Retrofit Case Studies

Energy, Health, and Comfort Transformations in Multi-Unit Buildings

November 30th, 2017

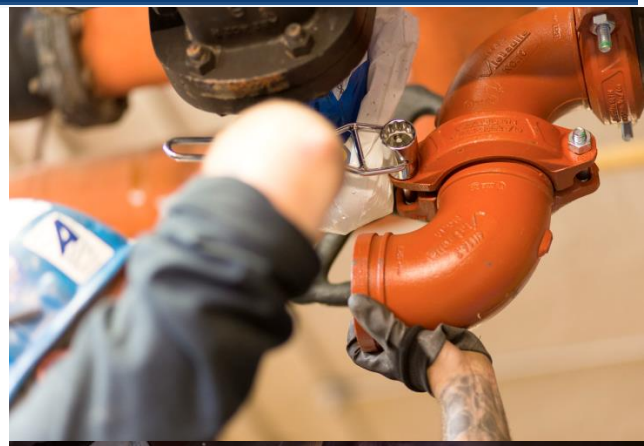
OVERVIEW

- Background
- Retrofit measure design & performance
- Lessons learned – construction & commissioning
- Best practice recommendations

The Atmospheric Fund (TAF) invests in urban solutions to reduce carbon emissions.

City of Toronto created TAF in 1991 Non-profit Public Agency

TAF has retrofitted 11 multi-unit residential buildings over last 5 years.



ABOUT ECOSYSTEM

We are specialists in energy ecosystems.

We design, build, optimize and guarantee outcome-based energy projects for organizations with complex energy needs.

24
Years in business

6
Locations Toronto | NYC | Montreal | Calgary | Boston | Quebec City

35%
Average project savings

105%
Aggregate Savings of Ecosystem projects over time

250
Projects in more than
1,250
buildings

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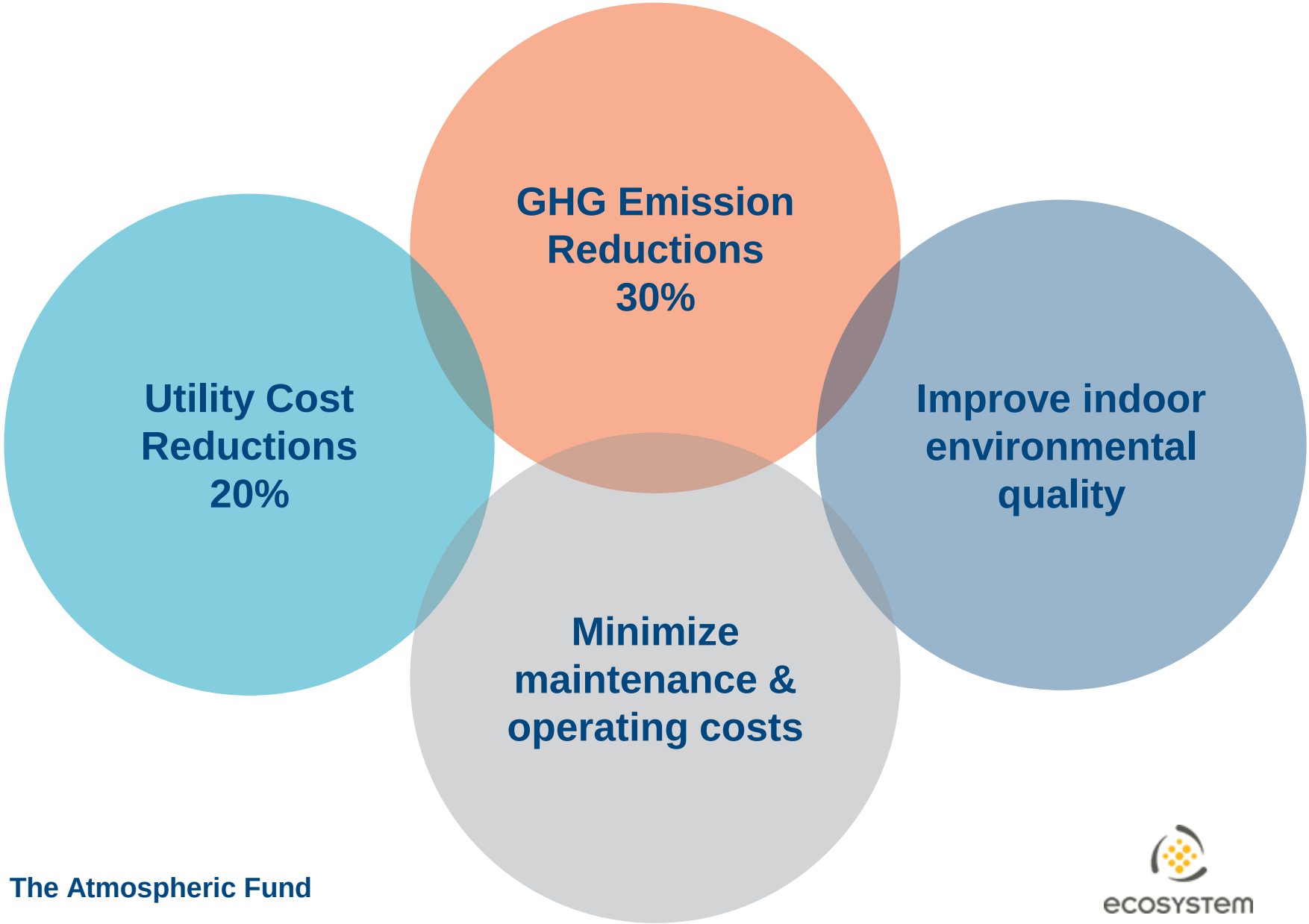
Background

