Mind the Gaps: Post-Occupancy Discoveries from Data and Operational Perspectives

Steven Winter Associates, Inc.
Improving the Built Environment Since 1972

Government Initiatives to Reduce CO_2

New York State Energy Plan

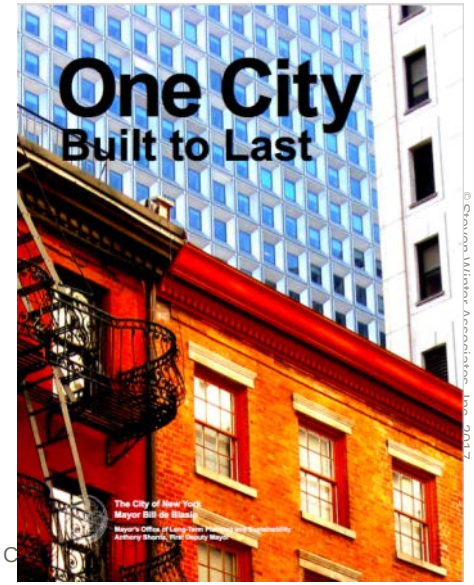
NEW YORK STATE OF OPPORTUNITY. | New York State Energy Plan

40% Reduce greenhouse gas emissions 40% (from 1990 levels) by 2030

50% Energy generation from renewable energy sources

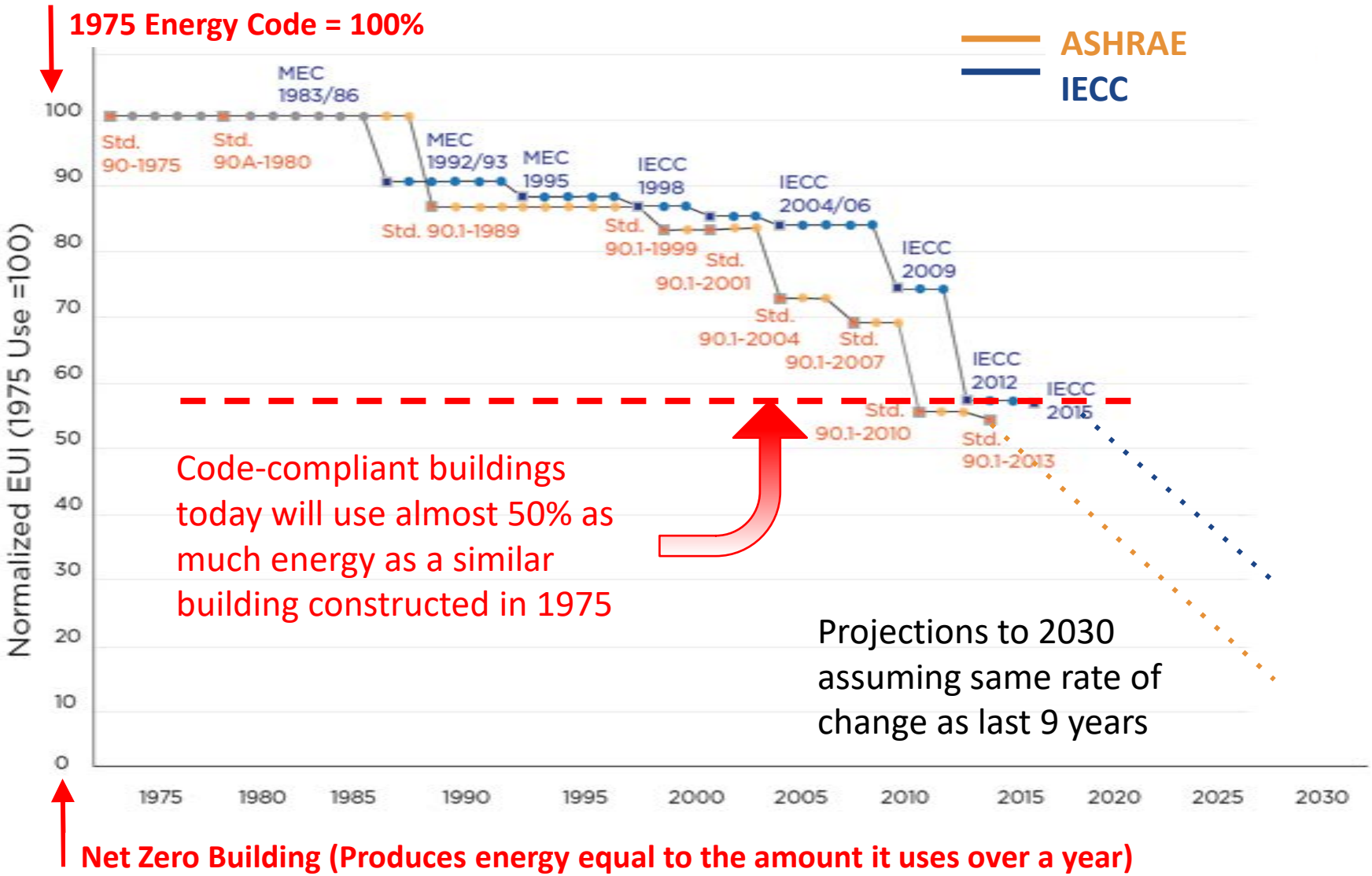
NYC One City Built to Last

80x50 Reduce greenhouse gas emissions 80% (from 2005 levels) x 2050



Credit: Urban Green Council

Efficiencies in the Code?



