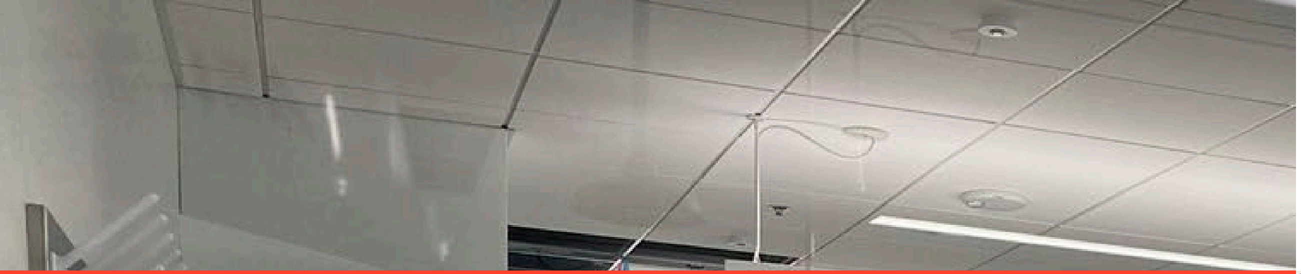


Overcoming the Hurdles of Laboratory Electrification

2021 Getting to Zero Forum | October 29, 2021

Speaking Today

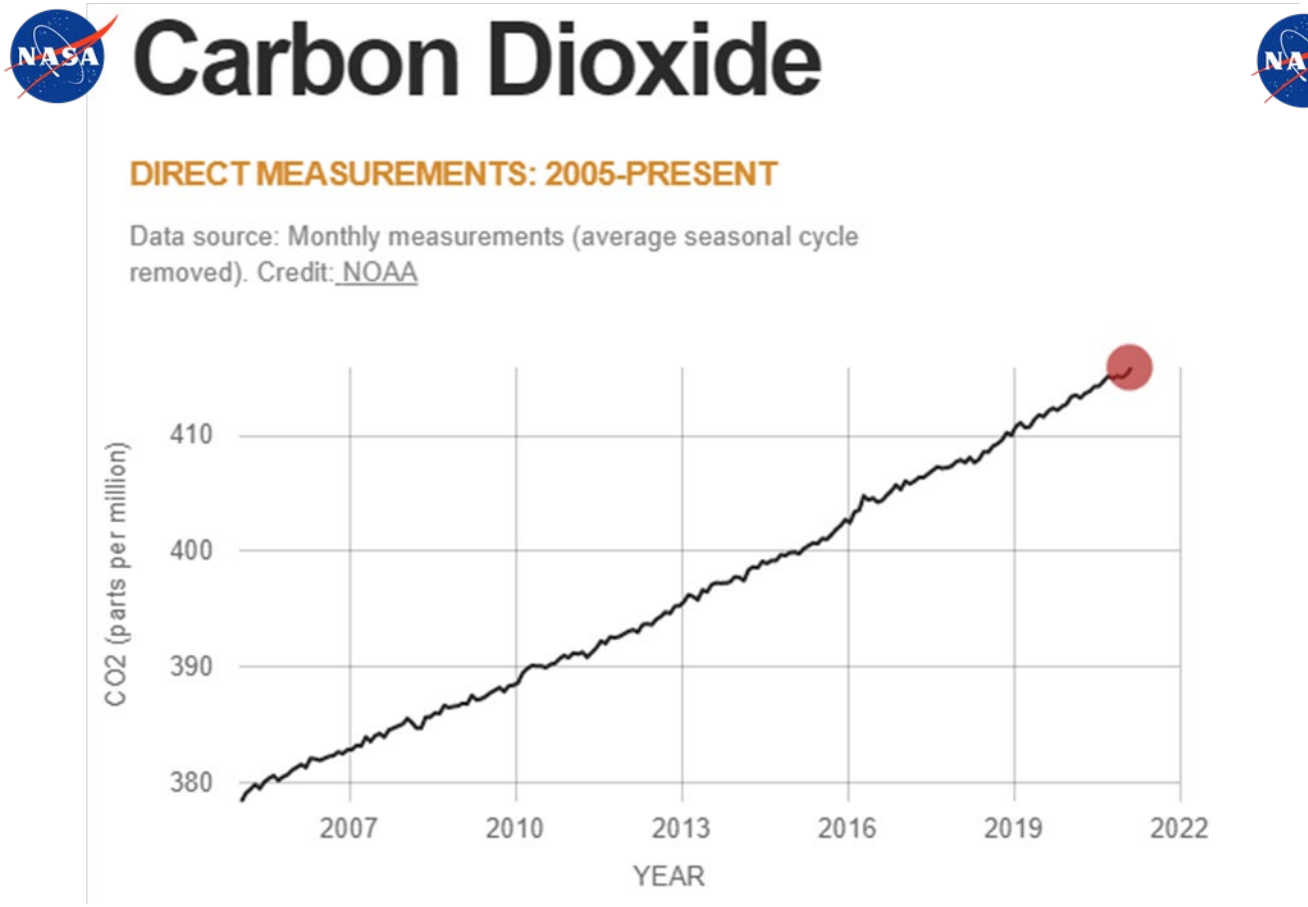
MEGAN GUNTHER, PE, LEED® AP BD+C, WELL AP
Head of Building Performance, San Francisco
Affiliated Engineers, Inc.

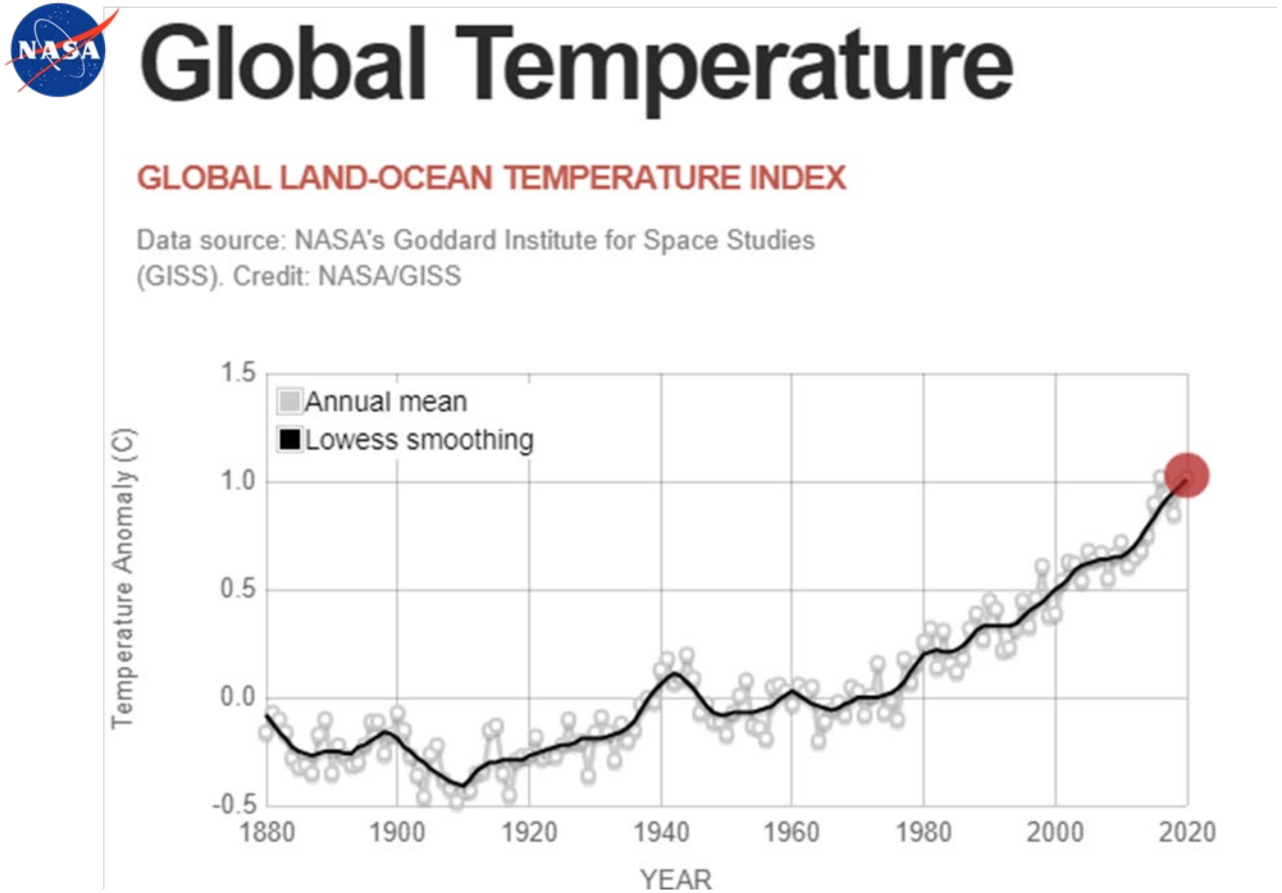
Agenda

- Why electrify?
- What makes laboratories different from other building types?
- Hurdles to overcome in laboratory electrification
- Technologies and solutions

Why electrify?

Why Decarbonize?



