NASCSP

2024 National Association for State Community Services Programs Annual Training Conference

Climate Change Impacts on WAP

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Christian Jewett – National Renewable Energy Laboratory

TURNING POSSIBILITIES INTO REALITIES

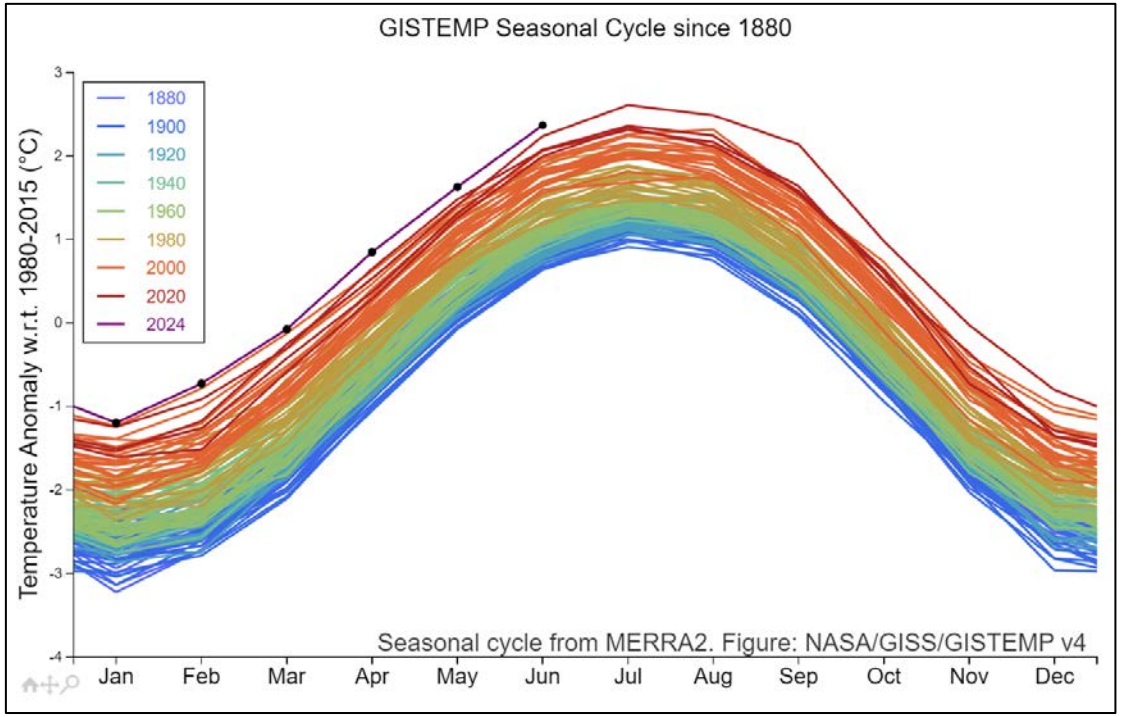
Table of Contents

Climate Science Overview

What is Climate Change?

Change in weather patterns ***on average*** over time

- Climate vs. Weather
  - Climate:
    - Regional or global changes in ***average*** temperature and weather over a long span of time.
    - Example: "On average, summers are warmer and natural disasters are more frequent than in 1950."
  - Weather:
    - Local conditions that occur on a short time span.
    - Example: "Next week will be 10 degrees Fahrenheit warmer than average."



Source: NASA's Goddard Institute for Space Studies [1]

What Causes Climate Change?

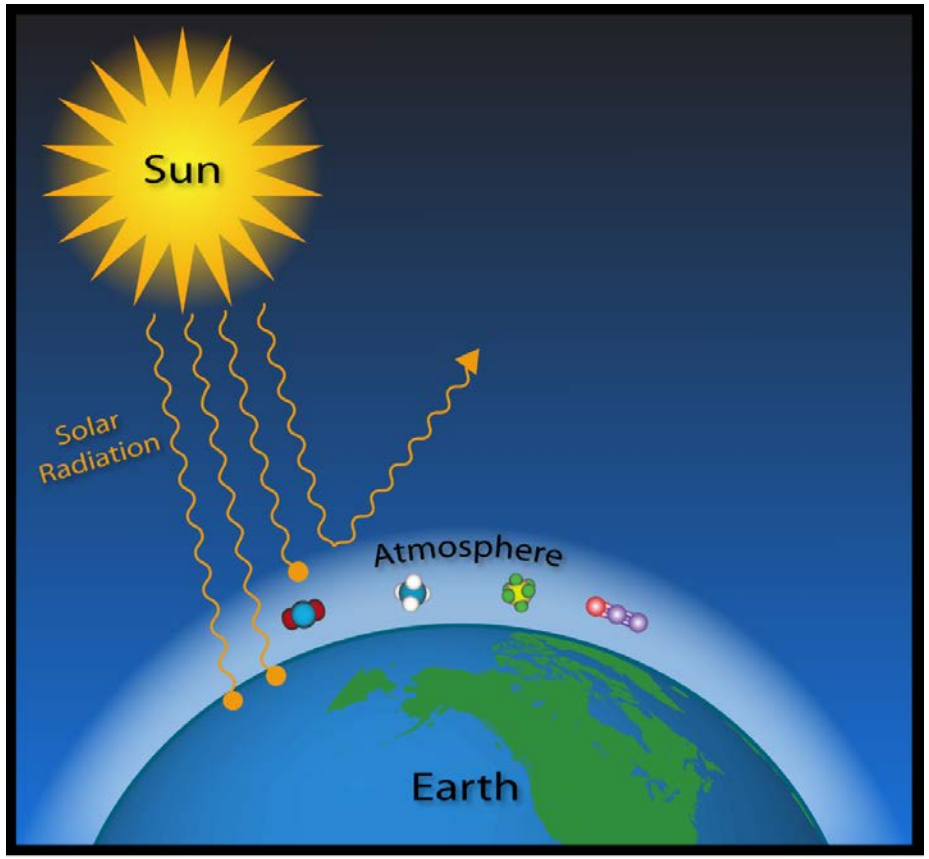


Illustration from Barb Deluisi, National Oceanic & Atmospheric Administration [2]

