EXPLORING CLIMATE SOLUTIONS WEBINAR SERIES

NEIGHBORHOOD-SCALE DECARBONIZATION: GEOTHERMAL AND BEYOND

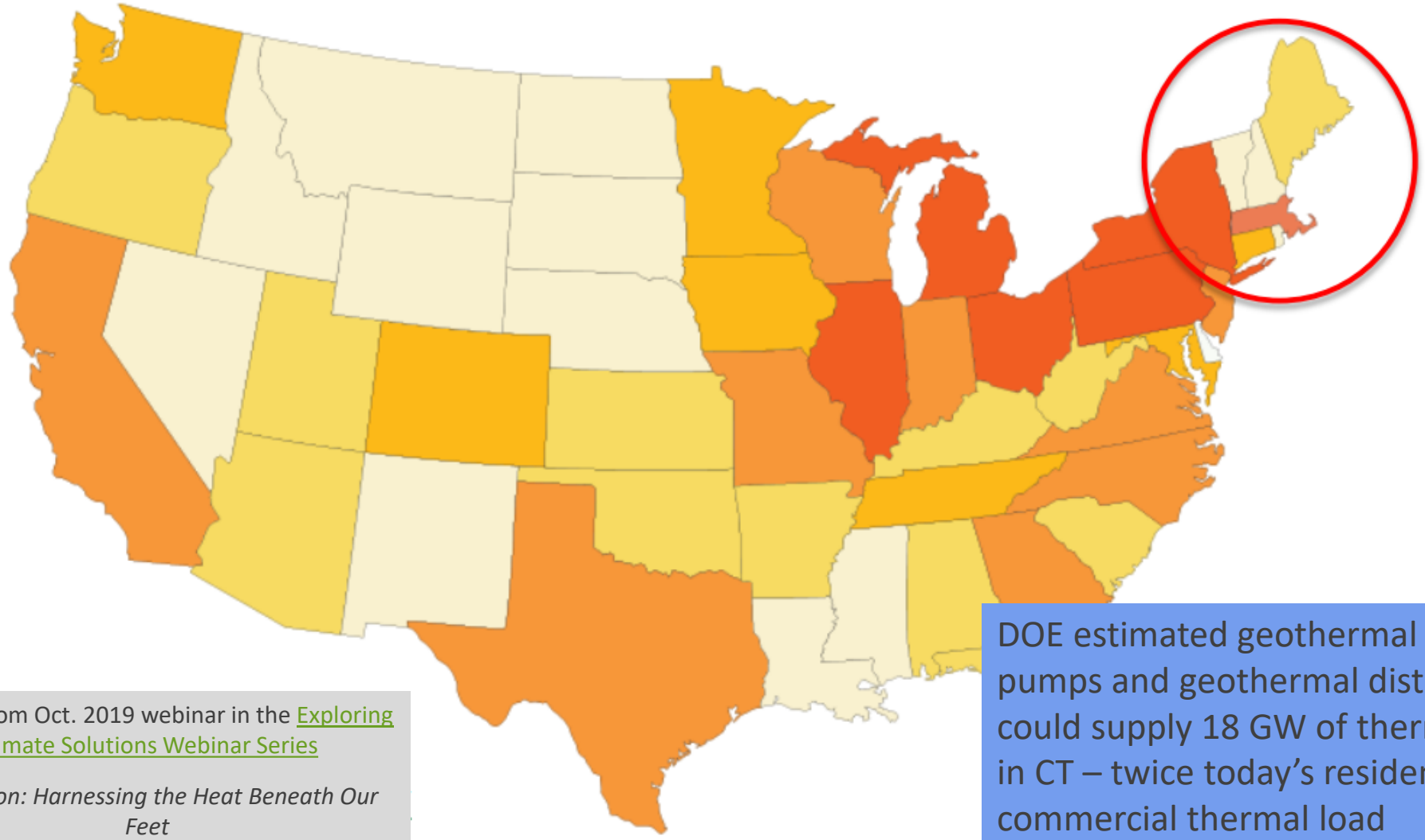
Bureau of Energy & Technology Policy

Exploring Climate Solutions Webinar Series

- Zero-carbon energy
- Climate resilience and adaptation
- Municipal climate planning
- Environmental justice
- Green buildings
- Transit-oriented development
- Green banks
- Renewable thermal energy
- Electric vehicles
- GHG reporting
- Carbon sequestration
- Transportation & Climate Initiative

60+ webinars since 2015

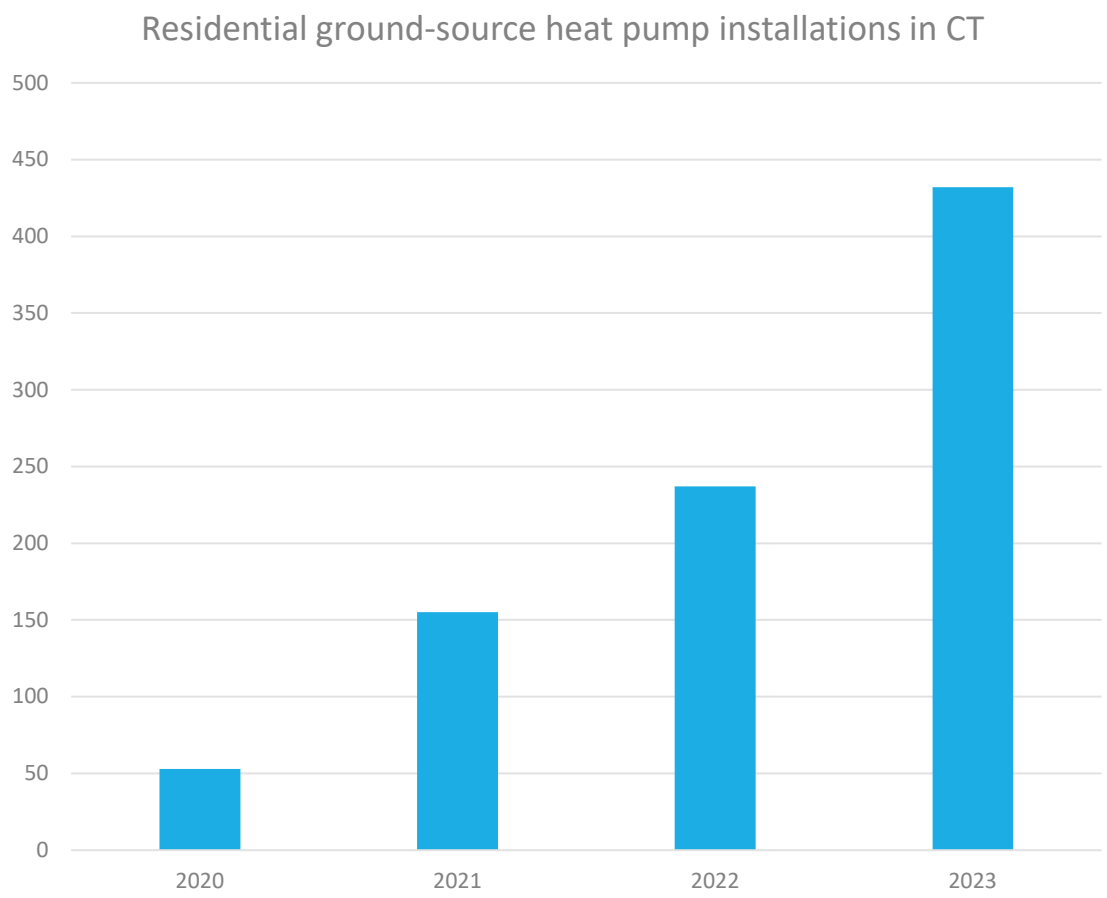
The *GeoVision* GHP Breakthrough scenario indicates significant economic potential for **geothermal heat pumps** in New England – more than 47,000 MW_{th} for the region by 2050. **Connecticut represents ~23% of this total capacity** (10,745 MW_{th}).



