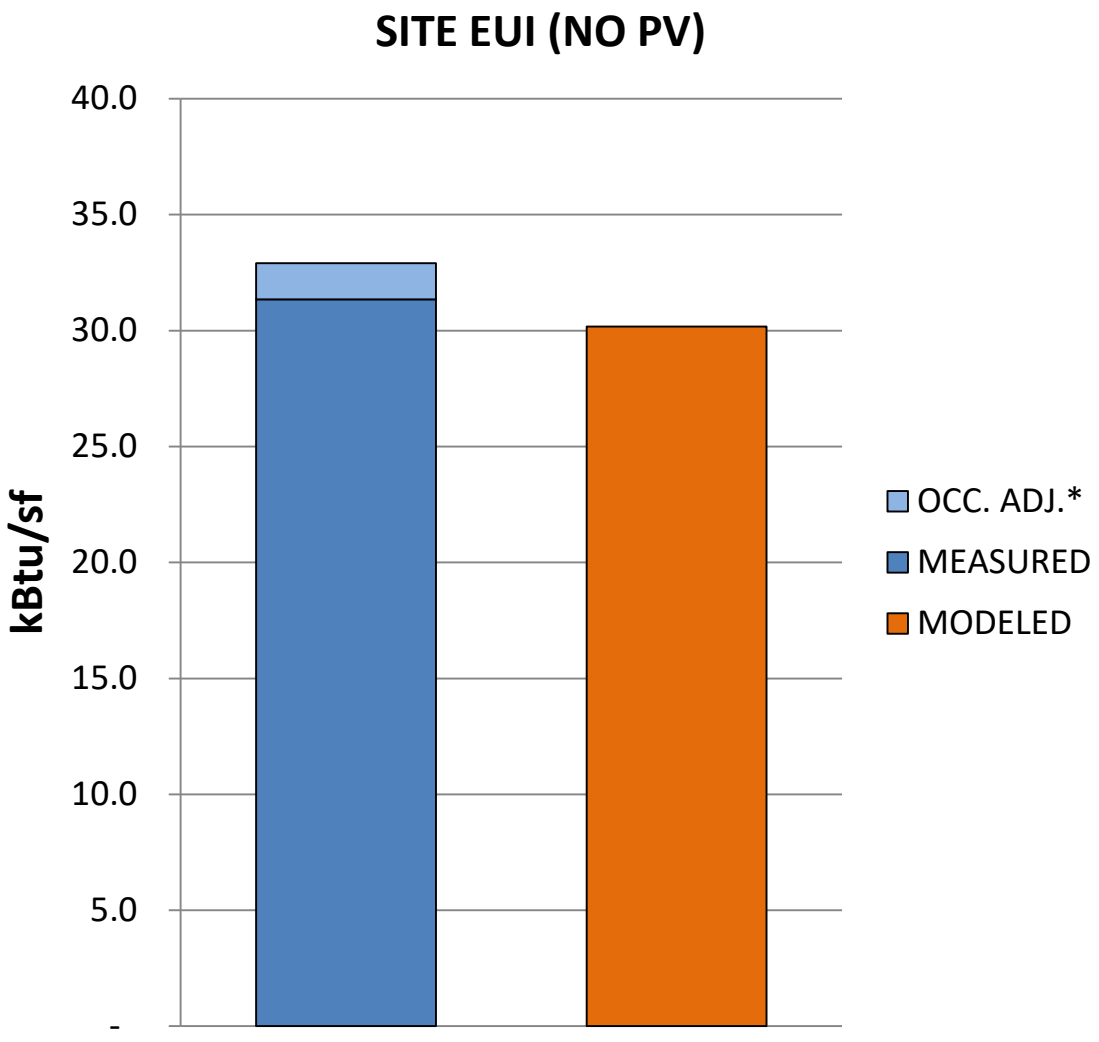

Rockaway Beach
Boulevard
United Rentals
1-800-UR-RENTS
60759-MG
R-9358

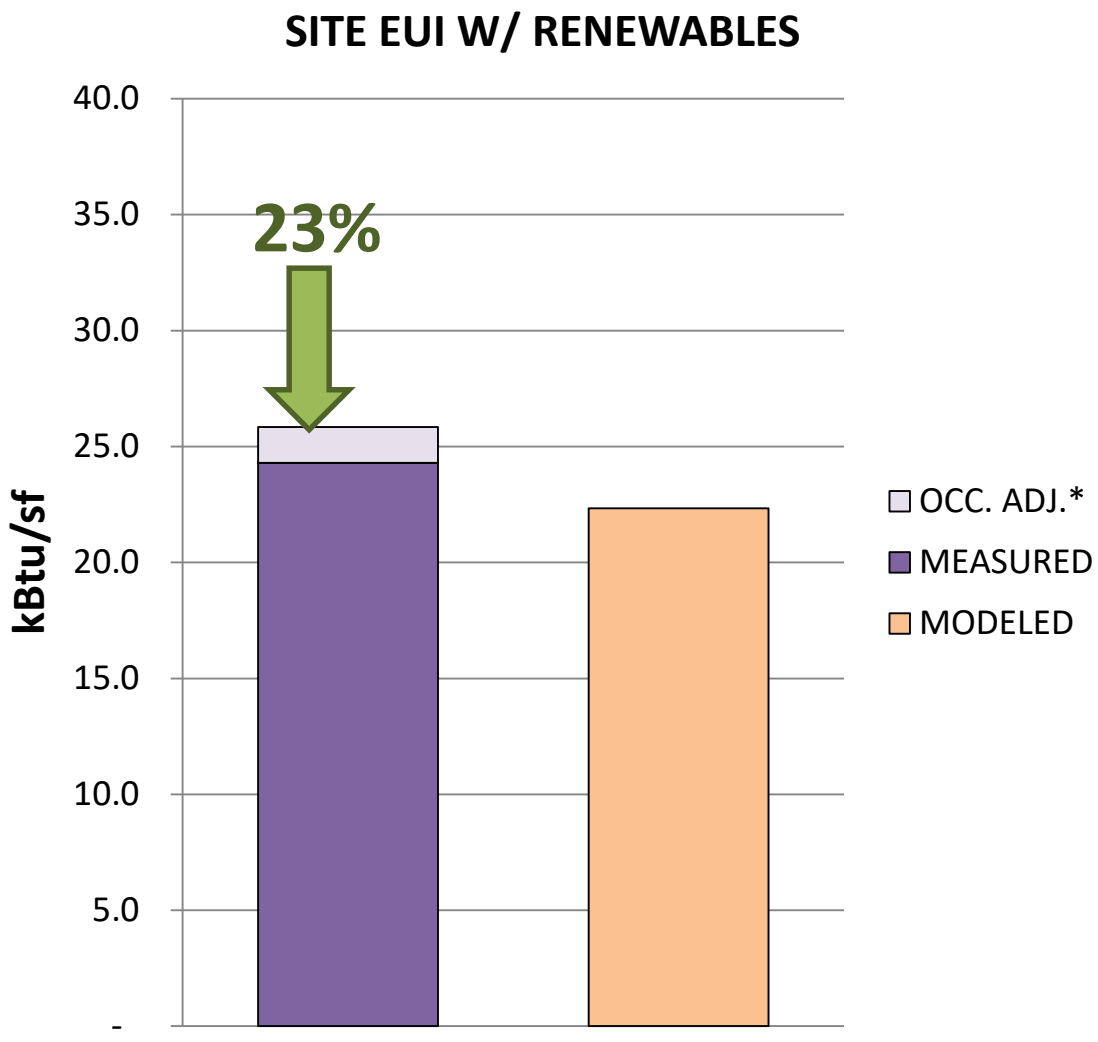
BEACH GREEN DUNES



BEACH GREEN DUNES

89% Modeled vs Actual





LESSONS LEARNED

- Assigning roles/responsibilities upfront is critical.
  Need a contact for design, installation, monitoring, debugging, resident.

- Monitoring never seems to be a priority, just “nice to have”.
  Hard to place priority on that over other budgetary/time constraints.

