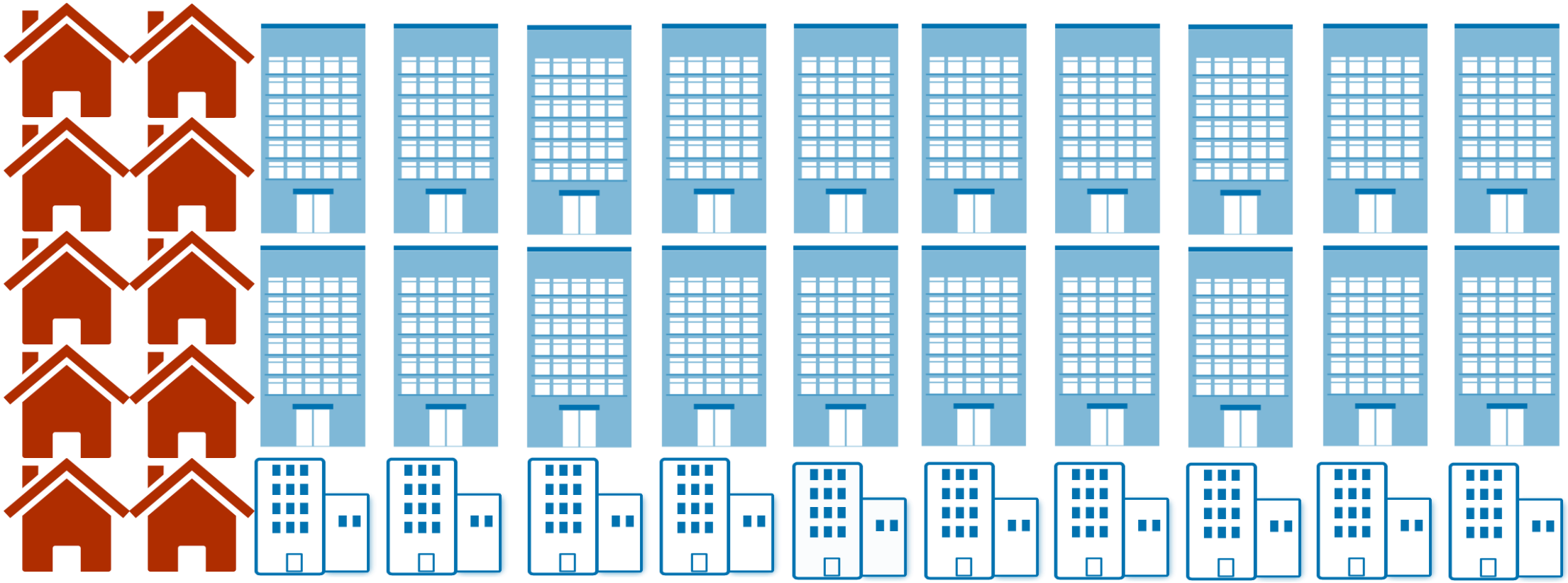
NZE Buildings Work Update

High Performance Buildings & Homes

Homes and Buildings Account for 64% of Denver's GHG Emissions



Agenda

1. Renewable Heating and Cooling Plan Briefing
2. Energize Denver Task Force update

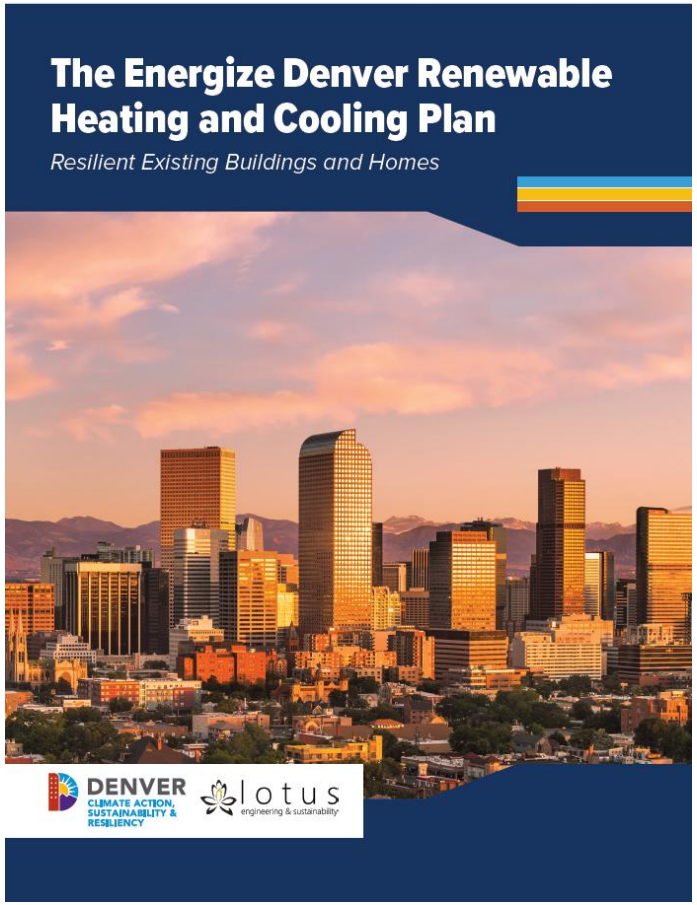
Renewable Heating and Cooling (Electrification)

Energize Denver Renewable Heating and Cooling Plan: Resilient Existing Building and Homes

June 2021

Community Engagement

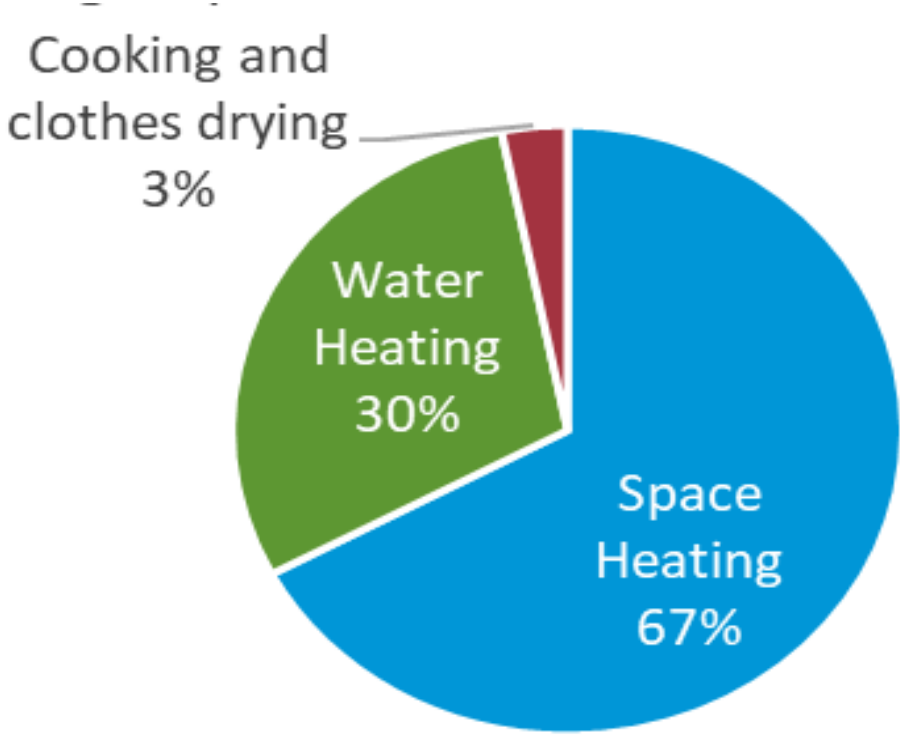
- Over 300 stakeholders engaged
- Two Workforce roundtables
- LMI phone calls and online surveys
- Six Advisory Group charettes