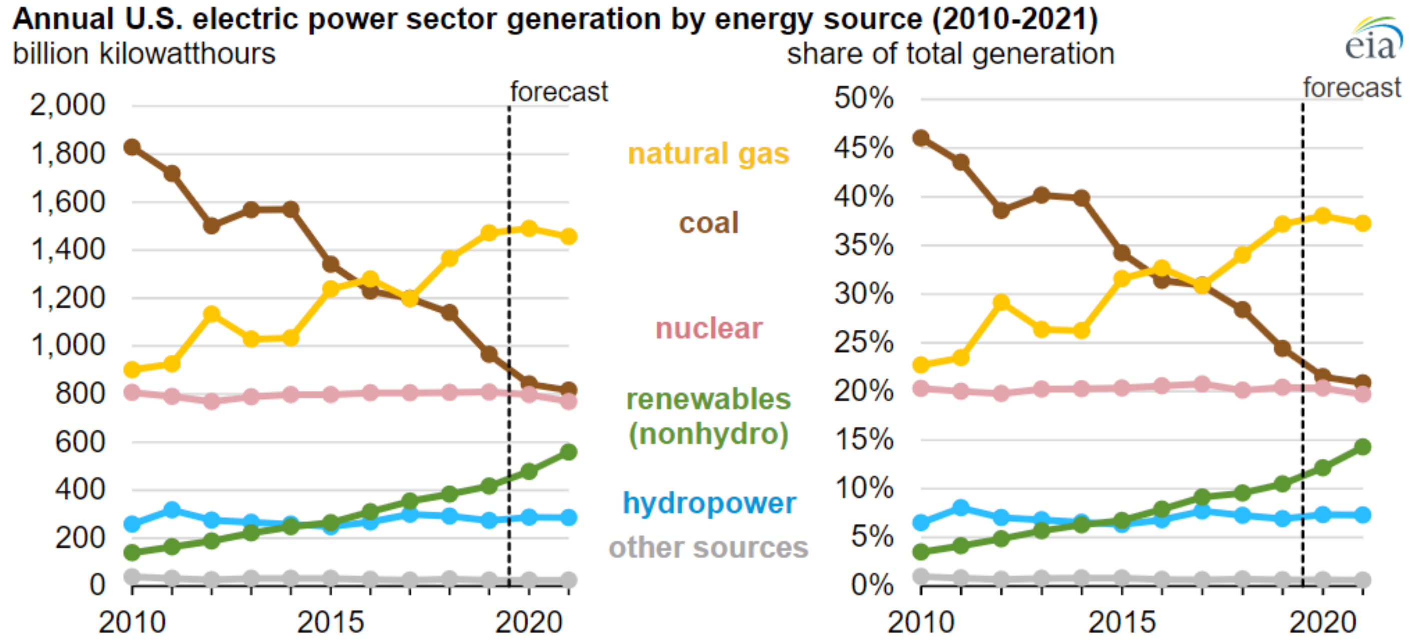


19 of the warmest years on record have occurred since 2000

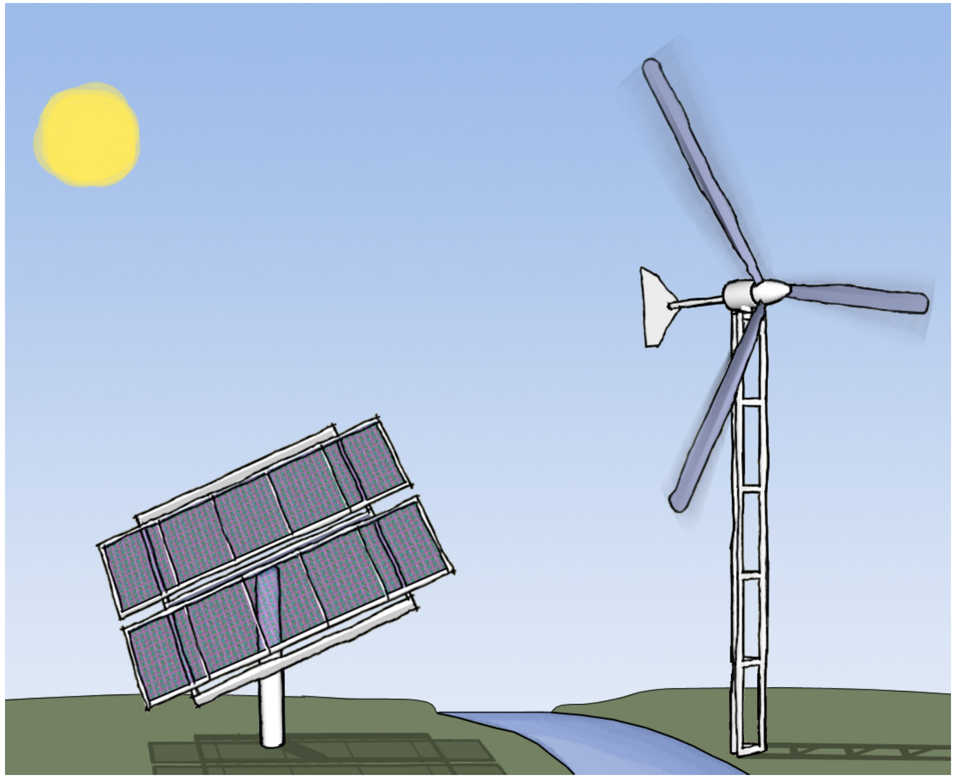
Why Electrify?

JANUARY 16, 2020

EIA forecasts slower growth in natural gas-fired generation while renewable energy rises



Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, January 2020



In 1990 coal made up 52% of electricity generation and has since declined to make up only 23%

Natural Gas Bans

Berkeley became first US city to ban natural gas. Here's what that may mean for the future

The California city on Tuesday voted to ban natural gas hook-ups in new buildings, in a historic move

▲ The view of the Bay from the Berkeley Hills. Photograph: Alamy Stock Photo

Berkeley this week became the first city in the United Sta
fossil gas hook-ups in new buildings.

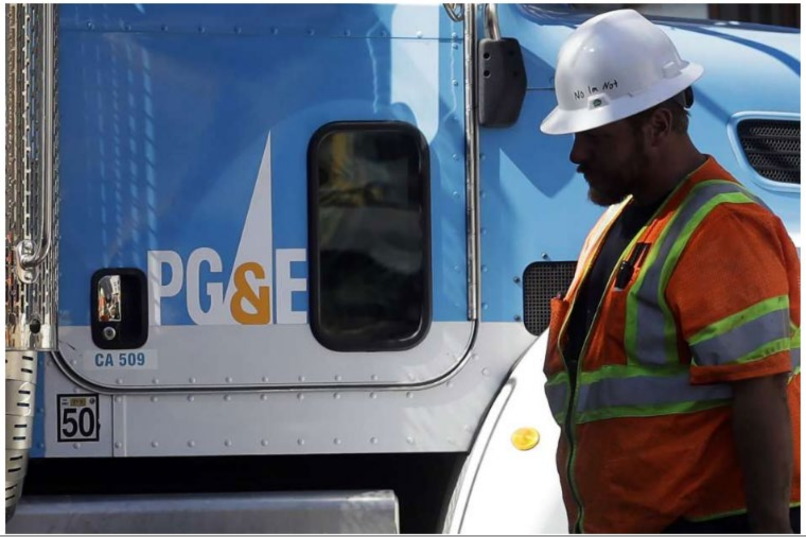
40+ California local governments have adopted zero-emissions codes

San Francisco Chronicle

BIZ & TECH // BUSINESS

SF bans natural gas in new city buildings, plans all construction ban

Mallory Moench | Jan. 19, 2020 | Updated: Jan. 23, 2020 9:04 a.m.



Local News
The Seattle Times

Seattle City Council passes measure to end most natural gas use in commercial buildings and some apartments

Feb. 1, 2021 at 6:49 pm | *Updated Feb. 4, 2021 at 2:37 pm*

onstruction crews work at 4700 Brooklyn Ave.
.E., a 24-story building, in Seattle's University
istrict. The Seattle City Council on Monday...
rika Schultz / The Seattle Times) **More**

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hanges to energy cod
as use in new comme
hree stories.

Denver eyes turning off natural gas, requiring all-electric new buildings in climate push

Feb 18, 2021, 2:53pm MST

The fossil fuel, produced by large Denver companies, isn't banned but it would be extinguished in a new electrification plan.

Greg Avery
Senior Reporter
Denver Business Journal

KATHLEEN LAVINE, DENVER BUSINESS JOURNAL FILE

A residential apartment building under construction in Denver. The city's net-zero energy building plan wants future new buildings all-electric, highly efficient and powered only by renewable energy.