Credit: Urban Green Council

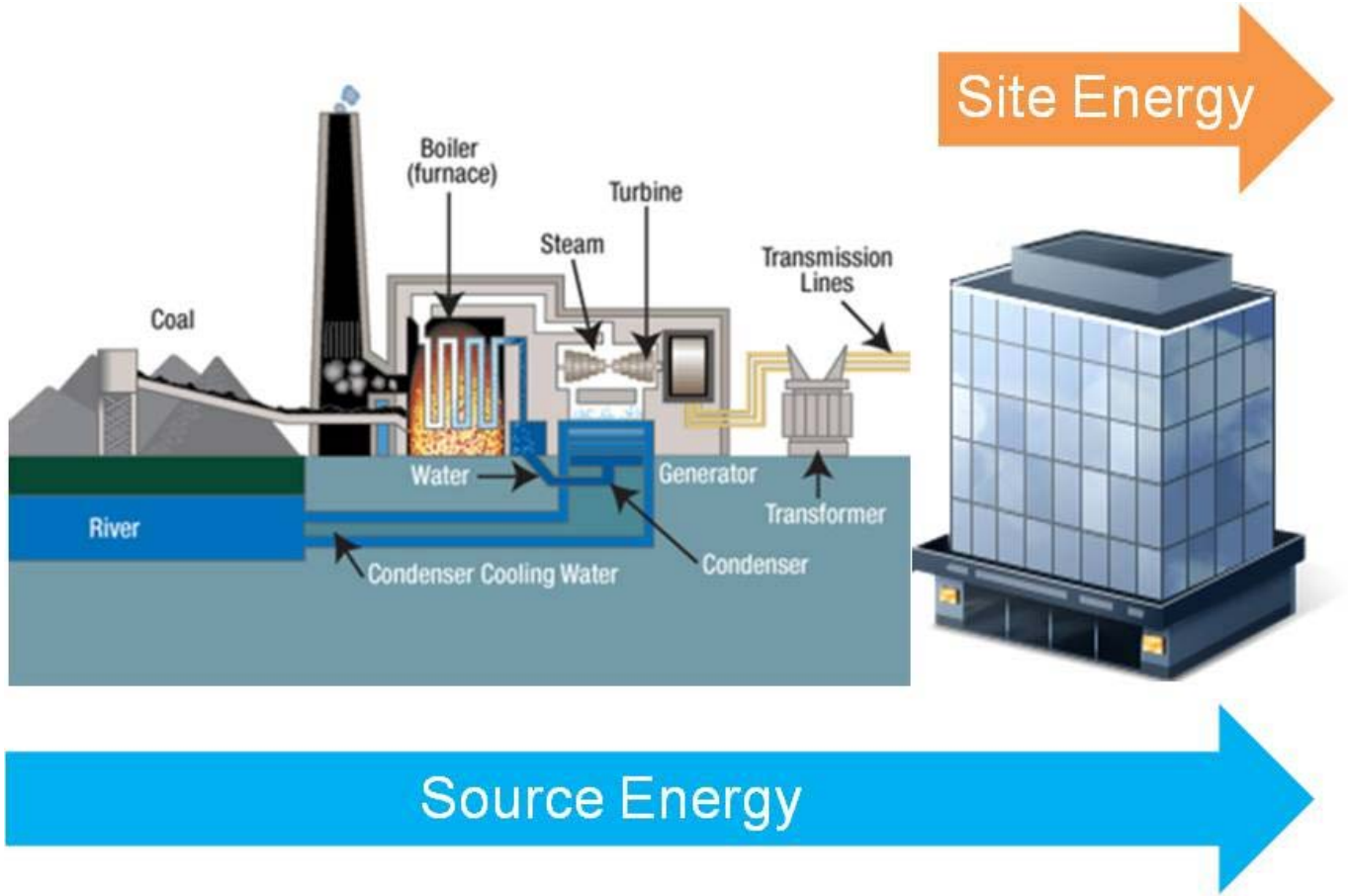
Performance Based Standard

- NYC performance standard
  - Intro Bill No. 1629
- NYC LL 84
- DOE Asset Score
  - National standardized tool for assessing energy efficiency of commercial and multifamily residential buildings.

Key Metrics: New Multifamily

Metric	Unit	Significance
Benchmark (EUI)	kBtu/SF	Whole-building source
Heating	Btu/SF/HDD	Owner-paid
Domestic Hot Water	kBtu/SF	Owner-paid
Fuel	kBtu/SF	Owner-paid
Electric	kWh/SF	Owner-paid
ENERGY STAR Score	1-100	Relative to similar buildings nationwide