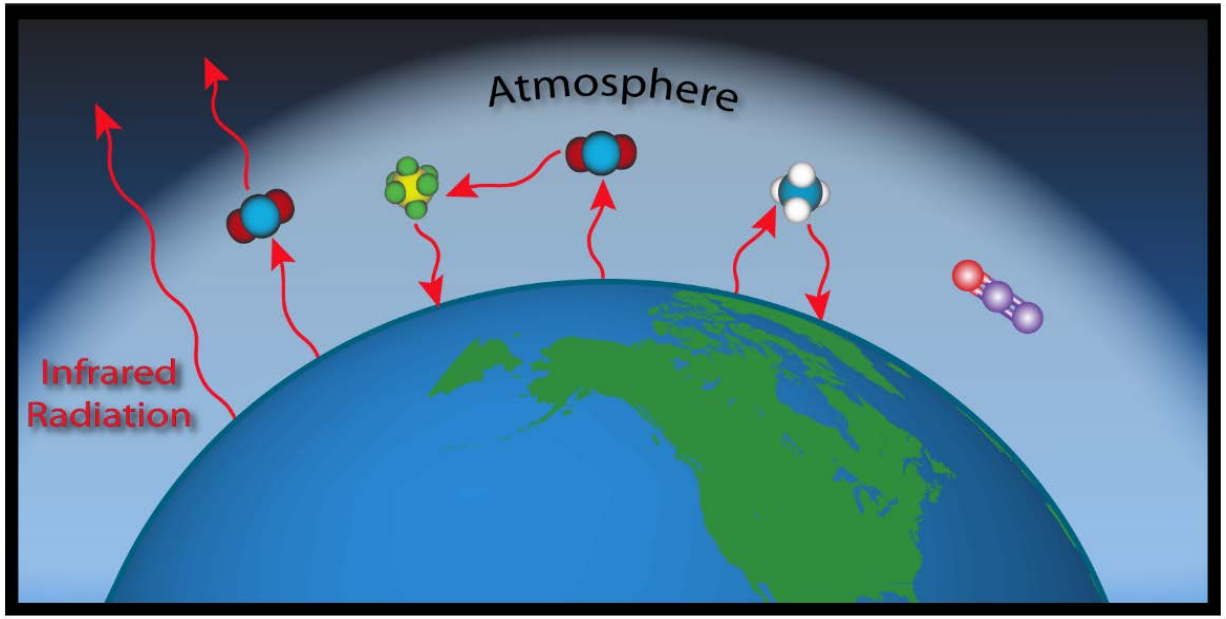


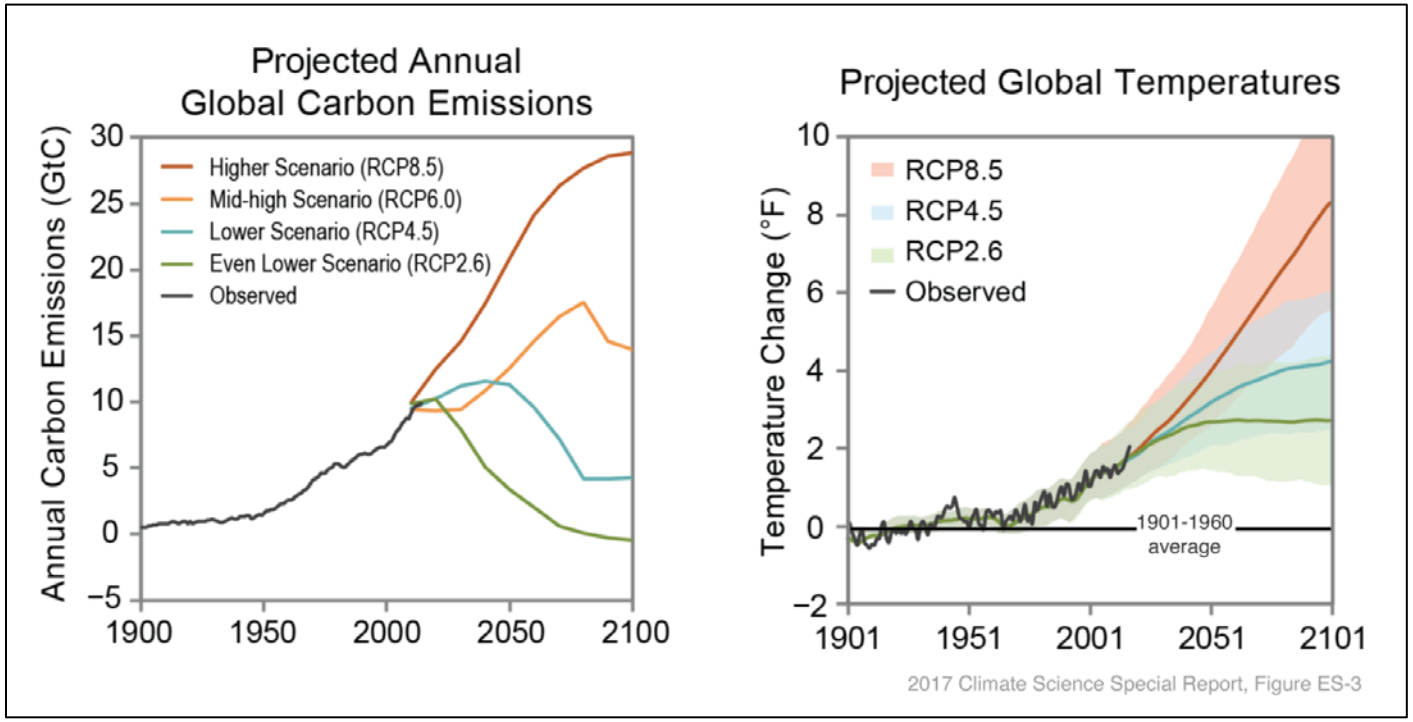
Illustration from Barb Deluisi, National Oceanic & Atmospheric Administration [2]

- Greenhouse gases (GHGs) trap infrared radiation (heat) from sun.
- Excess GHGs result in excessive heating.

Climate Model Scenarios

Various climate forecasts exist.

- Representative Concentration Pathways (RCPs)
  - Only account for different GHG concentrations.
  - Each RCP developed by a different team of researchers.[3]
- Shared Socioeconomic Pathways (SSPs)
  - Account for socioeconomic factors (i.e. population and economic growth, education, urbanization, technology development).
  - Developed by International Institute for Applied Systems Analysis (IIASA) and National Center for Atmospheric Research (NCAR).[4]



