Steven Winter Associates, Inc.

J827

Multifamily Domestic Hot Water Design: How Can We Do Better?

GBPP 109

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Steven Winter Associates

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Our services for new and existing commercial and residential properties include:

- Green Building Consulting Services
- Energy Efficiency Consulting Services
- Building Enclosure Design and Consulting
- Accessibility Compliance and Consulting

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

This presentation will inform listeners about the what the common methods are for domestic hot water heating in multifamily buildings. It will cover design strategies to reduce water heating energy demand and costs. Lastly, the presentation will introduce the idea of water heating strategies in a fossil free society.

Learning Objectives

At the end of the this course, participants will learn:

1. The basics of domestic hot water generation and delivery for multifamily (MF) buildings
2. Of the staggering energy footprint of hot water use in MF buildings
3. Design tips to reduce energy impact of domestic hot water systems
4. About the feasibility of fossil fuel free hot water generation

Presentation Overview

- Domestic hot water
  - Generation, distribution, & storage
- System types and those most common in multifamily (MF)?
- Efficient design strategies
- Energy demand and cost implications
- Water heating in a carbon-free future?

"Domestic Hot Water"

- **Hot water used for drinking, food prep, sanitation, and personal hygiene**
- Not for heating, swimming pools, commercial cooking, etc.

Multifamily Domestic Hot Water: How Can We Do Better?

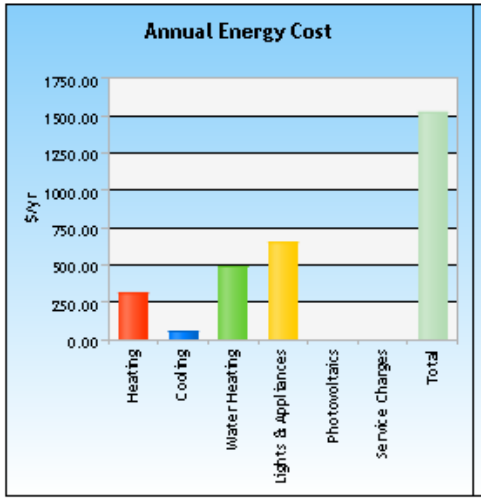
SYSTEM TYPES

System Types

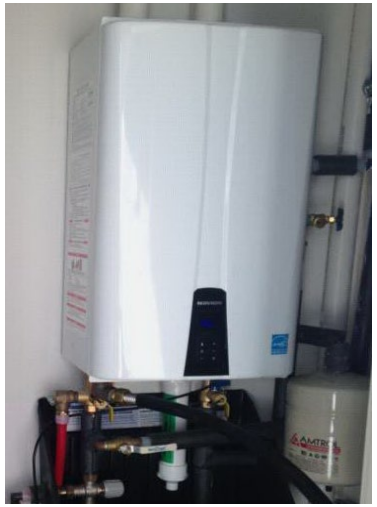
- Heat Generation
  - Gas boiler
  - Electric resistanc
  - Heat pump
- Distribution
  - Recirculation
  - Partial recirculation
  - No recirculation
- Storage vs. Instantaneous

