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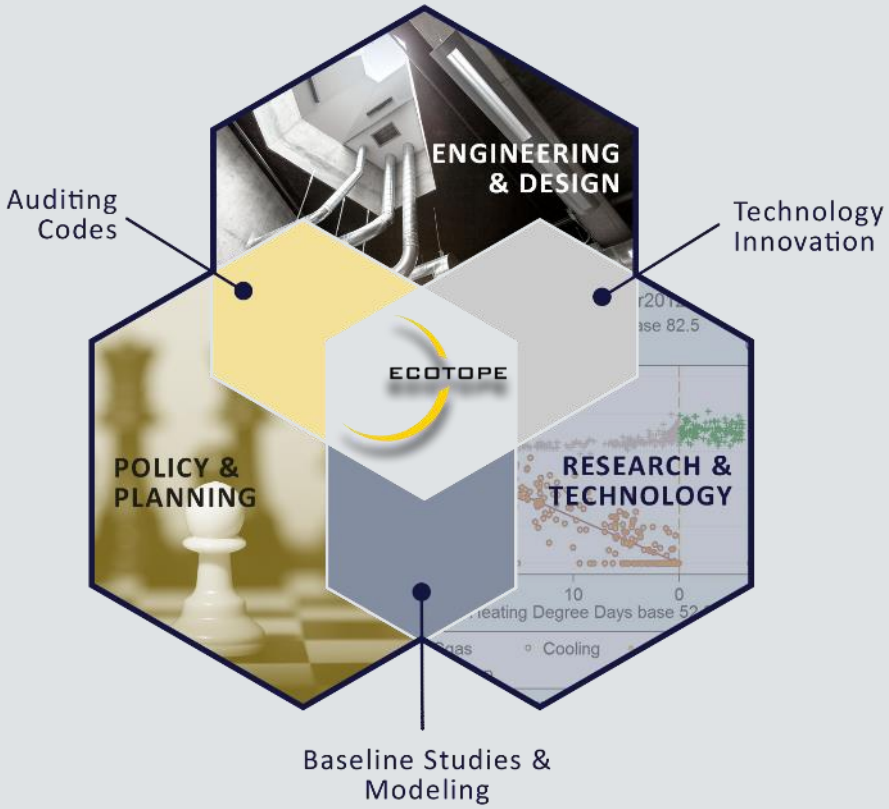
ECOTOPE

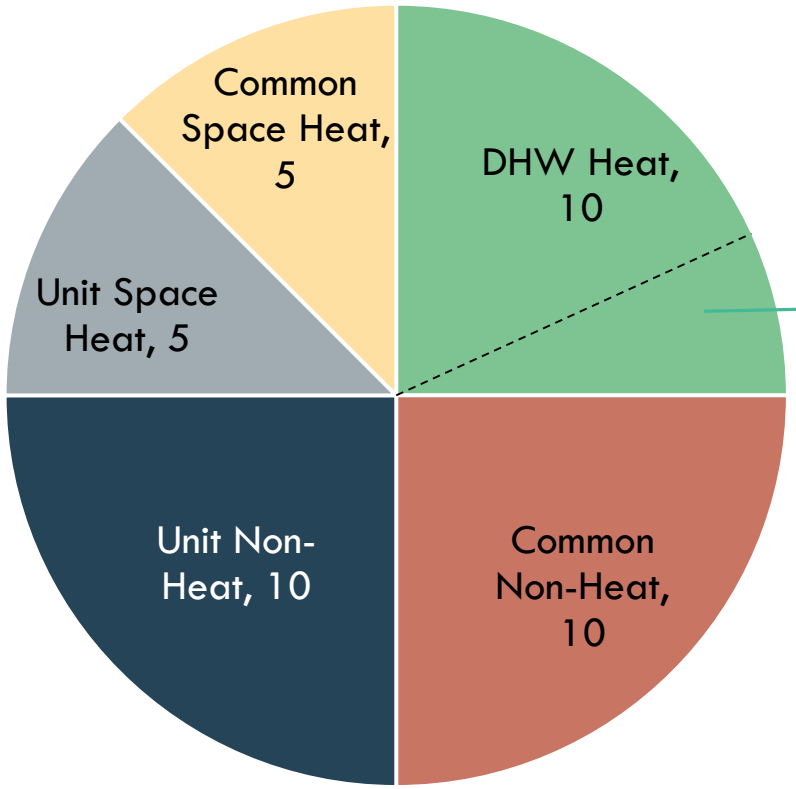
Heat Pumps Are Not Boilers

ACEEE – HOT WATER FORUM 2018 | **Shawn Oram, PE, LEED AP** Director of Engineering & Design



