STUDIO 605
ENERGY TRANSITION LANDSCAPES: DEERFIELD

NICK DOMBROWSKI, ORIYA FALK, NINA FRITSCH,
BRIDGET HEALY, EILEEN HELCK, MICHAEL NEVINS, LIA POTTER

PROF. CAROLINA ARAGON
UNIVERSITY OF MASSACHUSETTS AMHERST
LANDSCAPE ARCHITECTURE & REGIONAL PLANNING

FALL 2024

TABLE OF CONTENTS

INTRODUCTION

In 2021, Governor Charlie Baker signed into law 'An Act Creating A Next-Generation Roadmap for Massachusetts Climate Policy' which requires economy-wide emission reduction requirements and a comprehensive plan to achieve the required emission standards.

The Secretary of the Office of Energy and Enviromental Affairs has determined the economy wide emissions limit will be a 33% reduction from 1990 levels in 2025, and a 50% reduction in 2030.

This plan expresses the state's collective vision for a 2050 future in which there is minimal reliance on fossil fuels for heating homes, powering vehicles, and operating the electric grid.

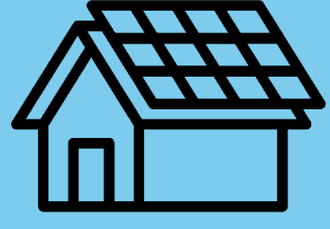
50%
REDUCTION
BY 2030

INTRODUCTION

Decrease Energy Use

Transitioning buildings, vehicles,and other end uses away from consuming fossil fuels

Energy Efficiency and Flexability



Aggressively pursuing energy efficiency and flexability to enable cost effective decarbonization

Decarbonizing Energy Supply

Producing zero and low carbon energy supplies to power our energy system

Carbon Sequestration

Balancing remaining emissions by facilitating carbon dioxide removal from the atmosphere

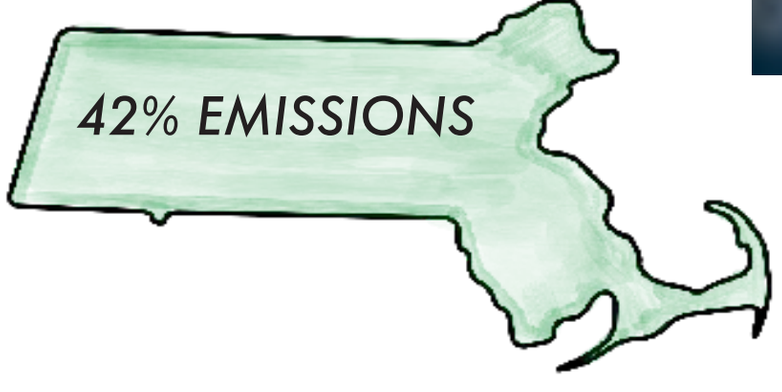
TRANSFORMING OUR TRANSPORTATION

TRANSFORMING OUR TRANSPORTATION

DRIVING OUR FUTURE FORWARD

Transportation is Massachusetts' largest source of pollutants; responsible for 42% of all emissions in 2019.

One major cause of the increased emissions is the result of growing prosperity and increasing population in the state; as more people begin to live and travel in the commonwealth, the total amount of transportation emissions has increased.



Interstate 90 outside Boston
Image: WBUR/Jesse Costa

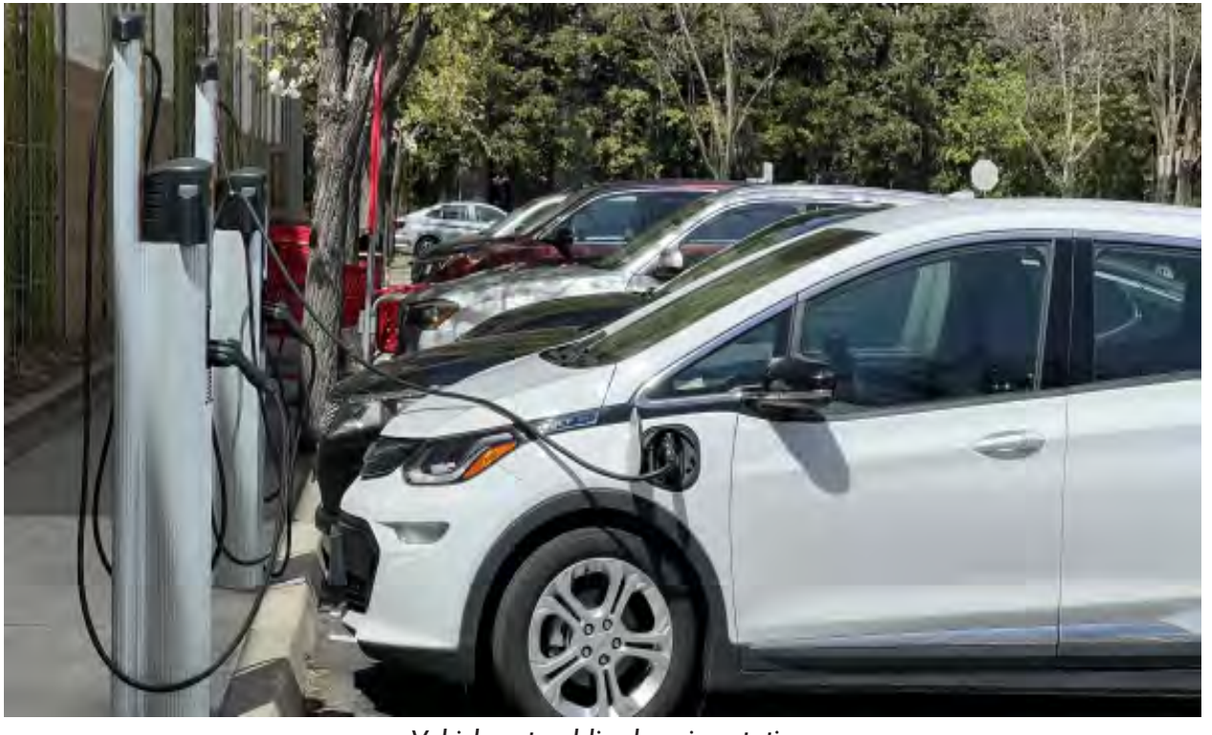
Massachusetts Clean Energy and Climate Plan for 2025 and 2030
United States Department of Energy

TRANSFORMING OUR TRANSPORTATION

PASSENGER VEHICLES

Passanger vehicles account for over 61 billion miles driven on Massachusetts road yearly.

To achieve the 2030 climate goals, Massachusetts aims to have 200,000 electric vehicles on their roads and over 15,000 electric vehicle charging stations installed on highways, city streets and parking lots around the Commonwealth. With the transition to EV's, Massachusetts residents could see a savings of more than 50% off their monthly fueling.



Vehicles at public charging station
Image: Pew Reseach Center

EV VS GASOLINE FUEL COST

TRANSFORMING OUR TRANSPORTATION

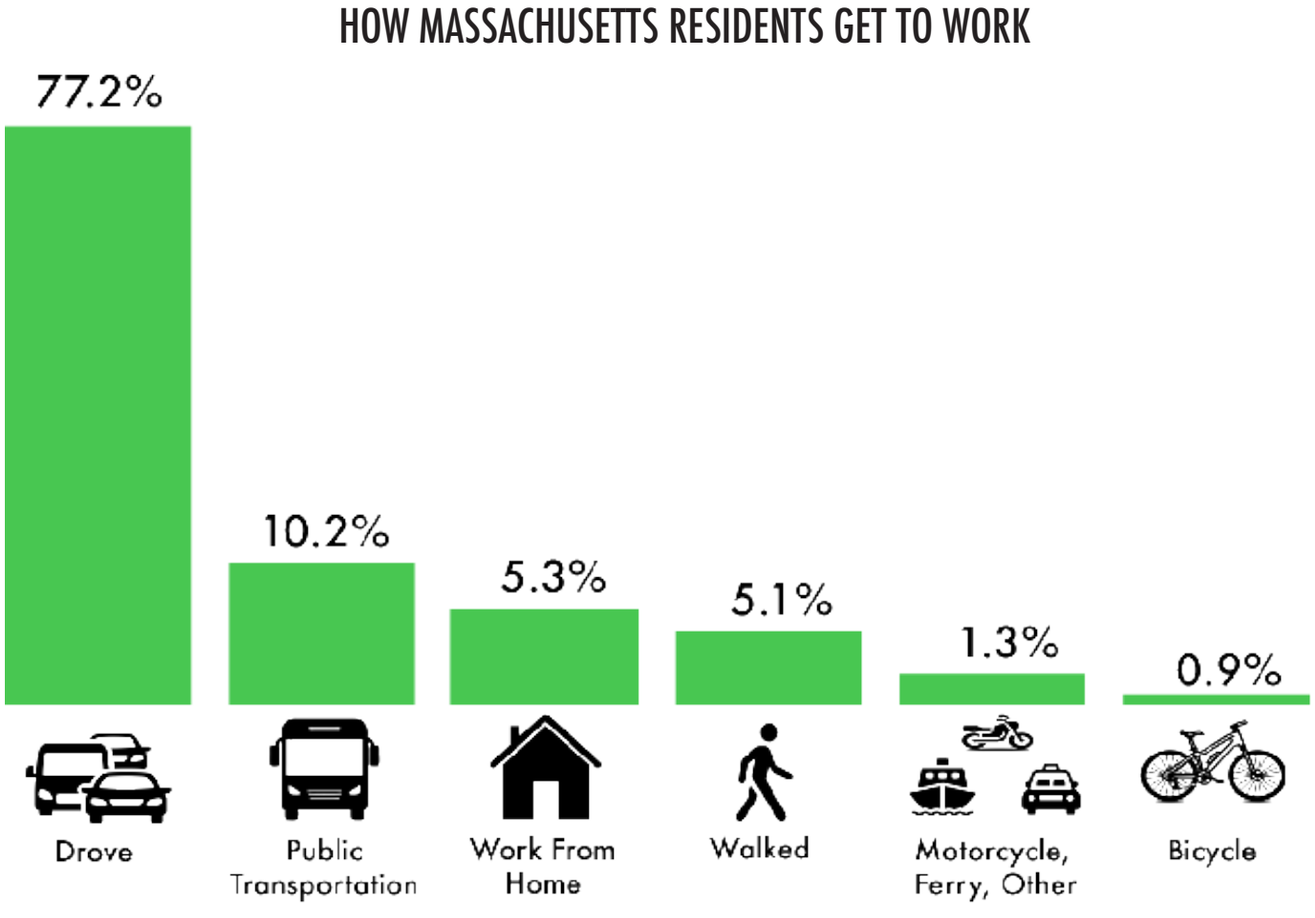
PUBLIC TRANSPORT

Public transportation is paramount to the sucess of Massachusetts climate goals. Support for large, transportation-related infastructure project will support the reduction of transportation emissions.

Allowing multi-family zoning near transit station. Many cities and towns have regulations in place, limiting the amount of people able to access to quality transportation.

Execute the MBTA and PVTA modernization program. Over 1300 public buses will be electric vehicles by 2030.

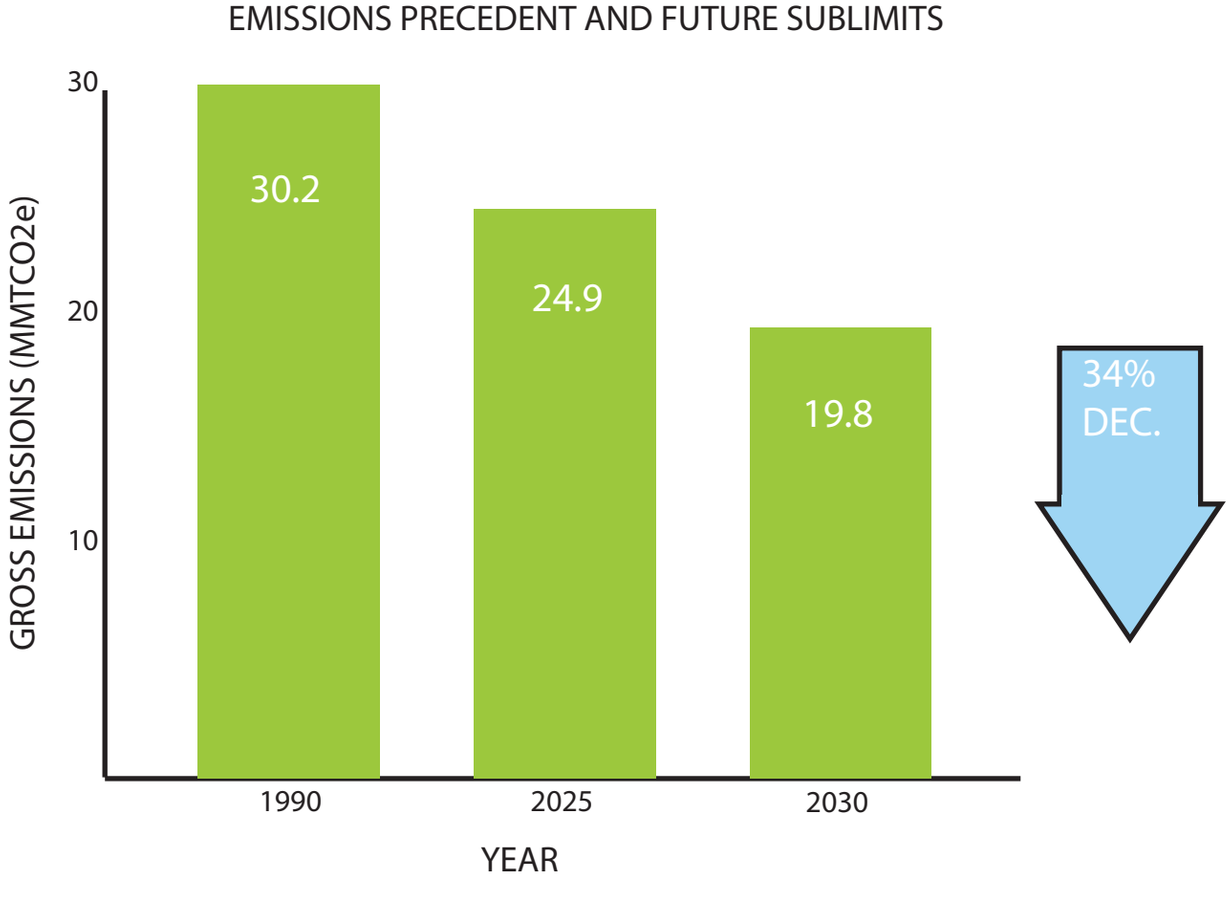
Support the 'Complete Streets' initiative. This program invests in local public transportation projects like bike lanes, sidewalks, and street designs that promote public safety.



Massachusetts Clean Energy and Climate Plan for 2025 and 2030
Bureau of Transportation Statistics

TRANSFORMING OUR TRANSPORTATION

EMISSION SUBLIMITS



The MBTA
Image: Boston Magazine

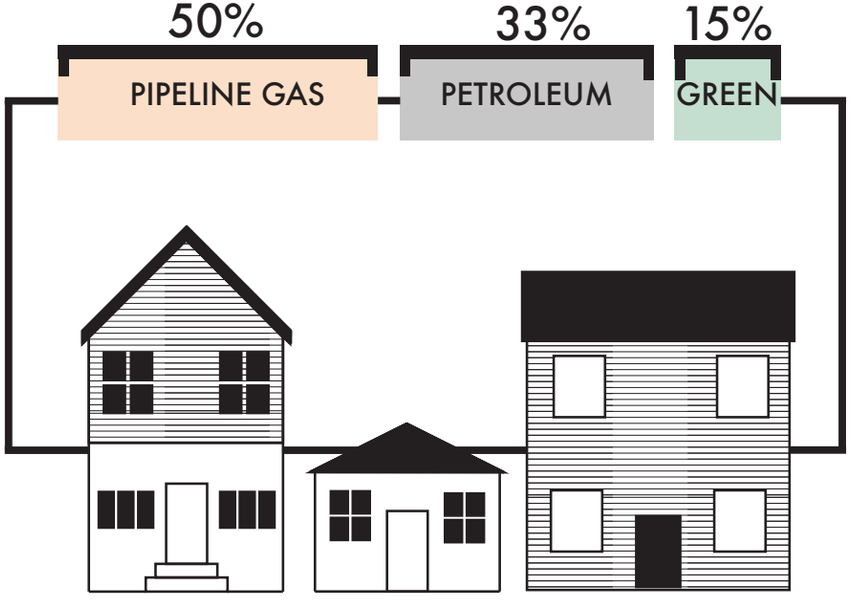
TRANSFORMING OUR BUILDINGS

Heating in buildings by oil and gas represented 30% of statewide GHG emissions in 2020.