Sections in Denver's Renewable Heating and Cooling Plan

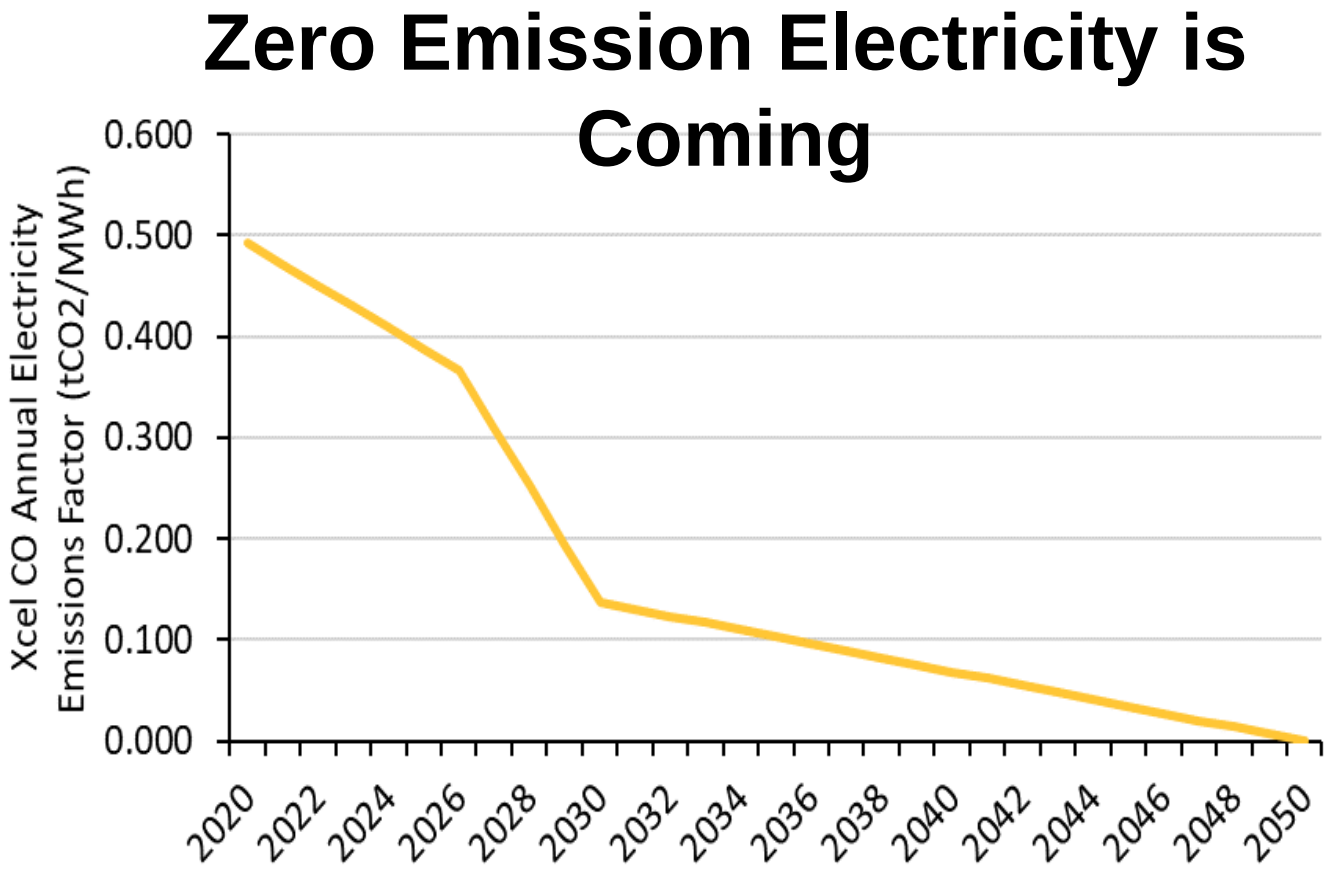
- Engaging the Community
- Why Renewable Heating and Cooling
- The Electric Grid
- Conversion Plan for Major Heating Systems
- Denver's Renewable Heating and Cooling Implementation Strategy

Gas Use in Buildings and Homes



High Impact Climate Benefits

- Methane, the primary component of natural gas, is released when we use gas and causes 80 times the amount of climate change as standard carbon dioxide emissions.
- As the grid moves to 100% renewable power, electric renewable heating and cooling is the clear path to reducing these emissions generated by homes and buildings.

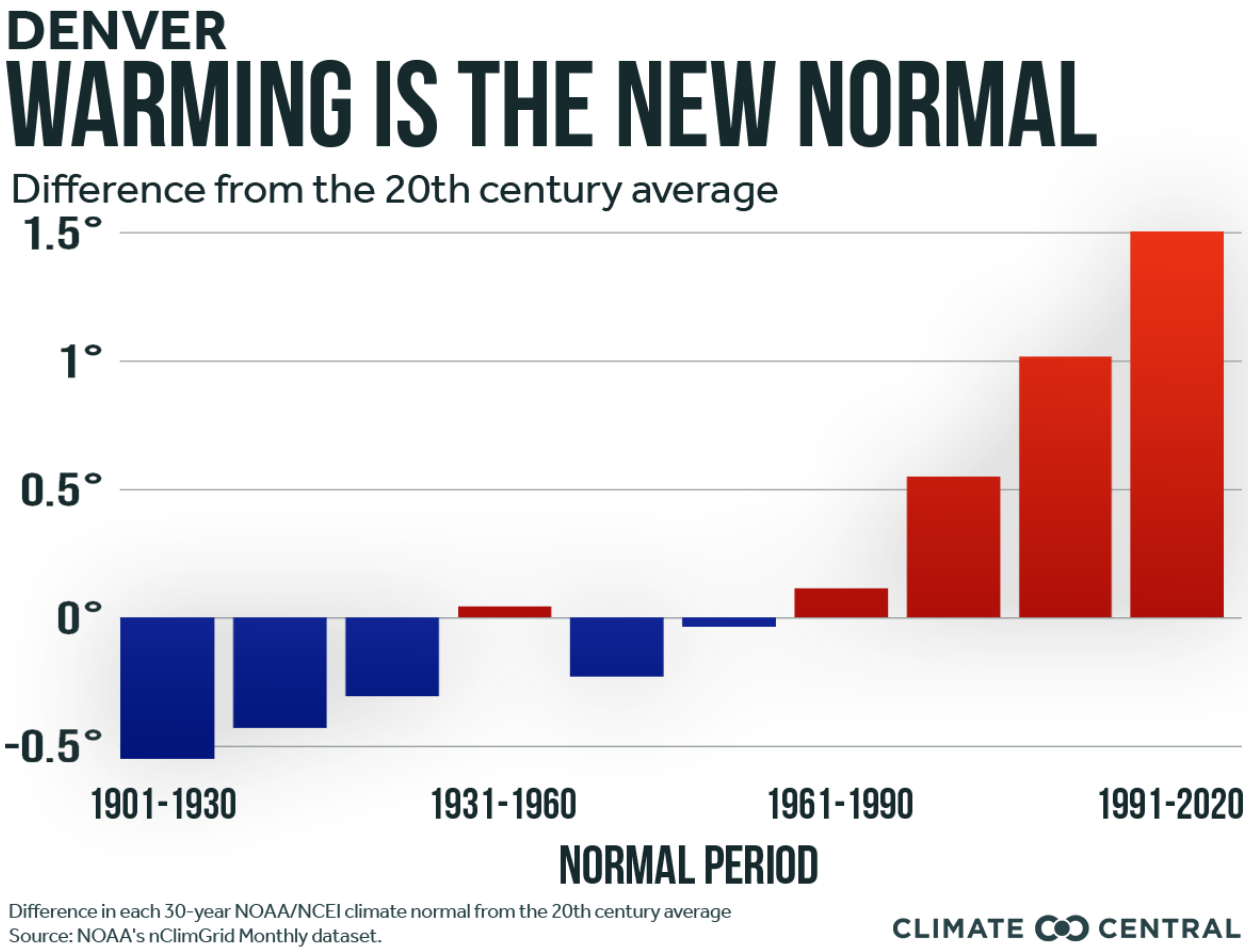


Heat Pumps

- Heat pumps move heat instead of creating it achieving 200-300% efficiency
- 100% efficiency is based on a source that creates heat

A/C for homes that lack it today

Approximately 30% of Denver homes do not have air conditioning, which is especially critical as temperatures rise.