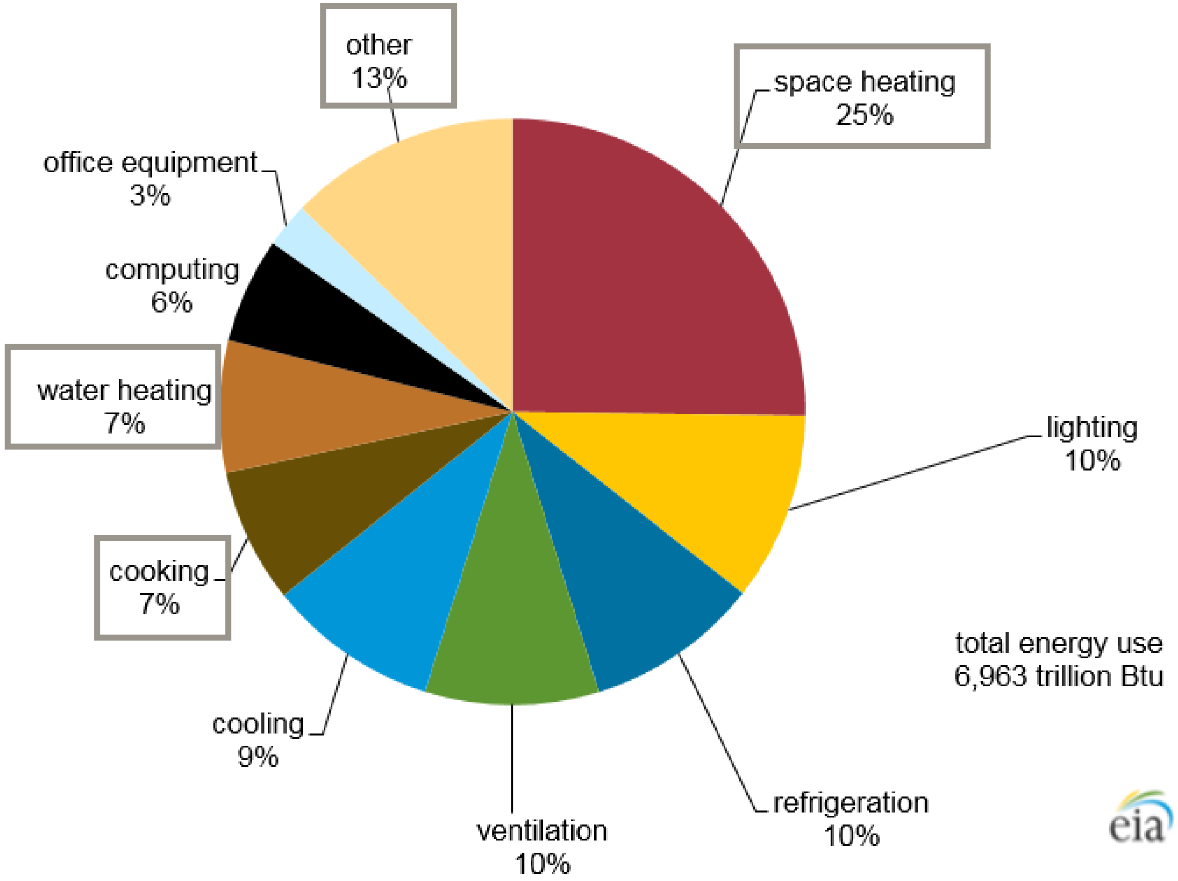
Natural Gas End Uses in Buildings

Water Heating

Space Heating

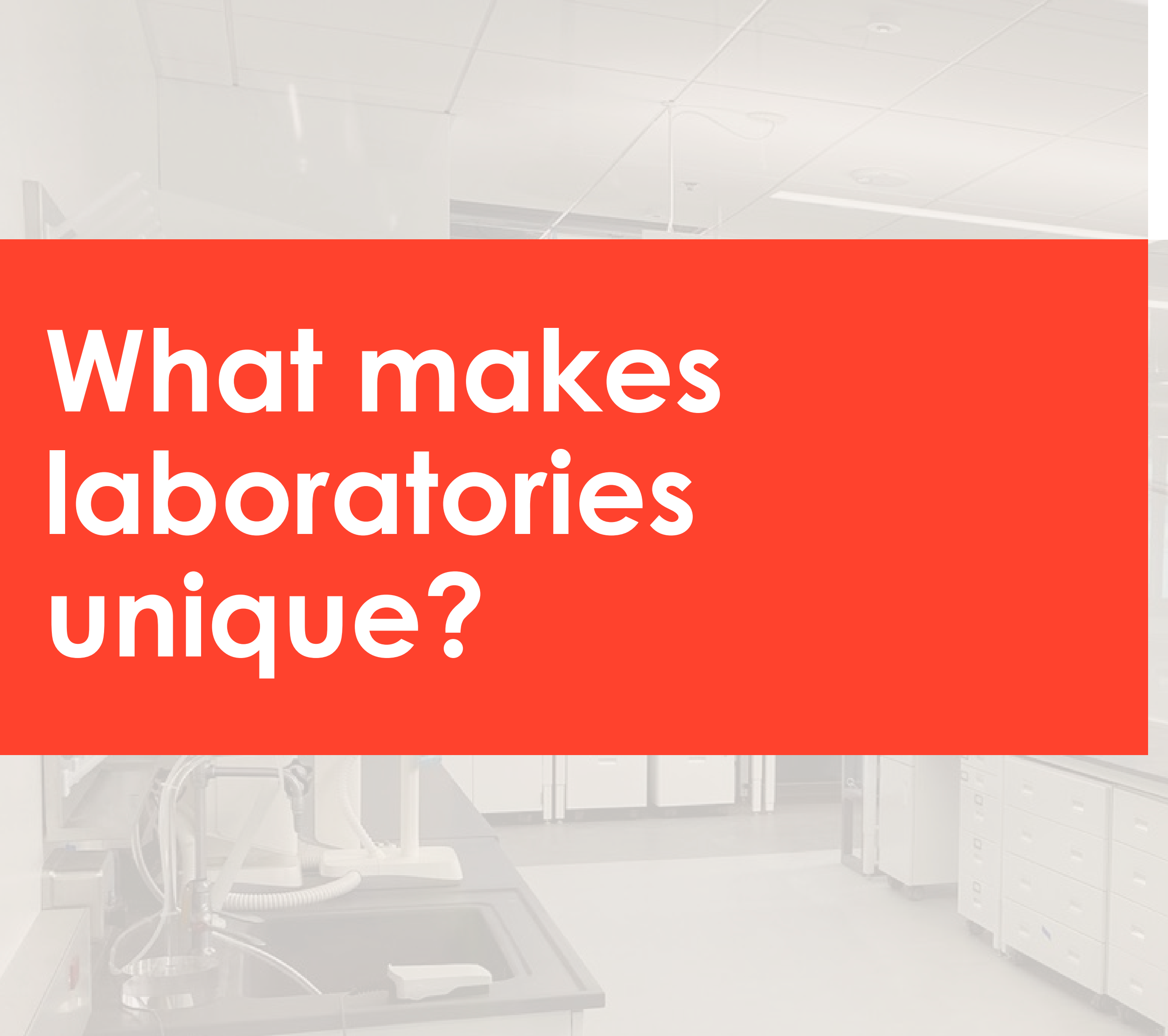
Process Loads

Cooking



Source: U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey.

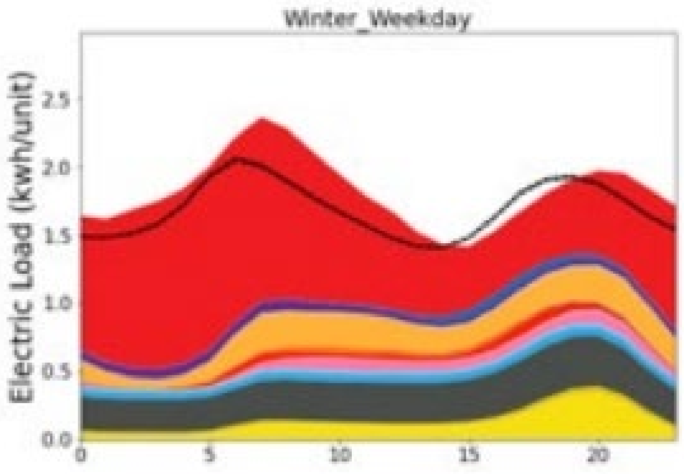
What makes laboratories unique?