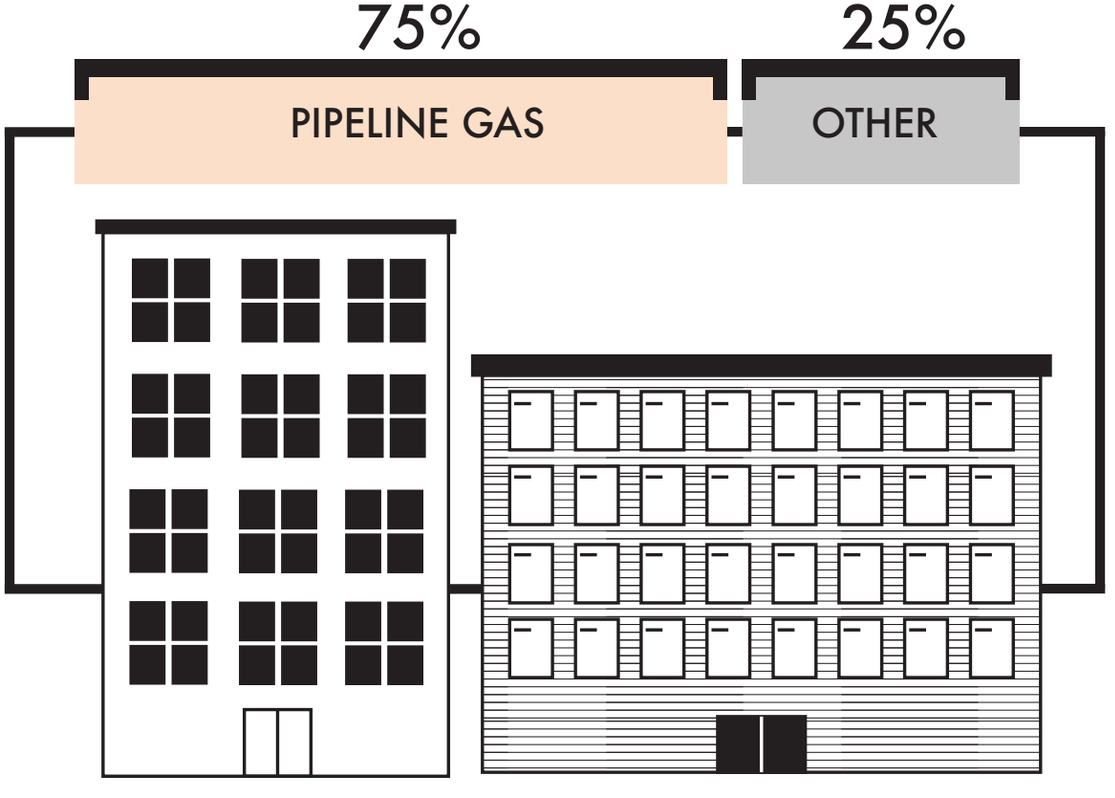
TRANSFORMING OUR BUILDINGS

THE BUILDING SECTOR

The Building sector of Massachusetts is large and diverse, with over two million individual buildings. Space heating is the biggest demand on a building's energy, followed by water heating, cooking, and electrical appliances.



Type of heat used in residential buildings

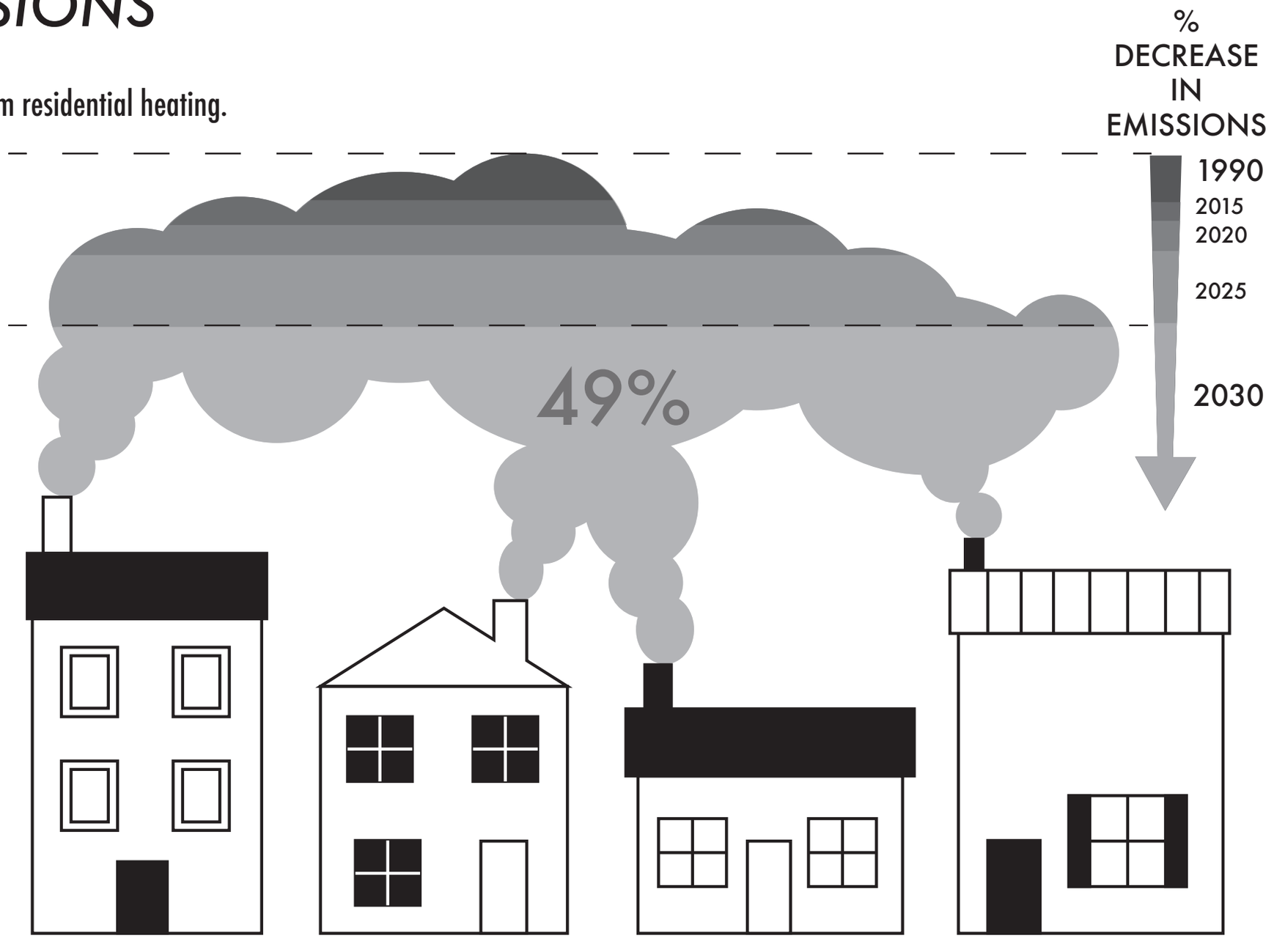


Type of heat used in commercial buildings

TRANSFORMING OUR BUILDINGS

EMISSIONS

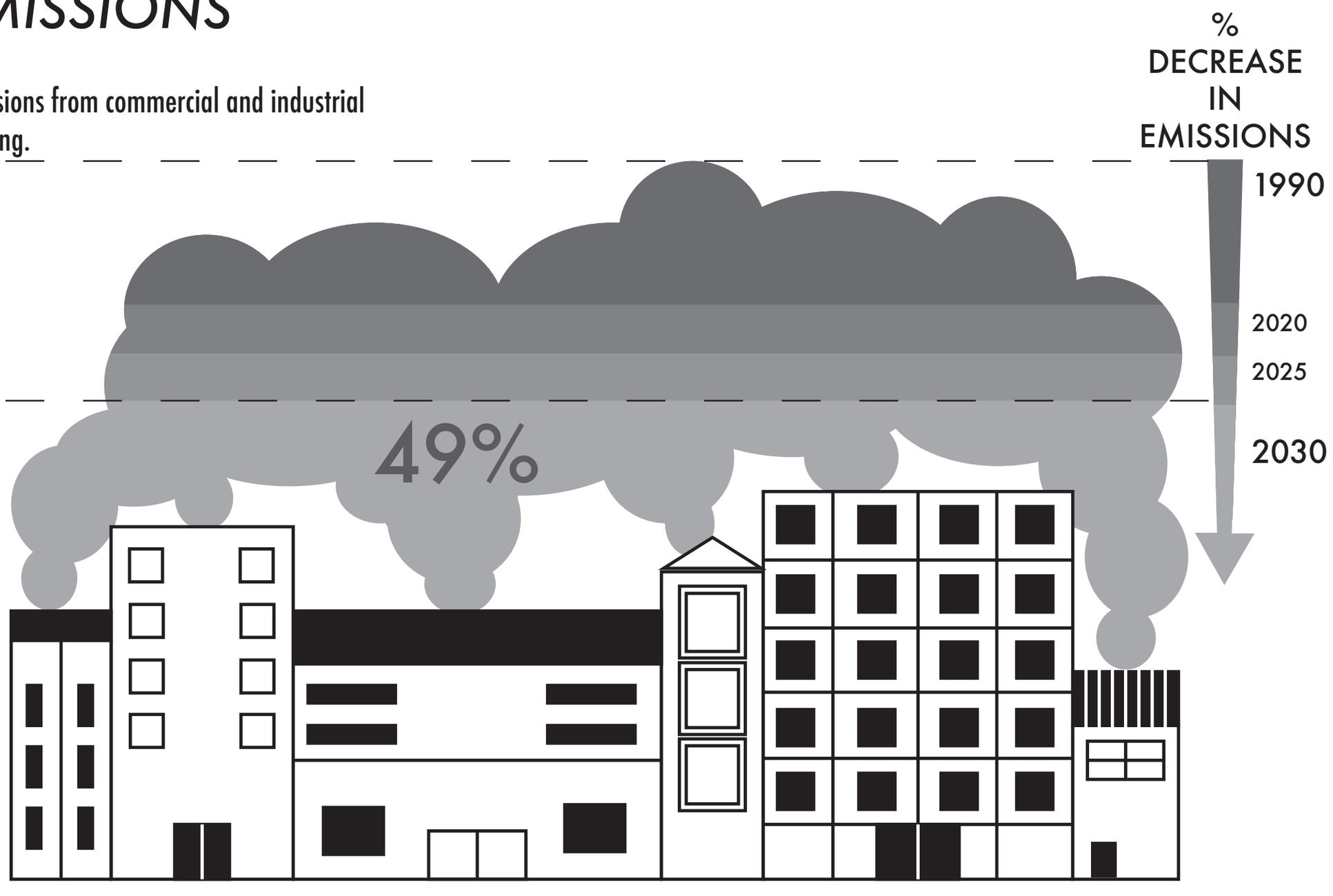
Emissions from residential heating.



TRANSFORMING OUR BUILDINGS

EMISSIONS

Emissions from commercial and industrial heating.



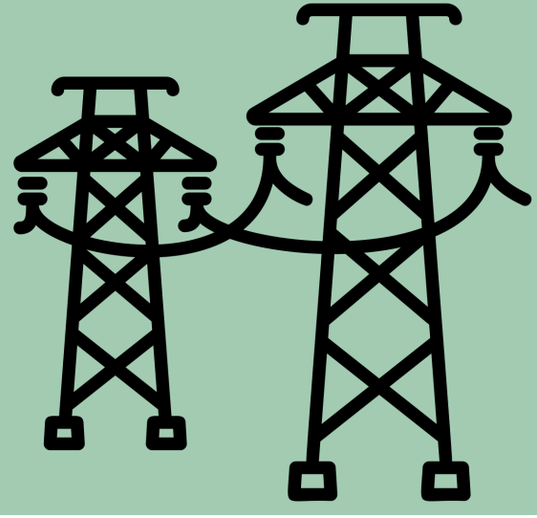
TRANSFORMING OUR BUILDINGS

INCREASING ENERGY EFFICIENCY

The best way to increase energy efficiency in buildings is through implementation of standards that drive investment in energy efficiency technologies.

For existing buildings, the new Mass Save Three-Year Energy Efficiency Plans include substantial incentives for building owners and operators to invest in measures that tighten building envelopes.