GOALS


GHG Emission Reductions 30%
Utility Cost Reductions 20%
Improve indoor environmental quality
Minimize maintenance & operating costs

CASE STUDY: SEVEN BUILDINGS

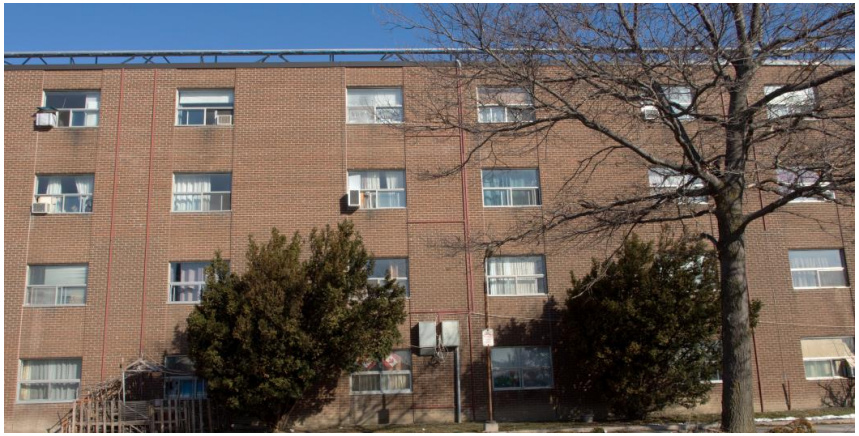
4 -19 storeys

1,237 units

1965 - 1974 construction

Bachelor/Seniors/Family

High-Rise

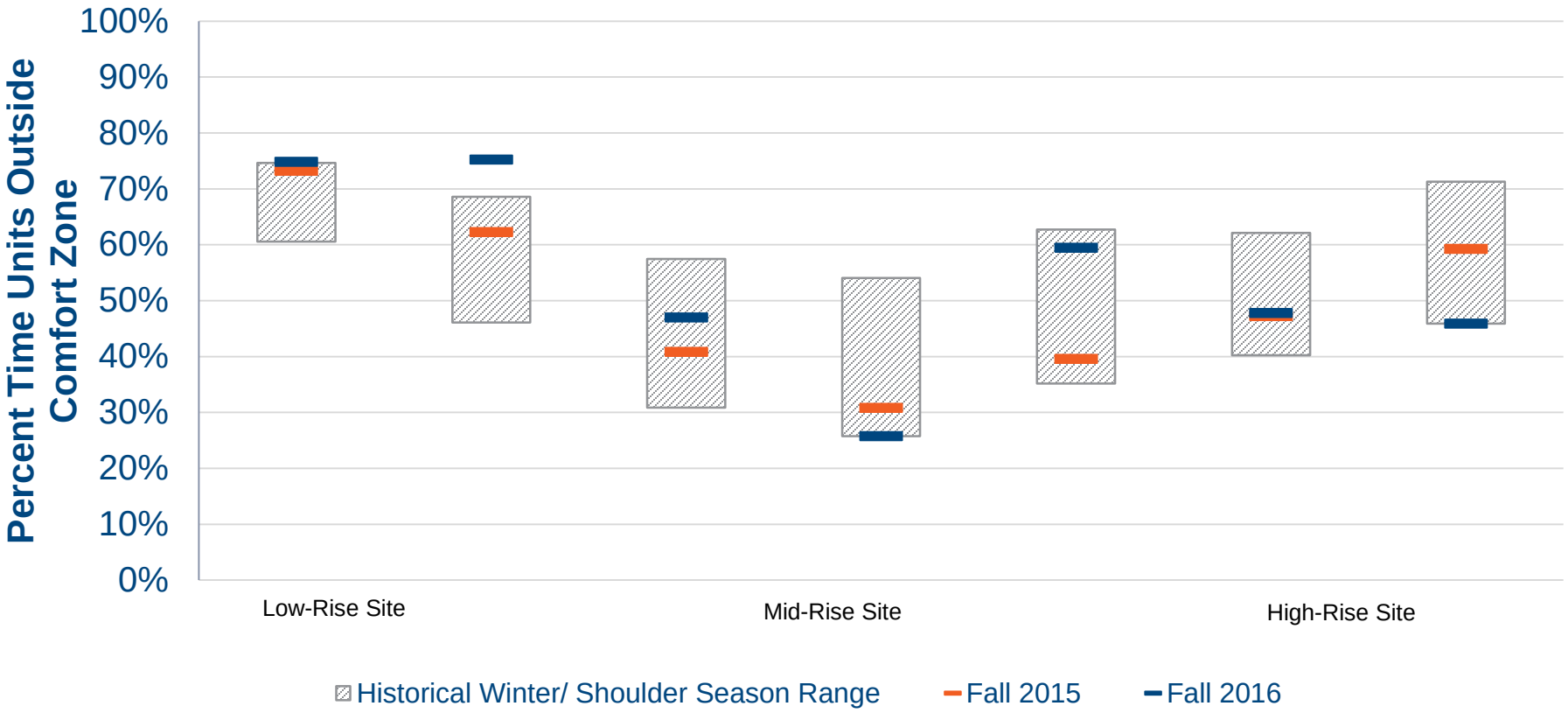


Low-Rise

Mid-Rise

FOCUS ON INDOOR ENVIRONMENTAL QUALITY

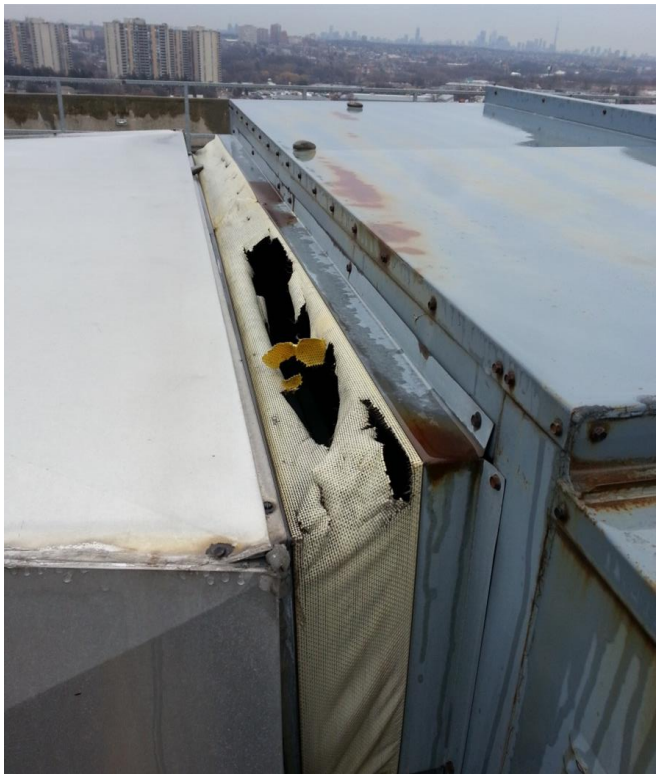
PRE-RETROFIT WINTER COMFORT



54% of time residents are uncomfortable during heating season

27°C average indoor temperatures during heating season

VENTILATION CHALLENGES