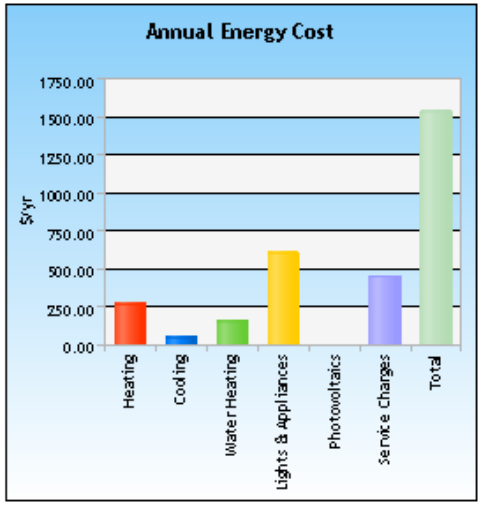
What's Typical in Unit

Electric Storage



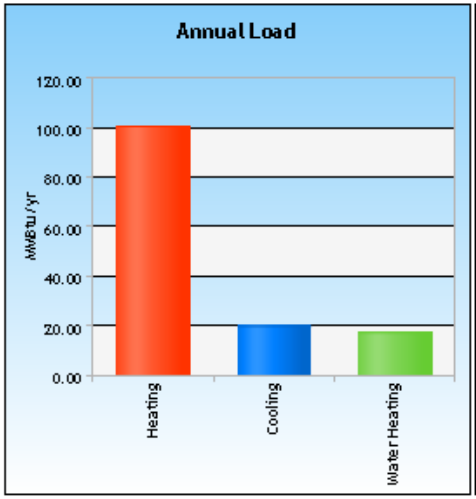
Gas Tankless

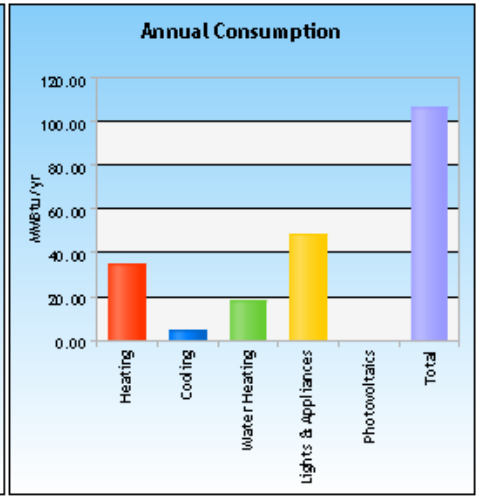




Not So Typical in Unit

Gas w/ Indirect Storage





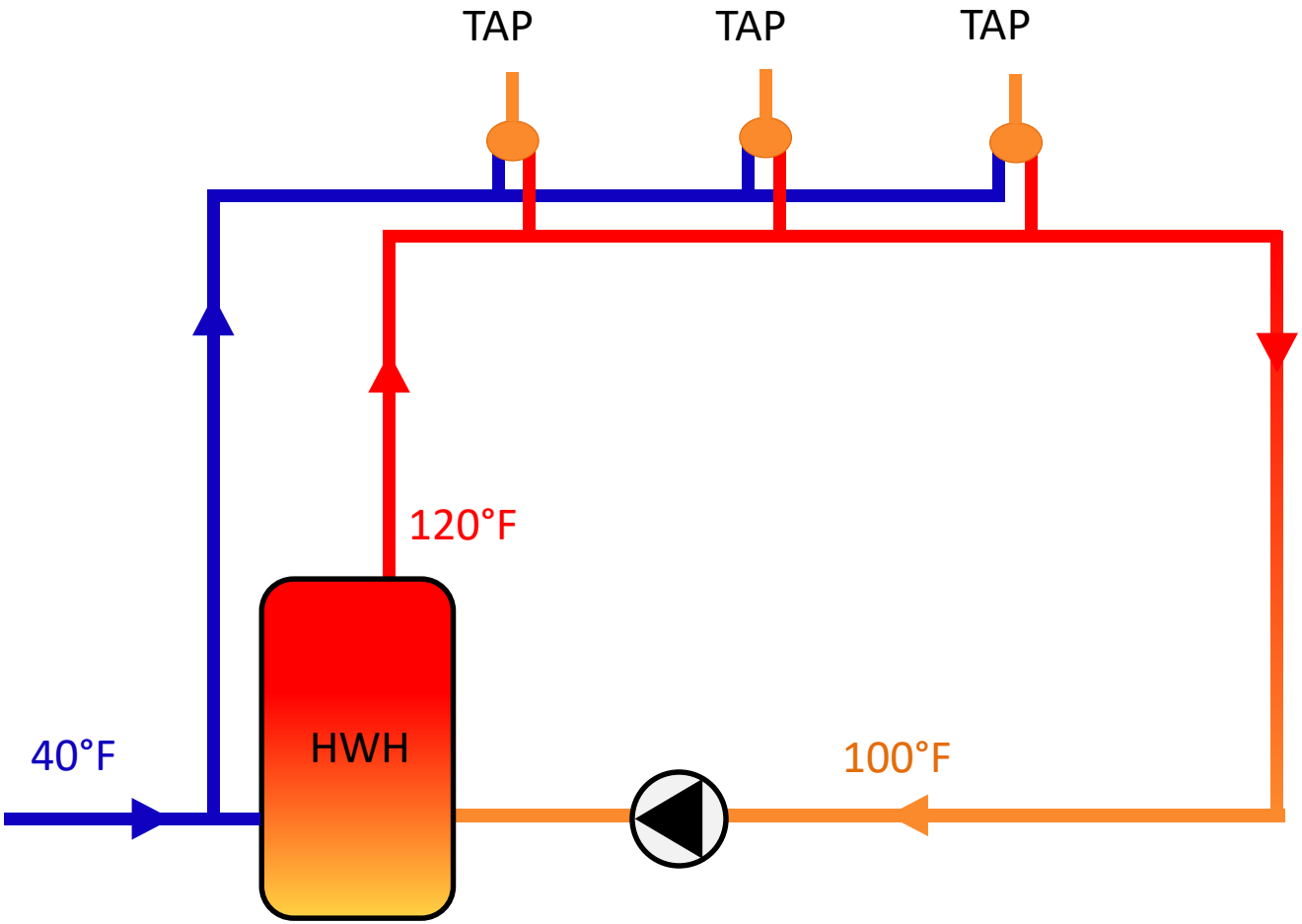
Electric Tankless

Most Common Mid & Highrise

Central Gas w/ Recirculation

Gas Boiler(s) with Recirculation

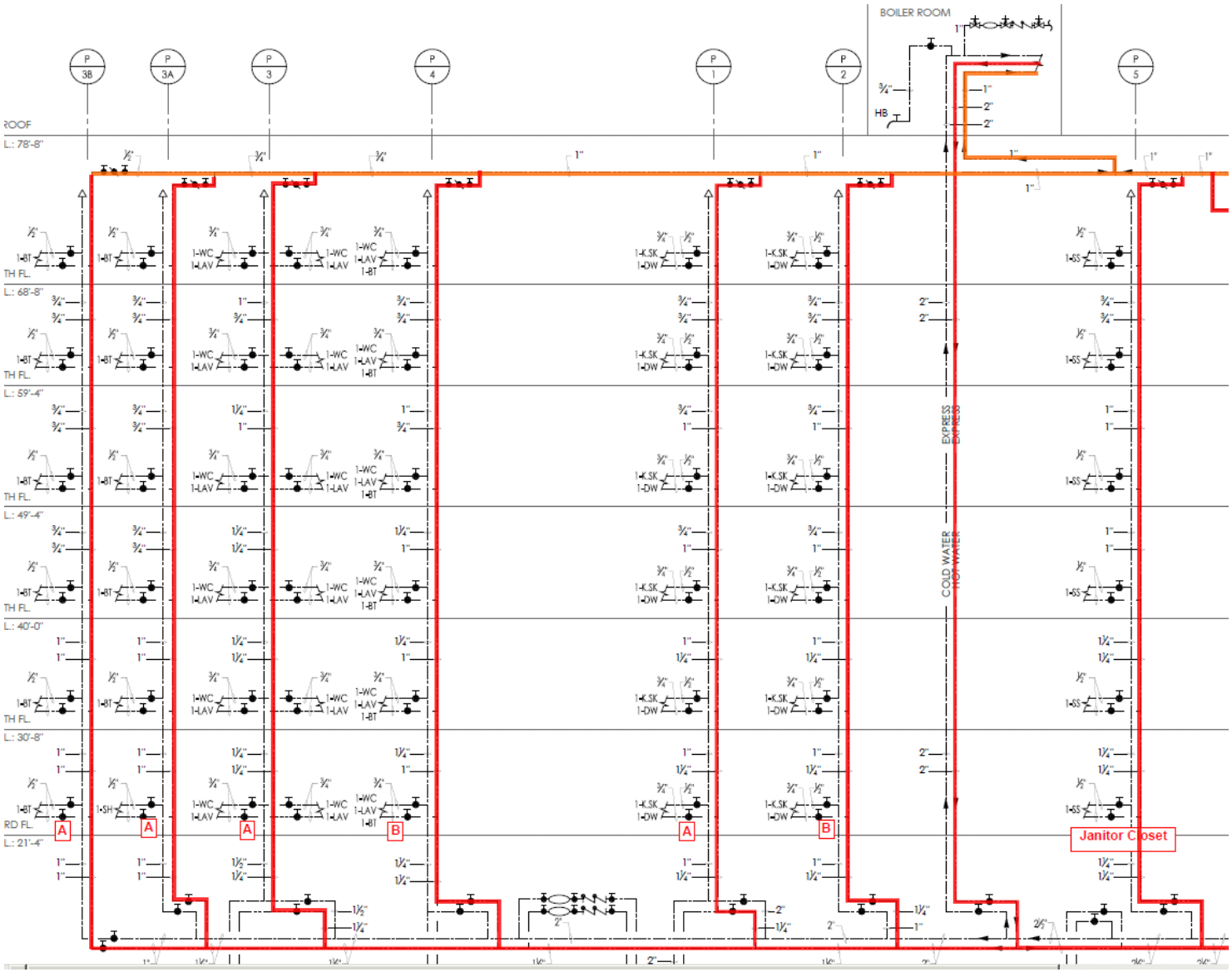
- Common in multifamily
- 24/7 operation



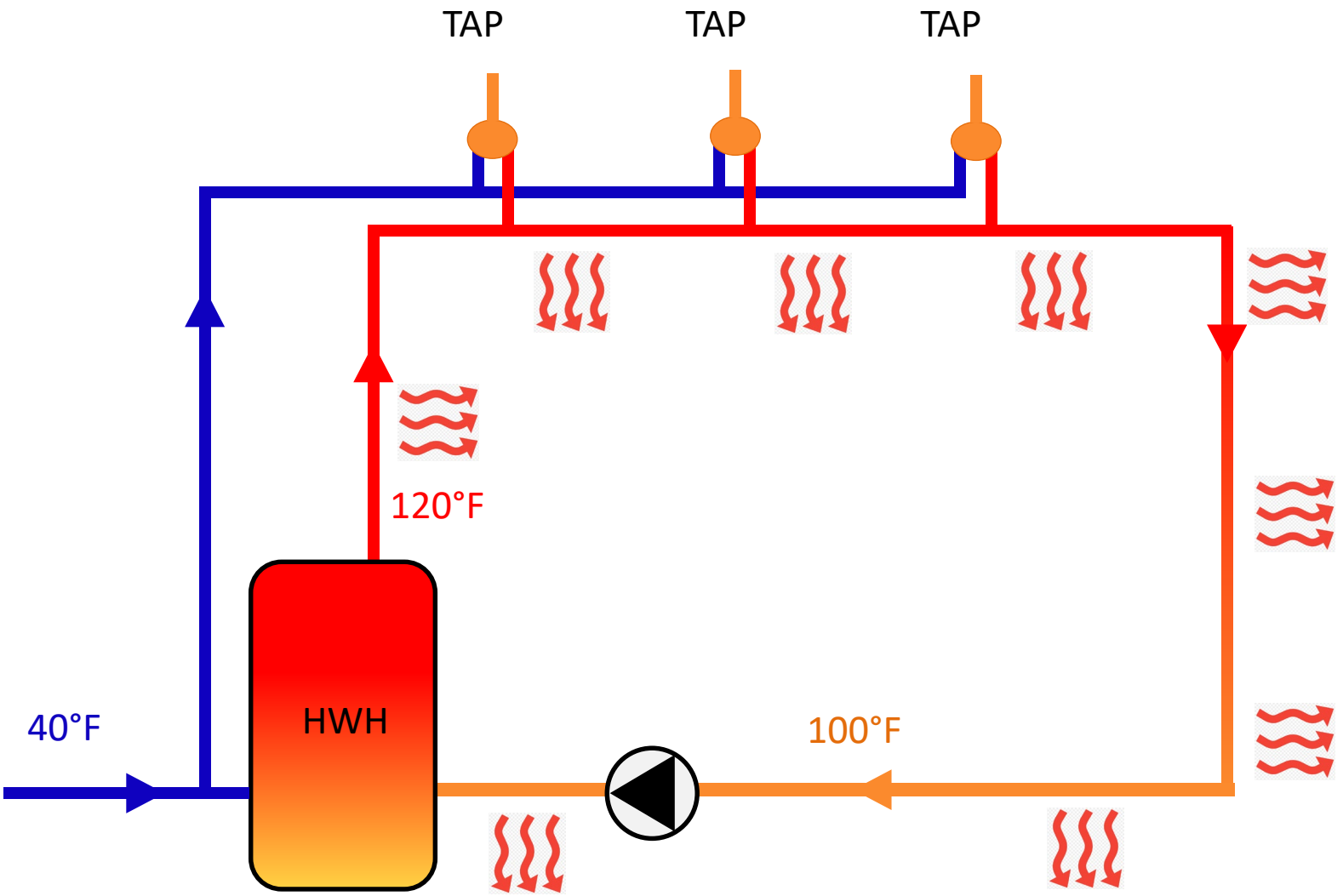
Multifamily Domestic Hot Water: How Can We Do Better?