TRANSFORMING OUR ENERGY SUPPLY



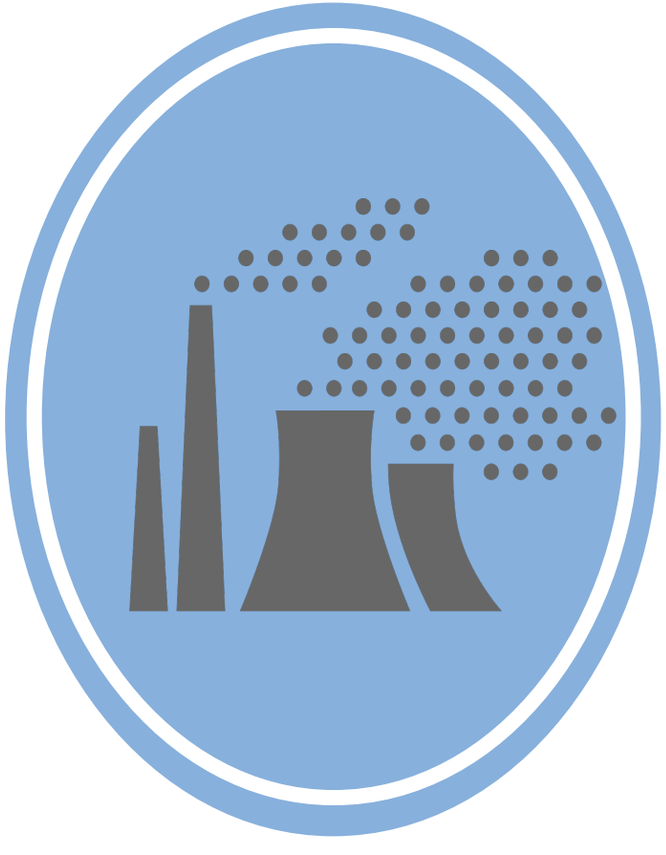
TRANSFORMING OUR ENERGY SUPPLY

CURRENT STATE OF ENERGY IN MASSACHUSETTS

As of 2020, the Electricity sector accounted for 20% statewide emissions

TRANSFORMING OUR ENERGY SUPPLY

GOALS FOR TRANSITION TO RENEWABLE ENERGY



1990 Baseline of GHG Emissions from Electricity Production

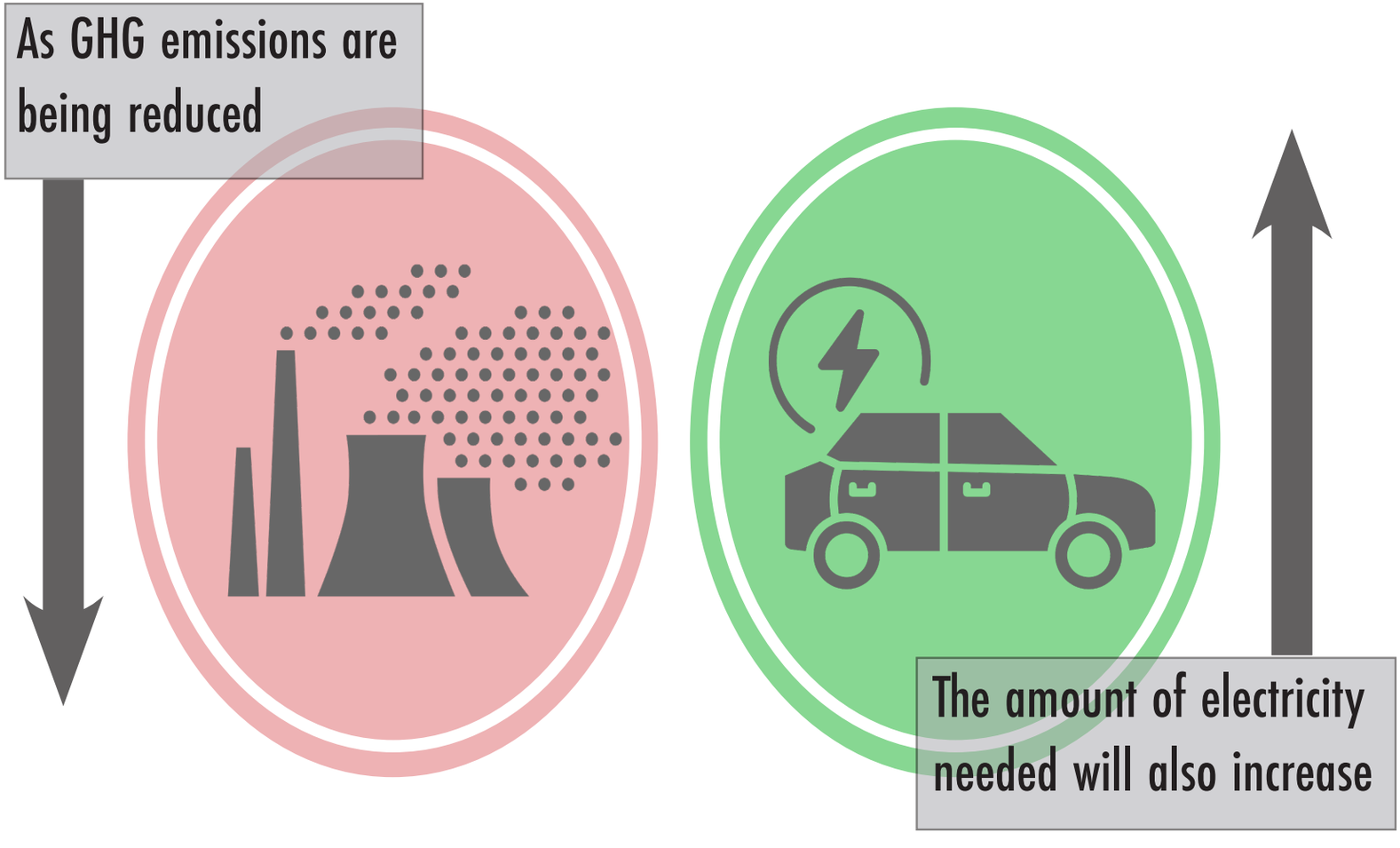
2025: 53% Emissions Reduction

2030: 70% Emissions Reduction

2050: Net Zero

TRANSFORMING OUR ENERGY SUPPLY

GOALS FOR TRANSITION TO RENEWABLE ENERGY

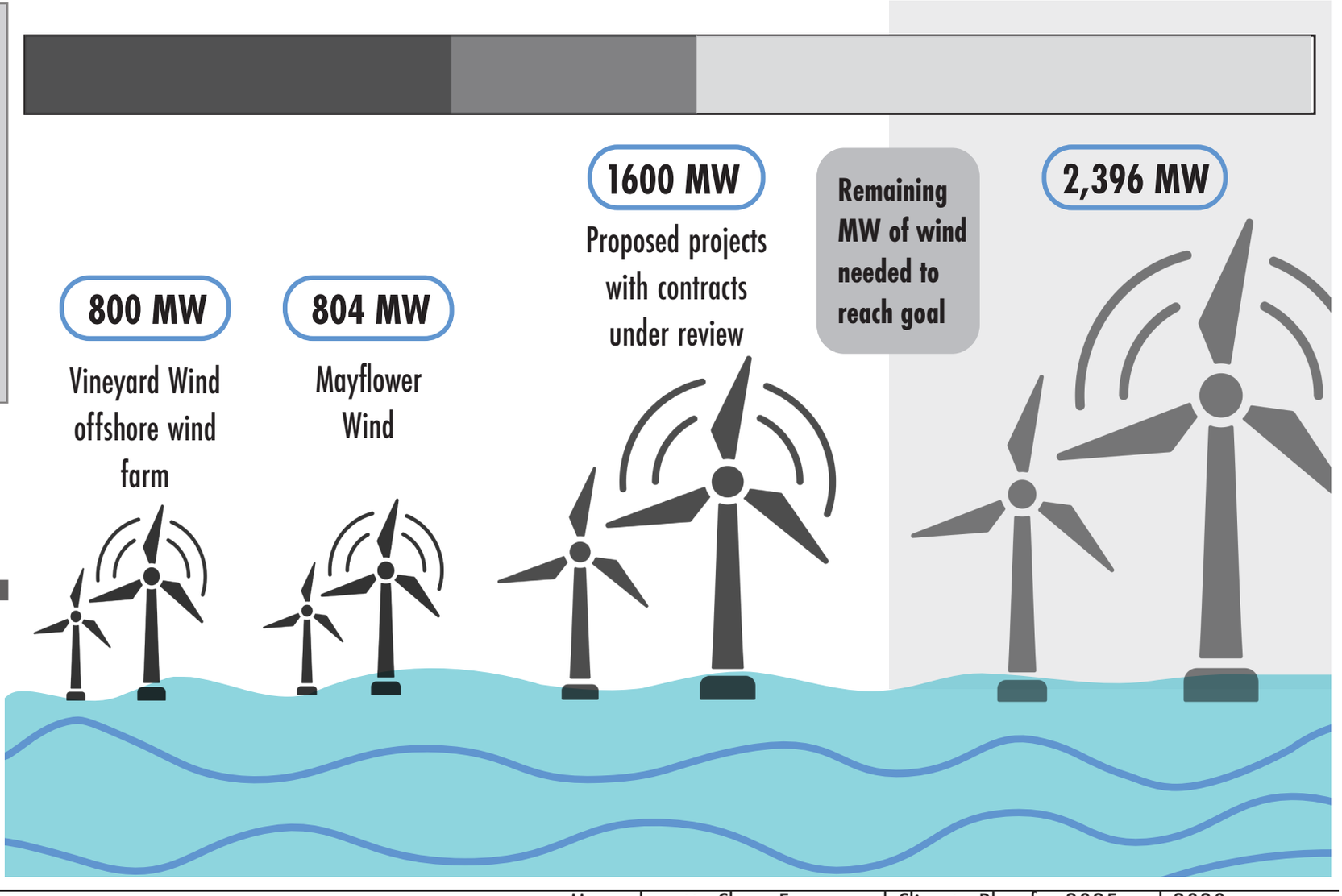


This means the amount of renewable energy needed to meet state climate goals needs to be consistantly reassesed to ensure accuracy

TRANSFORMING OUR ENERGY SUPPLY

NEXT STEPS: WIND

The goal for offshore wind production is 5,600mw/ year



TRANSFORMING OUR ENERGY SUPPLY

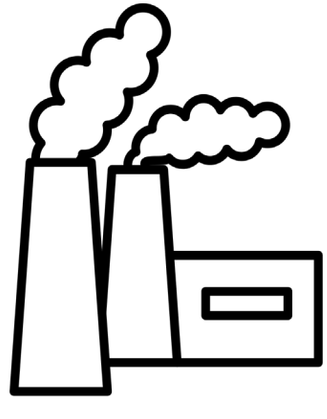
NEXT STEPS: SOLAR

New England is estimated to need over 40GW of solar power by 2050.

the Solar Massachusetts Renewable Target (SMART) program's goal is to assist in developing 3.2 GW of solar power.

3.2 GW 36.8 GW

GHG EMISSIONS FROM NON-ENERGY SOURCES & INDUSTRIAL USE



GHG EMISSIONS FROM NON-ENERGY SOURCES

COMMON EMISSION SOURCES

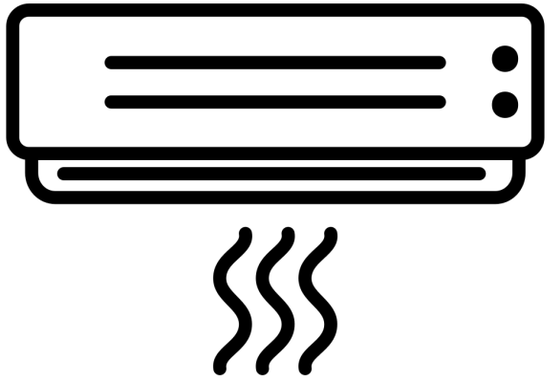
- REFRIGERATION
- COOLING
- SOLID WASTE MANAGEMENT
- COMPOSTING
- ANAEROBIC DIGESTION
- WASTEWATER TREATMENT
- GEOTHERMAL HEAT PUMPS
- SEPTIC TANKS
- EFLUENT MANAGEMENT
- NATURAL GAS TRANSMISSION & DISTRIBUTION
- AGRICULTURAL PRACTICES
- NON-COMBUSTION INDUSTRIAL PROCESSES

Haverhill Resource Recovery Thermochemical Treatment facility is an example of a non-energy source of GHG emissions Image Source

GHG EMISSIONS FROM NON-ENERGY SOURCES

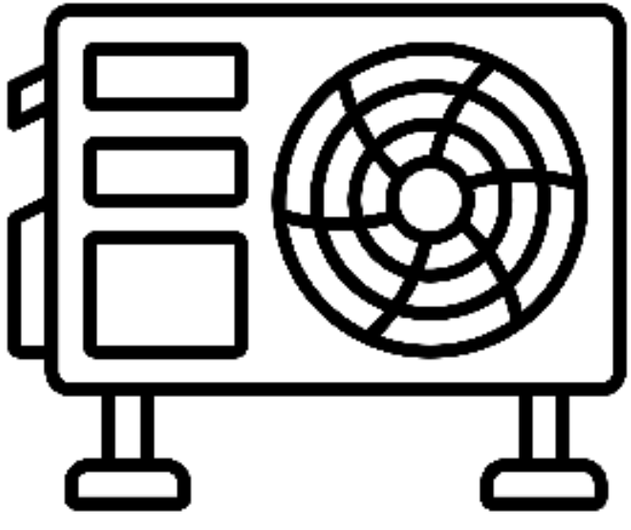
FLUORINATED GASES

- The use and leakage of high-Global Warming Potential (GWP) hydrofluorocarbon (HFC) F-gases is the fastest-growing source of GHG emissions in Massachusetts.



Common sources of F-gases include:

- air conditioning
- heat pumps
- stationary refrigeration



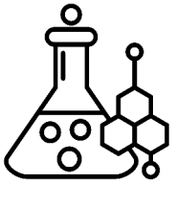
GHG EMISSIONS FROM INDUSTRIAL USE

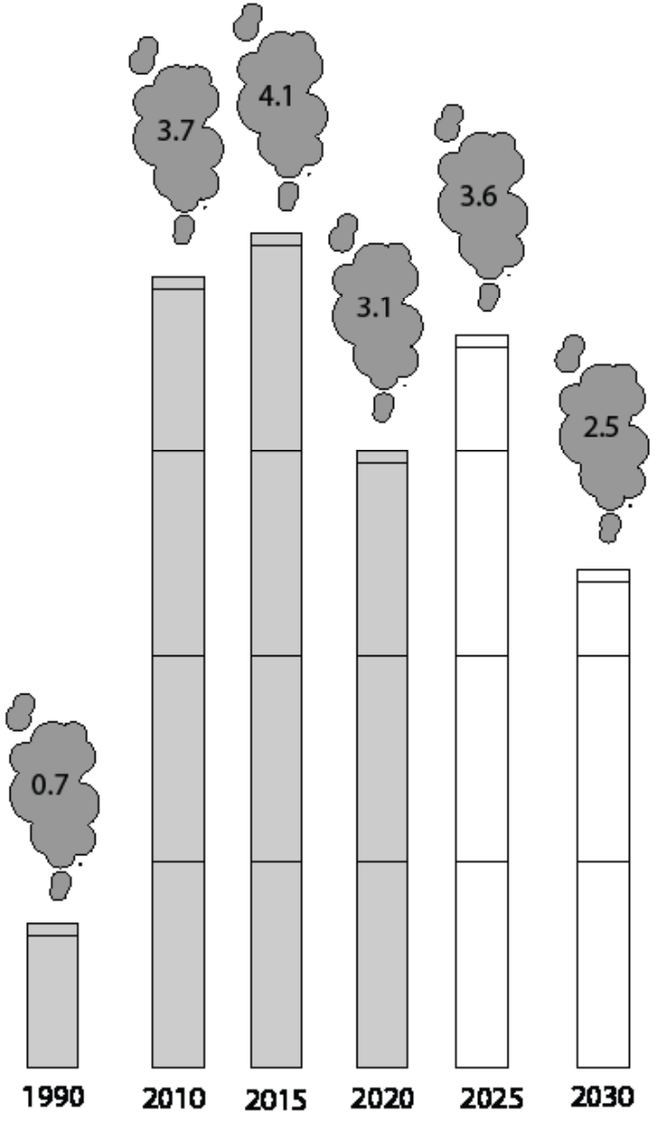
INDUSTRIAL PROCESSES

Massachusetts has a small industrial sector. It consumes electricity, petroleum, and natural gas. Emissions from industrial energy use have declined by around 20% since 1990. In 2020 the emissions from industrial use were around 5% of the Commonwealth's total gross emissions.

NON-ENERGY EMISSIONS:

- carbon dioxide (CO2)
- methane (CH4)
- nitrous oxide (N2O)
- fluorinated gas (F-gas)



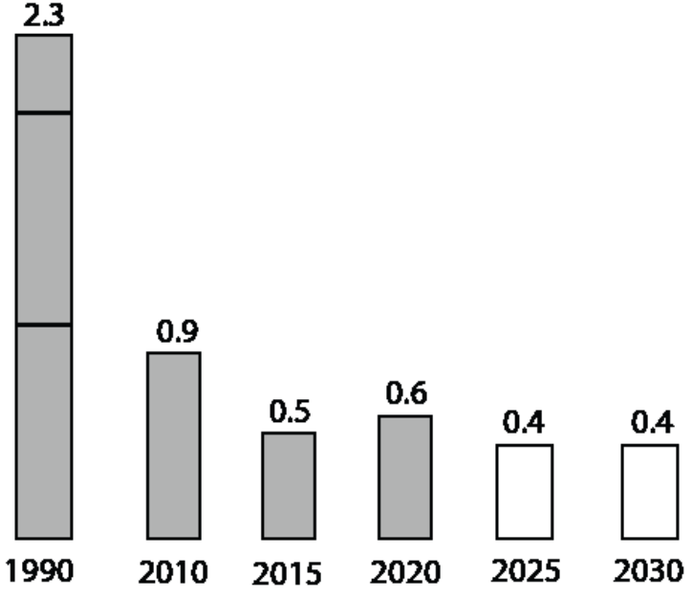


GROSS & PROJECTED GROSS GHG EMISSIONS FROM INDUSTRIAL PROCESSES (MMTCO2e)

GHG EMISSIONS FROM NON-ENERGY SOURCES

NATURAL GAS

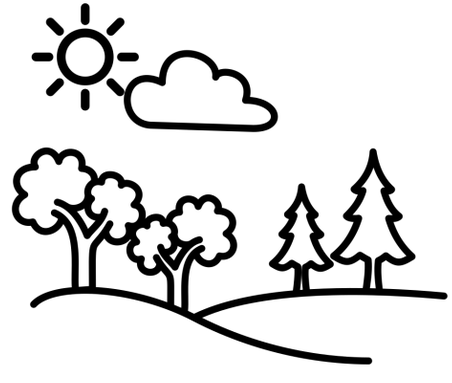
- The liquefied natural gas (LNG) terminal in Everett, Massachusetts, received 82% of the nation's total LNG imports in 2022, down from 99% in 2021.



