Multifamily New Construction Technology Roundup

Emerging Technologies Showcase
December 17, 2015

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Multifamily New Construction Technology Roundup

Emerging Technologies Showcase
December 17, 2015

Presenters:
Meghan Pinch – Seattle City Light
Jon Heller – Ecotope
Multifamily New Construction Technology Roundup

- Individual unit metering with real-time resident feedback at the Anhalt Apartments
- Sneak Peek at the soon to be released Energy Efficient Design Guidelines for Reverse Cycle Chillers (a heat-pump domestic hot water system for large multifamily buildings)
- A smaller scale alternative to RCCs: initial M & V results of a solar-assisted central heat pump hot water system at The Denning Apartments
Anhalt Apartments –
A Performance Approach to Code Compliance

Project overview
• 39 unit multifamily building
• Historic rehab of old building + new building on site
• Participated in the Seattle Outcome-Based Energy Code demonstration program

Problem:
How can multifamily building owners and residents effectively monitor building energy use?
Anhalt Apartments – Key Players

- **Trinity Real Estate**: Project Developer/Owner
- **Preservation Green Lab**: partnered with the City of Seattle Department of Planning and Development to create the outcome-based code demonstration program; served as technical consultant to building owner
- **Seattle City Light**: Provided technical assistance and financial energy incentives based on verified building performance
- **Submeter Solutions**: Designed the system and supplied system equipment to building owner
- **BPA E3T Fund**: Subsidized the cost of unit submetering system
Seattle’s Outcome Based Energy Code Compliance Project (2009 Energy Code)

Allows for broad departures from energy code requirements for specific building components/systems, so long as a building can demonstrate energy performance through verification.

How does it work?
Prove EUI virtually with energy modeling
Prove EUI operationally for a year

You’re done when you hit the target EUI!
## Setting Energy Performance Targets

<table>
<thead>
<tr>
<th>Item</th>
<th>Code Baseline</th>
<th>Proposed Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeled Site Energy Use</td>
<td>1336.8 MBlu</td>
<td>1197.8 MBlu</td>
</tr>
<tr>
<td>Total Conditioned Floor Area</td>
<td>29,848 sf²</td>
<td>29,848 sf</td>
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<tr>
<td>Modeled EUI</td>
<td>44.8 kBtu/s²</td>
<td>40.1 kBtu/sf</td>
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<td>Renewable Energy EUI</td>
<td>-0.5 kblu/sf</td>
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<td>Total Site EUI</td>
<td>44.3 kBtu/s²</td>
<td>40.1 kBtu/sf</td>
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<tr>
<td>Percent reduction below calculated allowable EUI</td>
<td>--</td>
<td>9.0%</td>
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</table>
Monitoring and Communicating Energy Use to Residents

**Solution:** Nest Thermostats

A great interface for users, but no ability to aggregate unit data for whole-building energy use information.
Measuring Building Performance – Building Owners

Energy monitoring system

- High accuracy CTs to measure current
- 10 eGauge units (each stores data for 4-5 units)
- Web-enabled to transfer data to web interface
Egauge Dashboard – Building Owner View

The data in this table is updated once an hour. You can click on most column-headings to sort by that column.

### Average Power [W]

<table>
<thead>
<tr>
<th>Name</th>
<th>S</th>
<th>Avail</th>
<th>Trip</th>
<th>LO</th>
<th>Rev</th>
<th>SumGenUse</th>
<th>GenUse</th>
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<td>100%</td>
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<td>-6981</td>
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### Cumulative Average Power [W]

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<th>Month</th>
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<td>0-4110</td>
<td>0-4110</td>
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</table>

E3T Energy Efficiency Emerging Technologies
Egaugue Detail – Building Owner View

Anhalt Apartments

Summary for time-period shown in graph
- Energy Used: -2.34 MWh
- Energy Generated: 0.00 Wh
- Net: 2.34 MWh sold

Summary over last 30 days
- Energy Used: -2.30 MWh
- Energy Generated: 0.00 Wh
- Net: 2.30 MWh sold

Graph showing energy usage and generation over time.
Project Costs, Lessons Learned, Next Steps

Equipment costs:
- $12,087 ($309 per unit)
- Bonneville Power Administration E3T grant paid 78% of the cost of the system equipment (78%).
- Owner paid balance of equipment costs and all of the additional installation costs

Challenges:
- Communicating, coordinating training electrician
- Training building owners and maintenance staff

Lessons learned:
- Involve electrician as early as possible
- Include system install in electrical SOW
- Budget time to train electrician and building staff
Reverse Cycle Chillers (RCCs) – New Design Guidelines

Problem:
How can RCCs help reduce a building’s domestic hot water load? What design strategies can be replicated in multiple new construction buildings?

