

Where We Went Right & Where We Went Left:

Modeled vs actual measured performance in MF passive buildings – how do they align?



Second and Delaware, Kansas City, MO

TERMINOLOGY

Demands, Peaks, Site & Primary Energy

Annual Demand [kBTU/yr.ft²]: Space conditioning energy consumed over the course of the year, delivered by the equipment to the space.

Peak Load [BTU/hr.ft²]: 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.ft²]: 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 lighting energy specific to vehicle parking areas)

*No requirement for PHIUS+ Certification

Source Energy [kWh/person.yr]: 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)

Two Case Studies



	<i>Stellar Apartments</i>	<i>Knickerbocker Commons</i>
<i>Location</i>	Eugene, OR	Brooklyn, NY
<i>Square Footage (Gross)</i>	6,200 ft ²	36,350 ft ²
<i>Number of Units</i>	6	24
<i>Modeled Occupancy</i>	18	72
<i>Actual Occupancy</i>	9	64
<i>PHIUS+ Project #</i>	1174	1274

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Stellar Apartments

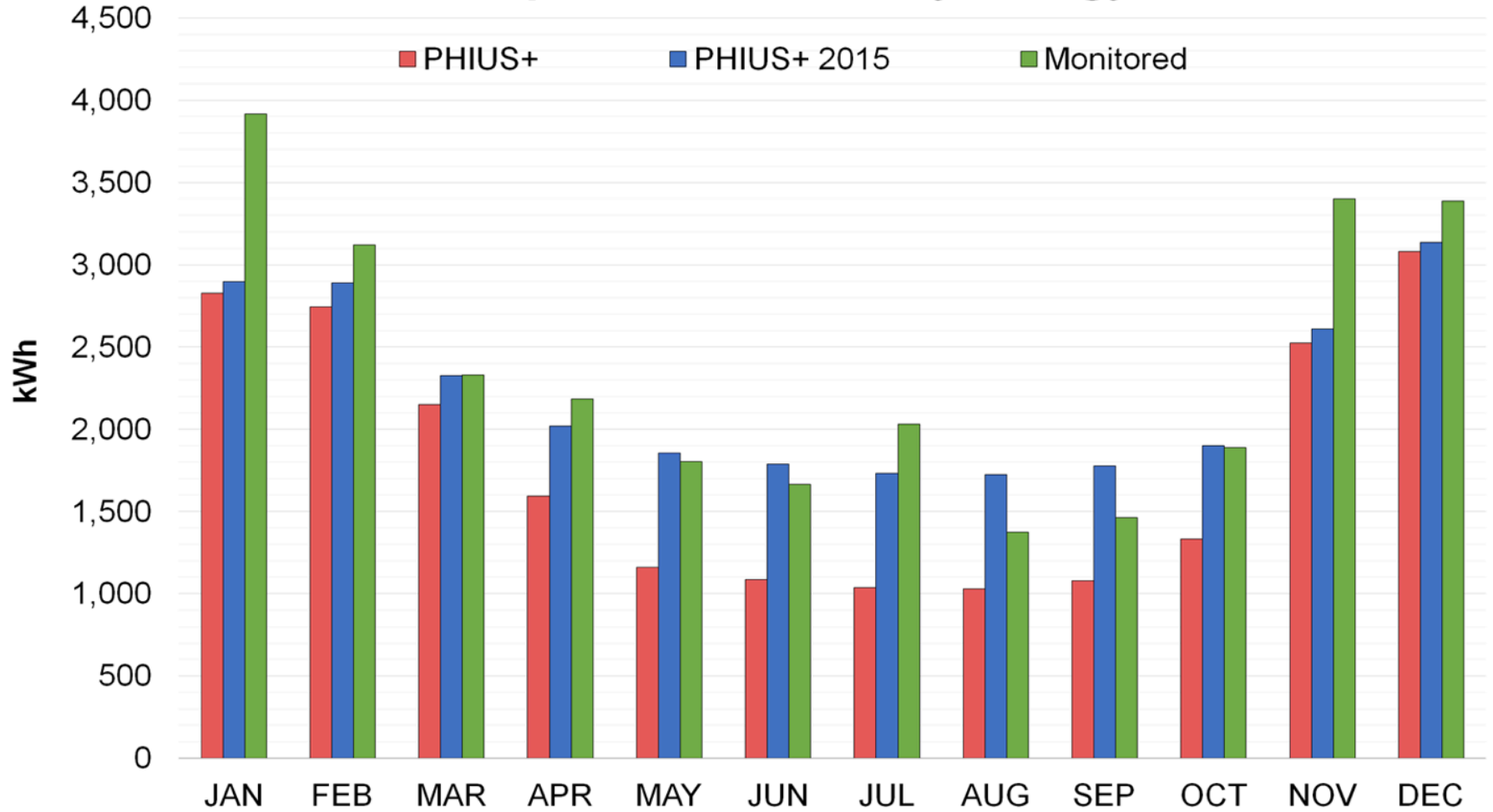


References: NetZED Case Study Laboratory. (2016) The Stellar Apartments Story. Eugene, OR: NetZED Case Study Laboratory.

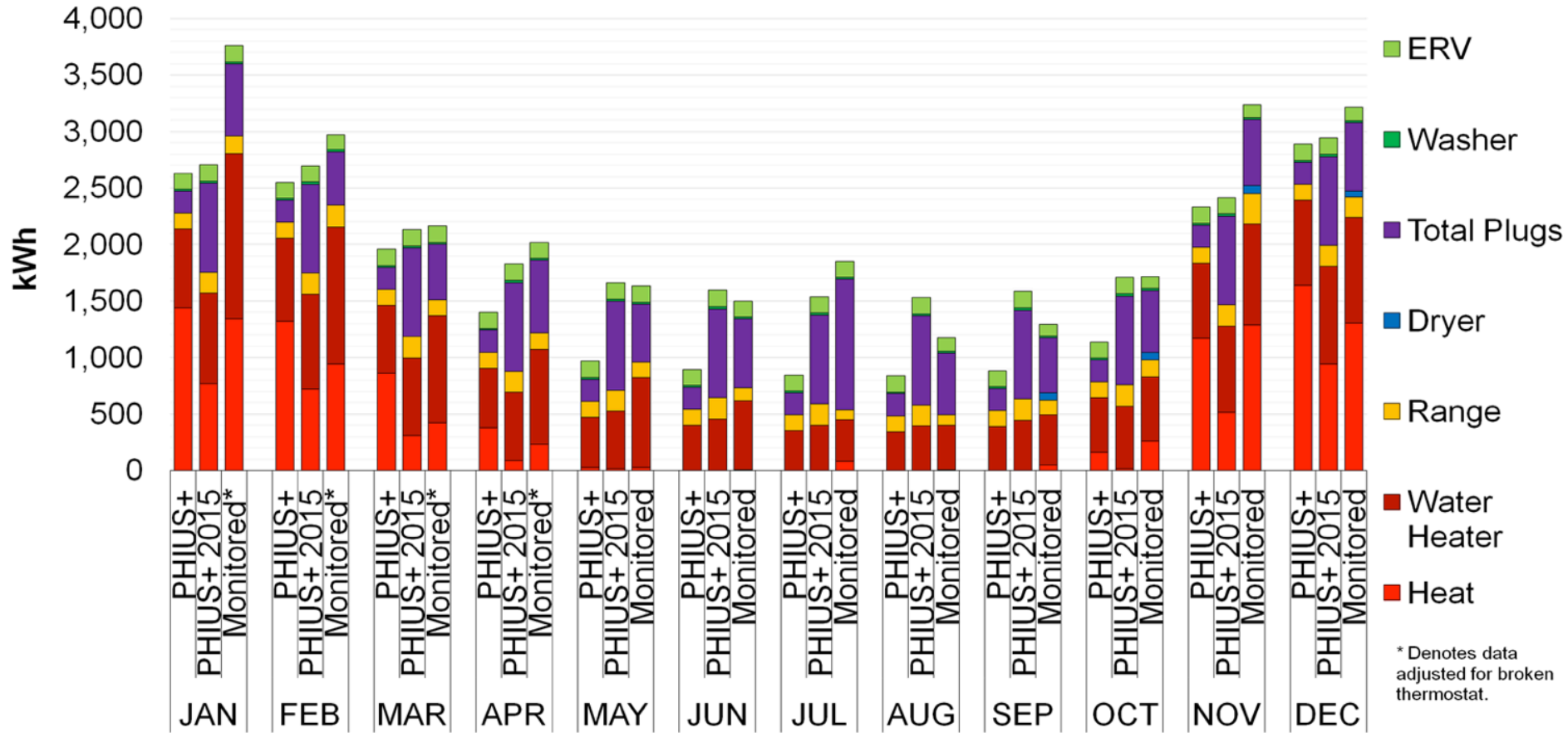
Things to keep in mind

- Monitoring Systems
 - 8 Electricity Monitors per Unit
 - Heating
 - ERV
 - Water Heater
 - Kitchen Range
 - Kitchen Outlets
 - Kitchen Fridge
 - Clothes Washer
 - Other
- Energy Model Limitations
 - ‘Other’ + ‘Kitchen Outlets’ = ‘Lighting/Plug Loads’
 - 7 total categories for comparison
- Shared Space
 - Small Central Stairwell - Not included
- Electric space heating
- Heat pump water heaters in semi-conditioned space
- ‘PHIUS+’ category shown here is equivalent to the PHI standard