Site vs. Source

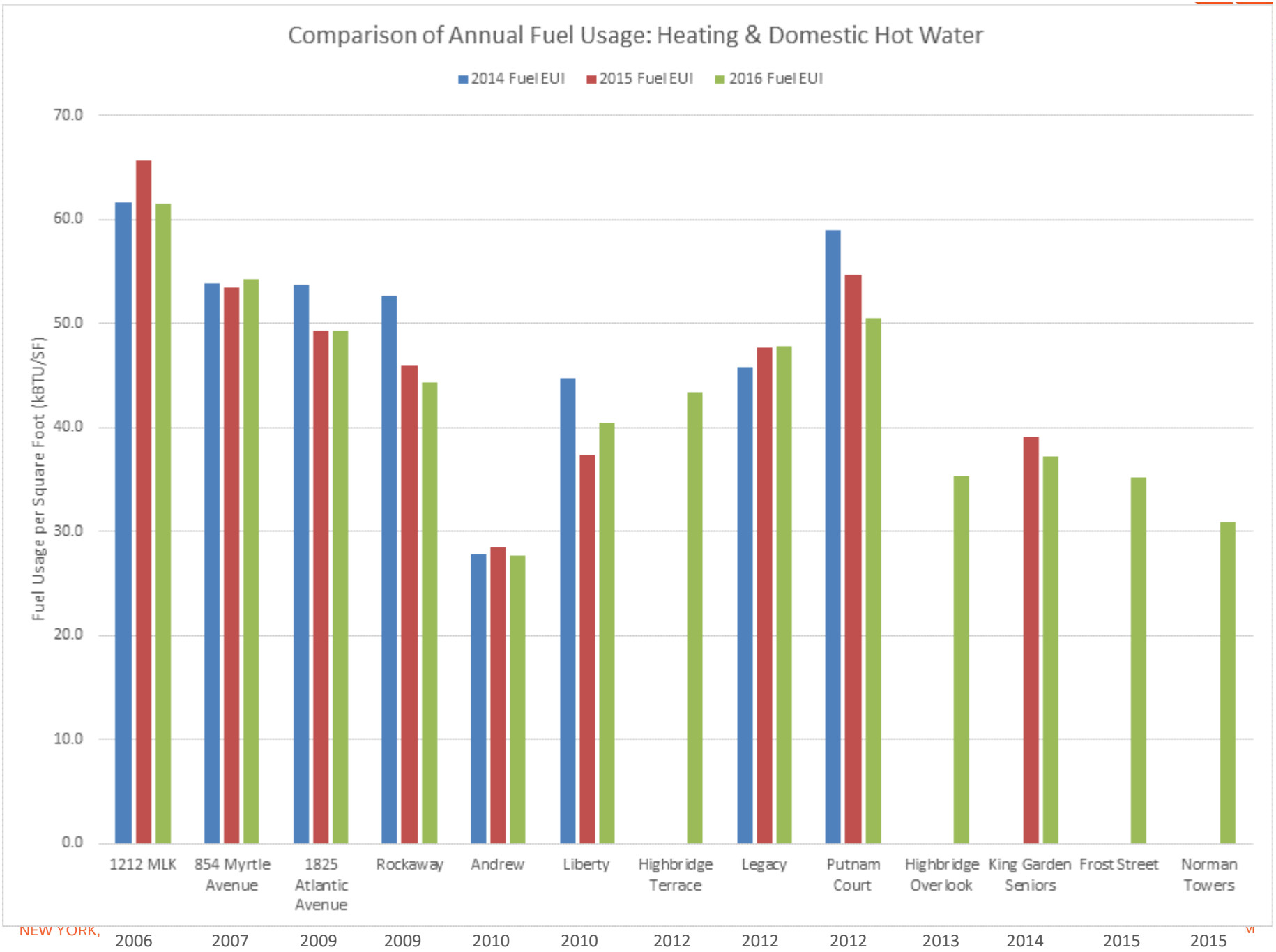


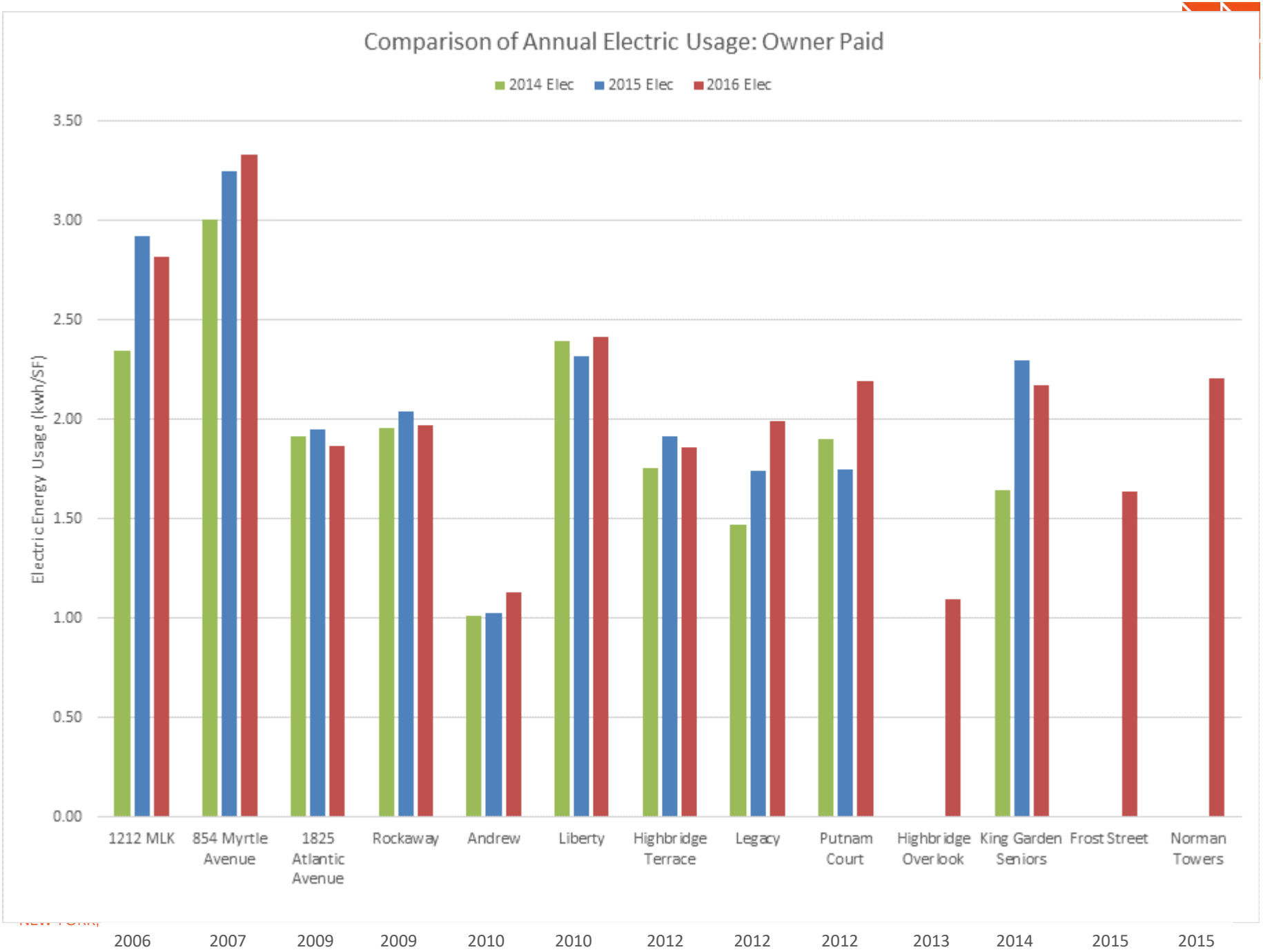
Data Challenges

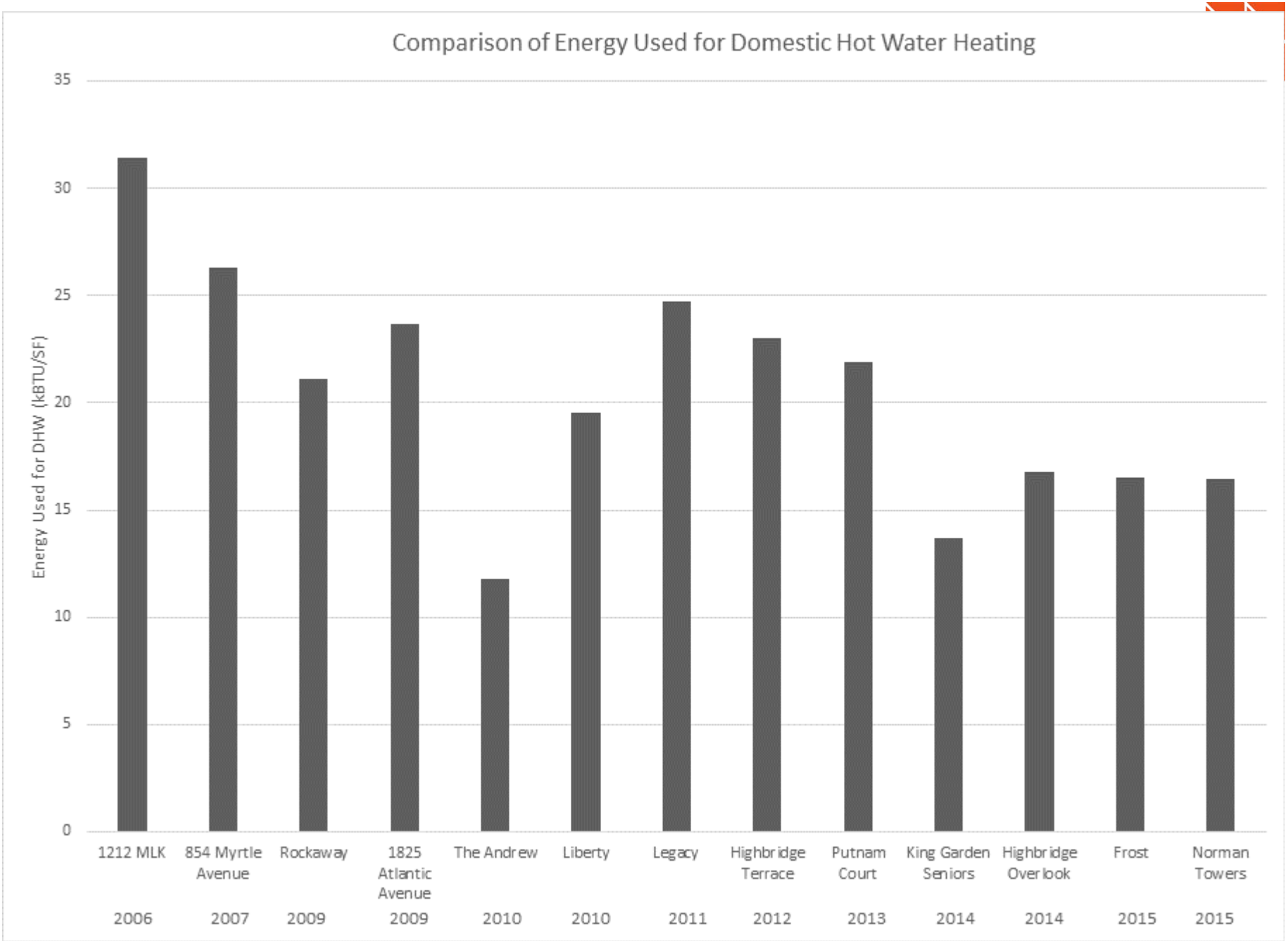
- Utility bill tracking
  - Master-metered
    - Sub-metered requires assistance from Owner
  - Direct-metered
  - Aggregate data
    - Commercial tenants receive “free” heat from central system, but also supplement their own
- Square footage discrepancies
  - Source: NYC DOF, DOB, OASIS
  - Parking garage
  - Cellar, sub-cellar not counted SF by DOF
  - Commercial space (provide heat, not electricity?)
- Renewables

ENERGY STAR Multifamily: Shifting Design

Design	Circa 2007	Now
Walls	Insulation Placement	Reduce Thermal Bridging
Windows	Aluminum vs. Fiberglass	Aluminum vs. uPVC
Ventilation	Code changes	Unitized exhaust/ERV
Heating	Boilers: Condensing?	Boilers vs. VRF
Distribution	Baseboard	PTAC
Cooling	Window vs. Sleeve AC	PTAC vs. Heat Pumps
DHW	Boilers with Indirect Storage	Same + HPWH?
Lighting	Fluorescents and Sensors	LED
On-site Power	Micro-cogeneration	Solar PV/cogen/batteries
Controls	Basic, Local	Smart
Modeling	ASHRAE 90.1 - 2004	ASHRAE 90.1 – 2013