AGENDA

- OVERVIEW
- END GAME
- WHAT'S AVAILABLE NOW
- PROBLEMS WE ARE SEEING
- MARKET DEVELOPMENT NEEDS
- QUESTIONS



1/3 OF THE LOAD IS TEMPERATURE MAINTAINANCE

2009 Multifamily EUI (KBTU/Sf/Yr) Breakdown By Energy End Use Type

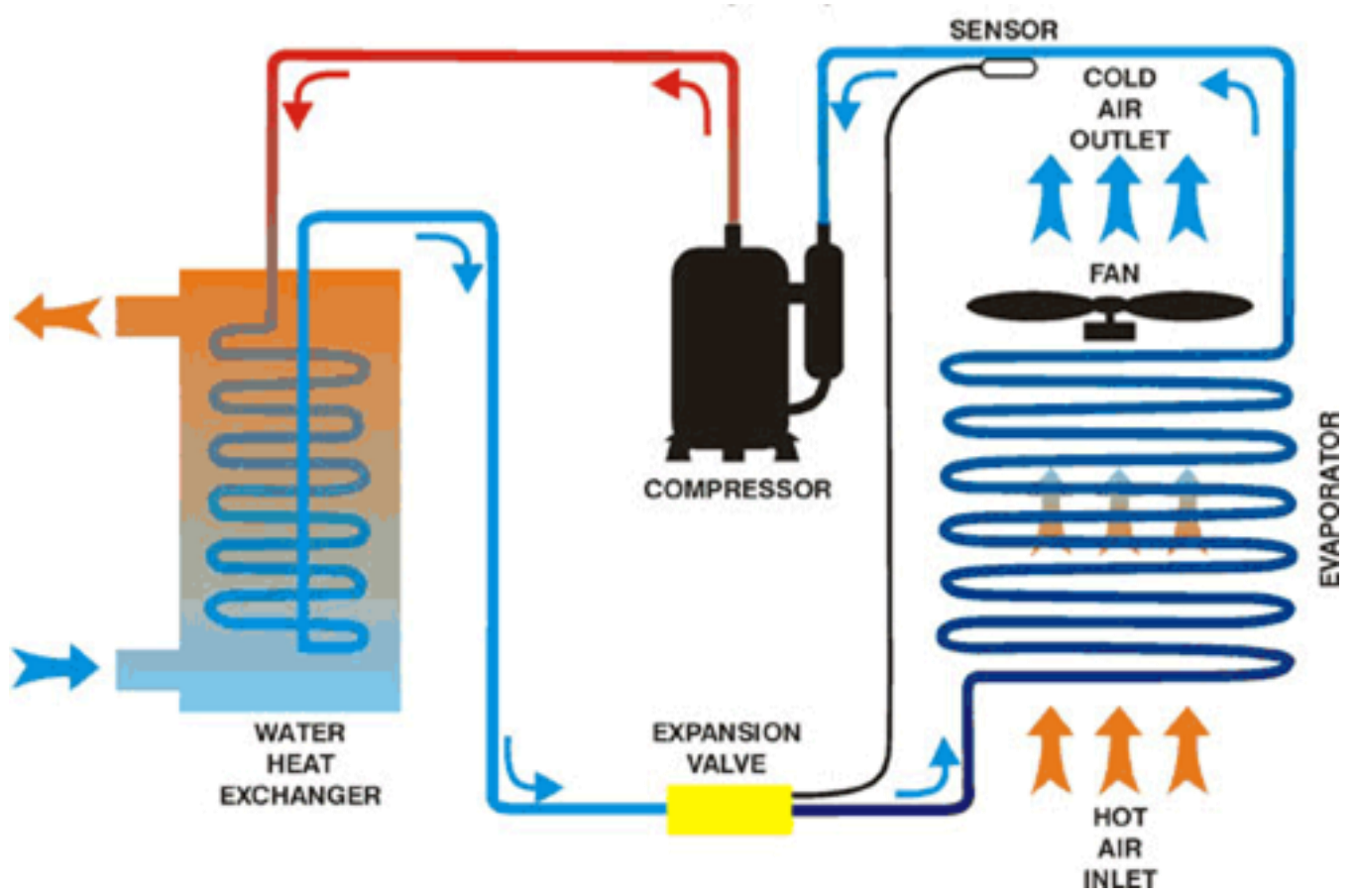
Seattle 2014 Benchmarking Data

Median EUI (kBtu/SF/yr)