Stellar Apartment - Monthly Energy Use



Stellar Apartments - Monthly Energy Use by Type

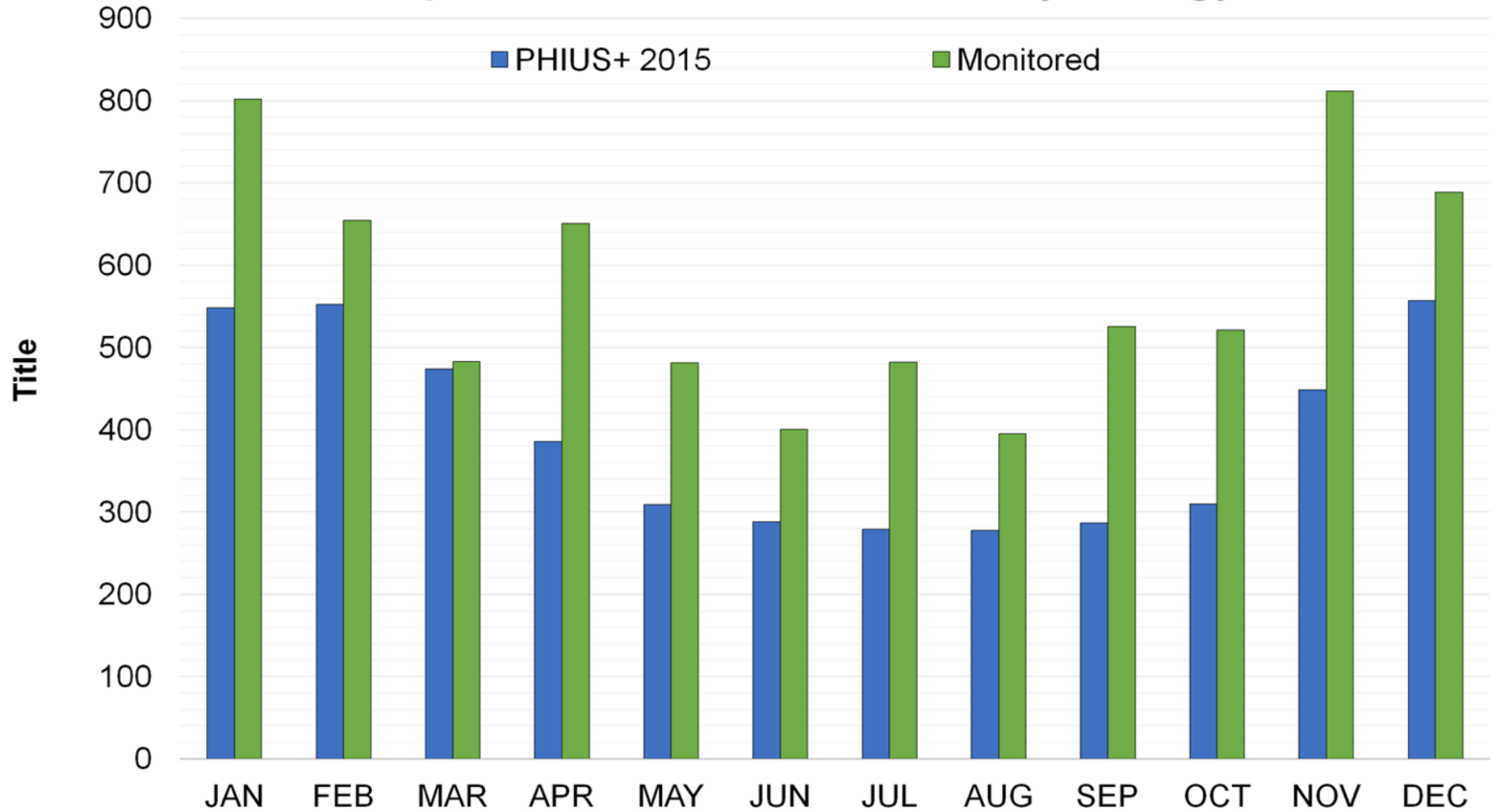


Annual Energy Use by Apartment



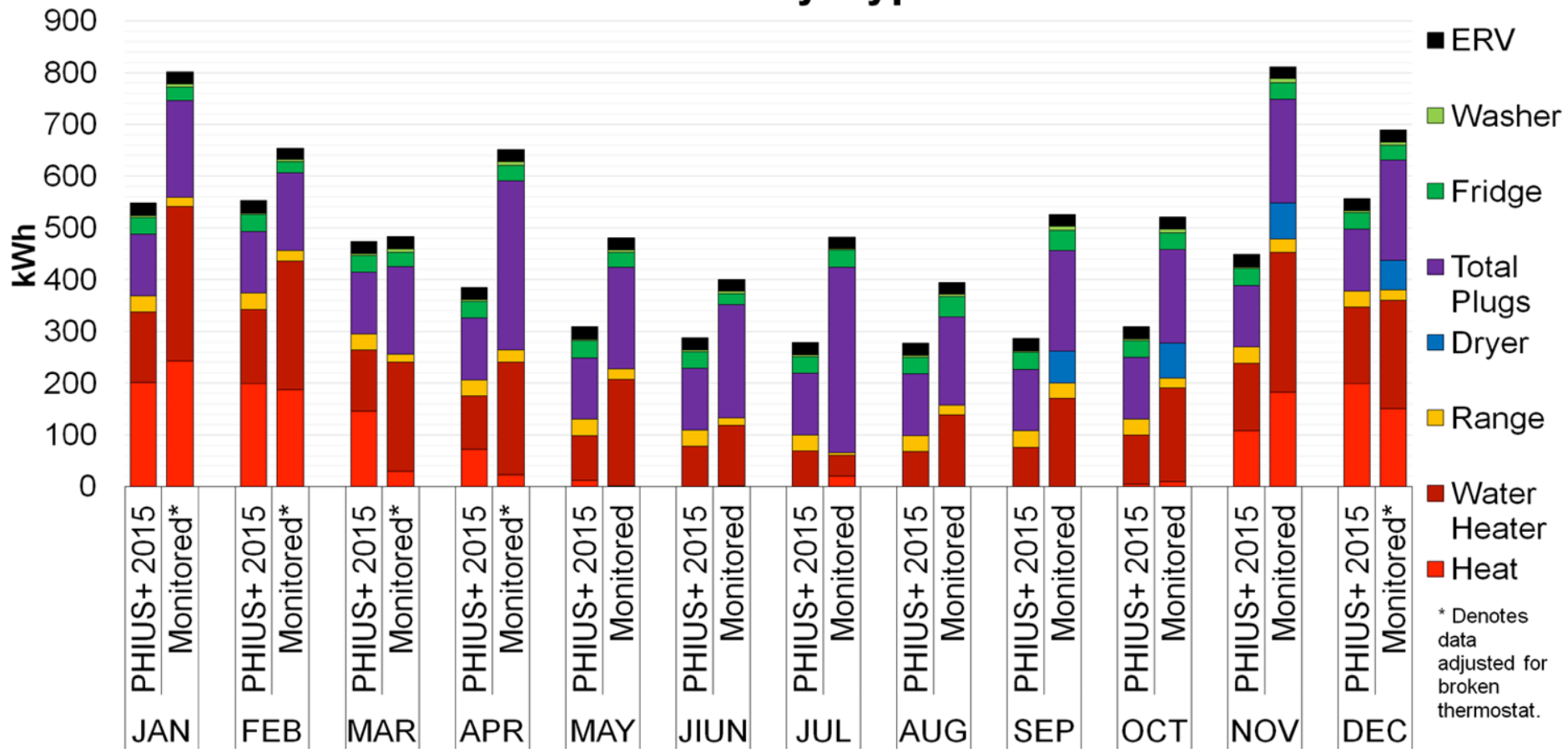
*Worst Case

Stellar Apartments Unit 7B - Monthly Energy Use



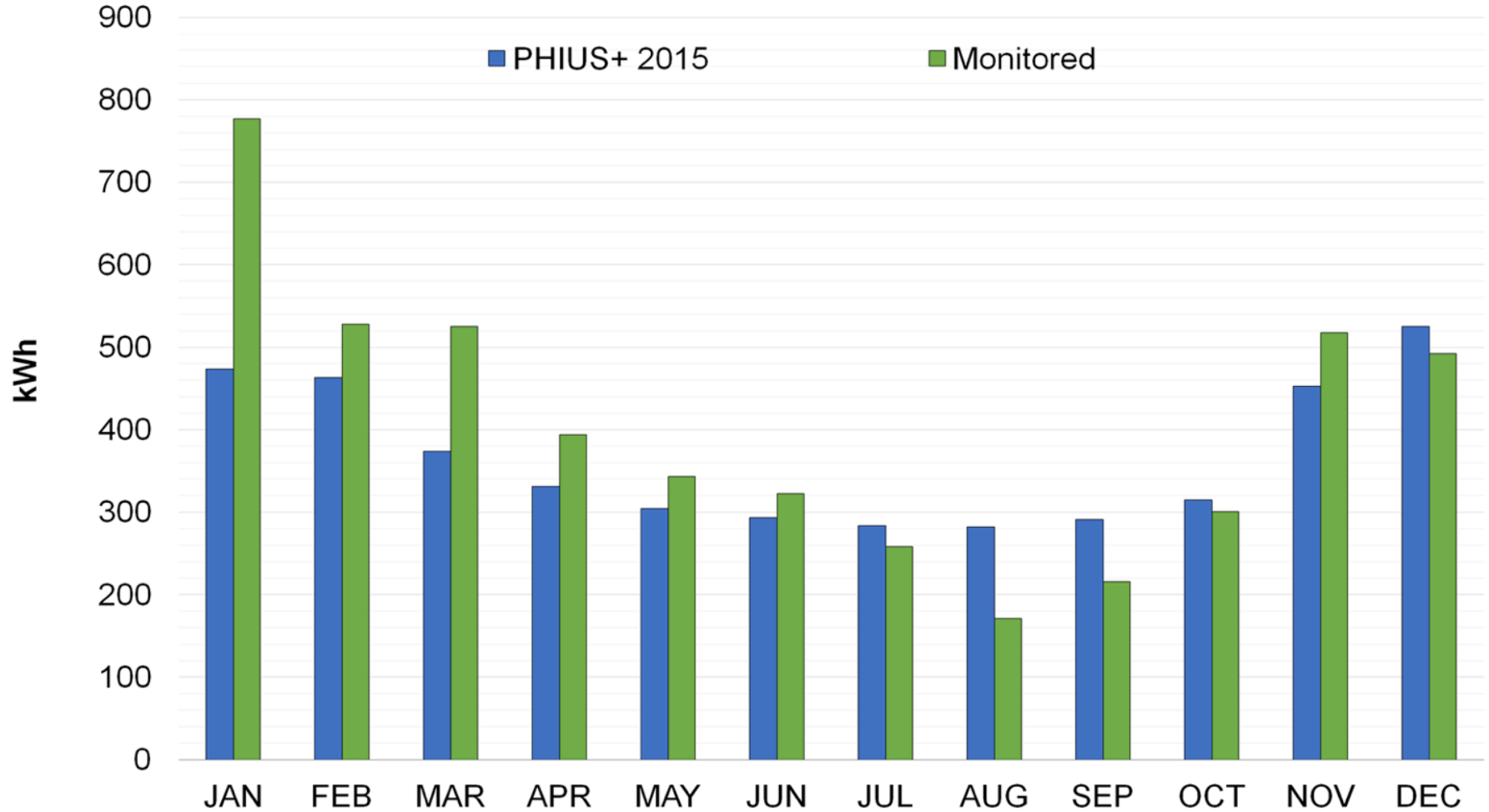
*Worst Case

Stellar Apartments Unit 7B - Monthly Energy Use by Type