Improved Equity and Safety

- In 30% of low-income homes in Denver today, gas equipment fails carbon monoxide tests, compared to less than 5% of market rate homes.

Lower Exposure to Indoor Air Pollutants

- Residents of homes with gas appliances have nearly three times the rate of asthma compared to homes with electric appliances.

Better Outcomes, Same Cost

- When a furnace, A/C compressor, or hot water heater fails, most homes and buildings can replace it with an electric equivalent with a similar cost for both installation and operation, as they would pay with a new gas system.

Increases Grid Utilization

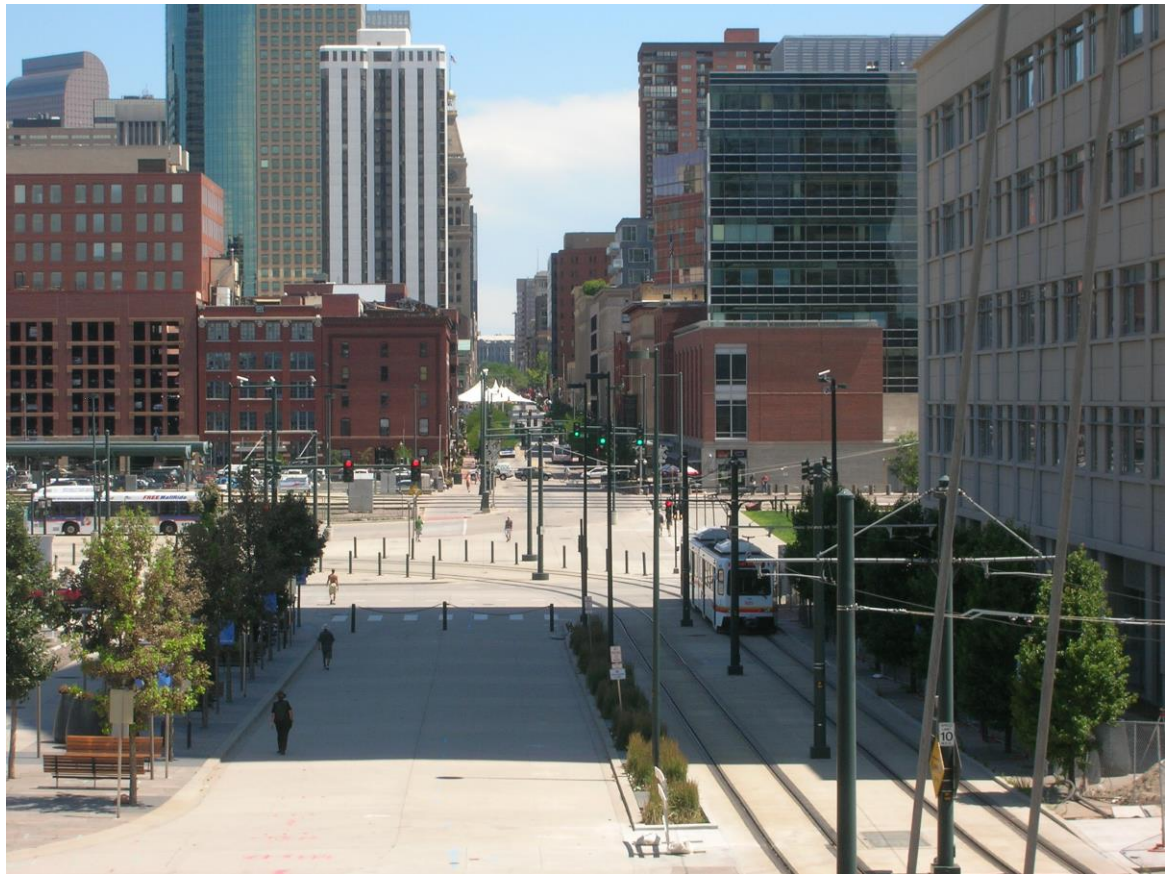
- Denver's electric system is already built to withstand high air conditioning load during the summer, therefore winter heating needs can shift to renewable electricity without significant infrastructure build-out.

Proven, Reliable Technology

- Heat pumps have been in use since the 1800s in American refrigerators.
- And, for decades to heat homes and buildings Asia and Europe.

Denver has an opportunity to lead

- Cities and businesses around the world are rapidly adapting to the new energy landscape.
- A delay in action could weaken Denver's economic position and add tremendous costs if we try and "catch up" later to our total conversion goals.