Source: National Oceanic & Atmospheric Administration

Climate Change Effects

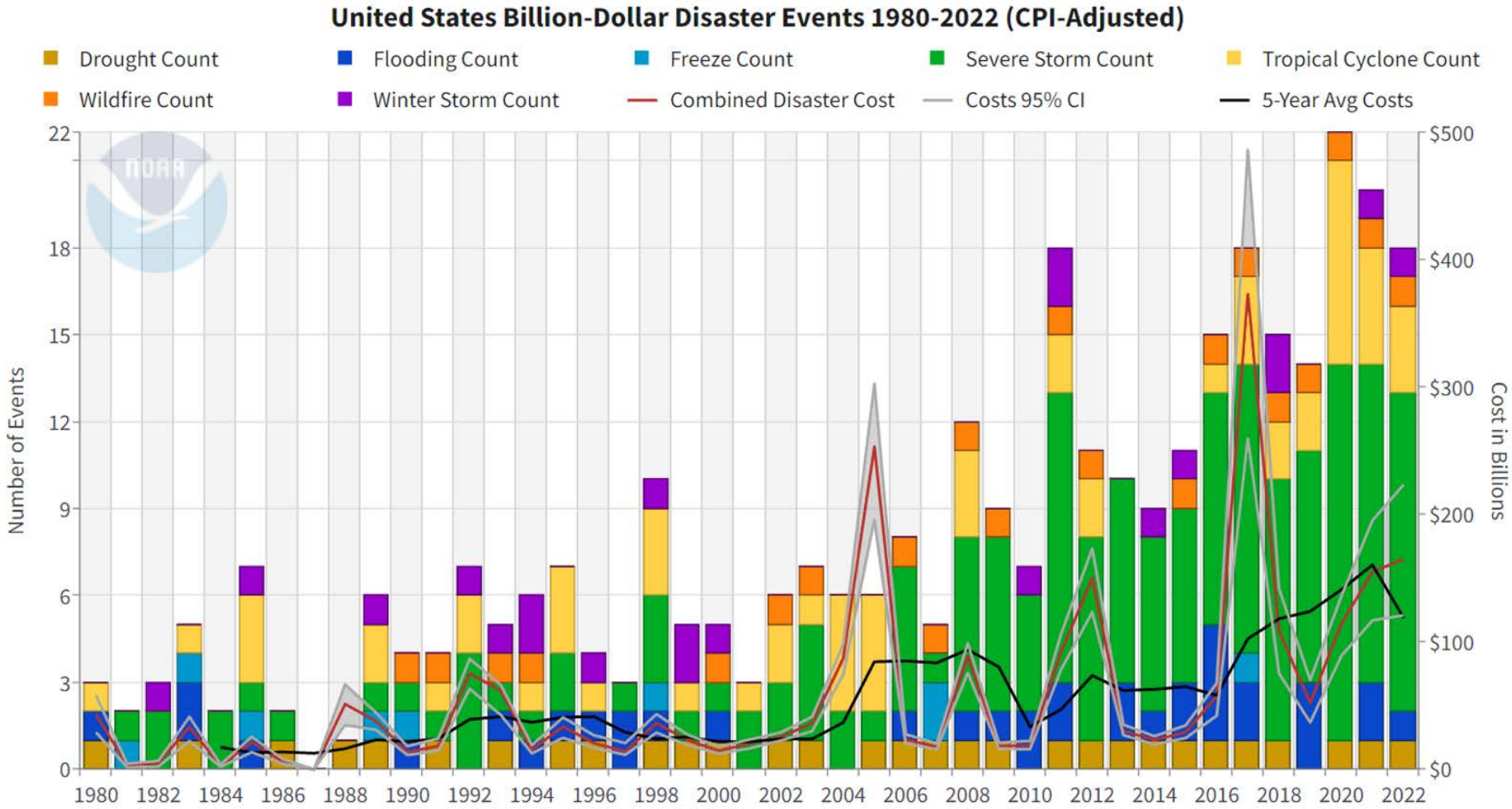
Changing Weather

- Over the past several decades weather patterns, extreme weather, and natural disasters have changed.

- Use of WAP funds is limited in federally declared emergencies/ disasters.

- For additional information on interaction between WAP and emergency declarations/disasters see WPN 12-7 or more recent guidance.

Extreme Weather Events



Source: National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) . "Billion-Dollar Weather and Climate Disasters." Accessed August 28, 2024. https://www.ncei.noaa.gov/access/billions/, DOI: 10.25921/stkw-7w73 [5]

Precipitation

- Dry areas got drier.
- Wet areas got wetter.
- Extreme one-day precipitation events increasing in frequency.
  - Intense rain yields more flooding and runoff which can inhibit groundwater renewal.

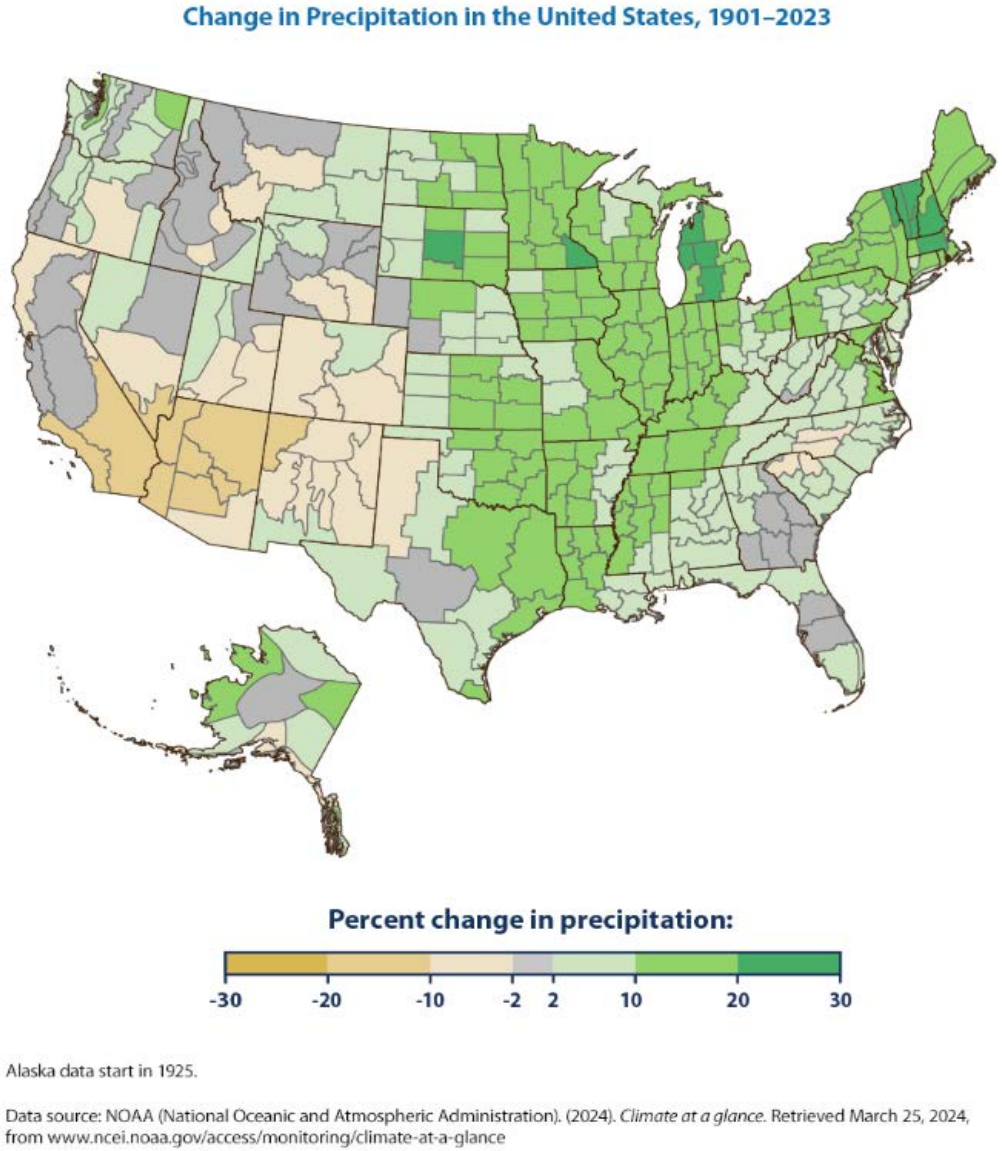


Illustration from the U.S. Environmental Protection Agency (EPA) [6]

Drought

- Drought and precipitation are correlated.

- This may pose risks to residential, commercial, and industrial water supplies (including energy generation).