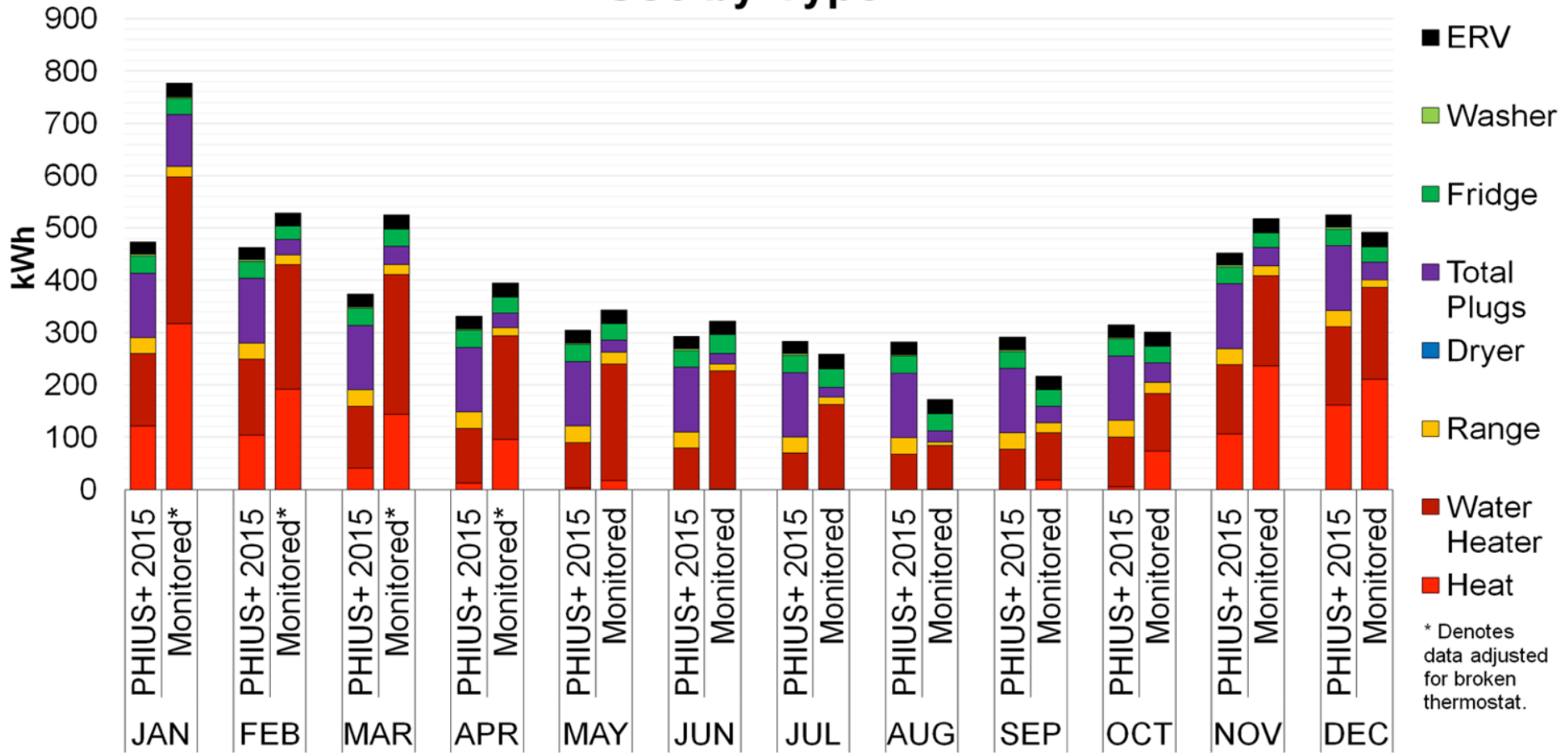
*Average Case

Stellar Apartments Unit 7C - Monthly Energy Use

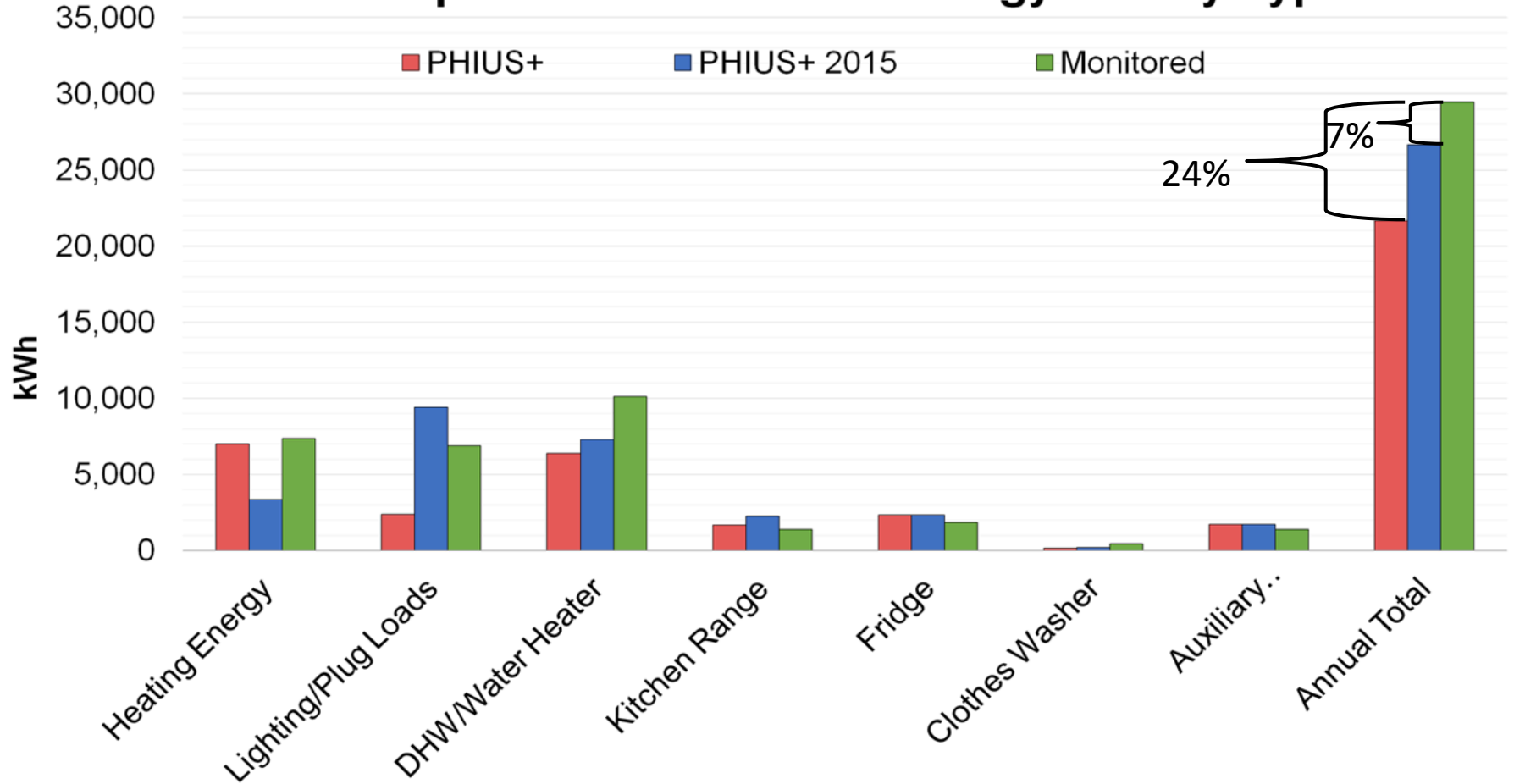


*Average Case

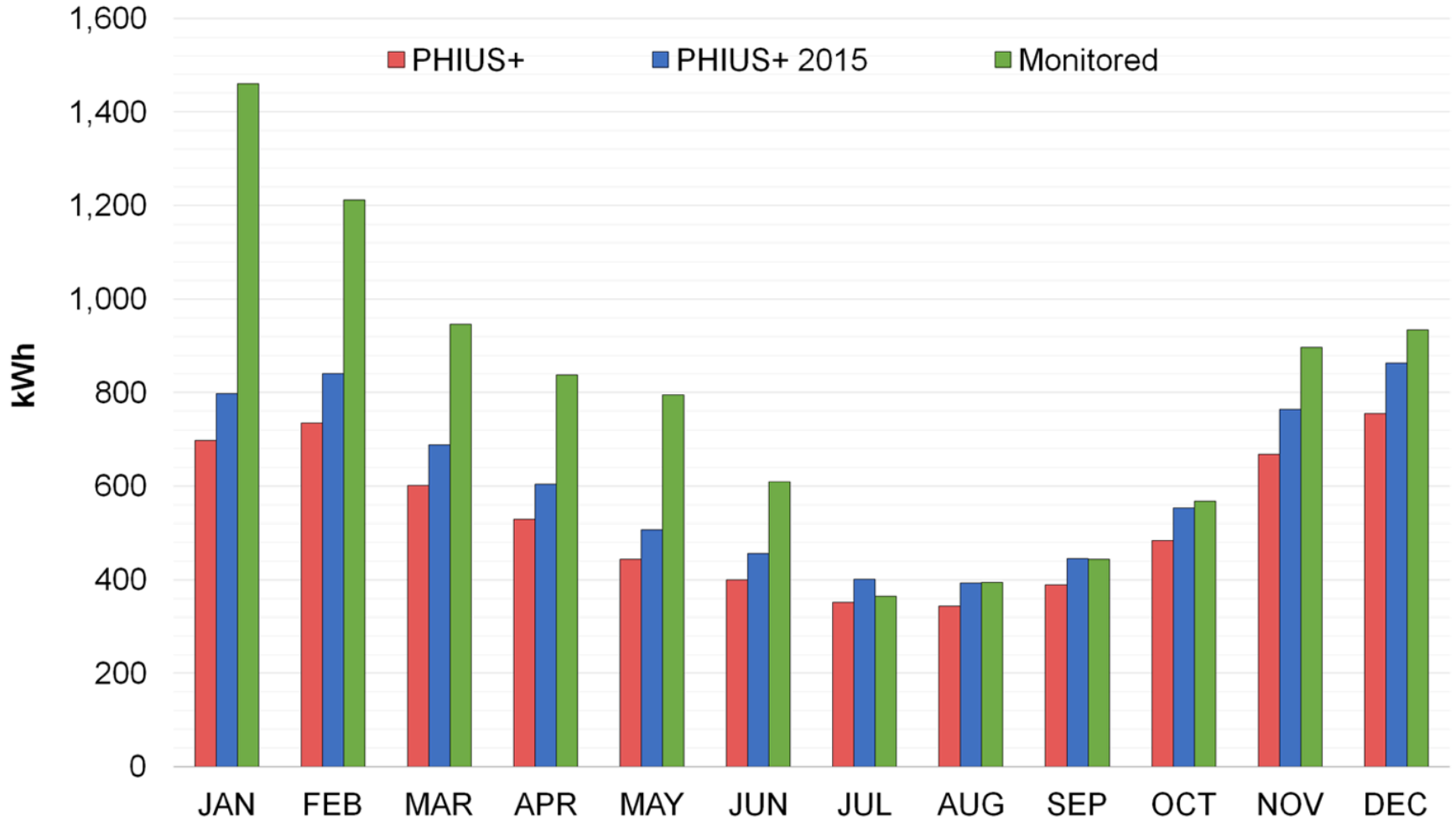
Stellar Apartments Unit 7C - Monthly Energy Use by Type



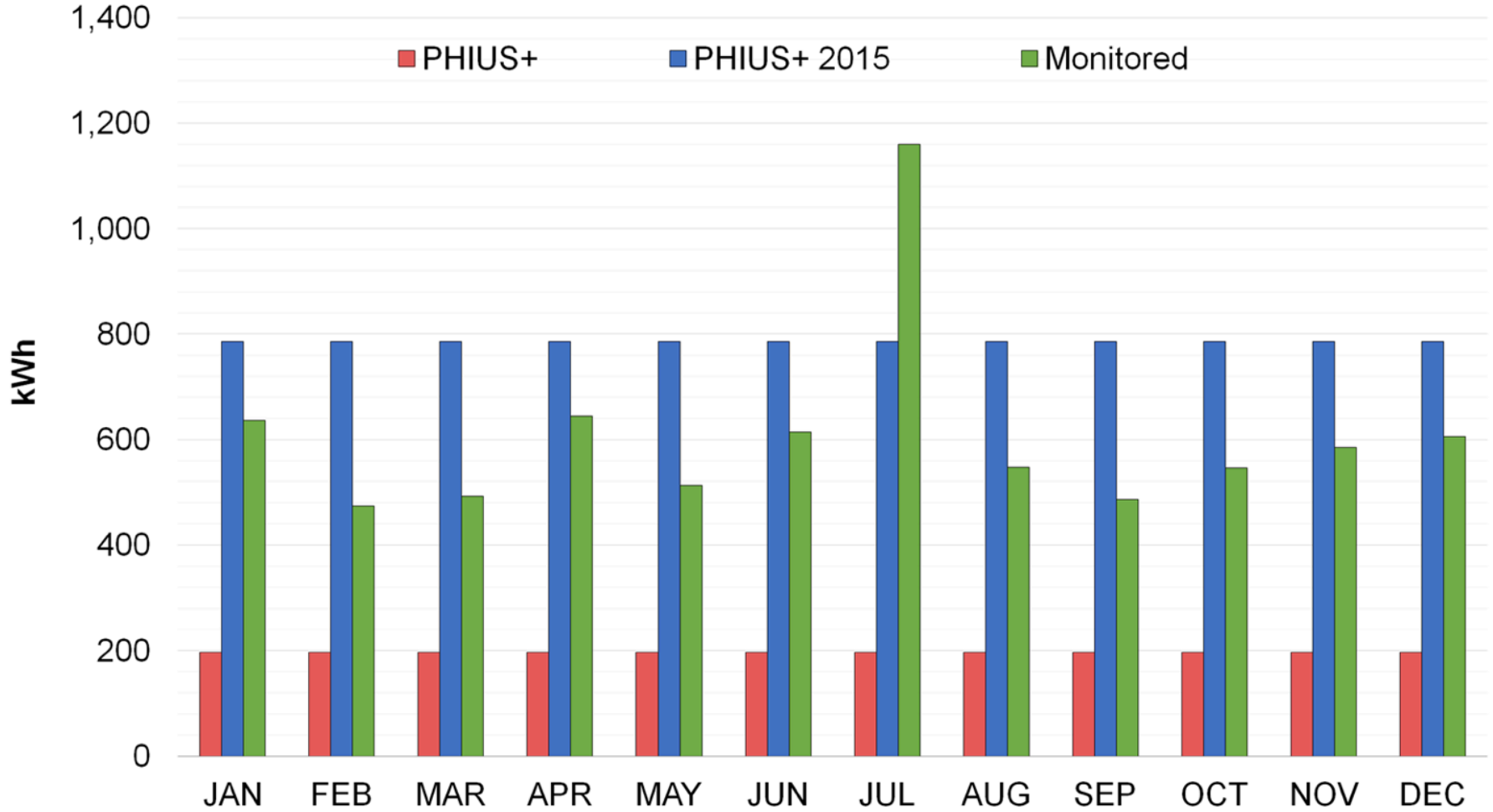
Stellar Apartments - Annual Energy Use by Type