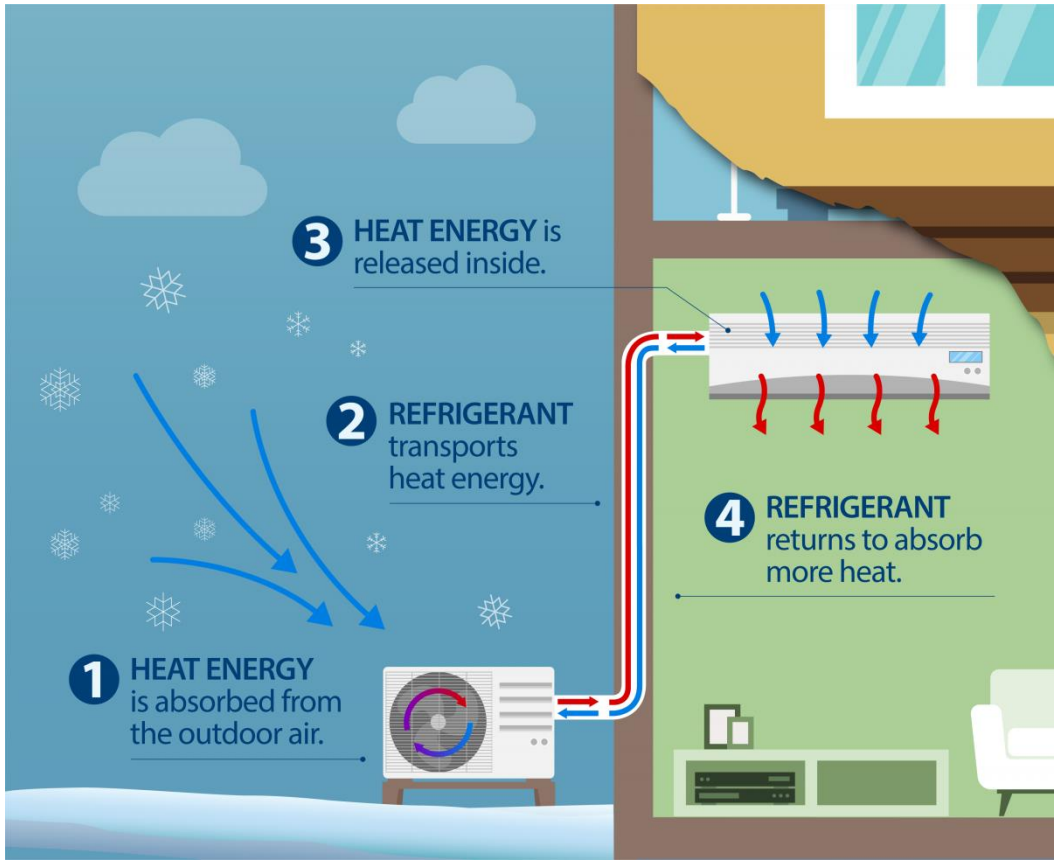


Renewable Heating and Cooling Systems

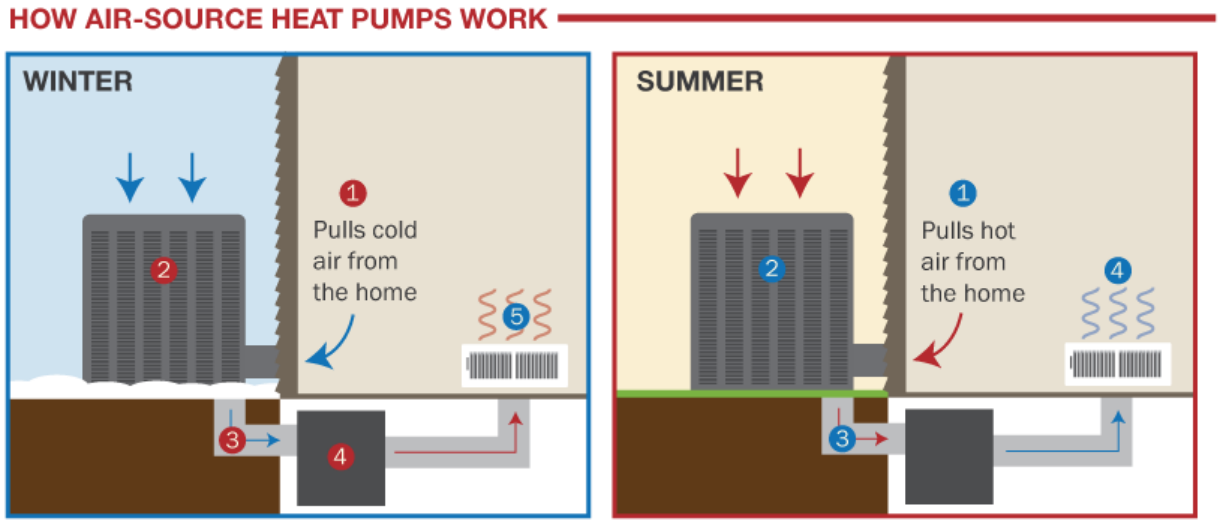
Homes

Space and Water Heating Systems

Systems to Electrify 80% of Space Heating in Homes



Furnace + Mini split heat pump



Furnace + Ducted heat pump

System to Electrify 100% of Water Heating in Homes

Individual System with Tank

What is Cost Effective to Electrify Today

Furnace ✓

Individual System with Tank ✓

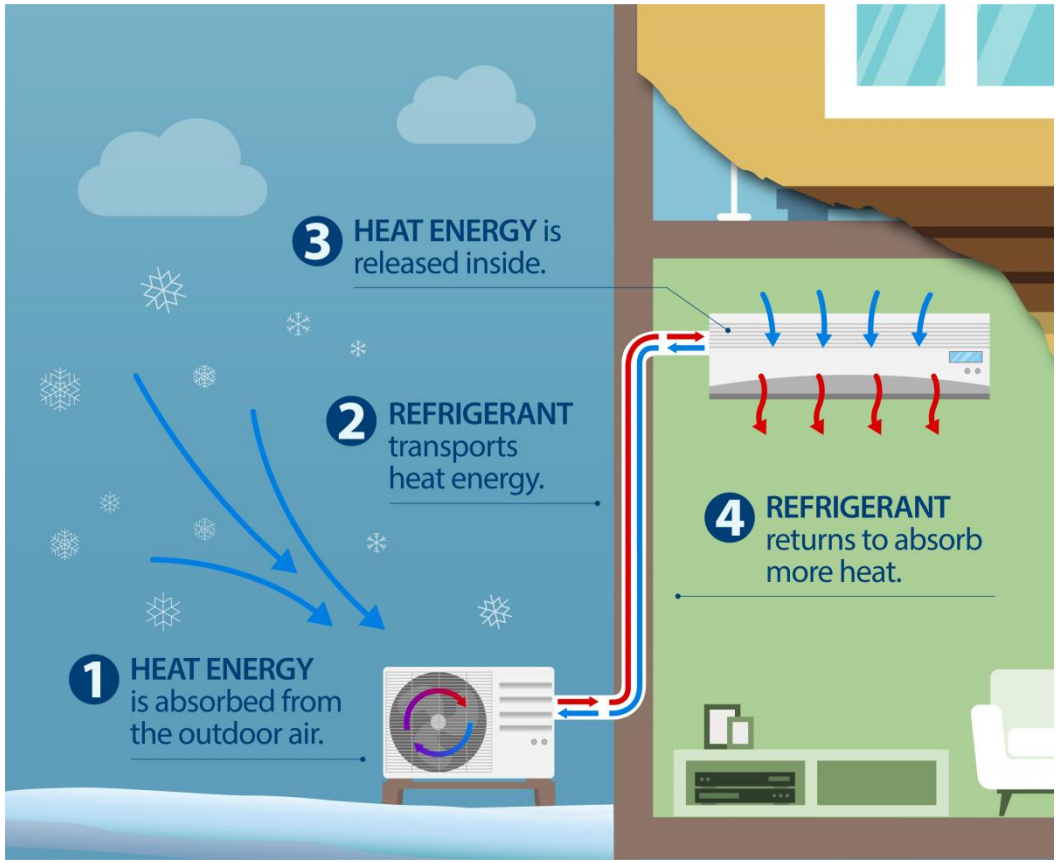
Current Xcel Energy incentives:
$500-$1000 for Air Source Heat Pumps
$600-$800 for Heat Pump Water Heaters

US Senator Martin Heinrich (D – N.M.) leads 11 Senators (including Michael Bennet D-CO) in introducing legislation to reduce the upfront costs of heat pumps through rebates of up to $10,000, with additional amount for LMI households and multifamily buildings

Commercial and Multifamily Buildings

Space and Water Heating Systems

Space Heating Systems 1 & 2



Furnace

Rooftop Units

Space Heating Systems 3 & 4

PTAC

Boilers

What is Cost Effective to Electrify Today

Furnace (32% C&MF)	✓
Rooftop Units (RTU) (25%)	✓
Packaged Terminal Air Conditioner (PTAC) (3%)	**not yet**
Boiler (12%)	**not yet**

Water Heating Typologies 1, 2 & 3

Individual System with Tank

Central System with Tank

Point of Use

What is Cost Effective to Electrify Today

Individual System with Tank (96% MFU) (~100% res) ✓

Central System with Tank (48%) ✓

Point of Use (21%) ✓

Energize Denver Task Force

Charge: Help the City design a building performance policy for existing buildings that:

- *Improves Health and Equity*
- *Creates Jobs*
- *Drives Climate Solutions in Existing Buildings that Achieve Net Zero Energy by 2040*

Energize Denver Task Force Members

Building Owners/Managers	Amie Mayhew, Colorado Hotel & Lodging Association Frank Arellano, LBA Realty Jon Buerge, Urban Villages Kathie Barstnar, NAIOP Colorado Lori Pace, Denver Metro Association of Realtors Peter Muccio, Apartment Association of Metro Denver Stephen Shepard, Denver Metro BOMA
Utility/Oil and Gas	Tyler Smith, Xcel Energy Sam Knaizer, bp, bpx energy Scott Prestidge, Colorado Oil and Gas Association
Residents/Tenants/ Non-Profit Representatives	Aaron Martinez, Urban Land Conservancy Angela Fletcher, Denver Housing Authority Jennifer Gremmert, Energy Outreach Colorado Jonathan Cappelli, Neighborhood Development Collaborative
Labor/Workforce Training	Eddie Bustamante, LiUNA! Local 720 Jennie Gonzales, IBEW 68 Sergio Cordova, Pipefitters Local Union No. 208
Environment/ Clean Energy	Ariana Gonzalez, Natural Resources Defense Council Celeste Cizik, Group 14 Engineering Christine Brinker, Southwest Energy Efficiency Project (SWEEP) Jenny Wilford, Colorado Sierra Club Mike Kruger, Colorado Solar and Storage Association (COSSA) Monique Dyers, Ensight Energy Consulting Steve Morgan, Bolder Energy Engineers, Rocky Mountain Assocx of Energy Engineers
City Council	Jolon Clark, Denver City Council District 7

The Energize Denver Task Force is focused on existing commercial and multifamily buildings 25,000 SF and larger.