EFFICIENT DESIGN

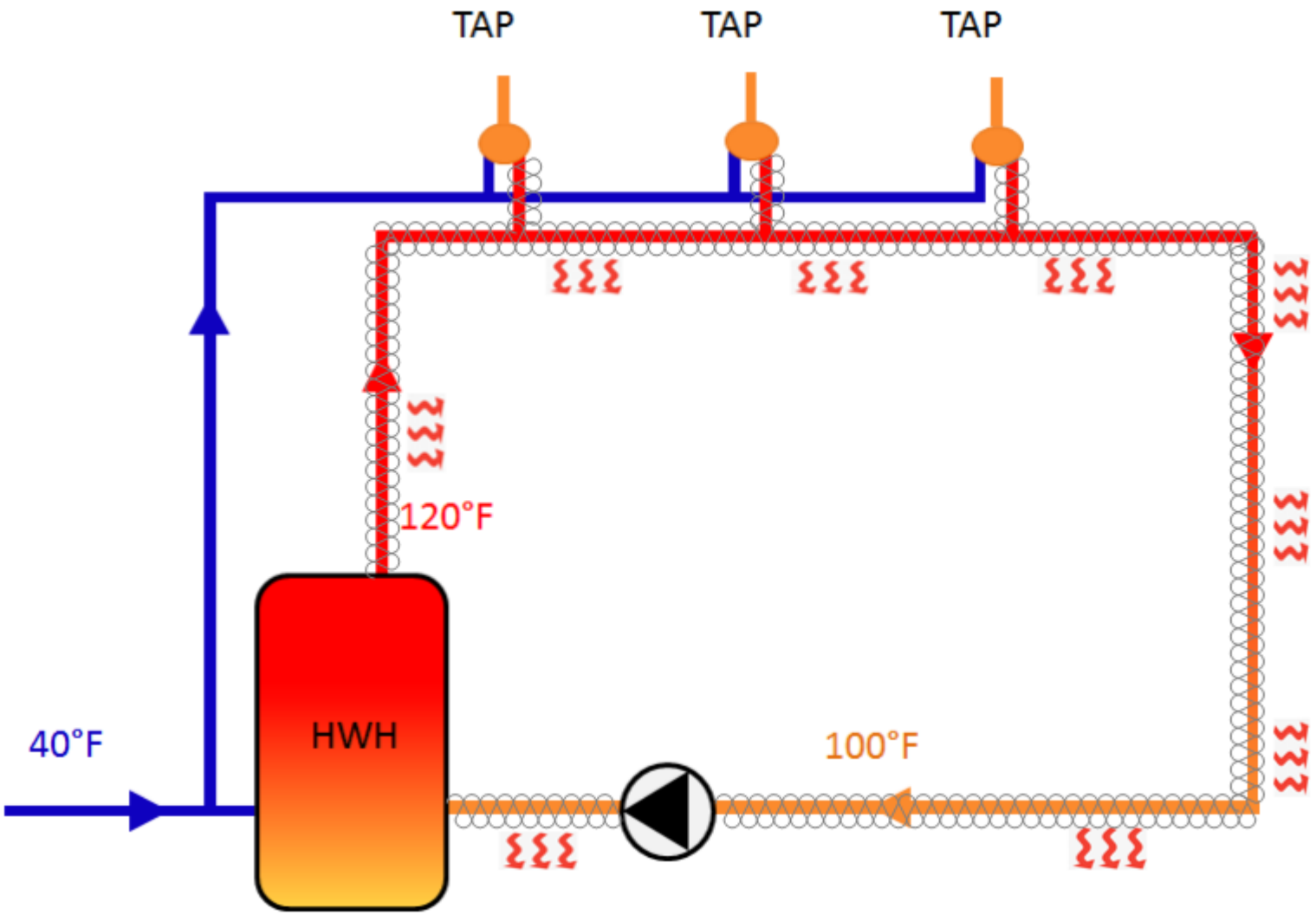
Central Recirculation



Gas Boiler(s) with Recirculation

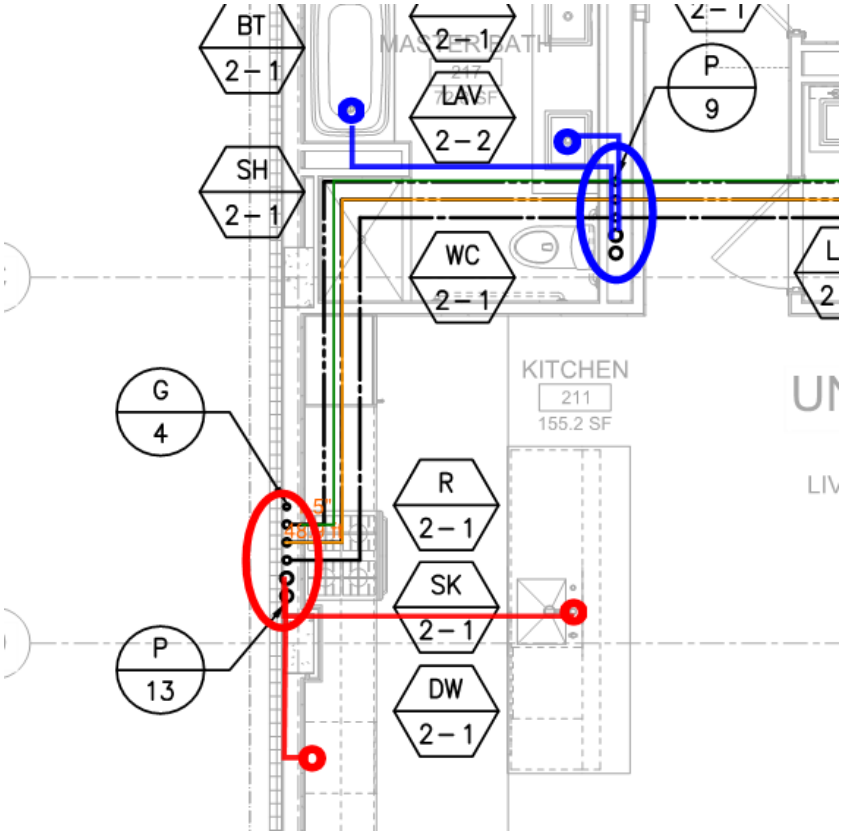


Gas Boiler(s) with Recirculation

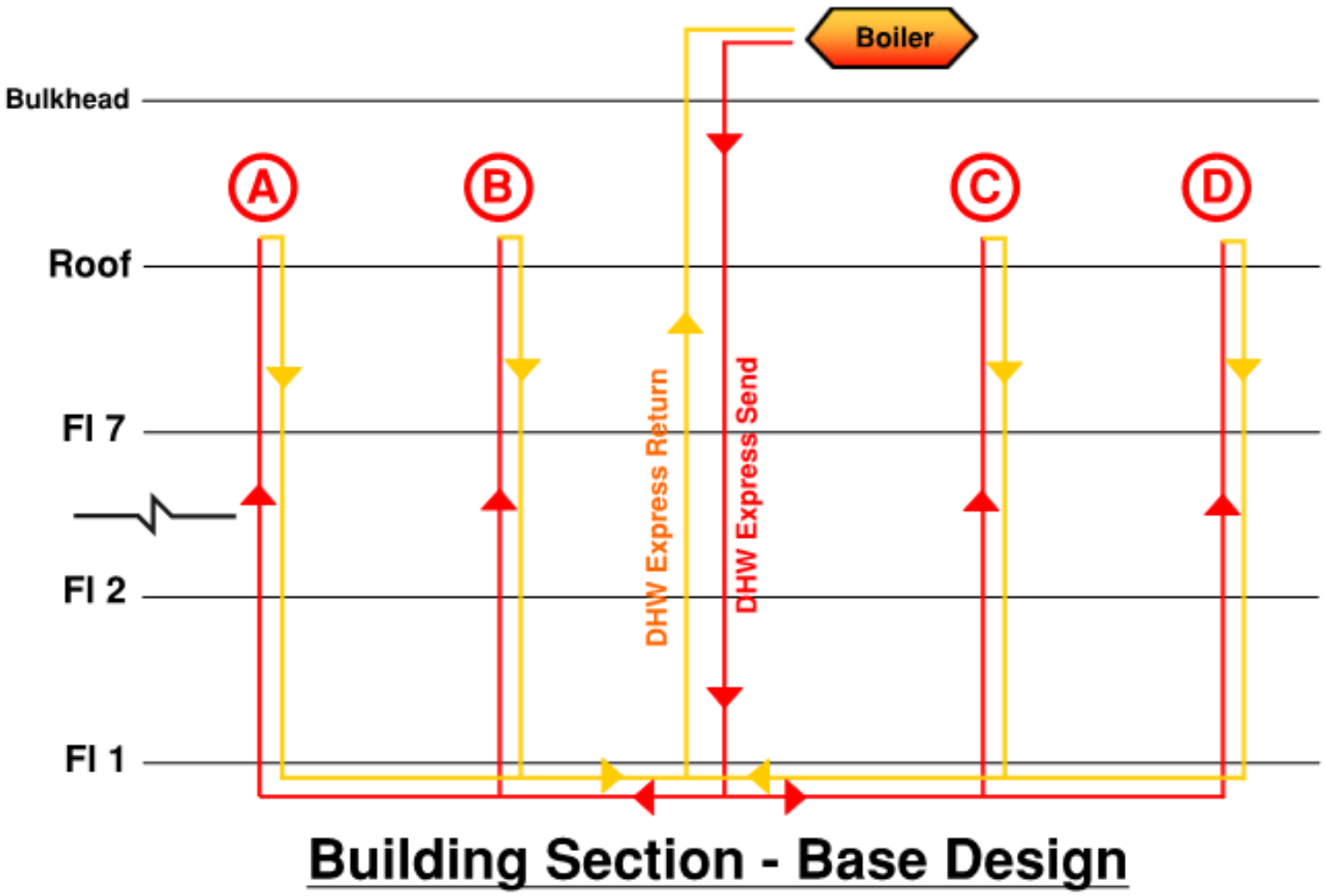


Central Recirculation

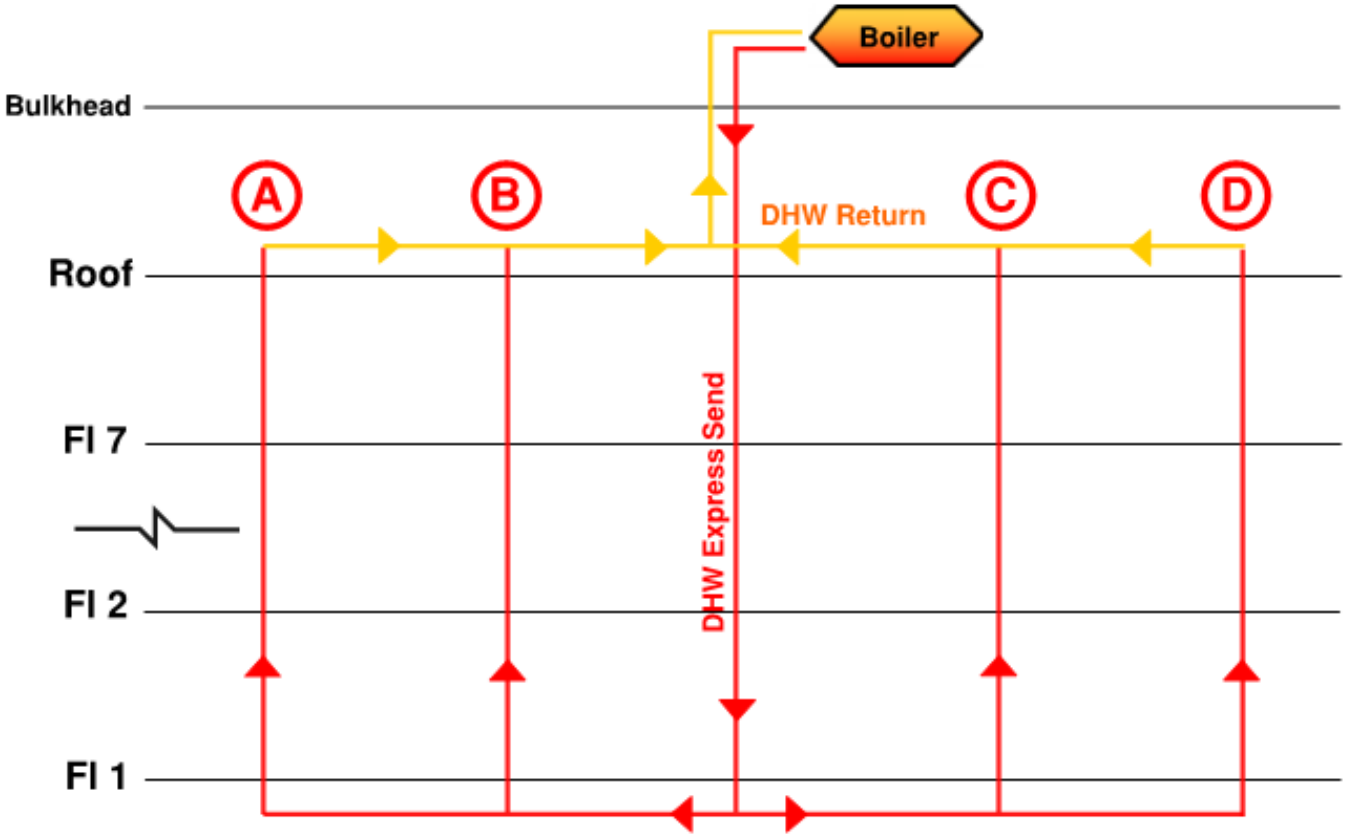
- Reduce # of risers
  - **Cluster** plumbing locations when feasible
- Insulation
  - 1” of mineral fiber minimum on all hot water pipes
  - 1.5-2” of mineral fiber on pipes over 2” in diameter