Slide is from Oct. 2019 webinar in the Exploring Climate Solutions Webinar Series

GeoVision: Harnessing the Heat Beneath Our Feet

DOE estimated geothermal heat pumps and geothermal district heating could supply 18 GW of thermal energy in CT – twice today's residential and commercial thermal load



8X growth in pace of installation of residential geothermal heat pumps, 2020-2023

Watch for DEEP web page on geothermal energy – launching soon

TODAY'S TOPIC

- Across region and U.S., thermal energy networks (TENs) that serve entire neighborhoods
- Geothermal and other low- and zero-carbon thermal resources for such networks
- Policies, programs, and practices to empower communities to harness this suite of technologies rapidly and equitably

TODAY'S TOPIC

- Across region and U.S., thermal energy networks (TENs) that serve entire neighborhoods
- Geothermal and other low- and zero-carbon thermal resources for such networks
- Policies, programs, and practices to empower communities to harness this suite of technologies rapidly and equitably

Please submit questions via Zoom's **Q&A feature**

Reserve **Chat** *exclusively* for any technical issues

PANELISTS

Jared Rodriguez Executive Director, Community Decarbonization Partners

Debbie New Coordinator, Vermont Community Thermal Networks

Steven Winter Executive Director, Office of Climate and Sustainability, City of New Haven

Host: Jeff Howard, Senior Environmental Analyst, DEEP

Neighborhood -scale decarbonization	Jared Rodriguez
Vermont approach	Debbie New
New Haven and other CT developments	Steven Winter and Jeff Howard
Discussion	
Q&A	

COMMUNITY DECARBONIZATION PARTNERS

www.communitydecarb.org

Transitioning buildings and neighborhoods to local renewable energy

Photo: Jerome Strauss

PLANNING FOR **RESOURCE EFFICIENT DECARBONIZATION** AT THE NEIGHBORHOOD SCALE

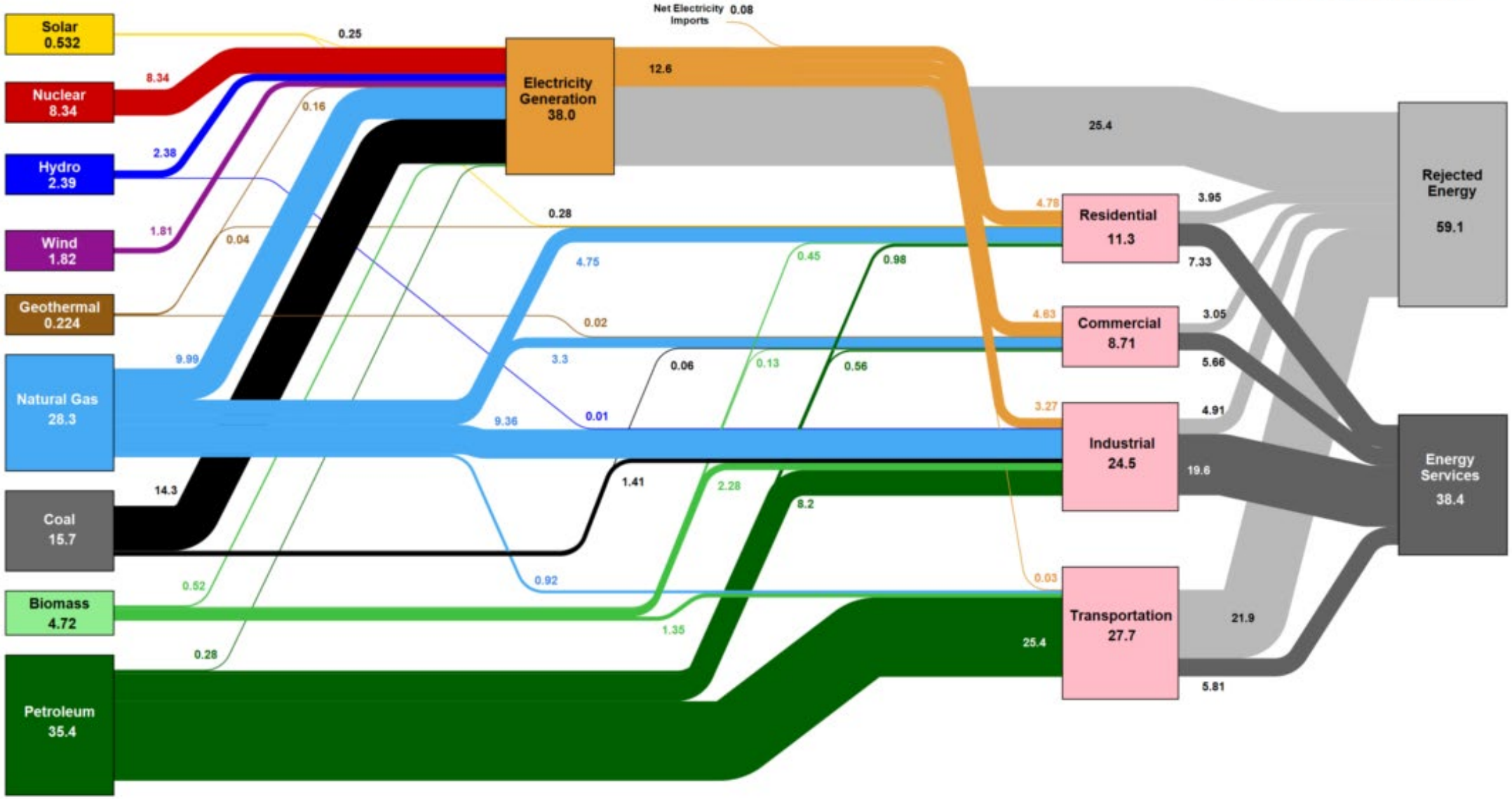
A Phased Approach to Eliminating Greenhouse Gas Emissions from Neighborhoods and Communities in Cold Climates.

A **holistic approach,** combined with a realistic phasing plan, can make scaling decarbonization technically and economically feasible.