43%-50% Supply below code

25% Exhaust below code

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HEATING PERFORMANCE

53% **Avg. boiler efficiency during heating season**

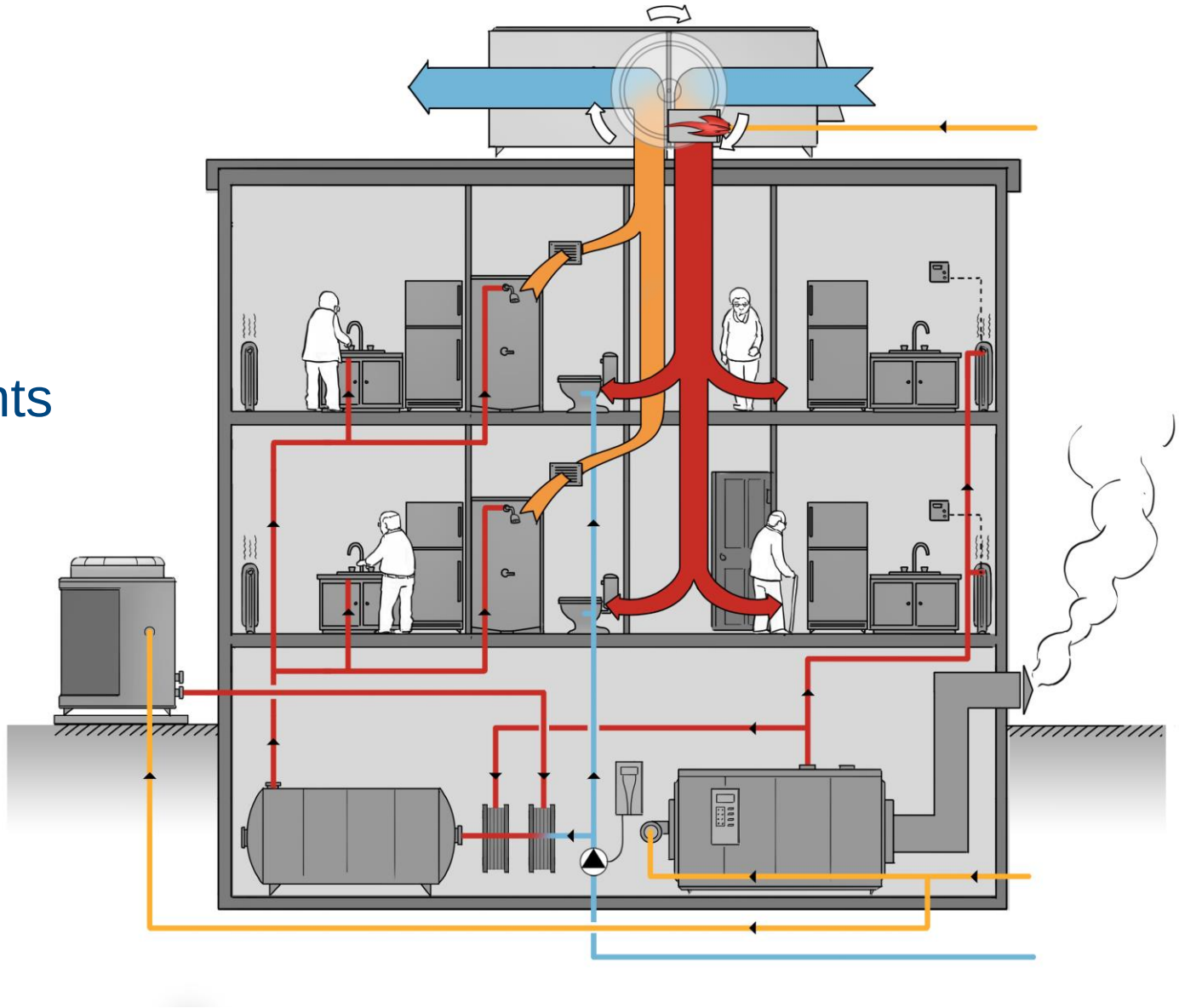
Design & Performance

COLLABORATIVE PROCESS

COMPREHENSIVE APPROACH TO ENERGY RETROFITS

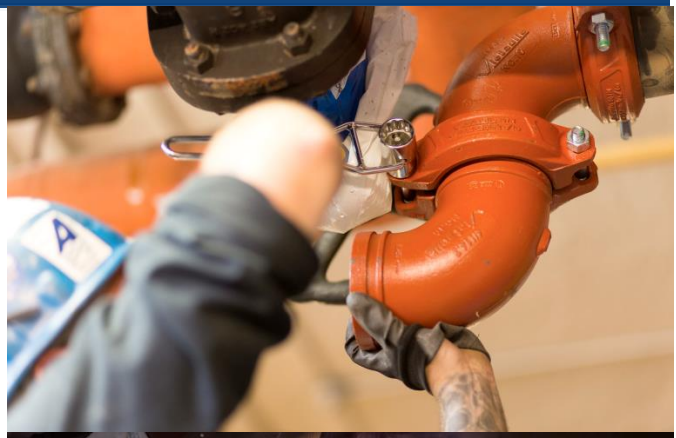
Focus:

- Systems
- Environments
- People
- Operations



BOILER ROOM RETROFITS

- 7 condensing boilers in six buildings
  - System downsizing
  - Higher modulation
  - Improved efficiency
- 2 GAHPs in two buildings
- Recommissioning of hot water and space heating boilers