Typical Commercial & Residential Building

Winter =

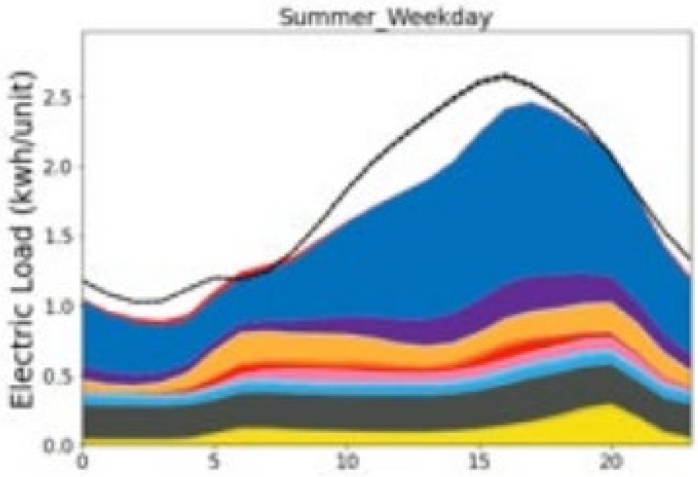
Space Heating



Chattanooga, TN Typical Winter Day End Use

Summer =

Space Cooling

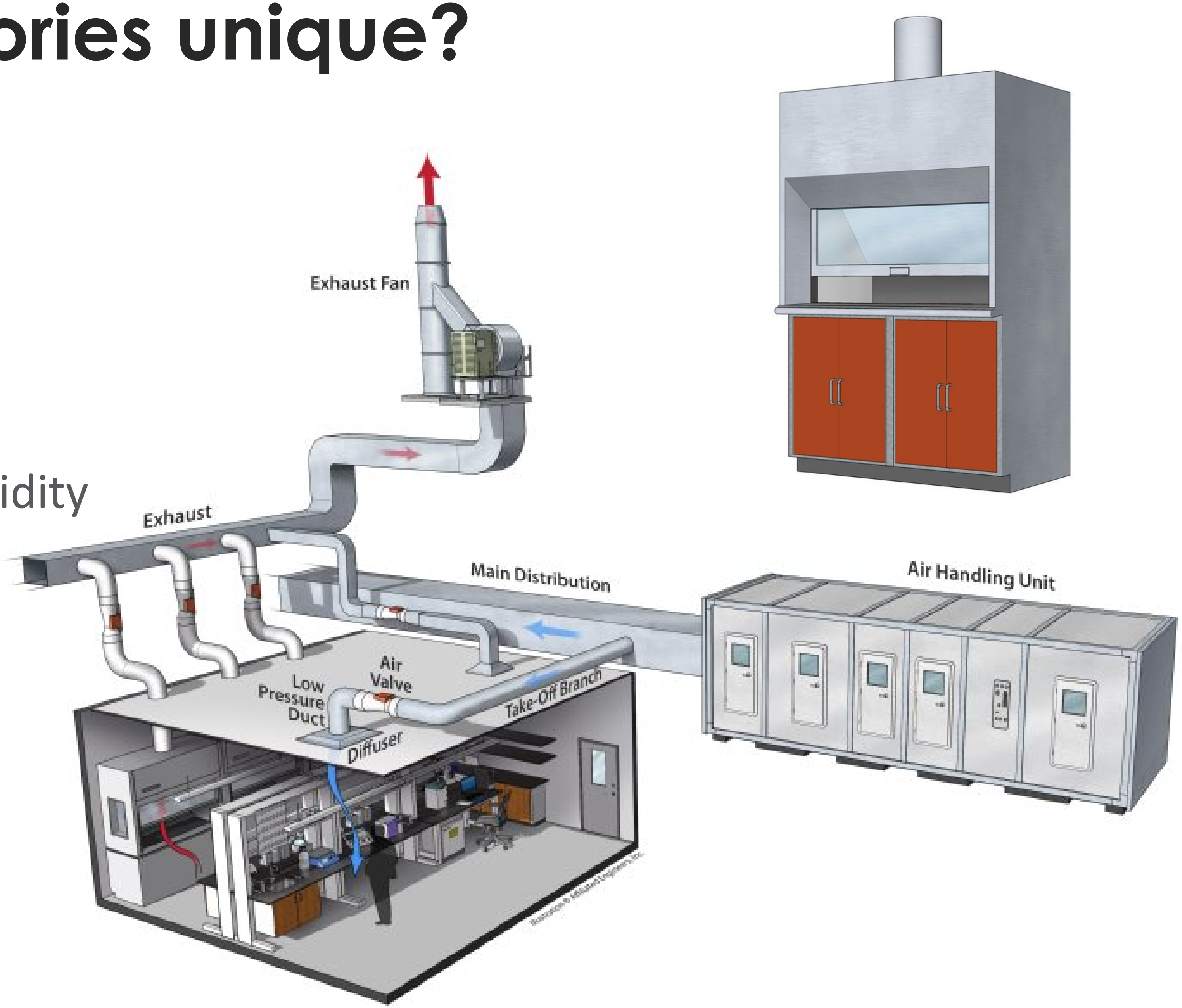


Chattanooga, TN Typical Summer Day End Use

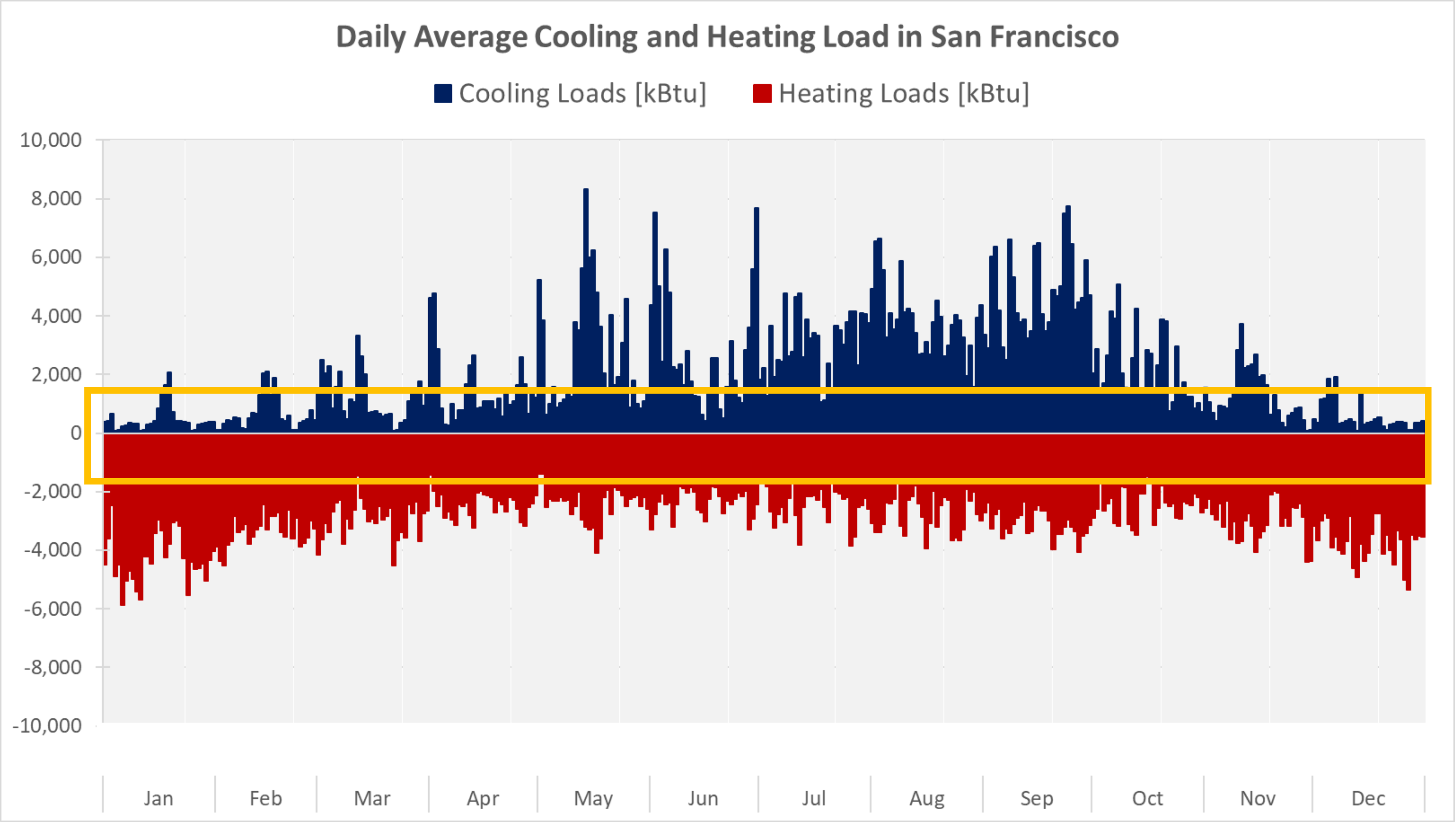
Source: NREL, End-Use Load Profiles for the US Building Stock.

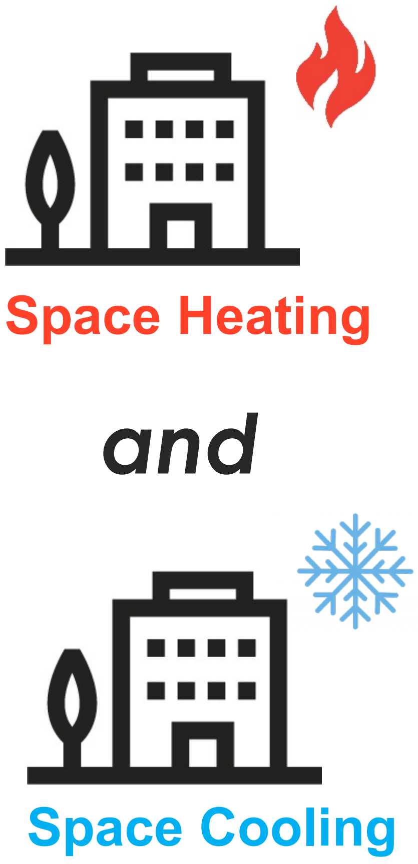
What makes laboratories unique?

- High air change rates
- Heavy equipment loads
- Process loads
- 24/7 operation
- Precise space temperature and humidity control