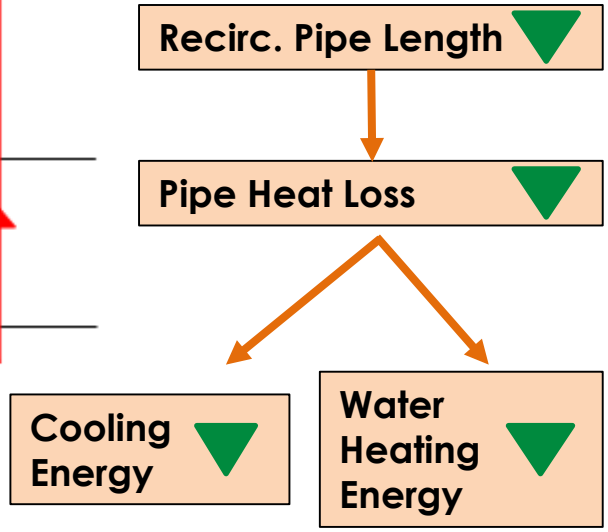
Central Recirculation



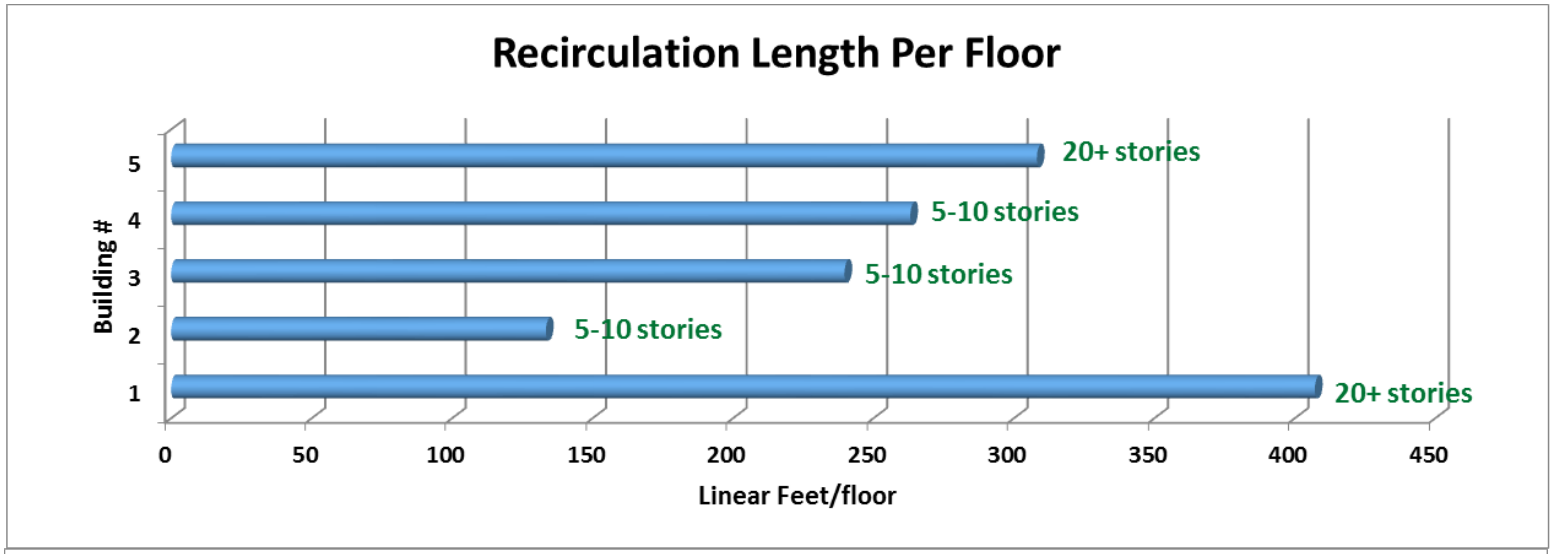
Efficient Central Recirculation

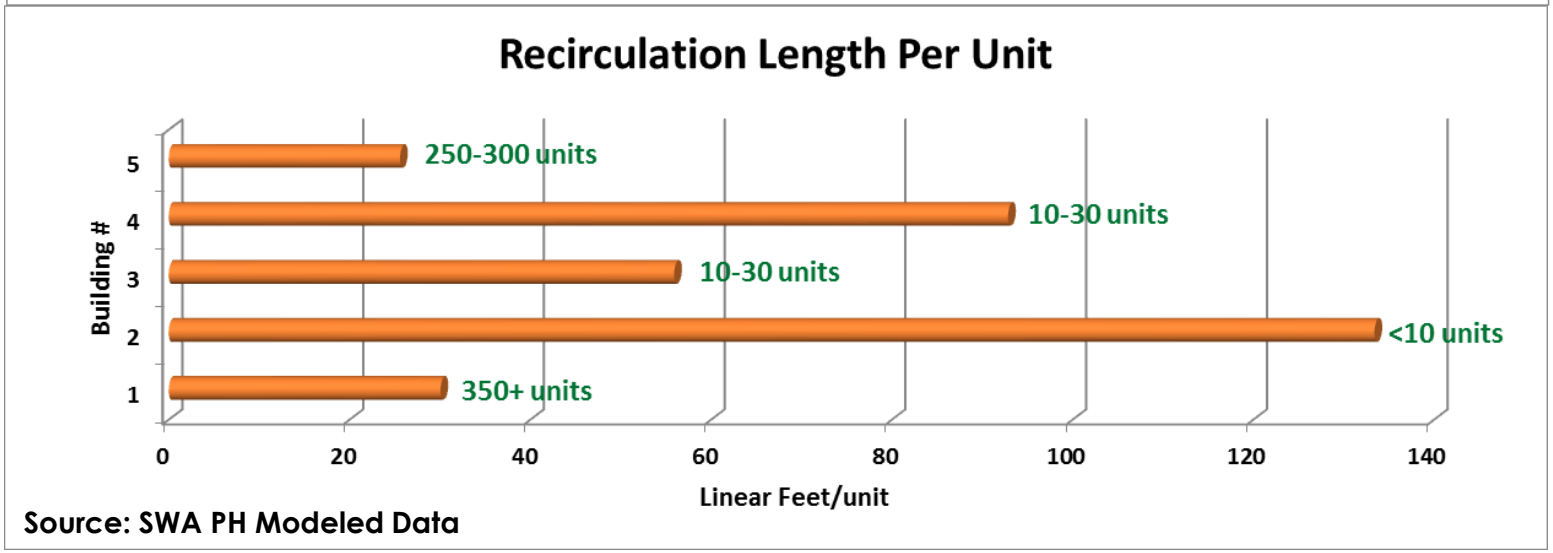


Building Section - Better Design



Central Recirculation





Source: SWA PH Modeled Data

Recirculation Controls

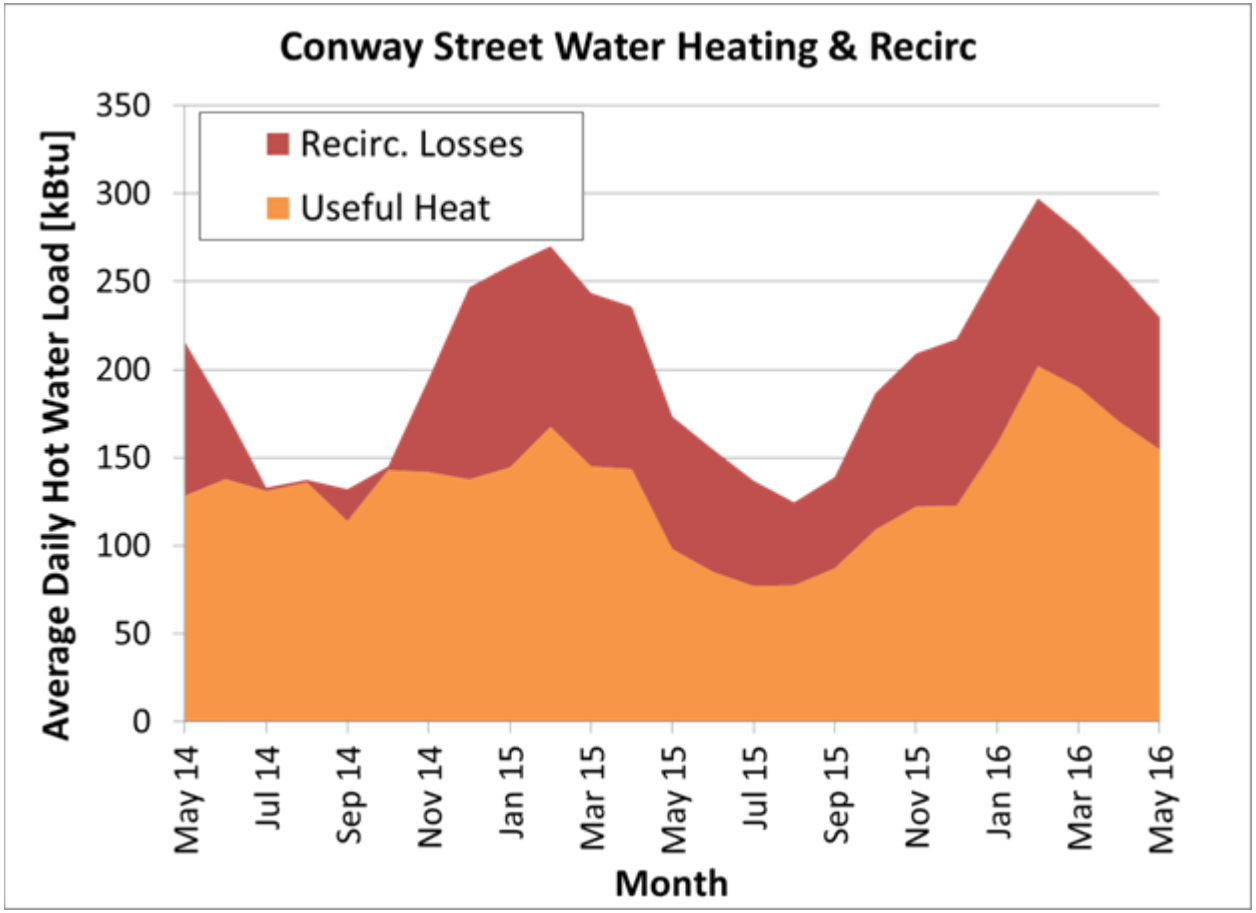
- Control Options
  - Timer Control
  - Temperature Control
  - Temperature Modulation Control
  - Demand Recirculation Control