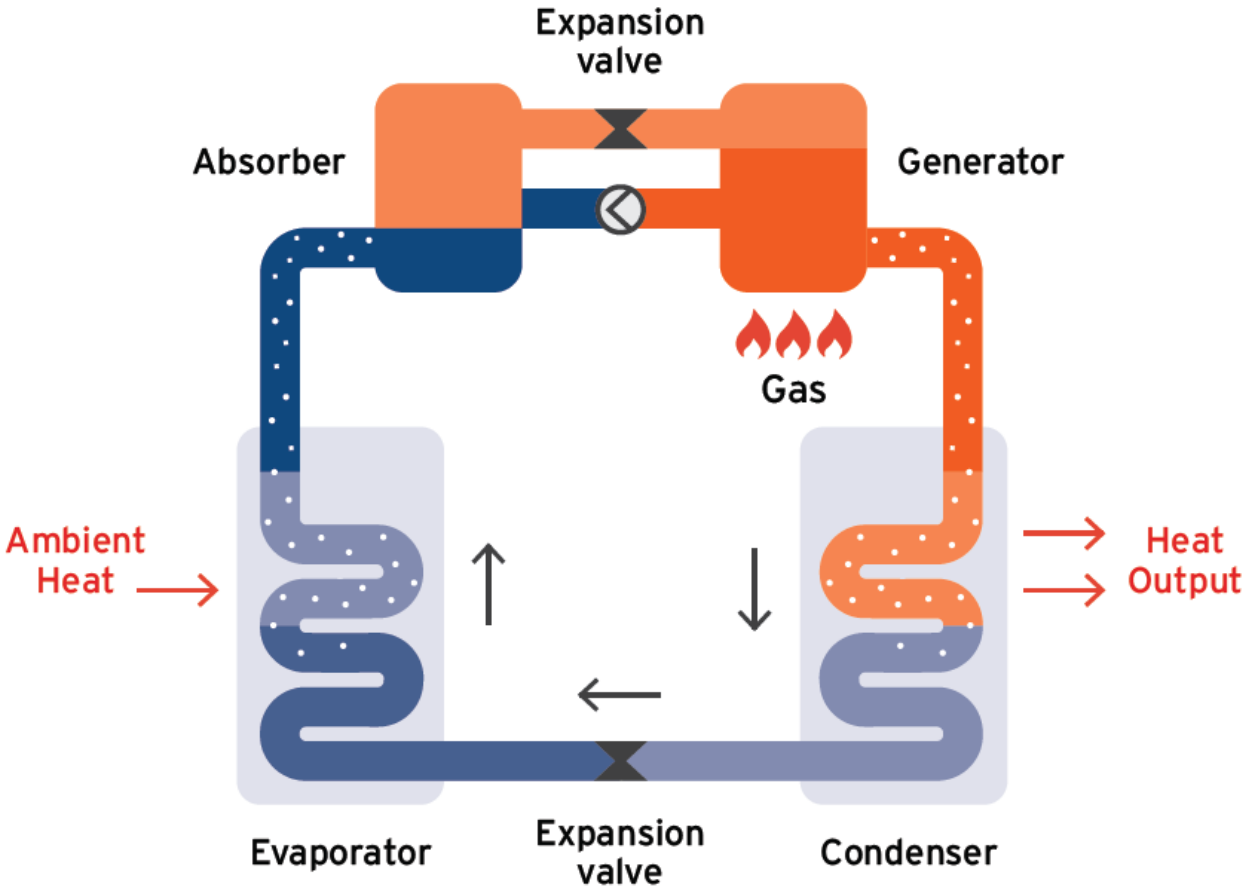
CONDENSING BOILERS

IN-SUITE HEATING CONTROLS

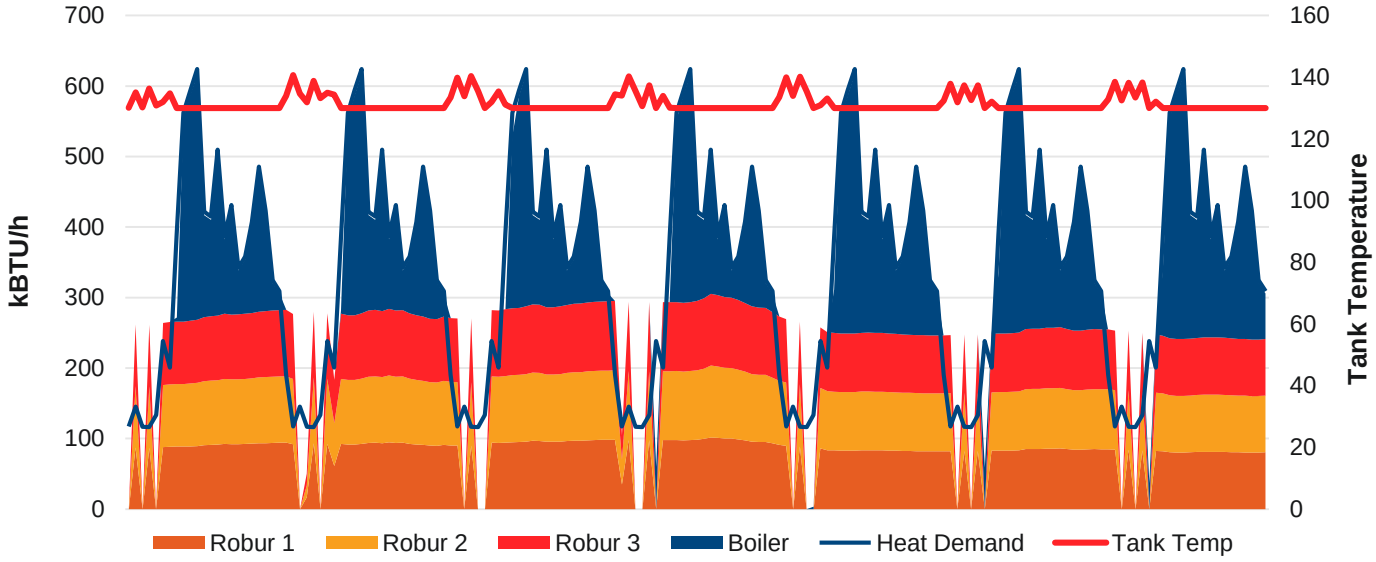
Maximizing heating system efficiency
+
Improving resident comfort

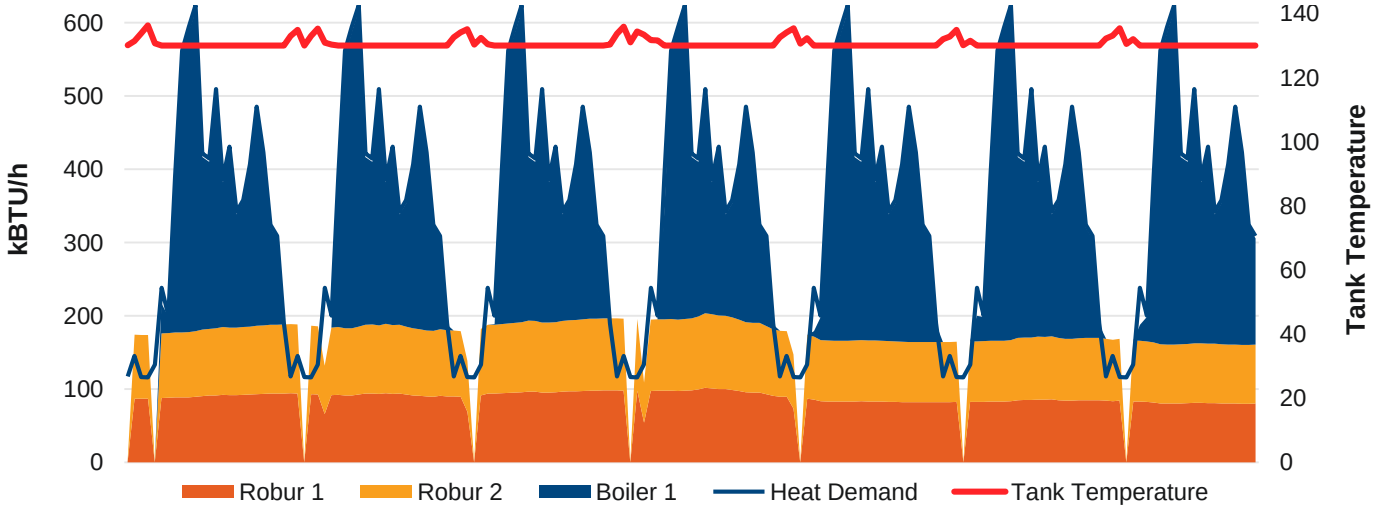
- Radiator valves controlled by adaptive thermostats
- Upper temperature limit programming

GAS ABSORPTION HEAT PUMPS