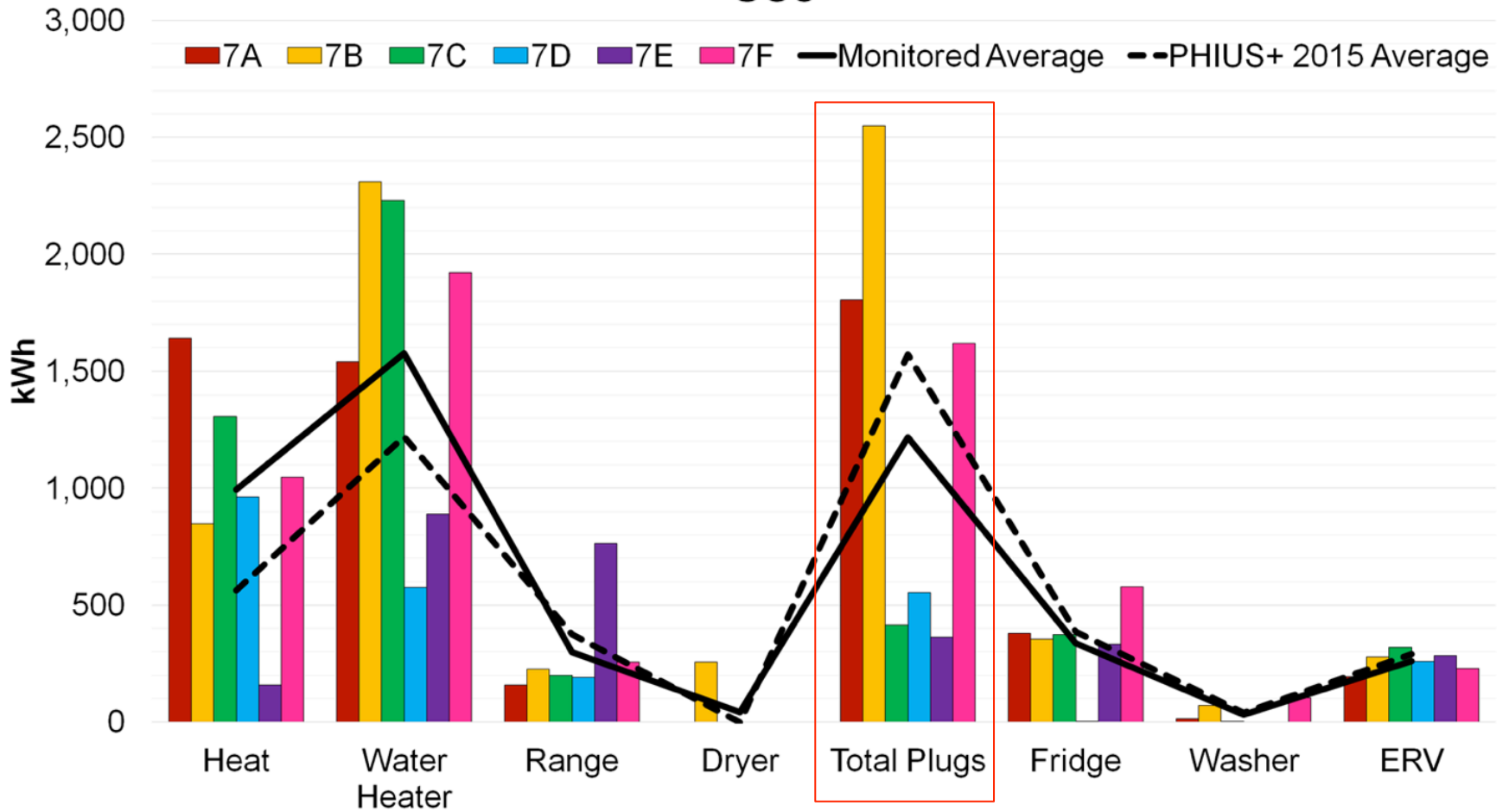
Stellar Apartments - Monthly Water Heater Energy



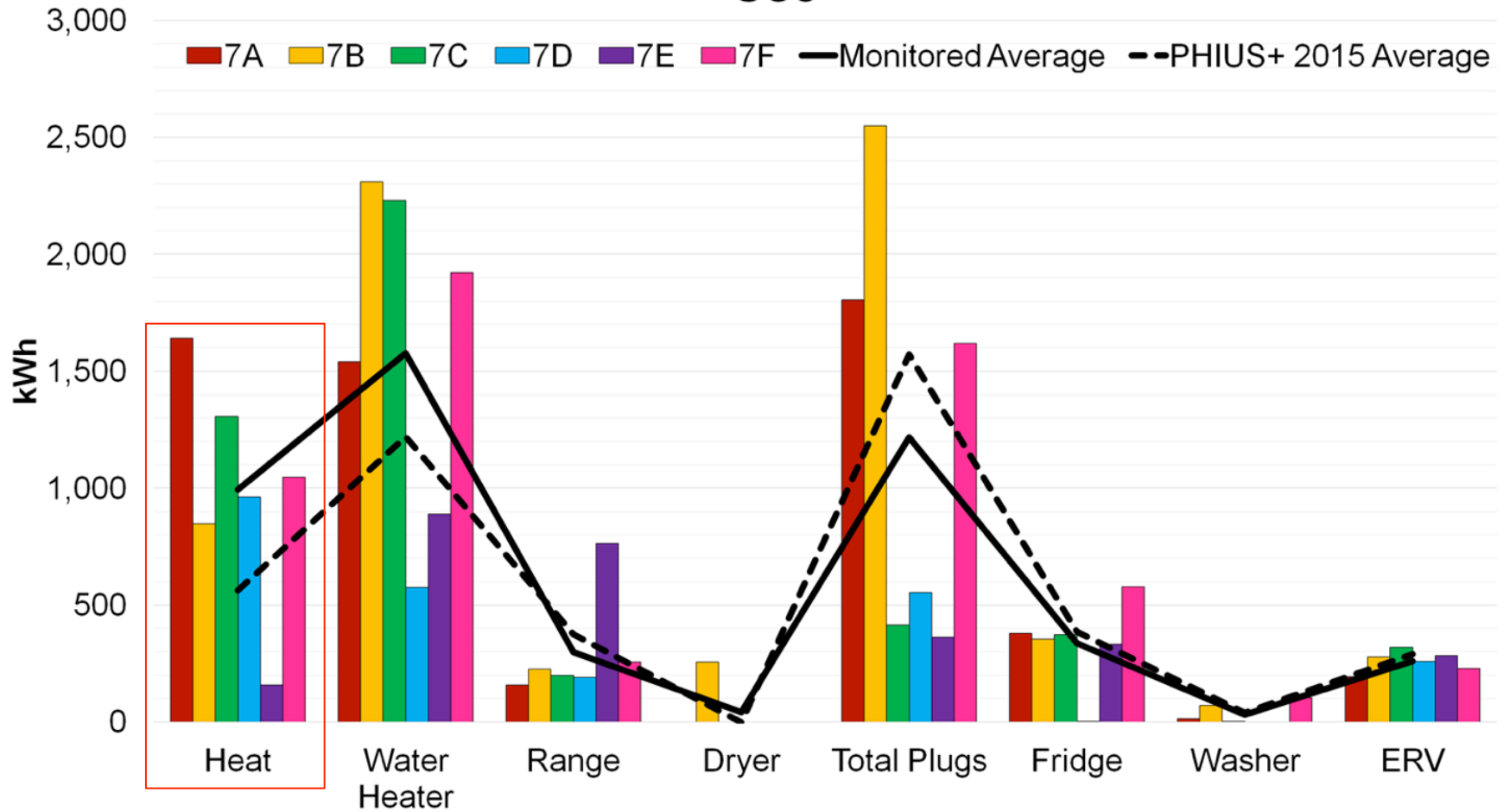
Stellar Apartments - Monthly Plug/Lighting Energy



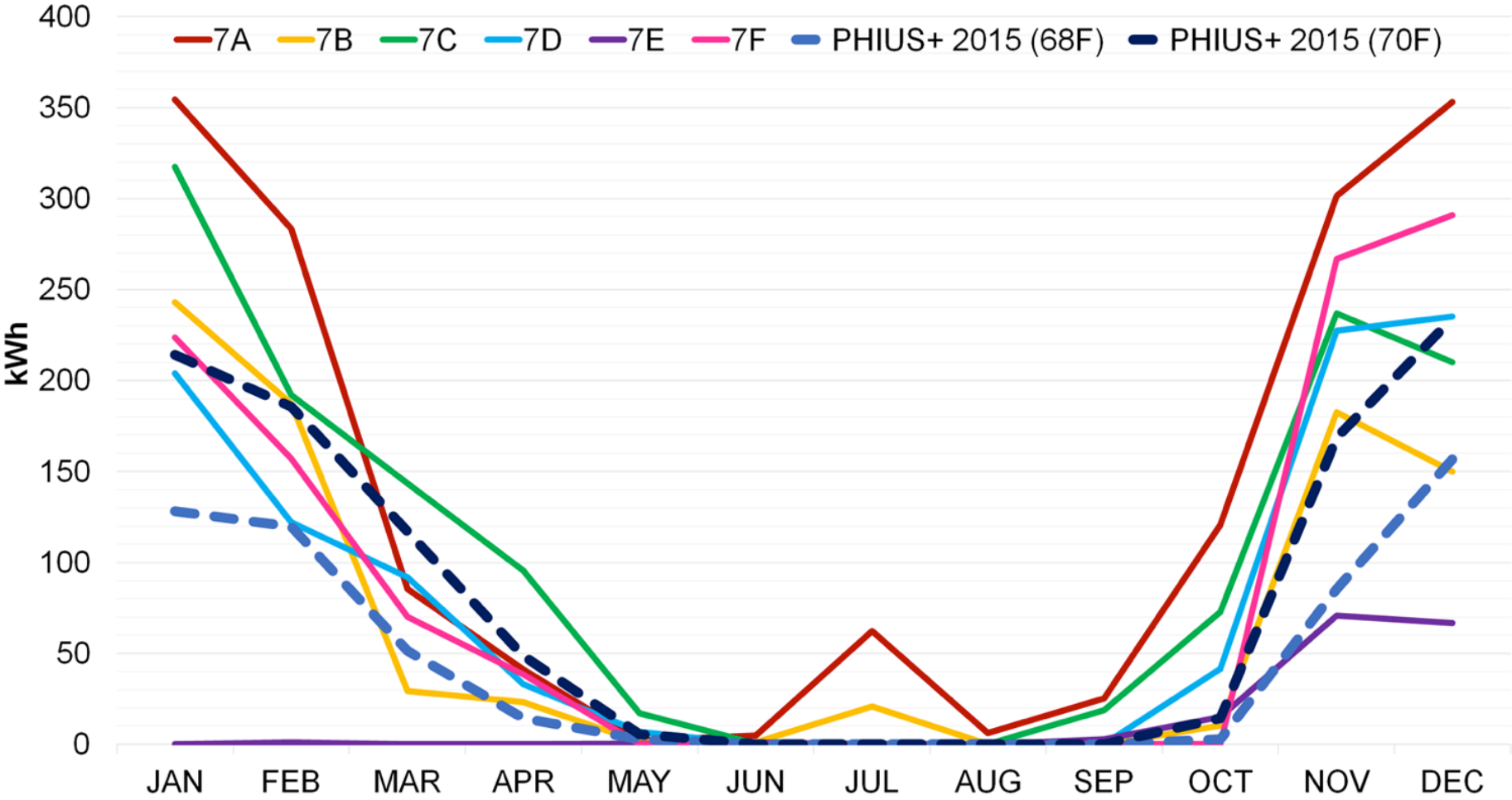
Individual Apartment Energy Use vs Average Energy Use