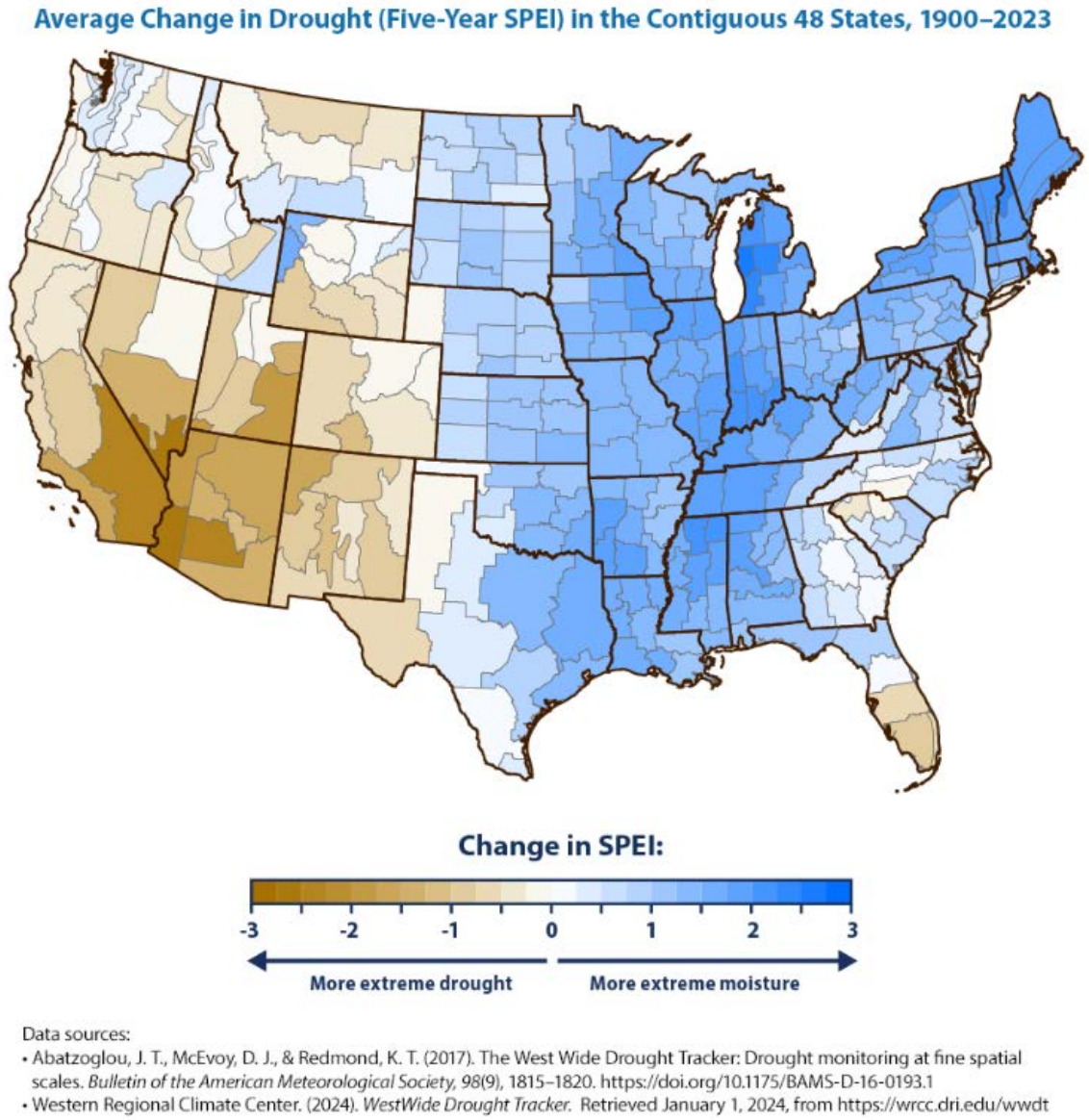
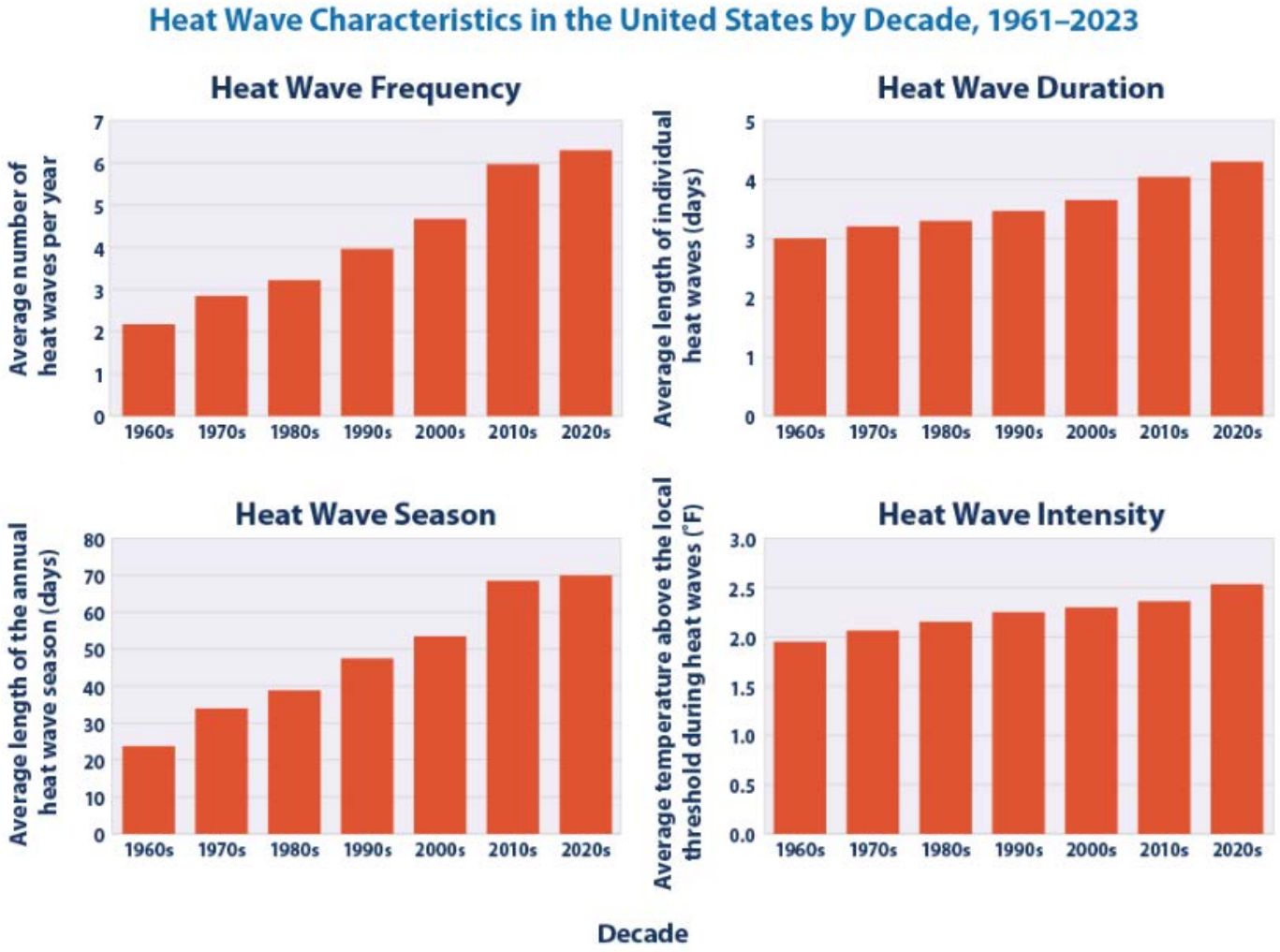


Illustration from the U.S. Environmental Protection Agency (EPA) [6]

Heat Waves

- Every decade since 1960, heat waves have gotten more severe.
- Even cities with increased precipitation and less drought have had increased heat wave severity.