DHW SYSTEM DESIGN - SENSITIVITY ANALYSIS





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Capacity

- 60% DHW
- 125 MBTU/h (ea.)
- 140°F max outlet

Performance Goals

- 110-120% GAHP
- >100% overall DHW

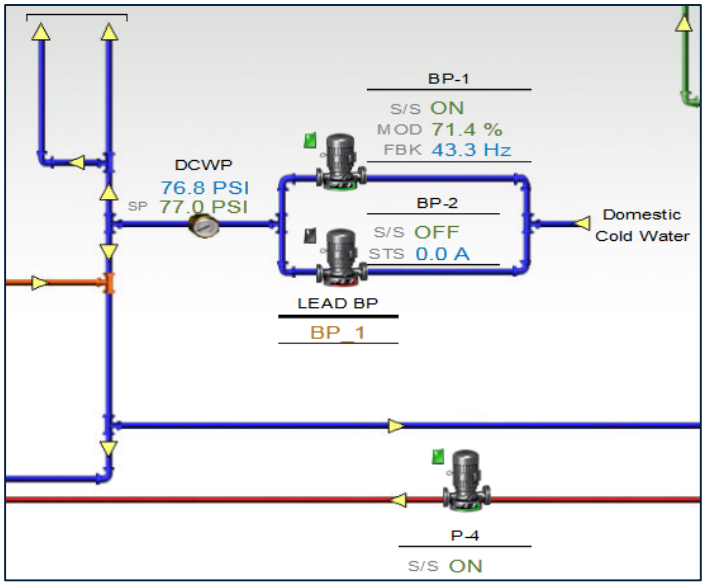
GAHP PERFORMANCE

110-117% Hourly real-time operating efficiency (average)

