Gas to Geo
Policy Pathway in Massachusetts

Zeyneb Magavi | December 2023

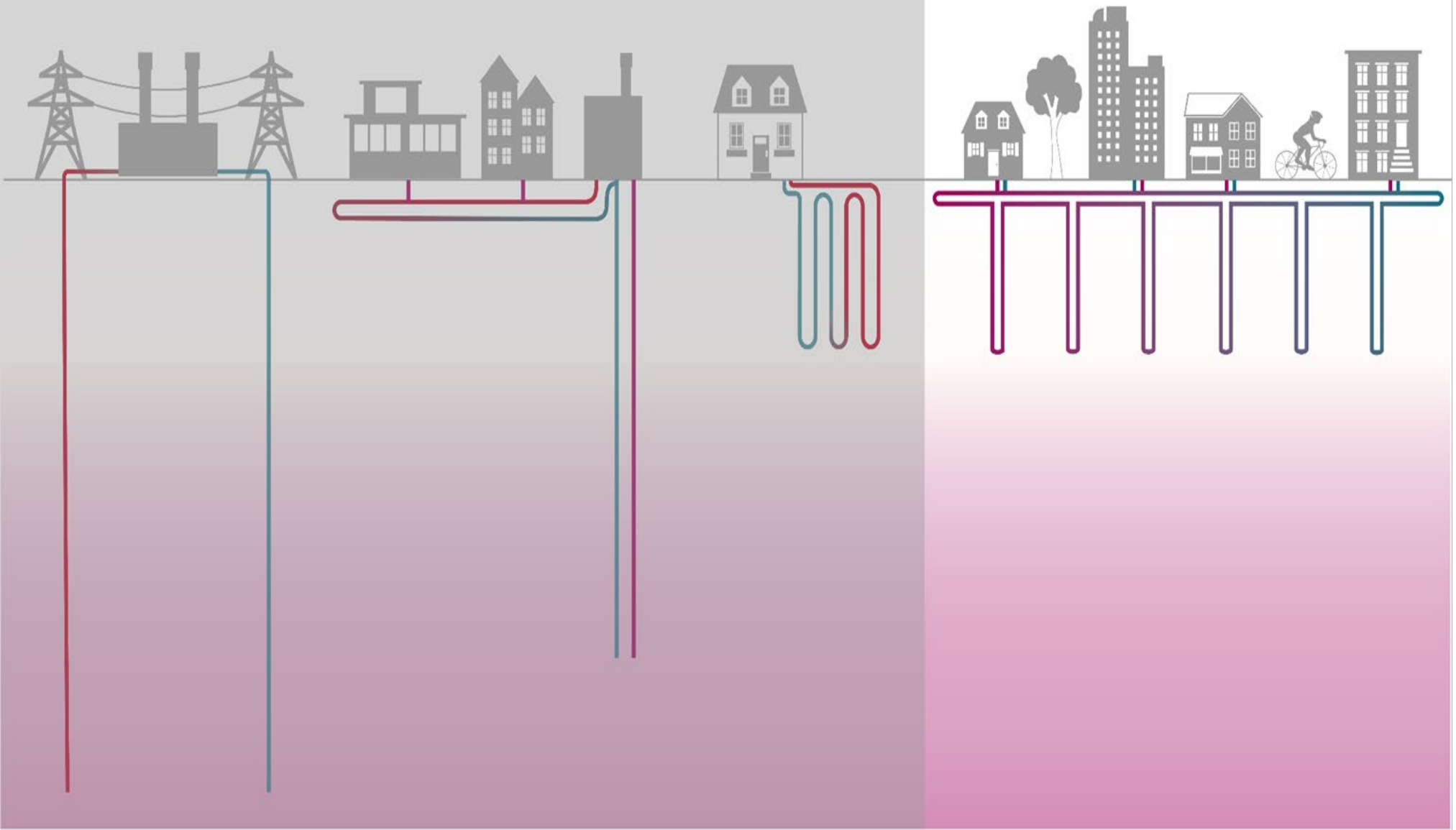
ENERGY FOUNDATION
building a new energy future
Barr Foundation
PUTNAM FOUNDATION
MASSACHUSETTS CLEAN ENERGY CENTER
E4 THE FUTURE
WINSLOW FOUNDATION

Geo Power
(electricity)

Geo District
(heat or cogen)

Geo Building
(heating & cooling)

Geo Network
(heating & cooling)



Geothermal Energy Technologies provide STABLE non-intermittent energy

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BUILDINGS :
(GROUND SOURCE HEAT PUMP)

THERMAL NETWORK

THERMAL SOURCES & SINKS :

- GEOEXCHANGE (BOREHOLES, ETC)
- WASTEWATER EXCHANGE
- INDUSTRIAL WASTE HEAT
- A MILLION OTHER THERMAL OPPORTUNITIES . . .

What's in a Geothermal Network ?

EFFICIENCY layers:

- GSHP
- Load Canceling
- Load Shifting
- Energy Storage
- Scale
- Management

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Growing a Geothermal Network to Scale