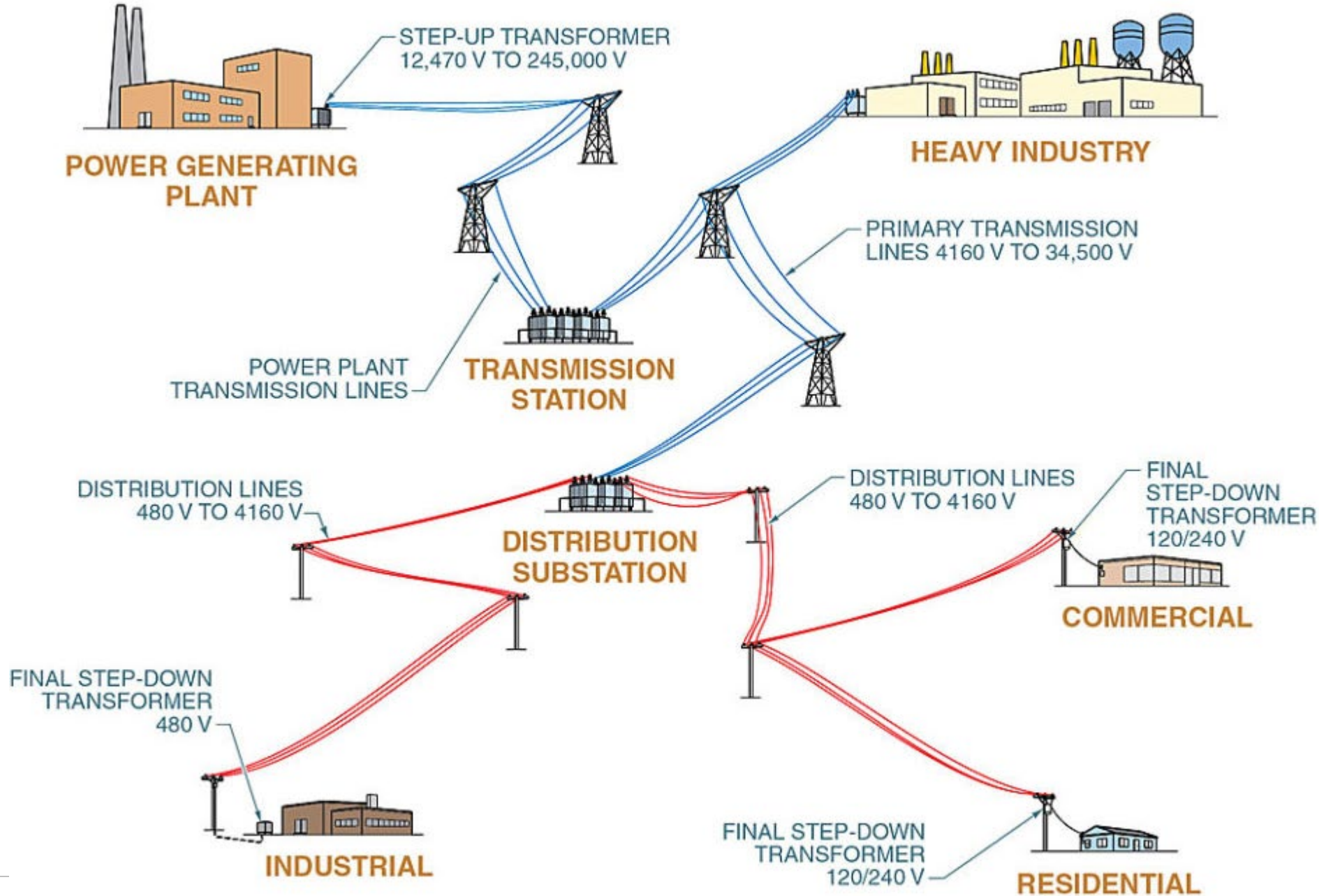
COMMUNITY DECARBONIZATION PARTNERS

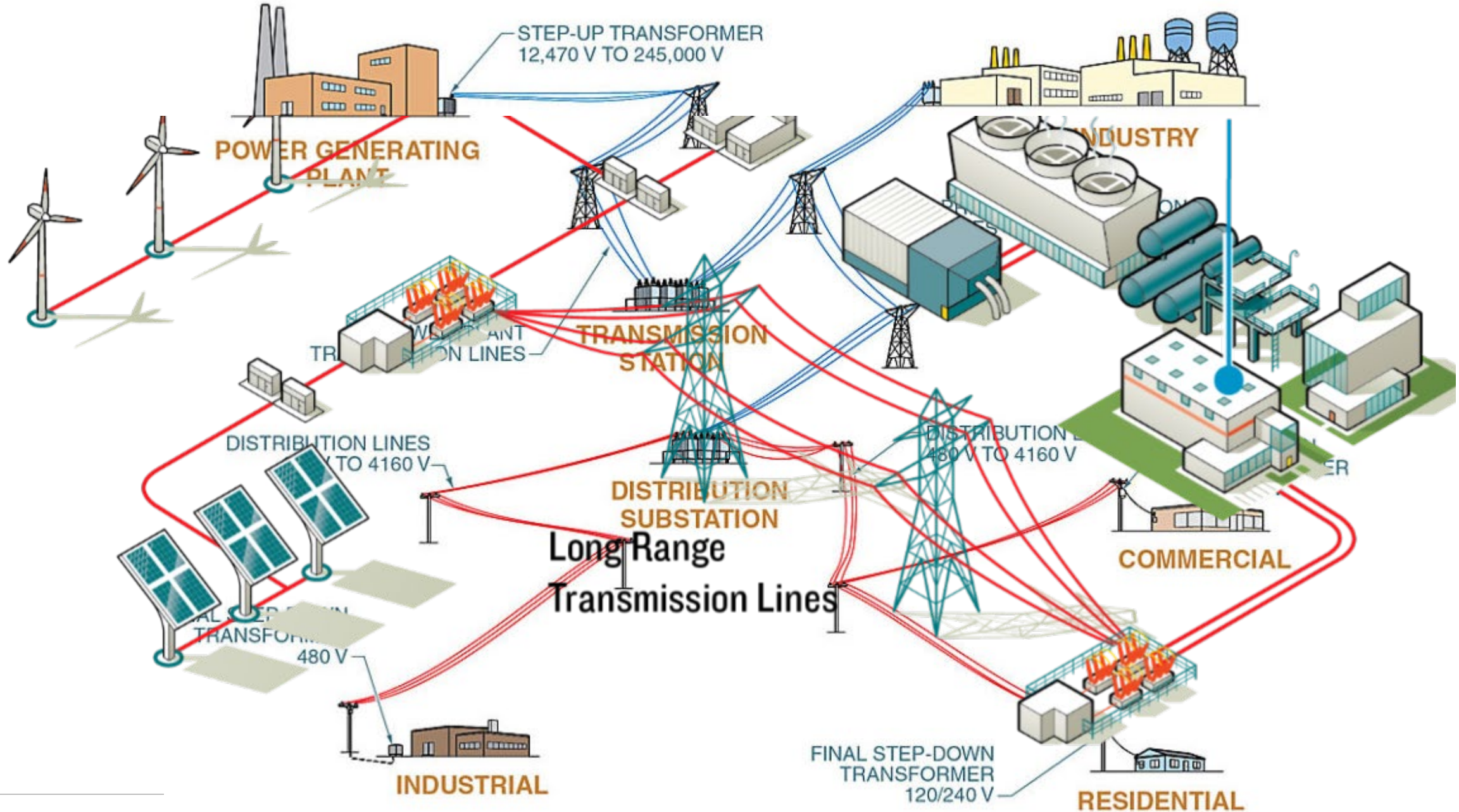
Estimated U.S. Energy Consumption in 2015: 97.5 Quads

Lawrence Livermore National Laboratory



Source: LLNL March, 2016. Data is based on DOE/EIA MER (2015). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 0.65% for the residential sector, 0.65% for the commercial sector, 0.8% for the industrial sector, and 0.21% for the transportation sector. Totals may not equal sum of components due to independent Rounding. LLNL-MI-410527


STEP-UP TRANSFORMER
12,470 V TO 245,000 V
POWER GENERATING PLANT
HEAVY INDUSTRY
PRIMARY TRANSMISSION
LINES 4160 V TO 34,500 V
POWER PLANT
TRANSMISSION LINES
TRANSMISSION
STATION
DISTRIBUTION LINES
480 V TO 4160 V
DISTRIBUTION
SUBSTATION
DISTRIBUTION LINES
480 V TO 4160 V
FINAL
STEP-DOWN
TRANSFORMER
120/240 V
COMMERCIAL
FINAL STEP-DOWN
TRANSFORMER
480 V
INDUSTRIAL
FINAL STEP-DOWN
TRANSFORMER
120/240 V
RESIDENTIAL


STEP-UP TRANSFORMER
12,470 V TO 245,000 V
POWER GENERATING
PLANT
INDUSTRY
TRANSMISSION
STATION
DISTRIBUTION LINES
TO 4160 V
DISTRIBUTION
SUBSTATION
480 V TO 4160 V
COMMERCIAL
Long Range
Transmission Lines
480 V
INDUSTRIAL
FINAL STEP-DOWN
TRANSFORMER
120/240 V
RESIDENTIAL

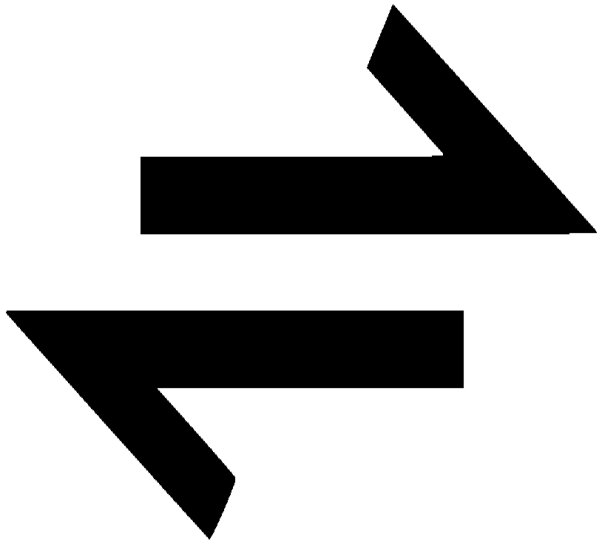
WIRES
RELIABILITY
STORAGE

If we Decarbonize the Economy . . .

Buildings and Industry must replace their thermal energy source with electrically driven sources (heat pumps, etc.).

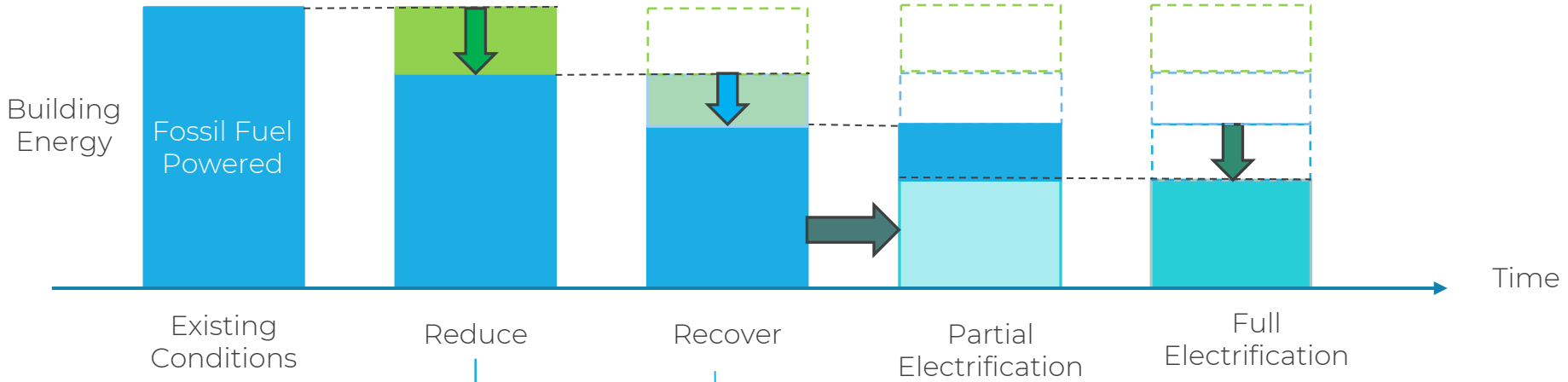
. . . Moving thermal energy across space and time becomes as important as moving electricity from a total system cost and reliability perspective.