GROSS & PROJECTED GROSS GHG EMISSIONS FROM NATURAL GAS DISTRIBUTION & SERVICES (MMTCO2e)

Everett liquified natural gas facility. Image Source

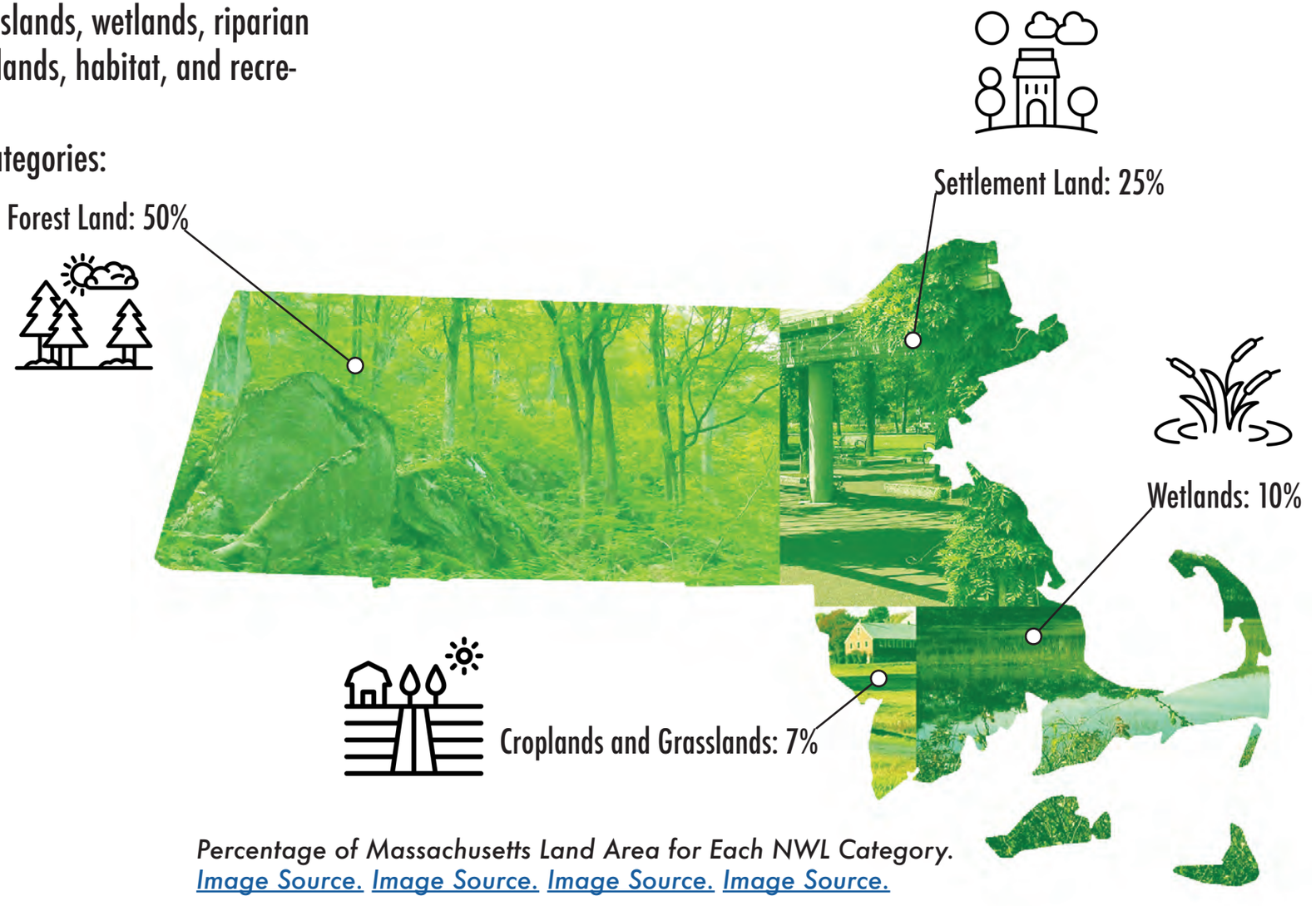
CARBON SEQUESTRATION ON NATURAL AND WORKING LANDS



NATURAL AND WORKING LANDS

WHAT ARE THEY?

Natural and working lands (NWL) include agricultural land, forests, grasslands, wetlands, riparian and coastal areas, wildlands, habitat, and recreation lands.
It is divided into four categories:



Percentage of Massachusetts Land Area for Each NWL Category.
Image Source. Image Source. Image Source. Image Source.

NATURAL AND WORKING LANDS

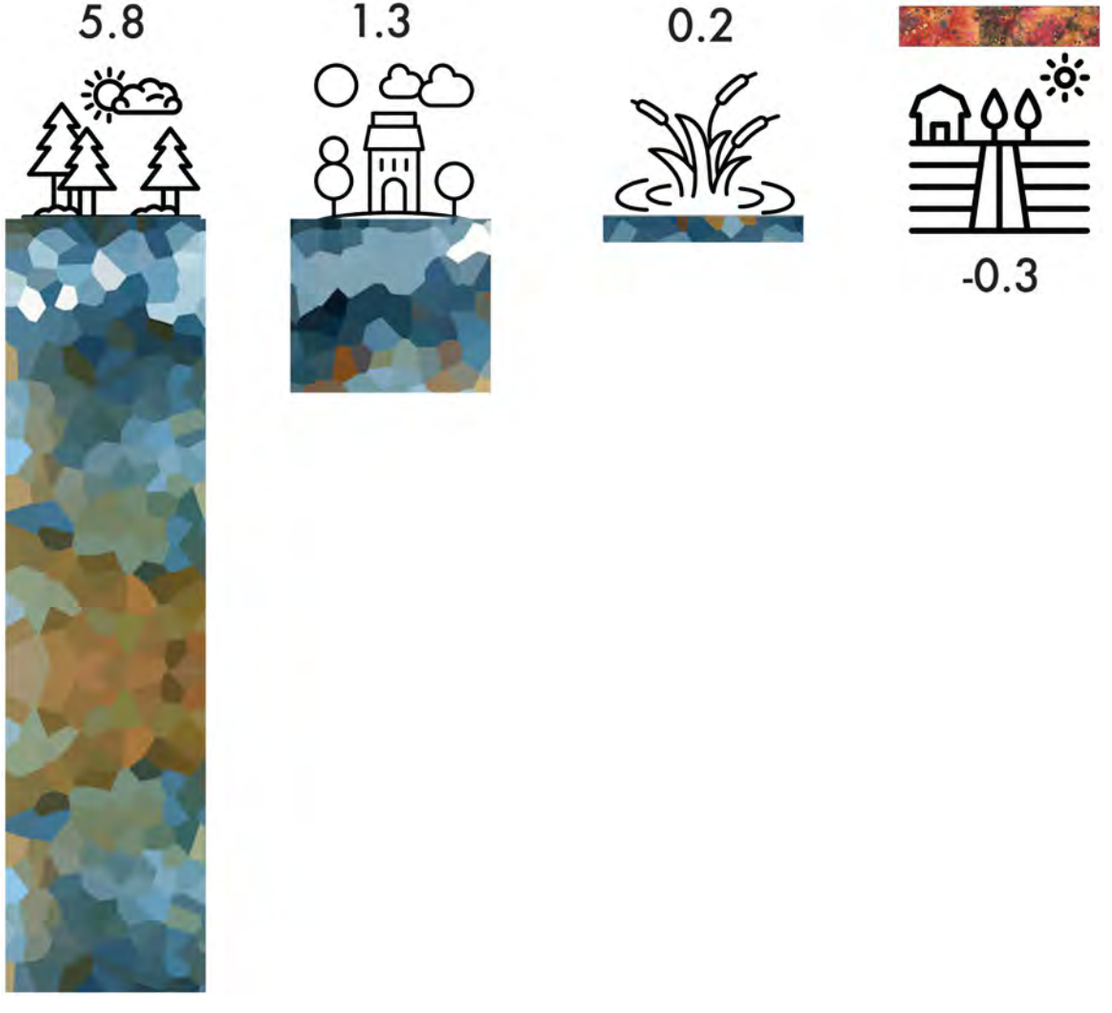
WHY DO THEY MATTER?

NWL are the environments where people and animals live, work, and play.

They provide ecosystem services such as cleaning the air and water.

They also capture carbon from the atmosphere and store it in vegetation and soils, and release carbon through respiration.

NWL Categories ranked by million metric tons of carbon sequestered annually.