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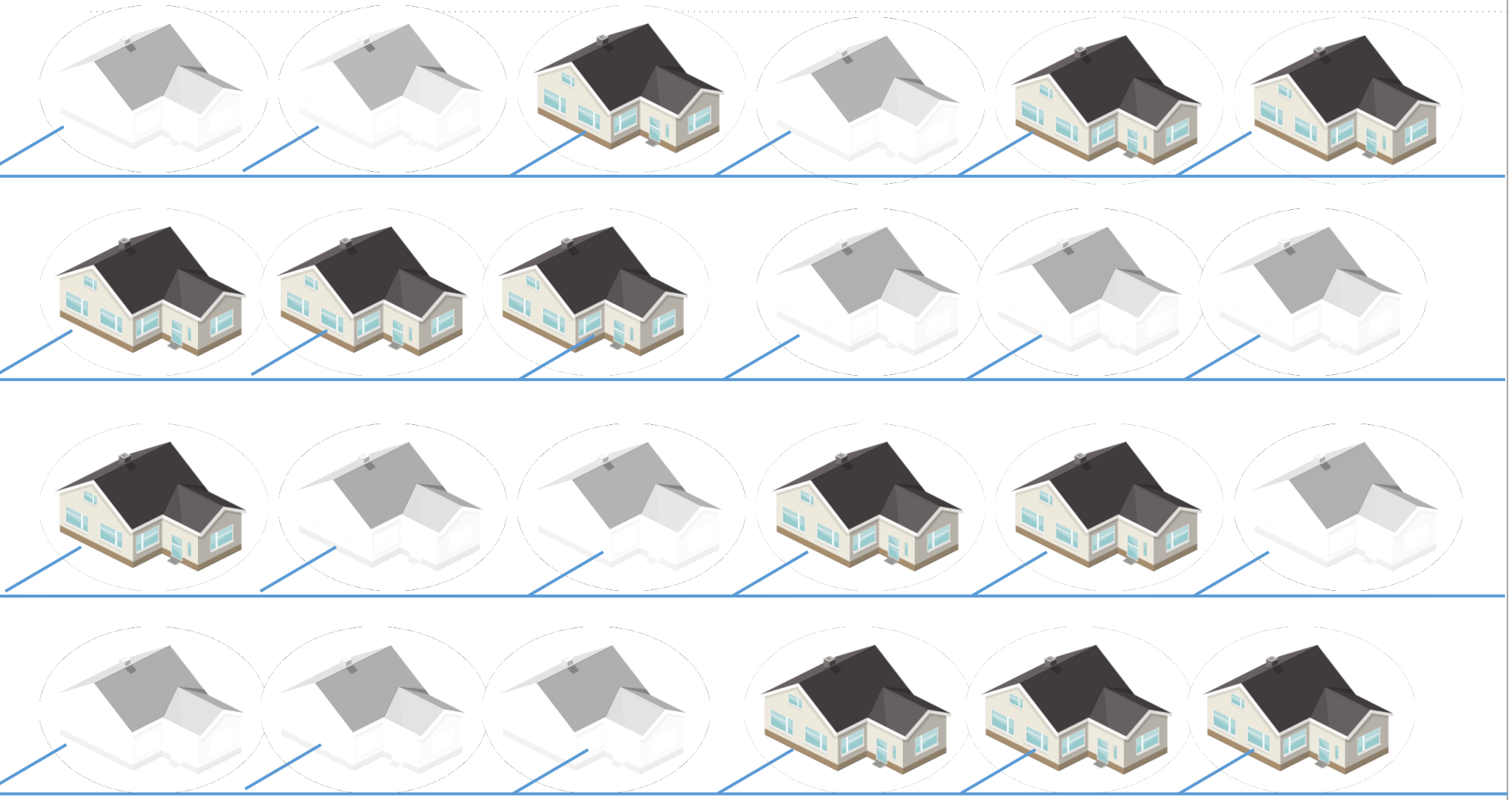

Building by Building Electrification off of gas network

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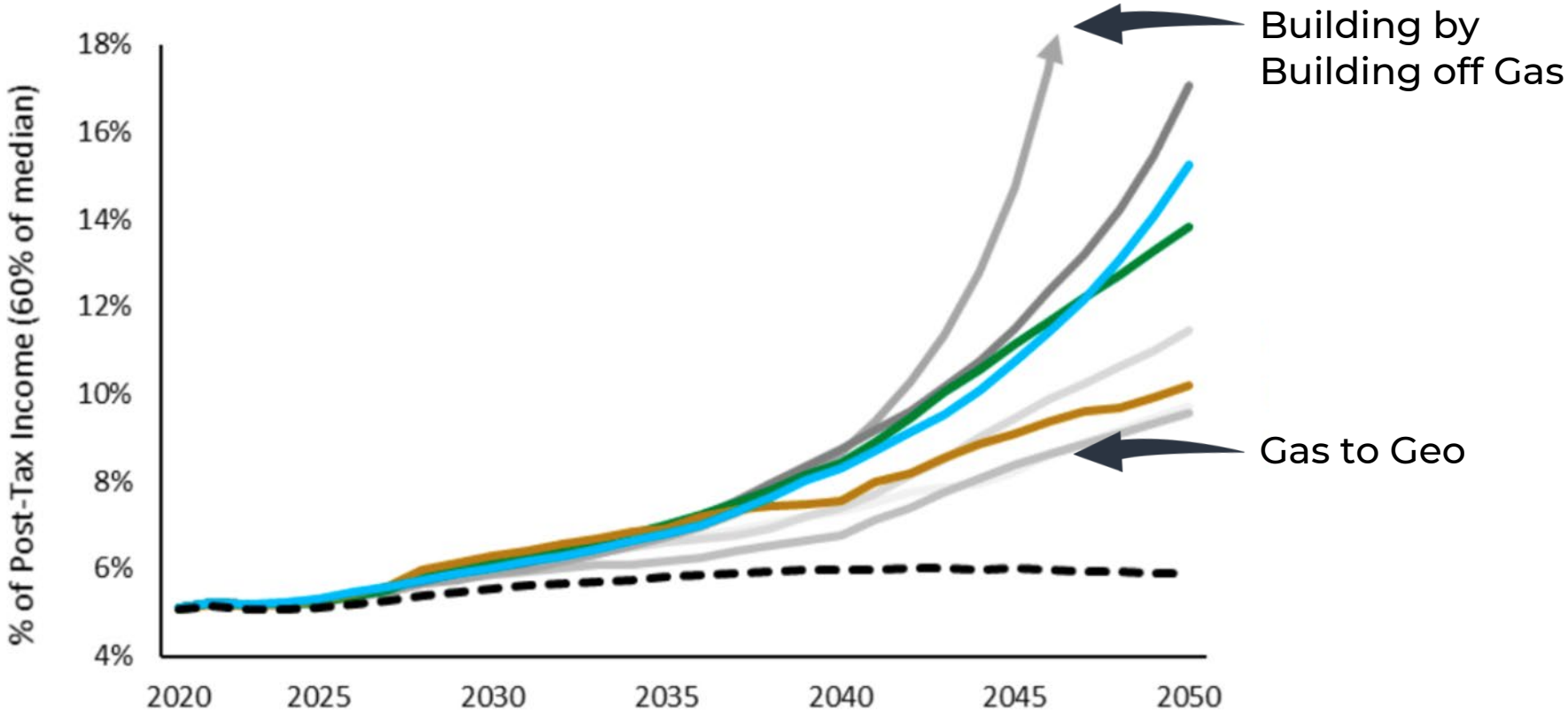
Future Energy Burden for Low-Income Customers