ELECTRIC



HEAT

RESOURCE EFFICIENT DECARBONIZATION (RED) IS A FRAMEWORK FOR PRIORITIZING PROJECTS WITHIN A BUILDING OR NEIGHBORHOOD.



Reduce Energy Load and Reconfigure

- Building Envelope Improvements
- Control Optimization
- Ventilation Improvements
- Dedicated Outside Air System
- Hydronic Distribution
- Lower Heating Supply Temp.
- Terminal Units Replacement

Recover Wasted Heat

- Waterside Heat Recovery
- Airside Heat Recovery
- Wastewater Heat Recovery
- Thermal Energy Networks

Partial Electrification

Replace fossil fuel inputs and prioritize the techno-economic portion of load

- Air Source Heat Pumps
- Water Source Heat Pumps
- Geothermal
- Thermal Layering

Full Electrification

In-time, replace or remove the remaining peak load equipment

- Heat Pumps
- Thermal Storage
- District Thermal Network
- Grid-interactivity

ALL PATHS TO RESOURCE EFFICIENT DECARBONIZATION INCLUDE HEAT RECOVERY, RECYCLING AND STORAGE ACROSS THE NEIGHBORHOOD.

Buildings lose heat through a variety of processes. Holistic building decarbonization requires recovering and recycling wasted heat through various interventions:

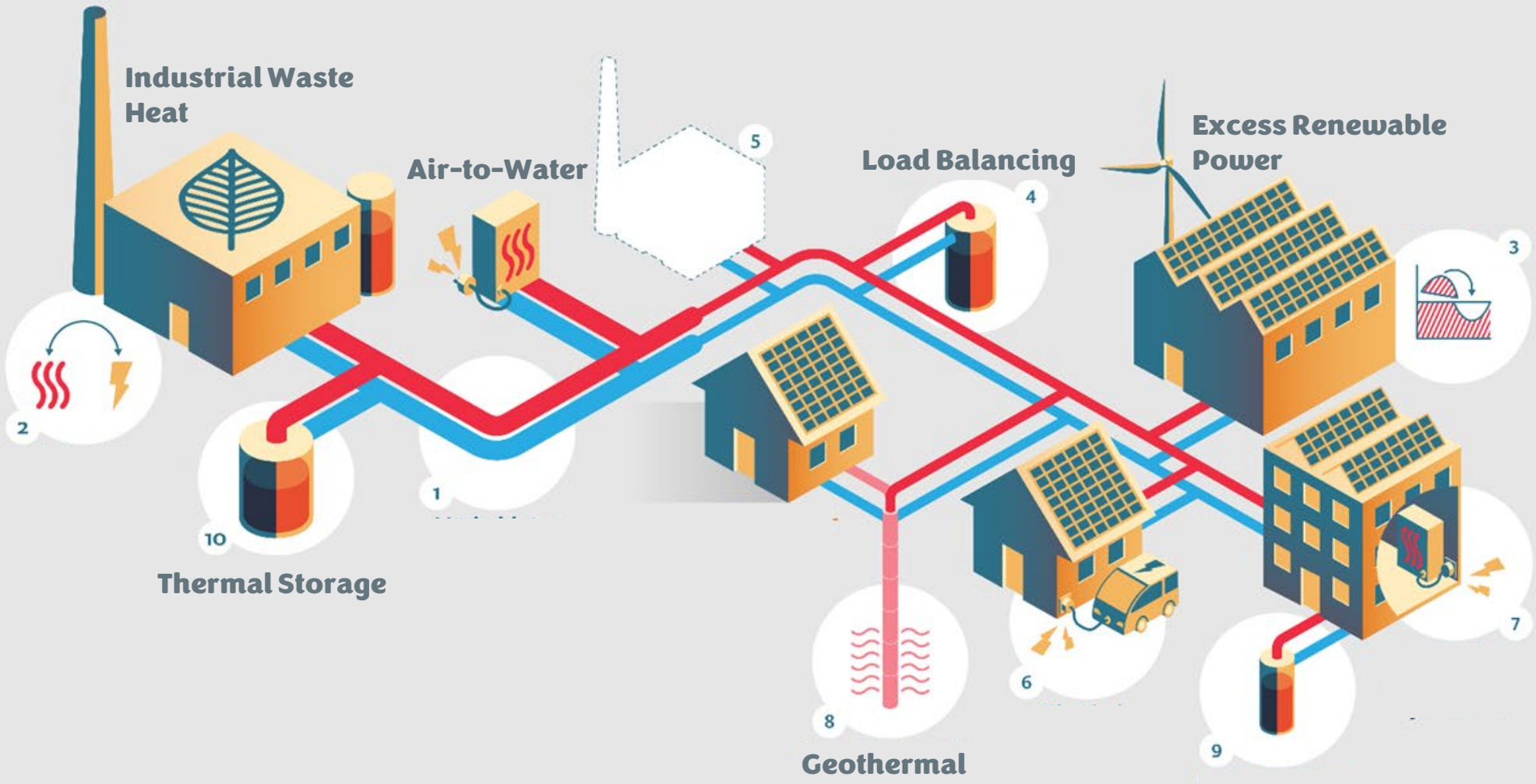
Cooling produces heat. Capture the heat and apply it to other uses, like domestic hot water.

Heat goes down the drain. Extract heat from wastewater with heat pumps and redirect it to other uses.

Think twice about ventilation. Fresh air is fundamental to healthy buildings. Be certain to recover heat and cool from exhaust air.

Save it for later. Incorporate thermal storage technology into designs to save recovered heat for when its most needed.

NEIGHBORHOODS OFFER DIFFERENT THERMAL ENERGY RESOURCES AND REQUIRE VARYING APPROACHES TO THERMAL ENERGY NETWORKS (TENS).



TENs are needed to achieve complete Resource Efficient Decarbonization.