Lowrise	EUI = 32
Midrise	EUI = 36
Highrise	EUI = 51

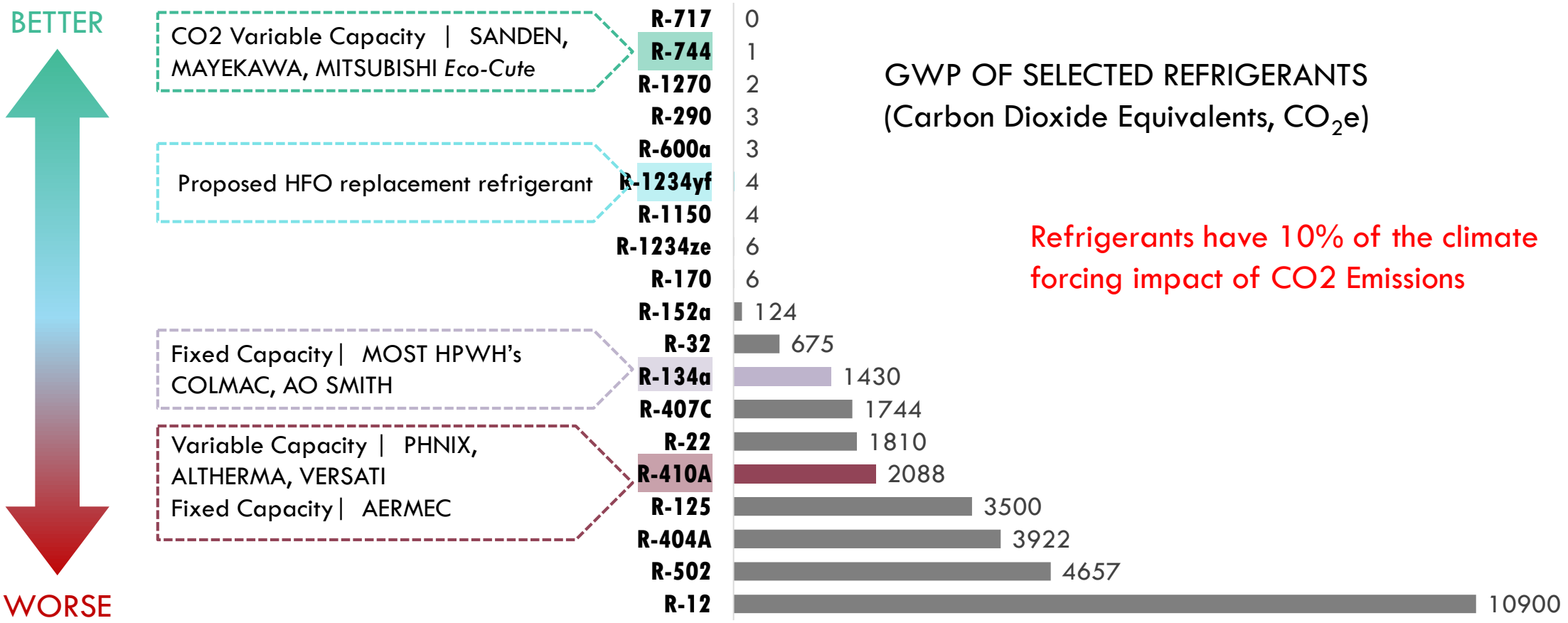
MULTIFAMILY ENERGY END USES

"Heat Pumps Move Heat"