Source: E3, Report for Massachusetts Gas Utilities, 2022

A Gas to Geo pathway can minimize energy burden for the low-income

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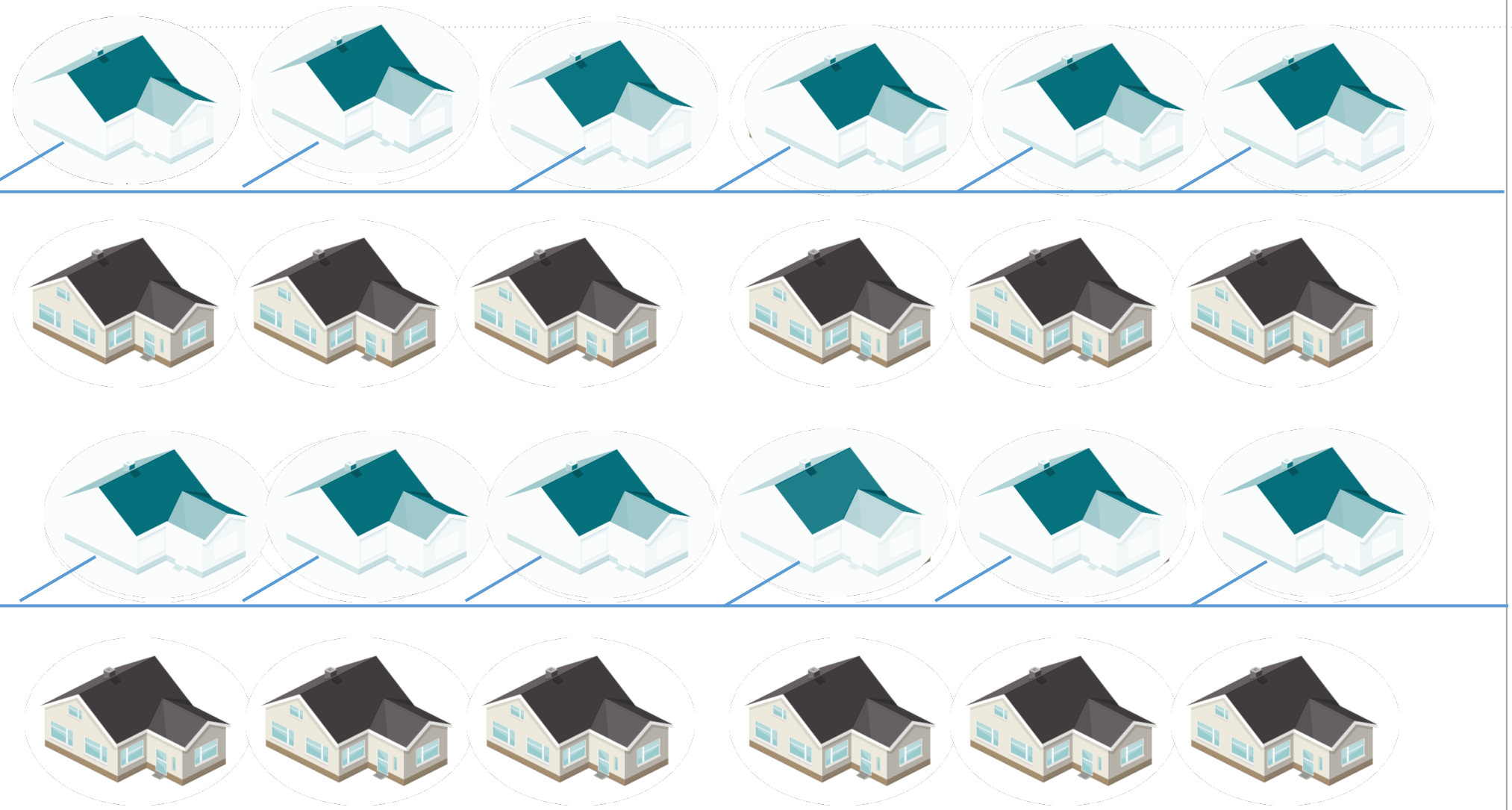

Gas to Geo ‘Zonal Electrification’:

Customers stay with utility, energy bills stay low

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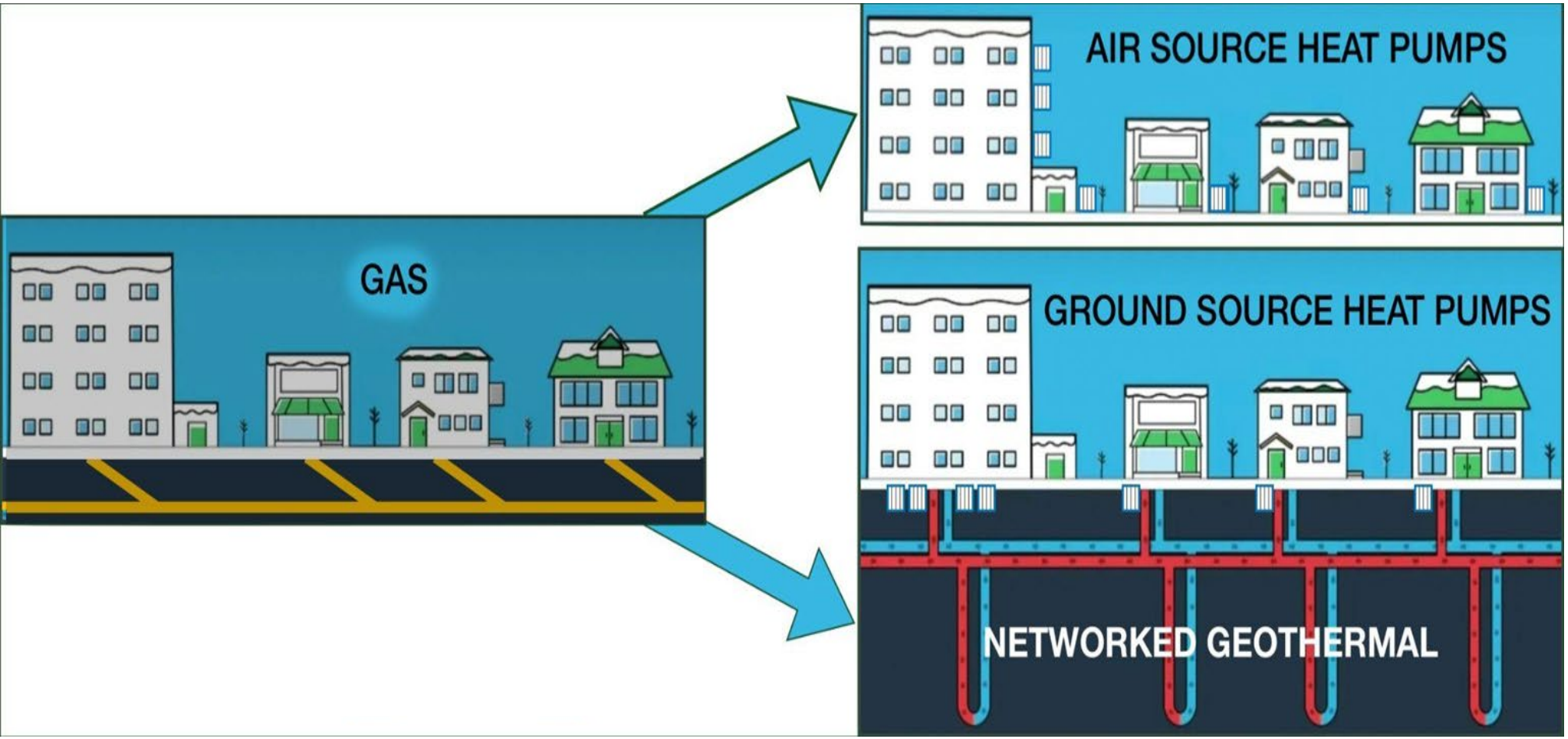