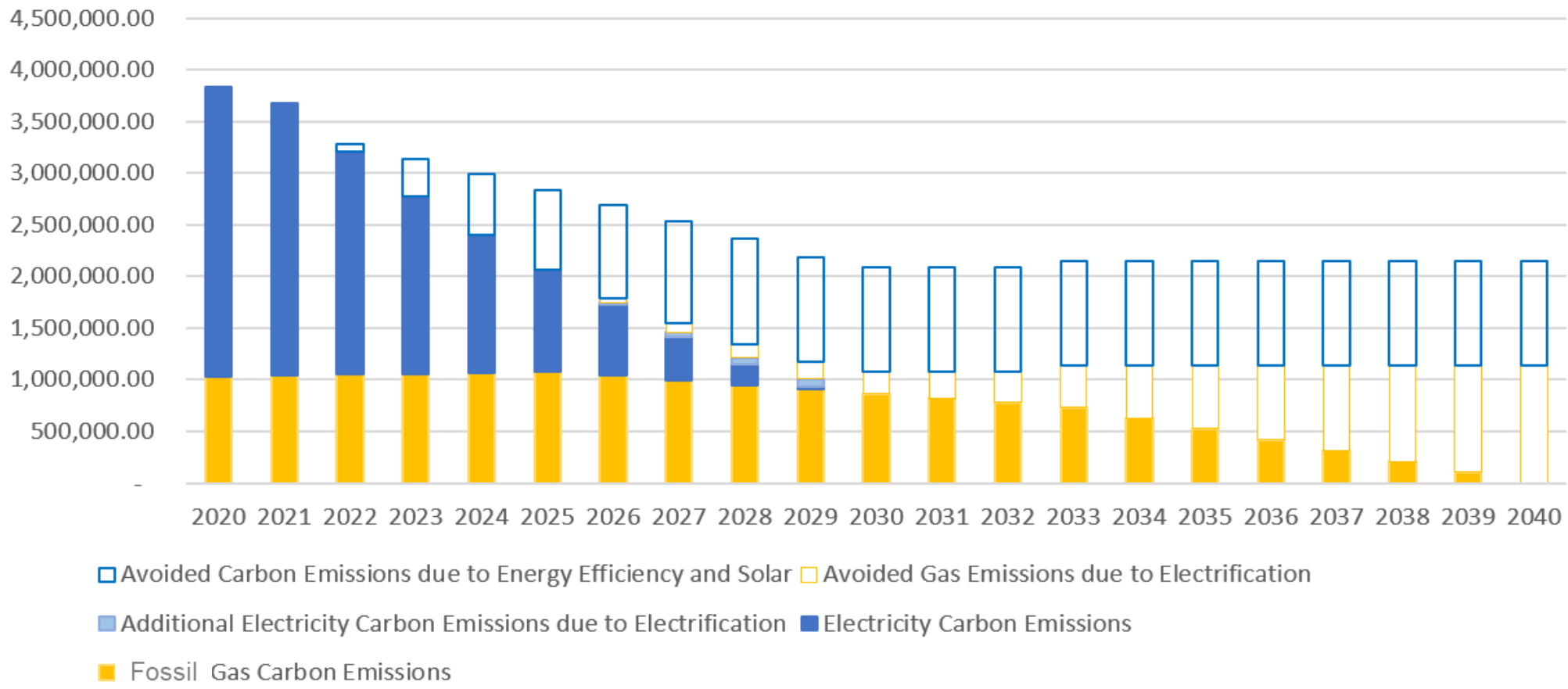
Not single-family homes

Task Force Draft Schedule

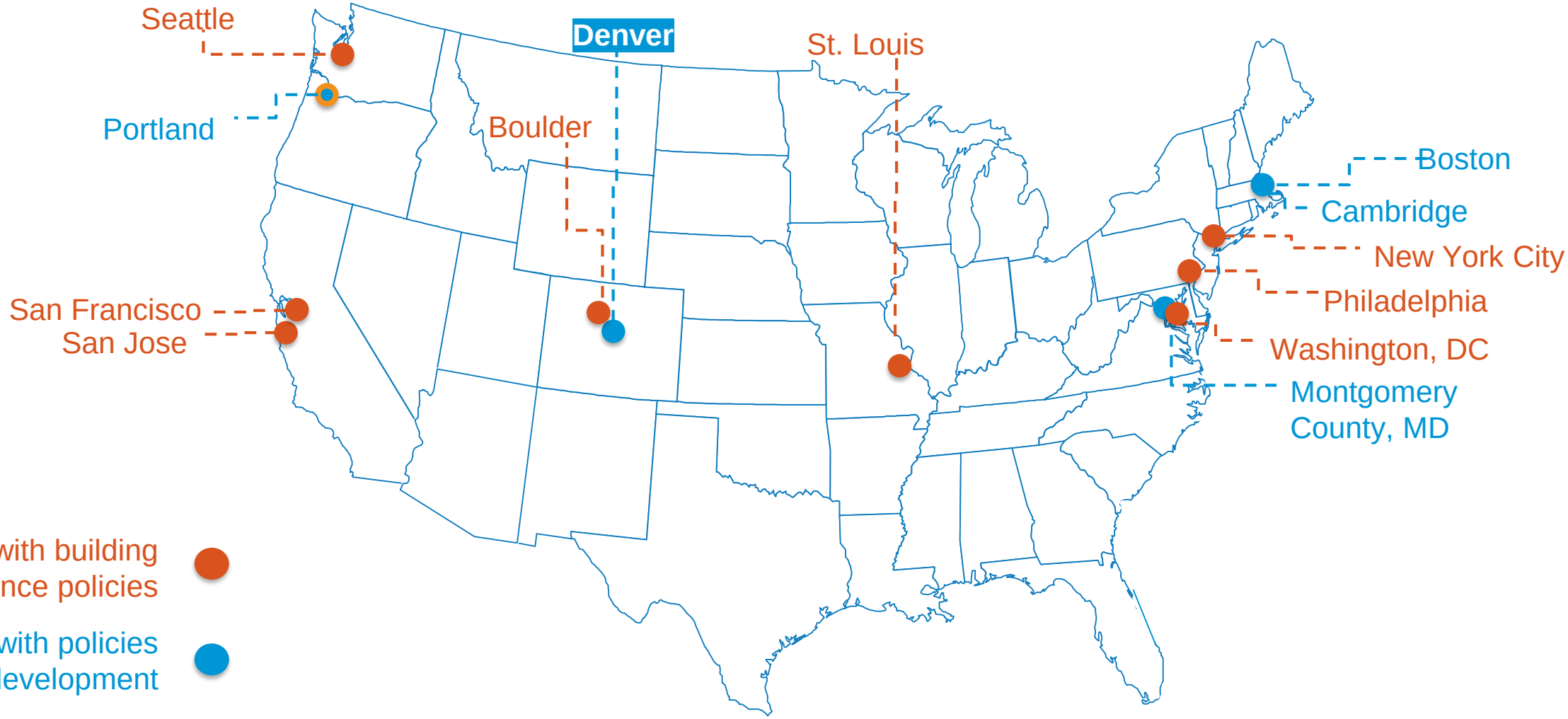
- **Meeting 1** Introductions, Guiding Principles, Scope
- **Meeting 2** Equity Workshop
- **Meeting 3** Review Approaches, Resources, and Shape the Process
- **Meetings 4&5** Energy Efficiency and Renewable Electricity
- **Meeting 6&7** Electrification and Heating Emission Reductions
- **Meeting 8** How it all comes together