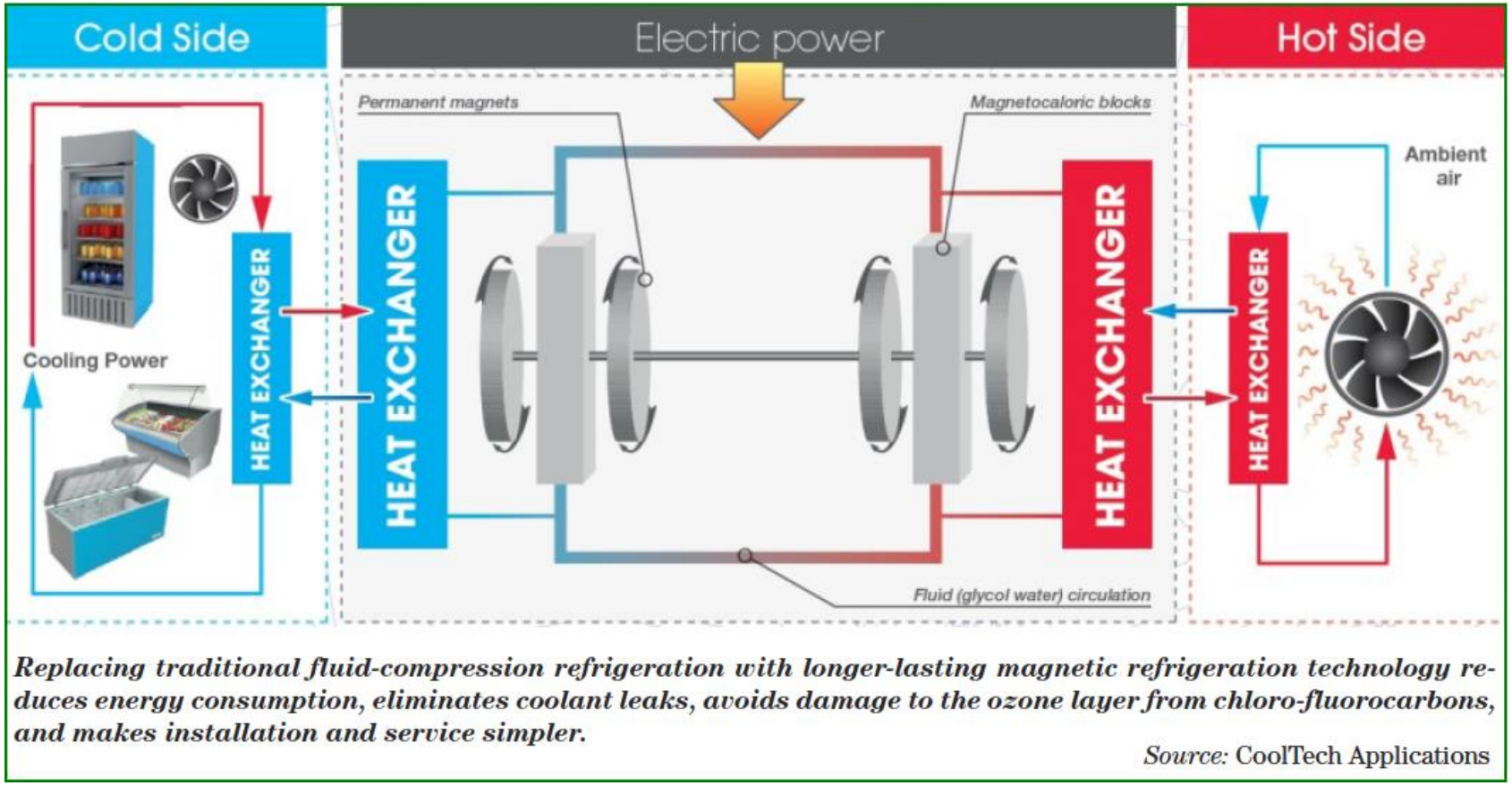


Optimize storage design to use coldest water possible

HEAT PUMP WATER HEATING



REFRIGERANT TYPES

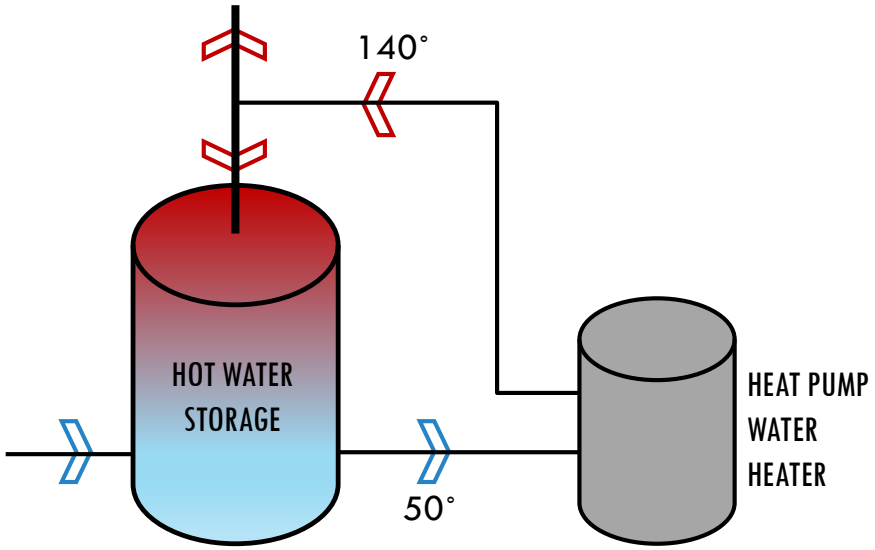


Replacing traditional fluid-compression refrigeration with longer-lasting magnetic refrigeration technology reduces energy consumption, eliminates coolant leaks, avoids damage to the ozone layer from chloro-fluorocarbons, and makes installation and service simpler.

Source: CoolTech Applications

- No Refrigerant
- 20-30% Less Energy
- Quiet
- GE/Oak Ridge Pilot
- Ready for Market -2020

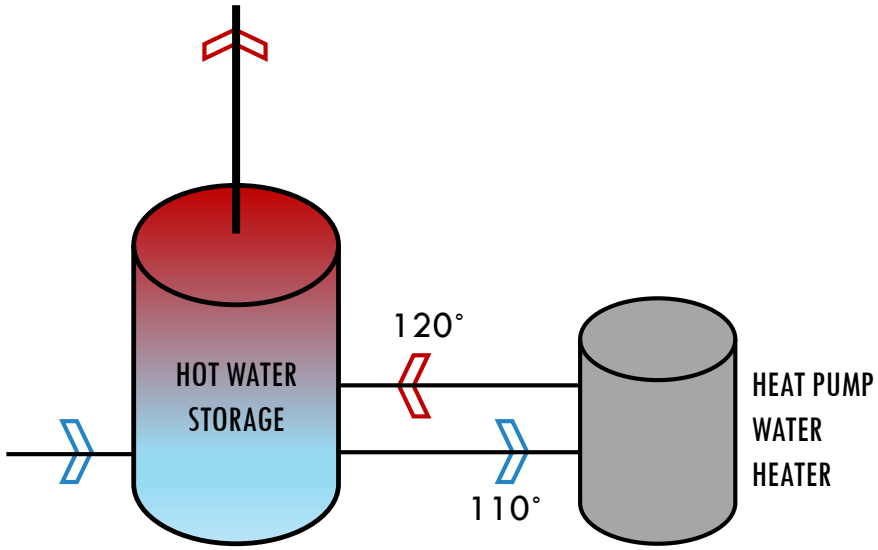
MAGNETO-CALORIC HEAT PUMP



Heat the water up to usable temp in a single pass.

Sanden (Inverter variable compressor)

Colmac RCC (throttling water flow)



Heat the water up 10-15 degrees per pass.