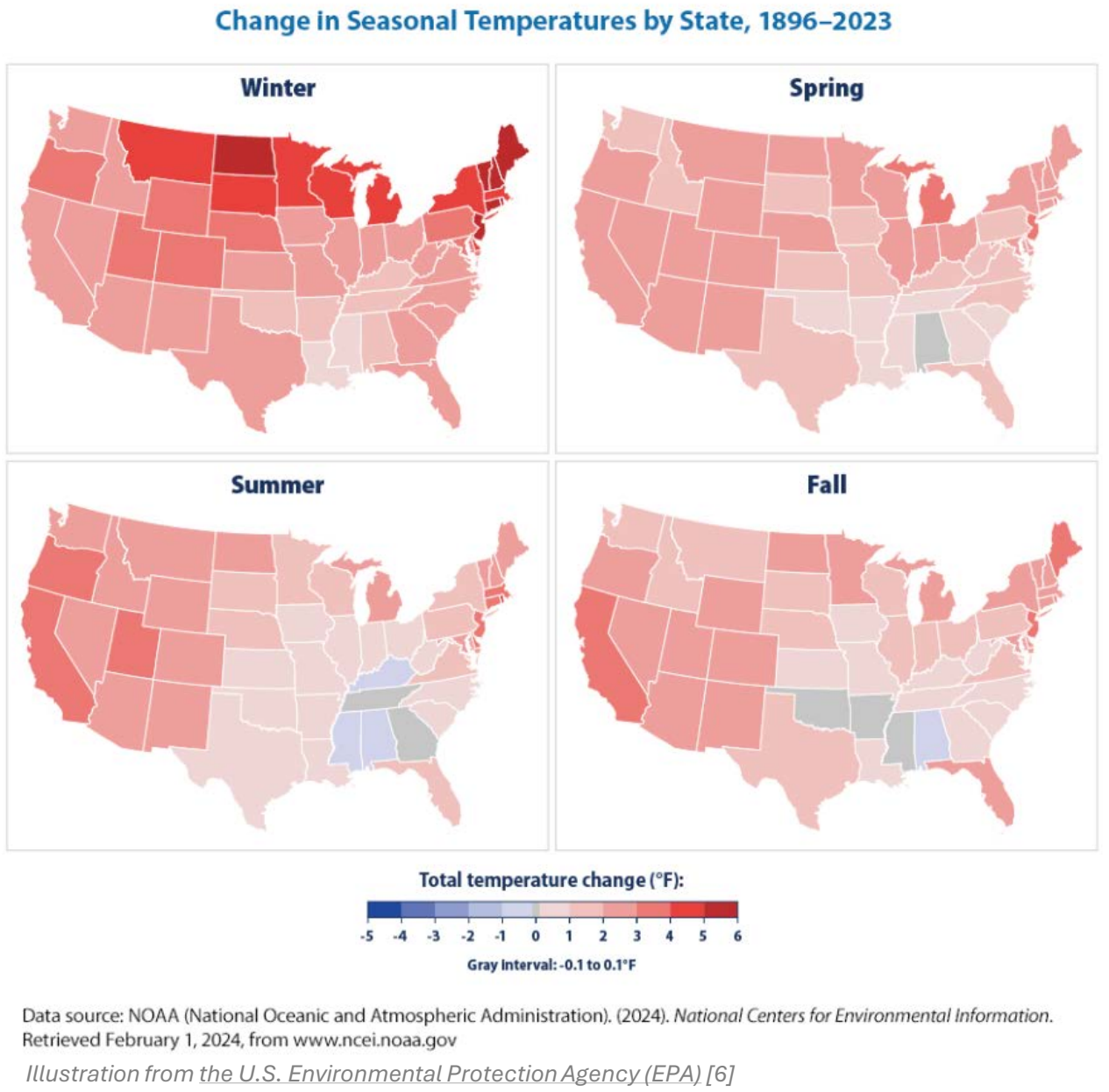
Data source: NOAA (National Oceanic and Atmospheric Administration). (2024). *Heat stress datasets and documentation* (provided to EPA by NOAA in April 2024) [Data set].

Illustration from the U.S. Environmental Protection Agency (EPA) [6]

Temperature

- In most states, temperatures have increased in all seasons.

- "Small" changes in temperature can:
  - Increase "extreme" events.
  - Yield large changes in energy consumption.



Data source: NOAA (National Oceanic and Atmospheric Administration). (2024). *National Centers for Environmental Information.* Retrieved February 1, 2024, from www.ncei.noaa.gov

Illustration from the U.S. Environmental Protection Agency (EPA) [6]

Unusually Hot Weather

- Noticeable differences across regions.

- Unusually hot weather may decrease while ***average*** temperatures increase.*

**Average temperatures on the previous slide were from a different time range (1896–2023).*

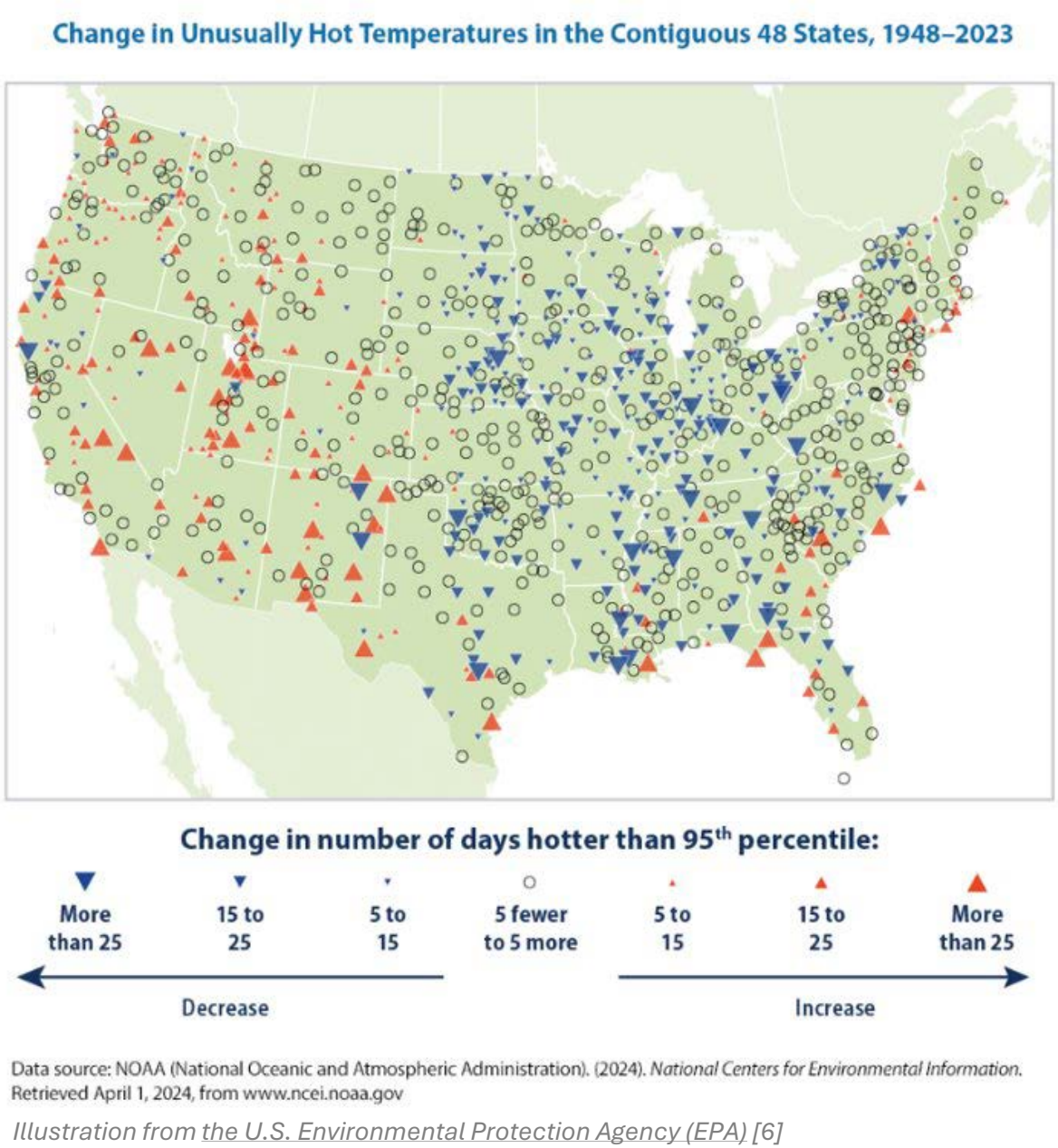
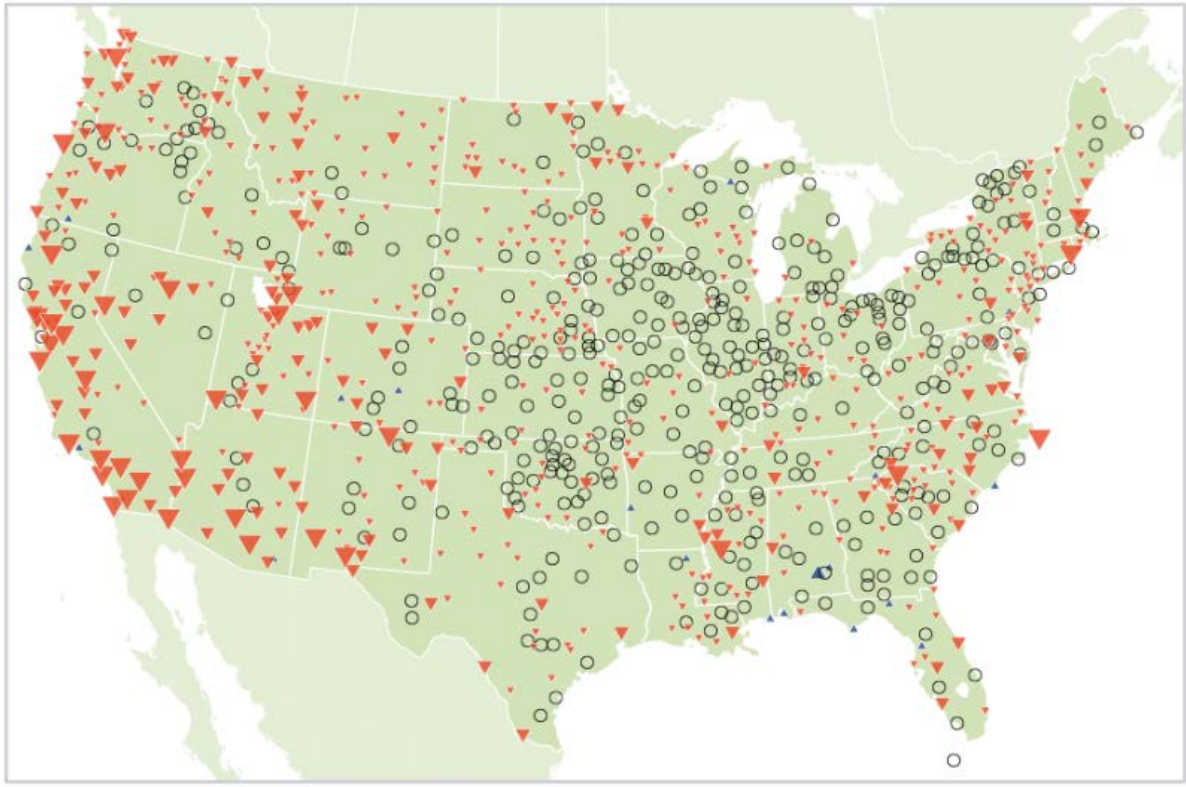