Gas Utility pipe segments can transition multiple ways depending on many factors including timing, electric grid capacity, equity, safety, and load.

Image courtesy of Gas Transition Allies

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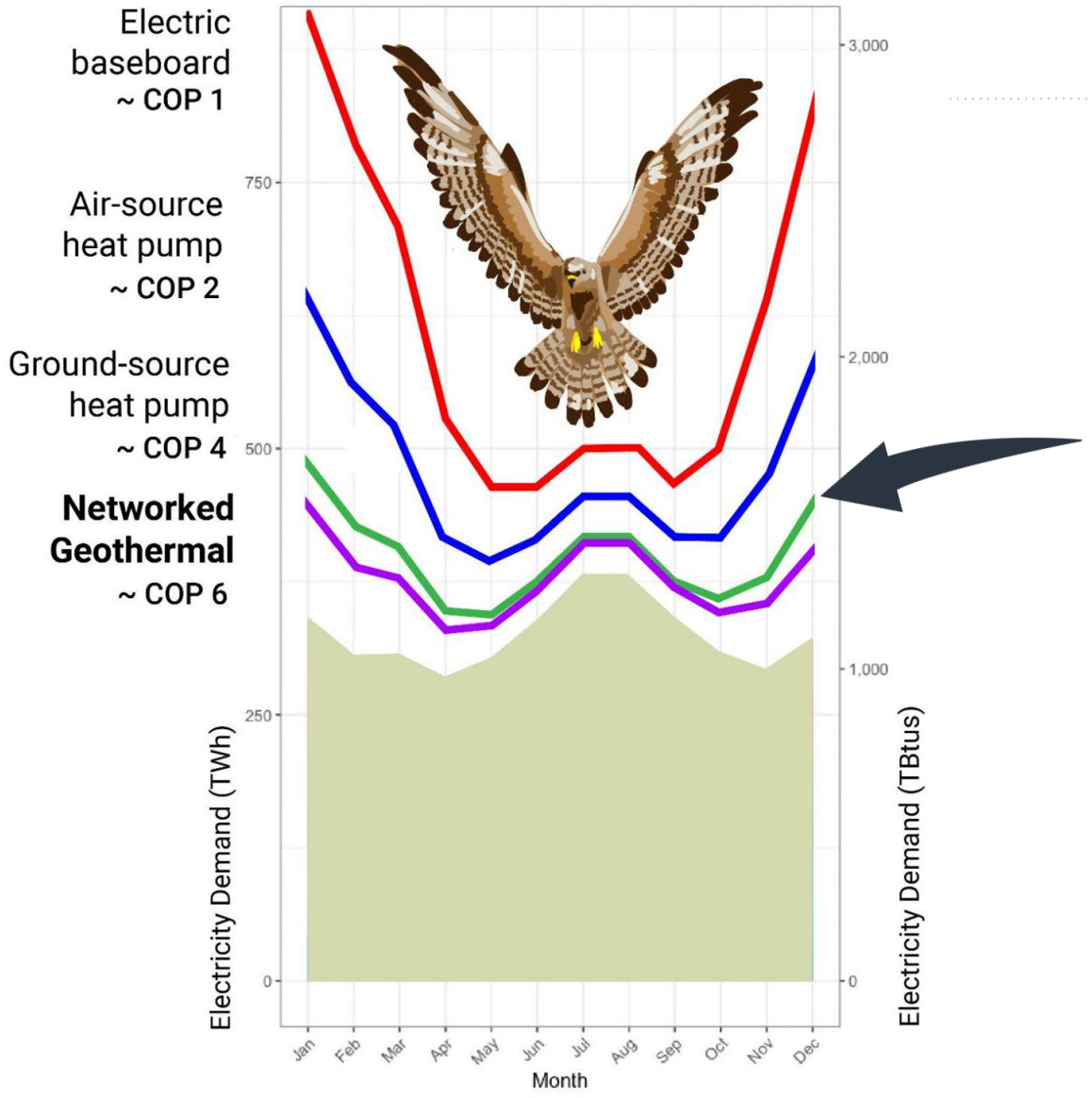

The Falcon Curve:

Future U.S. Building Electricity Use with varying Efficiency Electrification Technologies

(Jan to Jan)

Buonocore, J.J., Salimifard, P., Magavi, Z. et al. Inefficient Building Electrification Will Require Massive Buildout of Renewable Energy and Seasonal Energy Storage. Sci Rep 12, 11931 (2022).