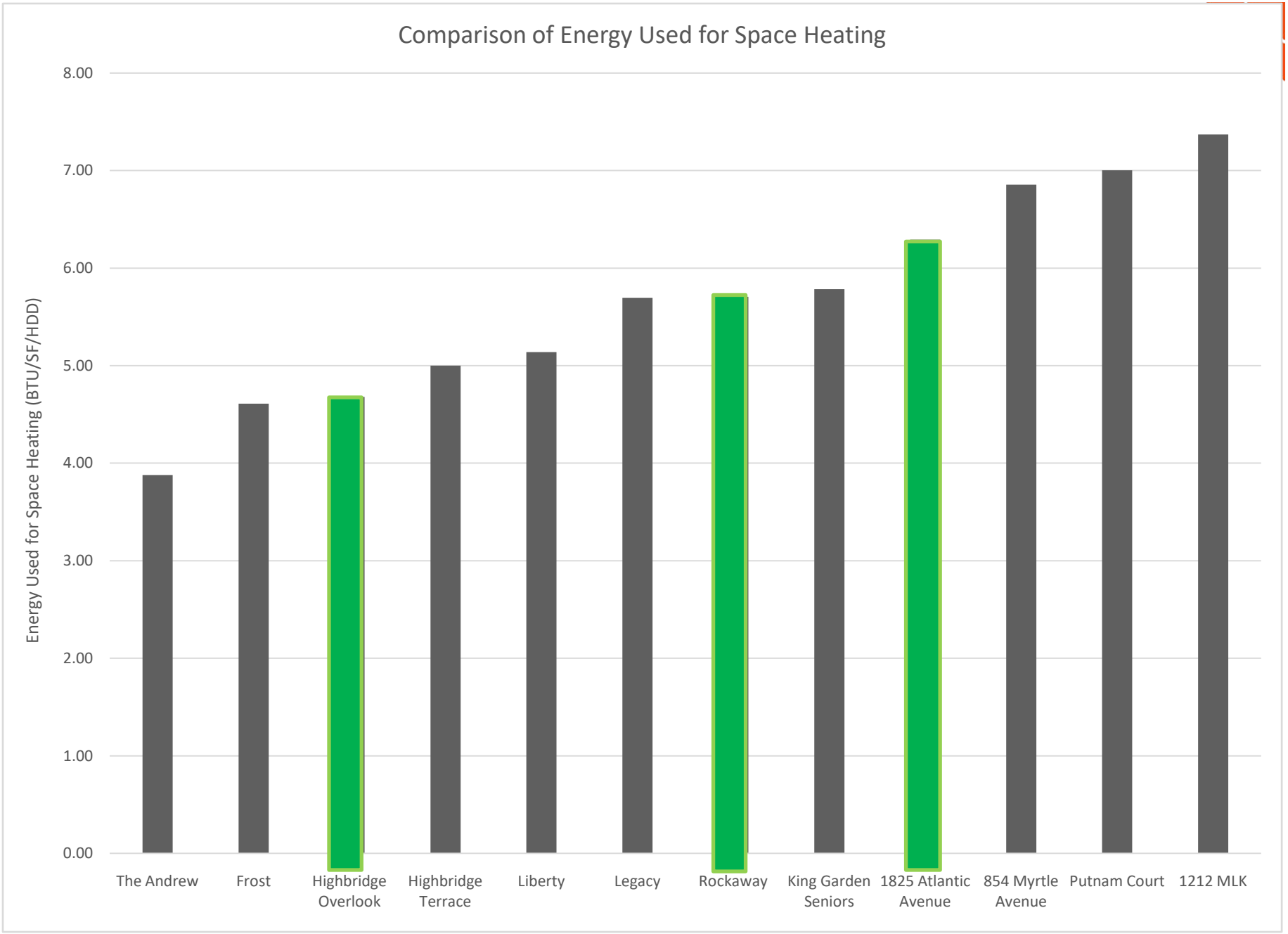

Comparison of Annual Fuel Usage: Heating & Domestic Hot Water
2014 Fuel EUI
2015 Fuel EUI
2016 Fuel EUI
Fuel Usage per Square Foot (kBTU/SF)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1212 MLK
854 Myrtle Avenue
1825 Atlantic Avenue
Rockaway
Andrew
Liberty
Highbridge Terrace
Legacy
Putnam Court
Highbridge Overlook
King Garden Seniors
Frost Street
Norman Towers
2006
2007
2009
2009
2010
2010
2012
2012
2012
2013
2014
2015
2015

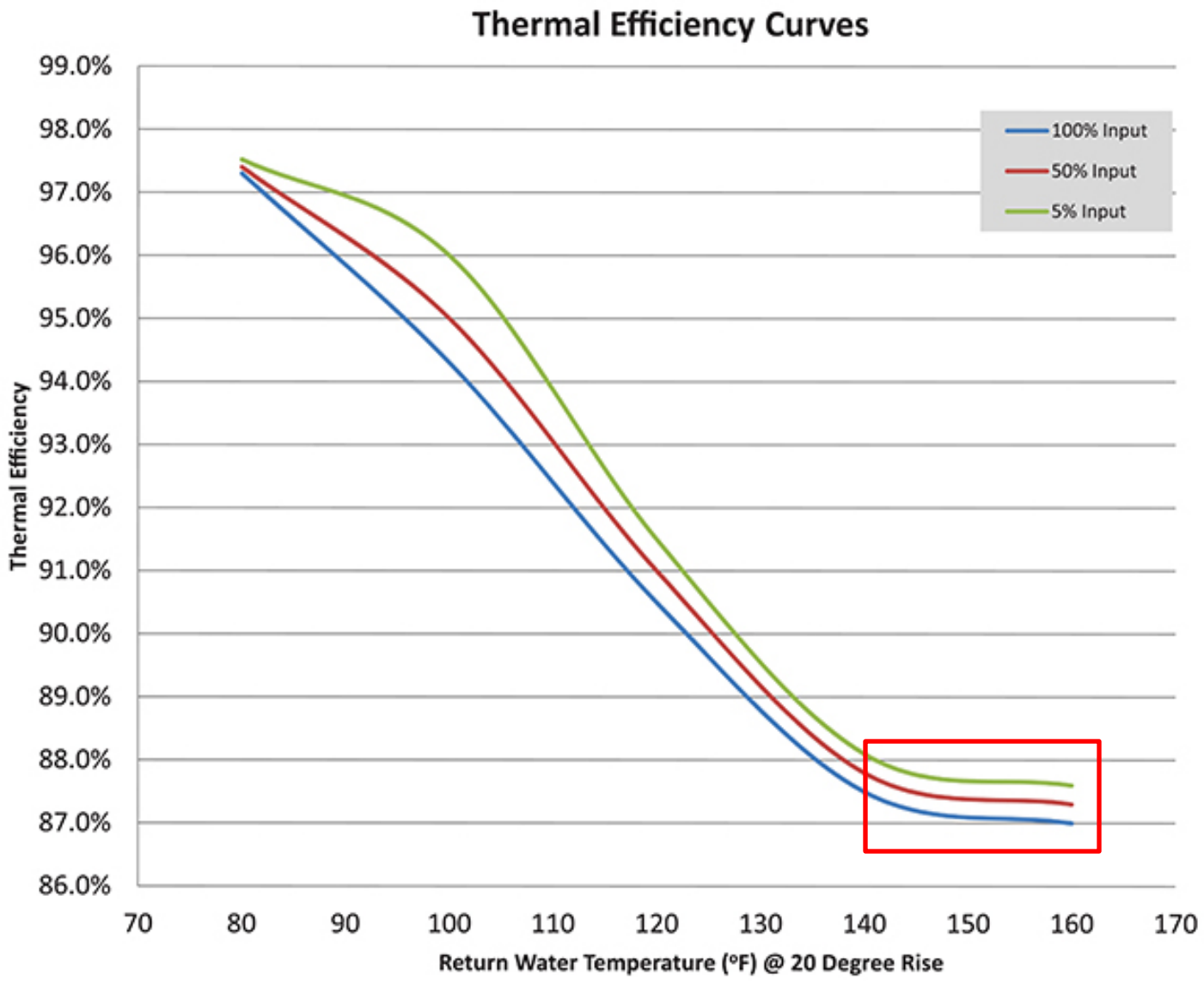

Comparison of Annual Electric Usage: Owner Paid
2014 Elec
2015 Elec
2016 Elec
Electric Energy Usage (kwh/SF)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1212 MLK
854 Myrtle Avenue
1825 Atlantic Avenue
Rockaway
Andrew
Liberty
Highbridge Terrace
Legacy
Putnam Court
Highbridge Overlook
King Garden Seniors
Frost Street
Norman Towers
2006
2007
2009
2009
2010
2010
2012
2012
2012
2013
2014
2015
2015


Comparison of Energy Used for Domestic Hot Water Heating
Energy Used for DHW (kBTU/SF)
35
30
25
20
15
10
5
0
1212 MLK
2006
854 Myrtle Avenue
2007
Rockaway
2009
1825 Atlantic Avenue
2009
The Andrew
2010
Liberty
2010
Legacy
2011
Highbridge Terrace
2012
Putnam Court
2013
King Garden Seniors
2014
Highbridge Overlook
2014
Frost
2015
Norman Towers
2015