25k Annual expected natural gas savings (cubic meters)

46 Annual GHG emission reductions (tonnes CO_2eq)

ELECTRICITY SAVINGS



LIGHTING RETROFITS – ALL SITES

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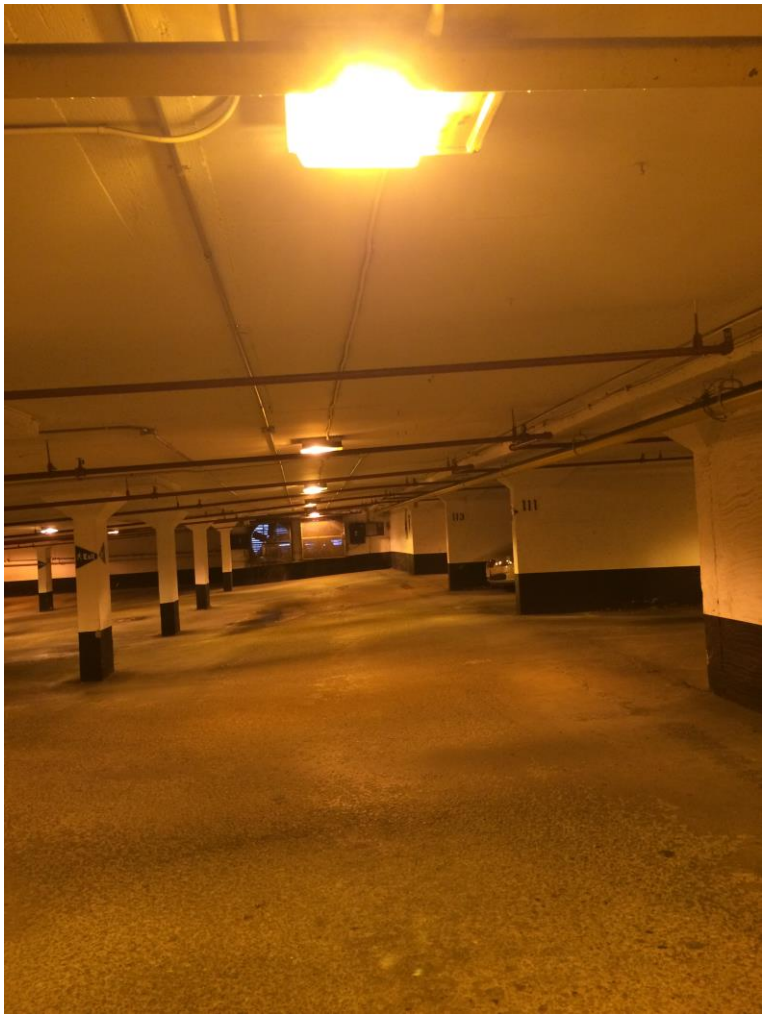
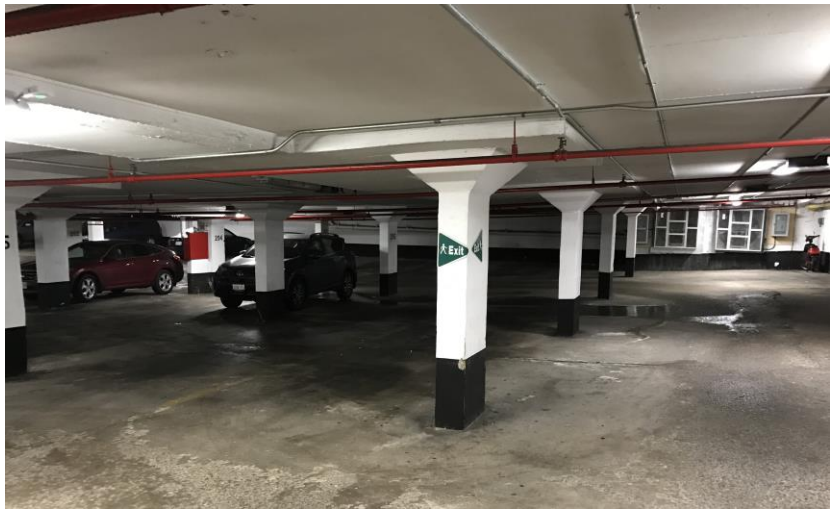
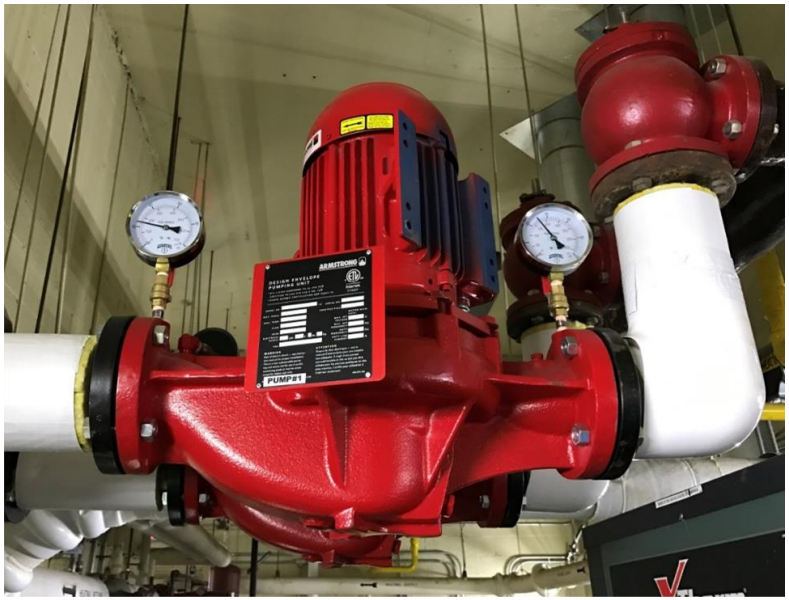