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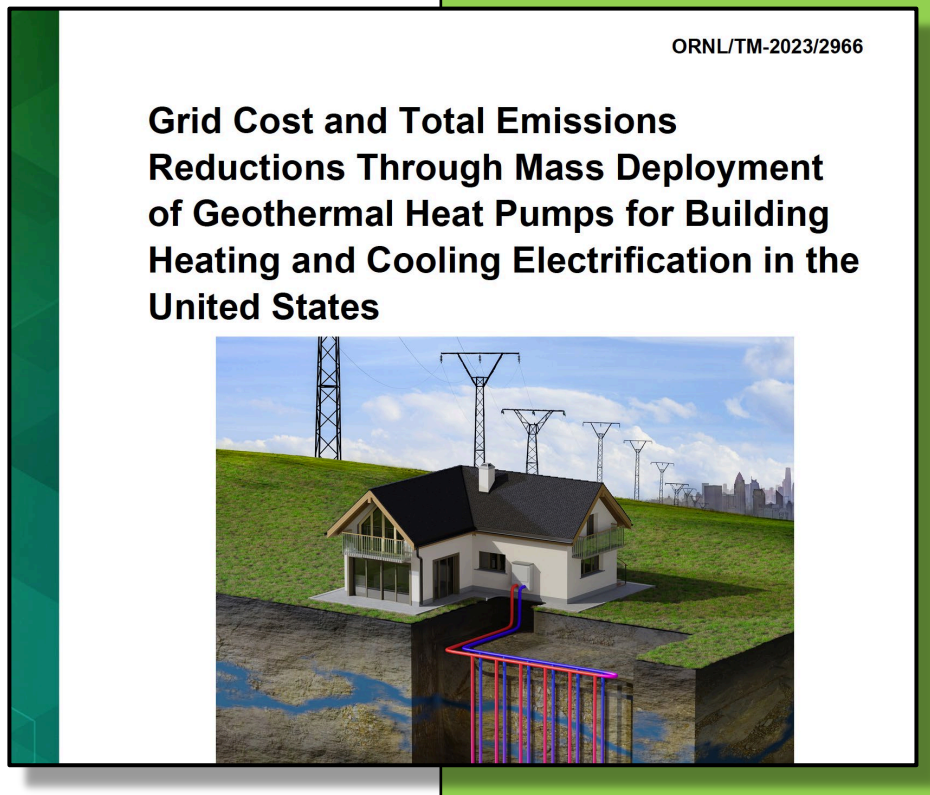
“most notable result is that GHPs are primarily a grid-cost reduction tool and technology that, when deployed at a national scale, also substantially reduces CO2 emissions, even in the absence of any other decarbonization policy”



- 12% cheaper wholesale electricity
- 7.34 GIGATONS CO2e SAVED
- 33% fewer miles of transmission
- 47% cheaper grid decarbonization
- $19 Billion/year fuel cost savings

- Cumulative savings > $1 Trillion

DOE Geothermal Heat Pump Study:

Geothermal Networks can exceed these numbers

AND

Can be accessible to all thanks to the utility model.

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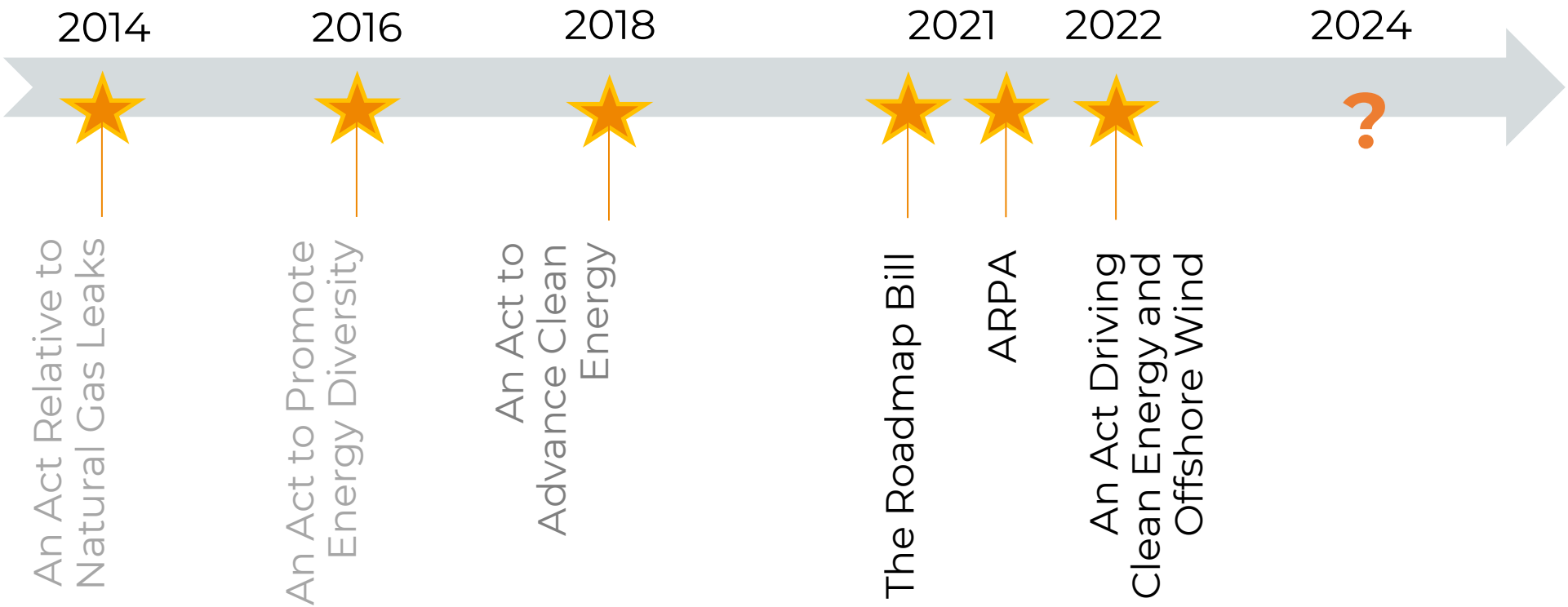
Relevant Massachusetts Legislative Action