Individual Apartment Energy Use vs Average Energy Use



Heating Energy Consumption by Apartment per Month

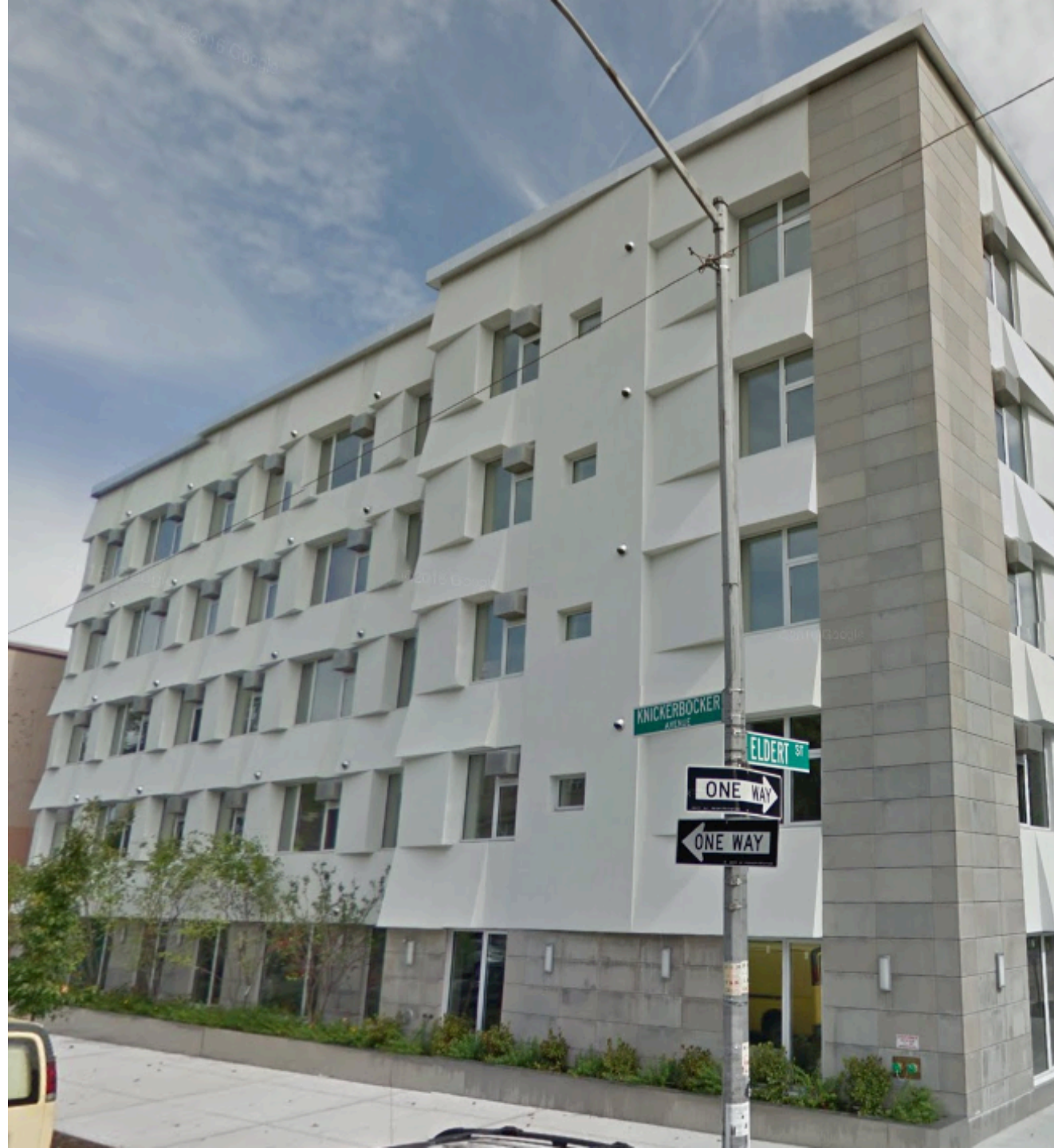


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Knickerbocker Commons



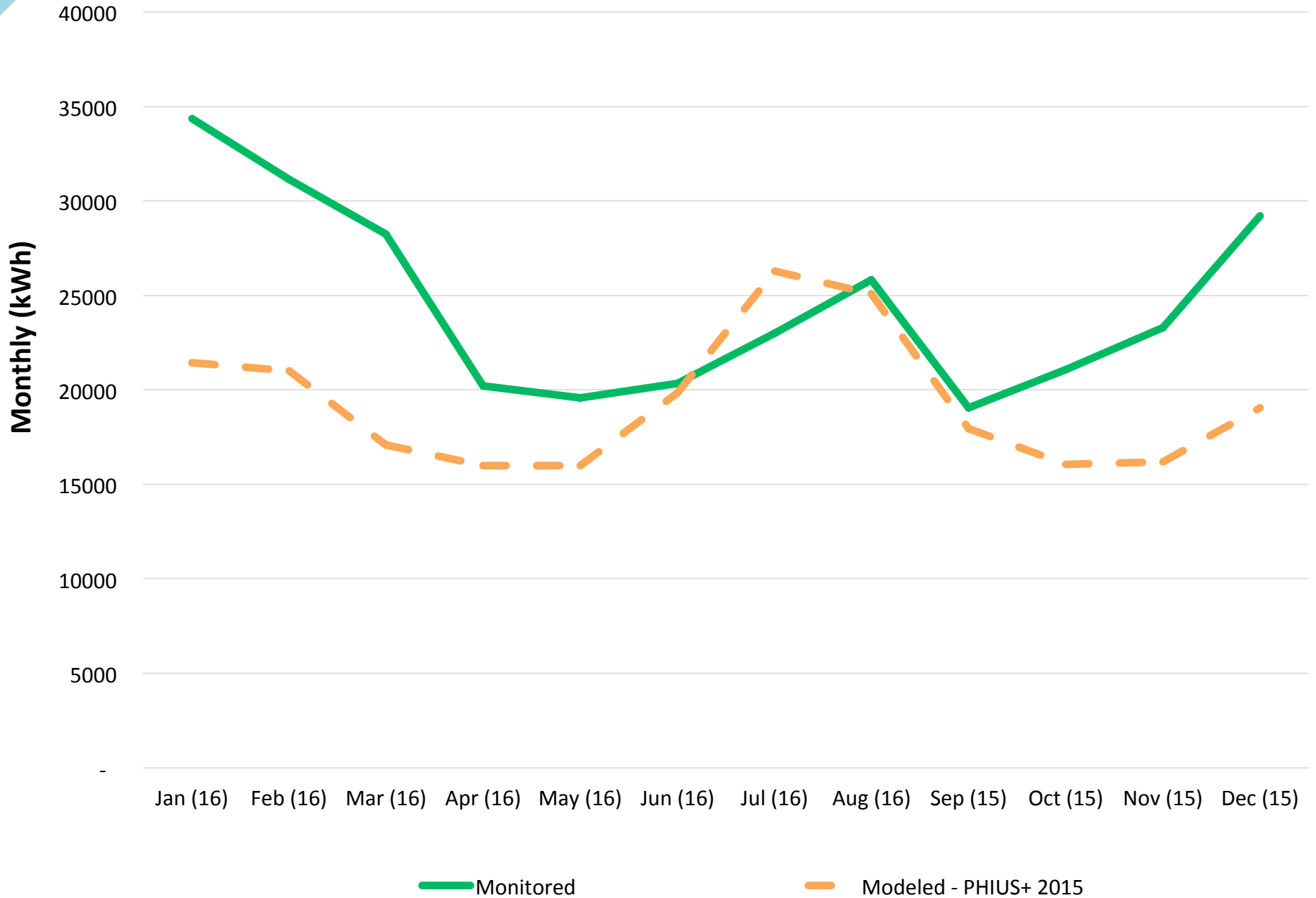
Things to keep in mind

- Project did not go through on-site Verification to become a Certified Passive House Project
- Site Energy analyzed
- Electricity and gas monitored separately
 - Electric: cooling, lighting, MELs
 - Gas: heating, water heating, dryers
- Hydronic Heating/water heater system
- ERVs – 1/unit
- Individual window AC units for cooling (~75 total)

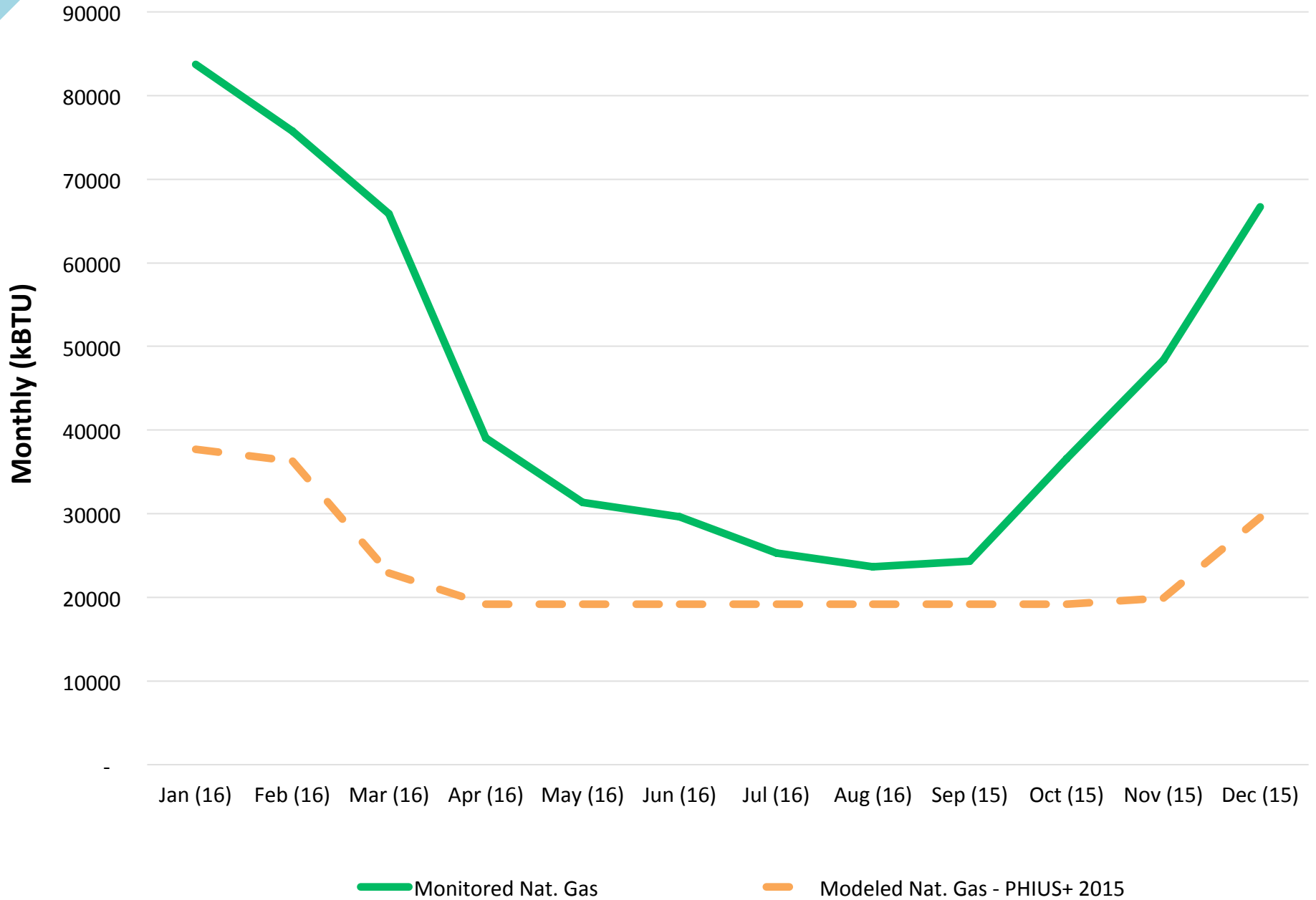
Things to keep in mind

- Electric Meter
 - House Meter
 - Elevator
 - Common Lighting
 - Exterior Lighting
 - Clothes Washers
 - Tenant Meter
 - Residential MELS
 - Residential Lighting
 - Refrigerator
 - Dishwasher
 - Cooktop
 - ERV/Auxiliary
- Natural Gas Meter
 - Hydronic Heating
 - Water Heaters
 - Exhaust Clothes Dryers

