Mind the Gaps:
Post-Occupancy Discoveries from Data and Operational Perspectives
Government Initiatives to Reduce CO₂

New York State Energy Plan

CO₂ 40% Reduce greenhouse gas emissions 40% (from 1990 levels) by 2030

CO₂ 50% Energy generation from renewable energy sources

NYC One City Built to Last

CO₂ 80x50 Reduce greenhouse gas emissions 80% (from 2005 levels) x 2050

Credit: Urban Green Council
1975 Energy Code = 100%

Code-compliant buildings today will use almost 50% as much energy as a similar building constructed in 1975.

Projections to 2030 assuming same rate of change as last 9 years.

Net Zero Building (Produces energy equal to the amount it uses over a year)

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

<table>
<thead>
<tr>
<th>Metric</th>
<th>Unit</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark (EUI)</td>
<td>kBtu/SF</td>
<td>Whole-building source</td>
</tr>
<tr>
<td>Heating</td>
<td>Btu/SF/HDD</td>
<td>Owner-paid</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>kBtu/SF</td>
<td>Owner-paid</td>
</tr>
<tr>
<td>Fuel</td>
<td>kBtu/SF</td>
<td>Owner-paid</td>
</tr>
<tr>
<td>Electric</td>
<td>kWh/SF</td>
<td>Owner-paid</td>
</tr>
<tr>
<td>ENERGY STAR Score</td>
<td>1-100</td>
<td>Relative to similar buildings nationwide</td>
</tr>
</tbody>
</table>
Site vs. Source

Site Energy

Source Energy
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

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

- 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?
Let’s add the heat pump project.
Comparison of Energy Used for Space Heating

- Norman Tower
- The Andrew
- Highbridge Overlook
- Highbridge Terrace
- Liberty
- Legacy
- Rockaway Garden
- 1825 Atlantic
- Assembly
- Vietnam Court
- 1212 MLK

- Energy Used for Space Heating (BTU/SF/HDD)
Comparison of Energy Used for Space Heating - Site

Energy Used for Space Heating (BTU/SF/HDD)

- Norman Towers: 1.0
- The Andrew: 3.0
- Highbridge Overlook: 4.0
- Highbridge Terrace: 5.0
- Liberty Legacy: 6.0
- Rockaway Garden: 7.0
- 1825 Atlantic: 8.0
- Assembly Run: 9.0
- Putnam Court: 10.0
- 1212 MLK: 11.0
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)
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)
What about solar and cogen?
Comparison of Energy Used for Common Area Electric

Electric Energy Used (kWh/SF)

- 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

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?
Questions?