Inverter Air-to-Water (Daikin Altherma or sim. 410a)

Aermec Constant Volume 410a

SINGLE-PASS VS. MULTI-PASS

Refrigerant/Compressor	Qty	Single Pass	Double Wall HX
R-410a Inverter Driven Variable Capacity	5		
R-410a Fixed Capacity	3		
R-134a Variable Capacity	1	1	1
R-134a Fixed Capacity	3		
R-744 (CO2) Inverter Driven Variable Capacity	3	3	3

What's Available Now

- Low GWP Refrigerant
- Variable and Fixed Capacity
- Air Source
- Plug and Play Design - Modular Setup
- Redundancy Built In
- High Performance Hot Water Distribution Design
- M&V Systems Temps, Power and Flow Meter
- Demand Response Capable

END GAME - CENTRAL HPWH

Heat Pumps Aren’t Boilers

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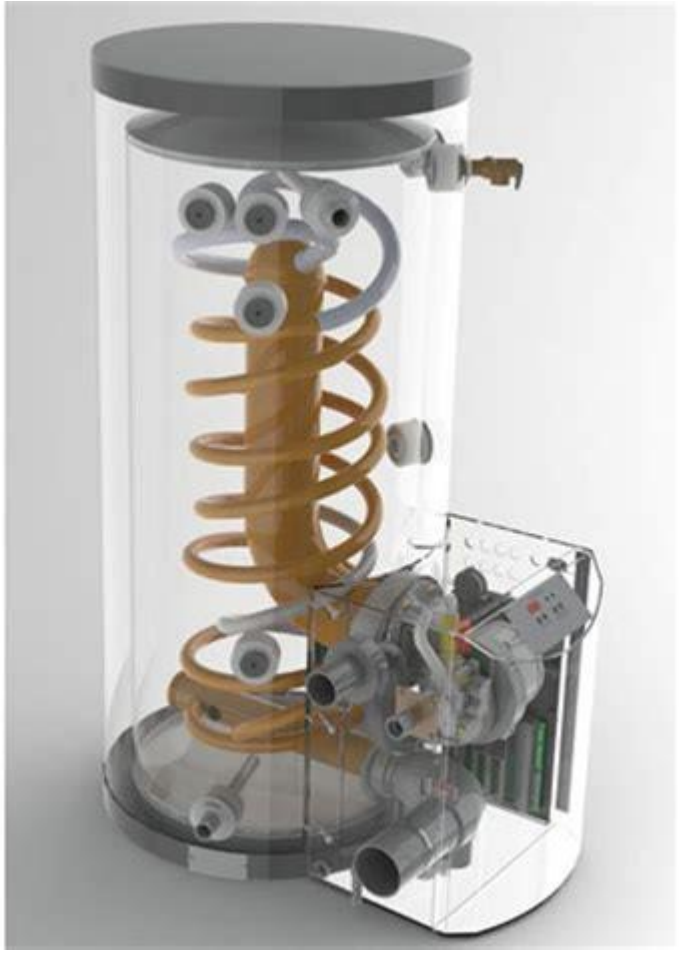

GAS HOT WATER BOILERS

- Can be Oversized
- Smart Controls
- Modulating Output
- Can Short Cycle
- Can be instantaneous heaters
- Compact Footprint
- Modular
- Plug and Play
- Don't care about outside temp
- Incoming water temp isn't an issue

Problem….

They Burn Fossil Fuels

What Do Gas Hot Water Boilers Do?

HEAT PUMPS ARE NOT BOILERS

- Efficiency impacted by Air and Water Temps
- Limited Temperature Ranges
- Output temperature limited
- Different refrigerants for different applications
- Larger Hot Water Plant Footprints
- Expensive Oversize
- Require Right Sizing (Both Loads)
- Shouldn't cycle more than 6x/Hr
- Defrost Cycles
- Complex Controls