  - Demand + Temperature Modulation Control
- Balance the System
  - Include DHW balancing specs
  - Include a detail for the riser balancing valves including a check valve
  - Show balancing valves on the riser diagram

Recirculation Controls

DOE Report
Conway Street Apartments: A Multifamily Deep Energy Retrofit
November 2014

Recirculation Controls

Recirculation Controls



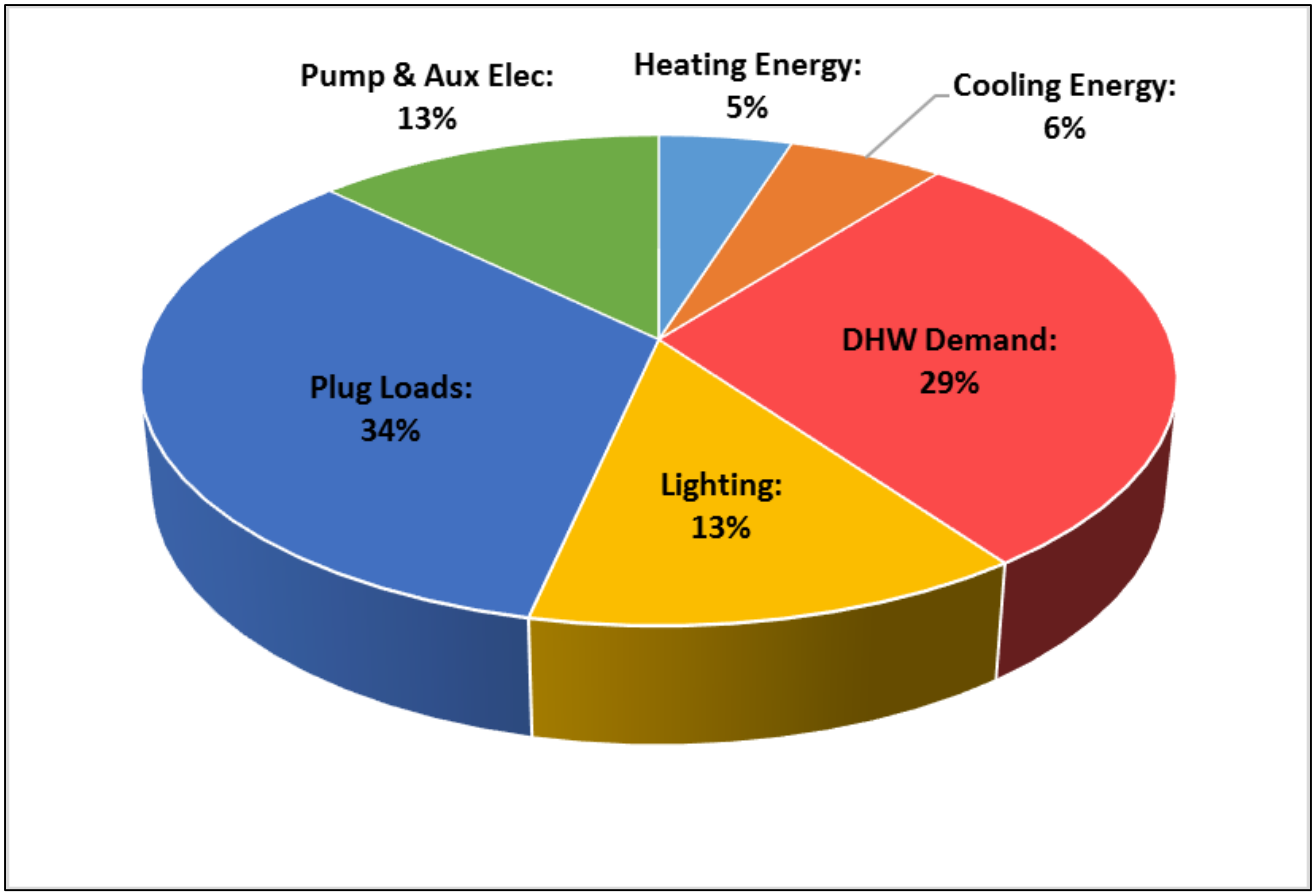
Multifamily Domestic Hot Water: How Can We Do Better?