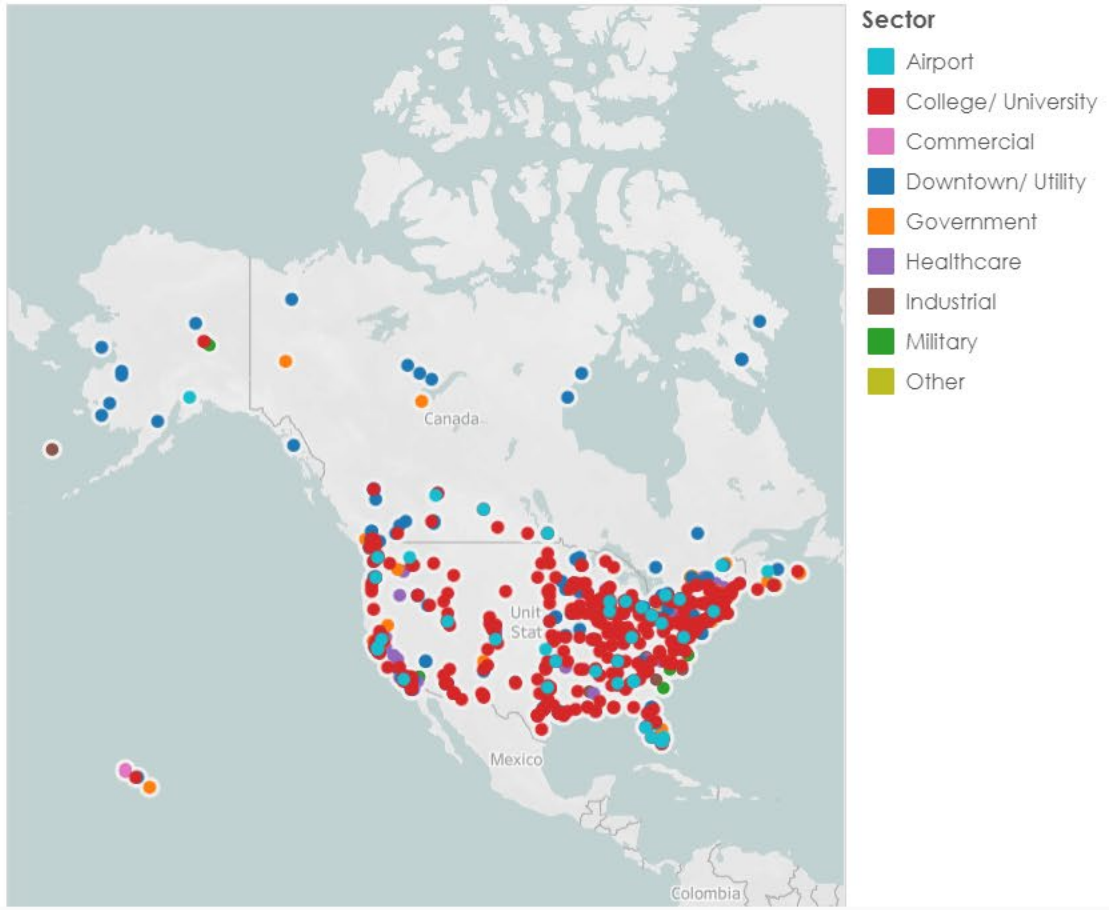
District Energy Systems

United States | Canada | North America

DIRECTIONS:

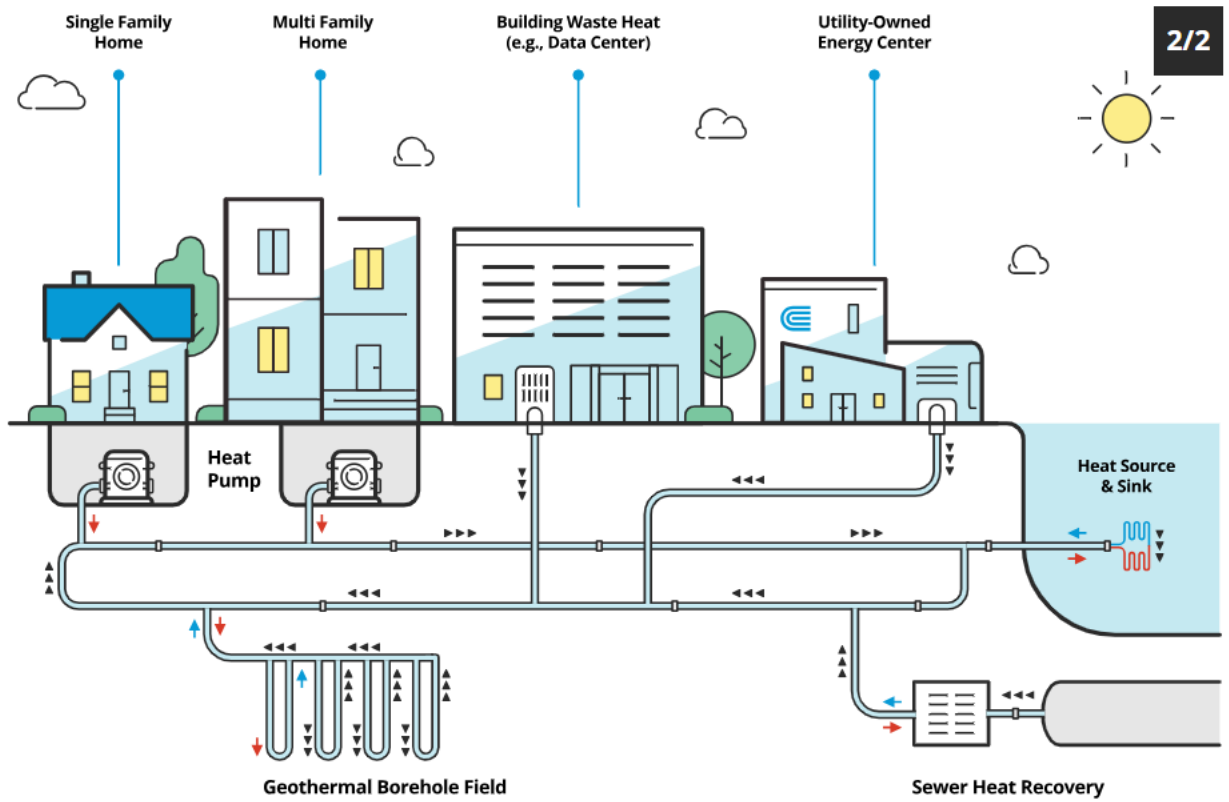
Use the tabs above to switch between maps for North America, the United States, and Canada.

Use the legend on the right to highlight systems in different sectors.



Sector

- Airport
- College/ University
- Commercial
- Downtown/ Utility
- Government
- Healthcare
- Industrial
- Military
- Other



2/2

Thermal Energy Network Cooling in Summer: Heat pumps remove heat from buildings and transfer it to an underground loop of pipes.

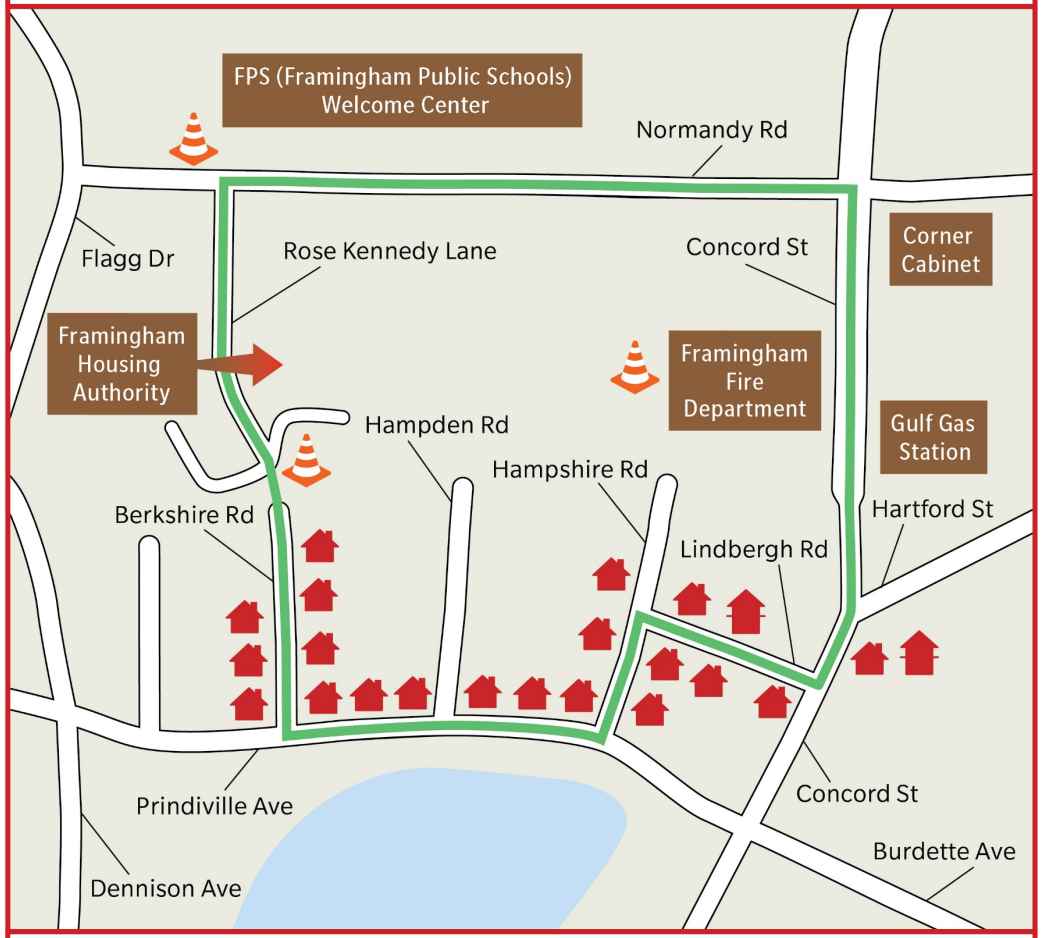
UPGRADE NY

Resources Thermal Energy Networks in NY

These are the pilot projects under consideration from the Public Service Commission (PSC). This map will be updated to reflect the progress made on

EVERSOURCE

Geothermal Pilot Project



Route | Borefield drilling sites | Participants | Residential pilot customers*

**Representation of 24 residential systems (20 single-family households, 2 two-family households).*

Green Streetscapes

Ground source heat pump networks can help to revitalize rural downtowns by creating access to clean heating and cooling.