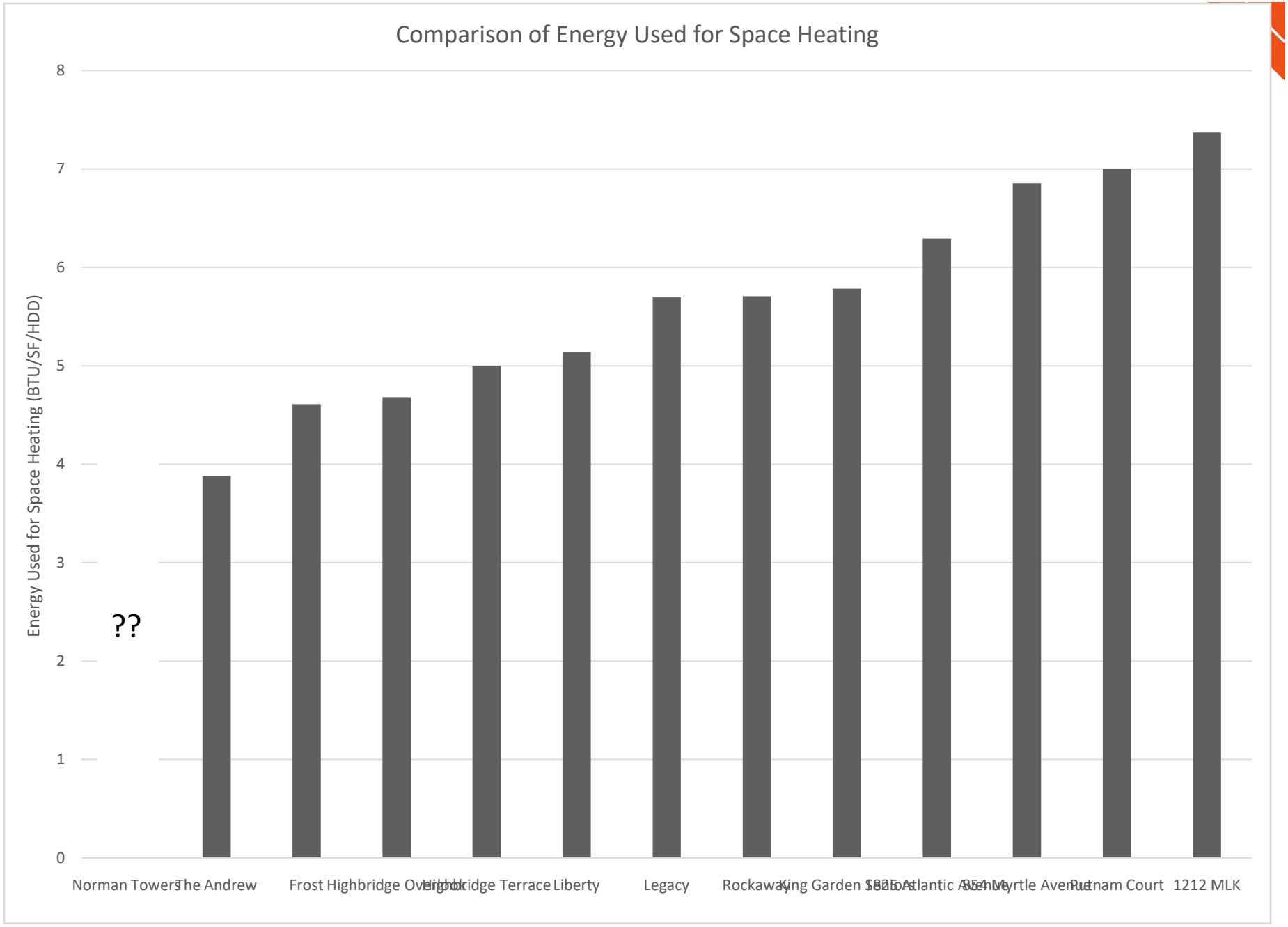
All of these buildings have hot water space heating distribution systems.

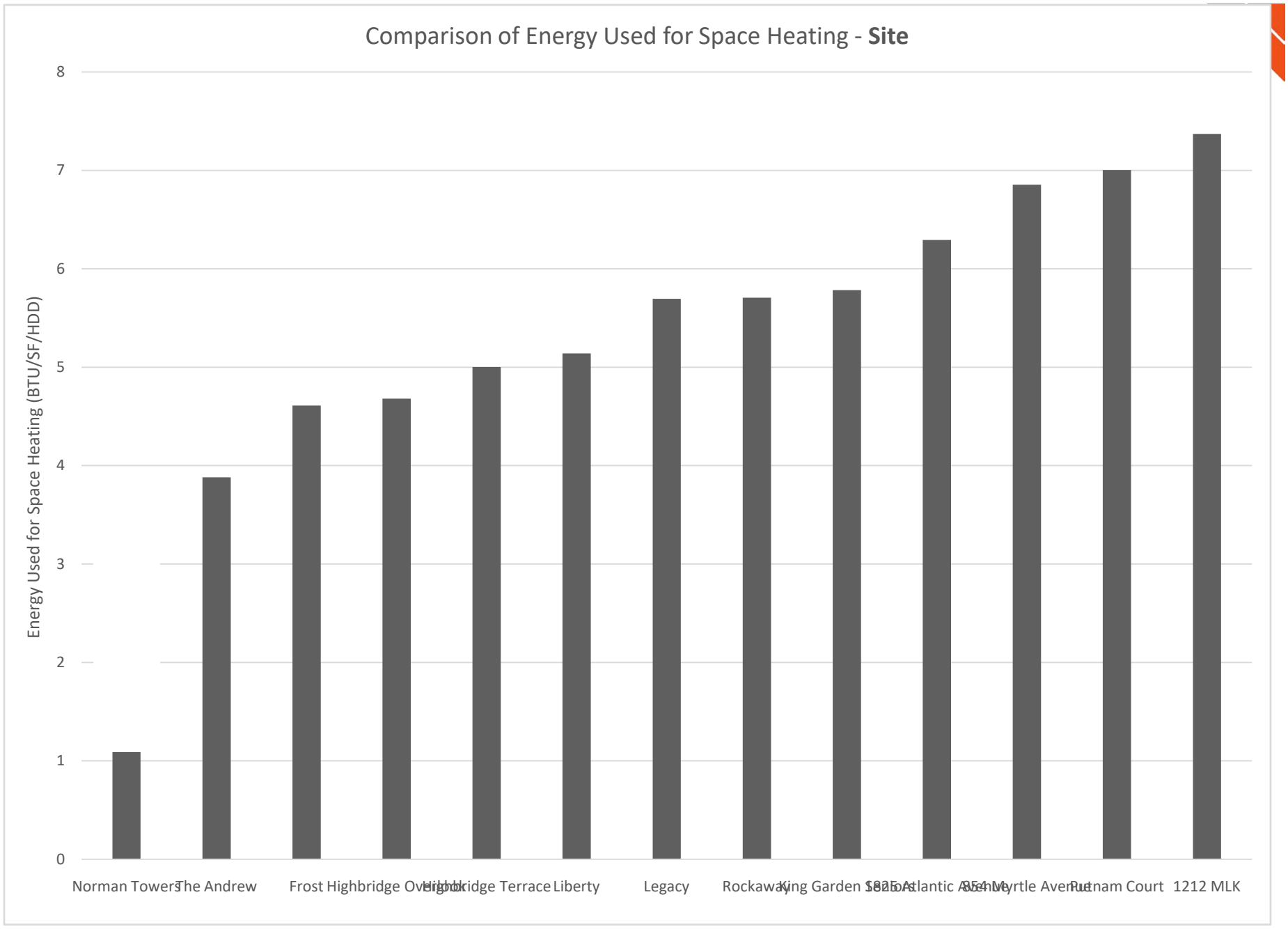
Which buildings do you think have condensing boilers?