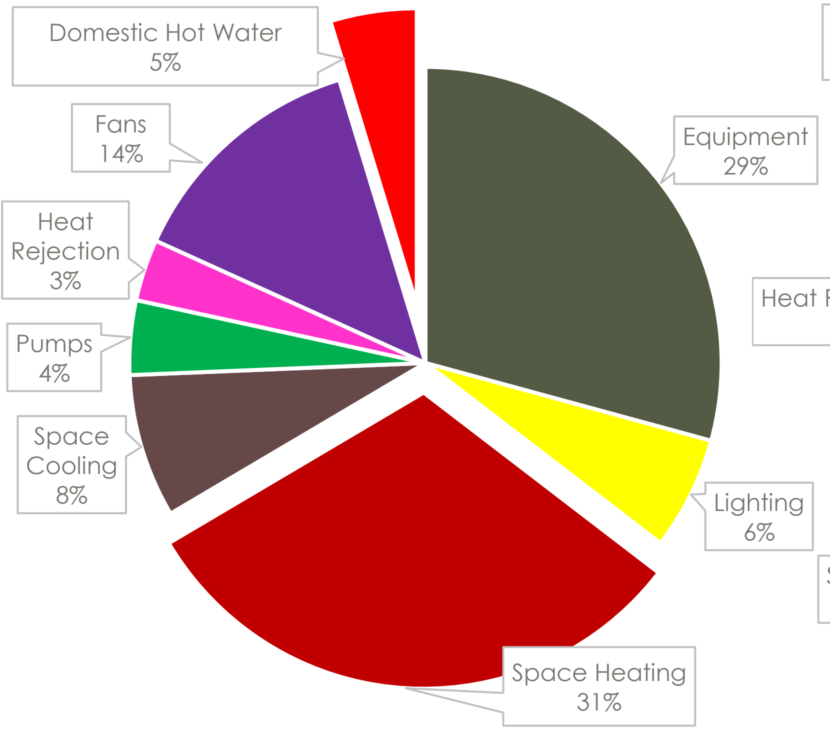


Simultaneous Heating and Cooling

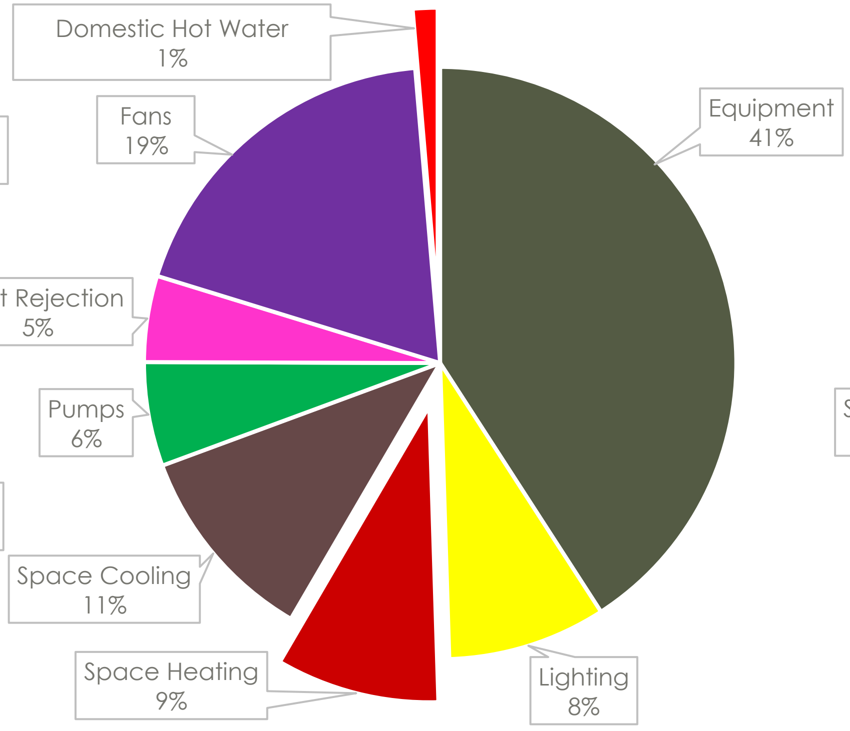




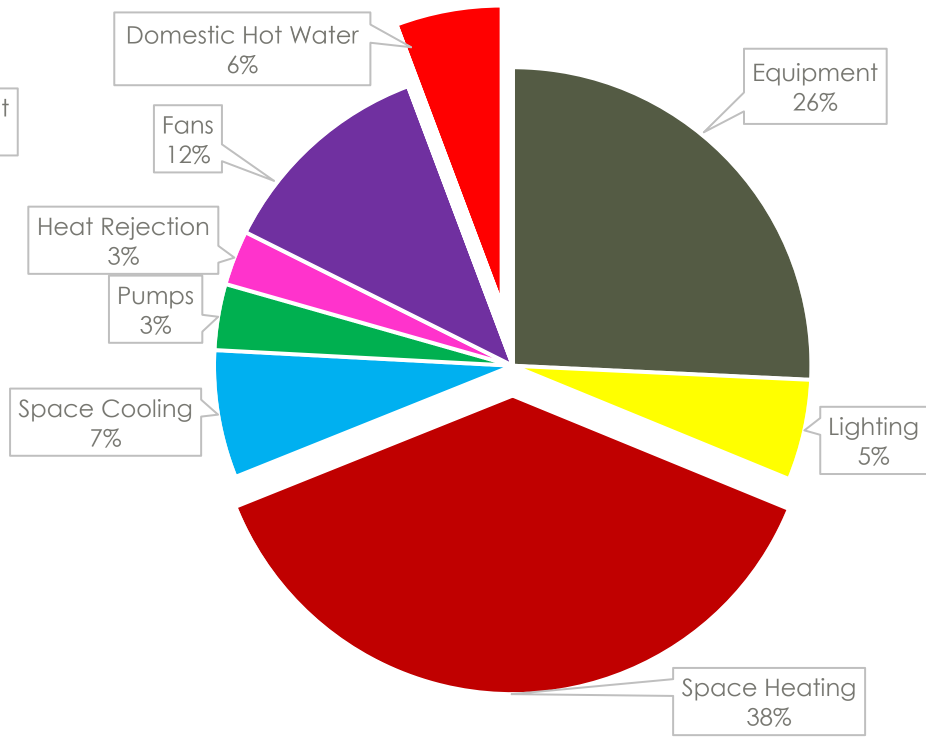
Energy End Uses and Metrics



Typical Lab **Energy Use** Breakdown



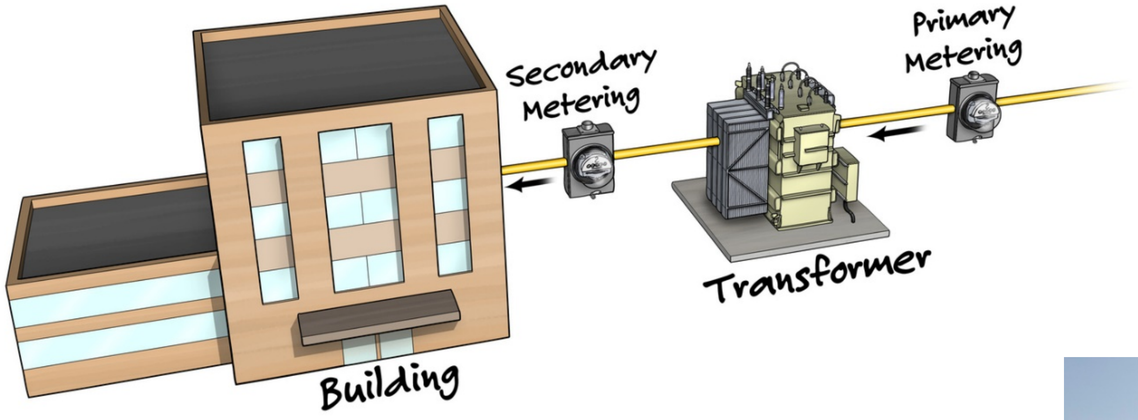
Typical Lab **Energy Cost** Breakdown



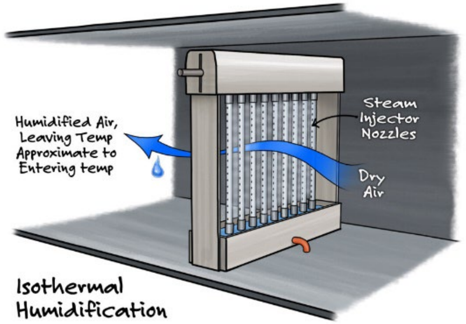
Typical Lab **CO2 emissions** Breakdown

Hurdles to Overcome

Hurdles of Laboratory Electrification



Impact to electrical service size

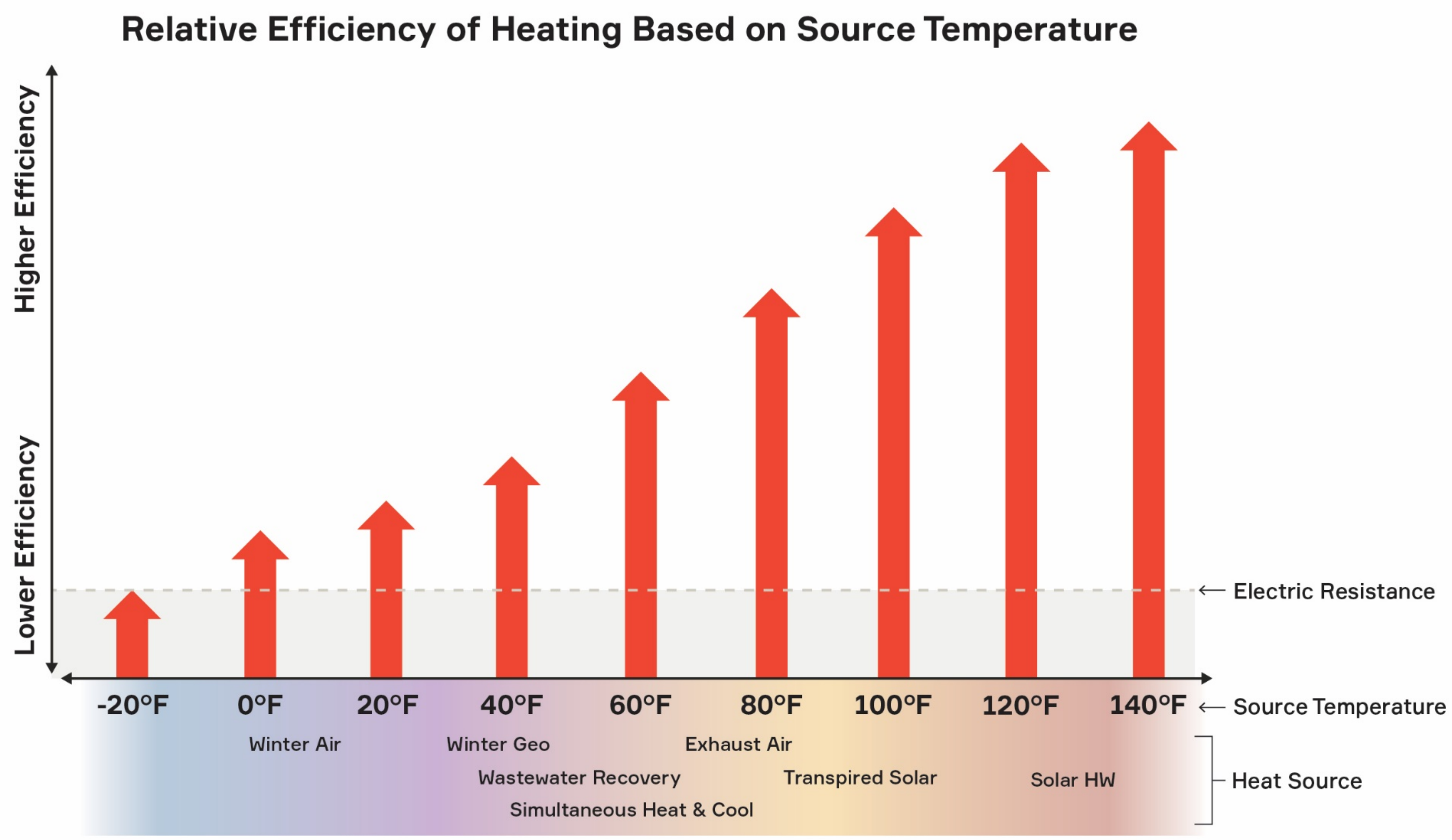


Limited Available Solutions

Equipment Space Constraints

Technologies & Solutions

Efficiency in Electric Heating



Efficiency in Electric Heating

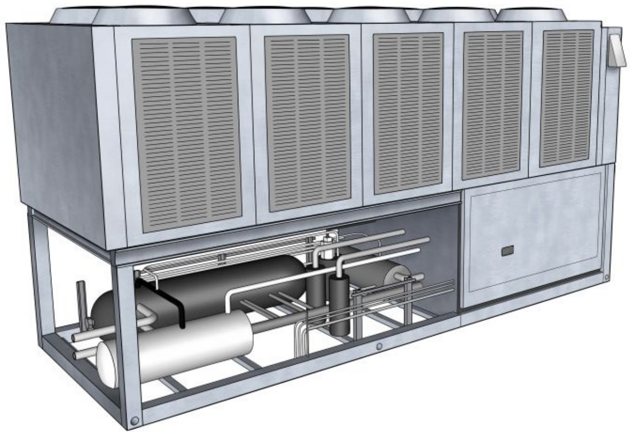
Space Heating

Electric Resistance Heating

COP = 1

Coefficient of Performance

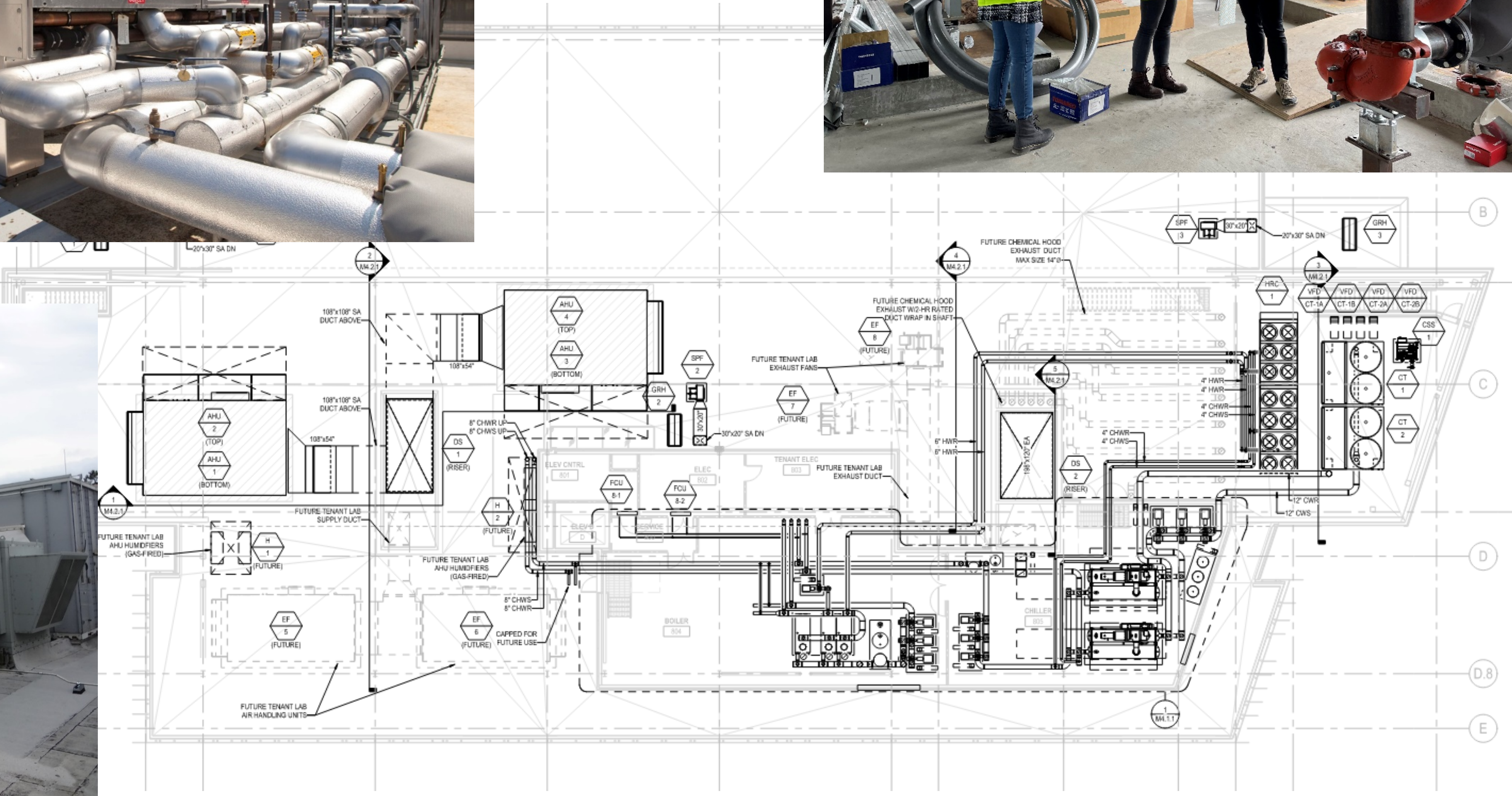
$$COP = \frac{\text{Energy Out}}{\text{Energy In}}$$



