BUILDINGENERGY BOSTON

Using District-Scale Heating to Accelerate Building Decarbonization & Resilience

Sasha Shyduroff (Metropolitan Area Planning Council)
Kevin Hagerty (Vicinity Energy)
Zeyneb Magavi (HEET)

Northeast Sustainable Energy Association (NESEA)
August 13, 2020

A City's Climate Toolbox: Exploring Water-Based District Heating and Cooling for Metro Boston

Sasha Shyduroff
Metropolitan Area Planning Council

August 2020

MAPC
METROPOLITAN AREA PLANNING COUNCIL

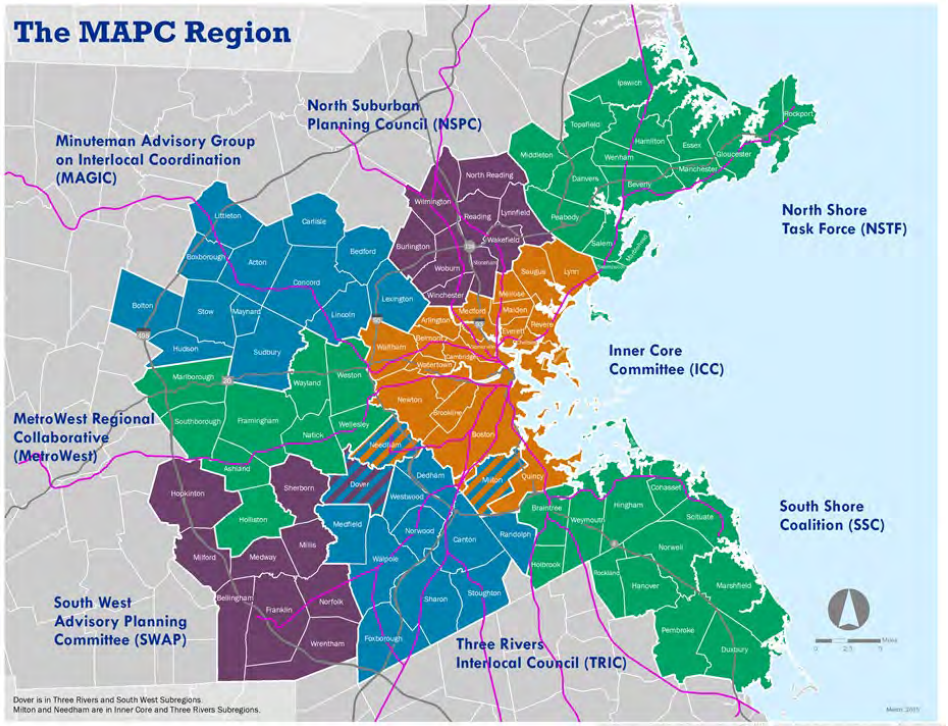
About the Metropolitan Area Planning Council

101 municipalities

1,440 square miles

Nearly **3.2 million** residents

1.8 million jobs (2010 Census)



MAPC
METROPOLITAN AREA PLANNING COUNCIL
Smart Growth & Regional Collaboration

Clean Energy at MAPC

Regional Energy
Projects

Climate and Energy
Planning

Energy **Technical Assistance**

Why District Energy?

- Low-carbon energy
- Future proofing
- Cost savings
- Price stability
- Reliability and resilience


Politics & Government

Somerville Pledges Support Of Paris Accord After Trump Withdrawal

Despite the president withdrawing from the international agreement, "Somerville is still in."

By Alex Newman (Patch Staff) - Updated June 2, 2017 3:03 pm ET

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Metro Mayors reaffirm commitment to Paris Climate Accord


Getting to Net Zero: Cambridge, MA


Lexington Town Meeting votes to adopt a net zero carbon emissions policy

Toward A Water-Based District Energy Governance Framework

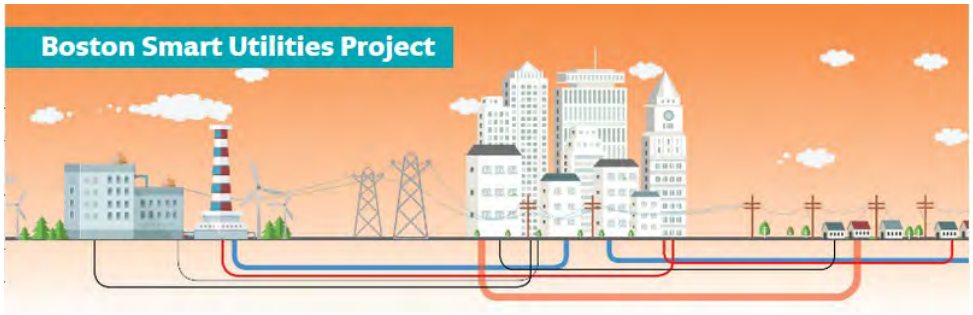
Governance: The laws, policies, regulations and decision-making processes that are used to manage and oversee district energy.

Municipal Efforts

- Cambridge, Boston and Somerville have developed climate action plans and committed to reducing GHG emissions
- Boston's 2016 Community Energy Study and City of Cambridge's Low Carbon Energy Supply Strategy Study identify potential areas appropriate for district energy
- Cambridge's Planning Unit Development 5 District in Kendall Square and DE Assessment required for Volpe development
- Boston's Smart Utilities Policy
- MAPC's Fix Our Pipes and E-Permitting work to coordinate street openings between utilities and municipalities

Boston Smart Utilities Policy for Article 80

Requires large scale developments to conduct a feasibility assessment across 5 utility sectors including District Energy Microgrids (Solar, Battery and EV Microgrids)



Source: Boston Planning and Development Agency.

Existing District Energy Systems

- Harvard University
- Massachusetts Institute of Technology
- French VC (Formerly Veolia) – serves Kendall Square and Downtown Boston – Steam system
- Medical Area Total Energy Plant (MATEP) in Boston Longwood Medical area- Steam

Image: Harvard's Alston Campus District Energy System built in 2019. Credit" Leers Weinzapfel Associates Architects.

Findings: Common Barriers

- **Physical Constraints:** Retrofitting existing buildings and space underground for additional pipes
- **Business Model Inertia:** High upfront costs and longer-payback periods may be difficult to compete with status quo of natural gas and traditional HVAC systems.
- **Customer Acquisition:** "Chicken and egg" challenge of confirming customers and financials.
- **Policies and Regulations:** Policy uncertainty may lead to investors not willing to invest due to perceived risk.

Findings: Potential Role of Municipalities

- Planner and Coordinator
  - Energy Mapping and Planning
  - Zoning Ordinance, Design Guidelines and Other Policies
  - Coordination of Customers
  - Coordination of Utilities
  - Provision of Financial Modeling Guidance
- Governance and Oversight
- System Owner
- System Customer/Anchor Load

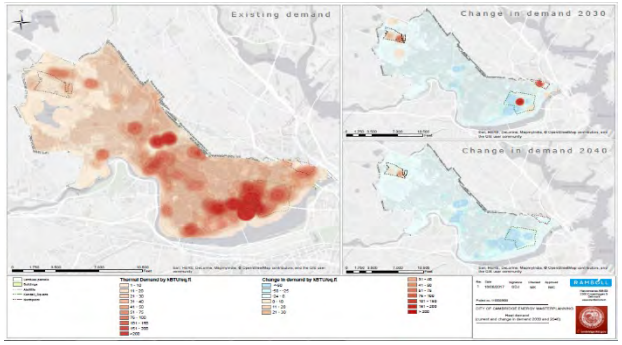


Image: City of Cambridge, Low Carbon Energy Supply Strategy Study.

Findings: Role of the State

- H. 3394 An Act Relative to the Authority of Department of Public Utilities to Regulate Steam (2007)
  - Massachusetts DPU's Pipeline Safety Division regulates steam distribution companies for safety and operation
  - Safety requirements during design, installation, operation, and maintenance
  - Annual testing and audits
- Electrical Restructuring Act, M.G.L 164 (1997)
  - Primarily responsible for the regulation of the provision and distribution of electrical energy and protecting consumers. While it applies to microgrids, it does not apply to thermal district energy systems.
  - Franchise clause (M.G.L c. 164, § 1B(a) applies to the electrical distribution grid, not thermal energy.

Key Takeaways

- Governance of district energy ranges from support of market-based dynamics to oversight of health, safety and welfare to rate setting, investment, and consumer protection.
- Water-based district energy is currently not regulated or governed in Massachusetts, while steam is regulated for health and safety purposes.
- Many States in the U.S. do not oversee thermal energy/district energy systems, in part because connection to district energy systems in the U.S. is typically not mandatory.
- Municipalities can play a significant role in enabling water-based district energy systems, helping overcome barriers, and build the market.

Recommendations

Data-Driven Analysis and Mapping

Enabling Policies and Guidance

Considerations for System Ownership

Regulation and Oversight

Thank You!

Sasha Shyduroff
Clean Energy and Climate Planner II

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District Energy

Building Decarbonization & Resilience

Building Energy Boston

VICINITY

About the Presenter

Kevin Hagerty
Chief Technology Officer

Kevin has over 20 years of experience working in all facets of the private utility space.

As Chief Technology Officer Vicinity Energy, he provides leadership and support for the owned, managed and operated facilities of Vicinity Energy. He is also responsible for the technical oversight of Vicinity Energy's district energy business.

Prior to Vicinity Energy, he was Sr. Vice President of Operations for Veolia North America's Water, Waste, and Energy business.

District Energy:
A Brief Overview

What is District Energy?