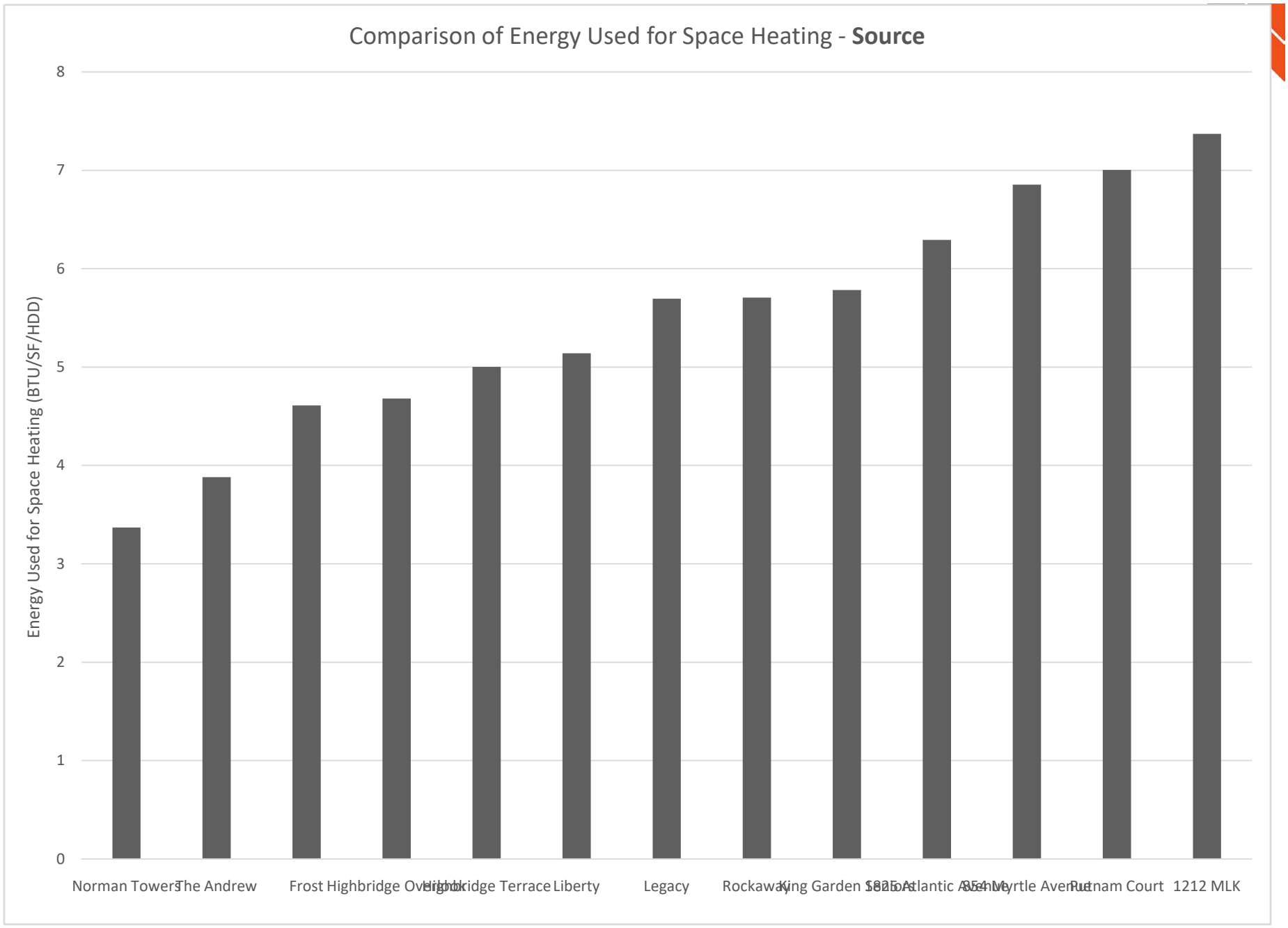

Comparison of Energy Used for Space Heating
Energy Used for Space Heating (BTU/SF/HDD)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
The Andrew
Frost
Highbridge Overlook
Highbridge Terrace
Liberty
Legacy
Rockaway
King Garden Seniors
1825 Atlantic Avenue
854 Myrtle Avenue
Putnam Court
1212 MLK



Let’s add the heat pump project.

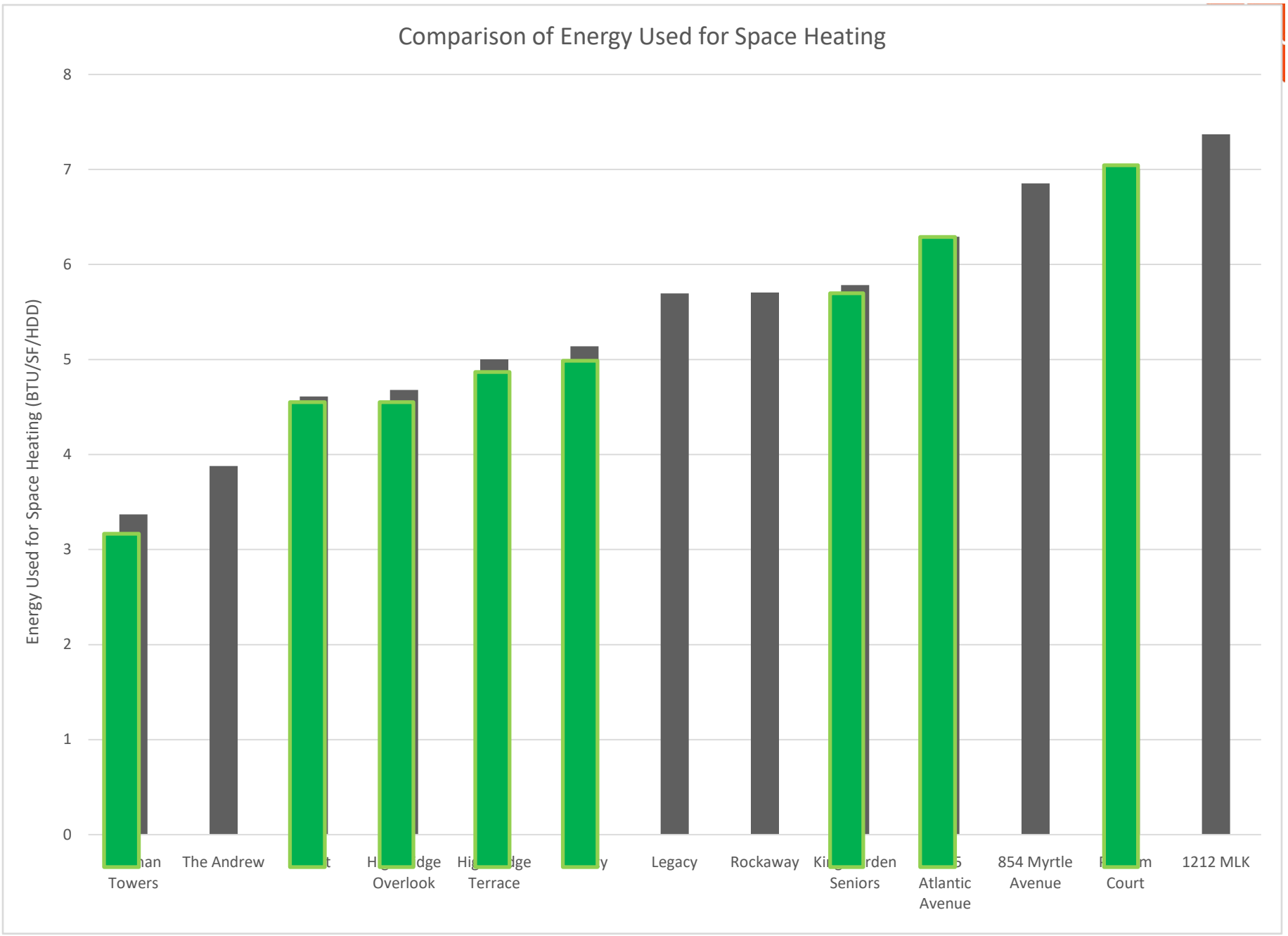

Comparison of Energy Used for Space Heating
Energy Used for Space Heating (BTU/SF/HDD)
0
1
2
3
4
5
6
7
8
??
Norman Towers
The Andrew
Frost
Highbridge Overlook
Highbridge Terrace
Liberty
Legacy
Rockaway
King Garden
1825 Atlantic Ave
854 Myrtle Avenue
Putnam Court
1212 MLK


Comparison of Energy Used for Space Heating - **Site**
Energy Used for Space Heating (BTU/SF/HDD)
0
1
2
3
4
5
6
7
8
Norman Towers
The Andrew
Frost
Highbridge Overlook
Highbridge Terrace
Liberty
Legacy
Rockaway
King Garden
1825 Atlantic Avenue
854 Myrtle Avenue
Putnam Court
1212 MLK


Comparison of Energy Used for Space Heating - **Source**
Energy Used for Space Heating (BTU/SF/HDD)
0
1
2
3
4
5
6
7
8
Norman Towers
The Andrew
Frost
Highbridge Overlook
Highbridge Terrace
Liberty
Legacy
Rockaway
King Garden
1825 Atlantic Avenue
854 Myrtle Avenue
Putnam Court
1212 MLK

All of these buildings supply fresh air to common area hallways.

