

Community-specific Cost-benefit Evaluation Framework for Beneficial Electrification

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Objective	▪ Direction for Fort Collins and Longmont to support climate goals
Problem Statement	▪ How do we select/prioritize building electrification measures?
Proposed Solution	▪ Jurisdiction-specific benefit-cost analysis of measures
Road Map	▪ Phased approach of education, program design, and policy steps



Aspirational community carbon and energy goals

Fort Collins – Our Climate Future

- 80 % greenhouse gas (GHG) emissions reduction goal by 2030
- 100% renewable electricity goal by 2030
- 20+ year commitment to Climate Action, focusing on Mitigation, Resilience, Equity

Longmont

- 66% GHG emissions reduction goal by 2030
- 100% renewable electricity goal by 2030
- Climate Action Recommendations Report and Building Electrification Plan

Opportunity: Buildings make up ~66% of GHG emissions in Fort Collins and ~80% in Longmont

Challenge: Affordably decarbonize buildings



2040 building greenhouse gas emissions

Residential end uses make up about 75% of building gas consumption.

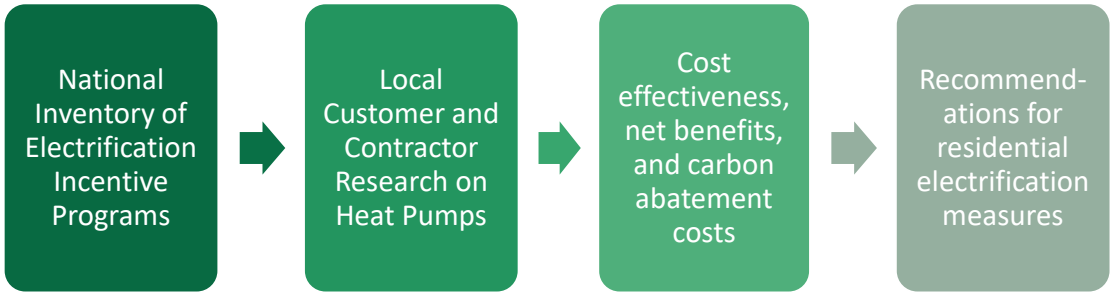
End Use	Existing/New	% of 2040 Residential GHG Emissions
Space heating	**Existing**	**52%**
Space heating	New	23%
Water heating	Existing	16%
Water heating	New	6%
Other	Existing	2%
Other	New	1%

Focus on <u>existing residential space heating</u>

- Progress toward community GHG emissions reduction goals
- Build in future grid flexibility
- Good place to start!



Research approach





Development of community test

Problem

- Building electrification is different because electricity consumption increases
- Traditional benefit-cost approaches not great for our context