Air-Source Heat Pump

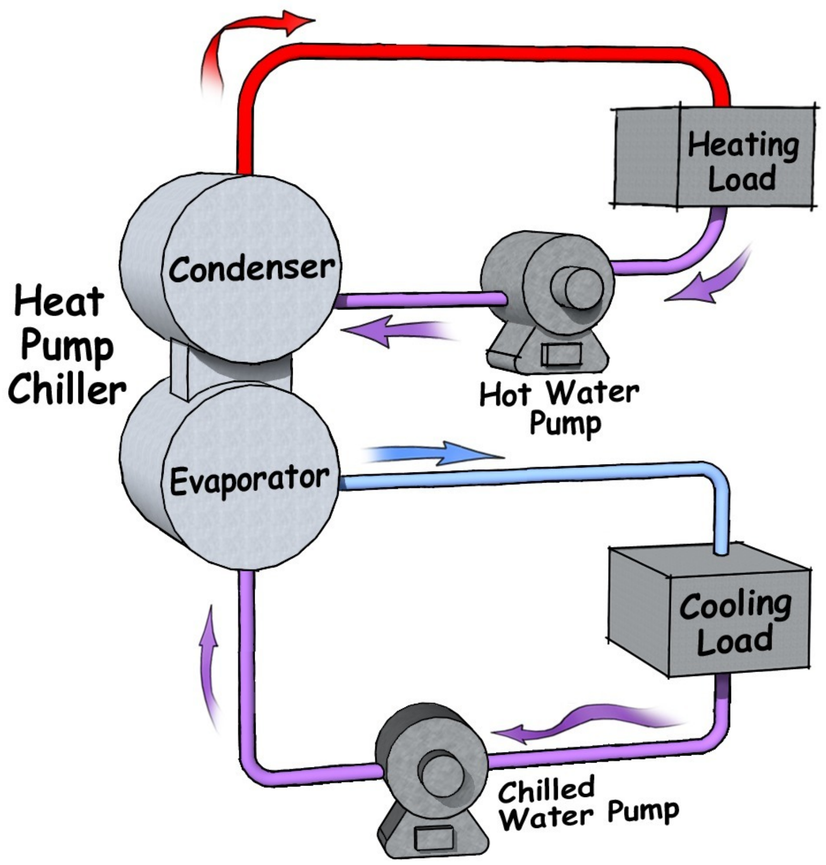
COP = 2-3 at 40F and below

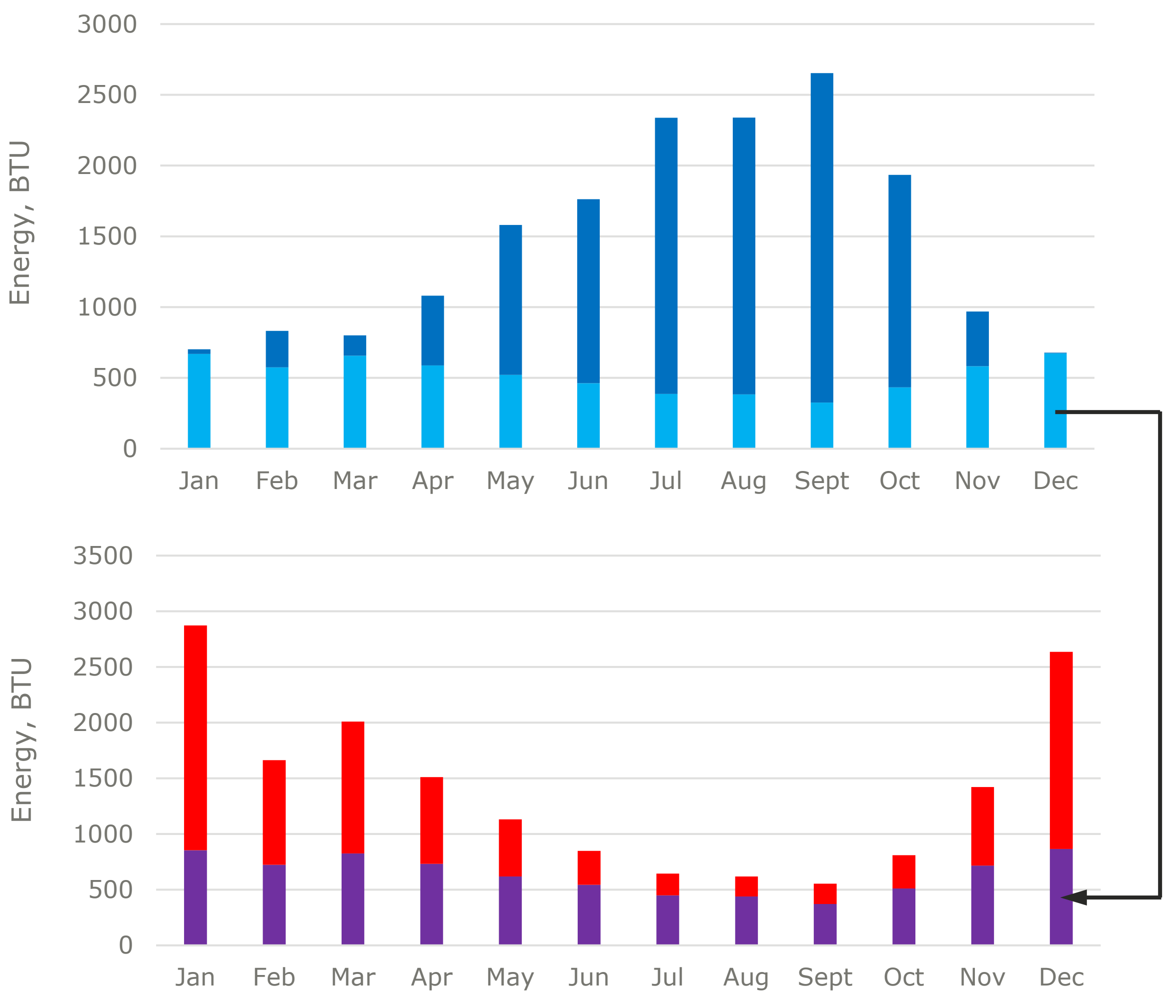
Space Constraints



Simultaneous Heating and Cooling

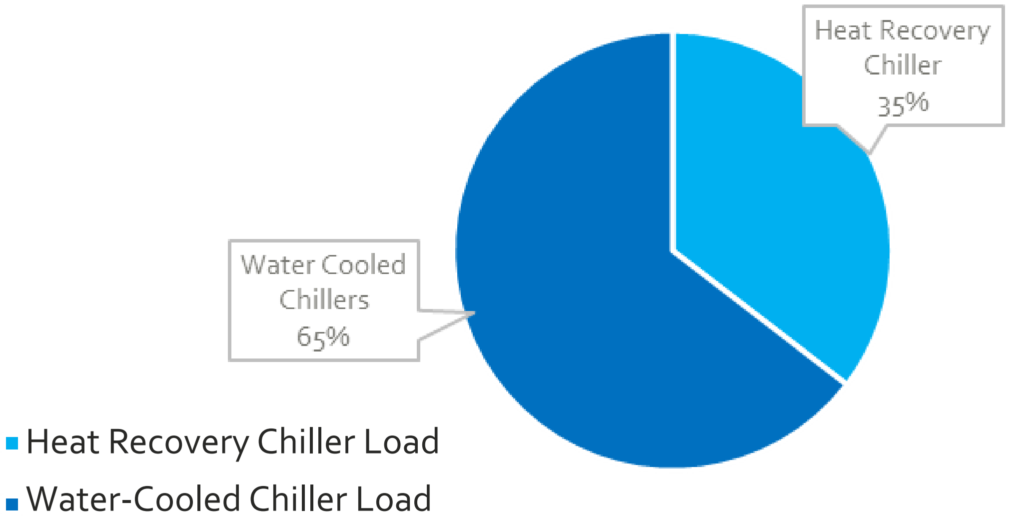
Space Heating

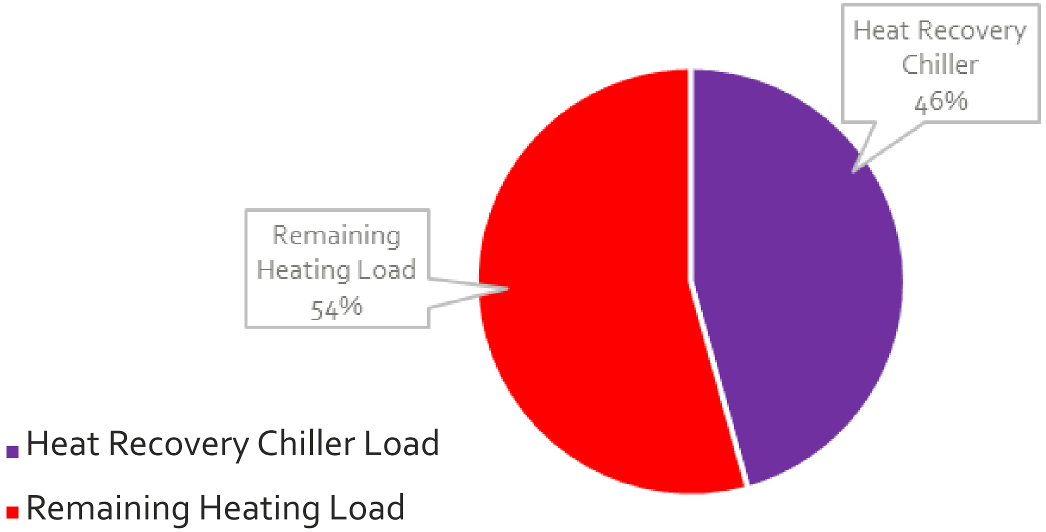




Simultaneous Heating and Cooling

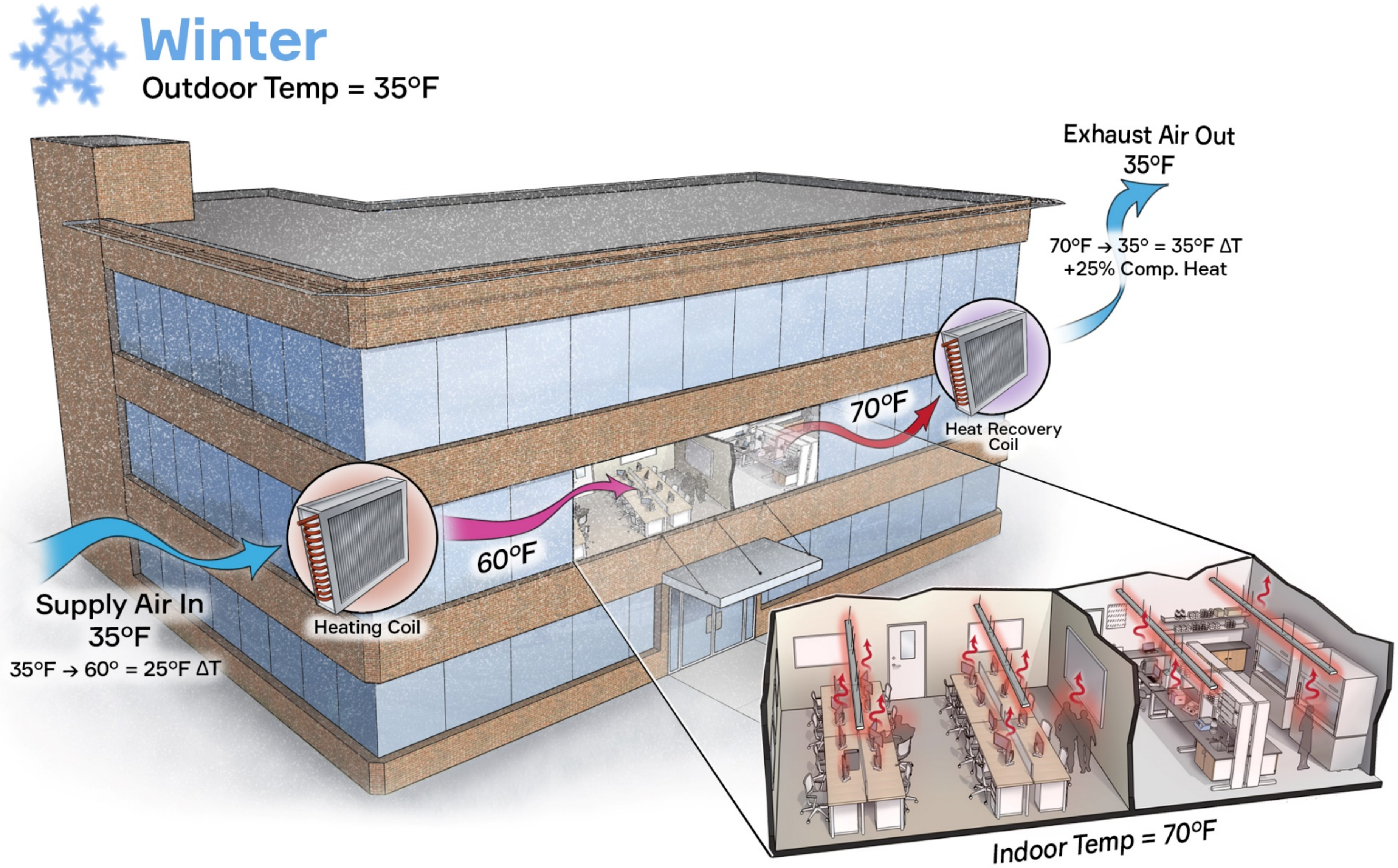
Space Heating





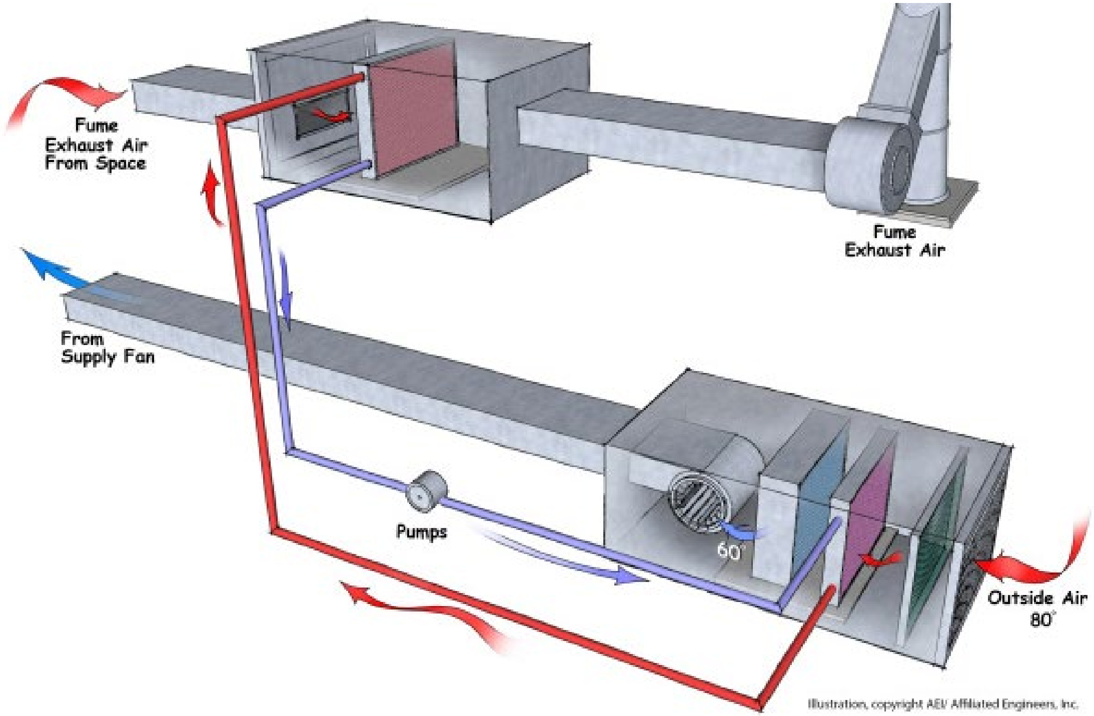