DEERFIELD COMMUNITY SOLAR ACTION PLAN

INFORMATION PROVIDED BY UMASS CLEAN ENERGY EXTENSION

DEERFIELD, MASSACHUSETTS

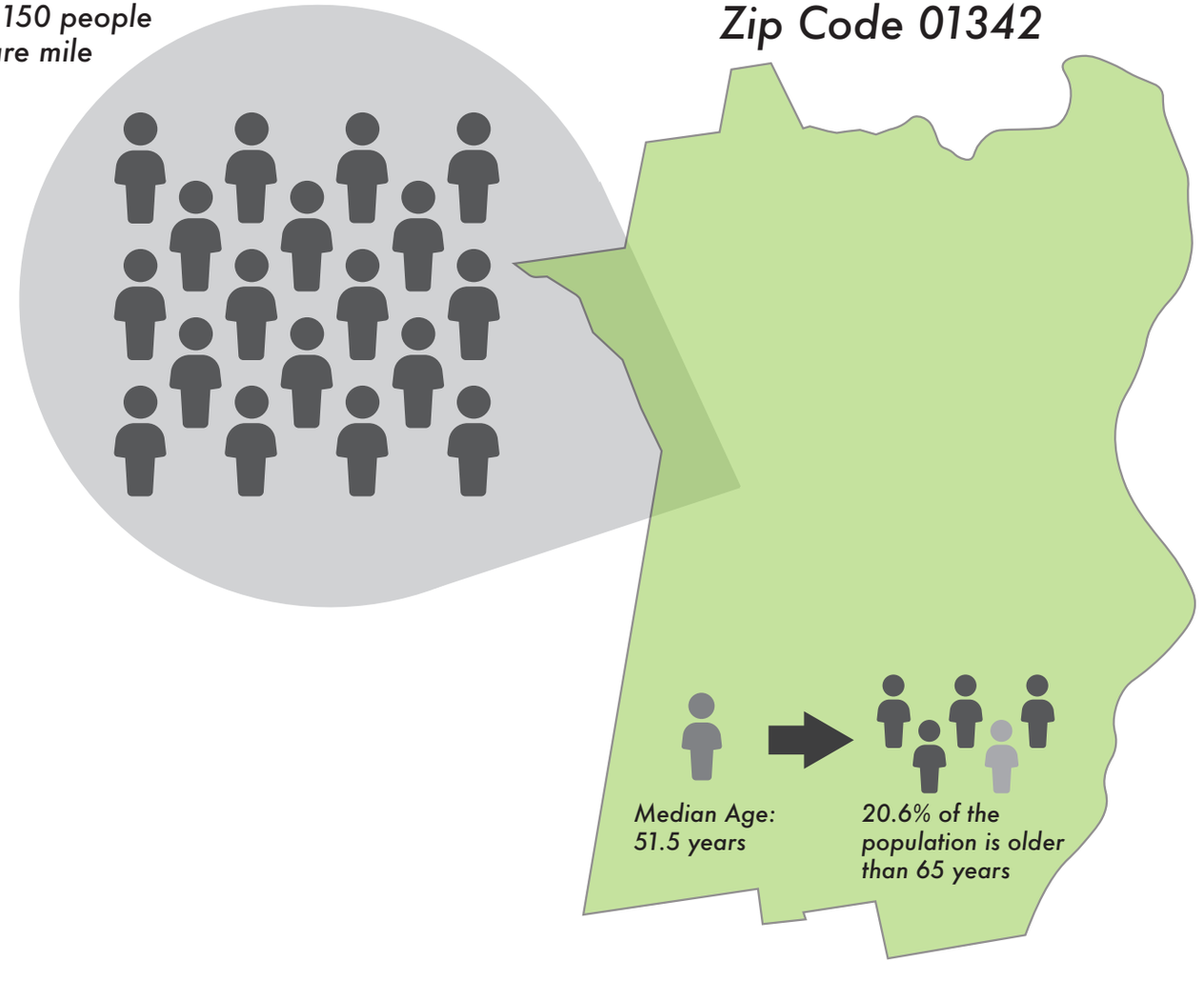
DEMOGRAPHICS

POPULATION

Total Population:
5,090 people

2020 Decennial Census

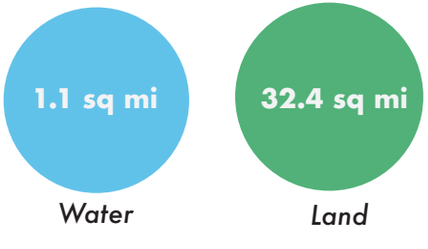
Density: 150 people per square mile



DEMOGRAPHICS

HOUSING

Total Area of Deerfield:
33.44 sq mi



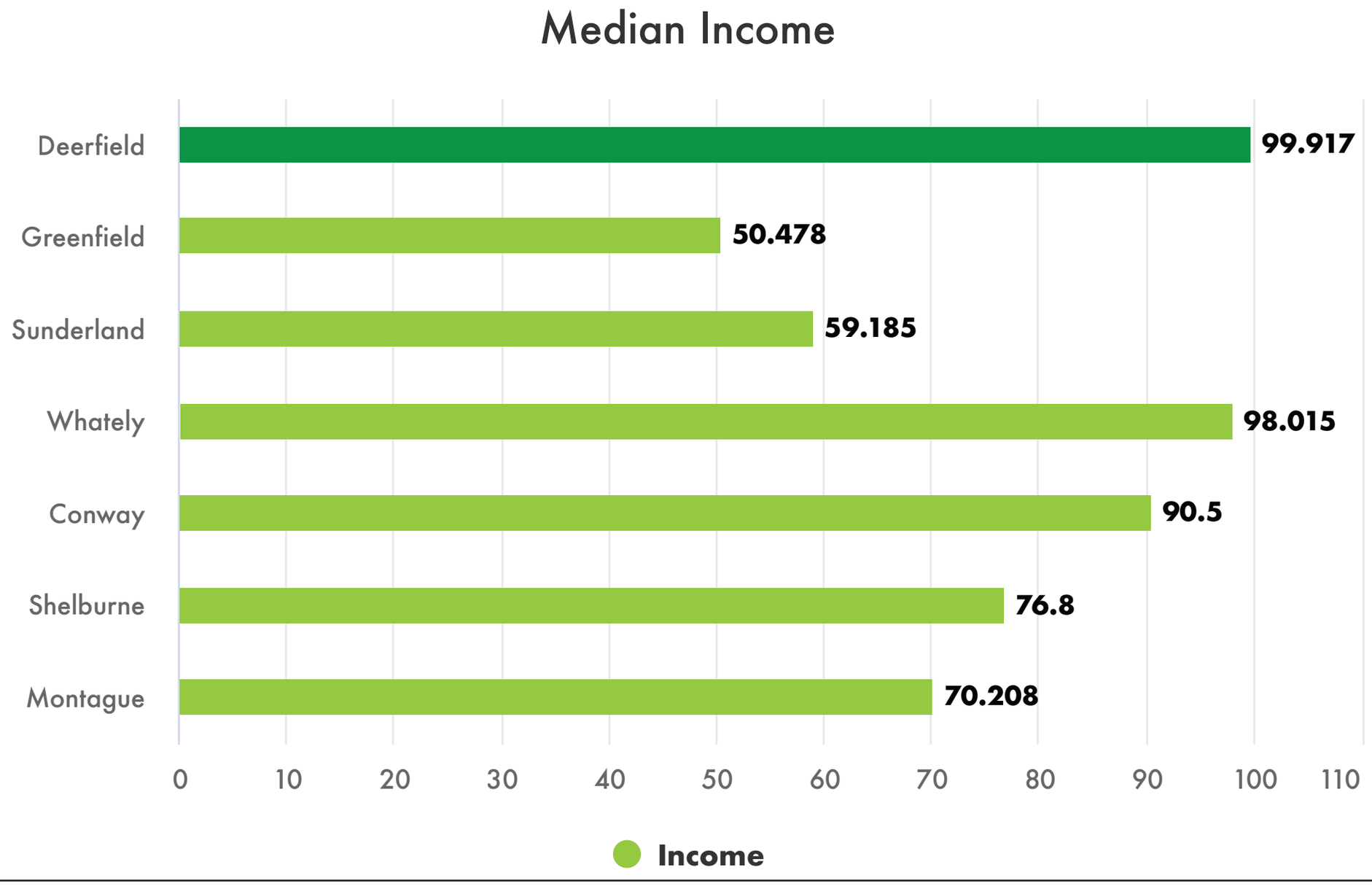
2,241 households

2022 American Community Survey
5-Year Estimates

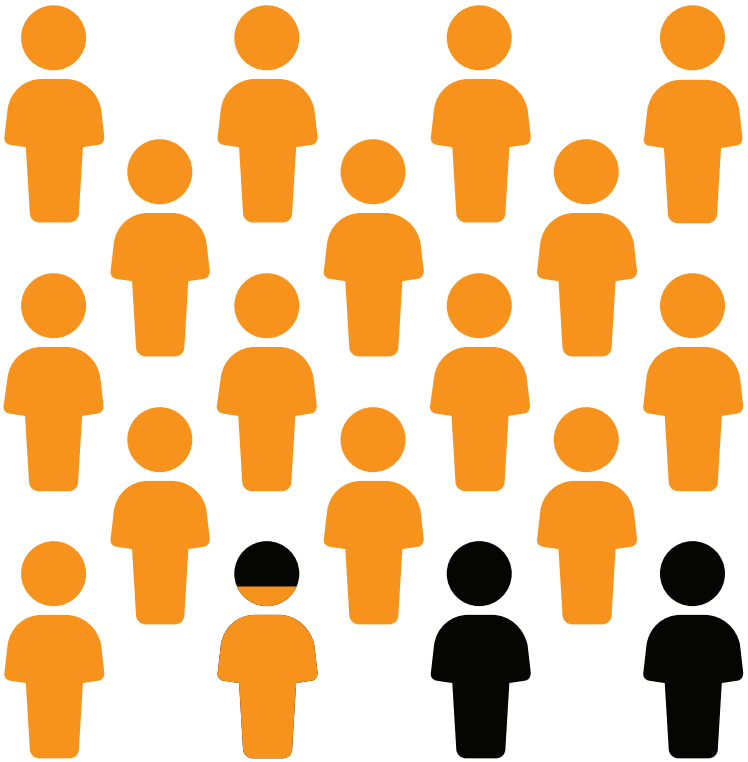
Average home value
$440,382

DEMOGRAPHICS

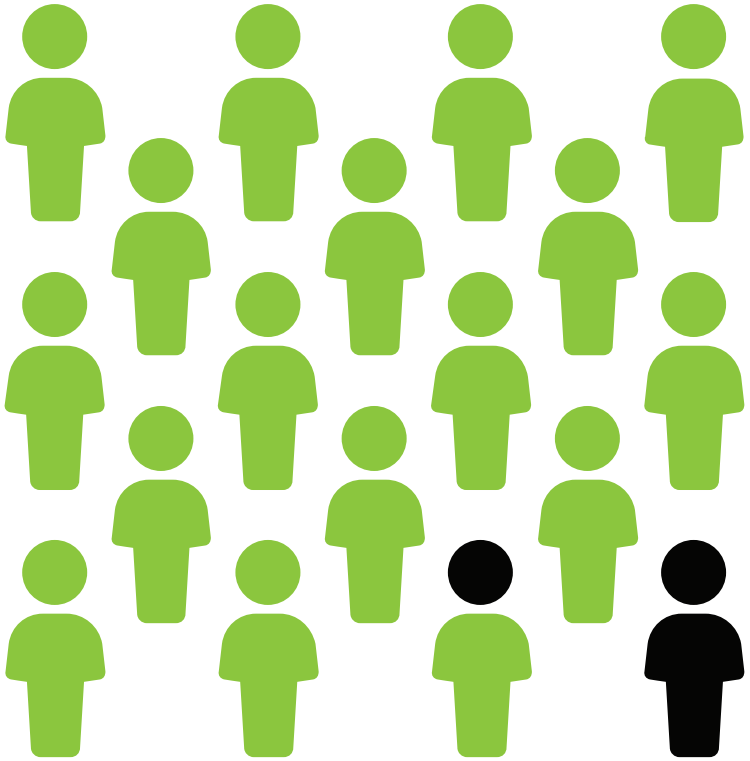
INCOME



PUBLIC OPINION

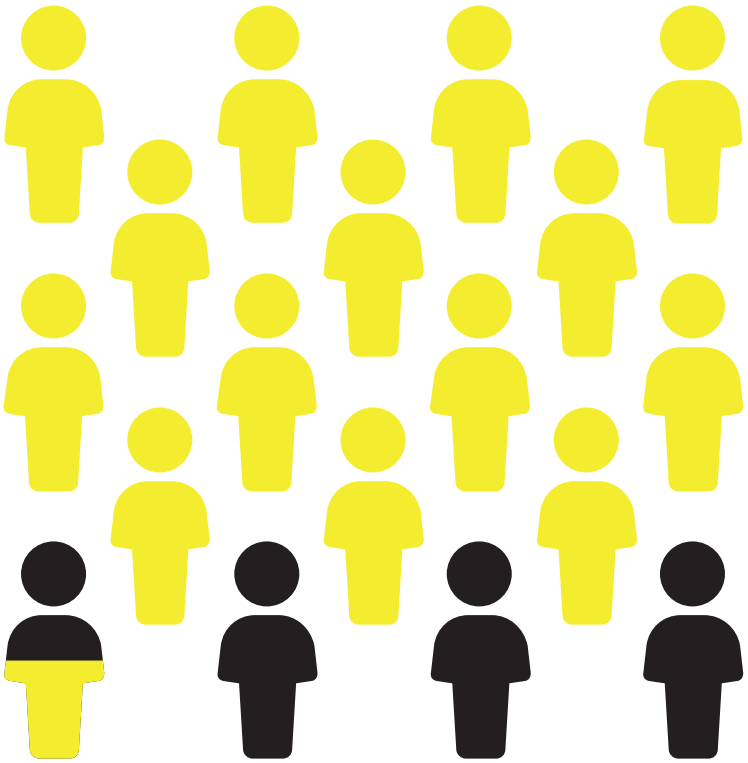


88% of Deerfield residents expressed "extreme" or "moderate" concern about climate change.

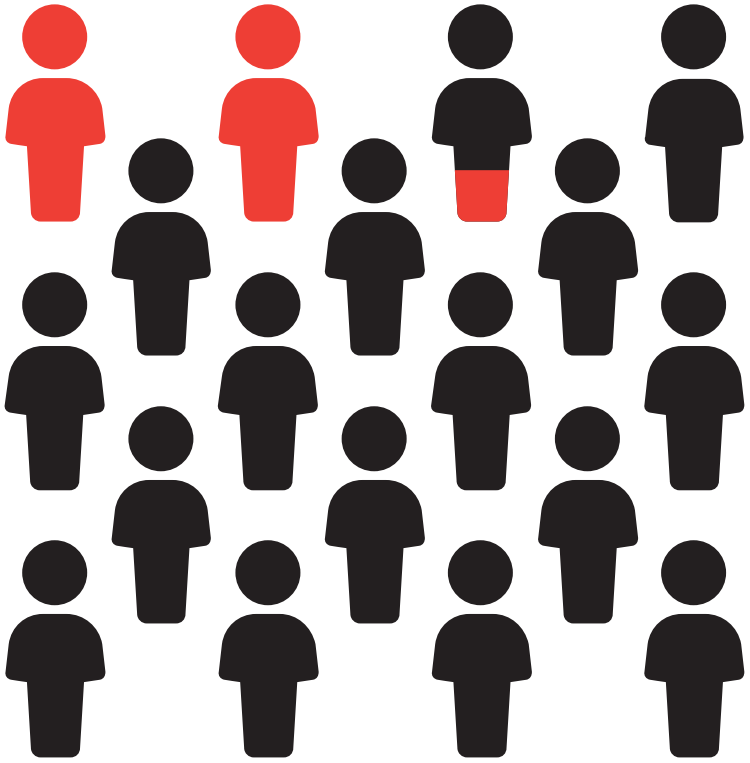


93% of Deerfield residents responded positively towards solar energy.

PUBLIC OPINION

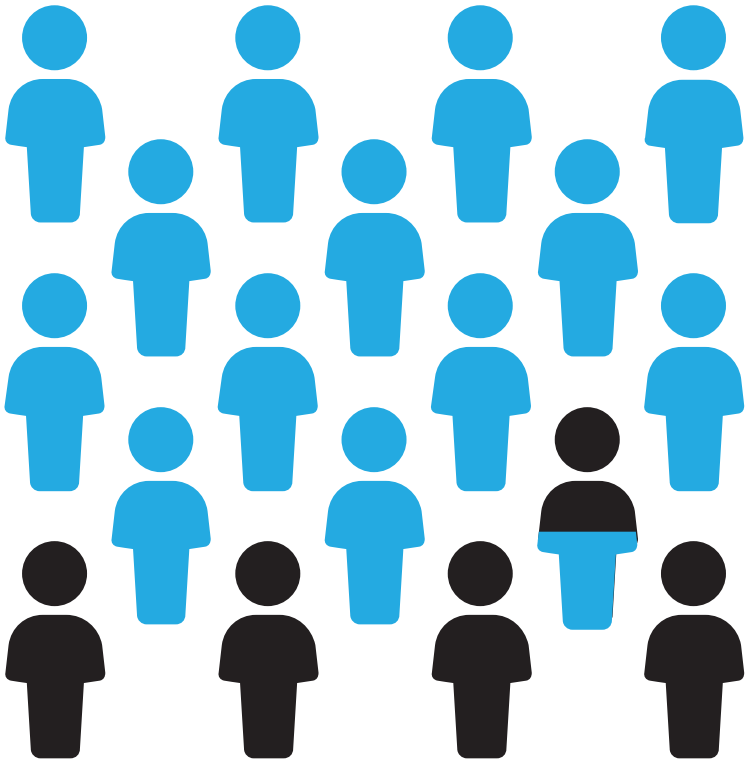


81% of Deerfield residents indicated support for a community goal of developing all available roofs, parking lots, and previously disturbed lands for solar.

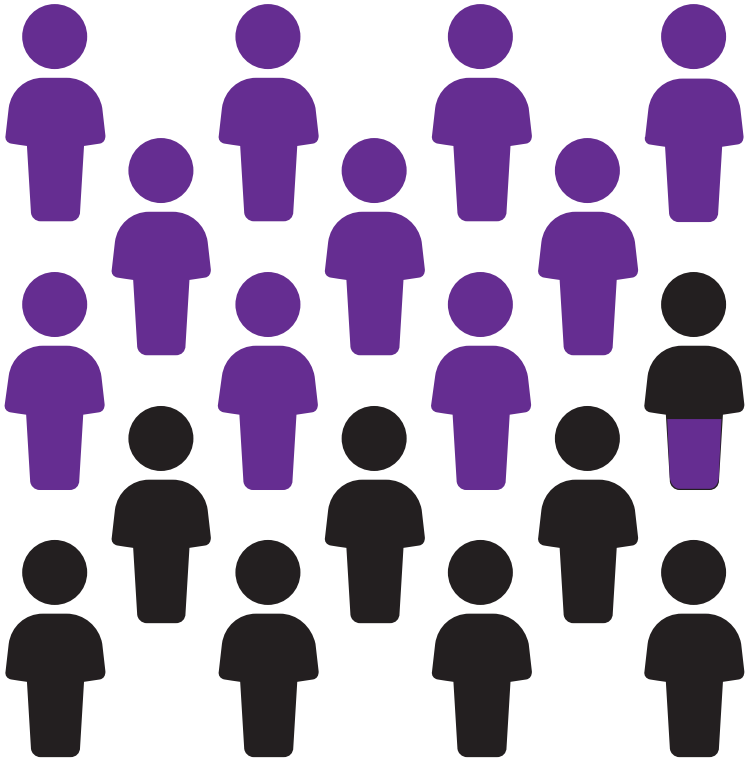


Only 13% of Deerfield residents responded positively towards solar development on argicultural and natural lands.

PUBLIC OPINION



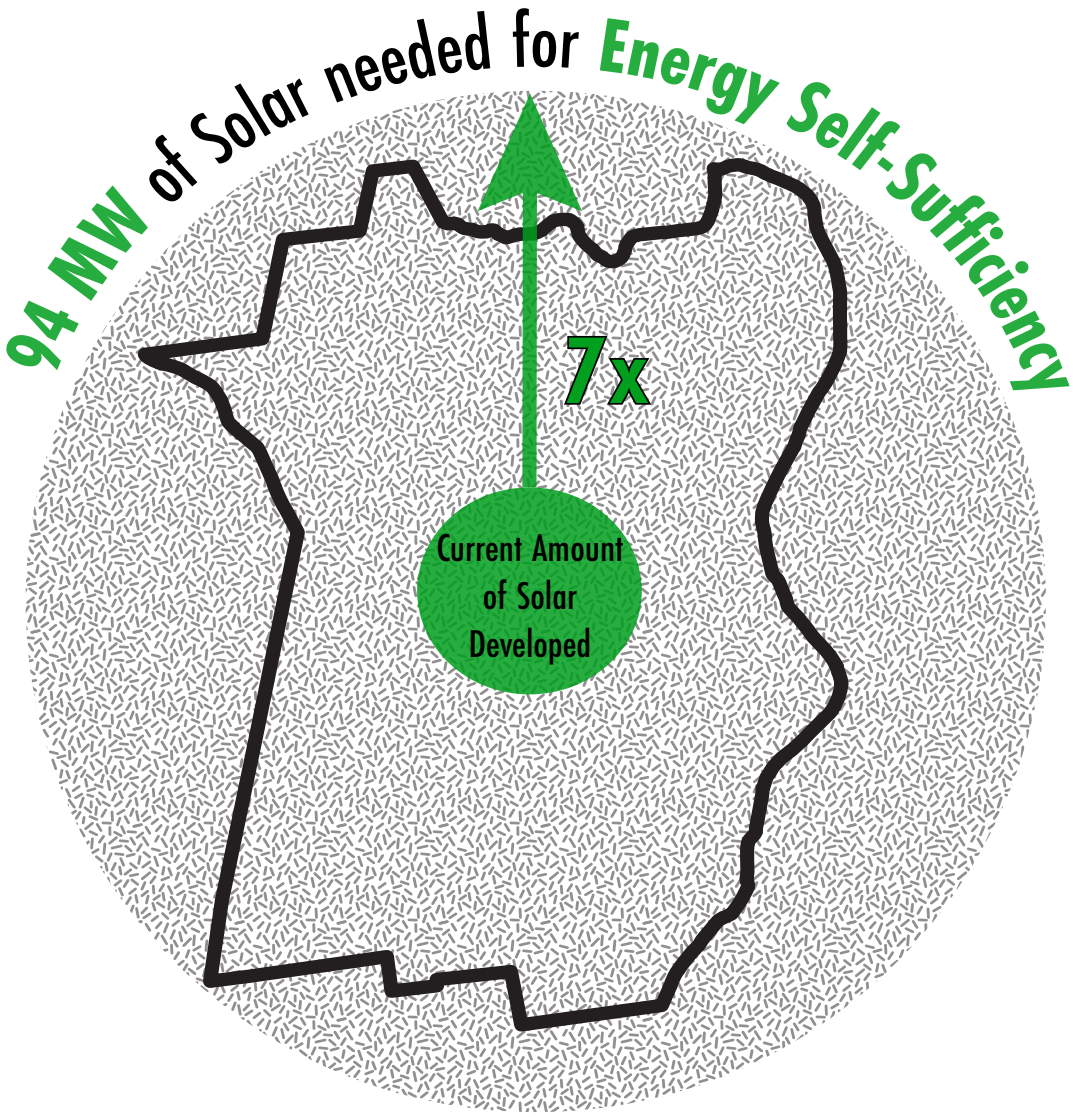
75% of Deerfield residents support solar development to meet regional goals.



58% of Deerfield residents support solar development to meet state goals.