Heat Pumps are Not Boilers

Application Issues

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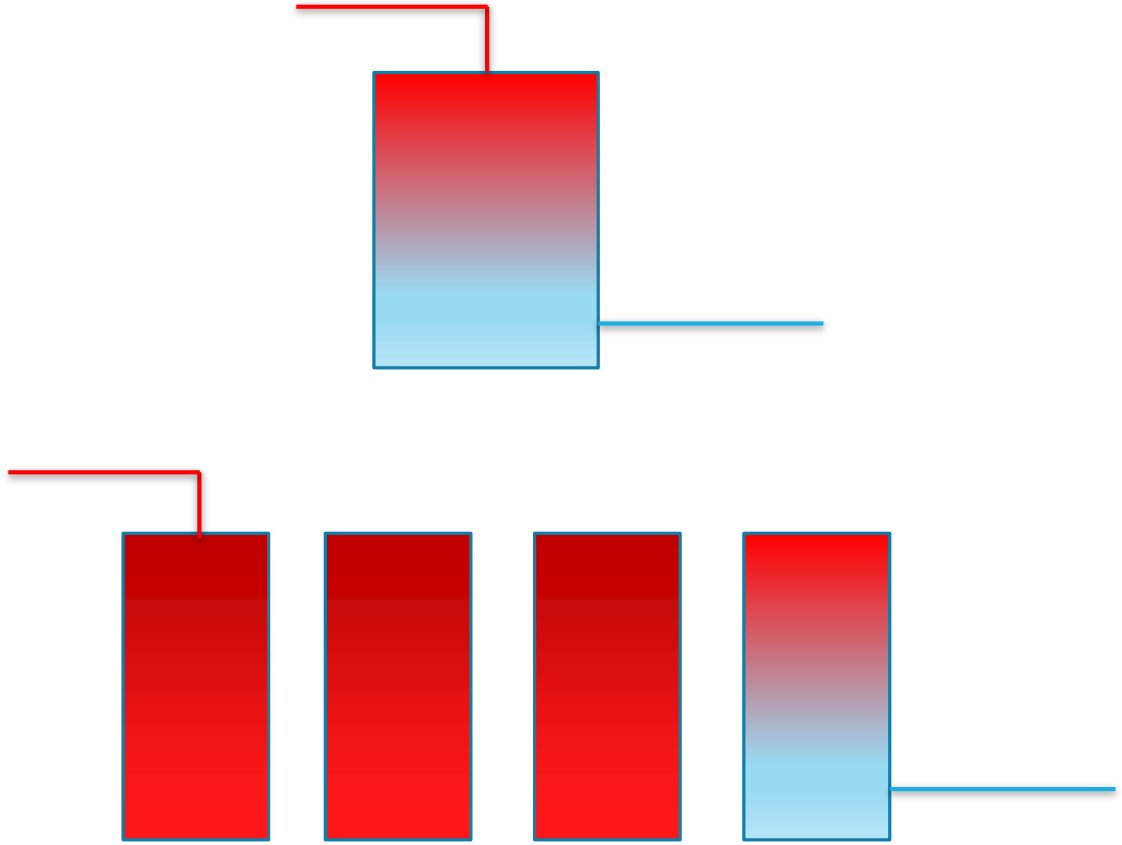
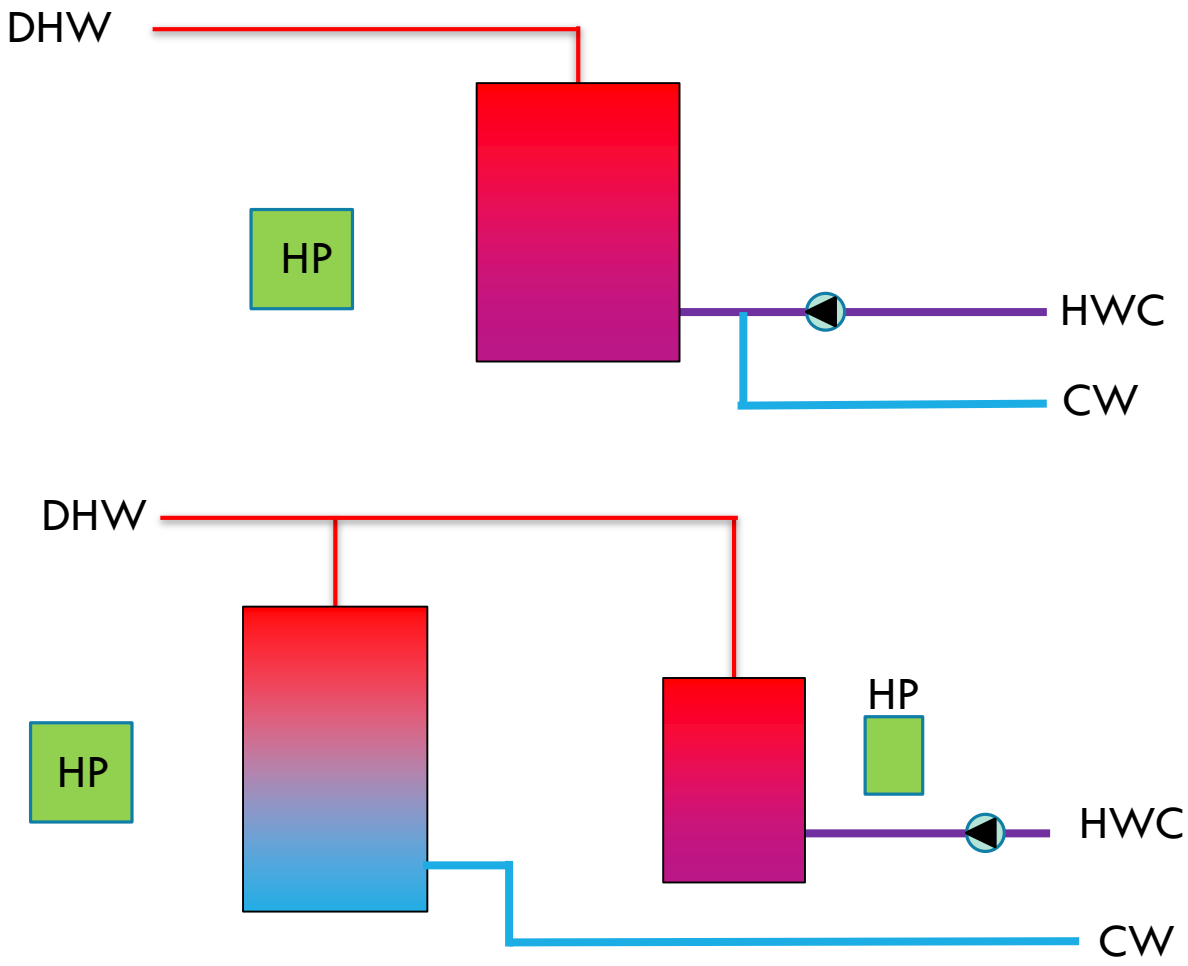


Stratification is Key to System and Heat Pump Performance and Longevity.

Problems:

- Selecting horizontal tanks that cannot stratify
- Storage is too small and leads to mixing at peaks when makeup water flows are highest.
- Poorly insulated tanks lead to degradation of hot water temp

Poor Stratification



Risky to Route Recirc through hot water storage with current equipment offerings

Problems

- Recirculation Load is hard to calculate and setup
- If primary water heat plant goes down, your recirc line will deplete the storage in minutes
- Recirc into storage tanks up mixing tank and you get a big efficiency hit at the heat pump.