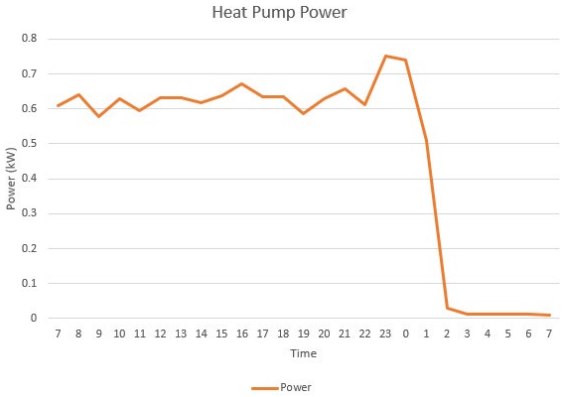
Solution

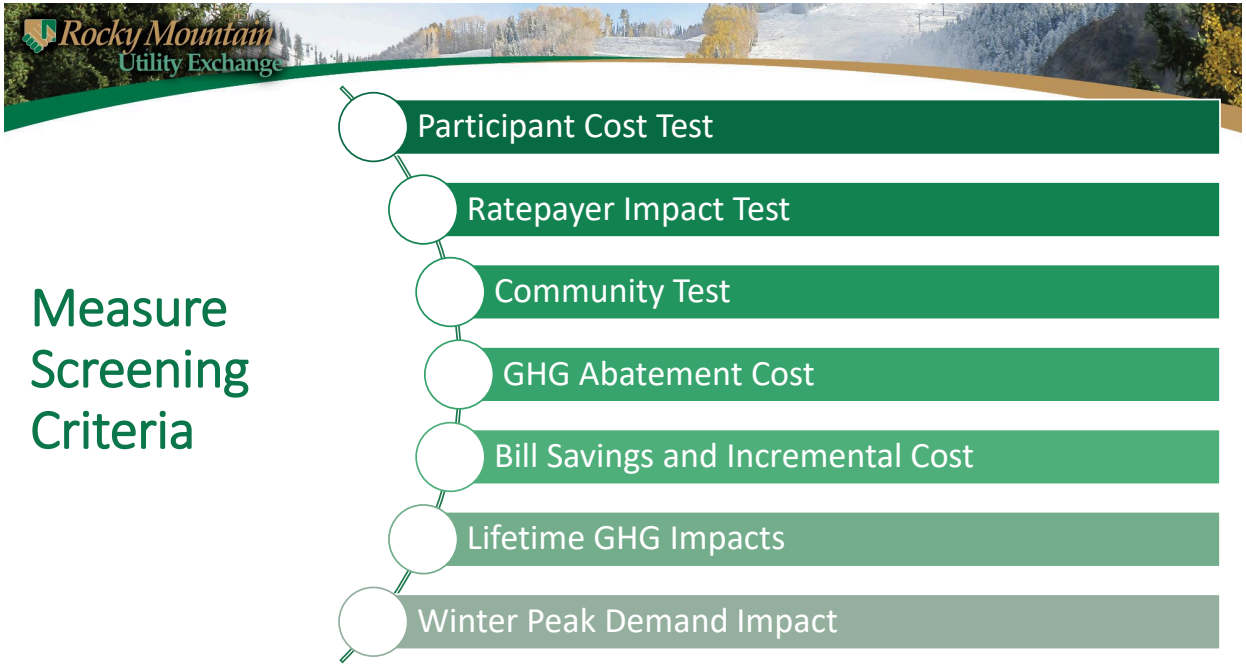
- Follow National Standard Practice Manual (NSPM) guidance for jurisdiction-specific test
- Work with stakeholders to agree on what to include

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How do we keep people warm during extremely cold weather?

- Capacity of heat pumps drops
- Hybrid heat pumps use existing gas furnace (0 grid impacts)
- Full electrification heat pumps use electric resistance (10 kW+/home)




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Measure Screening Criteria
Participant Cost Test
Ratepayer Impact Test
Community Test
GHG Abatement Cost
Bill Savings and Incremental Cost
Lifetime GHG Impacts
Winter Peak Demand Impact

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Best opportunity: Replace burned out or new CAC with heat pump, leaving furnace for cold weather



VS



Pros: Only costs ~$200-$500 extra, saves 50-80% of load
Cons: Only applicable in situations where somebody was already buying a new CAC



Full displacement with electric resistance = expensive for the utility and ratepayers

- Fort Collins/Longmont will become winter peaking sometime in 2030s.
- Each additional kW of winter peak costs $100+/year to meet with gas combustion turbines
- **Present value of capacity cost for 10 kW electric resistance was calculated as $17,000. Electric resistance heat is still a bad idea.**

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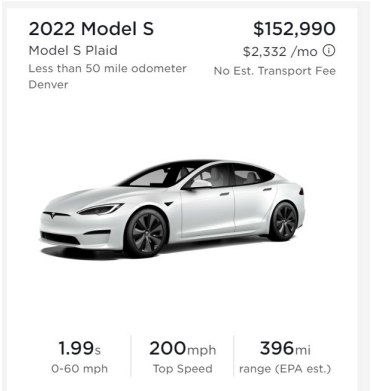
Adding heat pumps to homes with gas and without AC is a tough sell

There is no economic case to the customer with gas without the cooling benefits.