IMPACTS ON BUILDING ENERGY DEMAND & COST

Modeled Building Site Energy Demand

- 25 stories
- 274 units
- Affordable housing
- Gas fired w/ recirculation

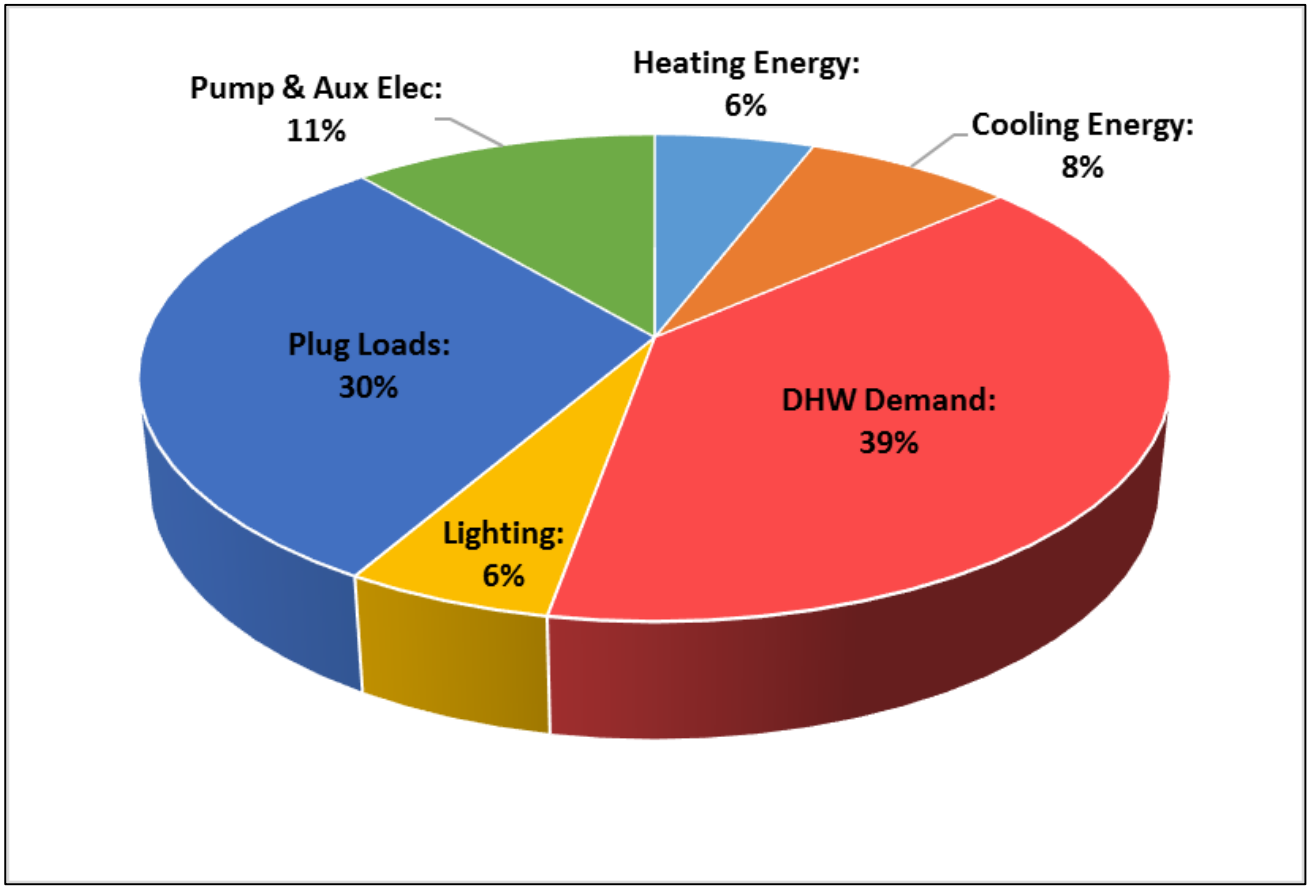
Passive House High Rise - NYC



Modeled Building Site Energy Demand

- 7 stories
- 37 units
- Market rate
- Gas fired w/ recirculation

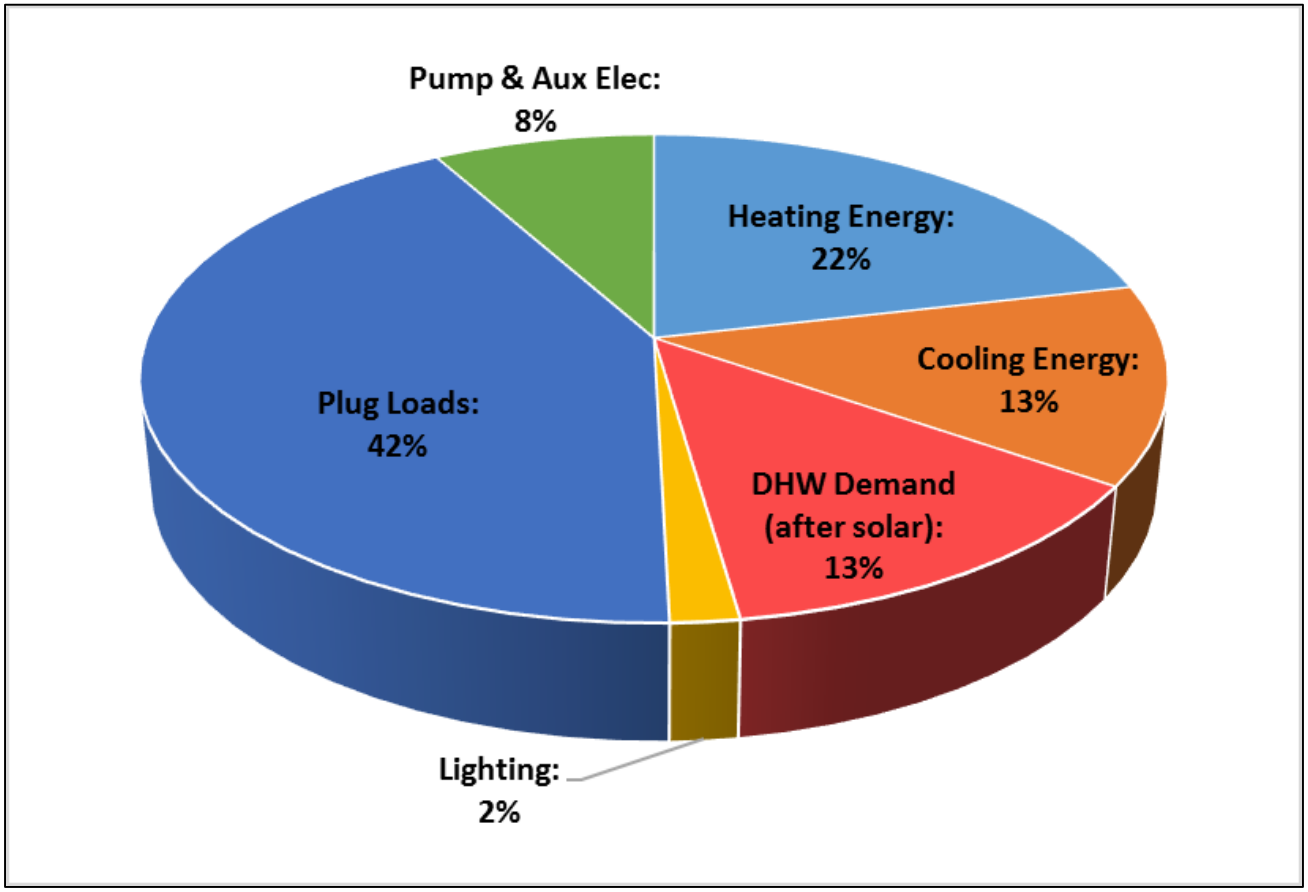
Passive House Mid Rise - NYC



Modeled Building Site Energy Demand

- 6 stories
- 6 units
- Market rate
- Electric boilers w/ in-unit recirculation
- Solar thermal