Routing Recirculation through HW Storage

Do NOT size a heat pump using a Boiler sizing methodology.

- 2 Loads Present
  - Temperature Maintenance
  - Heating Hot Water
- If Heat Pump cannot modulate down to TM load, decouple it.
- Better to have smaller stages of primary heat pump to deal with part load and provide redundancy.
- Err on the side of less capacity and more storage

Swap Boiler With Heat Pump - Oversized

Do Not Allow a situation where a Building Loses the Hot Water Plant.

- Add multiple Heat Pump stages
- Ensure 100% backup electric capacity
- Install Alarms to alert maintenance

Redundancy in Plants

2 Primary Heat Pumps in stages
1 Backup Electric Stage

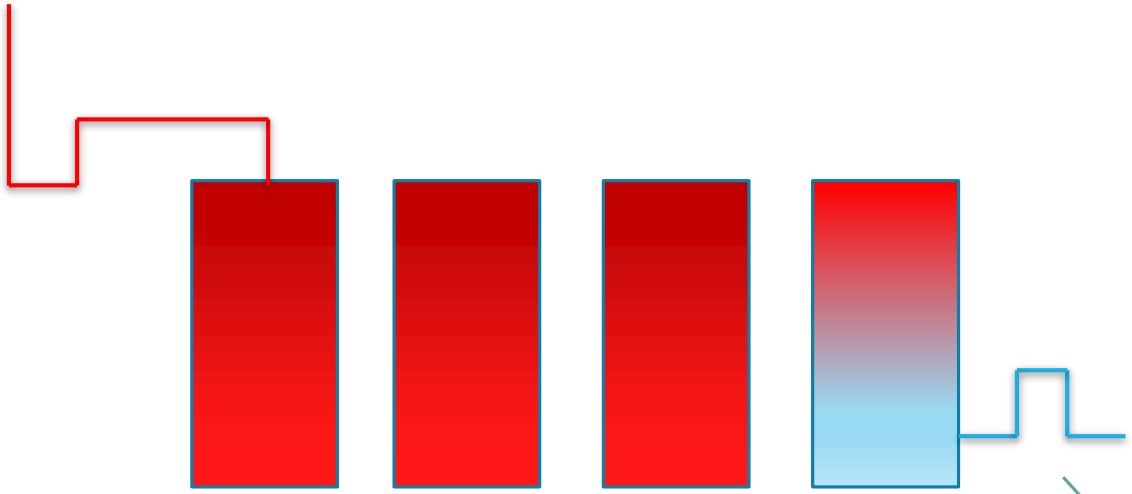
1 Primary Temperature Maintenance heat pump
1 backup Electric tanks

REDUCE PIPING UA

Problems

- Un-Insulated hot water lines will use a factor of 6-8X more Temperature Maintenance energy than Code Insulated lines.
- Larger Temperature Maintenance Pit the building owner with a higher life-cycle cost system both equipment and operating cost, insulation is cost effective.
- Remote Located Heat Plants lead to excessive losses and energy use.
- The closer the heat plant is to the source, the less pipe UA

Inefficient Hot Water Distribution



No HEAT TRAPS installed on both Cold and Hot side of Storage

Problems:

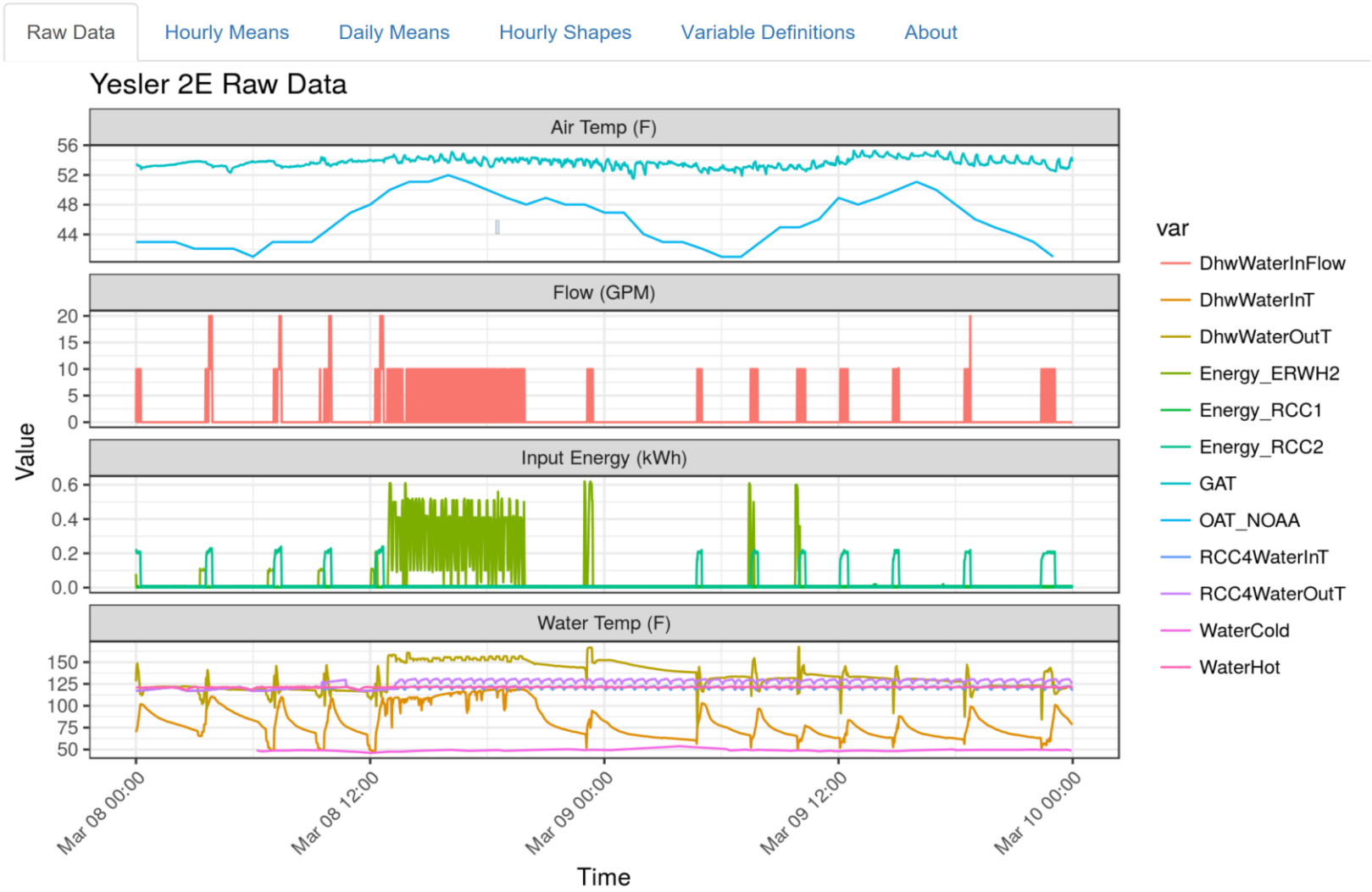
- Runaway Heat Loss as Hot Water migrates out of storage tanks
- Reduced Efficiency on the Heat Pump as our precious cold water entering heat pumps are hot.

Install Heat Traps on both Hot and Cold

NO HEAT TRAPS INSTALLED

CASE STUDY
ECOTOPE “RCC”
SYSTEM-194 UNIT

RCC 3.0 (Revision 5)



RCC 3.0 M&V Data for Tuning

MARKET DEVELOPMENT NEEDS

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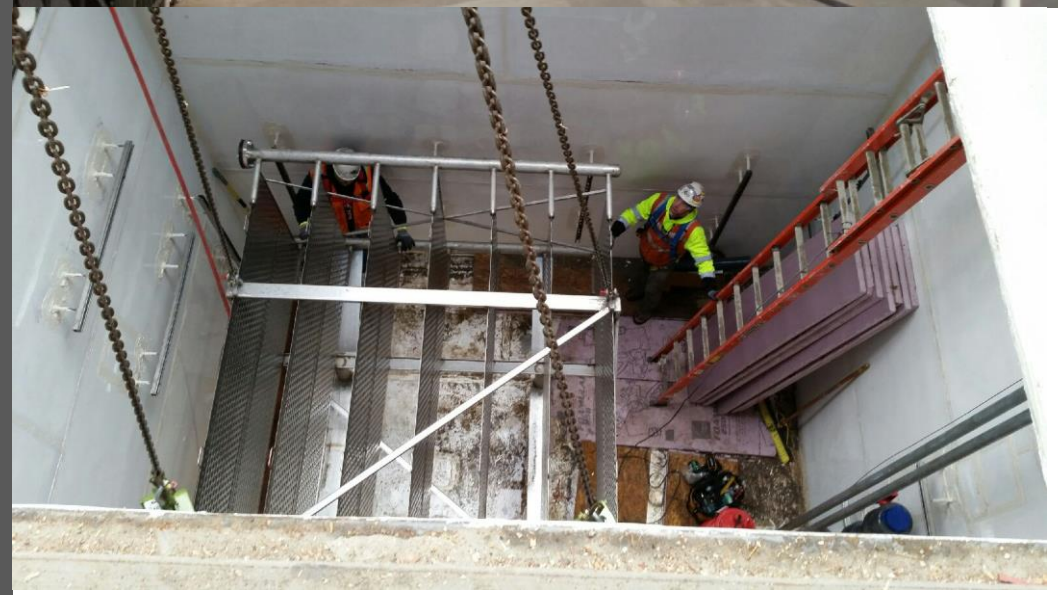

MARKET DEVELOPMENT NEEDS

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DESIGN TOOLS

- ❑Circulation loop losses and reheat sizing
- ❑Primary plant sizing (capacity & storage) optimization
- ❑Simulation Protocol

MARKET DEVELOPMENT NEEDS

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TECHNOLOGY

- Double-wall heat exchangers integrated in current heat pump offerings
- 5-15 Ton low-GWP refrigerant air source heat pumps needed
- Variable capacity temperature maintenance heat pump designed to handle ~110 degree incoming water

MARKET NEEDS

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RESEARCH

- ❑ Performance Test of Current Equipment
- ❑ Cost benefit analysis on piping insulation levels within de-Carb Environment
- ❑ Pilot projects of design innovation

QUESTIONS

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