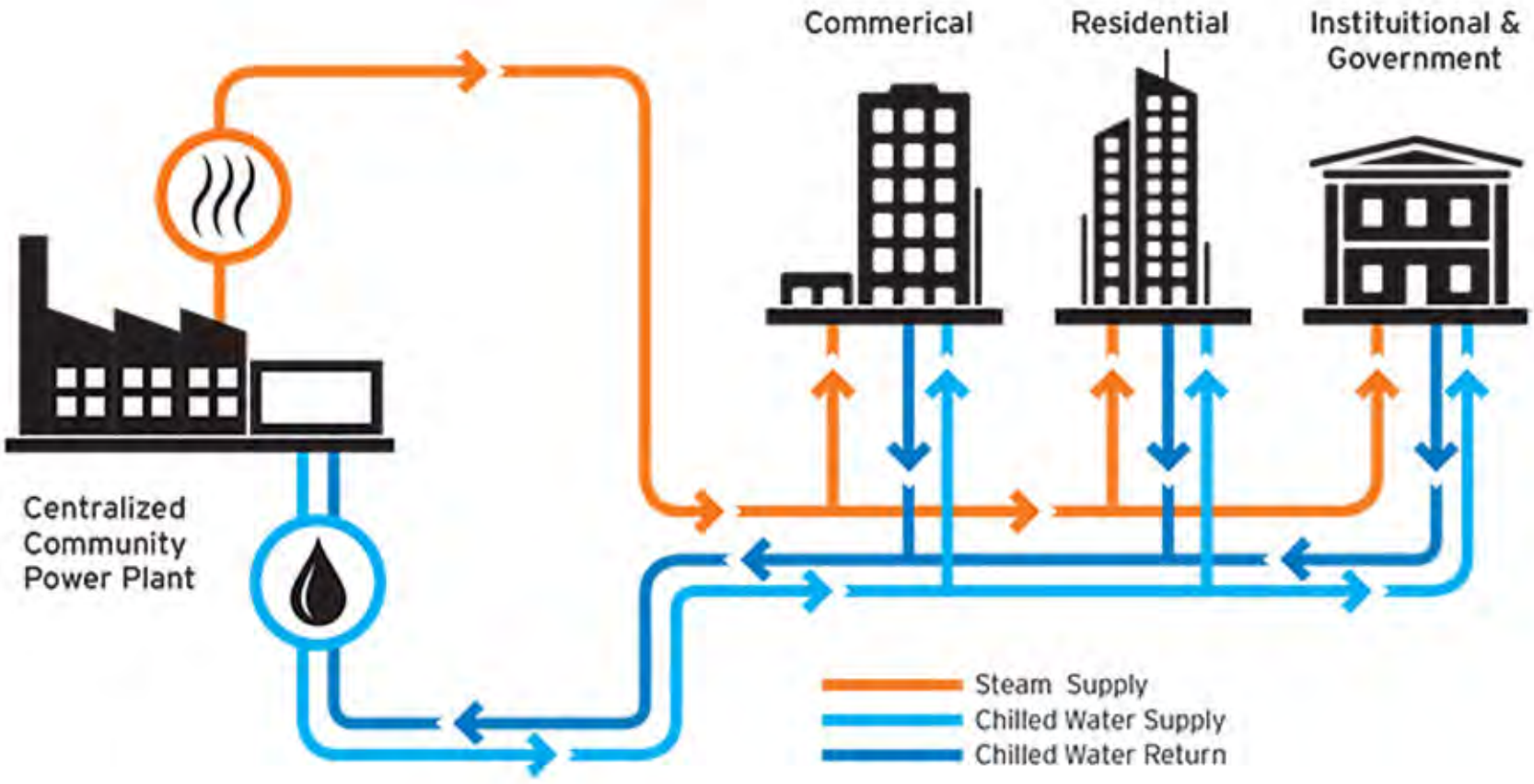


Image: International District Energy Association

Proven Approach and Evolving over a Century

SCIENTIFIC AMERICAN

[Entered at the Post Office of New York, N. Y., as Second Class Matter.]

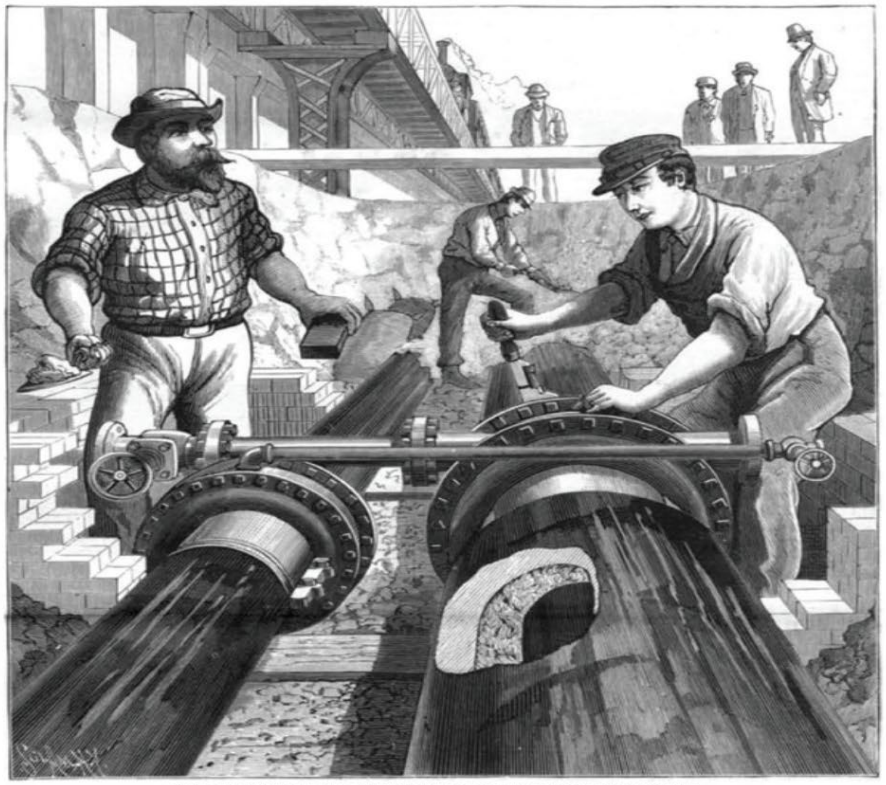
A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY AND MANUFACTURES.

Vol. XLV.—No. 21. [NEW SERIES.] NEW YORK, NOVEMBER 19, 1881. [$3.20 per Annum. [POSTAGE PREPAID.]

THE DISTRIBUTION OF LIGHT AND HEAT IN NEW YORK CITY.

The tendency of the day toward the centralization of capital and effort, and the simplification of domestic service through more perfect organization in the supplying of our material wants, is strikingly illustrated in two gigantic enterprises now in progress in this city, both dealing in problems of vital importance in social and domestic economy, and both calculated to do away with time-honored customs and methods.

We have become used to elaborate and wide-reaching systems of conveyance, which have displaced the use of private carriages—to a large extent even the use of the means of conveyance which nature provides. Equally wide-reaching systems of telegraph and telephone lines have brought every man in the community within hailing distance of every other. Our water supplies are laid on in every apartment by means of public water systems employing scores of miles of large aqueducts and thousands of miles of smaller pipes. Night is converted almost into day for us by illuminating gas supplied from central stations. And the next steps of social and domestic organization promise to be the distribution of motive power with our illuminant, and the displacement of our heaters and cooking stoves by steam conveyed through the streets in pipes, making it possible to banish fire absolutely from our dwellings, offices, and factories, either for warming or lighting, for cooking or for mechanical operations, heat, light, and motive power being generated in and supplied from huge central stations.



STEAM DISTRIBUTION—THE STEAM PIPES AND EXPANSION JOINTS.

Although electric lighting and steam heating have nothing in common, the circumstance that progress in each is represented by gigantic enterprises in vigorous prosecution in this city makes it proper to treat of them together in this place.

On the Eastern side of our city, down town, the Edison Electric Light Company is placing a complete system of conductors in the streets, while the New York Steam Company is occupying the streets on the Western side in the work of laying down pipes for the general distribution of steam for heat and power. The central stations of both companies are in process of erection, and preparations for business are making with a prospect of early completion.

The Edison Electric Light Company has laid about three miles of conductor in an area scant three-quarters of a mile square, south of Spruce street and east of Nassau street. When this district is complete there will be fourteen miles of conductor under the streets and seven miles of service conductor. These conductors will supply 16,000 lamps, and 400 horse power for driving machinery.

The operations of laying the conductors is shown in Fig. 1. In a trench about two