Illustration from the U.S. Environmental Protection Agency (EPA) [6]

Unusually Cold Weather

- Overall, unusually cold weather is decreasing or remaining mostly unchanged.
- Winters are warming differently than summers.
- Warmer winters may affect agriculture and pest pressures.



Data source: NOAA (National Oceanic and Atmospheric Administration). (2024). *National Centers for Environmental Information.* Retrieved April 1, 2024, from www.ncei.noaa.gov

Illustration from the U.S. Environmental Protection Agency (EPA) [6]

Climate Change and Weatherization

Building Energy Usage

"Typical" Weather

Weather varies from year to year.

Typical Meteorological Year (TMY):

- NREL-produced dataset of "typical" years[7].
- TMY3 is frequently used (date range: 1991–2005).
- Can be used for building energy modeling.
- Often used for energy savings calculation inputs (degree days, full load hours, etc.).

"Typical" Weather

Pros:

- Allows energy "normalization."
- Simplicity: one weather file.
- Industry acceptance.

Cons:

- Backward-looking.
- May overly "smooth" weather.
- TMY3 may not represent current or future weather.

Degree Days

Degree Days:

- Difference between average outdoor temperature and base temperature[8].

Heating Degree Days (HDDs):

- Heating degree days accrue during the heating season.

$$HDD = T_{base} - T_{average}$$

Cooling Degree Days (CDDs):

- Cooling degree days accrue during the cooling season.

$$CDD = T_{average} - T_{base}$$

Where:

$T_{average}$ is the average temperature outside for that day.

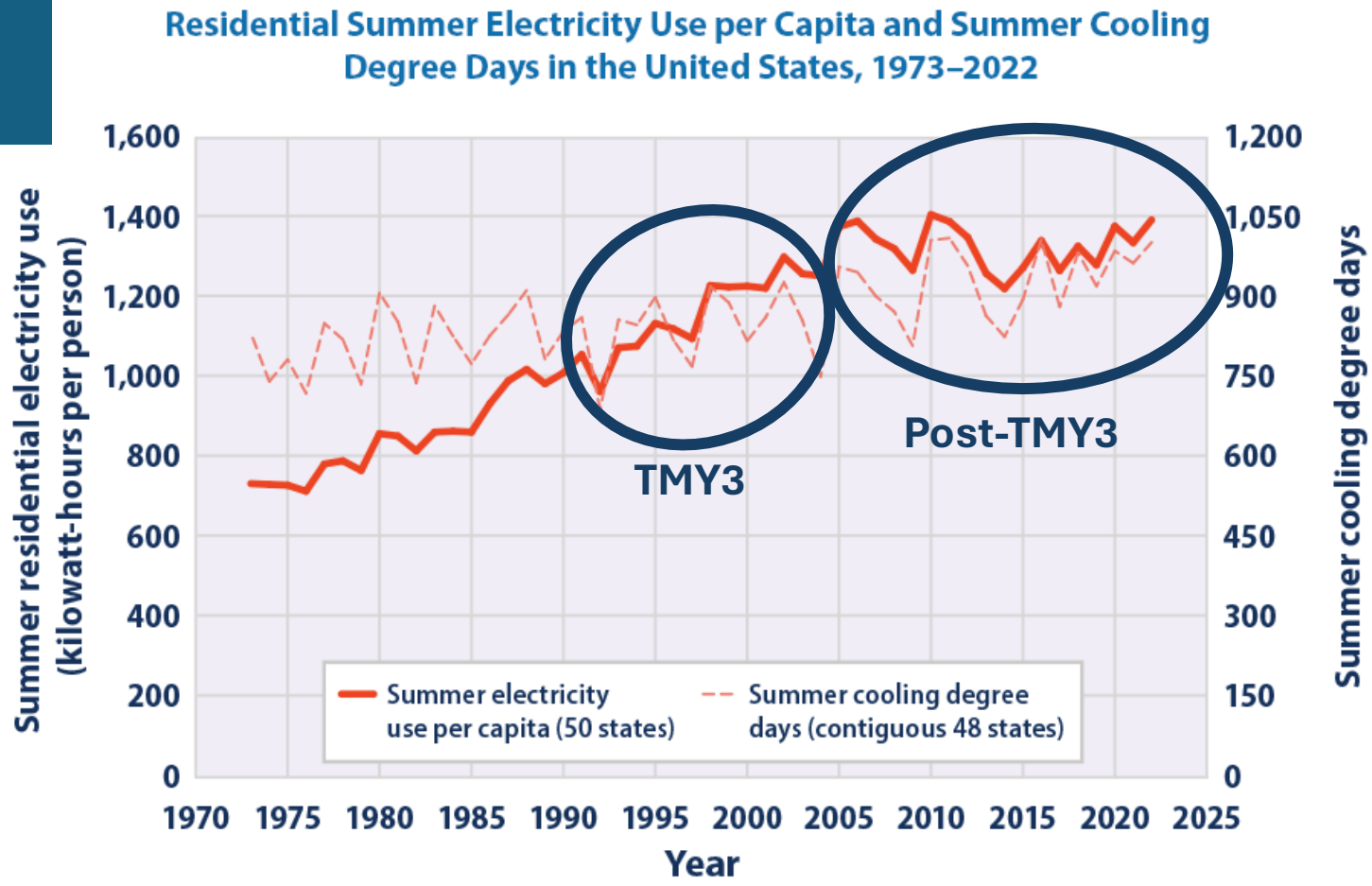
T_{base} is a theoretical temperature at which the building doesn't require heating or cooling energy.