Workgroups:
Equity Workgroup
Workforce Workgroup
Climate Solutions Workgroup

Goal of the Task Force: NZE by 2040



Building Performance Policies in Other Cities



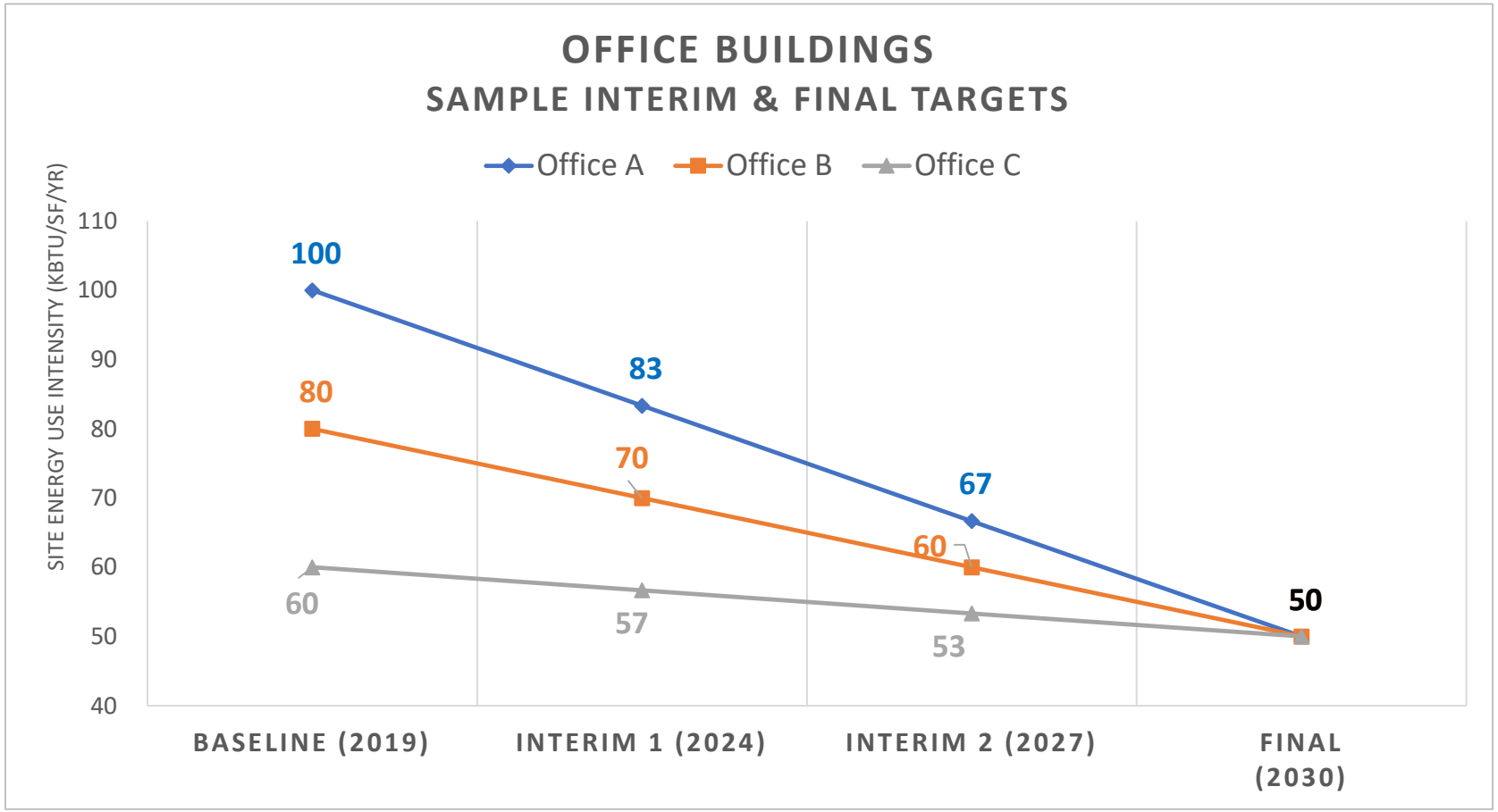
Energy Efficiency and Renewable Energy

DRAFT policy recommendations

30% Improvement in Energy Performance by 2030

- All buildings over certain **size** covered 25,000 sq ft
- Long-term **performance target** created for each building type, measured through Energy Use Intensity (**EUI**)
- Required **interim** targets for 2024 and 2027 set for **each building**, by drawing straight line from the building's baseline EUI to final EUI target
- **Solar** on-site fully credited towards energy use, directly lowering a building's net EUI
- Credit for **high performers**: the 15% of buildings that already meet the target EUI for that building type (or better) need no further action

30% Improvement in Energy Performance by 2030



Alternate Compliance Options

1. Request different **compliance timeline**
2. Adjust **end goal**
3. **Prescriptive** Option: for 25,000-100,000 sq ft buildings
4. Manufacturing/Agriculture: Rules to be developed by manufacturing and agricultural stakeholders to achieve 30% savings by 2030 across this sector.

Incentives, Supports and Outreach

- Performance **Portal**
- Web **Resources**
- **Materials**: how-to guide, check lists
- Targeted **Outreach** and **Education**
- **Technical** Assistance
- **Financial** Assistance
- Community **Engagement**
- Recognition/awards

Extra Support Provided for Under Resourced Buildings

1. Additional technical assistance – energy assessments and one on one consultative services.
2. Additional Financial Assistance
   a. Incentives to achieve cost parity relative to gas systems
   b. Additional project funding/subsidy by verification

Renewable Heating and Cooling (Electrification)

DRAFT policy recommendations

Policy and Incentive Phase

Step 1

- Incentives for Electrification Schematic Design and Costs

Step 2

- Permitting Ease Equal: Make the permitting process equal because permitting a heat pump is harder than gas system today.
- Incentives for Heat Pumps for All Buildings

Step 3

- Require heat pumps when systems are replaced.
- Incentives for Heat Pumps for only Under resourced Buildings

Furnaces, RTUs, Individual Systems with Tanks, Gas Point of Use

Building Heating System	2022	2023	2025
Gas Furnace	Step 1: Pay for electrification schematic design	Step 2: Incentivize heat pump replacements. Permitting Ease Equal	Step 3: Heat pumps required as the primary heating source (with fossil gas back-up allowed for space heat, and electric resistance allowed for point of use). Incentives only for under resourced buildings.
RTU			
Individual System with Tank			
Gas Point of Use System			
Total			

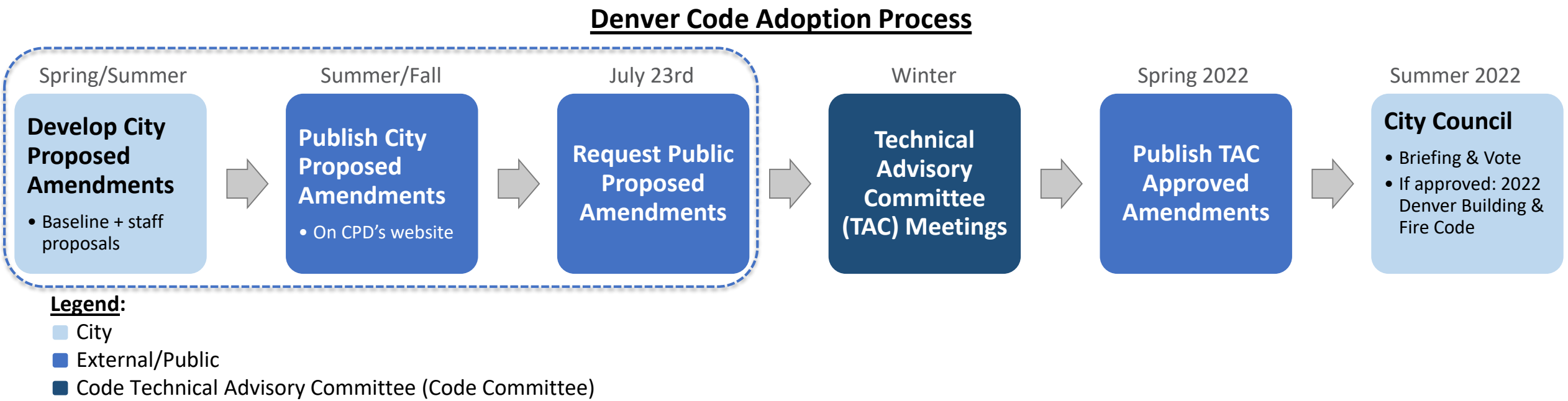
PTACs, Boilers, Central Hot Water

Building Heating System	2023	2024	2025	2027 (or when partial electrification nears cost parity)
PTAC's	Step 1: Pay for electrification schematic design and costs	Step 2a: Incentivize heat pump replacements for PTACs, and electrification options for boilers and central systems with a tank.	Step 2b: Permitting Ease Equal	Step3: PTAC: Heat pumps (PTHP) required as the primary heating source (with fossil gas back-up allowed). Boilers and central systems: Have to convert, at least partially, to heat pumps if they can, and if no heat pump for your application then not required. Incentives only for under resourced buildings to meet requirements.
Boilers				
Central System with Tank				
Total				