Image: Scientific American Magazine

Well Known District Energy Systems

Boston

New York City

Toronto

Philadelphia

San Francisco

Copenhagen

US District Energy Today

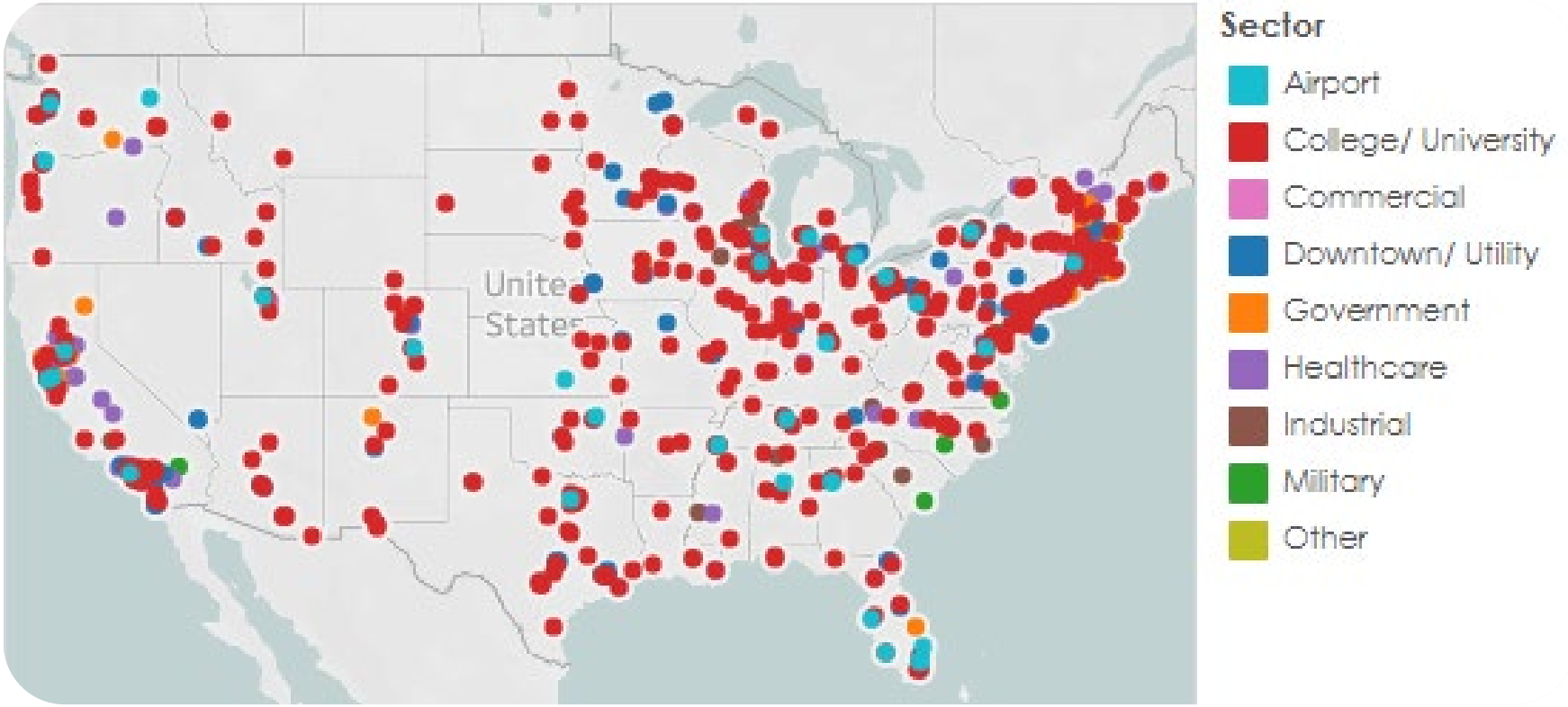


Image: International District Energy Association

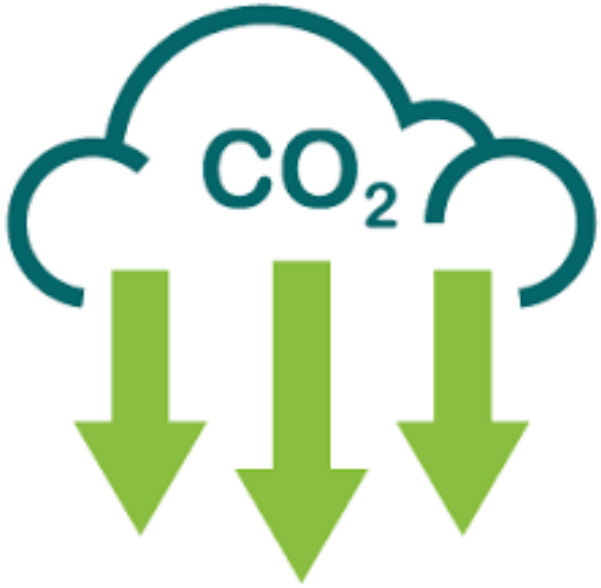
District Energy – Common Uses

Heating	• Hot water heating with shell/tube, plate/frame or flooded heat exchangers • Steam coils, steam radiators, radiant floor heating • Low grade condensate heat for loading docks or sidewalk heat/snow melt • Humidification for museums and art galleries
Hot water	• Potable hot water, domestic hot water • Hotel laundry and ironing • High temperature dishwashing in hotels and restaurants • Swimming pool heating
Cooling	• District cooling • Absorption cooling and steam turbine chillers • O&M of chillers and auxiliaries • Hybrid steam / electric chiller plants
Sterilization and clean steam generation	• Autoclaves • Glass and cage washes • Local lab sterilization
Industrial Processing	• Candy production • Soybean processing • Corn product processing • Brewing

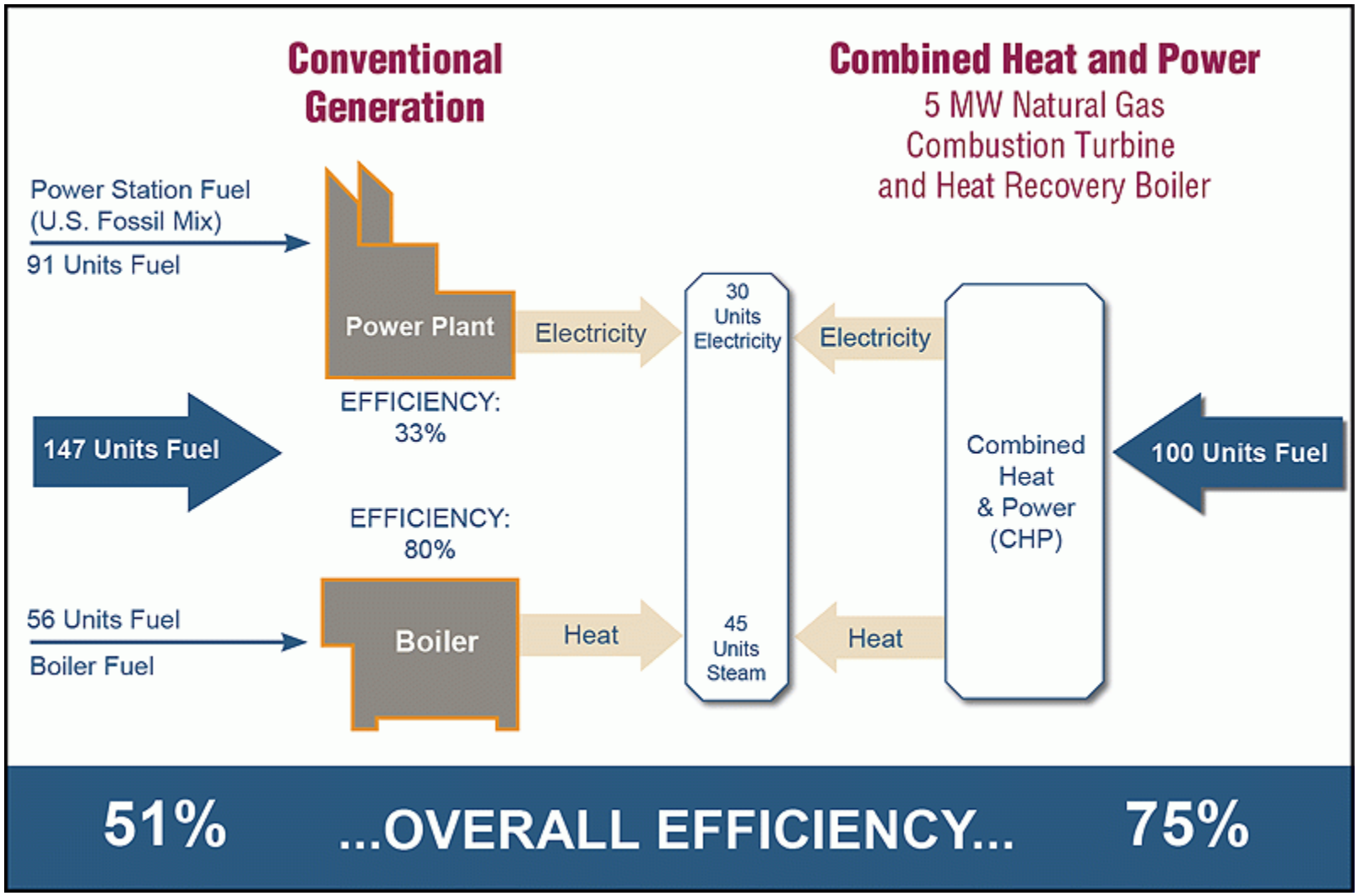
District Energy: How District Energy Reduces Carbon

Access to low carbon solutions that can be done at scale and don’t compete for building space

- Cogeneration
- Biofuels/Biosolids
- Thermal Storage
- Water Source Solutions (deep water, heat pumps)
- Electric Generation
- Battery Storage