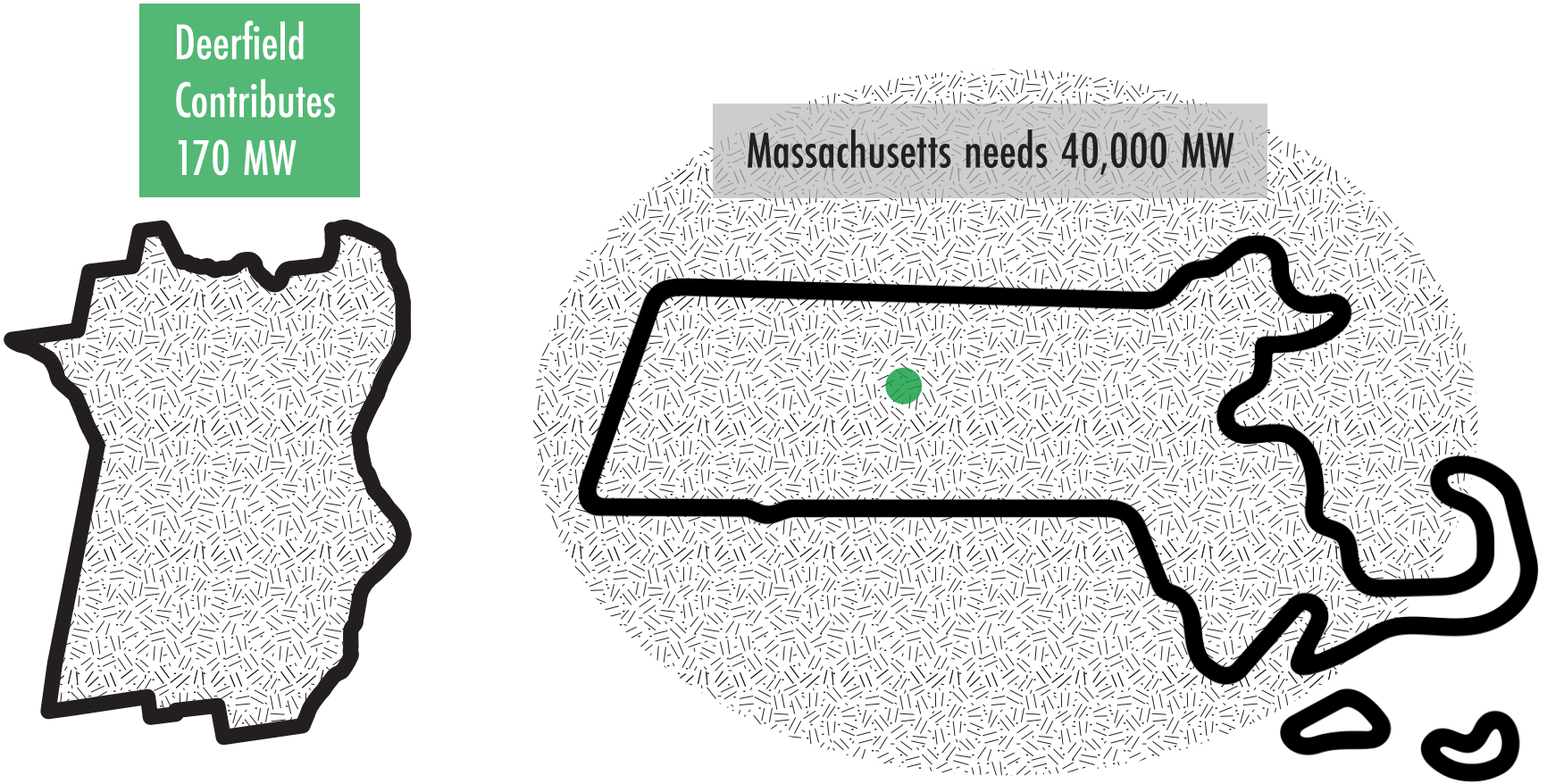
DEERFIELD SOLAR ACTION PLAN

SOLAR NEEDED TO MEET THE TOWN OF DEERFIELD'S GOALS

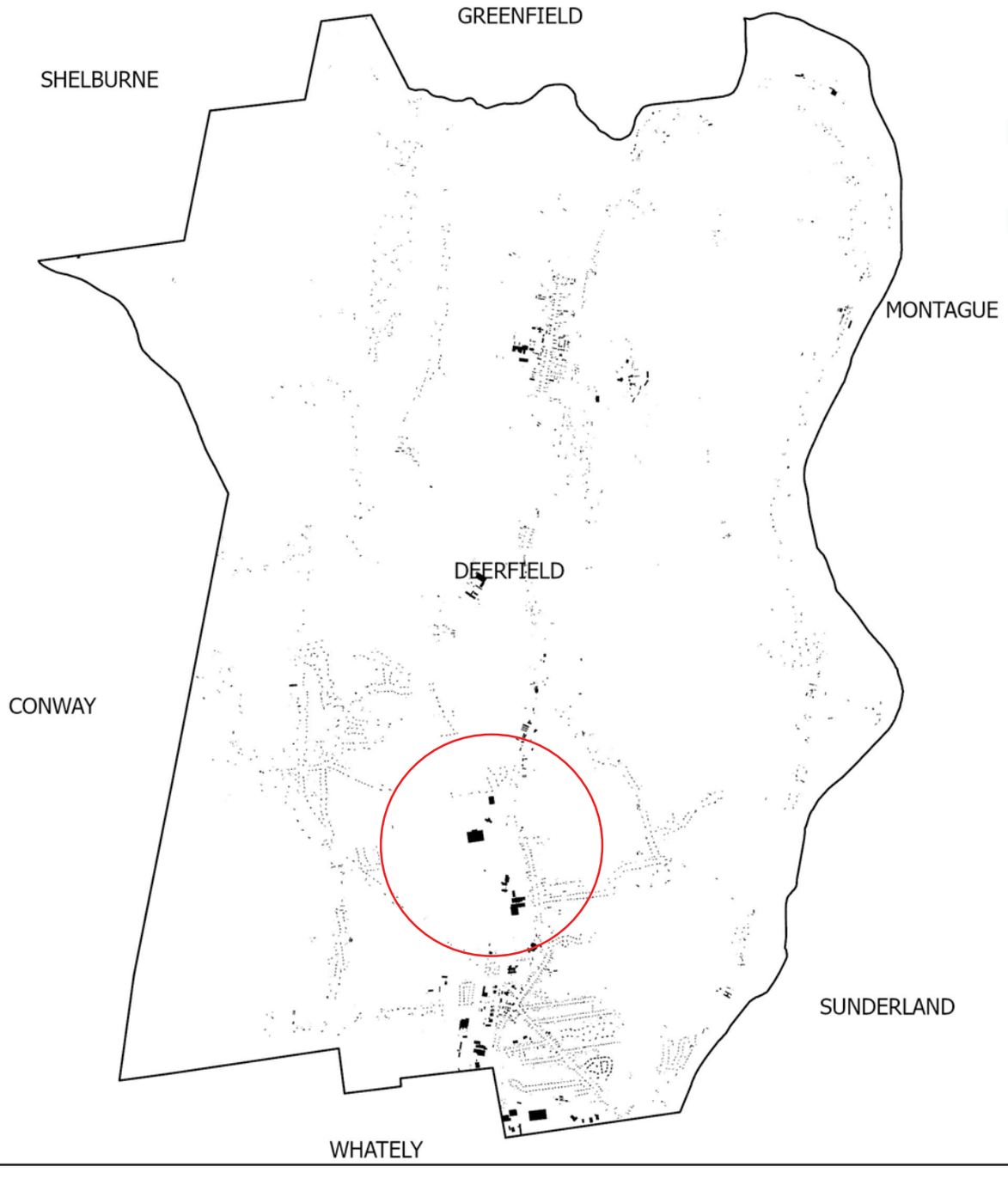


DEERFIELD SOLAR ACTION PLAN

SOLAR ENERGY NEEDED FROM DEERFIELD TO CONTRIBUTE TO STATE NEEDS



DEERFIELD SOLAR



MUNICIPAL

EXISTING: 35 kW Less than 1% OF TOTAL

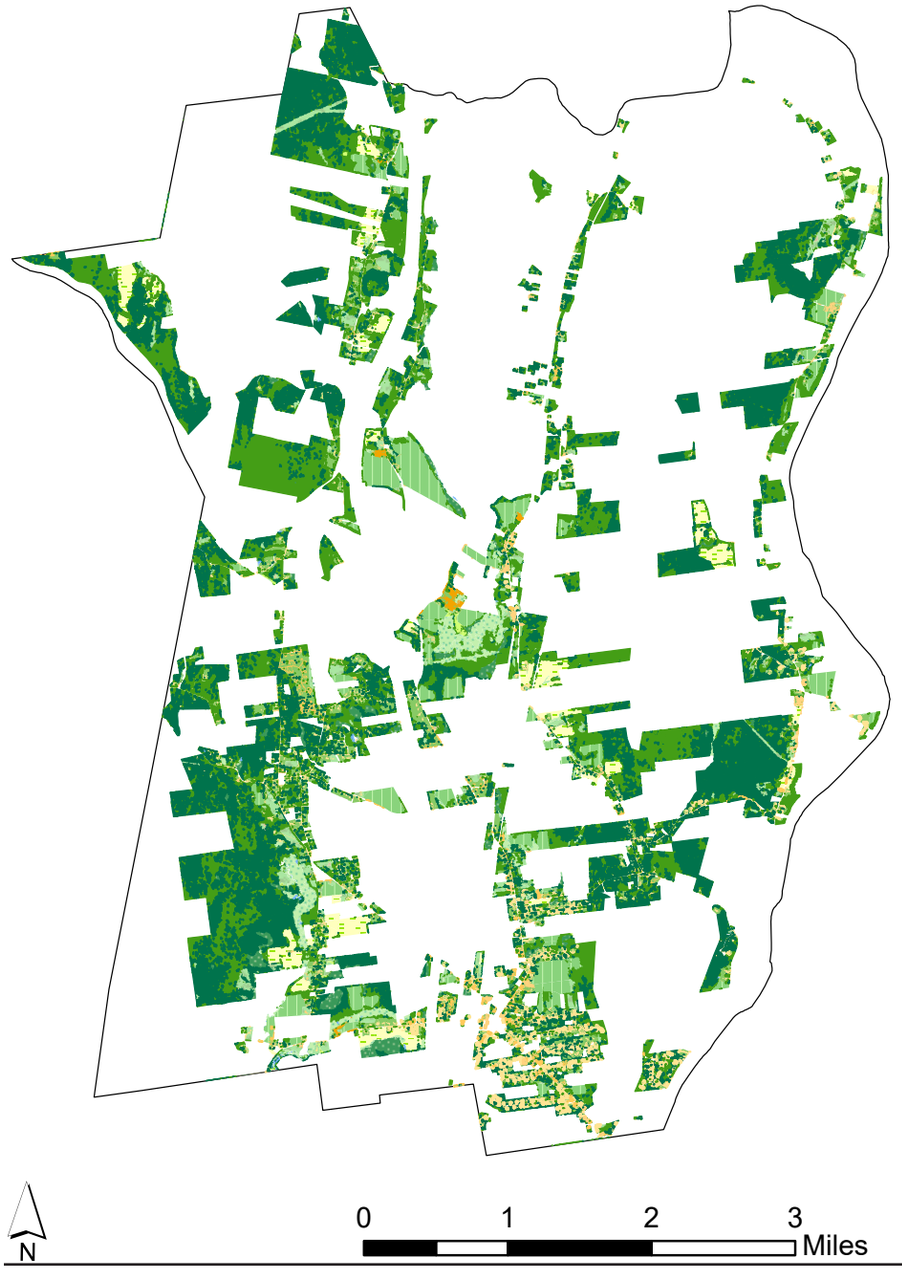
POTENTIAL: 4.25 MW 4 % OF TOTAL

N

0 0.5 1 2 Miles

DEERFIELD SOLAR

Land Cover in Residential Parcels in Deerfield, MA



RESIDENTIAL

EXISTING: 1,768 kW 2% OF TOTAL

POTENTIAL: 12.6 MW 13 % OF TOTAL

Legend

- Deerfield Town Boundary

Land Cover

- Residential - Single Family
- Residential - Multi-Family
- Residential - Other
- Mixed Use - Primarily Residential
- Mixed Use - Other
- Cultivated
- Pasture/Hay
- Developed Open Space
- Deciduous Forest
- Evergreen Forest
- Grassland
- Scrub/Shrub
- Bare Land
- Forested Wetland
- Non-forested Wetland
- Water
- Aquatic Bed

DEERFIELD SOLAR

INSTITUTIONAL

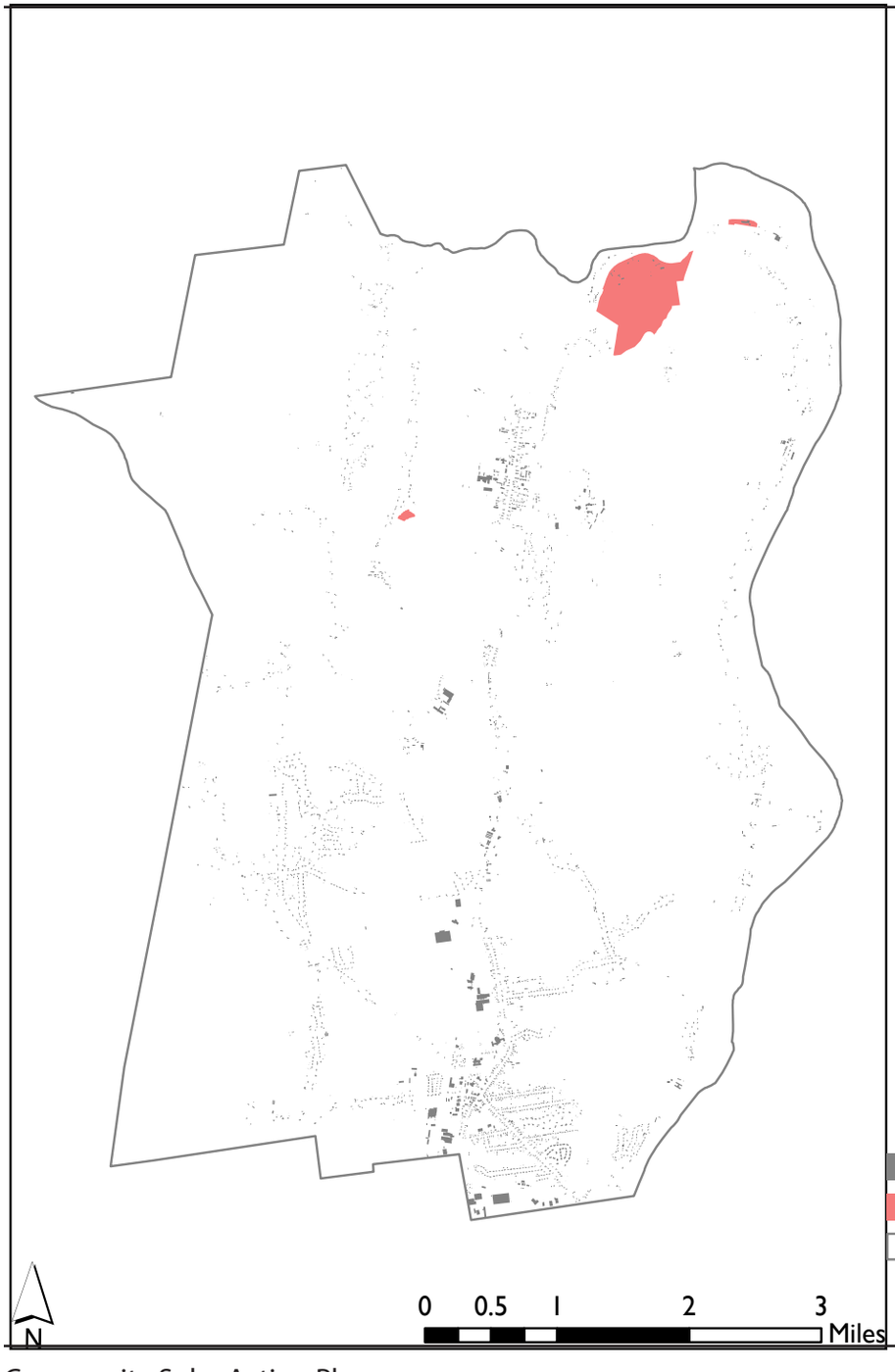
EXISTING: 372 kW — Less than 1% OF TOTAL