Net Zero Energy New Buildings

2021-22 Code Update

Denver Code Adoption Process

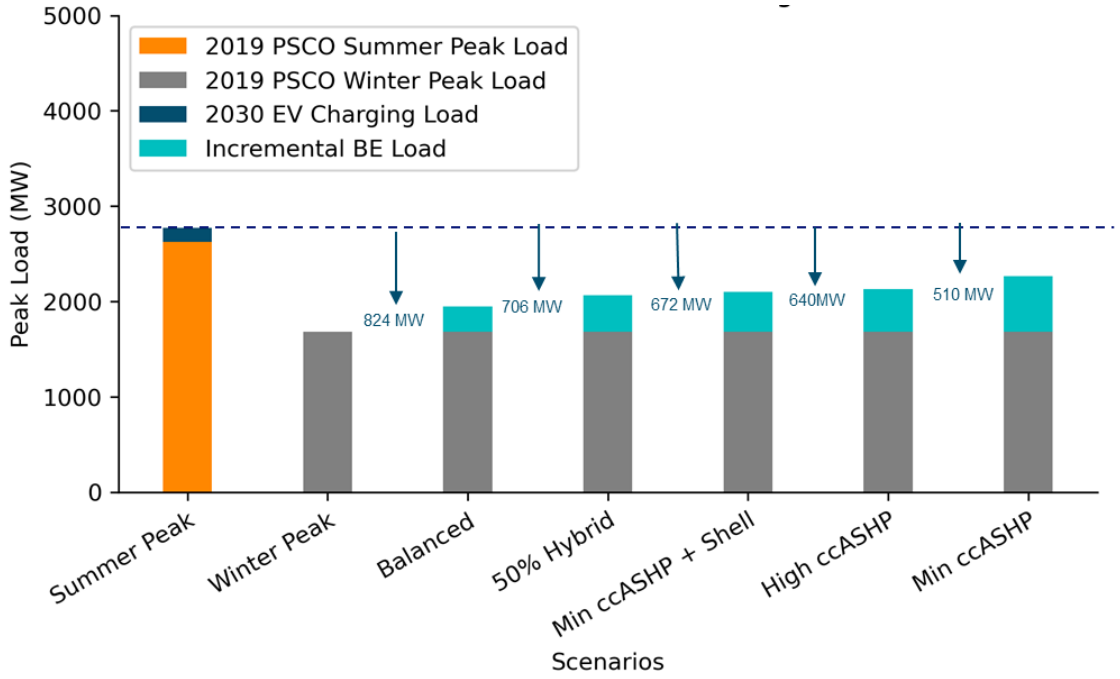


Thank you!

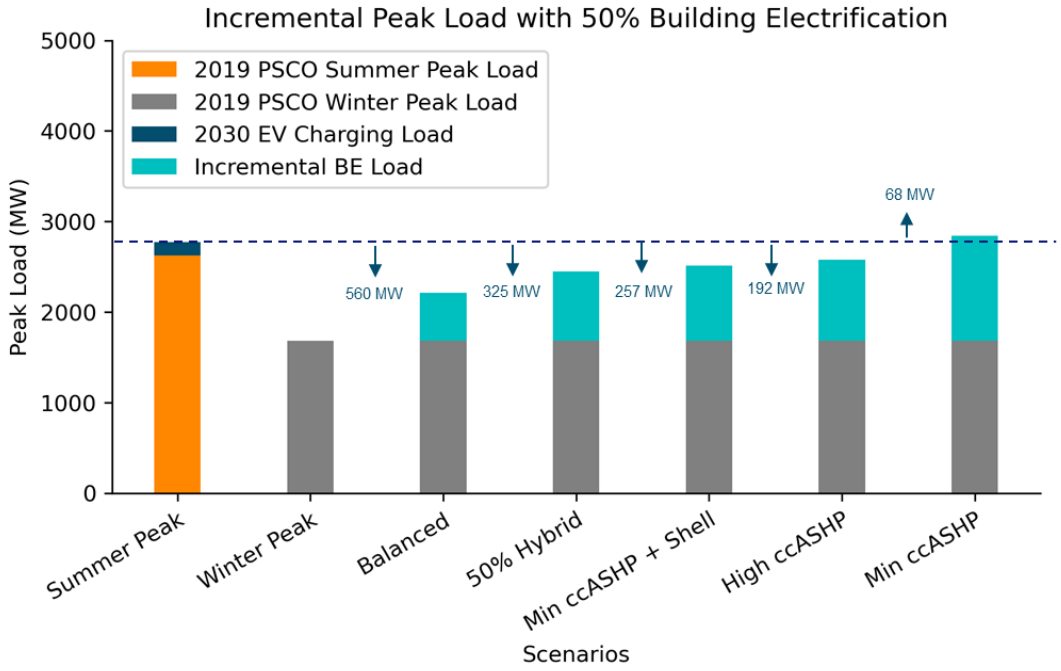
Appendix

Grid Analysis

25% Building Electrification (2030 or beyond)

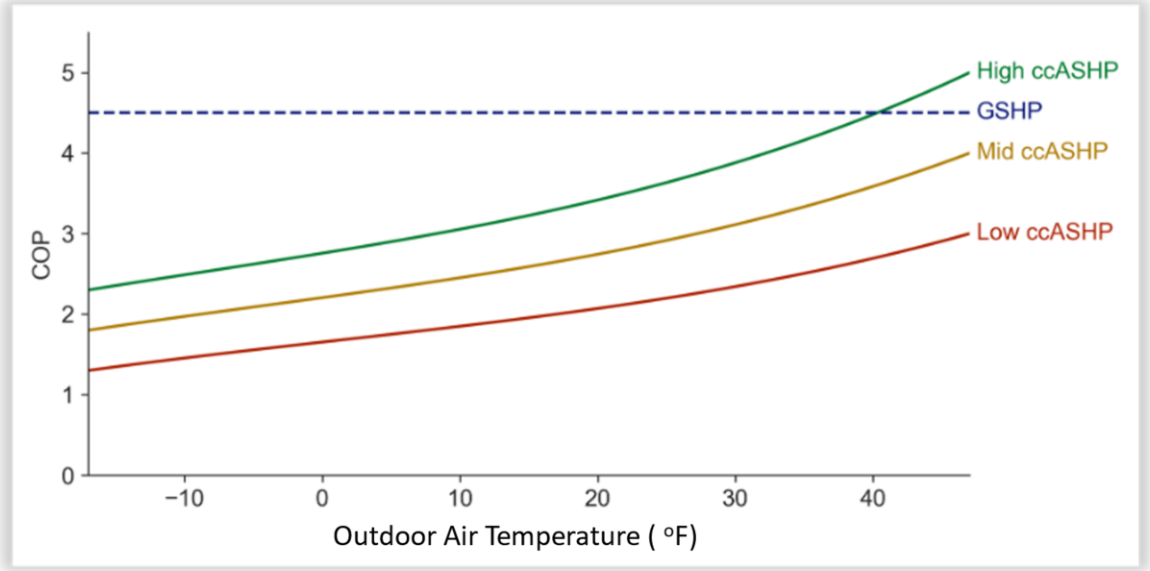


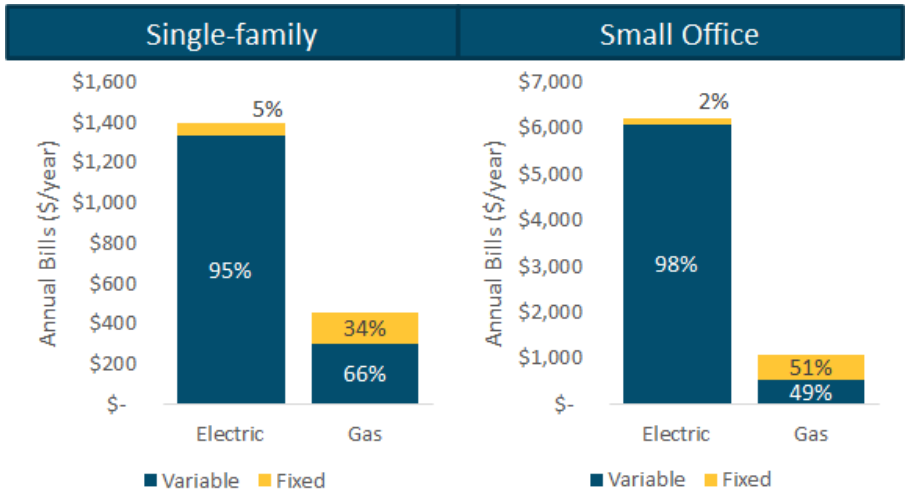
50% Building Electrification



Key considerations

- Heat pump efficiency increases with outdoor temperature
- Avoiding electric resistance saves on both capital and operating costs
- Either natural gas or electric resistance can kick in to support heat pump