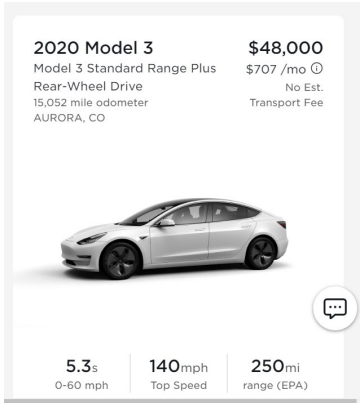


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Cold climate heat pumps cost A LOT



VS



Consider for 100% displacement, but still need to solve backup heat problem

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Phased recommendations

Phase 1:

Build market awareness, customer knowledge, and contractor capability

- *What would it take for contractors to almost always install a heat pump instead of an air conditioner?*
- Offer contractor training and downstream rebates for ALL heat pumps – not just cold climate
- Prioritize broad-based hybrid solutions

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Phased recommendations

Phase 2:

Throttle widespread adoption in most cost-effective applications

- Adopt codes for new construction
- Build midstream offerings (manufacturers/distributors)
- Improve heat pump economics through rate design

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Phased recommendations

Phase 3:

Push toward zero carbon

- Adopt codes for heat pumps/heat pump water heaters in all new installations
- Require all-electric new homes
- Could happen sooner outside of regular code review/adoption cycles



What's next...

- Program and incentive redesign and development
- Continued contractor training and engagement/customer education
- Continued Building Code evaluations for each community
  - Fort Collins zero carbon building code by 2030;
  - Boulder County Code Cohort recommendations for zero carbon new construction by 2030 in Longmont
- Distribution impacts study using transformer-level AMI
  - Inform Fort Collins Utilities' design standards, update 2023 Electric Capacity fees
- And IRA impacts…



Thank you! Enjoy the Exchange!

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Appendix & backup slides

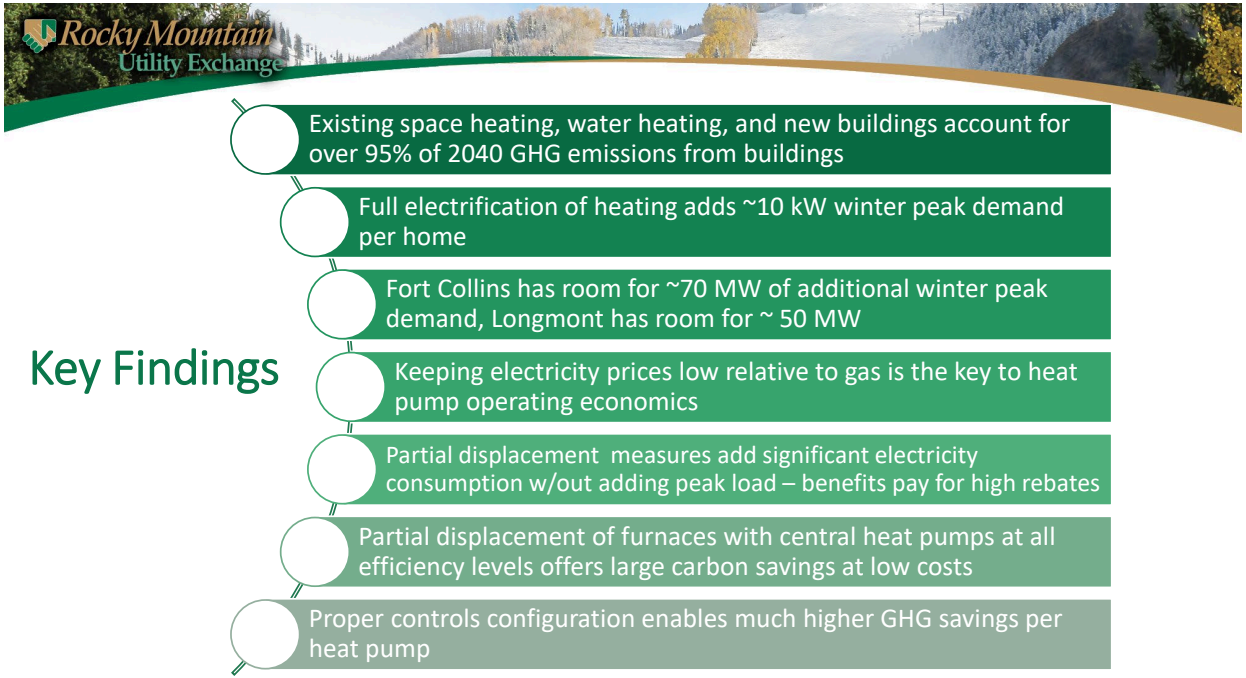


Market awareness: Contractors know something about heat pumps; customers do not!