Passive House Mid Rise - NYC



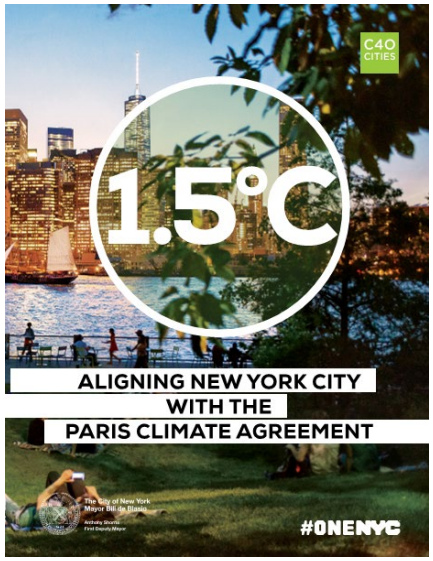
Building Energy Demand & Cost

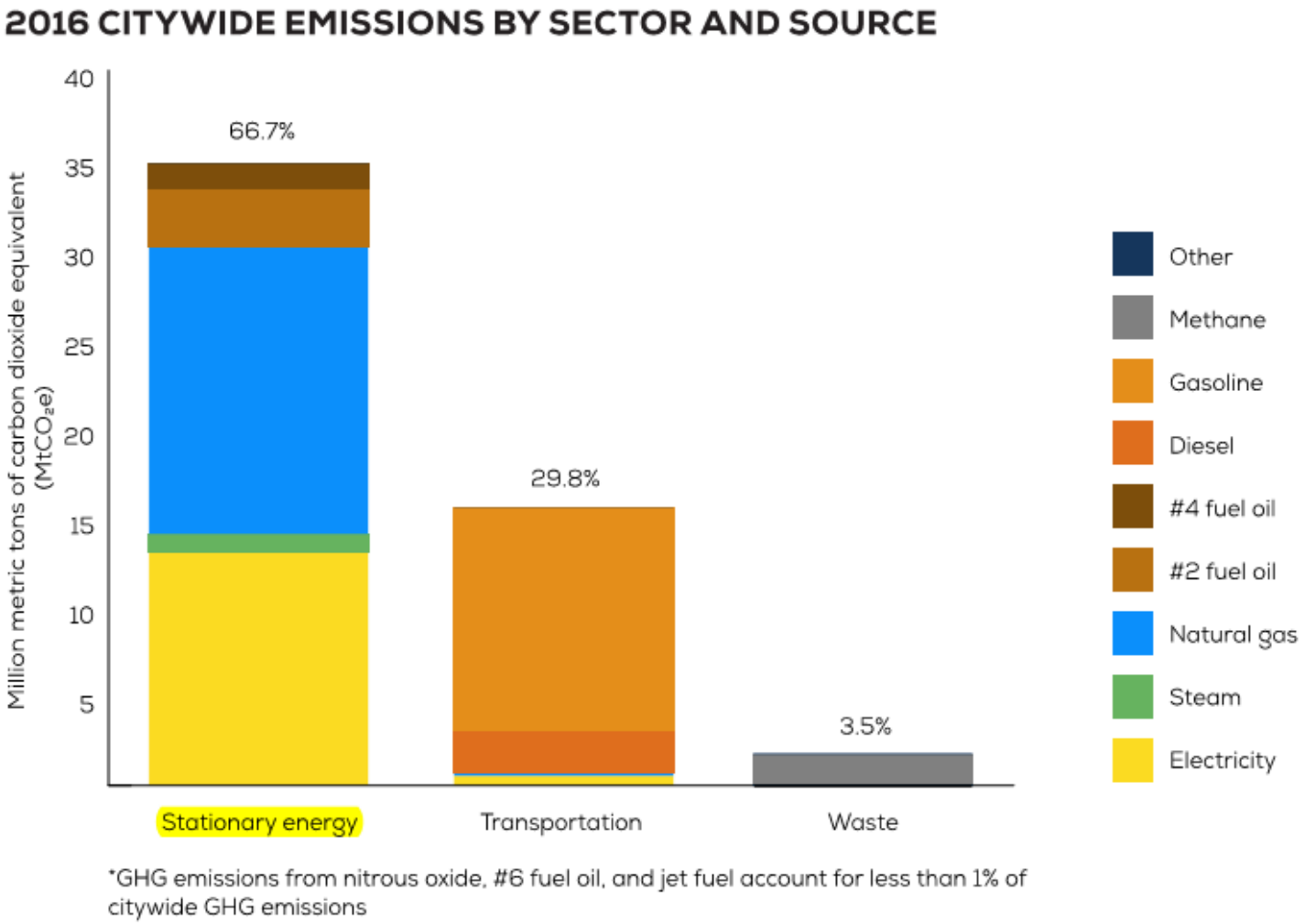
- Site energy demand
  - 20-40% of total building demand
  - How efficient are we building?
    - Code, Energy Star, Zero Energy Ready, Passive House, etc.
- How much $$?
  - Gas or electric? Location?
    - Gas - ~$50-$120 per unit/year
      - Costly to do in-unit required gas water heaters
    - Electric resistance - ~$250-$500 per unit/year

Multifamily Domestic Hot Water: How Can We Do Better?

HOW DO WE GET TO NET ZERO? – THE FUTURE IS NOW

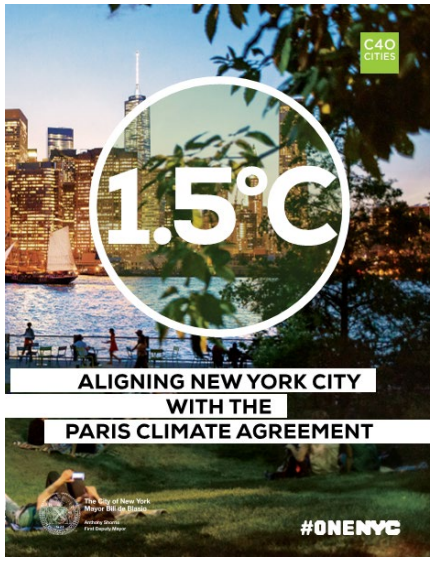
Carbon-Free Future?