Site Energy: Monitored vs Modeled



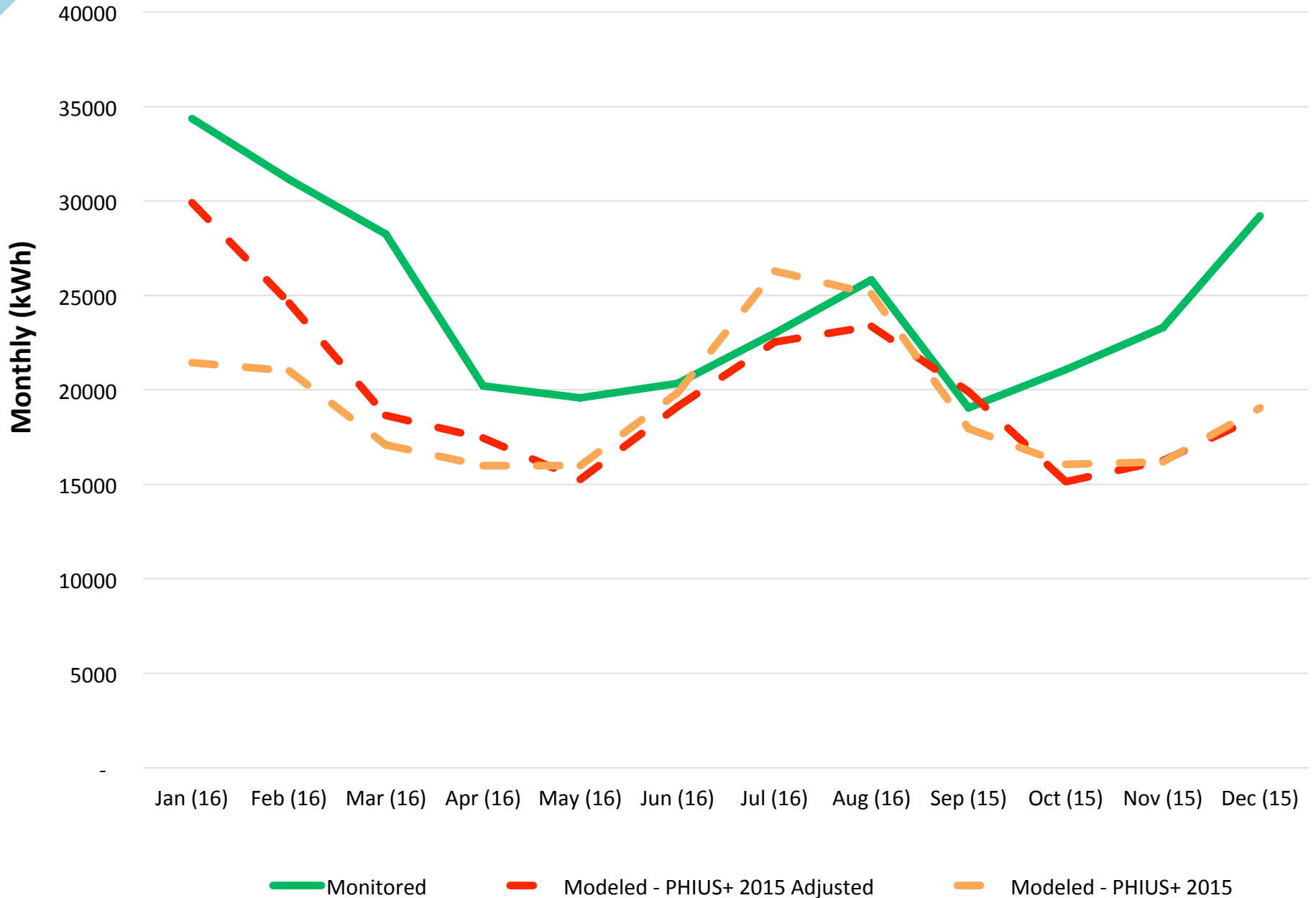
Site Natural Gas: Monitored vs Modeled



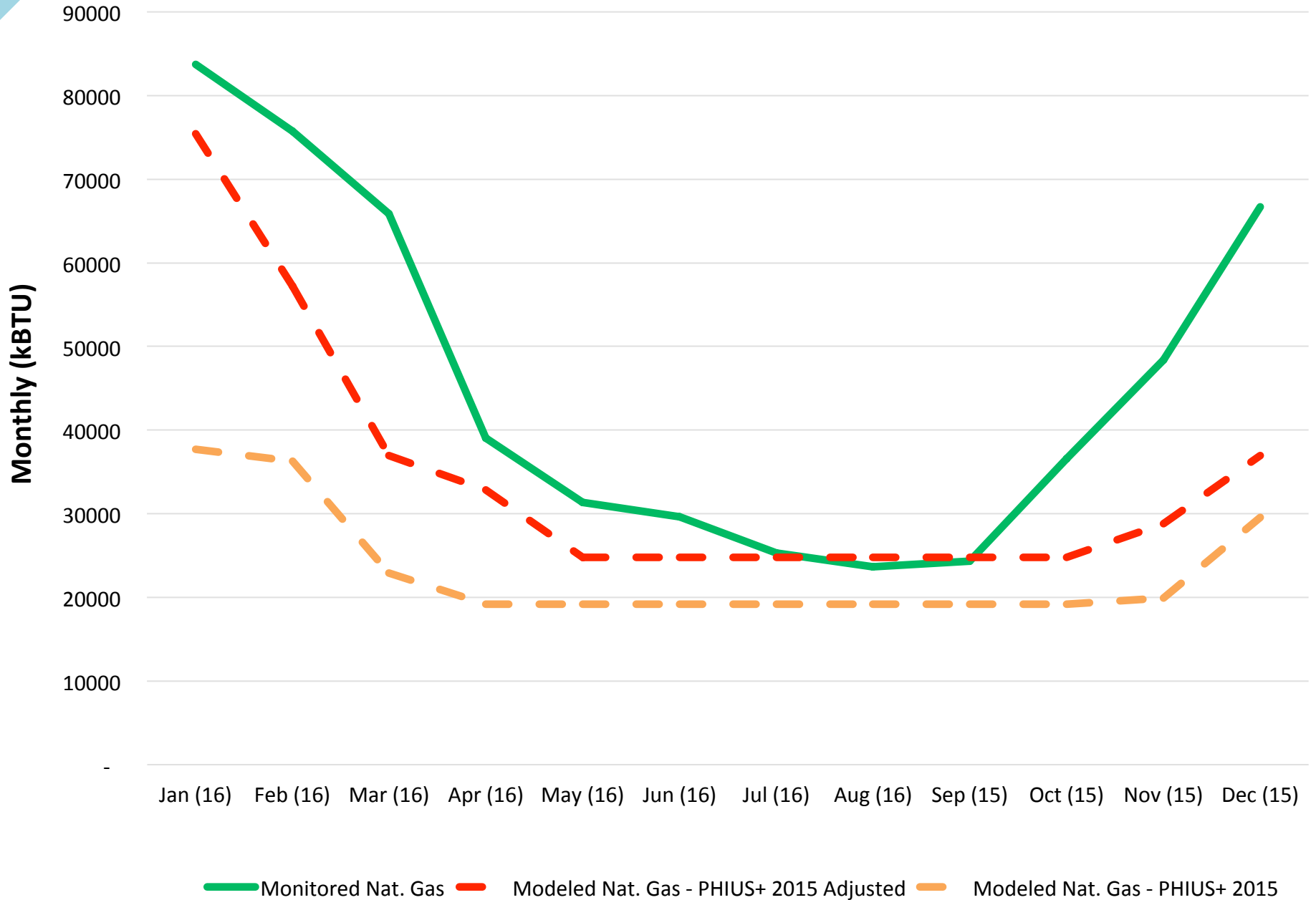
PHIUS+ 2015 – Adjusted Model

- Actual Climate Data
- Thermostats set to 72F (Winter/Summer)
- Actual Occupancy
- Increased HW usage
- 0.6 ACH50 -> 1.37 ACH50