Contractors:

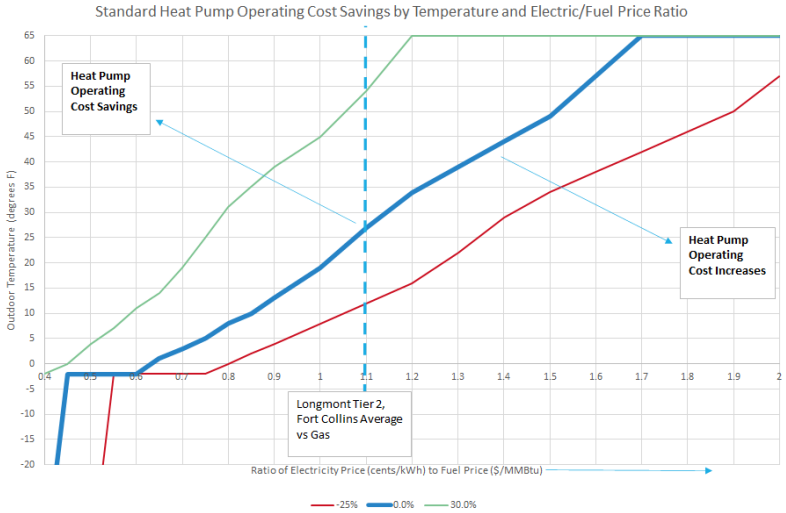
- Are aware of heat pump technology
- View heat pumps as opportunity
- Often recommend heat pumps for AC retrofits

- **Customers:**
  - 82% either not very or not at all familiar with heat pumps
  - Most replace equipment on failure and like-for-like (50% don't consider options)
  - Only 10% had contractors suggest heat pumps


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Key Findings
Existing space heating, water heating, and new buildings account for over 95% of 2040 GHG emissions from buildings
Full electrification of heating adds ~10 kW winter peak demand per home
Fort Collins has room for ~70 MW of additional winter peak demand, Longmont has room for ~ 50 MW
Keeping electricity prices low relative to gas is the key to heat pump operating economics
Partial displacement measures add significant electricity consumption w/out adding peak load – benefits pay for high rebates
Partial displacement of furnaces with central heat pumps at all efficiency levels offers large carbon savings at low costs
Proper controls configuration enables much higher GHG savings per heat pump

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Operating Cost-effectiveness





Existing Fossil Fuel Recommendations (near)

Focus on partial displacement heat pumps, water heating	Change heat pump/central AC rebates to promote heat pumps	Increase education and support
• No requirement for full electrification • No extra rebates for full electrification	• Stop incenting central AC; require heat pumps for central cooling efficiency rebates • Remove cold climate requirement for central heat pumps • Keep ductless rebates • Offer new base rebate (e.g. $500-1000) for ANY heat pump installed, regardless of efficiency or commissioning • Offer additional high efficiency rebate (e.g. $1000 more) for high efficiency heat pump with controls commissioning	• Provide customer education/support focused on key benefits, payback, and set expectations • Provide contractor training/support focused on promoting use of lower switchover temps • Provide customer education/support focused on heat pump operations (scheduling, maintenance, differences vs gas furnace)



Existing Fossil Heating Recommendations (med/long)

Medium-term

- Consider extra rebate incentives for early retirements of existing fossil equipment
- Develop low-income heating program
- Develop measures to incent use of proper controls to increase usage at colder temperatures (adding lockouts, lower switchover temps, etc.)

Long-term

- For 2028 code implementation cycle, require all central AC installations be heat pumps
- Develop additional offerings focused on full electrification based on improving technologies of various kinds



Measure Screening Details

PCT (Customer):

- Positive net benefits: customer comes out ahead w/out rebates, negative needs rebate to offset.
- For IQ, negative net benefit needs to be offset with incentive.