Location: West Union, IA
Size: 330,000 sq ft
Operating Since: 2012

Photo: Jerome Strauss

THANK YOU.

COMMUNITY DECARBONIZATION PARTNERS

VERMONT
COMMUNITY
THERMAL
NETWORKS

Education • Advocacy • Project Development • Policy

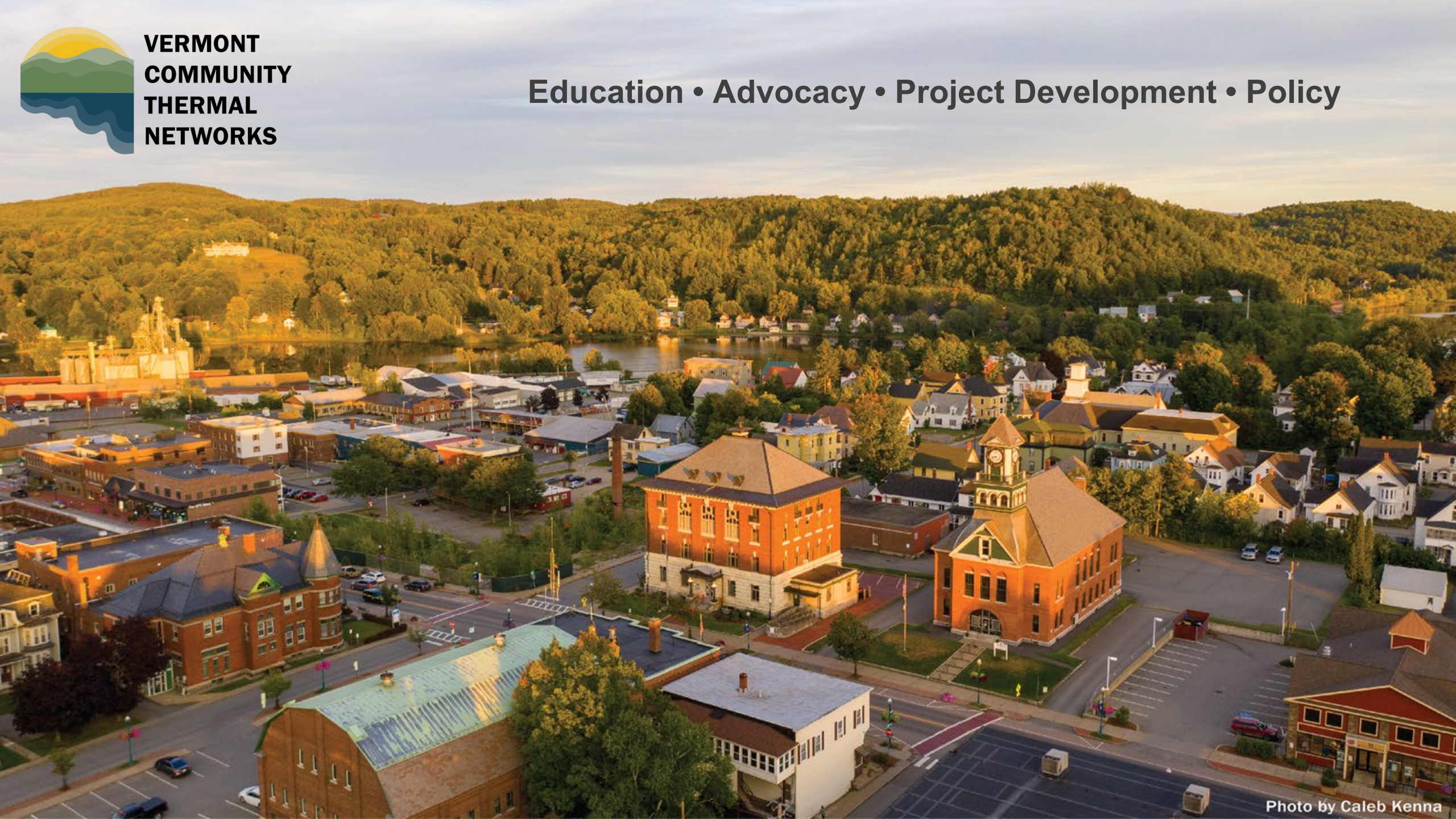
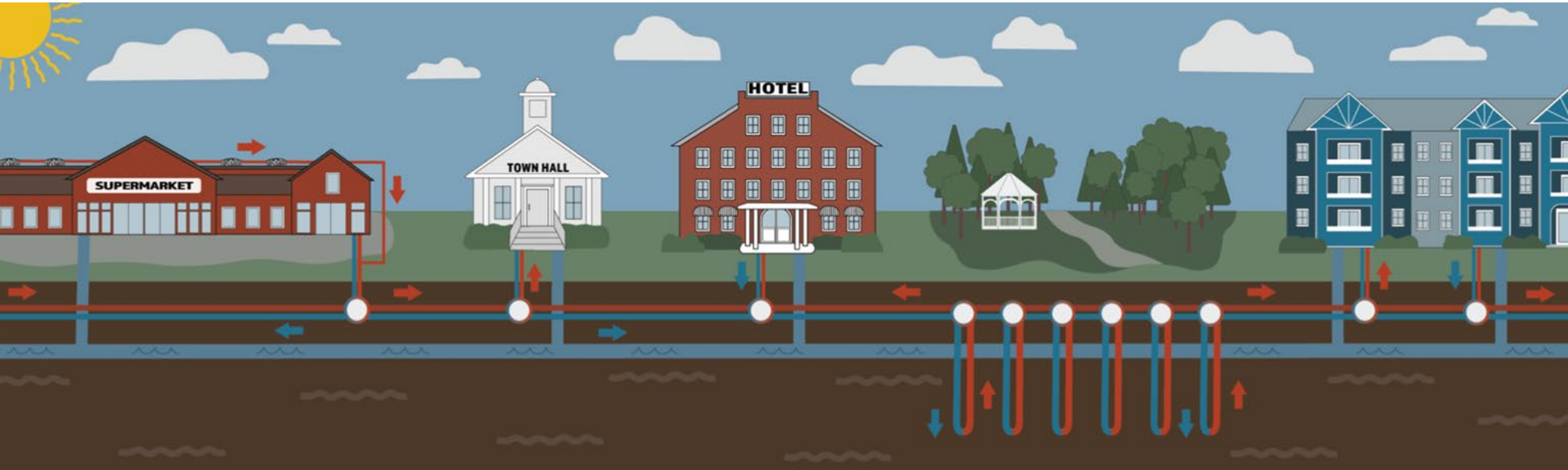


Photo by Caleb Kenna

Community-driven Thermal Energy Networks

Place-based **Local goals & needs** **Multiple pathways**



Thermal Energy Resources

- Grocery stores
- Buildings with large refrigeration systems
- Ice arenas and public pools
- Wastewater treatment facilities
- Data processing centers
- Telephone or internet facilities
- Breweries and distilleries
- Bakeries
- Large office buildings with year-round cooling needs
- Industrial facilities that use or create heat as part of their processes
- Ponds, reservoirs, quarries, and mines
- Green spaces, parking lots, recreation fields that could host geothermal borefields
- Existing solar arrays

"I like that we're not just replicating something pre-packaged. We're asking questions, we're learning, and we're implementing it ourselves, so people are more receptive. Our town has agency."

– Town Energy Committee Member

- ❑ What's already happening?
- ❑ Where could this work?
- ❑ Who's needed?