 - (Leaky AC Units/Open Windows?)
- Boiler Efficiency: 85% -> 80%

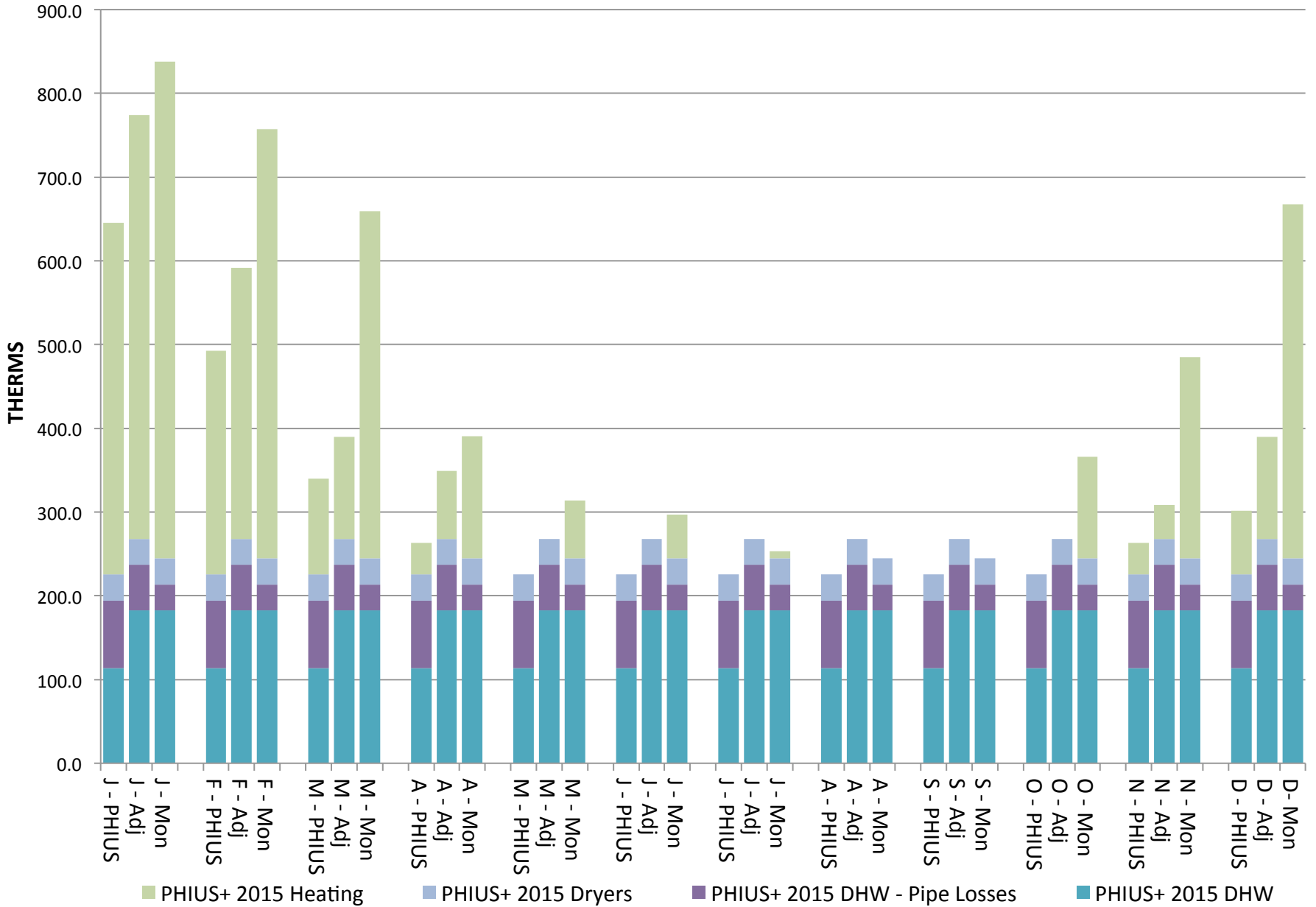
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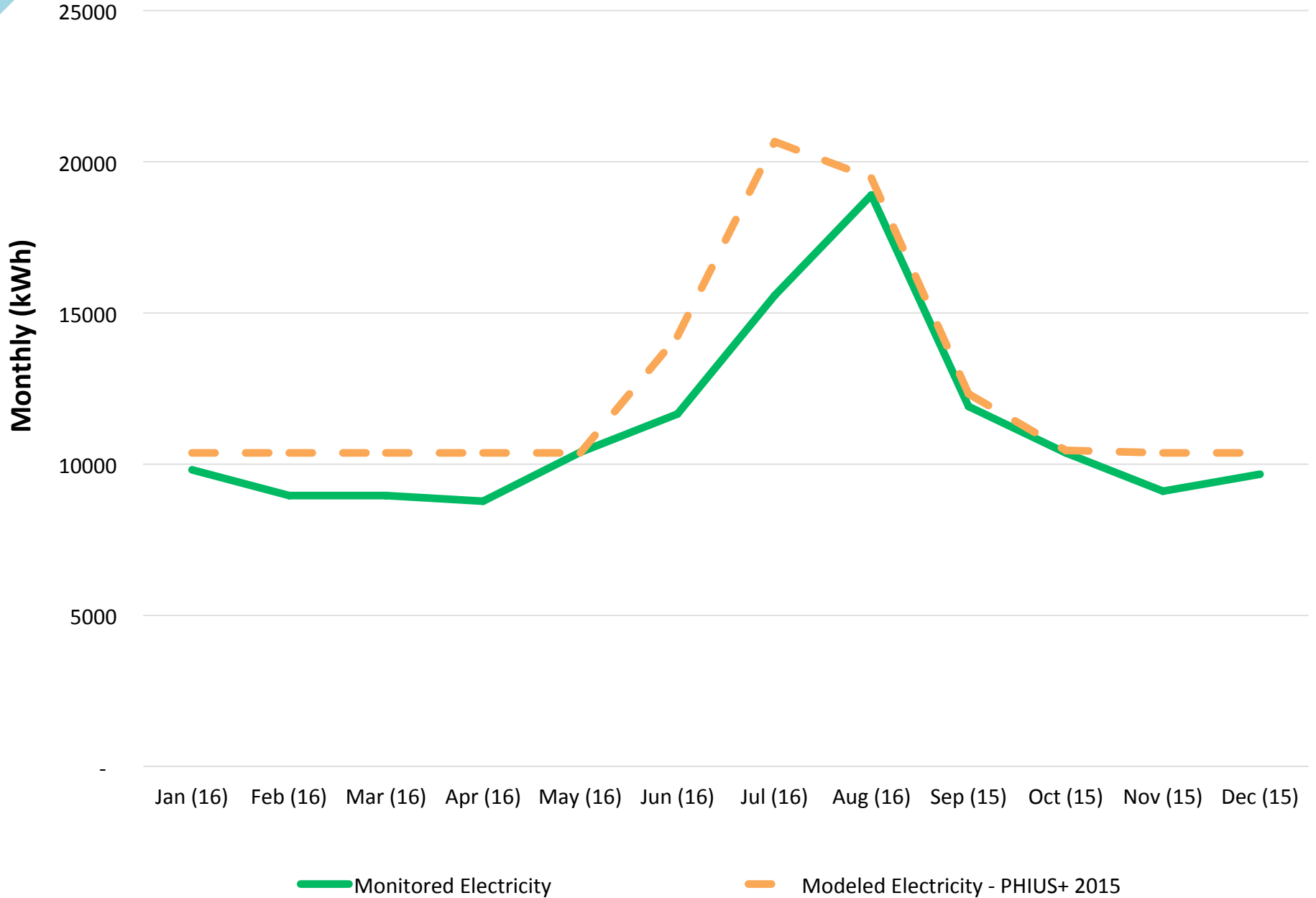
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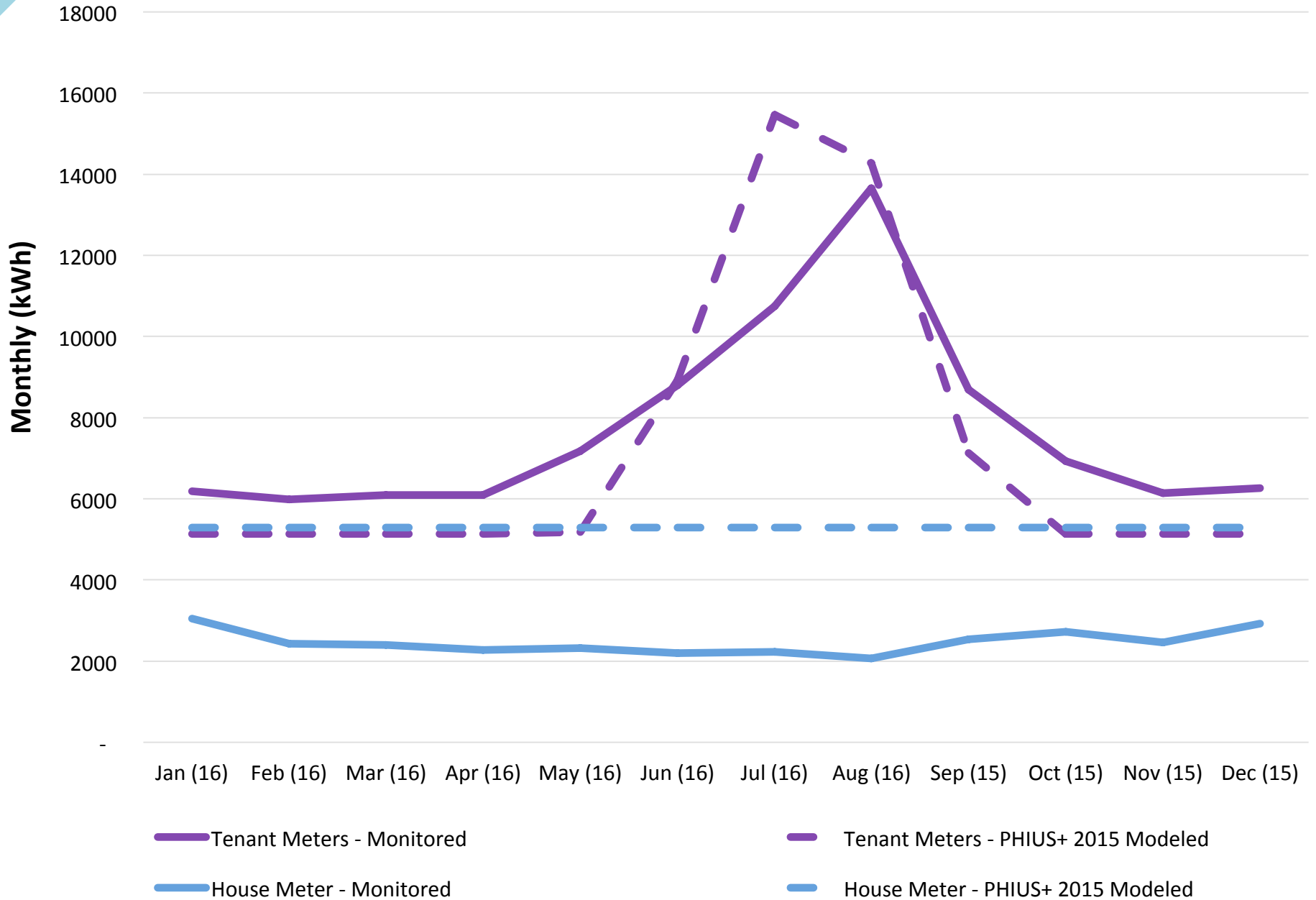
Knickerbocker - Natural Gas