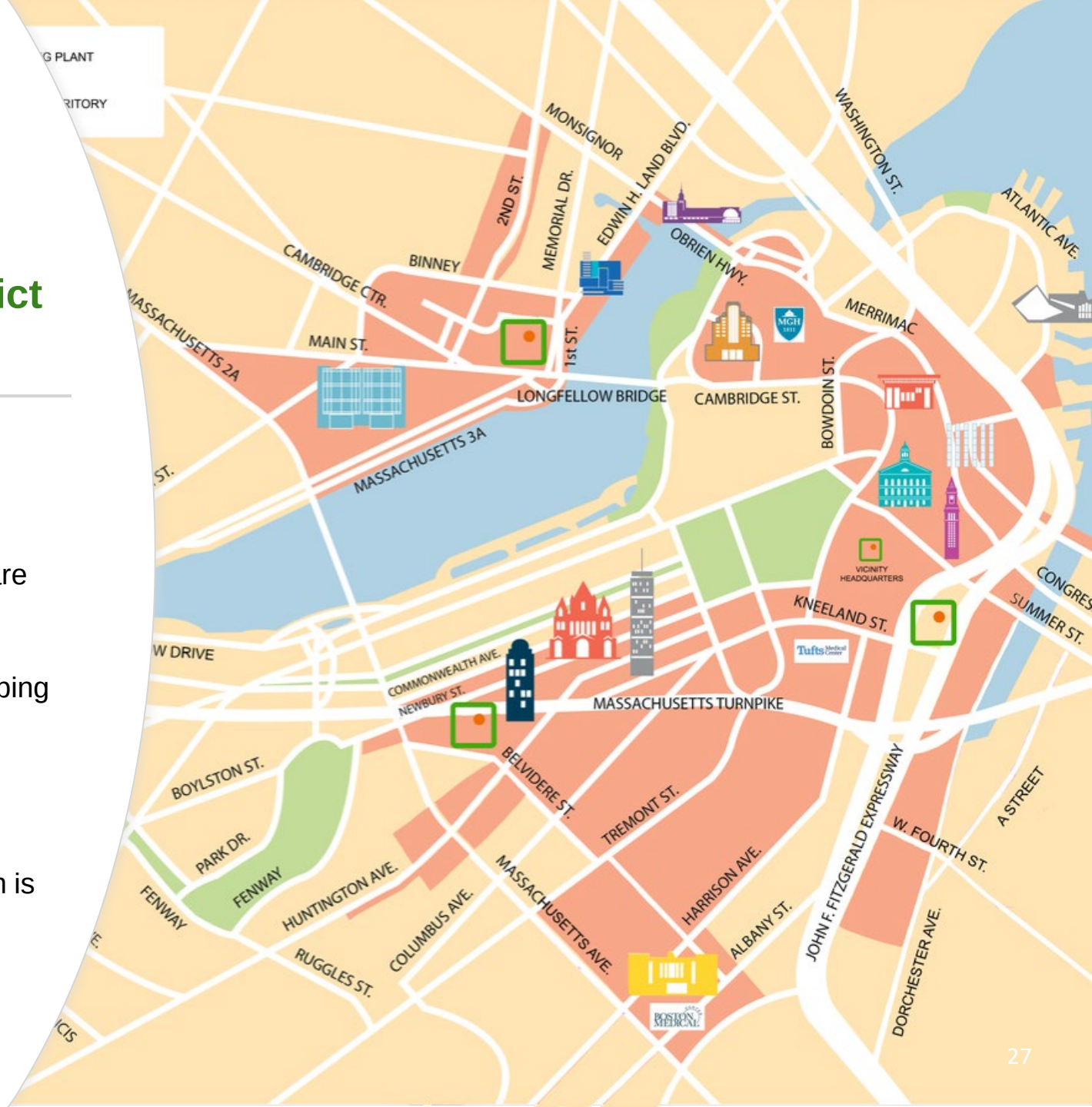


Cogeneration



Boston & Cambridge District Energy System

- Over 260 buildings served
- Over 60 million square feet of space served
- 26 miles of steam piping
- 3 central generation facilities
- 75% of district steam is cogenerated



Boston-Cambridge Resilience & Reliability

Redundancy

- **Fuel diversity:** Plants can burn clean natural gas, ultra-low sulfur oil or biofuels in the event of interruption of gas supply
- **3 steam plants w/ 12 boilers** feed into the district steam loop to backup CHP
- **Backup Power:** Kendall Station has grid "blackstart" capability and redundant power feeds. Kendall plays critical role in ISO NE post blackout grid restoration
- **Multiple feeds:** Multiple steam feeds supply in networked piping systems

Reliability

- **Reliability:** 99.99% reliable delivery, a must for major hospitals and other critical loads... all customers benefit from this reliability profile

Network

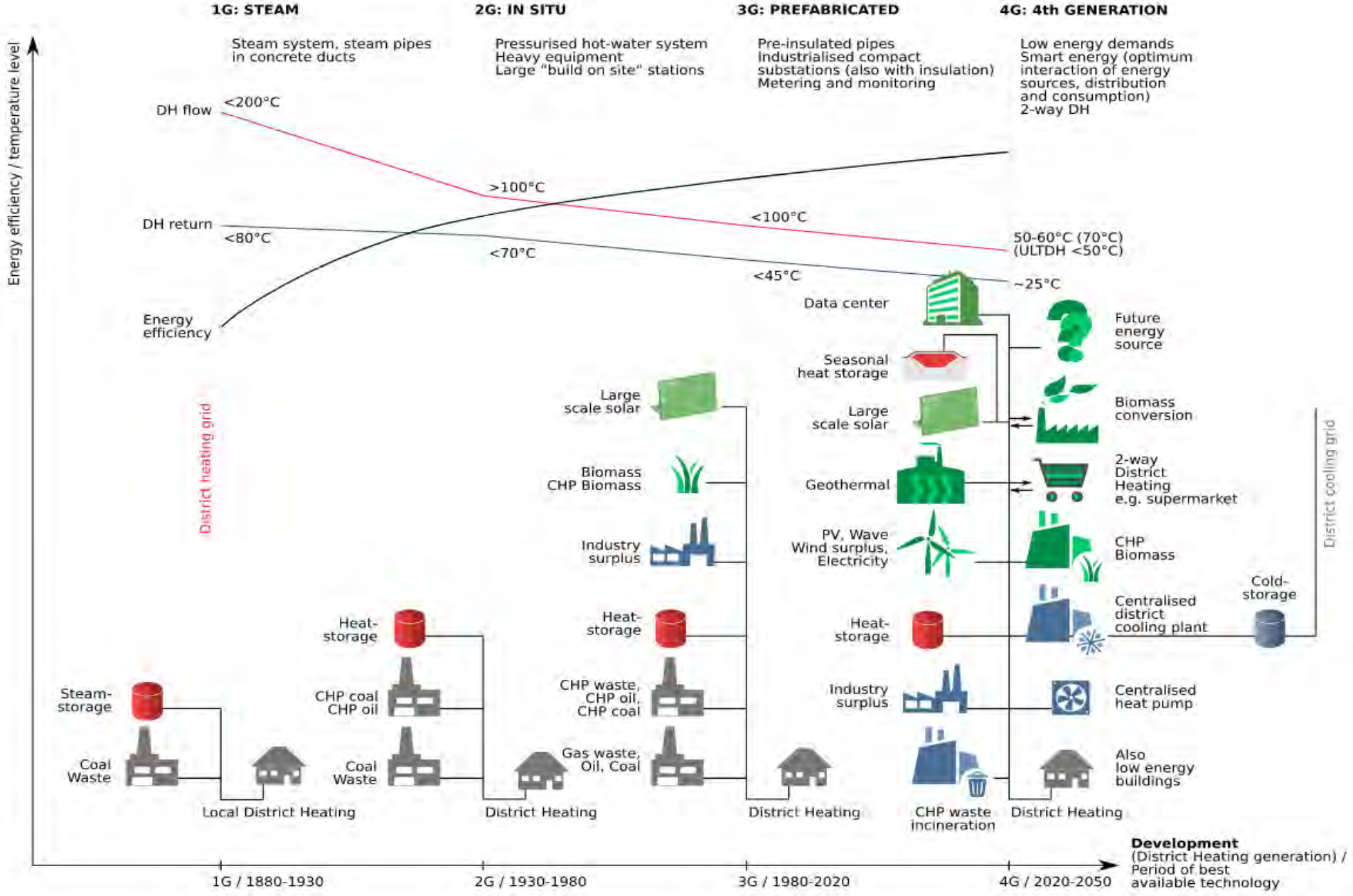
- **Connections**: As a grid networked it requires multiple distribution points to be compromised to adversely affect delivery.

Restoration

- **Restoration:** Expedited restoration capability during an emergency, including flooding events; fastest utility to recover (less than 24 hours)
- **Emergency Preparedness**: Vicinity district energy plants are Critical Facilities and Infrastructure by FEMA designation and part of ReadyBoston initiative

District Energy:
The Future

A Hedge in Sustainability – The Future of District Energy



A Leading Method to Resiliently Reduce Carbon Emissions

- Deployment of carbon solutions at larger economies of scale
- Significantly broadens carbon reduction solutions for a city
- Allows carbon impacts at scale with single changes to the central generation facilities – millions of square feet affected at a time.
- If near grid, any building can connect to the district energy system.

Thank you

VICINITY

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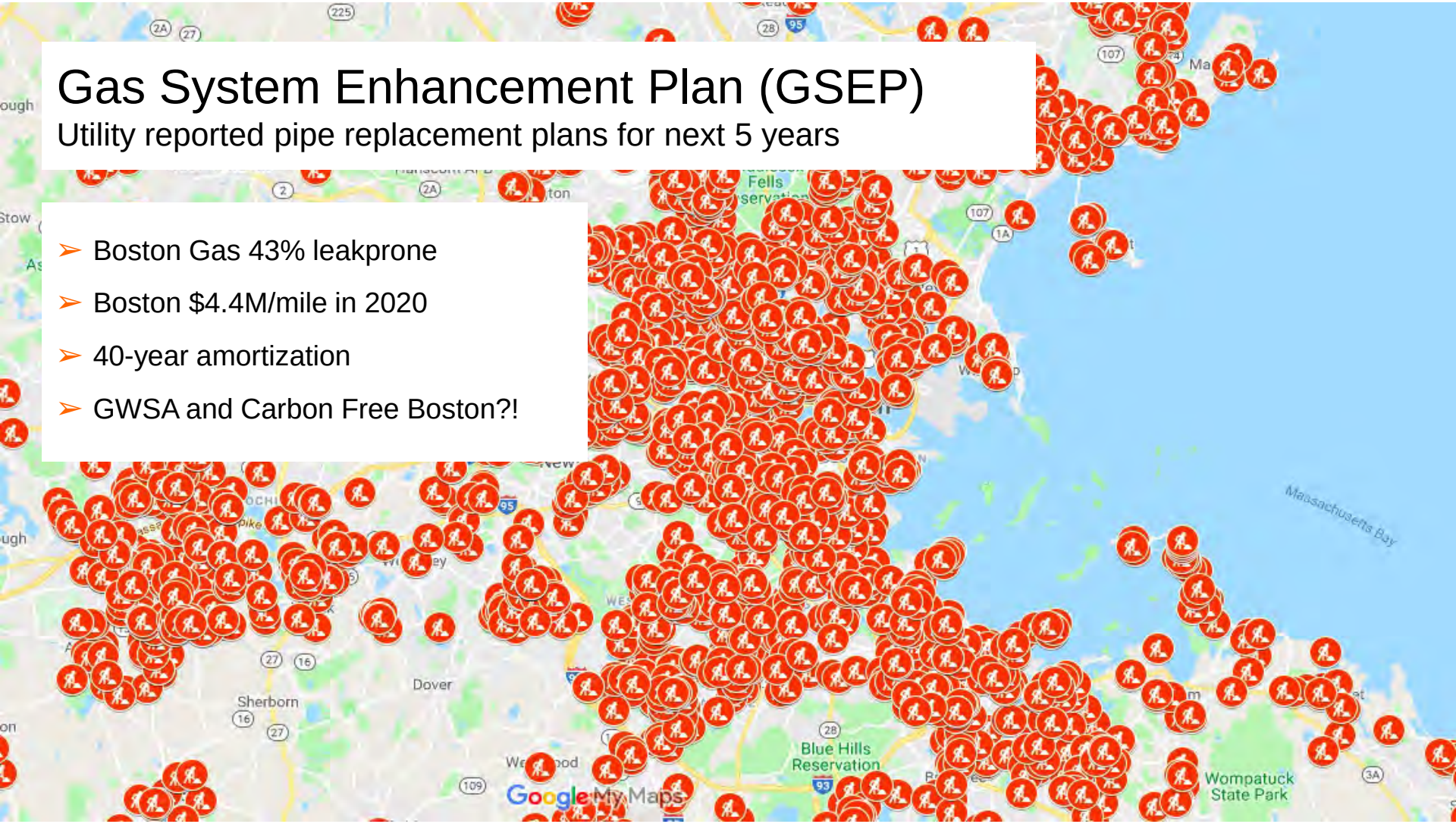
Seeks to cut carbon emissions NOW by driving systems change.