Summer Electricity Use

Historical Patterns:

- Since 1973 CDDs have been increasing.
- Electricity use is increasing at faster annual percentage gain than CDDs.

Cooling energy savings may be underestimated by TMY weather files.



Data sources:

- EIA (Energy Information Administration). 2022. Electricity retail sales to the residential sector, monthly. Accessed January 2023. www.eia.gov/opendata.
- BEA (Bureau of Economic Analysis). 2022. Population. U.S. Census Bureau data analyzed by BEA and hosted by the Federal Reserve Bank of St. Louis. Accessed January 2023. https://fred.stlouisfed.org/series/POPTHM.
- NOAA (National Oceanic and Atmospheric Administration). 2022. National Centers for Environmental Information. Accessed January 2023. www.ncei.noaa.gov.

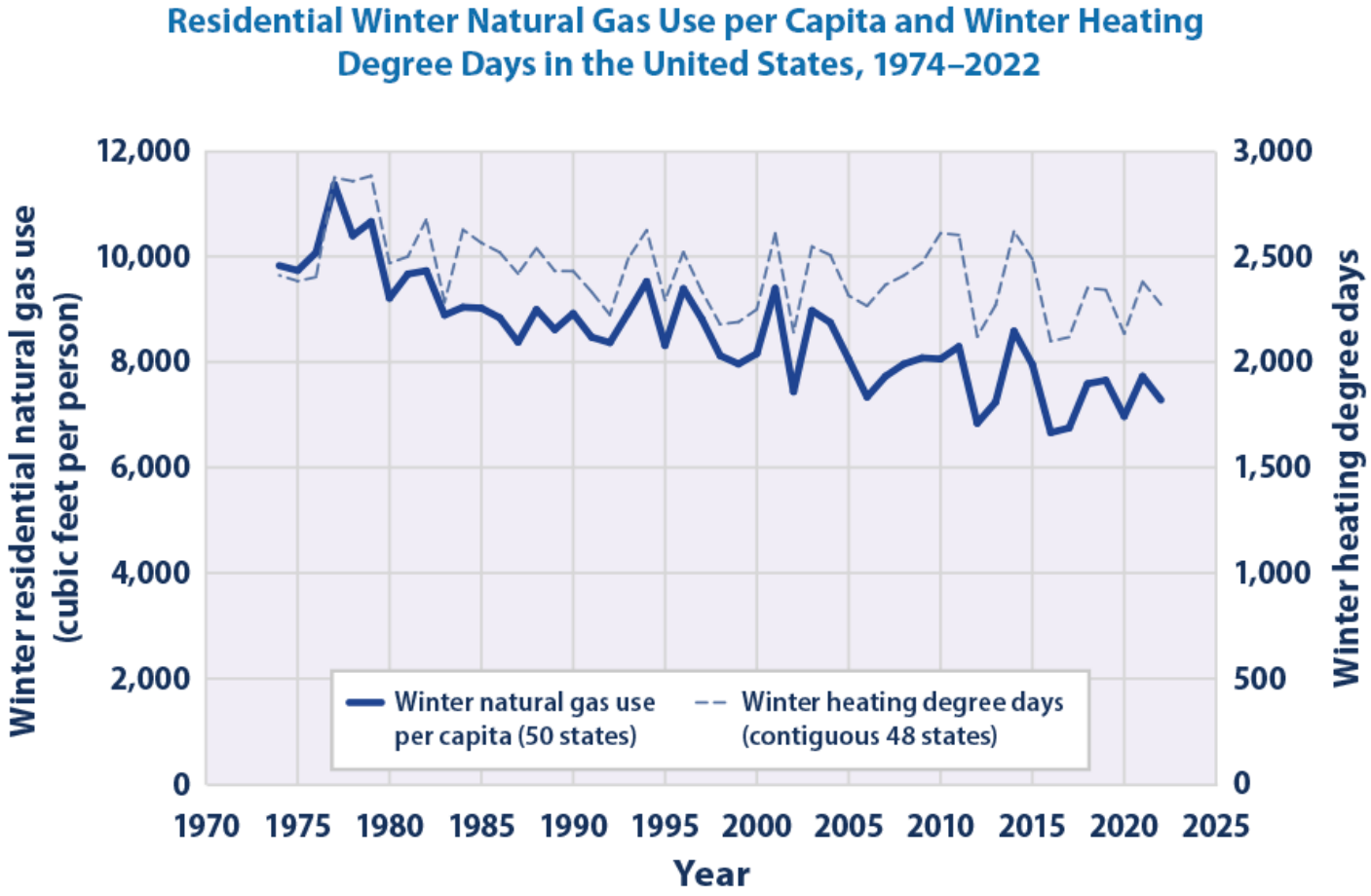
Illustration from the U.S. Environmental Protection Agency (EPA) [6]

Winter Gas Use

Historical Patterns:

- Since 1974 HDDs have been decreasing with natural gas use decreasing at faster annual percentage.
- May change with heat pump adoption.

Heating energy savings may be overestimated by TMY weather files.



Data sources:

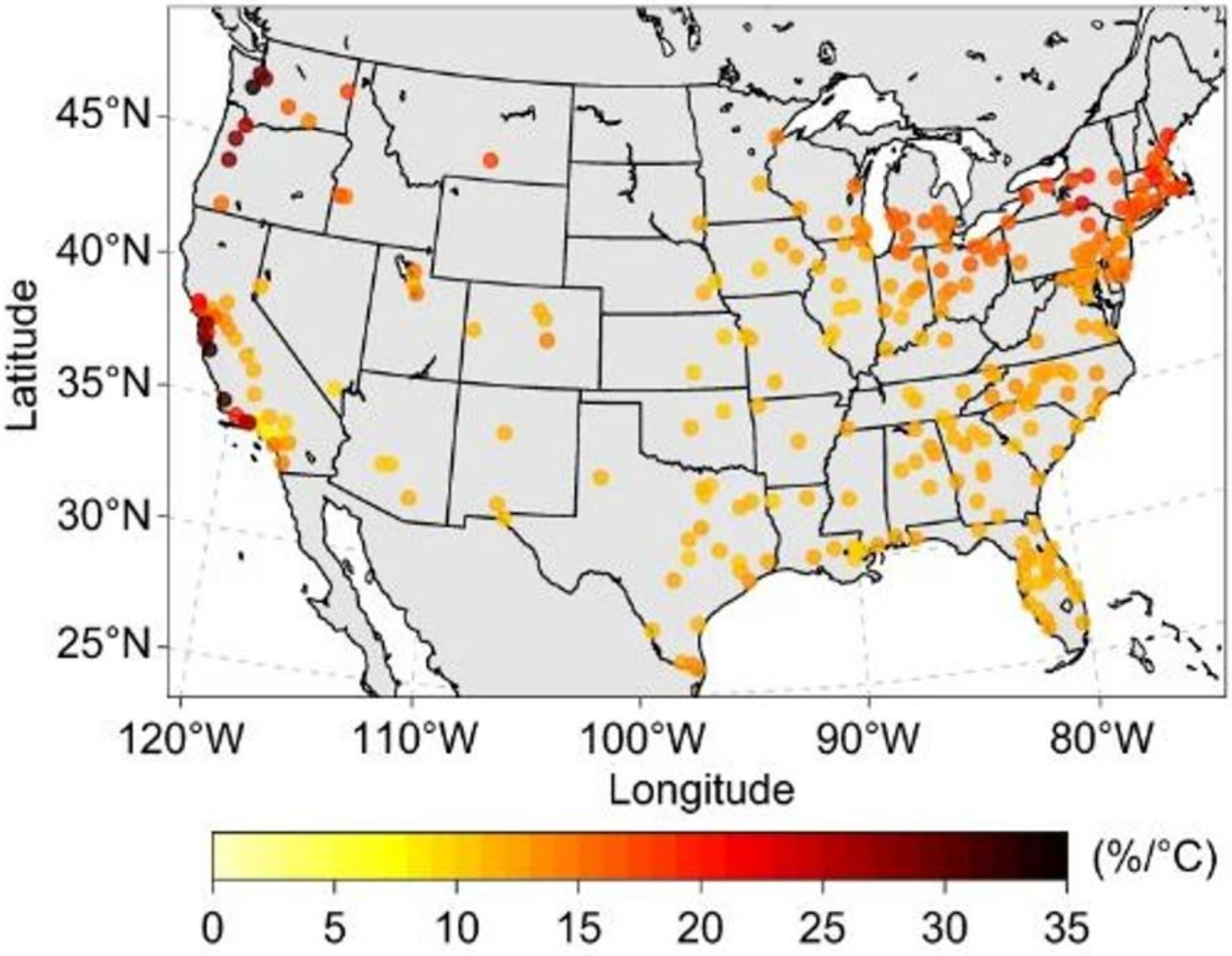
- EIA (Energy Information Administration). 2022. U.S. natural gas residential consumption, monthly. Accessed January 2023. www.eia.gov/opendata.
- BEA (Bureau of Economic Analysis). 2022. Population. U.S. Census Bureau data analyzed by BEA and hosted by the Federal Reserve Bank of St. Louis. Accessed January 2023. https://fred.stlouisfed.org/series/POPTHM.
- NOAA (National Oceanic and Atmospheric Administration). 2022. National Centers for Environmental Information. Accessed January 2023. www.ncei.noaa.gov.