RIM (Ratepayer):

- Positive net benefits: ratepayer comes out ahead, negative is red flag
- Difference between Ratepayer – Customer = Max Incentive

Community:

- Includes emissions and non-energy benefits
- Positive net benefits: community comes out ahead

CO2 Abatement Cost:

- (Community Test without GHG)/(tons of GHG)
- Lower is cheaper; compare to $76 in community test

Total Bill Savings; Incremental Cost

- Annual bill savings net of fossil and electric impacts; Positive is good;
- Upfront incremental cost to customer

Winter Peak Demand Impact

- Winter peak impact in kW
- $1700/kW cost not included in other tests

Lifetime GHG Impacts

- Tons of CO2e saved over life of measure
- Results for measure implemented in 2022 with dropping electricity GHG impacts

Composite Measure Score

- 4/5 are high priority
- 3/2 are low priority or no impact
- 1 is to be avoided



Best opportunity: Replace burned out or new CAC with heat pump, leaving furnace for cold weather

Standard and medium efficiency HP with 30 degree switchover (50% displacement)

Measure	Type	PCT	RIM	Community	CO2 Abatement Cost	Total Bill Savings	Incremental Cost	Winter Peak Demand Impact	Lifetime GHG impacts (tons CO2e)	Composite Measure Score
14 SEER CHP | Gas furnace | CAC | CAC ROF | 50% Disp | Fort Collins	ROB	$ (380)	$ 1,236	$ 2,774	$ (90)	$ 12	$ 450	0	15.9	4
16 SEER CHP | Gas furnace | CAC | CAC ROF - HE | 50% Disp | Fort Collins	ROB	$ (196)	$ 1,111	$ 2,895	$ (93)	$ 29	$ 450	0	16.3	4
16 SEER CHP | Gas furnace | CAC | CAC ROF | 50% Disp | Fort Collins	ROB	$ (2,196)	$ 1,111	$ 1,095	$ 18	$ 29	$ 2,250	0	16.3	3

Standard and medium efficiency HP with 20 degree switchover (80% displacement)

Measure	Type	PCT	RIM	Community	CO2 Abatement Cost	Total Bill Savings	Incremental Cost	Winter Peak Demand Impact	Lifetime GHG impacts (tons CO2e)	Composite Measure Score
14 SEER CHP | Gas furnace | CAC | CAC ROF | 80% Disp | Fort Collins	ROB	$ (381)	$ 2,033	$ 4,738	$ (99)	$ 12	$ 450	0	25.8	4
16 SEER CHP | Gas furnace | CAC | CAC ROF - HE | 80% Disp | Fort Collins	ROB	$ 10	$ 1,777	$ 5,010	$ (103)	$ 49	$ 450	0	26.7	5
16 SEER CHP | Gas furnace | CAC | CAC ROF | 80% Disp | Fort Collins	ROB	$ (1,990)	$ 1,777	$ 3,210	$ (35)	$ 49	$ 2,250	0	26.7	4

We want people to use heat pumps as much as possible – better controls are key!



Adding heat pumps to homes with gas and without AC is not very cost-effective

Measure	Type	PCT	RIM	Community	CO2 Abatement Cost	Total Bill Savings	Incremental Cost	Winter Peak Demand Impact (kW)	Lifetime GHG impacts (tons CO2e)	Composite Measure Score
14 SEER CHP | Gas furnace | No AC | RET | 50% Disp | Fort Collins	RET	$ (9,082)	$ 2,572	$ (1,839)	$ 217	$ (105)	$ 7,200	0	14.0	2
16 SEER CHP | Gas furnace | No AC | RET | 50% Disp | Fort Collins	RET	$ (10,932)	$ 2,405	$ (3,264)	$ 315	$ (90)	$ 9,000	0	14.2	2
CC CHP | Gas furnace | No AC | RET | 50% Disp | Fort Collins	RET	$ (13,542)	$ 2,073	$ (5,382)	$ 444	$ (52)	$ 11,700	0	15.0	2
14 SEER CHP | Gas furnace | No AC | RET | 80% Disp | Fort Collins	RET	$ (9,084)	$ 3,369	$ 124	$ 80	$ (105)	$ 7,200	0	23.9	3
16 SEER CHP | Gas furnace | No AC | RET | 80% Disp | Fort Collins	RET	$ (10,542)	$ 2,946	$ (1,029)	$ 126	$ (52)	$ 9,000	0	25.1	3