POTENTIAL: 1.82 MW — 1.93 % OF TOTAL

Legend

- Campus Buildings
- Buildings
- Campus Parcels
- Deerfield Town Boundary

DEERFIELD SOLAR



LARGE GROUND-MOUNTED

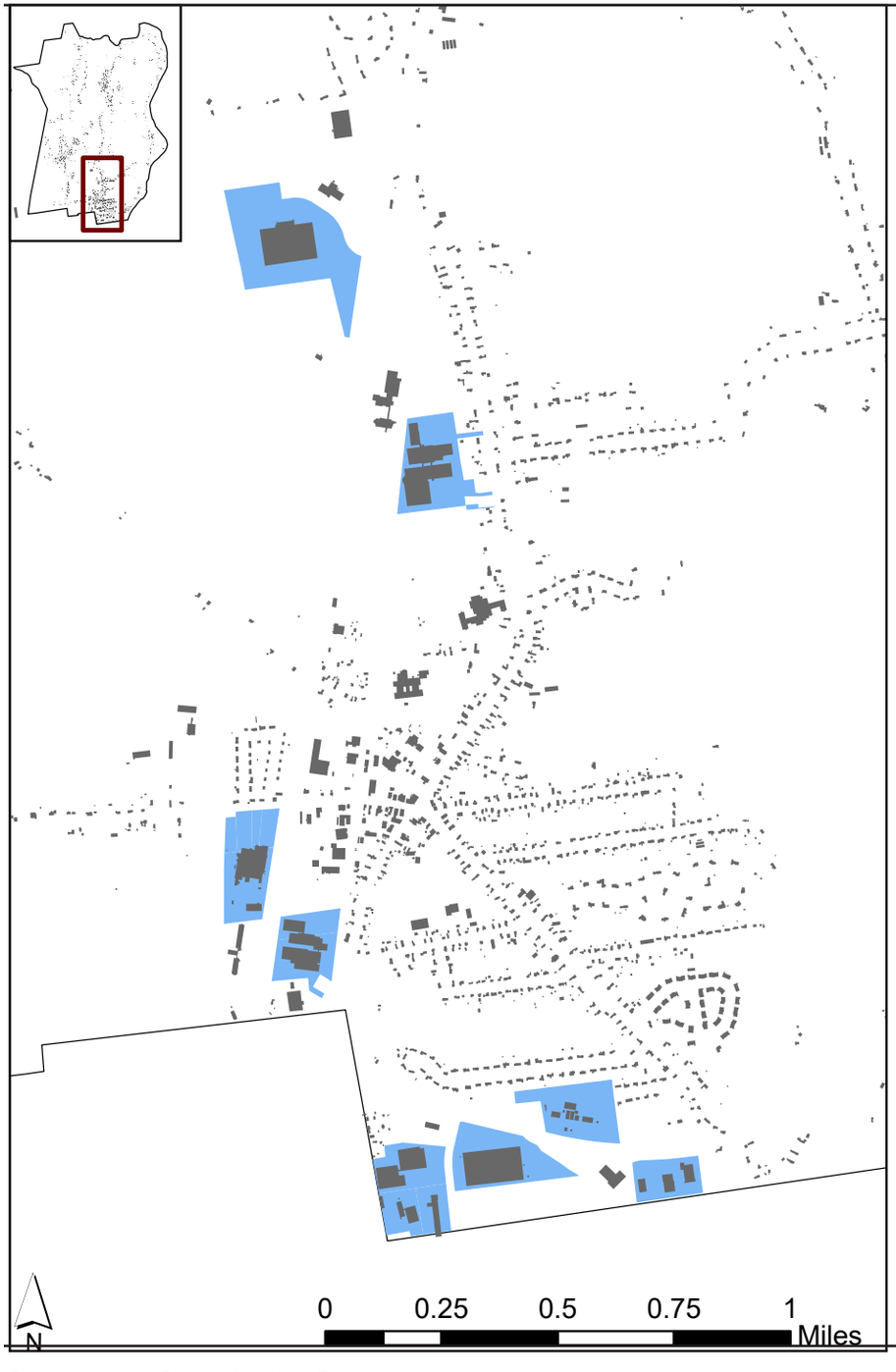
EXISTING: 4.01 MW 4.27 % OF TOTAL

POTENTIAL: 31.40 MW 33.40 % OF TOTAL

Legend

- Buildings
- Disturbed Sites
- Deerfield Town Boundary

DEERFIELD SOLAR

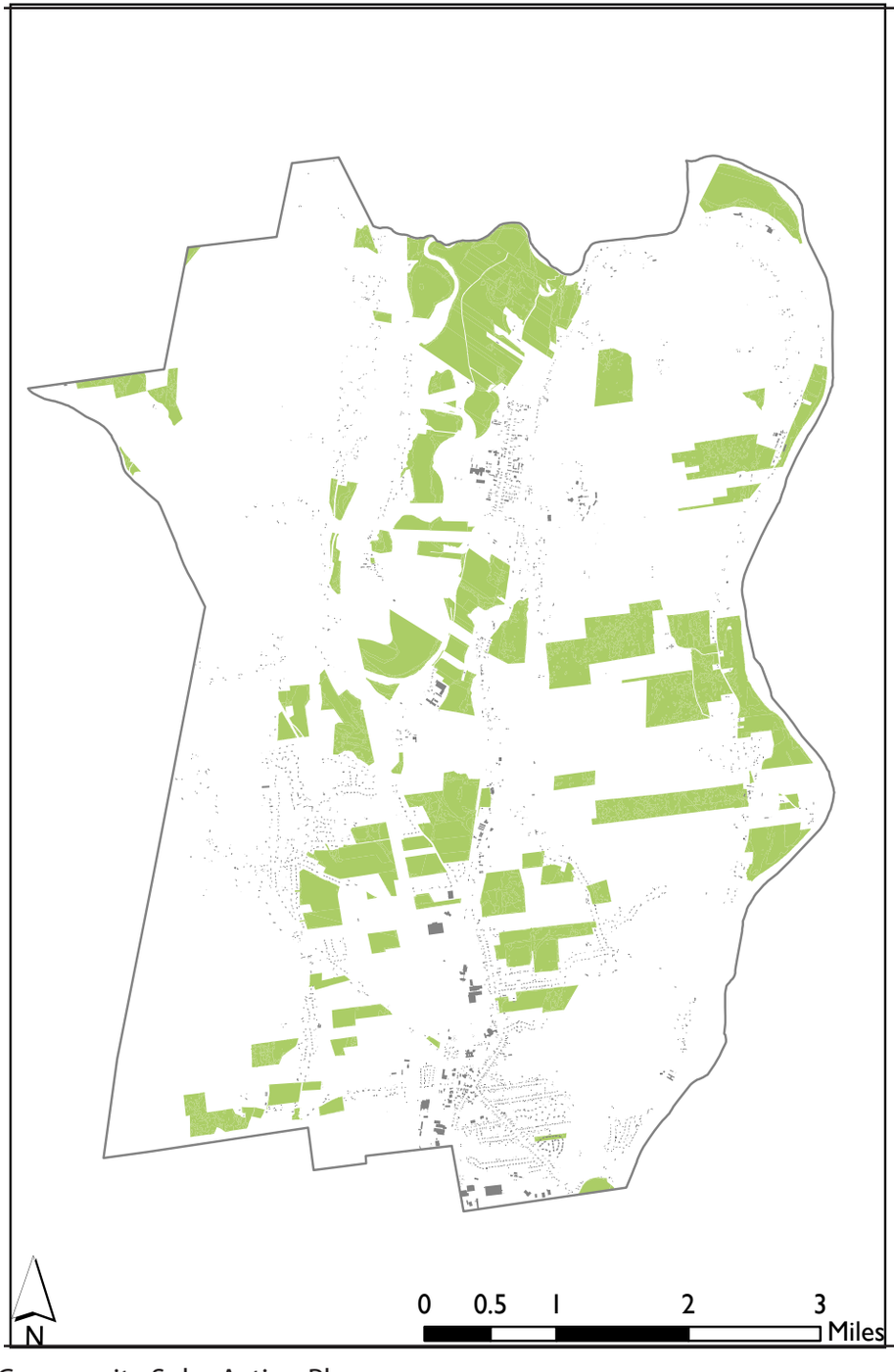


BUSINESS

EXISTING: NOT REPORTED

POTENTIAL: 28.47 MW 30.28 % OF TOTAL

DEERFIELD SOLAR



ON-FARM

EXISTING: 151 kW Less than 1 % OF TOTAL

POTENTIAL: 2.55 MW 2.71 % OF TOTAL

Legend

- Deerfield Town Boundary
- Buildings
- Agricultural Land

DEERFIELD PLANNING BOARD

CONSTRAINTS

Financial

Other priorities

Zoning

Red tape

Time

Deerfield Selectboard members Carolyn Shores Ness, Trevor McDaniel and Tim Hilchey, standing at right, talk with Massachusetts Climate Chief Melissa Hoffer in the Deerfield Town Offices on Monday - Paul Franz, Greenfield Recorder

DEERFIELD PLANNING BOARD

SUMMARY AND LOOKING FORWARD

Connect solar to other priorities

Continue to raise grants to fund public energy projects

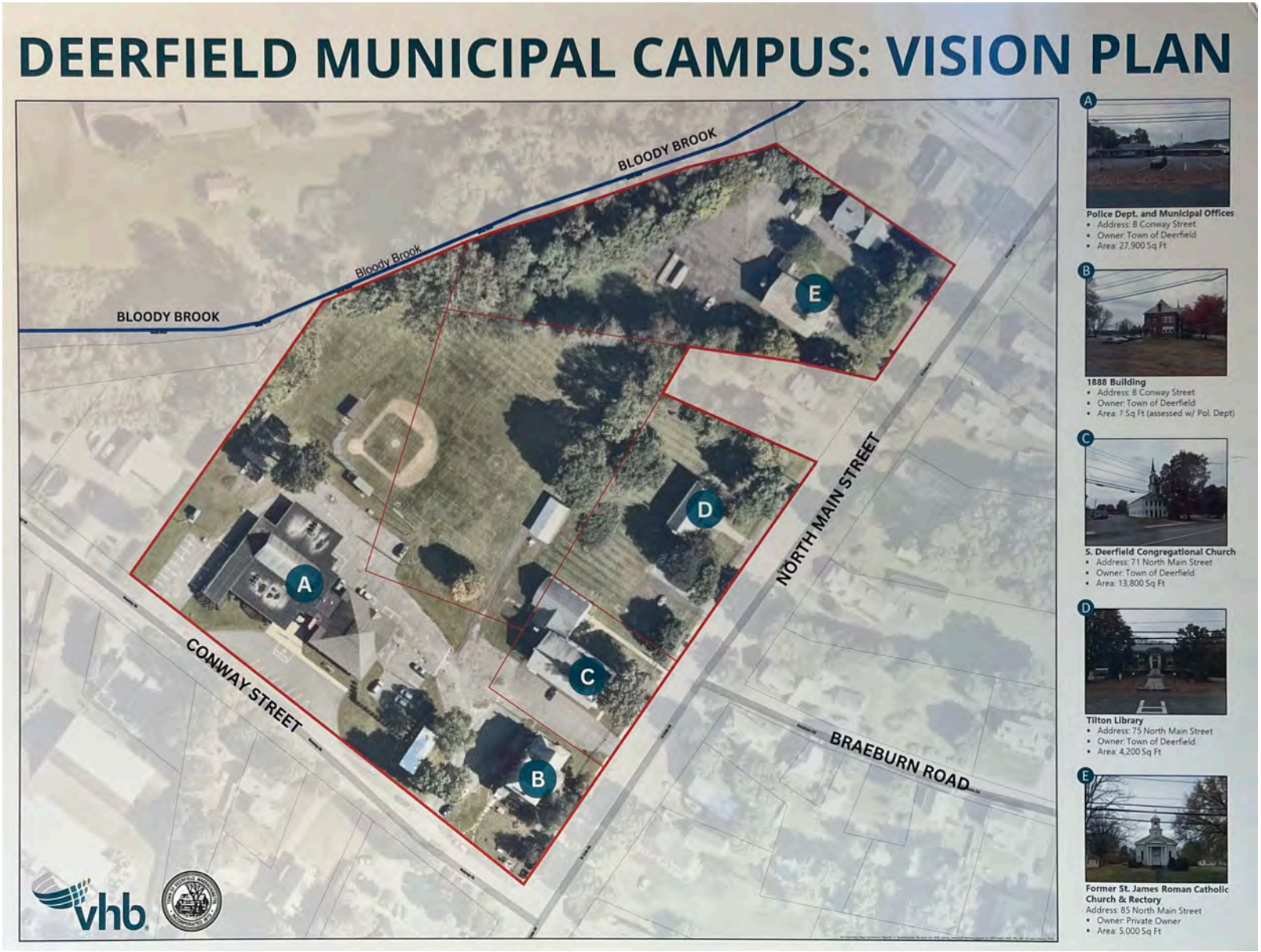
Continue to educate public

Make legislative changes to reduce red

From left, Deerfield Selectboard member Tim Hilchey, Massachusetts Climate Chief Melissa Hoffer, Deerfield Planning Board Chair Denise Mason and M.A. Swedlund of the Deerfield Energy Committee - Paul Franz, Greenfield Recorder