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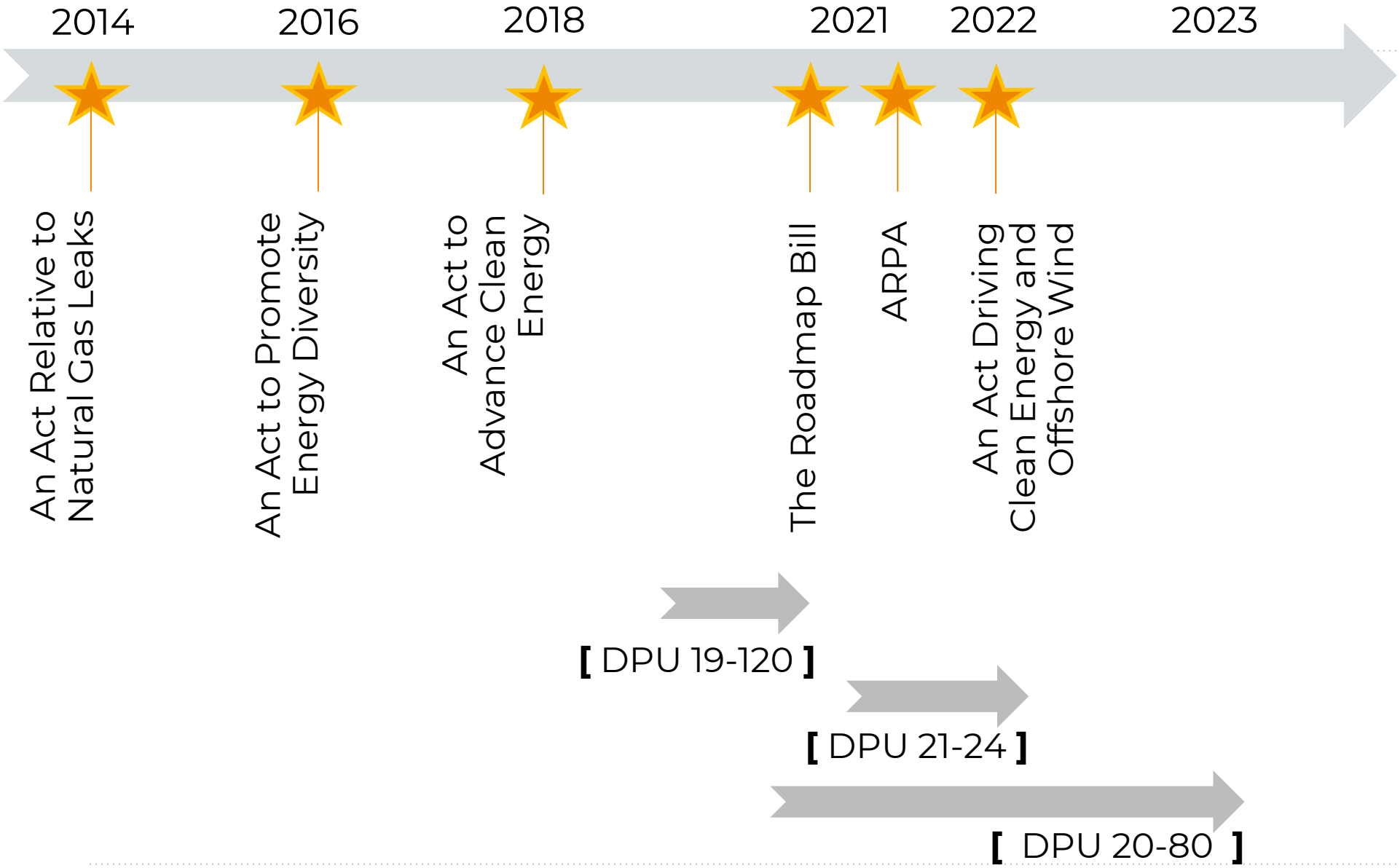
Relevant Massachusetts Regulatory Action



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Framingham, MA Geothermal Pilot

EVERSOURCE

- Project approval as part of NSTAR Gas rate case in 2020
- Project began in 2021 with site selection with commissioning and operation targeted for later this year
- Single pipe system of approximately 1 mile of main throughout a neighborhood in Framingham, MA
- 40 buildings with 150 individual customers throughout
- 113 boreholes to provide capacity of approximately 375 tons of load

HEET first proposed this technology to Eversource Gas in winter of 2017/2018

Regulatory Approval in 2020

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Loop in street is currently complete. Still drilling boreholes.

Photos from Framingham, MA Eversource Gas Installation

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OPEN database of projects using normalized data to compare & learn

OPEN library of resources and tools including predictive system models for design and evaluation

Scaling & Impact Projections & Potential Studies

Learning from the Ground Up Research Team (LeGUp):

Participants from:

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

BURO HAPPOLD

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection

MIT
MANAGEMENT
SLOAN SCHOOL

BERKELEY LAB

BOSTON UNIVERSITY
SCHOOL of Public Health

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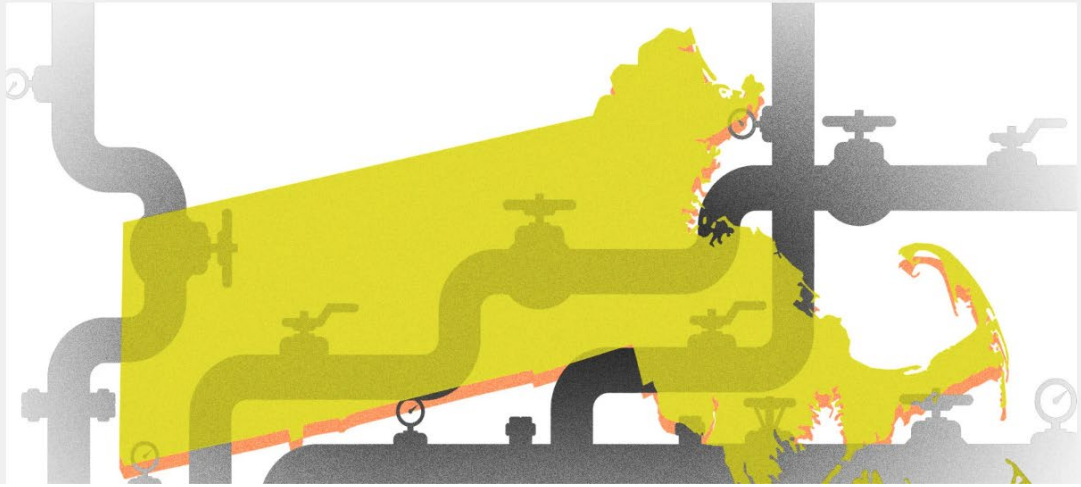
Can gas utilities survive the energy transition? Massachusetts is going to find out.

Massachusetts, Colorado join the lists of states investigating the future of natural gas in buildings.