GOAL: Identify an approach that's acceptable locally

LOCAL CHAMPION

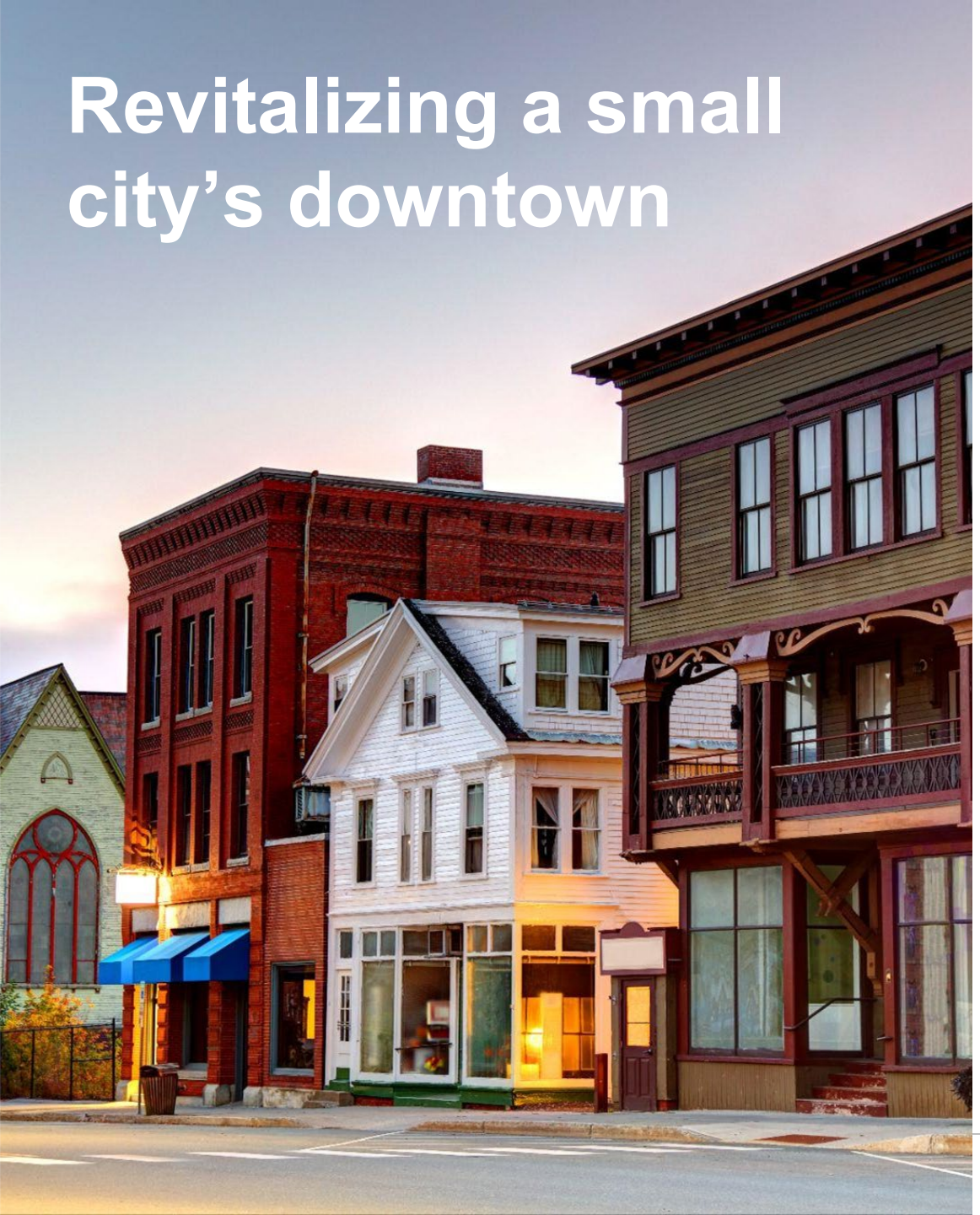
LOCAL KNOWLEDGE

START SMALL

OWNERSHIP OPPORTUNITIES

CO-BENEFITS

Revitalizing a small city's downtown



LOCAL CHAMPION: Town Manager

LOCAL KNOWLEDGE

- **Lead with economic development**
- **Highlight "What's in it for you."**

START SMALL

- **Start with 2 buildings already in development**
- **Add the rest of the block**
- Extend to school, senior housing

OWNERSHIP OPPORTUNITY: Third party

MUNICIPAL ENGAGEMENT: Local champion

CO-BENEFITS

- **Relieve financial pressure on existing projects**
- Affordable heat for affordable housing
- Create Main Street focus & identity

Supporting economic development

LOCAL CHAMPION: Energy Committee Chair

LOCAL KNOWLEDGE

- **Fix the town pool's energy problem**
- Recruit the developer to lead

START SMALL

- **Housing first**
- Tie in industrial park

OWNERSHIP OPPORTUNITY: Regional Economic Development Corporation

MUNICIPAL ENGAGEMENT:

- **City Manager needs help**
- Mayor manages industrial park

CO-BENEFITS:

- Housing demand creates density
- New businesses attracted by lower cost energy

Creating an Energy Innovation District

LOCAL CHAMPION: Housing advocate

LOCAL KNOWLEDGE

- **Need for housing, services, & spaces**
- **Bond constraints require different pathway**

START SMALL: Begin with property owners & businesses

OWNERSHIP OPPORTUNITY: LLC with existing Community Trust

MUNICIPAL ENGAGEMENT

- Town Planner
- Key selectboard member and village trustee

CO-BENEFITS

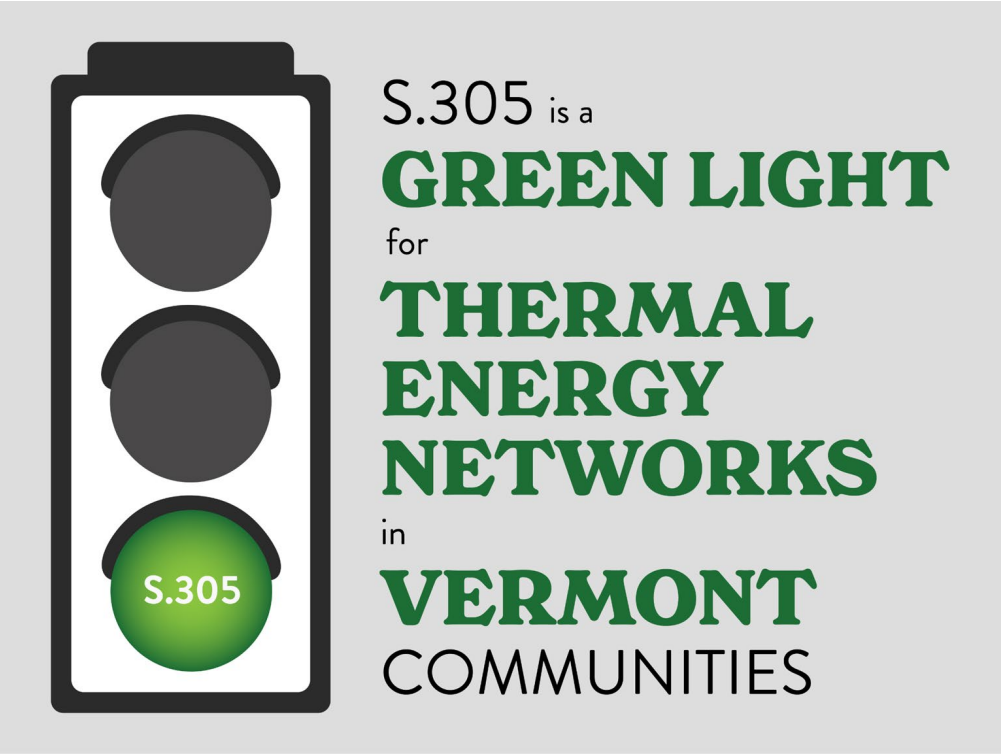
- **Move shelved development plan forward**
- Preserve local historic, aesthetic character

LOCAL CHAMPION	LOCAL KNOWLEDGE	START SMALL	OWNERSHIP OPPORTUNITIES	CO-BENEFITS
Leadership	Messaging	Cluster & phase	Flexible	Local priorities
Network	Workshops	De-risk	Acceptable	Multiple needs


CANADA
Maine
Orleans
Essex
Franklin
Lamoille
Caledonia
Washington
Orange
Grafton
Vermont
Windsor
Rutland
Sullivan
Washington
Saratoga
Bennington
Windham
Cheshire
Rensselaer
Franklin
Vermont LDCs
Interstate Pipelines
Facilities

SIGNED INTO LAW MAY 30, 2024

Vermont's Thermal Energy Networks Act



Allows municipalities, co-ops, businesses, non-profits, and other community-based organizations to operate Thermal Energy Networks

Heat is a precious resource.

We have the heat we need . . . *and* opportunities to harness it.