DEERFIELD PLANNING BOAROD

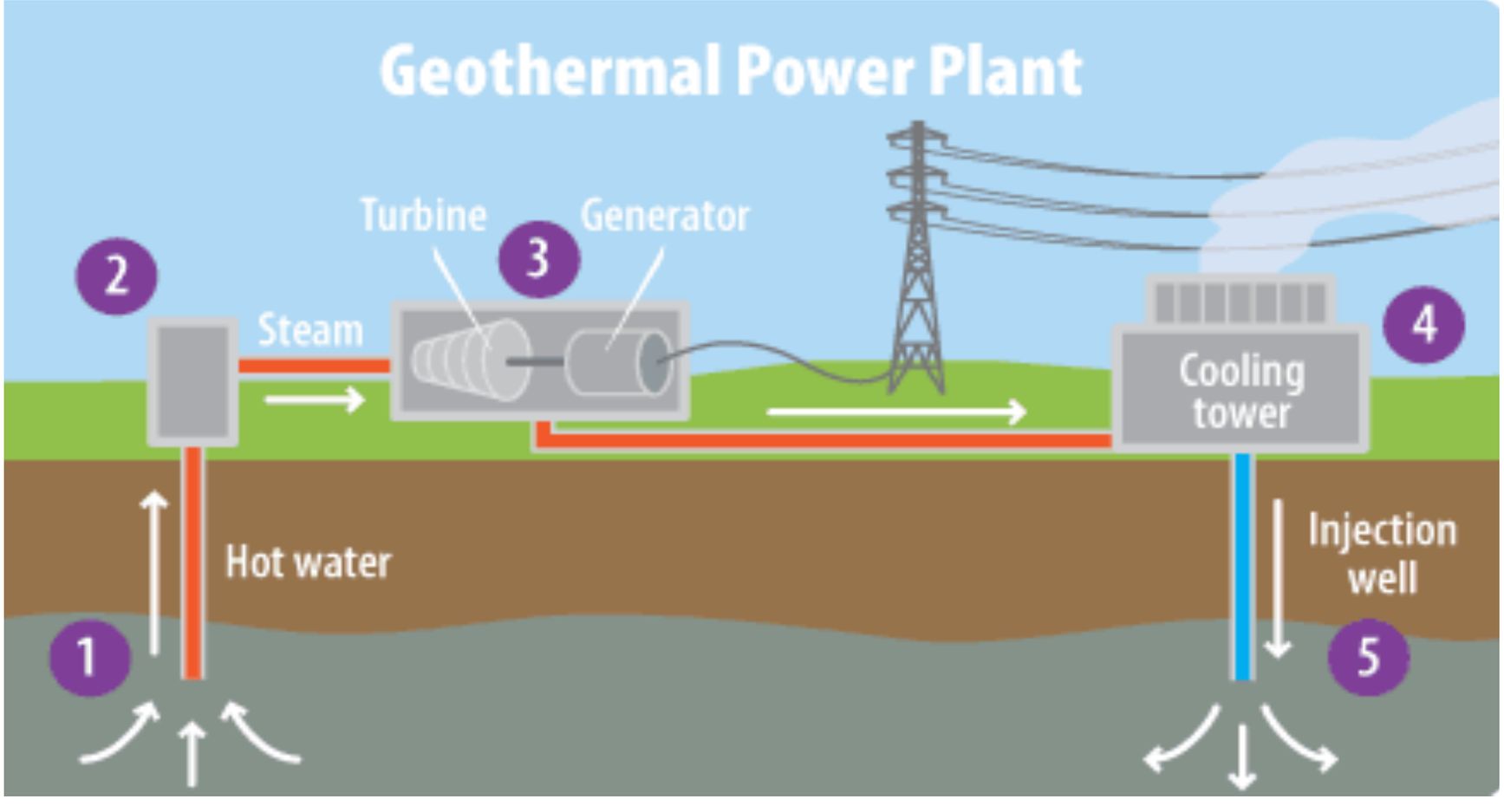
SUMMARY AND LOOKING FORWARD



Municipal Campus Plan - Town of Deerfield

GEOTHERMAL

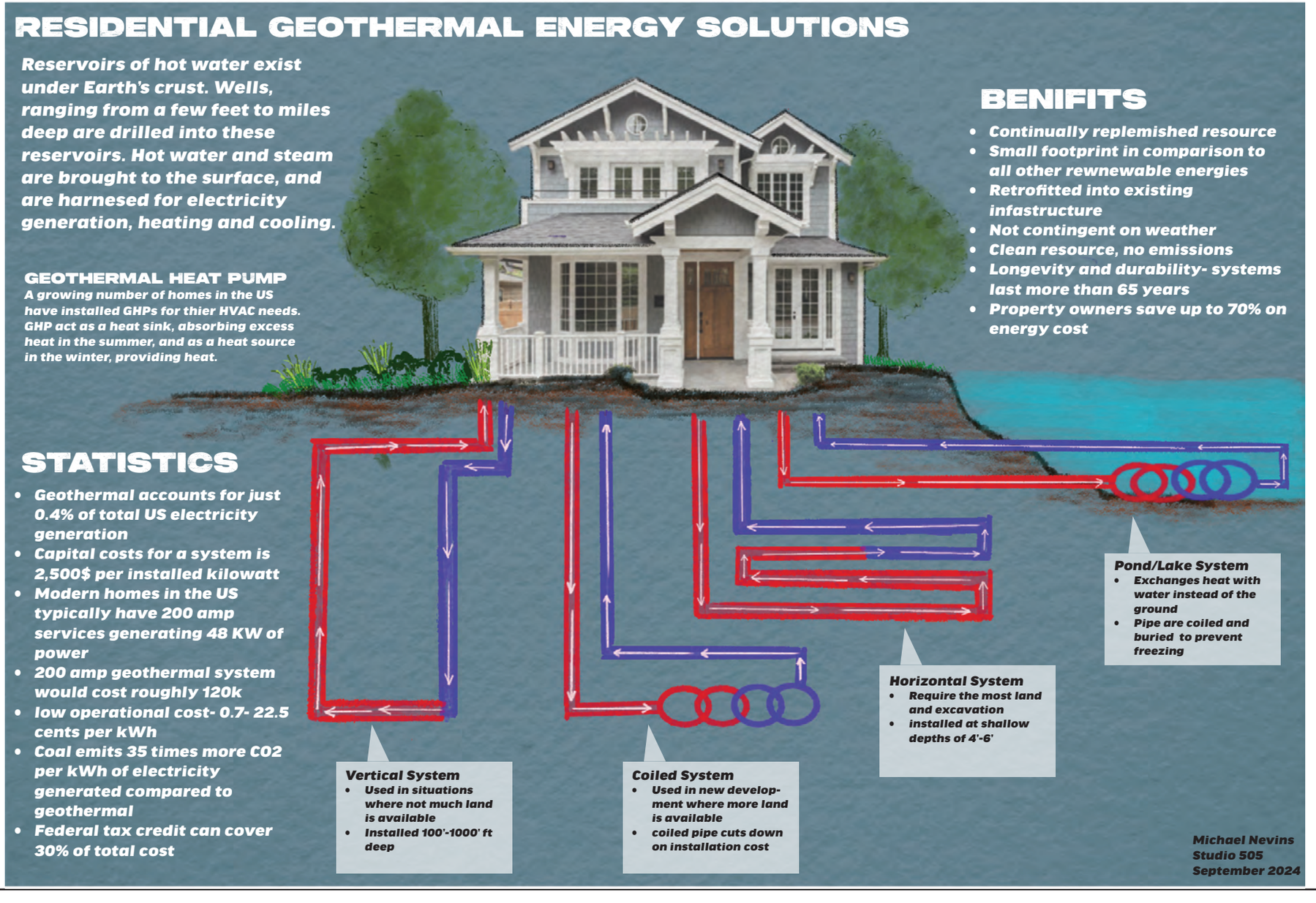
HOW IT WORKS



United States Department of Energy

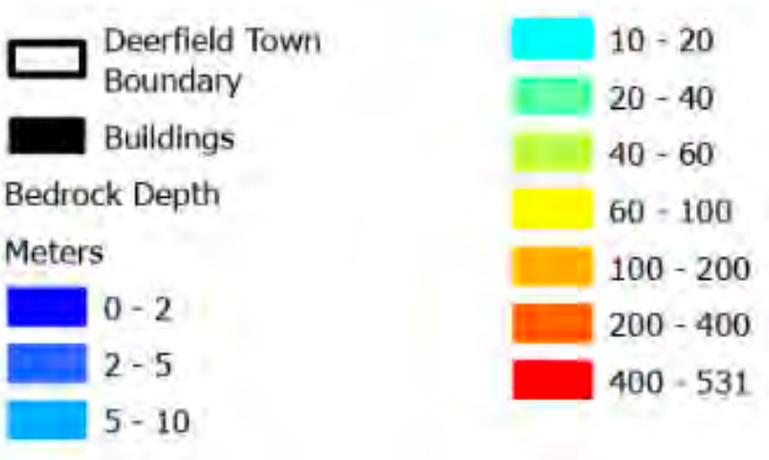
GEOTHERMAL

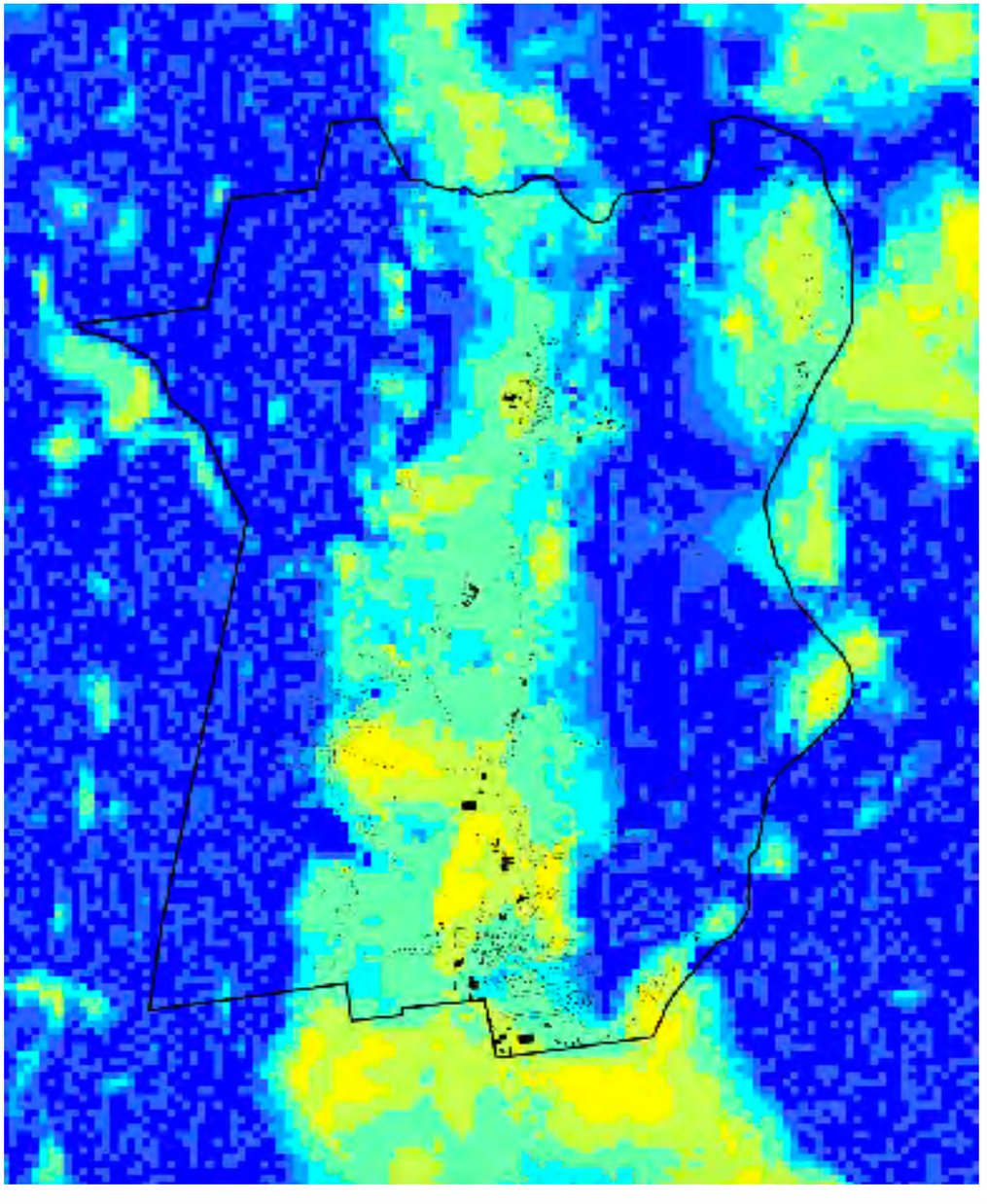
GROUND SOURCE HEAT PUMPS



GEOTHERMAL

TOWN WIDE BEDROCK DEPTH



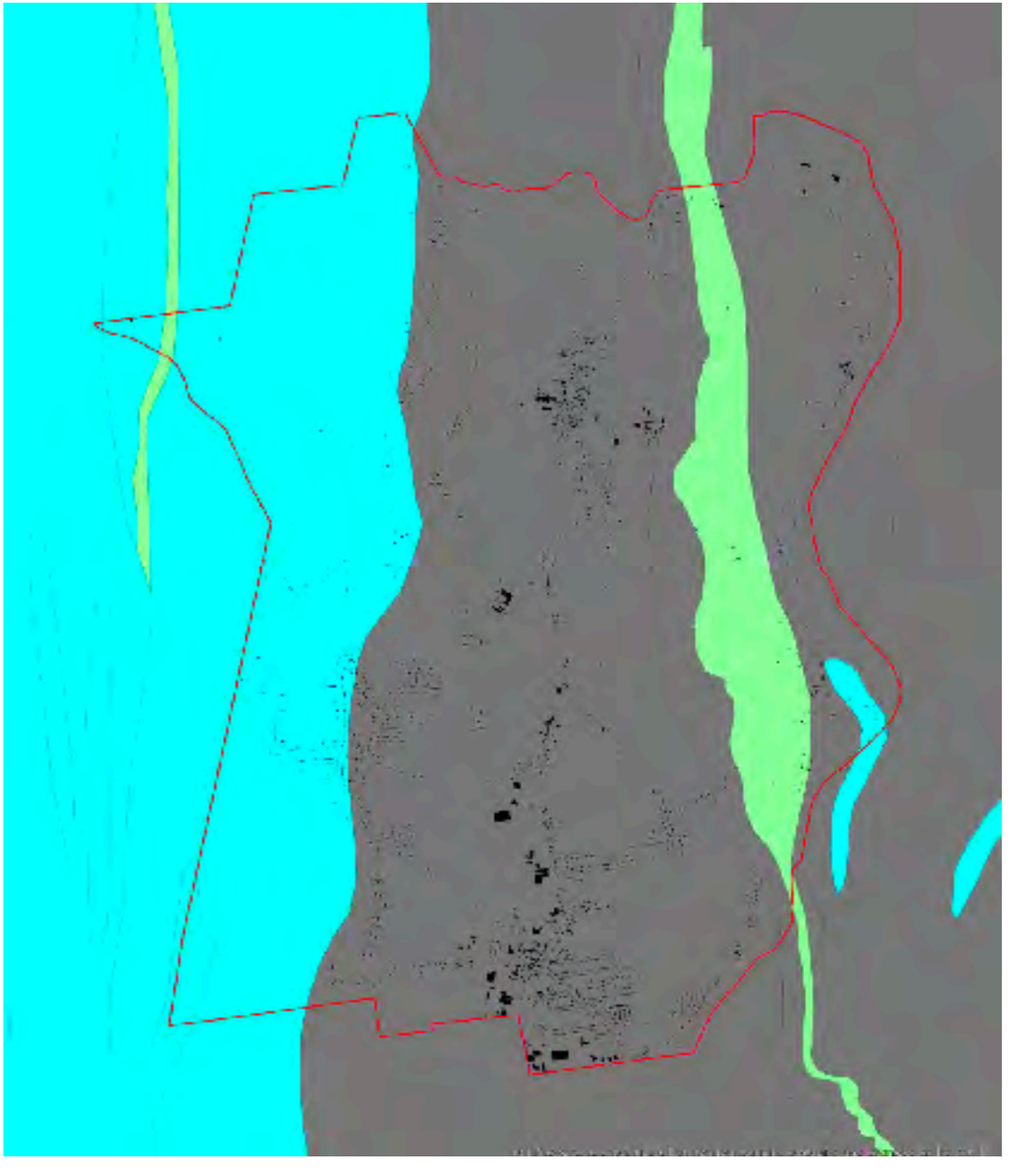


GEOTHERMAL

BEDROCK LITHOLOGY

Deerfield is predominately made up of Basin Sedimentary, Calcpelite, and Mafic bedrock.

Most Geothermal energy made in the past century has come from Sedimentary bedrock, as it is a host for heat found in the Earth. Sedimentary basins contain large resources of hot bedrock at depths that are well within the range of conventional energy borholes needed for Geothermal.

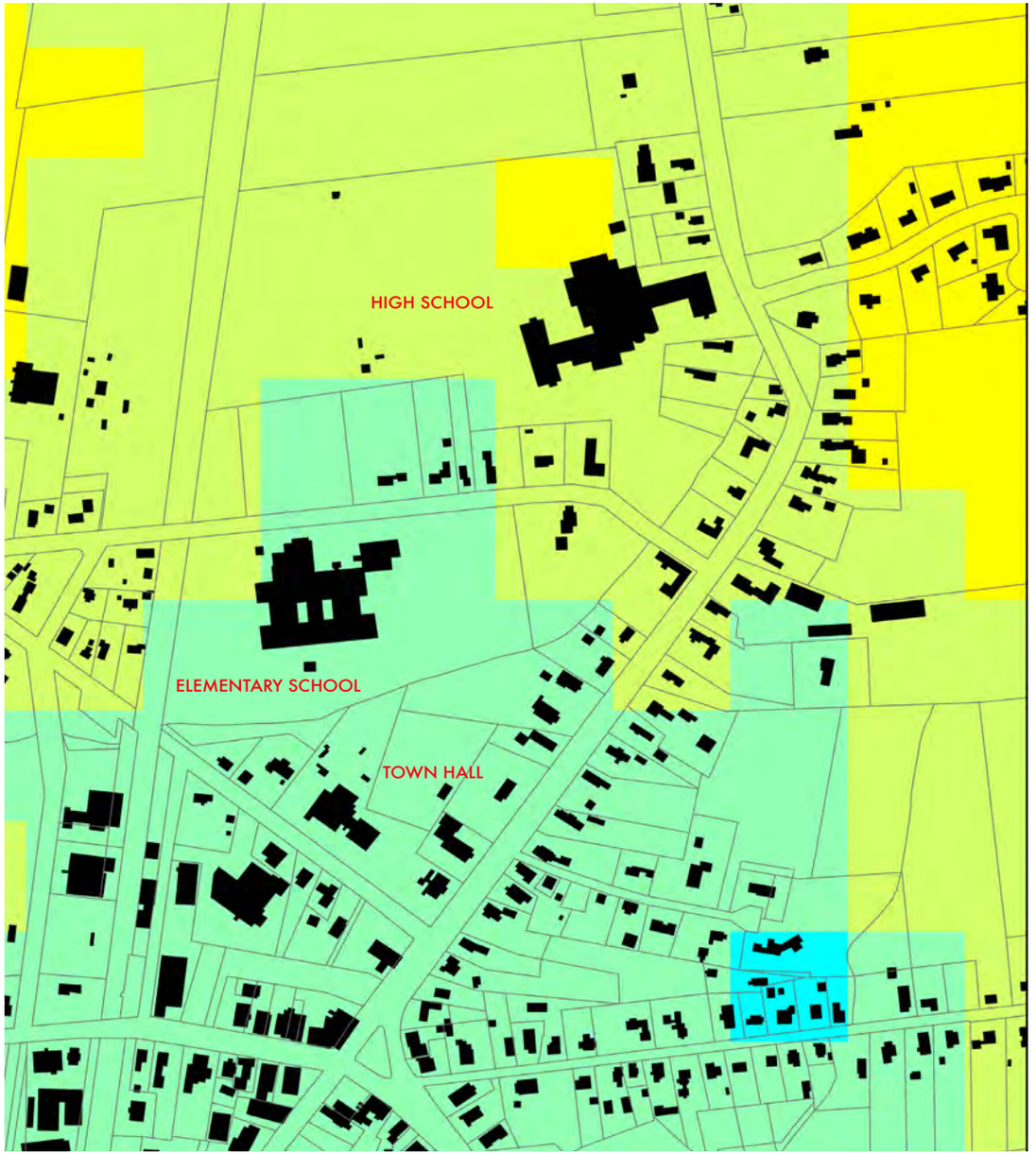


GEOTHERMAL

TOWN CENTER BEDROCK DEPTH

-Horizontal Geothermal systems are buried at depths from 6-10 feet deep, but require more land area to accomplish

-Vertical Geothermal systems require much more excavation, digging holes up to 200-500 feet deep, but require far less land area.



Deerfield Town Boundary

Buildings

Bedrock Depth

Meters

- 0 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 40
- 40 - 60
- 60 - 100
- 100 - 200
- 200 - 400
- 400 - 531

THANK YOU

Town of Deerfield
Christopher Dunne
Acting Town Administrator/Planning & Economic Development Coordinator

Denise Mason
Chair Planning Board, Town of Deerfield

MA Swedlund
Energy Committee Member, Town of Deerfield

UMass Amherst
Dwayne Breger
Assistant Director, Clean Energy Extension

Jordan Kantner
Assistant Professor of Architecture

Samantha Solano
Assistant Professor of Landscape Architecture

River Strong
Director, Clean Energy Extension

Carolina Aragón
Studio 605 Professor

Berkshire Design Group
Rachel Loeffler
Principal