GeoMicroDistricts & GeoGrids

Gas System Enhancement Plan (GSEP)

Utility reported pipe replacement plans for next 5 years

- Boston Gas 43% leakprone
- Boston $4.4M/mile in 2020
- 40-year amortization
- GWSA and Carbon Free Boston?!



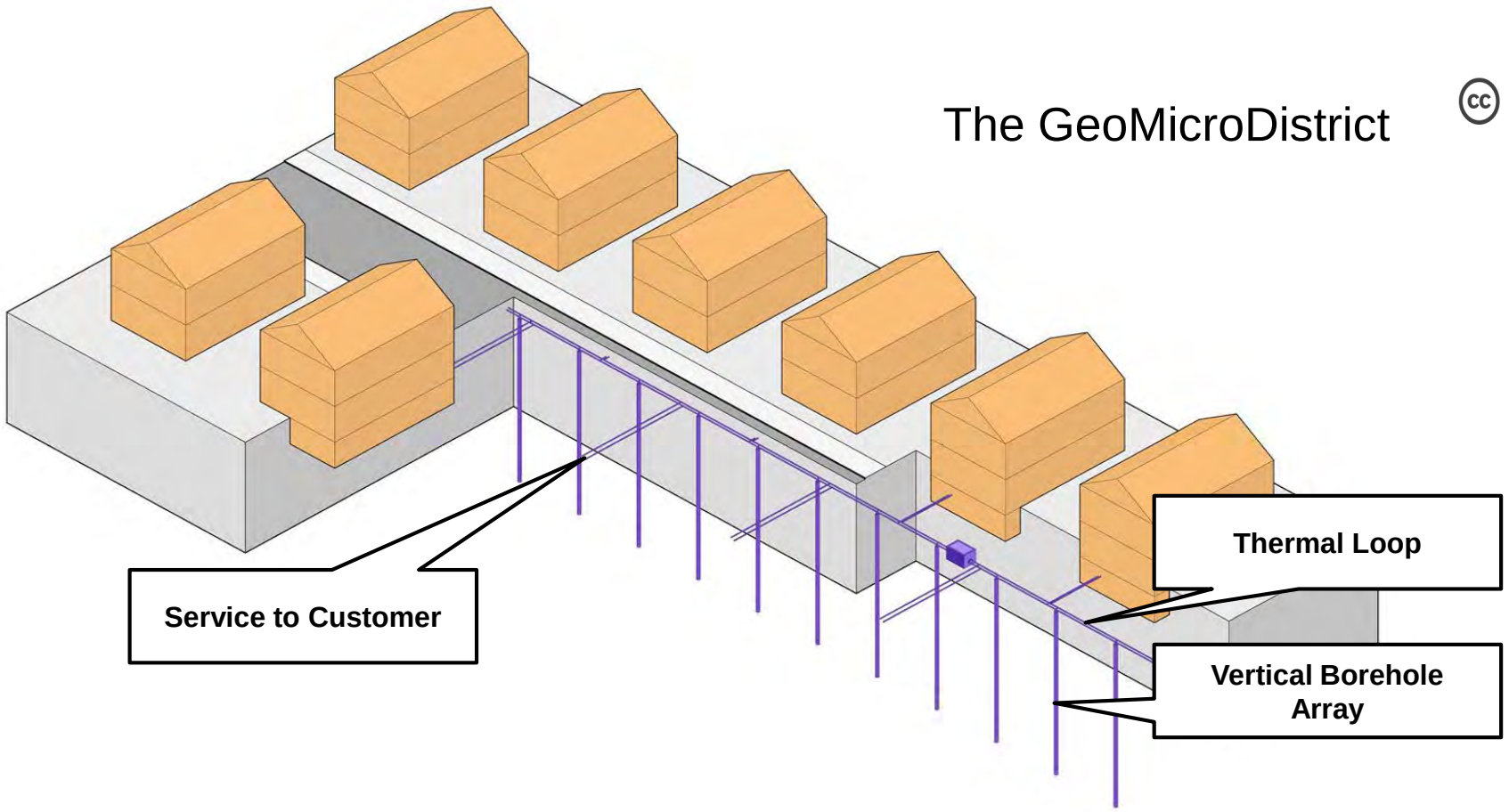
Design Principles:

- SAFE
- Renewable & Resilient & Reliable
- Economic sense for utility & consumer
- Workers keep their Jobs
- Minimize legislative & regulatory change
- Scalable & Adaptable & Equitable

‘5G’ District Systems

- Ambient Temperature
- Bi-Directional
- Heating & Cooling
- Decentralized, Decarbonized, Digitilized & Democratized