Using the building as your heat source

Space Heating

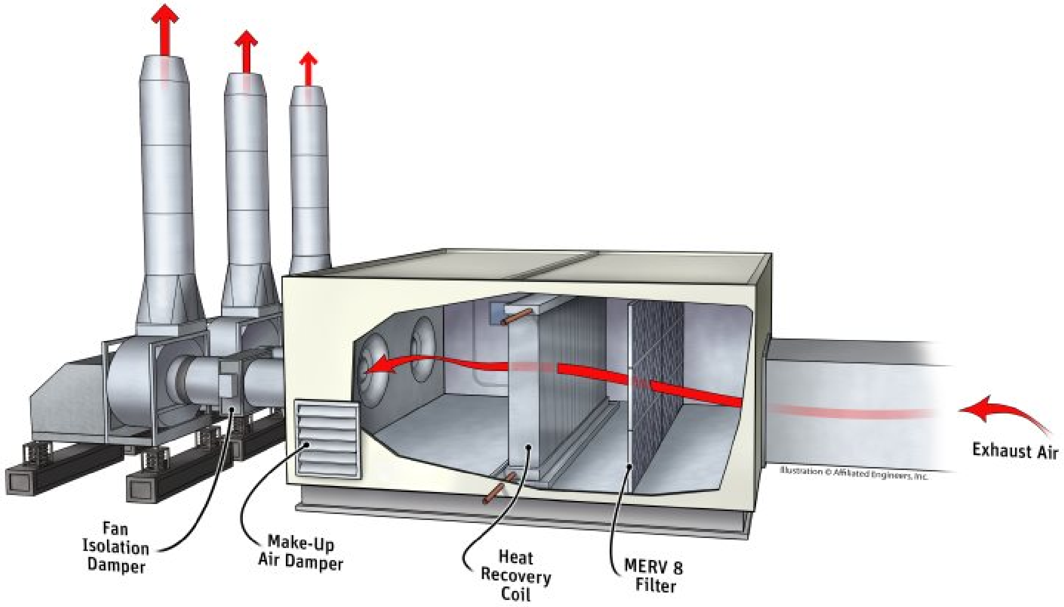


Air-Source Heat Recovery

Space Heating



Run-around Loop

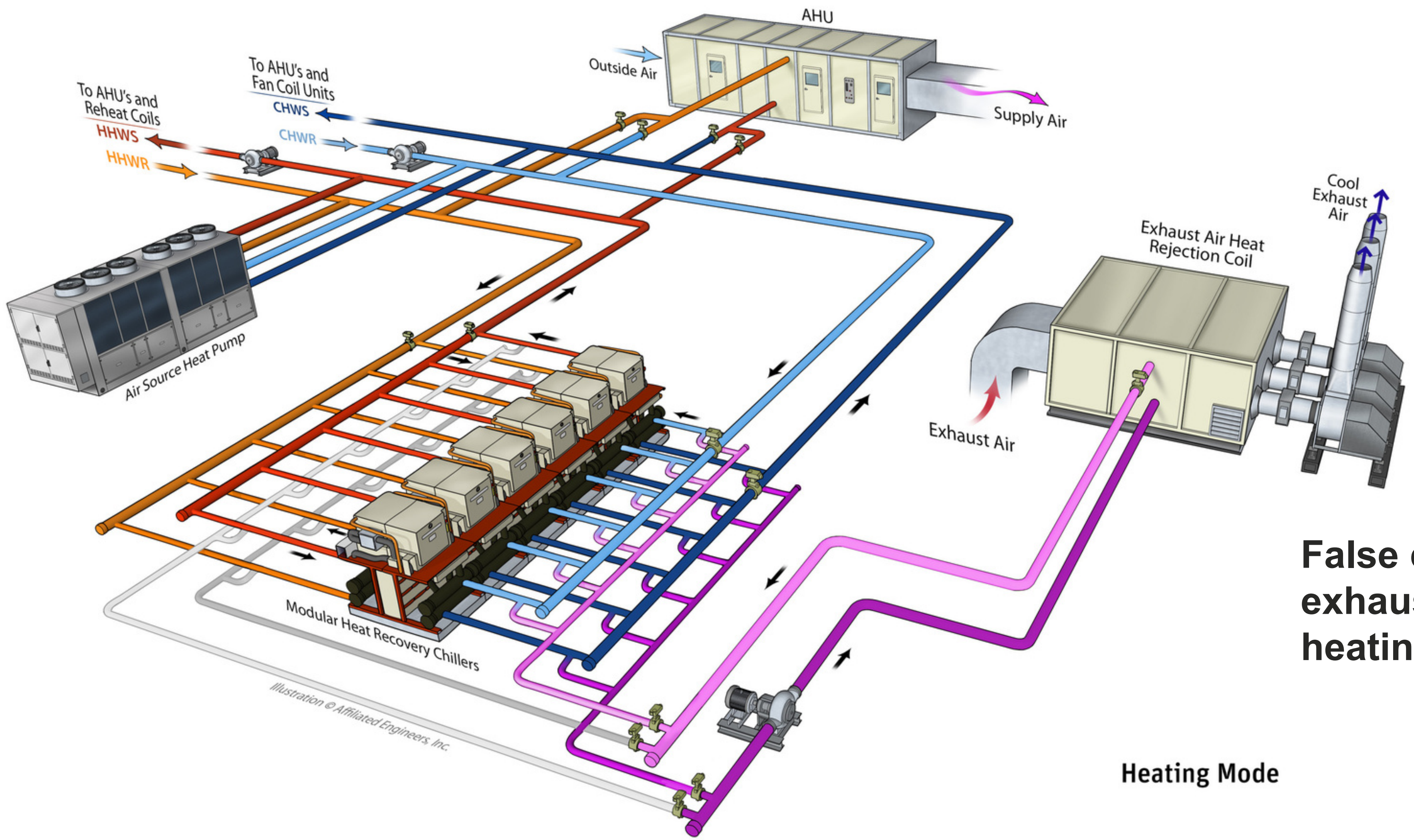


Exhaust Air Heat Recovery

Advanced Simultaneous Heating & Cooling

Space Heating

Building Electrification

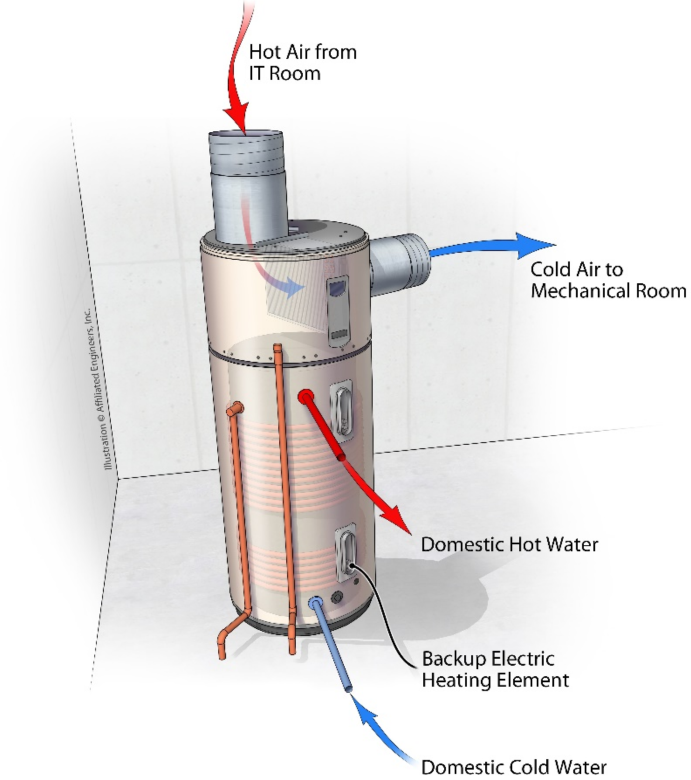


False cooling of the building exhaust air provides an all-electric heating source