- Adding heat pumps to homes without AC generally has poor customer and community economics.
- Homes with propane would have a different



Cold climate heat pumps cost A LOT

Measure (Efficient name | Baseline heat name | Baseline cool name | Upgrade type | Displacement Case | City Name)	PCT	RIM	Communi	CO2 Abatement Co	Total Bill Saving	Incremental Co	Winter Peak Demand Impact (kW)	Lifetime GHG impacts (tons CO2e)	Composite Measure Score
CC CHP | Gas furnace | CAC | CAC ROF | 50% Disp | Fort Collins	$ (5,140)	$ 1,071	$ (1,572)	$ 181	$ 35	$ 4,950	0	16.4	2
CC CHP | Gas furnace | CAC | CAC ROF | 80% Disp | Fort Collins	$ (5,027)	$ 1,800	$ 482	$ 67	$ 46	$ 4,950	0	26.6	3
CC CHP | Gas furnace | CAC | CAC ROF | 100% Disp | Fort Collins	$ (6,112)	$ 2,337	$ 713	$ 63	$ 38	$ 5,850	10	32.4	1

- Economics are not very good
- Provide benefits, but incremental cost is much higher, sinking participant economics
- Consider for 100% displacement, but still need to solve backup heat problem



Adding heat pumps to propane-heated homes with boilers = mixed economics

Measure	Type	PCT	RIM	Community	CO2 Abatement Cost	Total Bill Savings	Incremental Cost	Winter Peak Demand Impact (kW)	Lifetime GHG impacts (tons CO2e)	Composite Measure Score
CC DHP | Gas boiler | Cooling blend | RET | 50% Disp | Fort Collins	RET	$ (13,391)	$ 1,906	$ (5,487)	$ 446	$ (38)	$ 11,700	0	15.2	3
CC DHP | Gas boiler | Cooling blend | RET | 80% Partial Disp | Fort Collins	RET	$ (13,279)	$ 2,635	$ (3,432)	$ 220	$ (27)	$ 11,700	0	25.4	3
CC DHP | Gas boiler | Cooling blend | RET | 100% Full Disp | Fort Collins	RET	$ (15,363)	$ 3,172	$ (4,102)	$ 216	$ (35)	$ 13,500	10	31.2	1
CC DHP | Gas boiler | Cooling blend | ROF/New Central Cooling | CC DHP | 100%	ROB	$ (10,363)	$ 3,172	$ 398	$ 72	$ (35)	$ 9,000	10	31.2	1
CC DHP | Propane boiler | Cooling blend | RET | 50% Disp | Fort Collins	RET	$ (9,725)	$ 1,906	$ (395)	$ 104	$ 312	$ 11,700	0	20.4	3
CC DHP | Propane boiler | Cooling blend | RET | 80% Partial Disp | Fort Collins	RET	$ (7,185)	$ 2,635	$ 5,030	$ (63)	$ 555	$ 11,700	0	34.0	4
CC DHP | Propane boiler | Cooling blend | RET | 100% Full Disp | Fort Collins	RET	$ (7,803)	$ 3,172	$ 6,397	$ (68)	$ 687	$ 13,500	10	41.8	1
CC DHP | Propane boiler | Cooling blend | ROF/New Central Cooling | CC DHP |	ROB	$ (2,803)	$ 3,172	$ 10,897	$ (175)	$ 687	$ 9,000	10	41.8	1

- A cold-climate ductless heat pump displacing propane boiler usage has poor participant economics (but maybe not so bad after the Inflation Reduction Act!)
- Other economics are strong



Adding heat pumps to propane-heated homes with boilers = mixed economics

- A cold-climate ductless heat pump displacing propane boiler usage has mixed participant economics (but maybe not so bad after the Inflation Reduction Act!)
- Other economics are strong