Which buildings do you think use ERVs?


Comparison of Energy Used for Space Heating
Energy Used for Space Heating (BTU/SF/HDD)
8
7
6
5
4
3
2
1
0
The Andrew
Legacy
Rockaway
854 Myrtle Avenue
1212 MLK

All of these buildings utilized different strategies to exceed code requirements for wall insulation:

- Interior only
- Exterior only
- Insulated Concrete Form

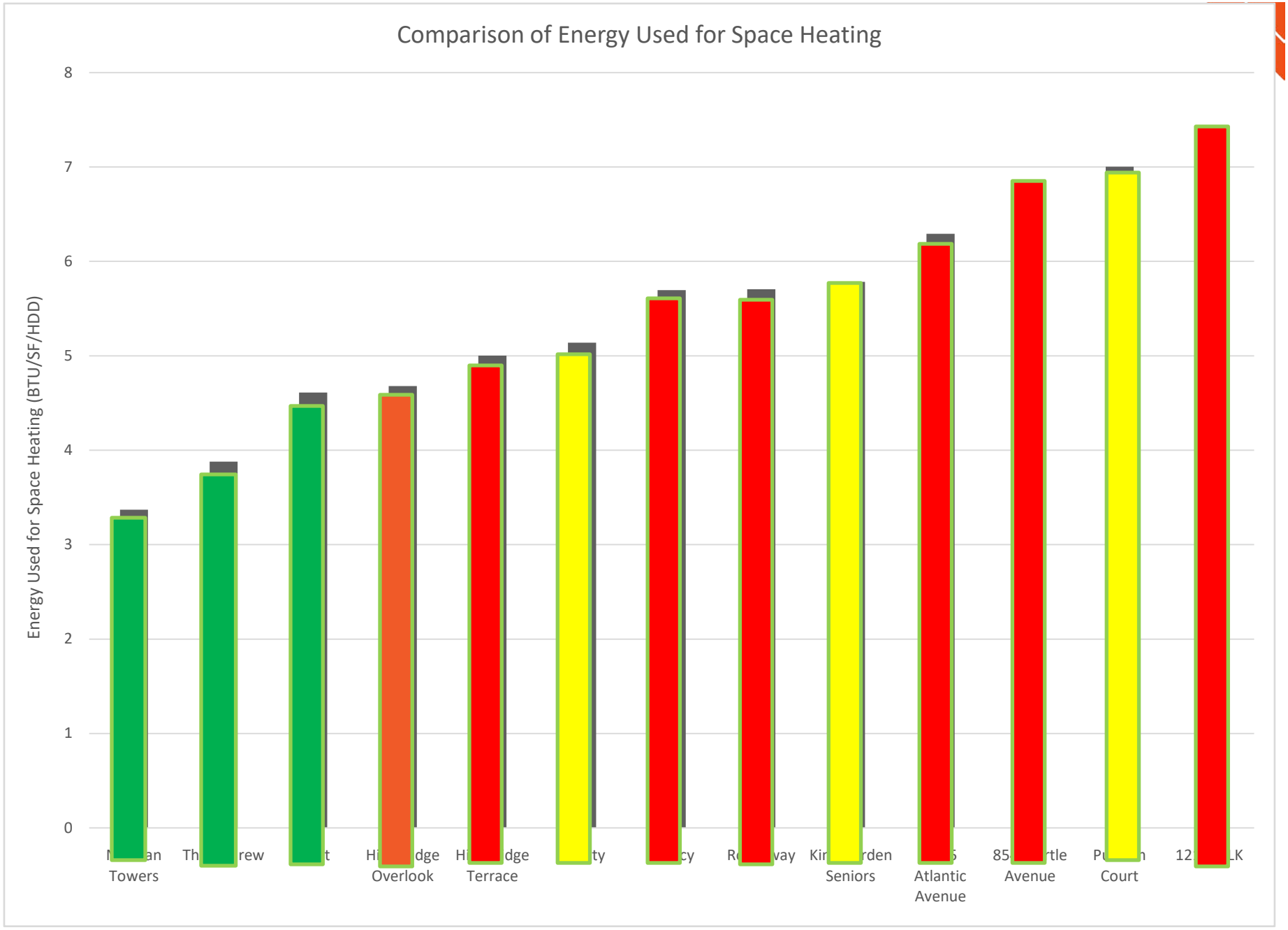
Which do you think performs best?

Which buildings do you think have interior insulation?

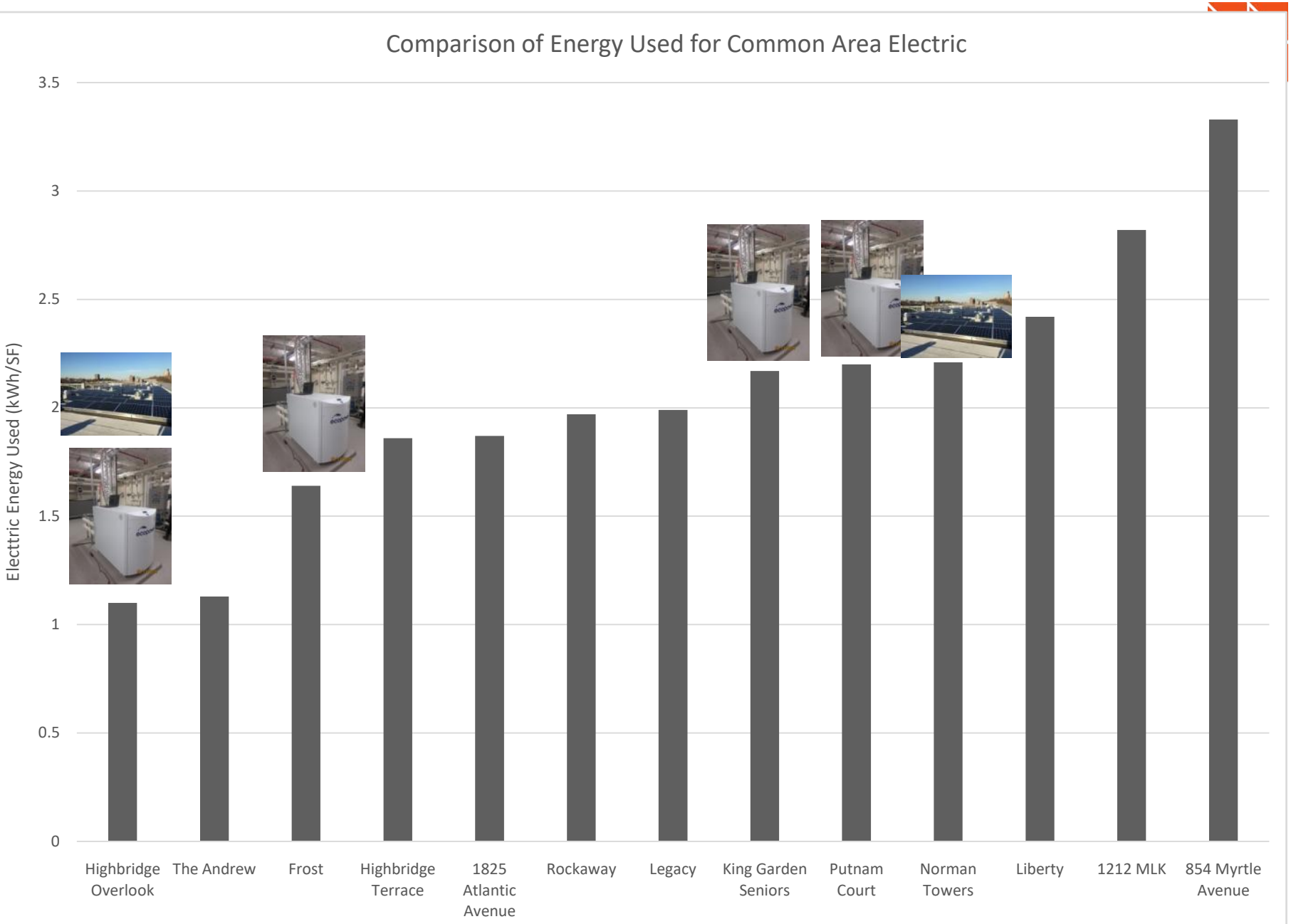
Inboard Insulation

Outboard Insulation

Insulated Concrete Form


Comparison of Energy Used for Space Heating
Energy Used for Space Heating (BTU/SF/HDD)
8
7
6
5
4
3
2
1
0
Towers
Overlook
Terrace
Seniors
Atlantic Avenue
Avenue
Court

What about solar and cogen?