ASSET RENEWAL



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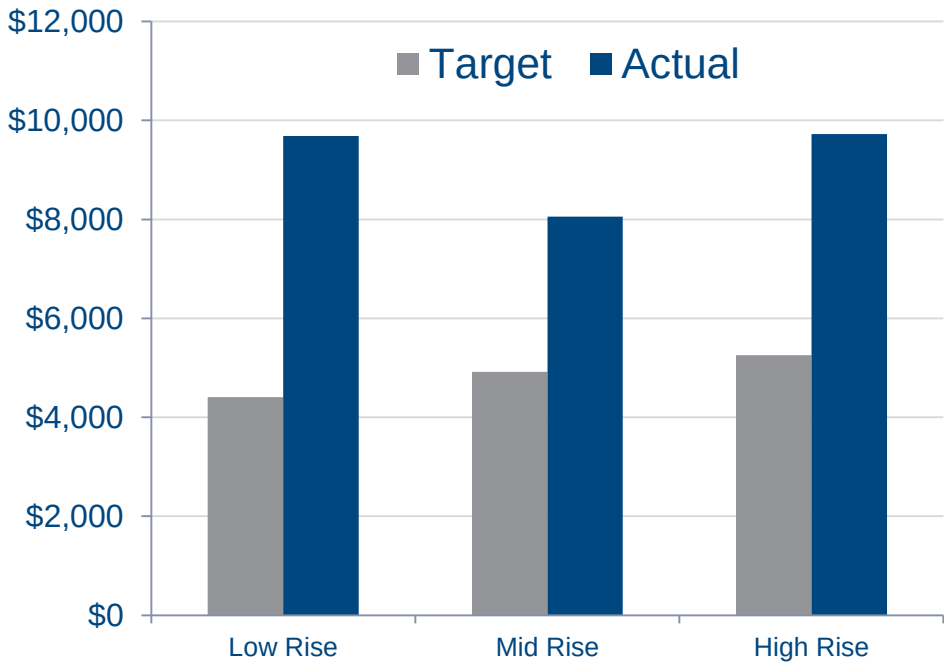
WATER SAVINGS



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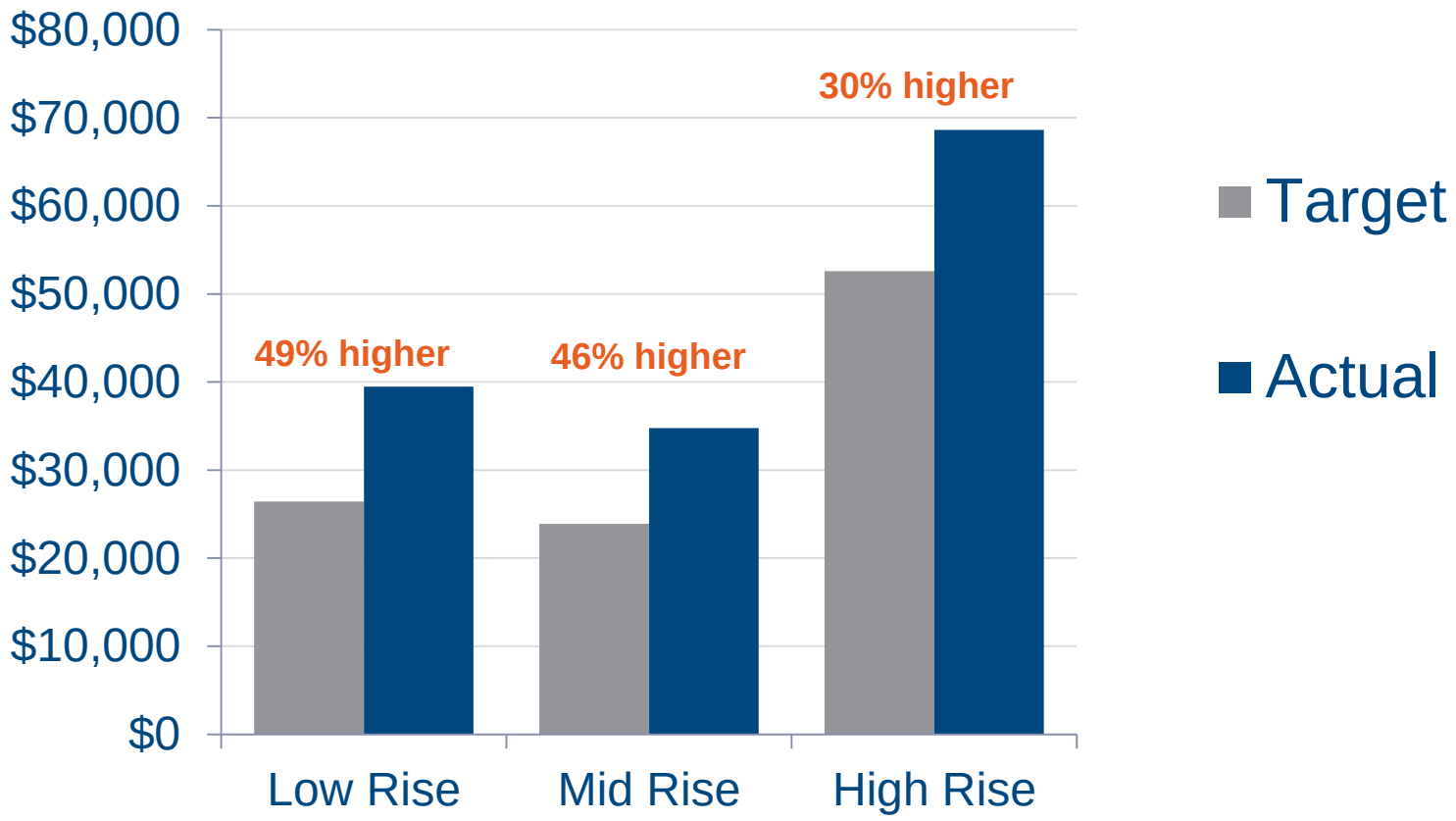
POST-RETROFIT PERFORMANCE