Site Electricity: Monitored vs Modeled



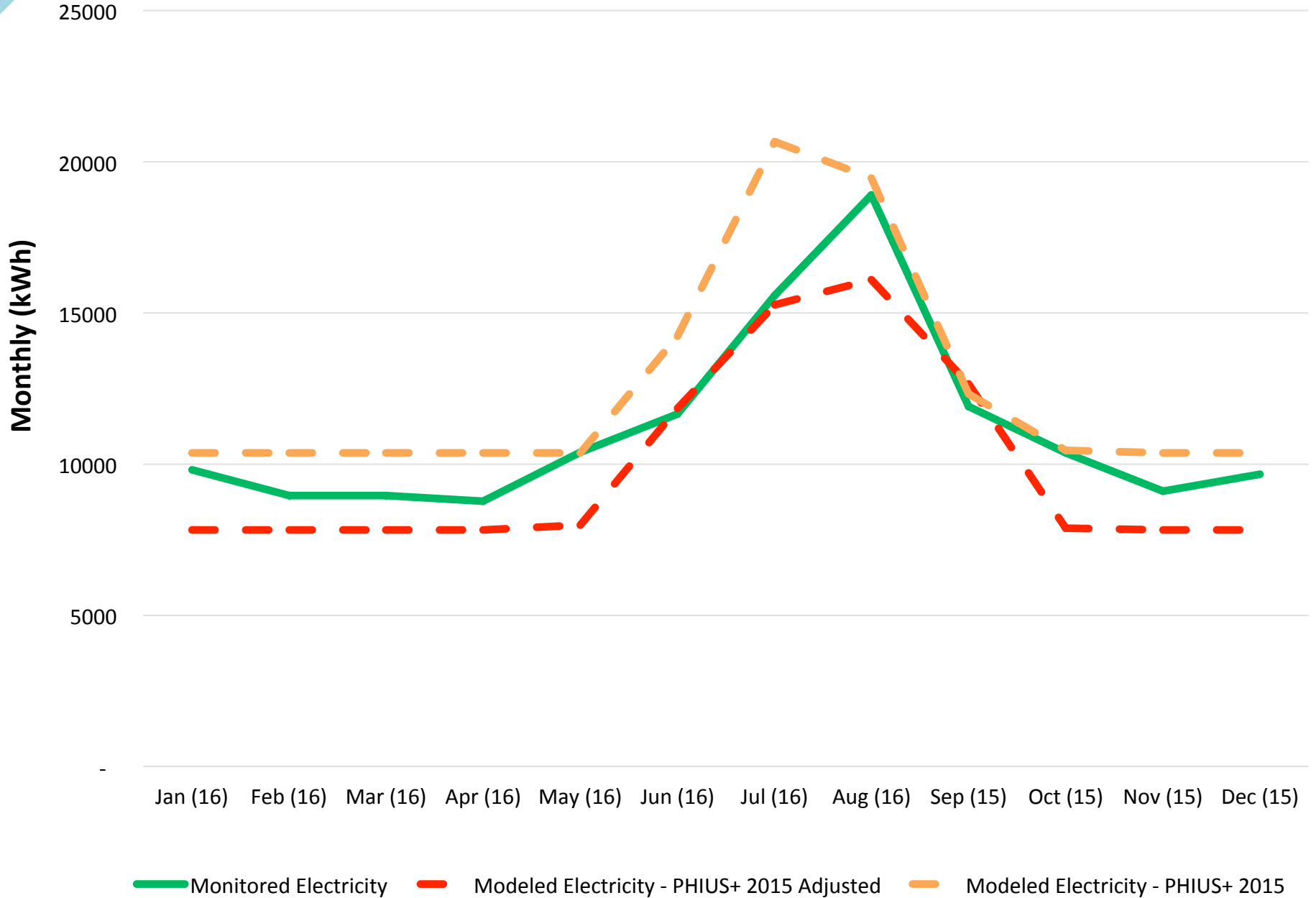
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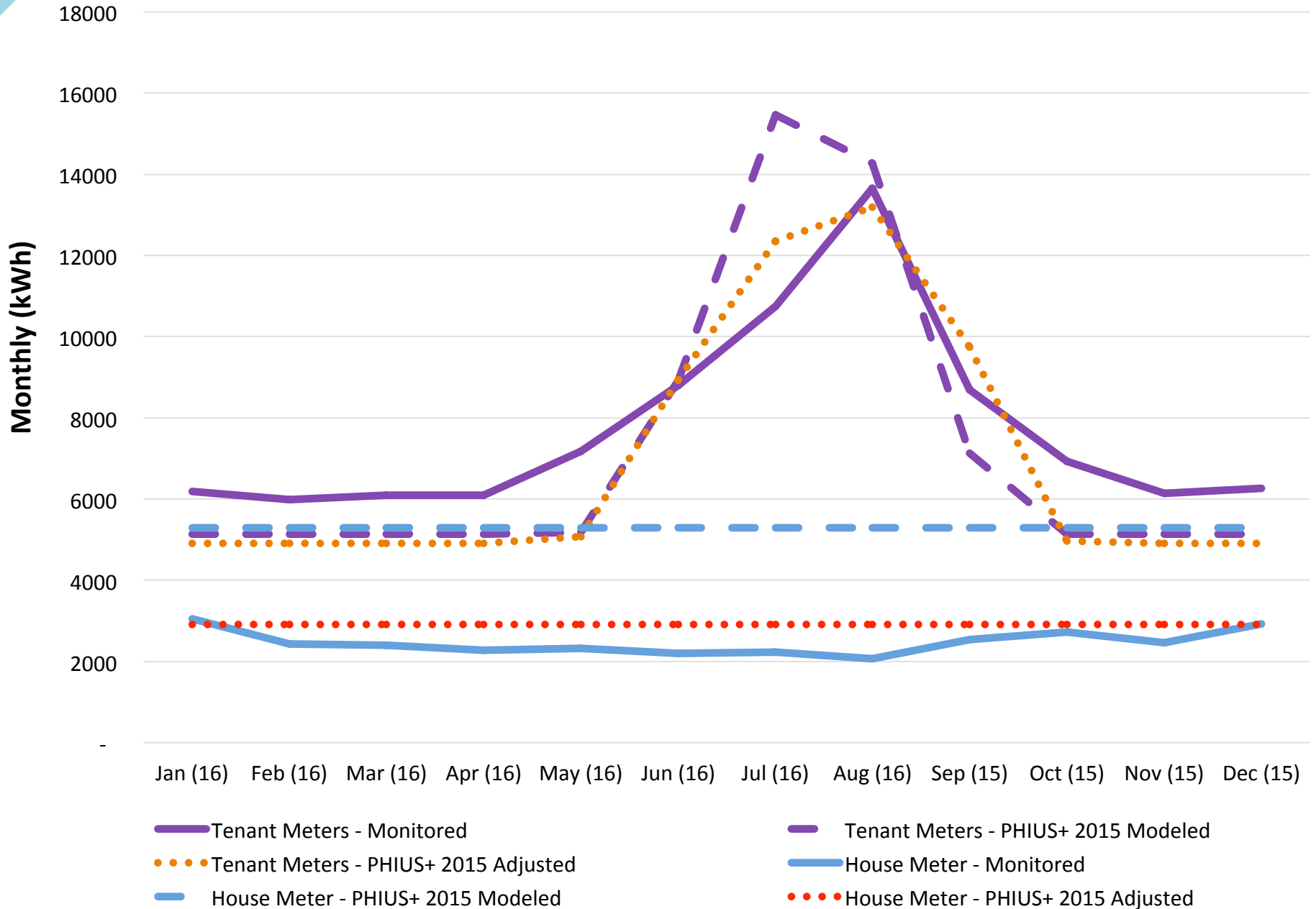
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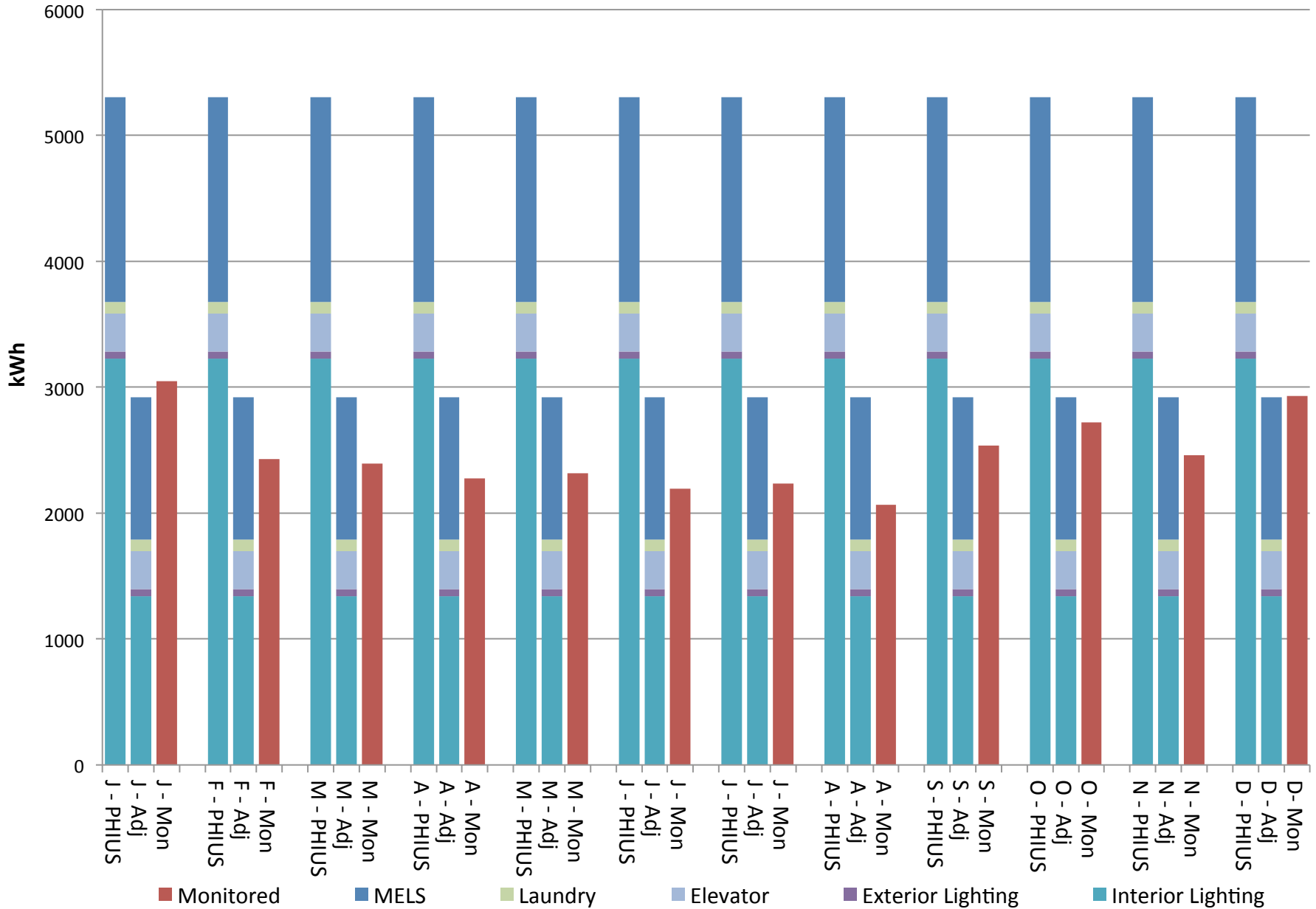
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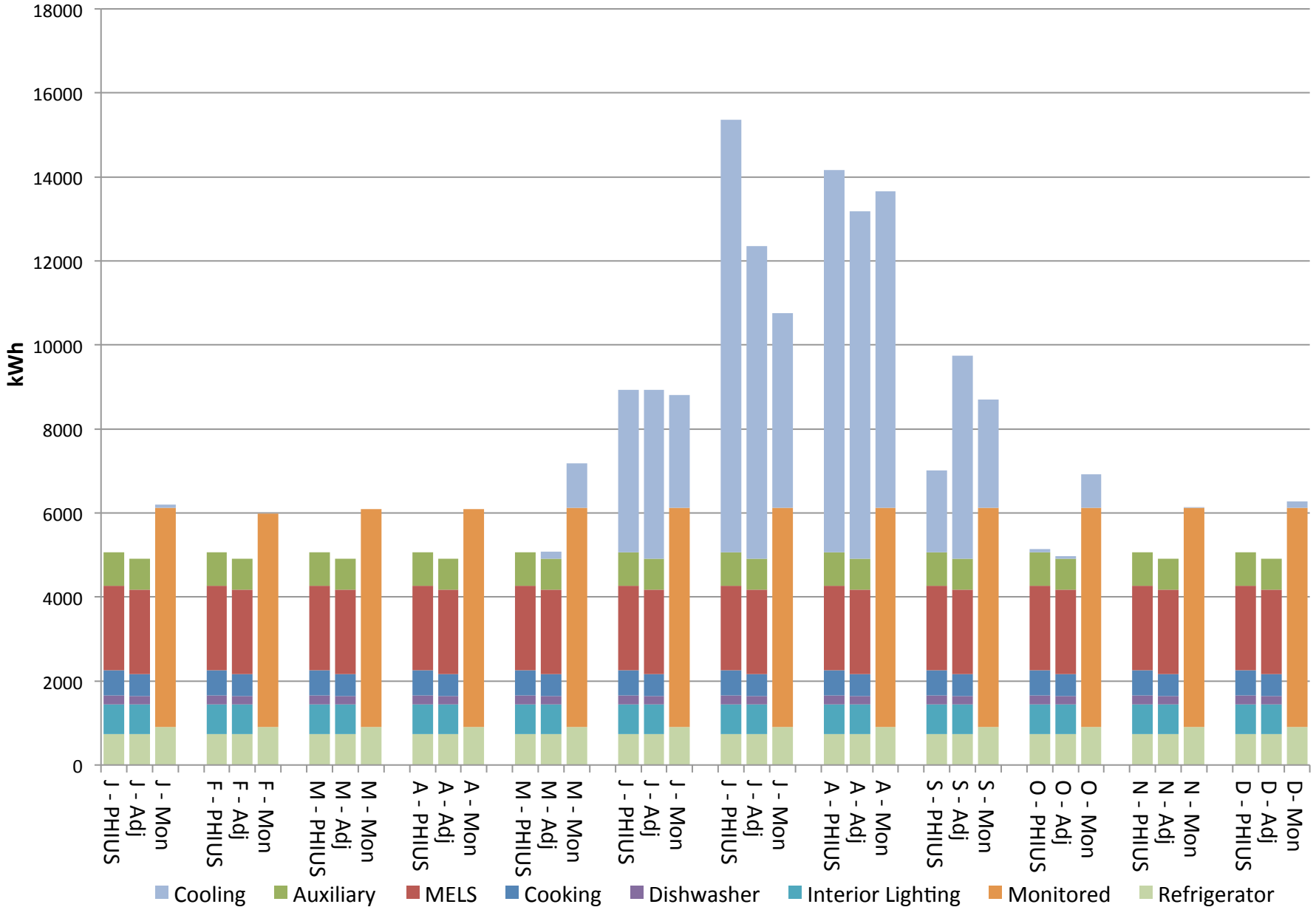
Site Energy: Monitored vs Modeled



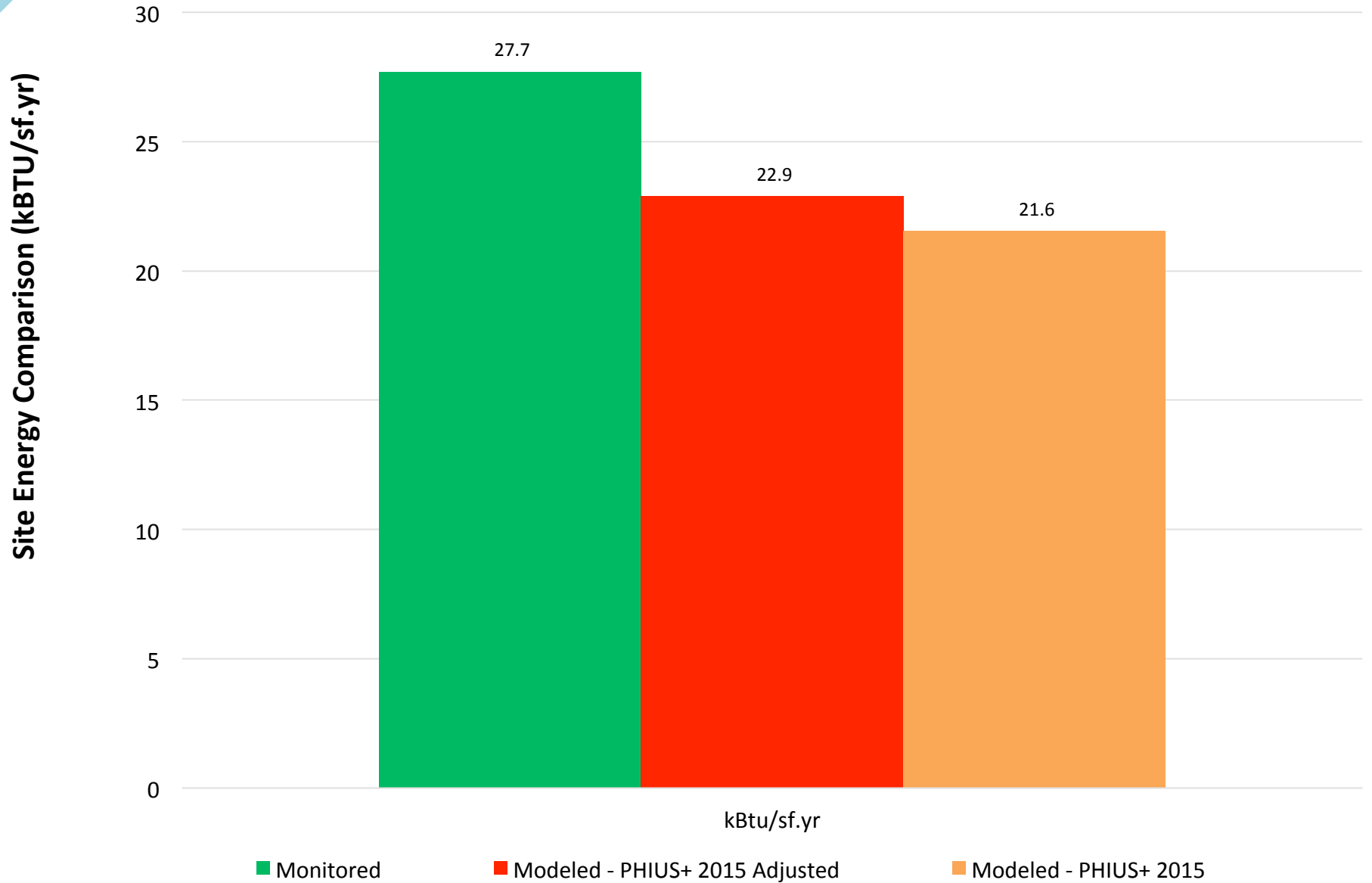
Knickerbocker - House Meter



Knickerbocker - Tenant Meter



Site Energy: Monitored vs Modeled





Second and Delaware – Kansas City

PASSIVE BUILDING

PART OF THE SOLUTION

www.PHIUS.org/www.PHAUS.org