The GeoMicroDistrict

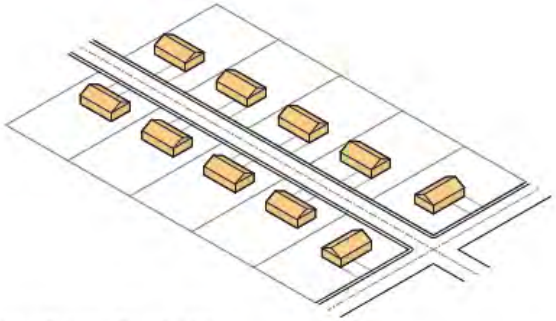


Feasibility Study

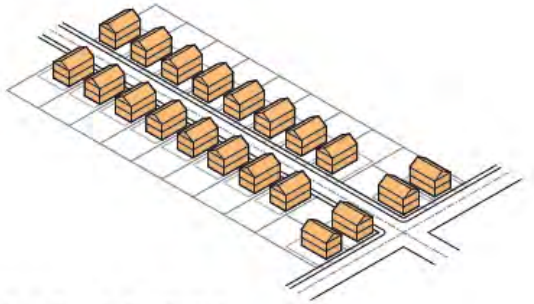
2019

BUROHAPPOLD ENGINEERING

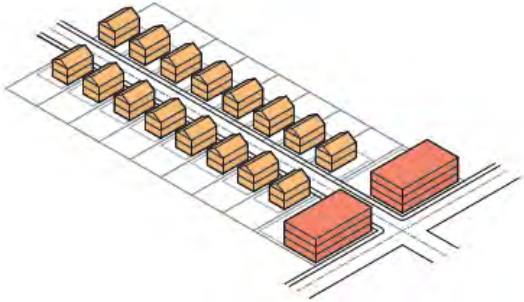
Prototype street segments created



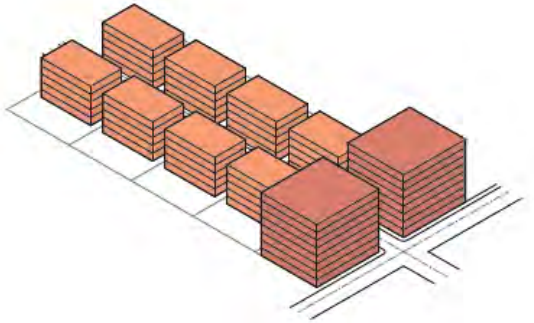
Low density residential



Medium density residential



Medium density mixed-use



High density mixed-use

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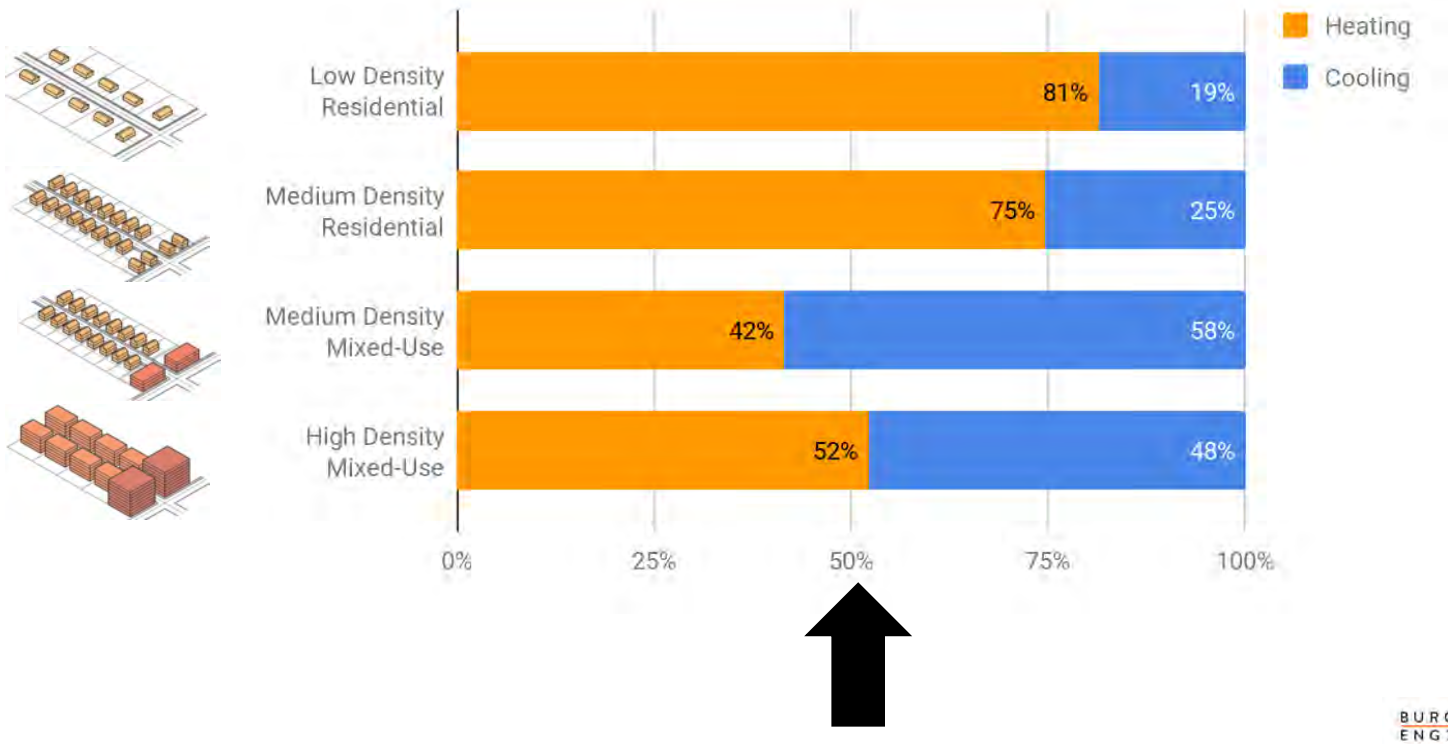
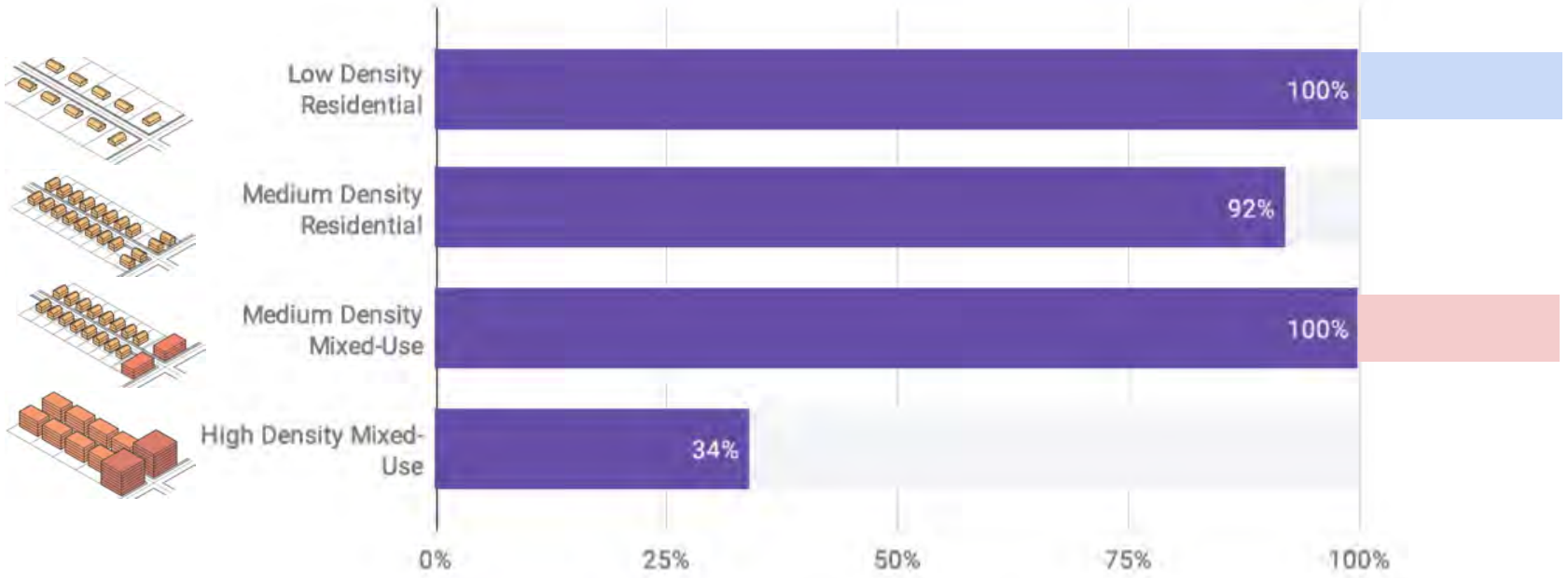
Opportunity in Annual Load Balancing



BUROHAPPOLD ENGINEERING

FEASIBILITY (per street segment)

The capacity to meet energy demand through ‘shallow’ boreholes in the street only



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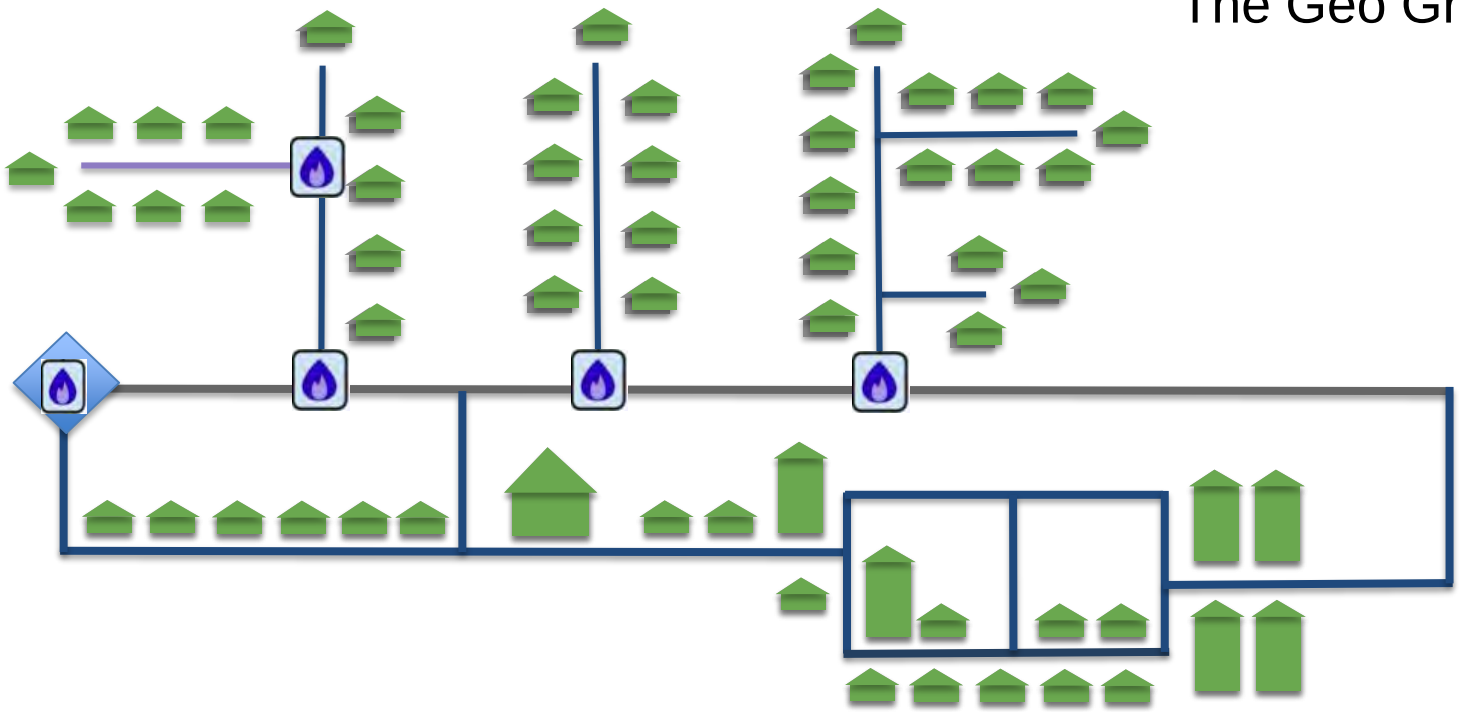
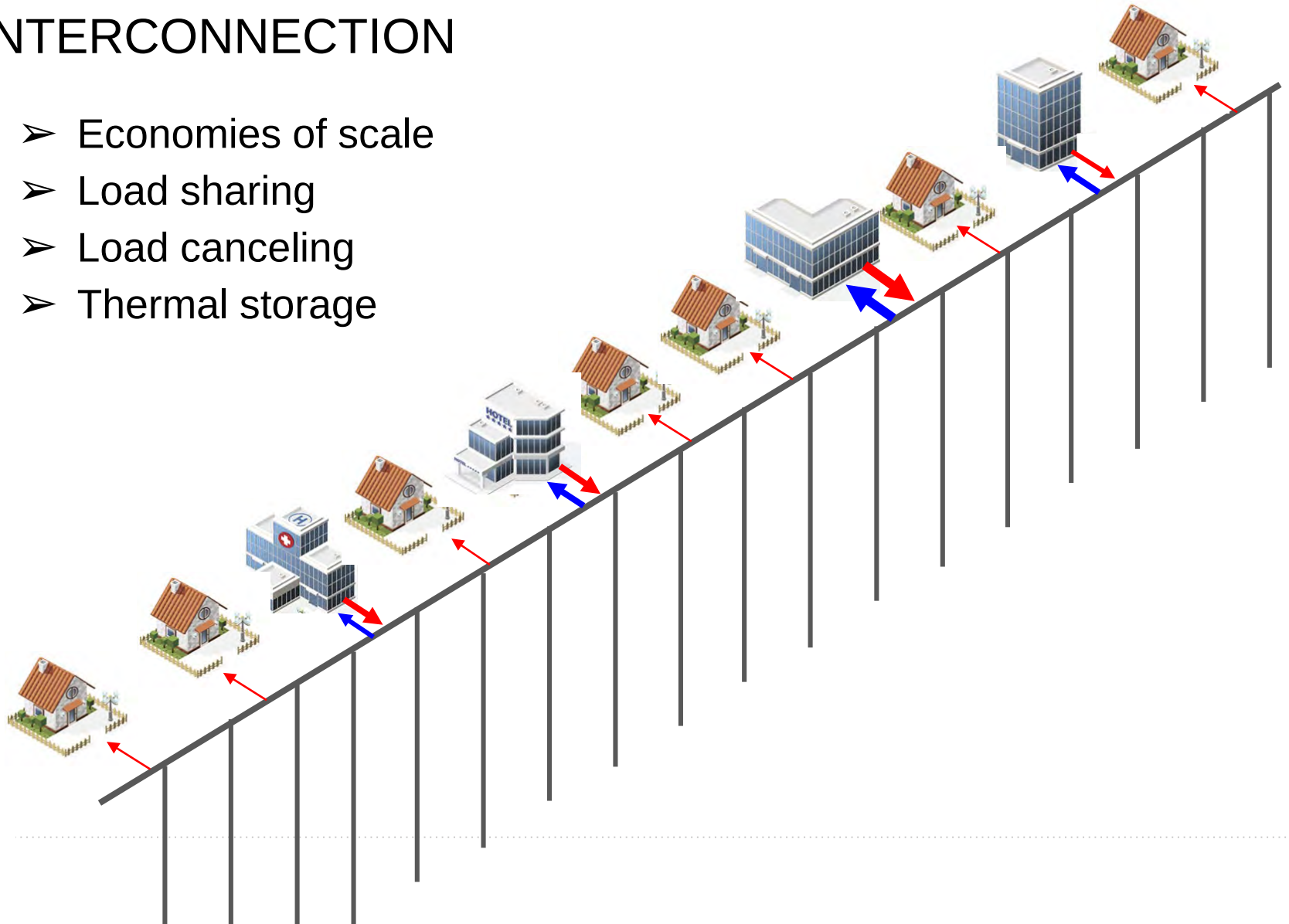
The Geo Grid