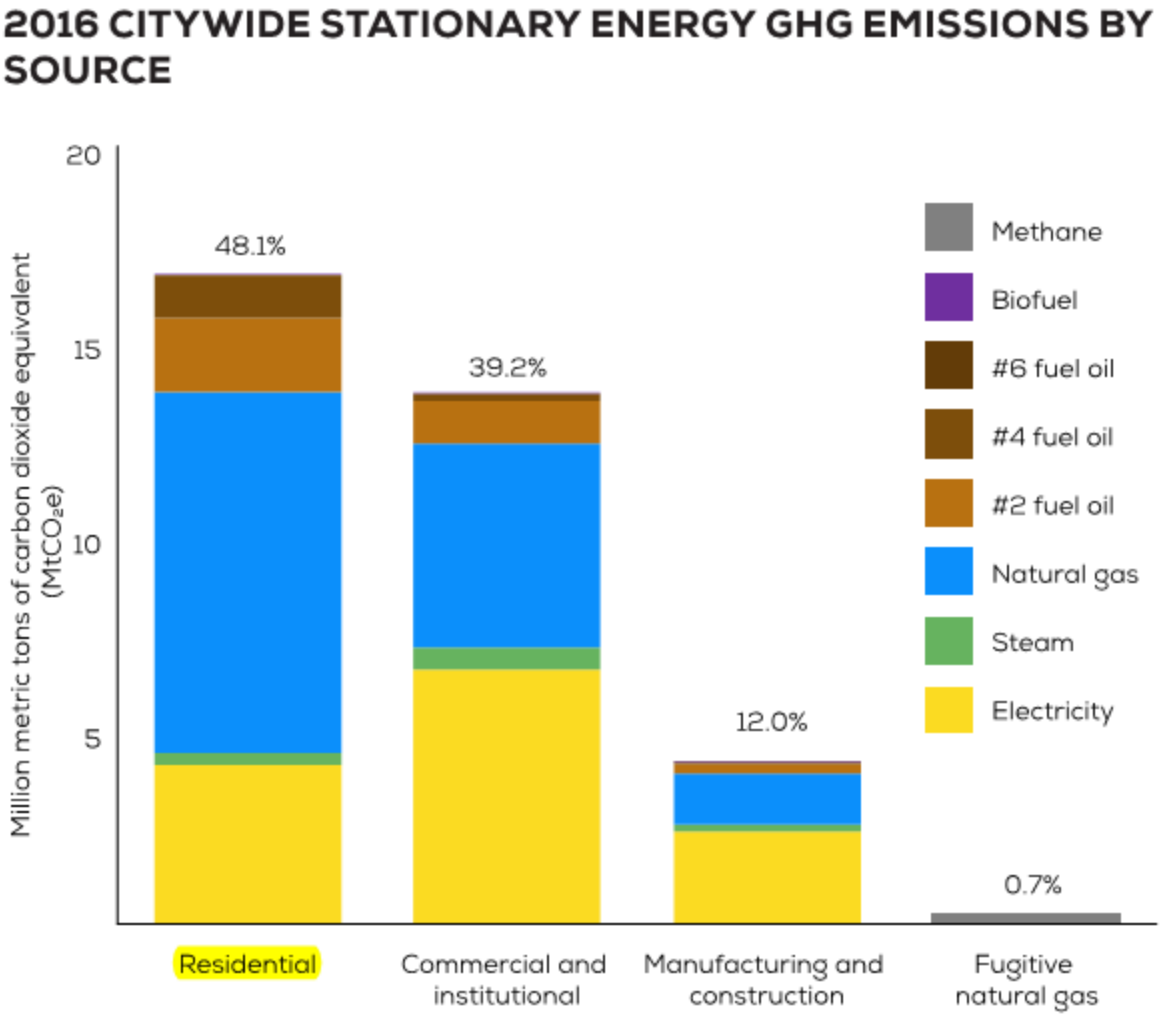




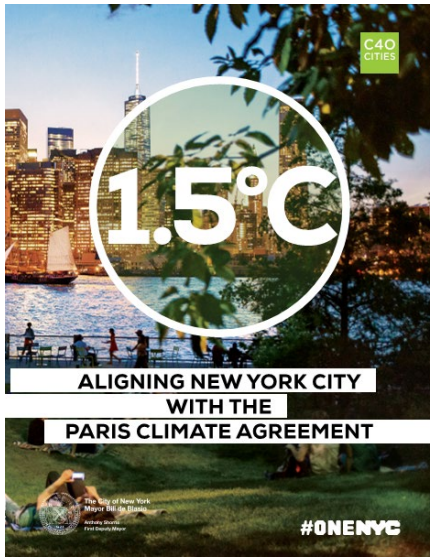
*GHG emissions from nitrous oxide, #6 fuel oil, and jet fuel account for less than 1% of citywide GHG emissions

Carbon-Free Future?





Electrification



WHAT ELSE NEEDS TO HAPPEN

In order to align with the Paris Agreement, NYC must continue to take bold actions beyond 2020 to achieve the strategies outlined in *New York City's Roadmap to 80 x 50* at an accelerated pace.

REDUCED AND MORE EFFICIENT CONSUMPTION

- Complete deep energy retrofits that achieve more than 50% reduction in energy use, on average, in all of the city's one million buildings
- Shift away from personal vehicle use and toward commuter rail, subway, buses, ferries, bikes, and walking, achieving an 80% sustainable mode share, with New Yorkers taking 4 out of every 5 trips by foot, bicycle, or public transit
- Achieve zero waste to landfill

TRANSITION TO CLEAN ENERGY

- Transition away from fossil fuel use for heating and hot water production in the majority of buildings
- Transition to a renewables-based electricity supply with a minimum of 70% of NYC electricity derived from renewable sources
- Maximize on-site renewable energy installations across public and private properties
- Transition to zero-emission vehicles and low-carbon fuels

CLIMATE CHANGE LEADERSHIP

- Develop strategies to achieve carbon neutrality by 2050

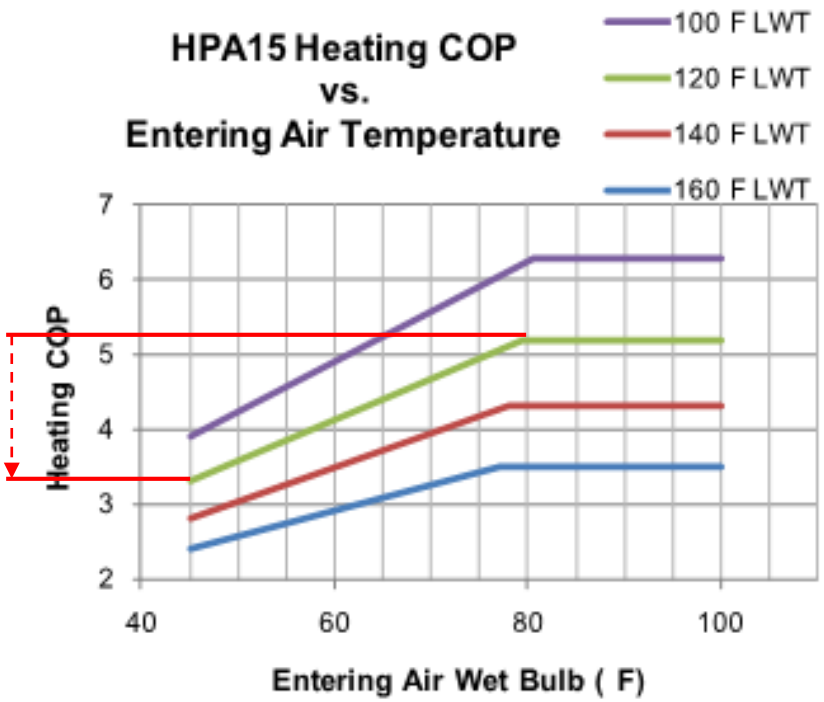
- Electric Options
  - Direct Electric ✗
  - Heat Pump Water Heaters ✓
- CO_2 refrigerant
  - Global warming potential = 1
  - Carbon capture?

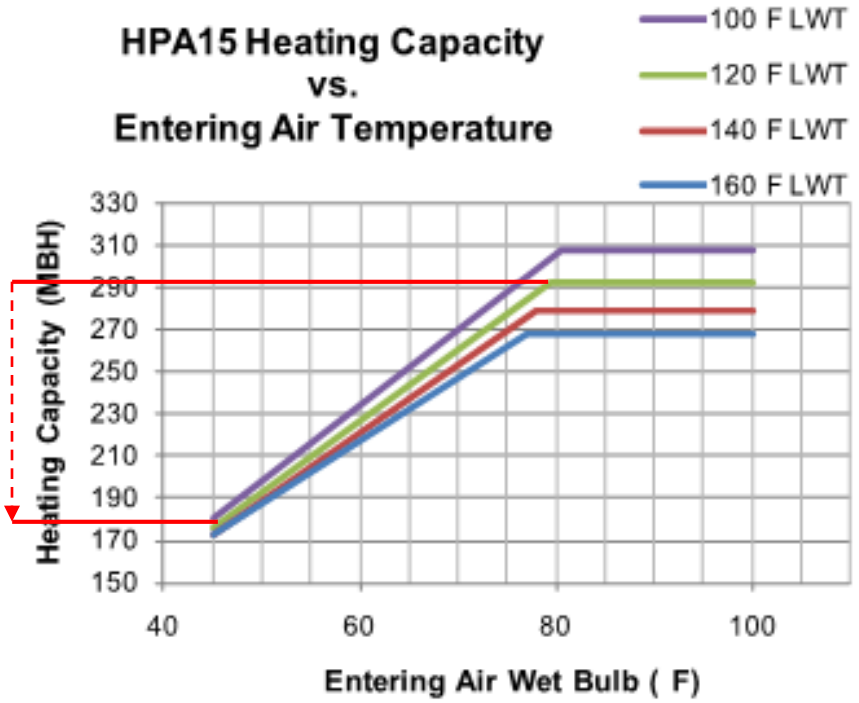
Heat Pumps – Centralized

- Rated COPs ~3-6
  - Elec. resistance -> 1
- High Capacity Units
  - 10-250 tons heating
  - 2 options currently available on US market
- Indoor and outdoor options

Heat Pumps – Designing Properly

Cold Weather Performance





36% efficiency drop in colder temps

Impacts **energy costs and savings**

38% capacity drop in colder temps

Impacts **sizing of storage**

Heat Pumps – Centralized

Storage Sizing Scenarios

# of units	# of bedrooms	Exterior Air Wet-Bulb Temp (°F)	Rated Heating Capacity of HPWH	# of HPWH	Storage Volume (gallons)[1]	
274	416	45	25 tons	2	10,000	+194%
274	416	80 - 100	25 tons	2	3,400	
150	228	45	25 tons	1	2,800	+55%
150	228	80-100	25 tons	1	1,800	
50	90	45	25 tons	1	1,000	+233%
50	90	80-100	25 tons	1	300	

1. Does not include water volume in recirculation lines
* Based on ASHRAE DHW sizing method
** Assumes recirculation in all 3 scenarios

- Accounting for cold weather performance matters

Heat Pumps – Smaller / De-Centralized

- Many indoor options readily available in US market
- 1,000 ft^3 of air per heat pump
- Can be loud
- Don't heat space with electric resistance!

In Summary

Solutions Are Everywhere

- Most common in MF
  - Gas fired central recirculation systems
- Designing efficiently
  - Cluster DHW taps
  - Plan layouts to reduce piping lengths
  - Insulate pipes
  - Incorporate recirculation controls w/ proper installation
  - Avoid electric resistance heating
- Gas currently cheaper than electric resistance in energy costs
- A carbon-free future?
  - Heat pump water heaters
    - Study up on proper design requirements and proper sizing methods
    - CO_2 refrigerant HPWHs

Thank You

Questions?

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