Comparison of Energy Used for Common Area Electric
Electtric Energy Used (kWh/SF)
3.5
3
2.5
2
1.5
1
0.5
0
Highbridge Overlook
The Andrew
Frost
Highbridge Terrace
1825 Atlantic Avenue
Rockaway
Legacy
King Garden Seniors
Putnam Court
Norman Towers
Liberty
1212 MLK
854 Myrtle Avenue

Owner Paid Electric: Other Factors

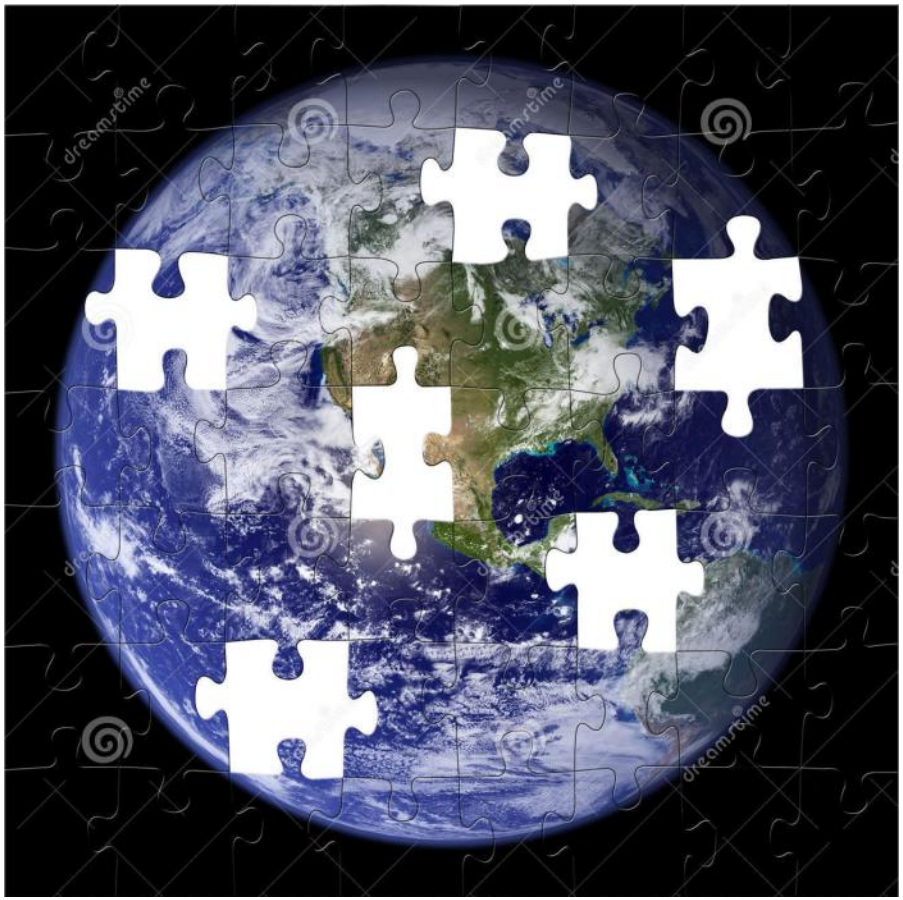
- Apartment Exhaust Ventilation
  - Central versus unitized
- Booster pumps
- Heating circulator pumps

The Andrew: Keeping it Simple

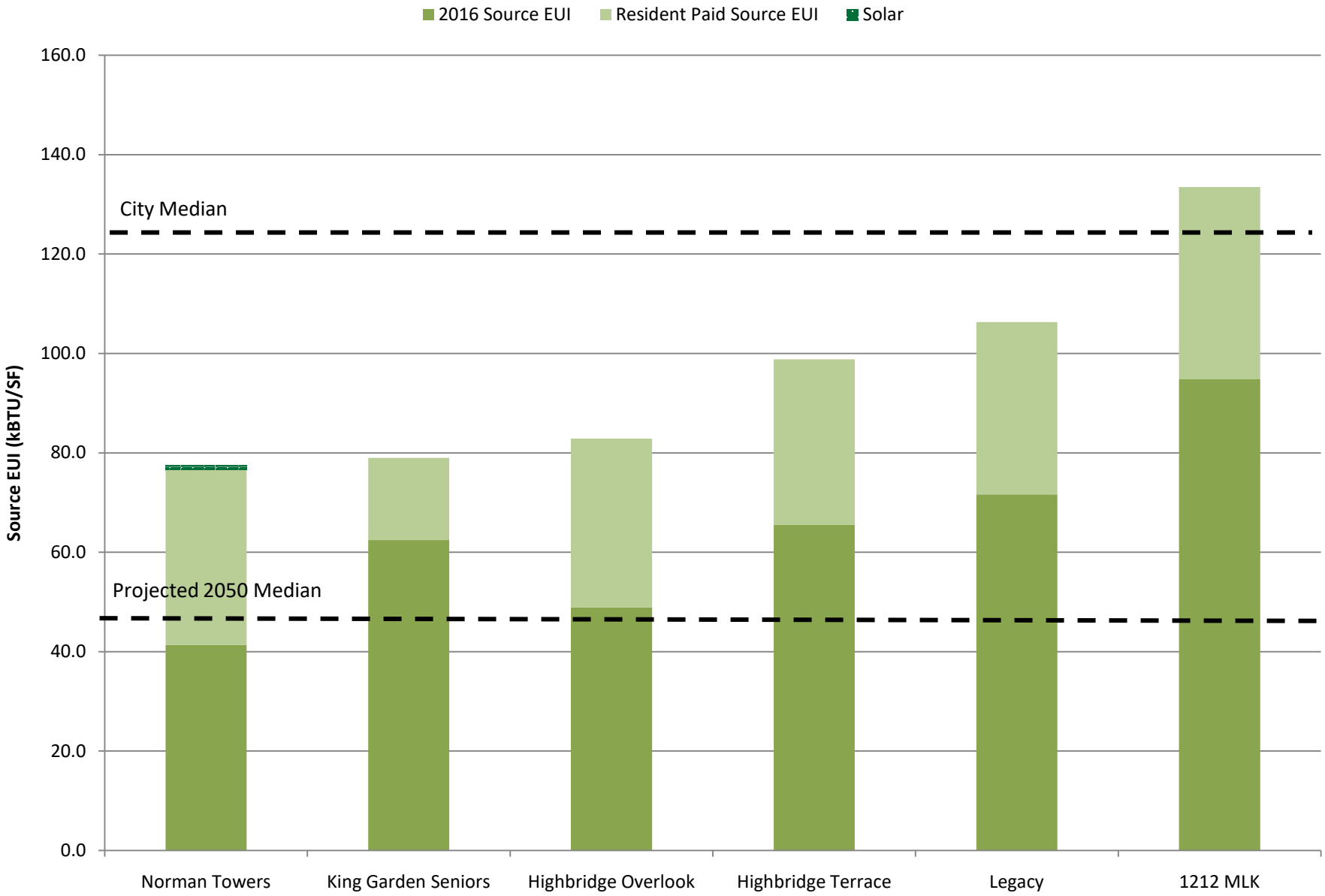
- Unitized exhaust ventilation
- Heating circulators
- Booster pumps

Whole Building EUI

- What about the rest of these buildings?



Comparison of Whole Building Source Energy Use



Questions?