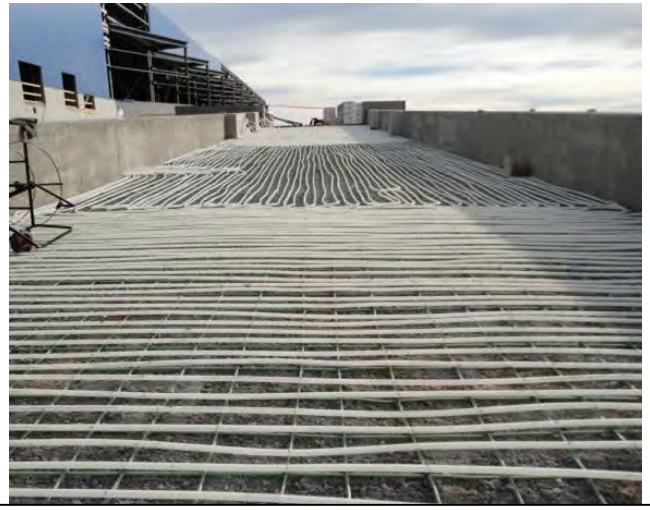
INTERCONNECTION

- Economies of scale
- Load sharing
- Load canceling
- Thermal storage



Other Methods of Thermal Management

Prewarmed Irrigation Water



Melted Snow on Sidewalks

Courtesy of The GreyEdge Group© & IGSHPA

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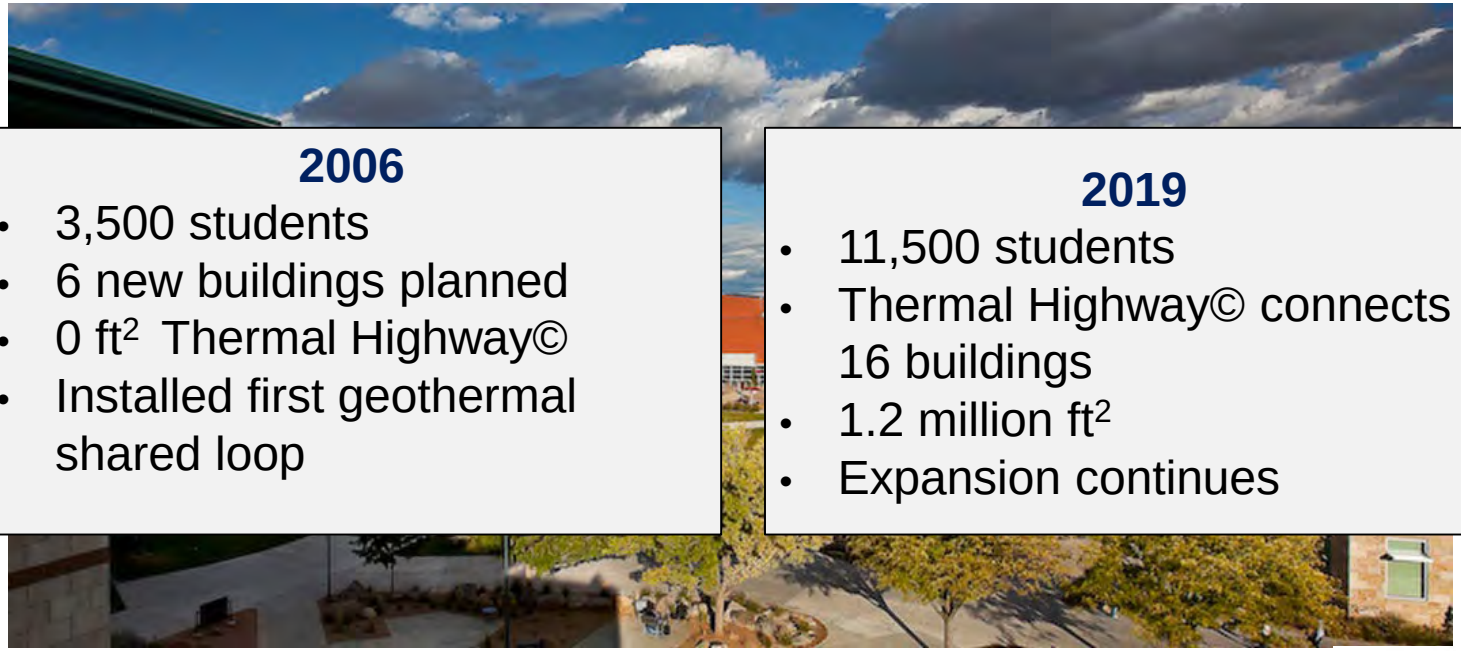
Case Study - Colorado

COLORADO MESA UNIVERSITY



2006

- 3,500 students
- 6 new buildings planned
- 0 ft^2 Thermal Highway©
- Installed first geothermal shared loop

2019

- 11,500 students
- Thermal Highway© connects 16 buildings
- 1.2 million ft^2
- Expansion continues

Thermal Management: Cooling

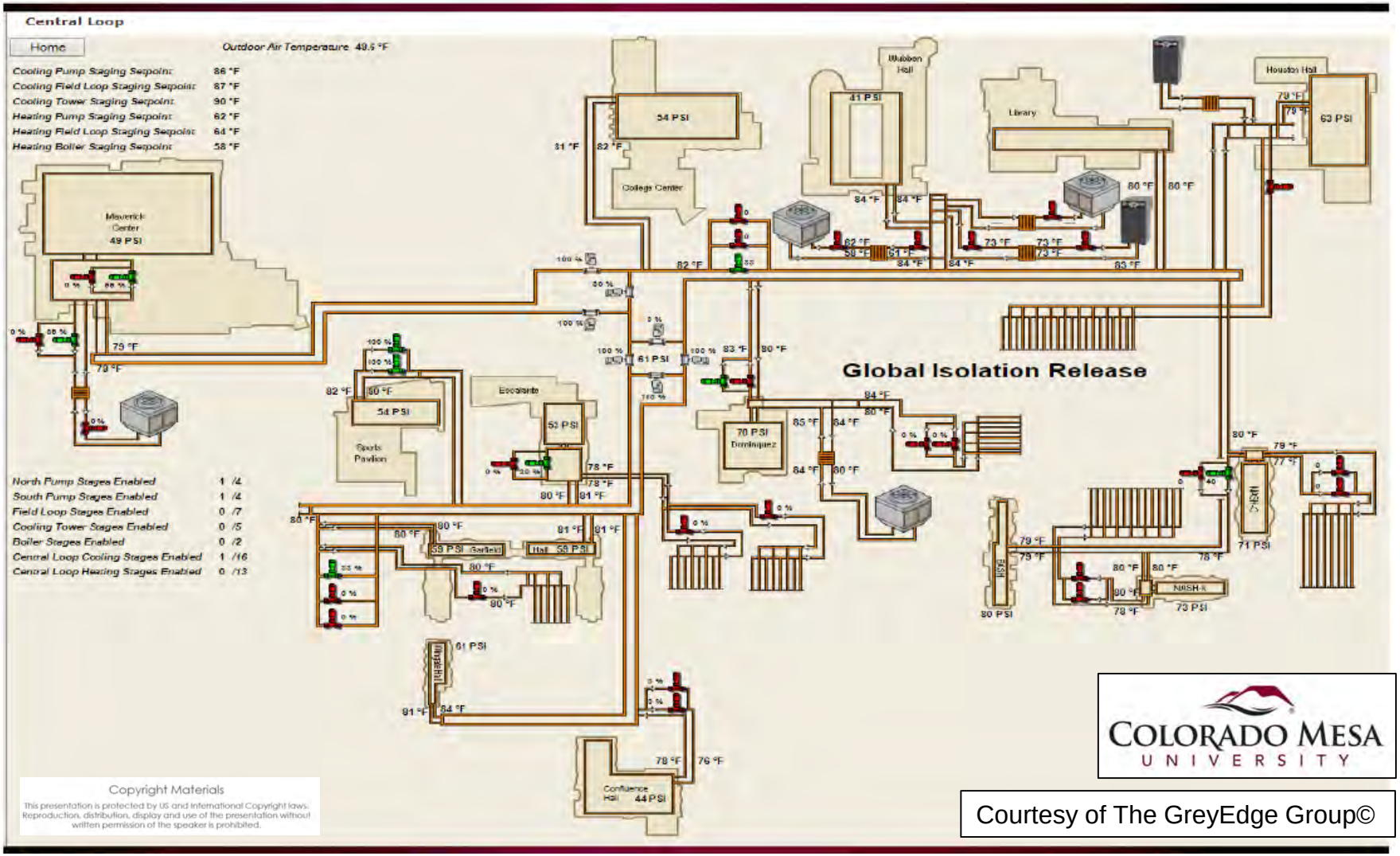
Before:

- ~ 3,400 tons
- 14.5mm gallons/yr
- 784 kW

After:

- 750 tons
- 4.5mm gallons/yr
- 185 kW

Courtesy of The GreyEdge Group© & IGSHPA

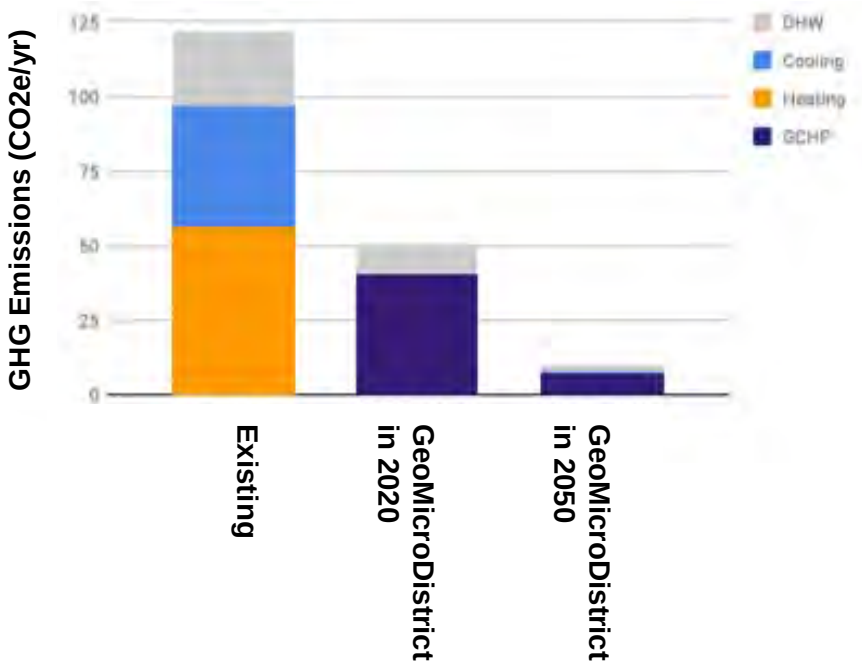


COLORADO MESA UNIVERSITY

Courtesy of The GreyEdge Group©

EXPECTED OUTCOMES ?

- SAFETY
- **Cuts GHG**
- Equitable access
- Good green jobs
- Resilient and reliable
- Provides cooling
- Flattens grid loads
- Cheap energy storage
- Equitable & Low Cost



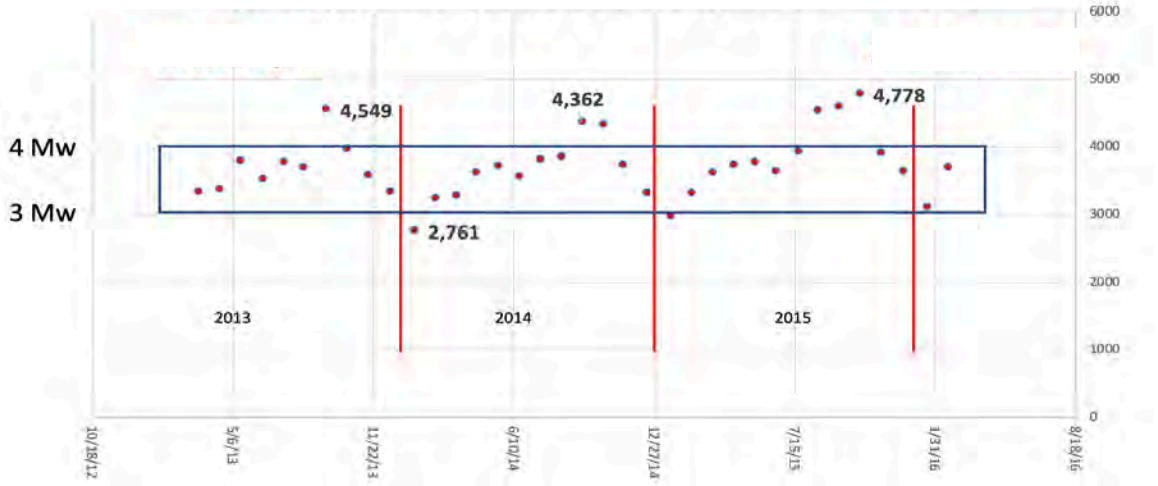
EXPECTED OUTCOMES ?

- SAFETY
- Cuts GHG 90% by 2050
- Equitable access
- Good green jobs
- Resilient and reliable
- Provides cooling
- **Flattens grid loads**
- Cheap energy storage
- Equitable & Low Cost

Colorado Mesa University

PEAK kW Monthly as Shared Geo Grows

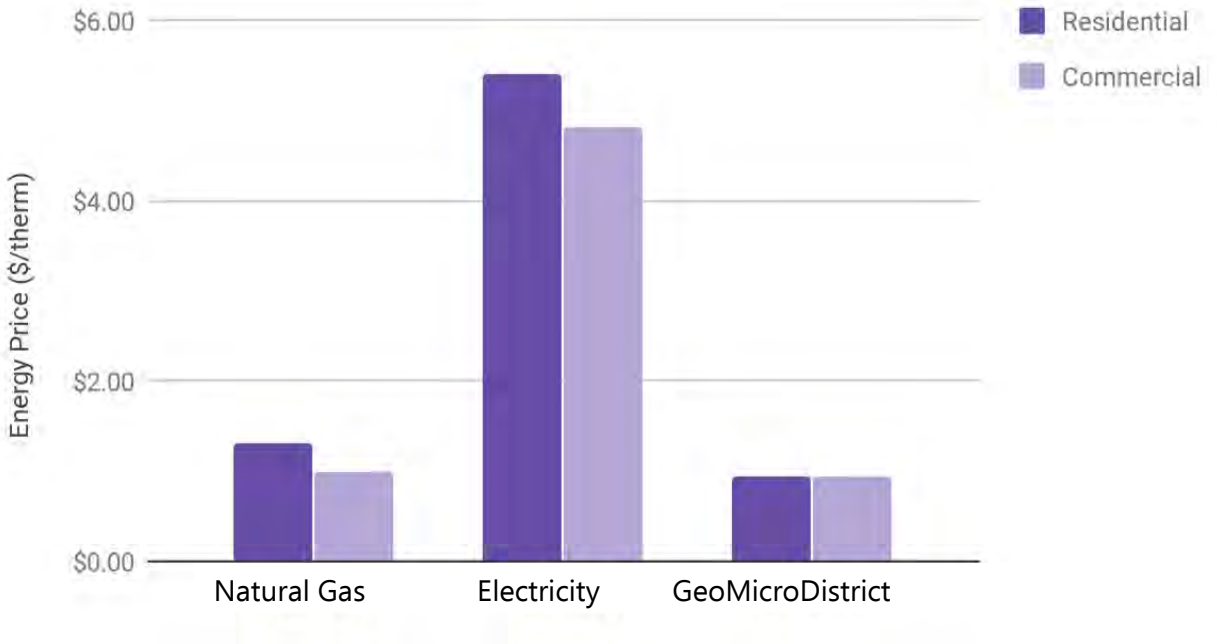
2013 (800,000 ft^2) – 2016 (1,200,000 ft^2)



Courtesy of The GreyEdge Group©

EXPECTED OUTCOMES ?

- SAFETY
- Cuts GHG 90% by 2050
- Equitable access
- Keeps gas worker's jobs
- Resilient and reliable
- Provides cooling
- Flattens grid loads
- Cheap energy storage
- **Equitable & Low Cost**



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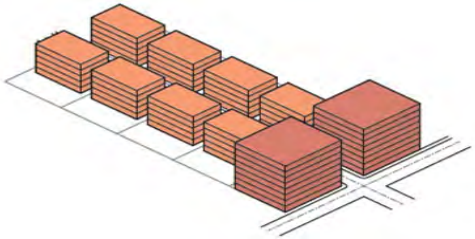
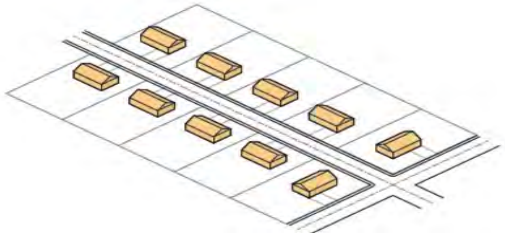
How A Climate Change Nonprofit Got Eversource Thinking About A Geothermal Future

Massachusetts Today

Eversource Gas President



High density mixed-use



Low density residential

Attorney General Healey

U.S. LEGAL NEWS JUNE 4, 2020 / 7:06 PM / 13 DAYS AGO

Massachusetts directs agency to study phase-out of natural gas

Research & Evaluation Team

- **MIT** Sloan School , System Dynamics
- **Harvard** T.H.Chan School of Public Health, C-CHANGE Institute
- **BuroHappold** Engineering
- Massachusetts **DEP** (Department of Environmental Protection)
- **Berkeley National Lab**, Earth and Environmental Science
- University of California, **Berkeley**, Civil & Environmental Engineering
- **National Renewable Energy Laboratories**
- Massachusetts **CEC** (Clean Energy Center)
- The **Grey Edge Group**

Let’s not leave it all up to her.

Thank you to :
Putnam Foundation &
Barr Foundation