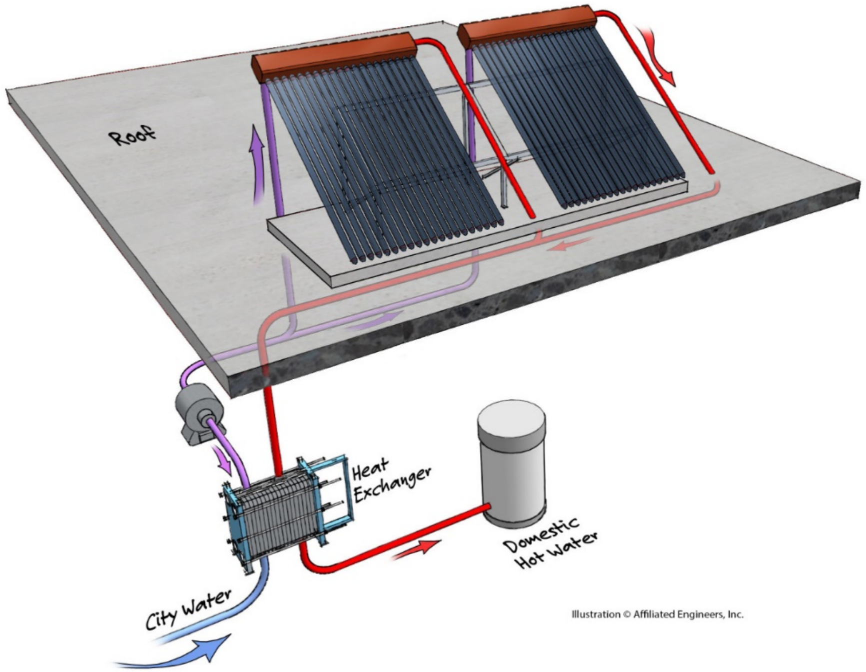
Domestic Water Heating

Water Heating

Electric resistance (tankless or storage)



Heat pump water heater



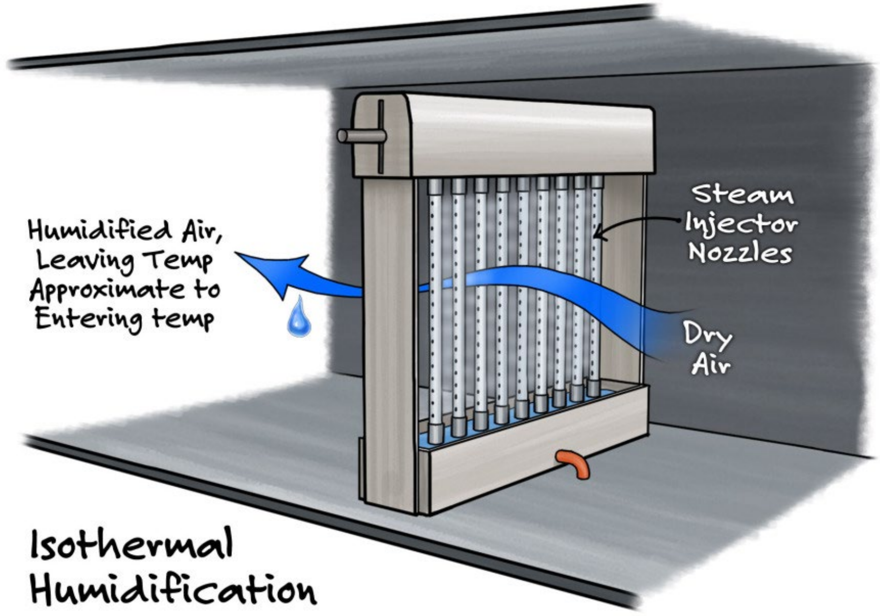
Solar thermal

Process Loads

Process Loads

Sterilizer

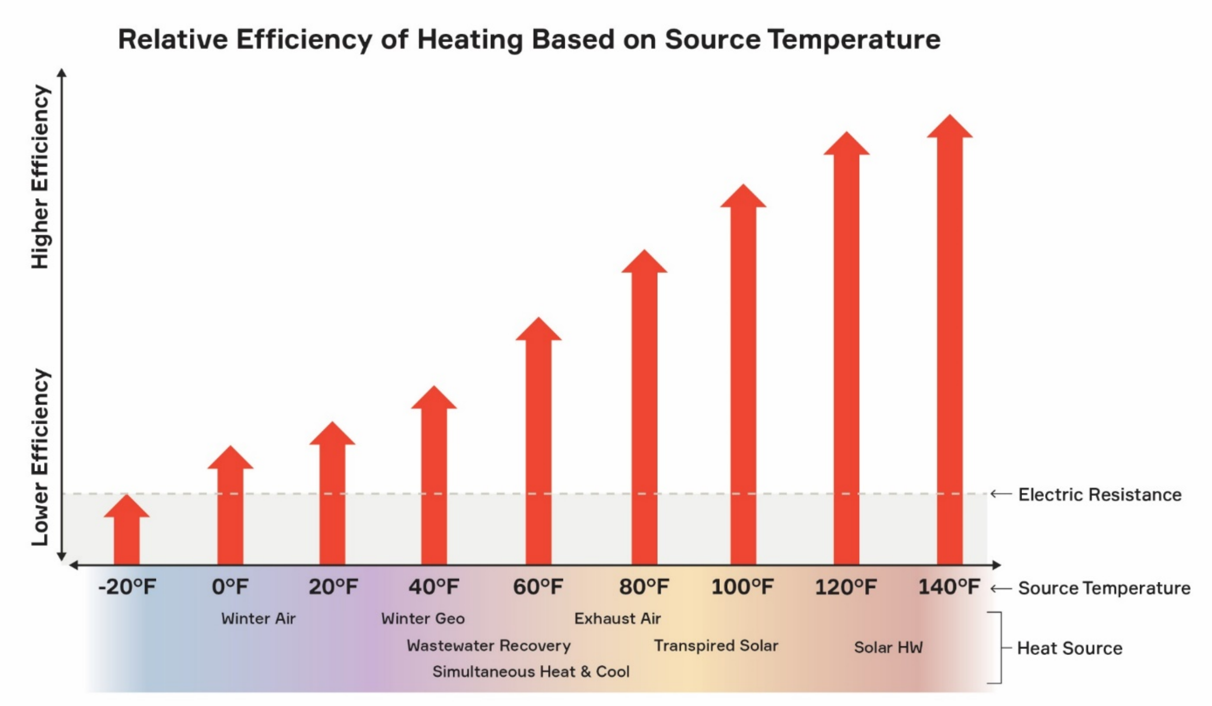
Glass Washer

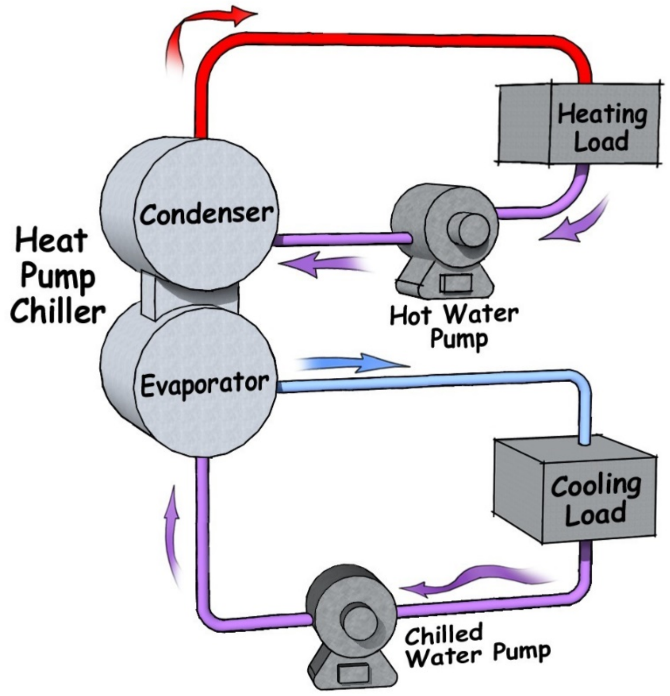


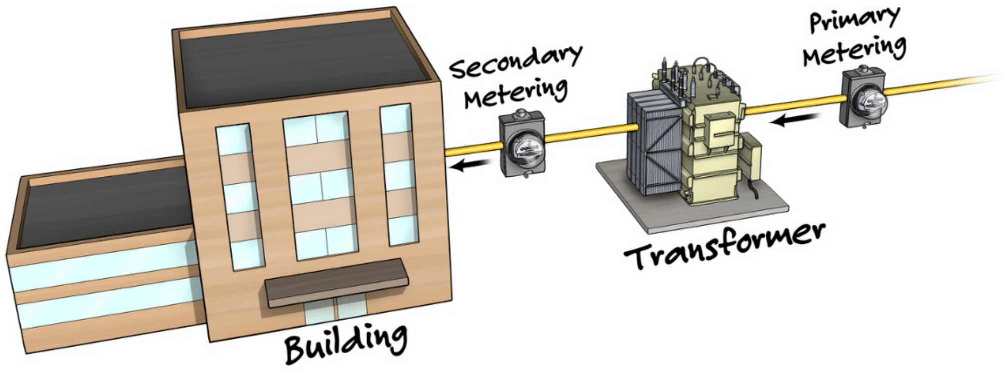
Humidification

Recap

- Prioritize reuse and efficiency
- Balance space constraints with available technologies
- Limit increase on electrical service size







Thank You!