Non-fossil gas alternatives

- Biogas - limited supply (5-10%)
- Hydrogen – can be blended with gas up to 7% of pipeline mix (requires excess renewables)
- Synthetic gas – to meet EDTF climate goals would be 4x cost of fossil gas

End to end efficiency

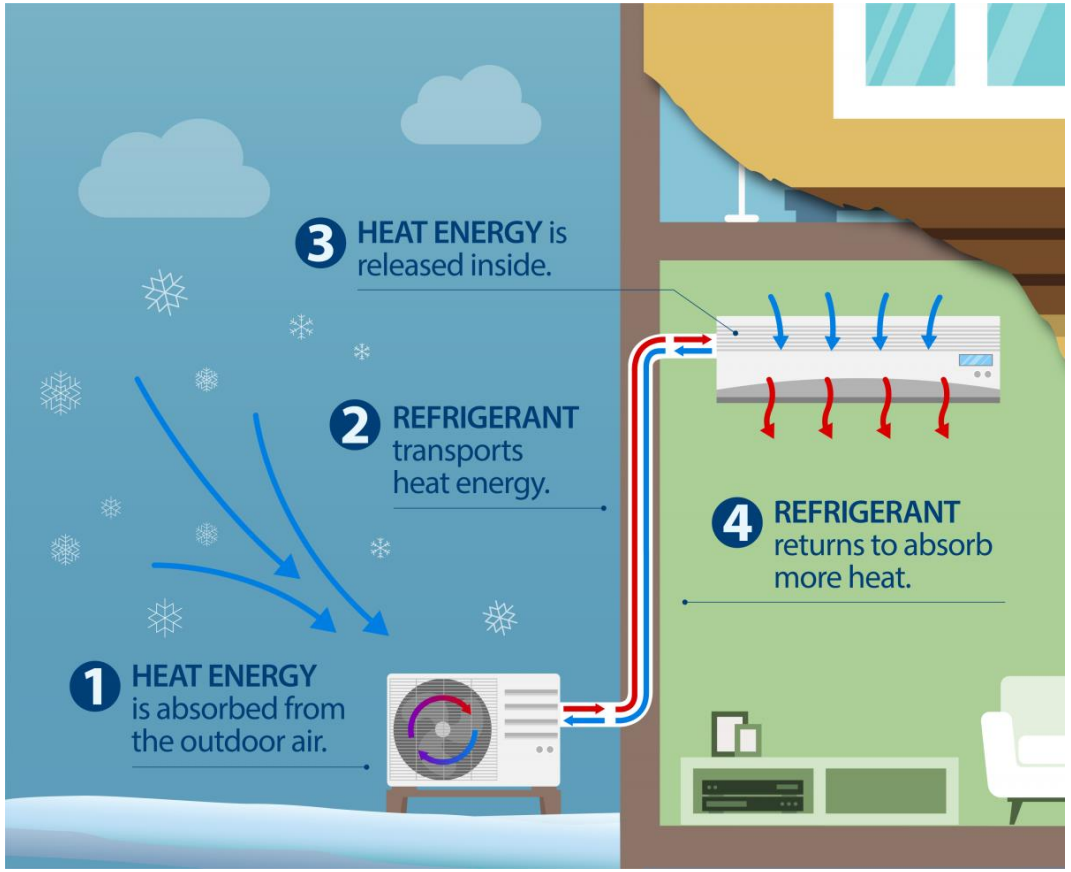
	Syn-gas	Heat pump
Generation	64%	100%
	↓	↓
Distribution	98%	95%
	↓	↓
End use	90%	250%
	=	=
Total efficiency	56%	235%

Electrification Typologies

Space Heating Typologies

	Partial Electrification		Full Electrification	
	Capital Cost	Operating Cost	Capital Cost	Operating Cost
Furnace				
Rooftop Unit				
PTAC				
Boiler				

Space Heating



Space Heating Typology 1: Furnace
14% Commercial, 48% of Denver's multifamily square footage

Small commercial spaces or multifamily buildings can utilize either a **ducted** or **ductless** heat pump in place of a furnace, and benefit from either **full** electrification or **partial** electrification packages

Space Heating Typology 1: Furnace

	Partial Electrification		Full Electrification	
	Ducted (<20F gas backup)	Mini-split (<15F gas backup)	Ducted	Mini-split
Installation Cost relative to like-for-like	5%-18%	0-8.5%	35%-60%	15-30%
Energy Bills	0%	-4.5%	5%	5%
Gas reduction	70%	82%	100%	100%
EUI reduction	24%		30%	

Space Heating Typology 2: RTUs

37% Commercial square footage

Medium sized commercial spaces can swap out their Rooftop units (RTUs) for either fully electrified heat pump models or heat pump based models that contain a gas furnace that can serve heating below 15 degrees F

Space Heating Typology 2: RTUs

	Partial Electrification	Full Electrification
Installation Cost relative to like-for-like	0-12%	50-72%
Energy Bills	0%	-5%
Gas reduction	81% @ 15F	100%
EUI reduction	24%	30%

Common in hotels, and multifamily buildings, PTACs (packaged terminal air conditioners) provide both heating and cooling at the terminal unit. PTHP (packaged terminal heat pumps) can serve both heating and cooling needs more efficiently

Space Heating Typology 3: PTACs

3% Commercial, 21% of Denver's multifamily square footage

Space Heating Typology 3: PTACs

	Partial Electrification	Full Electrification
Installation Cost relative to like-for-like	78%	98%
Energy Bills	-10%	12%
Gas reduction	58% @ 15F	100%
EUI reduction	21%	24%

Space Heating Typology 4: Boilers

12% of Denver's commercial square footage

Large commercial buildings utilize a centralized heating and cooling system with a dedicated chiller and boiler. Existing gas boilers can be replaced with electric boilers,

Space Heating Typology 4: Boilers

	Full Electrification
Installation Cost relative to like-for-like	66%
Energy Bills	19%
Gas reduction	100%
EUI reduction	24%

Water Heating

Water Heating Typologies

- Typology 1: Individual system with tank. (96% of single family and multi-family residences)
- Typology 2: Central system with tank. (84% of commercial space)
- Typology 3: Gas point of use system. (39% of commercial space)

Water Heating Typology 1: Individual System with Tank

14% Commercial, 48% of Denver's multifamily square footage

Small commercial spaces or some multifamily buildings can benefit from a heat pump water heater to replace their existing gas water heater

Water Heating Typology 1: Individual System with Tank

	Full Electrification
Installation Cost relative to like-for-like	0-48%
Energy Bills	1%
Gas reduction	100%

Water Heating Typology 2: Central System with Tank

84% Commercial, 96% of Denver's multifamily square footage

A large central system can be electrified using a central tanked HPWH with additional electric resistance heating elements to satisfy periods of increased hot water demand

Water Heating Typology 2: Central System with Tank

	Full Electrification
Installation Cost relative to like-for-like	7-20%
Energy Bills	4%
Gas reduction	100%

Water Heating Typology 3: Point of Use

39% of Denver's Commercial square footage

Some buildings do not pipe domestic hot water through the building like other building typologies, and instead rely on point-of-use tankless water heating.

Water Heating Typology 3: Point of Use

	Full Electrification
Installation Cost relative to like-for-like	30-45%
Energy Bills	5%
Gas reduction	100%