A community-driven approach for Connecticut

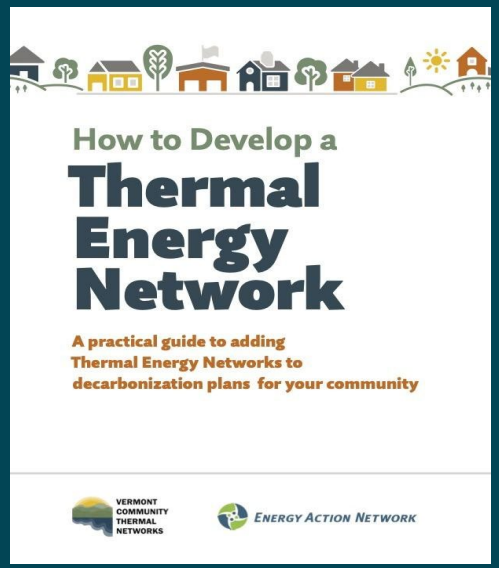
VERMONT COMMUNITY THERMAL NETWORKS

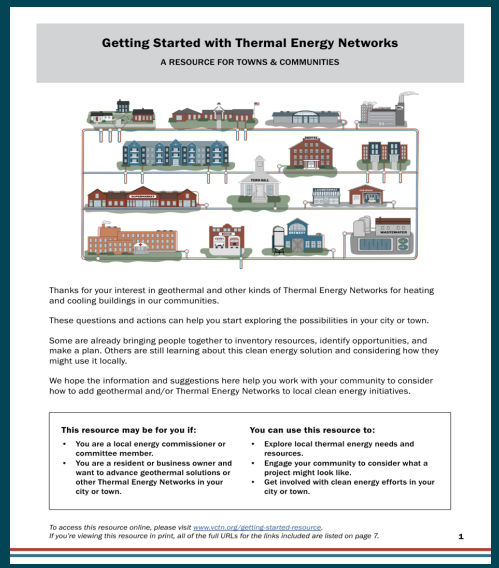
www.vctn.org

debbie@vctn.org

COMMUNITY DECARBONIZATION PARTNERS

www.communitydecarb.org





CONNECTICUT

Commercial/institutional geothermal installations

- **At least 14 Connecticut municipalities** – town halls, libraries, schools, other public facilities
- **At least 6 colleges and universities** – academic buildings, residence halls
- **Numerous companies, private schools, housing authorities**

50+ projects, existing or in development

Watch for DEEP web page on geothermal energy – launching soon

No utility-led TENs

- **Statutory obstacle**

But municipalities and private developers are exploring potential TENs

- **Manchester**
- **Westport**
- **New Haven**

Union Station Area Thermal Energy Network (USATEN) Proposal

US EPA Climate Pollution Reduction Grants Program - Implementation Grants

Generational Investment in New Haven Clean Energy

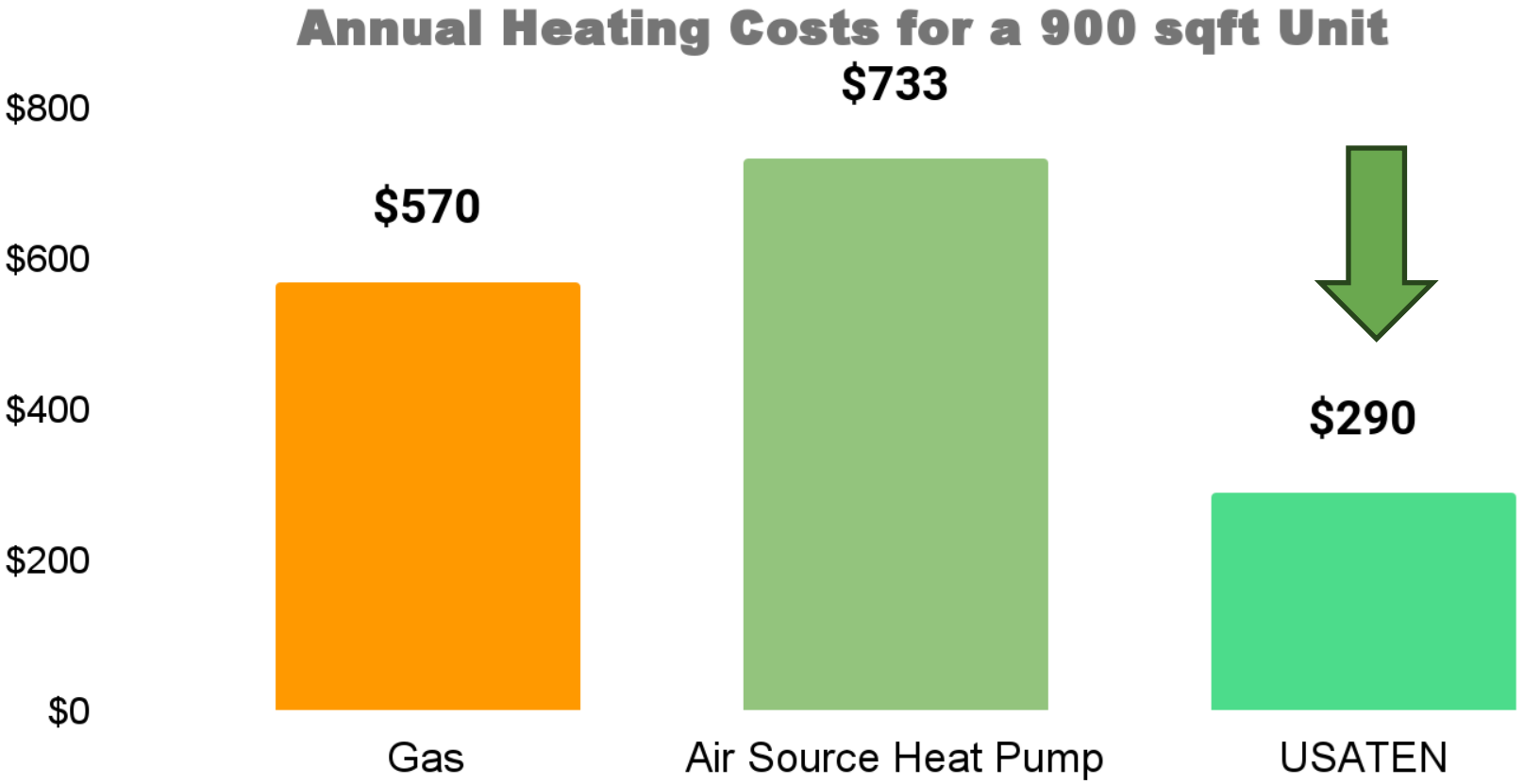
Partnership between the City, ECC, and NHPA to decarbonize one of New Haven's most important buildings – historic Union Station – and provide clean, affordable heating and cooling to the new Union Square development.

- Reduce climate and air pollution
- Build shared platform for affordable, neighborhood-level decarbonization
- Create high-quality jobs/apprenticeship opportunities

Project Site

- The Union Station Area Thermal Energy Network (USATEN) is a networked geothermal system to provide the lowest-cost, carbon free heating and cooling to Union Station and the Union Square development across Union Ave
- Additional buildings (e.g., Trowbridge Square, 1 Union Ave) can be added as system expands in the future at lower cost.

Utility Bill Benefits for Residents



50% reduction in heating cost

Data: EnergizeCT, EIA, NOAA. ASHP COP: 3.1; USATEN COP: 6.

DEEP post-webinar note: As Steven Winter discussed the previous slide, his audio transmission faltered. The following is a transcript of the audio edited to convey his intended meaning. (In the webinar recording, this passage occurs between 37:46 and 39:30.)

So this slide focuses on our reduction in heating costs that we forecast for the system. It's based on data from the Energize CT heat pump specialists that compares heating costs for natural gas and various air source heat pump systems, looking at the last few winters in Connecticut and the prevailing utility rates. And then we've scaled those costs down based on the assumed coefficient of performance of the area thermal network (or USA 10 is what we call it). So you can see that there's really a significant reduction in the forecast heating costs. There'd be a similar – roughly cutting in half – reduction of cooling costs. One cost that's not covered in the diagram would be the cost of drawing on the thermal network as a resource. We would expect that households – and Union Station – would pay a monthly fee to draw energy from the thermal energy network. And we think that would roughly cancel out the savings from reduced cooling as compared with typical air condition – that it is roughly a wash. So assuming that the cooling cost savings and monthly cost to connect to the thermal energy network are roughly equivalent, there is still a very significant, roughly 50 percent, reduction in heating costs.

Expansion: Neighborhood-Scale Decarbonization

- Expansion can meet the needs of new development and existing neighborhood buildings
- Bringing on new “anchor” properties will help lower the cost to serving smaller properties
- A diversity of uses increase the system efficiency: buildings with heating and cooling needs can push and pull heat into the system

Q& A

Please submit questions via Zoom's Q&A feature

Indicate whether question is for a particular individual, or for the panel

Thanks

Webinar recording and slides will be on
Exploring Climate Solutions Webinar Series web page

Contact: Jeff.L.Howard@ct.gov