- Systems work incorrectly (or not at all) quite often. Meters also break.
  Whose responsibility is it to check up on that, and then fix it?

- Monitoring should be part of the design process at the start, not finish.
  And maintained throughout all phases of design.

- Critical to follow through with plan during construction.
  And inspect/track after final installation.

PASSIVE BUILDING

PART OF THE SOLUTION

James Ortega – james@passivehouse.us

www.PHIUS.org

ENERGY STAR Benchmarking Passive House Multifamily Properties

October 4, 2018

NESEA Building Energy 2018, New York

Stuart Brodsky, Clinical Assistant Professor, Director

New York University School of Professional Studies Schack Institute of Real Estate

Center for the Sustainable Built Environment

Contents

- Why Benchmark to Energy Star
- Performance of Three Properties
- Next Steps

Why Benchmark to ENERGY STAR

Why Benchmark to ENERGY STAR

- National point of reference
- Required in some jurisdictions
  - NYC
- FANNIE MAE funding

Performance of Three Properties

Benchmarked Performance

Property	ENERGY STAR Rating	Total GHG (Metric tons)	CO2e lbs / SF
188 Uptown Lofts, Pittsburgh, PA	72*	126	11.4
1279 Apartments, Brewer, ME	100	50.8	2.04
1343 Apartments, Portland, ME	100	63.1	3.59

ENERGY STAR® Statement of Energy Performance

LEARN MORE AT energystar.gov

100

ENERGY STAR® Score[1]

1279 Apartments

Primary Property Type: Multifamily Housing
Gross Floor Area (ft²): 54,886
Built: 2016

For Year Ending: September 30, 2017
Date Generated: October 02, 2018

Property & Contact Information

Property Address
1279 Apartments
266 Center Street
Brewer, Maine 04412

Property Owner
New York University, Schack Institute of Real Estate
11 West 42nd St,
New York, NY 10036
(____)____-_____

Primary Contact
Stuart brodsky
11 West 42nd St,
New York, NY 10036
202 531 0036
sb4311@nyu.edu

Property ID: 6458182

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
15.1 kBtu/ft²

Source EUI
29 kBtu/ft²

Annual Energy by Fuel

Electric - Grid (kBtu)	363,940 (44%)
Electric - Solar (kBtu)	90,162 (11%)
Natural Gas (kBtu)	375,824 (45%)

National Median Comparison

National Median Site EUI (kBtu/ft²)	60.2
National Median Source EUI (kBtu/ft²)	115.3
% Diff from National Median Source EUI	-75%

Annual Emissions

Greenhouse Gas Emissions (Metric Tons CO2e/year)	51

ENERGY STAR® Statement of Energy Performance

LEARN MORE AT energystar.gov

100

ENERGY STAR® Score[1]

1343 Apartments / Oxford Street

Primary Property Type: Multifamily Housing
Gross Floor Area (ft²): 38,760
Built: 2016

For Year Ending: February 28, 2018
Date Generated: October 02, 2018

Property & Contact Information

Property Address
1343 Apartments / Oxford Street
81 East Oxford Street
Portland, Maine 04412

Property Owner
New York University, Schack Institute of Real Estate
11 West 42nd St,
New York, NY 10036
(____)____-_____

Primary Contact
Stuart brodsky
11 West 42nd St,
New York, NY 10036
202 531 0036
sb4311@nyu.edu

Property ID: 6454351

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
23.9 kBtu/ft²

Source EUI
53.8 kBtu/ft²

Annual Energy by Fuel

Electric - Grid (kBtu)	635,841 (69%)
Natural Gas (kBtu)	290,162 (31%)

National Median Comparison

National Median Site EUI (kBtu/ft²)	49.8
National Median Source EUI (kBtu/ft²)	112.1
% Diff from National Median Source EUI	-52%

Annual Emissions

Greenhouse Gas Emissions (Metric Tons CO2e/year)	63

Next Steps

Next Steps

- Energy operating cost data
- Impact on rental rates
- Impact on net operating income
- Impact on asset value