A GRIST article from 2020 on launch of 'Future of Gas' (docket 20-80)

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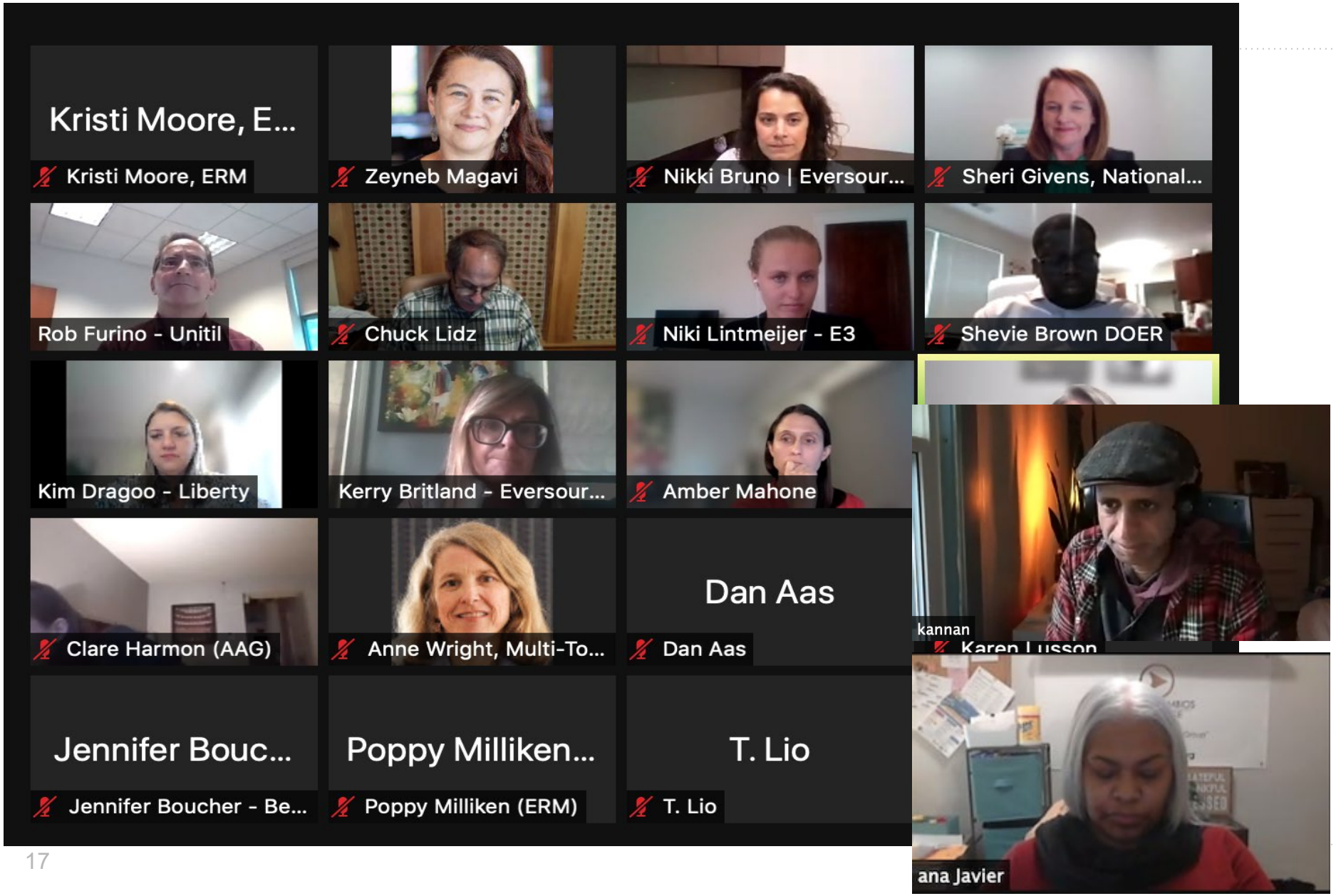

This is the Stakeholder Process of 'Future of Gas' (docket 20-80)

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MENU | B | WATCH: GLOBE TODAY | MONEY, POWER, INEQUALITY | METRO | SPORTS | BUSINESS | POLITICS | OPINION | HEALTH | CAMBERVILLE | AROUND MASS.

State charts a new energy future for Mass., beyond natural gas

By Sabrina Shankman Globe Staff, Updated December 6, 2023, 8:48 p.m.

58

'The state of Massachusetts appears to be breaking up with natural gas"

- Shankman, Boston Globe

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Key Findings

- Discourage further expansion of natural gas distribution system
  - Line extension policies, “public interest” standard
  - Non-gas pipeline alternatives (NPAs) and maintenance of existing system
  - Demonstration projects
    - Networked geothermal, electrification

Chair Van Nostrand’s Slide from RAAB

(Dec 8, 2023)

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Regulatory Principles

- Recovery of existing investment
- The regulatory framework going forward
  - A “beyond gas” future
  - “Exceedingly complex issues”

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Chair Van Nostrand’s Slide from RAAB

(Dec 8, 2023)

Is this coffee warm or cold?

1. Consistency of the proposed demonstration program with applicable laws, policies, and precedent
2. Reasonableness of the size, scope, and scale of the proposed projects in relation to the likely benefits to be achieved
3. Adequacy of the proposed performance metrics and evaluation plans
4. Bill impacts to customers

D.P.U. 16-178, at 26;

D.P.U. 17-05, at 234;

D.P.U. 16-184, at 11.

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- Projects are consistent with GWSA and 2050 Climate Change Emission Reduction Mandates.
- Will advance knowledge of their viability, effectiveness, and scalability in the field for the benefit of ratepayers.
- Third-party independent review and annual reports filed with DPU.
- Expenditures are approved based on prudency.
  - Company's actions, based on all that it knew or should have known at that time, were reasonable and prudent in light of the existing circumstances. A*ttorney General v. Department of Public Utilities*, 390 Mass. 208, 229 (1983).

D.P.U. 19-120, at 139-151.

What's Next?

Or

What will we KNOW & NOT KNOW?

"Widespread adoption of geothermal networks has the potential to significantly reduce carbon emissions in the Commonwealth."

DPU 19-120, at 138.

Projects will inform many aspects of this assertion, but not all of them.