MAY 2017 TO AUGUST 2017



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Comfort levels **improved** **20%** compared to pre-retrofit conditions

Lessons Learned

Construction & Commissioning

COMMUNITY AWARENESS

LESSONS LEARNED

- Whole building approach
  - Correct sizing balancing performance and financials
- Iterative design
  - Incorporate information along the way
- Proper startup commissioning
  - Don’t forget about ongoing optimization!
- Preventative maintenance
  - Maintain your investment

CONSTRUCTION/COMMISSIONING AND LESSONS LEARNED

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KEY TAKEAWAYS

1. **Major energy retrofits** can achieve energy savings **and** enhance resident comfort.

2. Maximizing energy and non-energy benefits requires an **integrated design and project delivery process**.

3. **Enhanced Measurement and Verification** protects savings and extends equipment life.

4. Building automation systems need to be properly used to **track long-term energy savings**.

RETROFIT BEST PRACTICES

1. Undertake **duct cleaning** when MAUs are replaced to maximize fresh air benefits.

2. **Oversized boilers** can contribute to high energy consumption, especially during the shoulder season. **Right sizing boilers** and modular mechanical system design is critical.

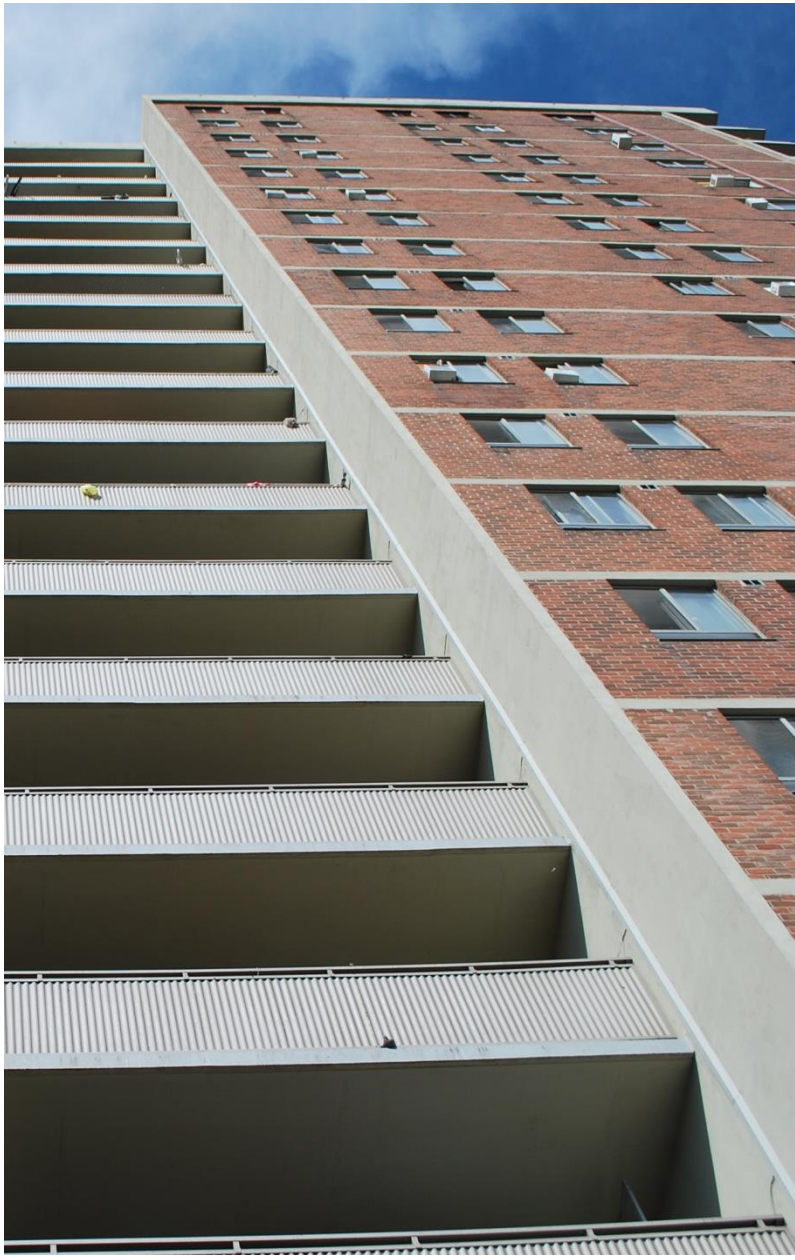
3. In-suite heating controls can help maximize the comfort and energy savings during the heating season.

MAINTENANCE BEST PRACTICES

1. **Knowledgeable and qualified** vendors should be used for troubleshooting and preventative maintenance. Training is key.

2. Mechanical systems should **not be switched to manual mode**, which can compromise savings.

3. The BAS should always be used to **sequence the systems** and **track long-term performance**.



STAY CONNECTED!

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