Project overview:
- A set of design guidelines will soon be available to inform design choices for Reverse Cycle Chiller hot water systems.
- Design guidelines build on lessons learned from two pilot RCC design and M & V projects
- Cost: Free! Guidelines will be available online
RCC Guidelines - Key Players

- **BPA E3T Fund**: Provided design and M & V funding for two pilot RCC projects as well as funding for development of Design Guidelines
- **Stream Uptown and Sunset Electric**: The multifamily buildings participating in the pilot design projects
- **Ecotope**: Designed RCC systems, performed M & V studies, authored Design Guidelines
- **Seattle City Light**: financial energy incentives for pilot RCC projects; gave feedback on development of Design Guidelines.
RCC Schematic

GARAGE EXHAUST

HOT WATER STORAGE TANKS

REVERSE CYCLE CHILLER (RCC)

OUTSIDE AIR (25F)

OUTSIDE AIR WARMED TO 50 F

L5
L4
L3
L2
L1
P3
P2
P1
RCC Design Features

- R134a refrigerant
- Operate down to ~40F airsource
- Produce water up to 130-160F
- Single Pass Design
- Annual COP ~2.6 for garage
Sunset Apartment M&V Data
Hot Water Flow by Hour of Day

Stream Weekday  Stream Weekend

Sunset Weekday  Sunset Weekend

GPM

Hour of Day

Summary
- 5%
- 25%
- Median
- 75%
- 95%
### E3T Energy Efficiency Emerging Technologies

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<tr>
<th>Measure</th>
<th>Range</th>
<th>Stream</th>
<th>Sunset</th>
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<tr>
<td>Apartments</td>
<td>118</td>
<td>92</td>
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</tr>
<tr>
<td>Occupants</td>
<td>140</td>
<td>110</td>
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<tr>
<td>Garage Temp °F</td>
<td>Average</td>
<td>66</td>
<td>63</td>
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<tr>
<td></td>
<td>High (99%)</td>
<td>81</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>Low (1%)</td>
<td>53</td>
<td>50</td>
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<tr>
<td>Hot Water (Gal/Person/Day)</td>
<td>Average</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>High (95%)</td>
<td>23</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Low (5%)</td>
<td>16</td>
<td>-</td>
</tr>
<tr>
<td>RCC COP</td>
<td>Average</td>
<td>2.8*</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>-</td>
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<td></td>
<td>Low</td>
<td>-</td>
<td>2.2</td>
</tr>
<tr>
<td>Losses</td>
<td>kBtu / year</td>
<td>200,000</td>
<td>210,000</td>
</tr>
<tr>
<td></td>
<td>Average %</td>
<td>30%*</td>
<td>44%</td>
</tr>
<tr>
<td>RCC Energy Use</td>
<td>262,000**</td>
<td>210,000</td>
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Summary Recommendations

1. Install RCCs in Buffered Area
2. Use Single Pass Configuration
3. Provide Stratified Storage
5. Provide Multiple Stages in Parallel w/ Lead/Lag Controller
6. Fully Insulate Distribution Piping
7. Separate Heating for Circulation Loop
8. Configure Back-up as Emergency Only
9. <150 Watts of Fans and Pumps per Ton of Capacity
10. Include Alarms and M&V Diagnostics
RCC Design Guidelines- Next Steps

Guidelines will be available for FREE online in January 2016

Downloadable from Seattle City Light and Bonneville Power Administration

OR

Email Meghan at Meghan.pinch@seattle.gov if you would like a copy
What if there is no Parking Garage?
Passive Solar Pre-Heat at the Denning

**Problem:** How can heat pump hot water heaters be incorporated into smaller buildings without parking garages? What are the potential savings through HP hot water heater applications?

**Project Overview:** HP Hot water heater with solar assist pilot project and M & V study at the Denning Apartments

**Key Players**
- **Ecotope:** Designed system, performed M & V study
- **BPA E3T Fund:** Provided funding for M & V study
- **Seattle City Light:** financial energy incentives for project owner; gave feedback on study.
Denning Apartments HP Hot Water System Design Schematic
Solarium Adds ~13F

The Denning Solarium

Air Temperature
- Indoor
- Outdoor
Estimated Average COP = 3.25
Coming Soon

- CO2 Transcritical Heat Pump (TCHP)
- COP ~3-4
- Low global warming potential
- Modular systems for smaller buildings ~(10-50 Apartments)
- Installed outside
Waste Water – The Ultimate Source
Thank you!

Questions?
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