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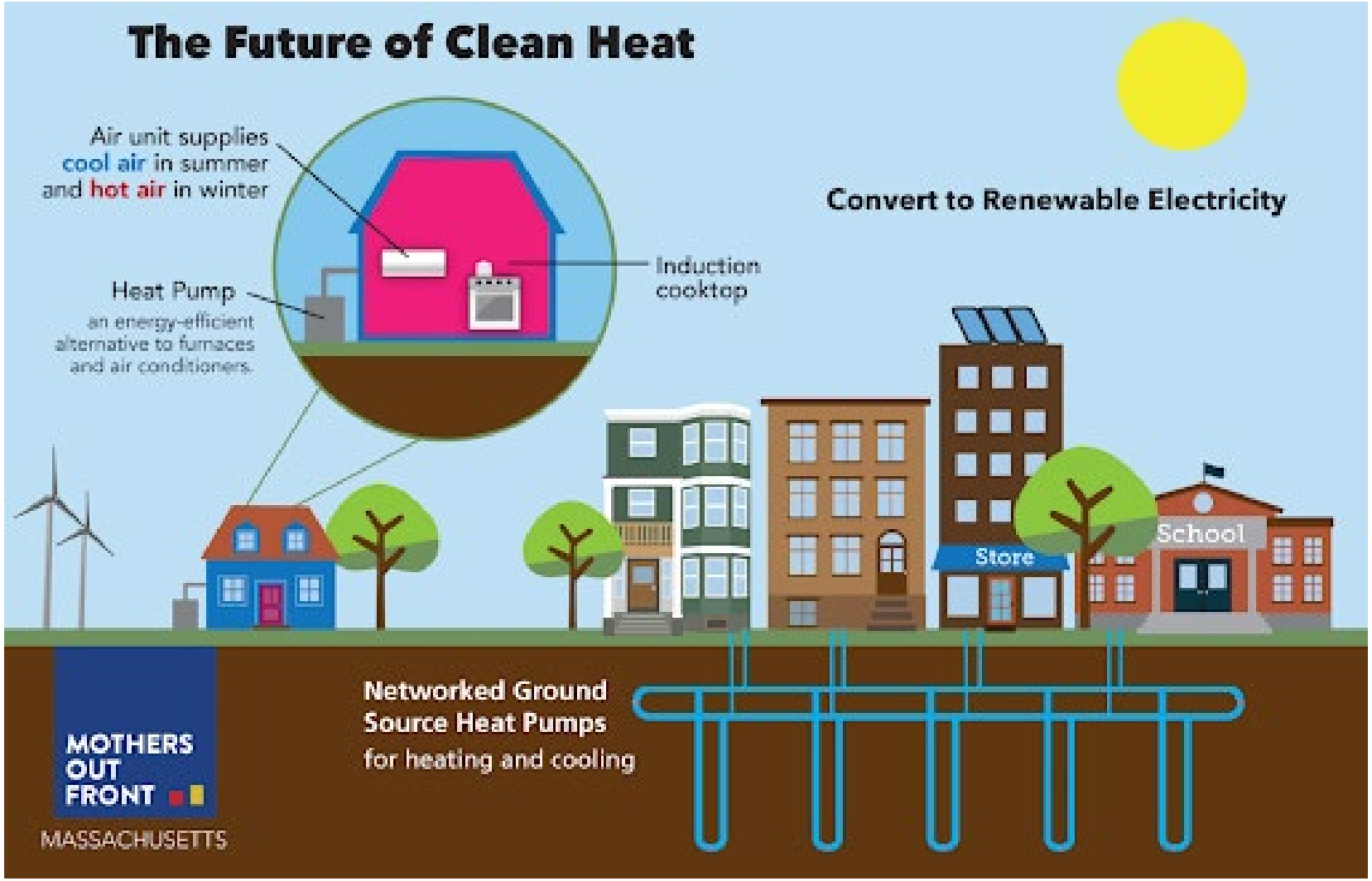
QUESTION	KNOWN	UNKNOWN	LeGUp Research	Demonstrations
Does it WORK?!	YES. Most efficient heating & cooling. Since 1980s. IGSHPA provides certification	Models for design and performance optimization at neighborhood scale	✓	✓
Reliability?	No systemic single point failure. Islandable. Centralized backup. Long lifespan. Low O&M.	Never been built at regional scale, never integrated with an islandable electric grid	✓	✓
Safety?	Not explosive. Resilient to flooding and storms.	-	✓	✓
Security?	Not explosive, resilient, underground & invisible	-		
Affordability?	Monthly bills lower than gas today. Completed projects pay off in 10-12 years before IRA	Bond rates, amortization and ratemaking will determine exactly how affordable	✓	✓
Equity?	Utility business model addresses equity of access, merged thermal rate base avoids spiking energy burdens as gas customers electrify	Have never stabilized a gas rate base with geo before.	✓	✓
Workforce?	UA pipefitters are all in. Gas workers already certified for HDPE pipe. NEED DRILLERS	How to train drillers and increase supply of drills to meet demand and lower costs		✓
Emissions?	IF zero on electric grid, thermal grid will be zero. In MA 70% cut today.	Further reductions due to waste thermal capture and reuse?	✓	✓

QUESTION	KNOWN	UNKNOWN	LeGUp Research	Demonstrations
Natural monopoly?	YES, this is a natural monopoly and should be regulated	-		
Do people want it?	Eversource Gas Sales Team success is encouraging	We don't know yet?!		✓
Metering & billing	Vancouver & others have examples	No clarity on the optimal method	✓	✓
Ratemaking	This is doable?	So many things		✓
Ownership	The utility model built our energy infrastructure in the 1800s/1900s Currently no one owns wind or solar energy, just the land it is on.	Will anyone 'own' thermal energy? Will thermal networks create a thermal market?		✓
Cost variability & learning curve costs	Innovation and learning curves expected & site variability expected	How quickly & how far will costs decrease? How much site variability?	✓	✓
Electric grid impacts?	Can achieve COP of 6, flattens load, stores energy seasonally	Optimizing design and operation for electric grid impacts (maximizing seasonal storage for example) has never been done	✓	✓
Planning needs	Integrated planning ideal (electric/gas/thermal)	Non-borehole thermal resources are not mapped yet		

QUESTION	KNOWN	UNKNOWN	LeGUp Research	Demonstrations
One pipe vs. two	One pipe allows highest efficiency and utility growth model			✓
Water? Glycol?	Water used in northern Canada. Glycol adds cost, friction & impacts	What will become standard?	✓	✓
Standards & codes	IATMO, UMC 2021 ATL Appendix, 2024: ATLs in Chpt. 17, 2027: Full Standard			
Depth	Depth reduces seasonal thermal variability, avoids frost in cold areas	Standard will likely be location dependent	✓	✓
Controls?	Existing controls are customized	How will controls evolve as systems scale?	✓	✓
Heat pumps	Water source, extended range. Geo Ready - ASHP/GSHP	How will market evolve?	✓	✓
Heat exchangers	No isolation needed by building, adds cost & friction	What will become standard?	✓	✓
Temperature range	‘Ambient’: typically between 40-90F	What will become standard?	✓	✓



What's Next? Will 'Future of Clean Heat' legislation pass this session?

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