Illustration from the U.S. Environmental Protection Agency (EPA) [6]

Research on Future Energy Use

- Heating and cooling energy use intensities (EUIs) subject to change under various future climate scenarios (Wang et al. 2023).
- Methods:
  - Assessed the impacts of different climate scenarios and atmospheric CO_2 concentrations.
  - Utilized building energy models and NREL's ResStock™ datasets to assess the impact of different future weather scenarios on building energy use profiles.

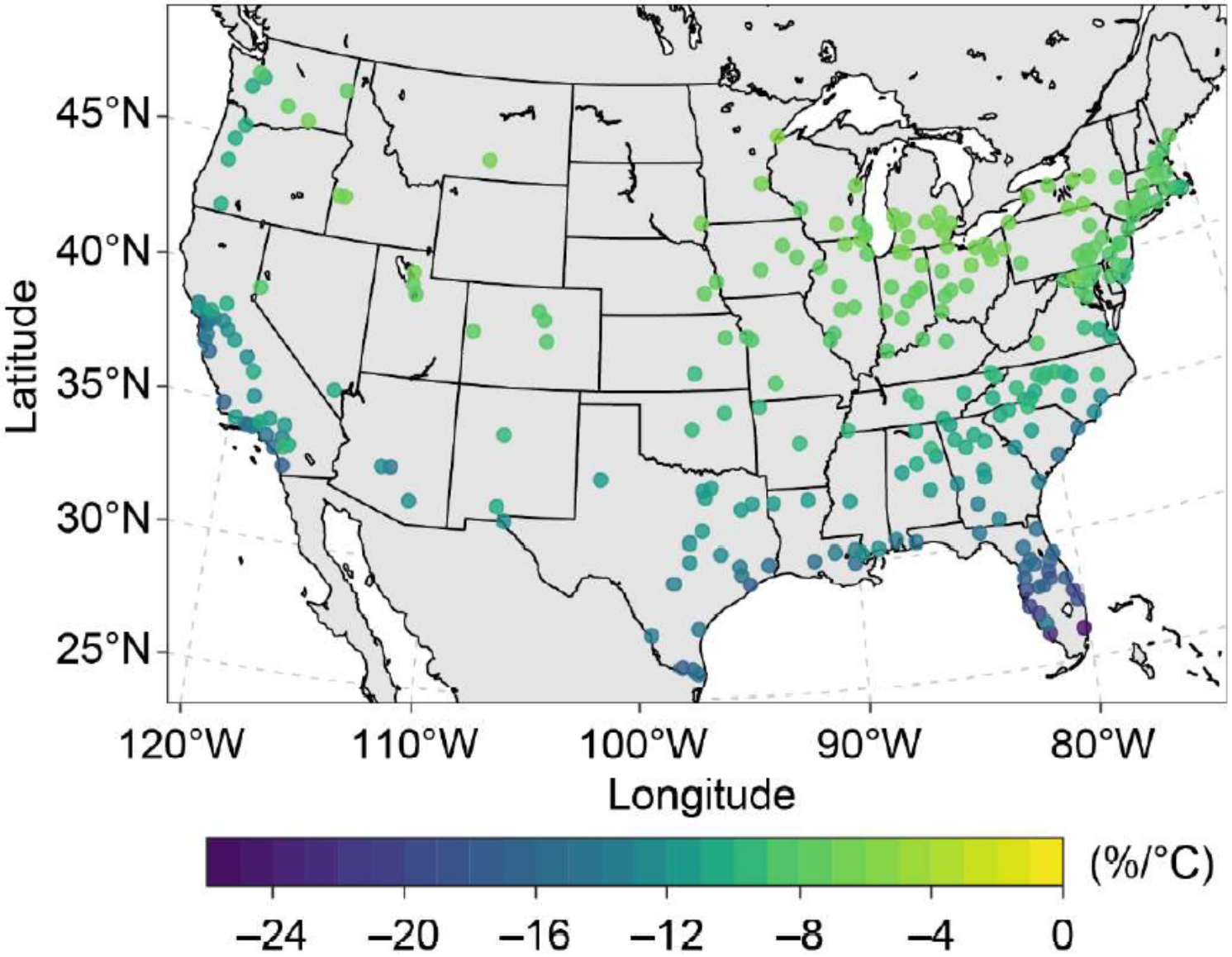
Response of annual EUI for space cooling to a 1°C temperature change in the 2050s



- Every 1°C (2.6°F) increase in temperature on average yields a 14% increase in electricity EUI for space cooling.
- Electricity for cooling is expected to have the greatest percentage increase in cooler climate regions.

***Average of all SSP Scenarios** Source: Wang et al. (2023) Nature Communications

Response of annual natural gas EUI for space conditioning to a 1°C temperature change in the 2050s



- Every 1°C (2.6°F) increase in temperature on average yields a 9–11% decrease in fossil fuel EUI for space heating.
- Heating EUI is expected to have the greatest percentage decrease in warmer climate regions.

***Average of all SSP Scenarios**

Source: Wang et al. (2023) Nature Communications

Key Takeaways

Expected climate change impacts across measure life:

- Historically, uneven changes in hot and cold weather across the United States.
- Winters are warming almost everywhere for all climate change scenarios.
- Measures that reduce consumption during the cooling season are expected to have increasing bill savings.
- Measures that reduce heating energy are expected to yield decreasing energy bill savings.

Discussion

- Have any of the historical climate changes already impacted your work? How?

- If these trends continue or intensify, how might that affect weatherization work moving forward?

Human Health and Safety

Worker Health

- Extreme heat can threaten worker health.
- Construction workers accounted for 34% of deaths between 1992 and 2022.
- Underreporting is believed to be more common in industries with undocumented workers.

Heat-Related Workplace Deaths in the United States, 1992–2022

Data source: BLS (U.S. Bureau of Labor Statistics). (2024). *Census of Fatal Occupational Injuries (CFOI)*. Retrieved April 29, 2024, from www.bls.gov/iif/oshcfoi1.htm

Illustration from the U.S. Environmental Protection Agency (EPA) [6]

Discussion

- How might Weatherization Assistance Program (WAP) work be affected by rising heat risks (e.g., exposure to mold, hotter attics and rooftops)?

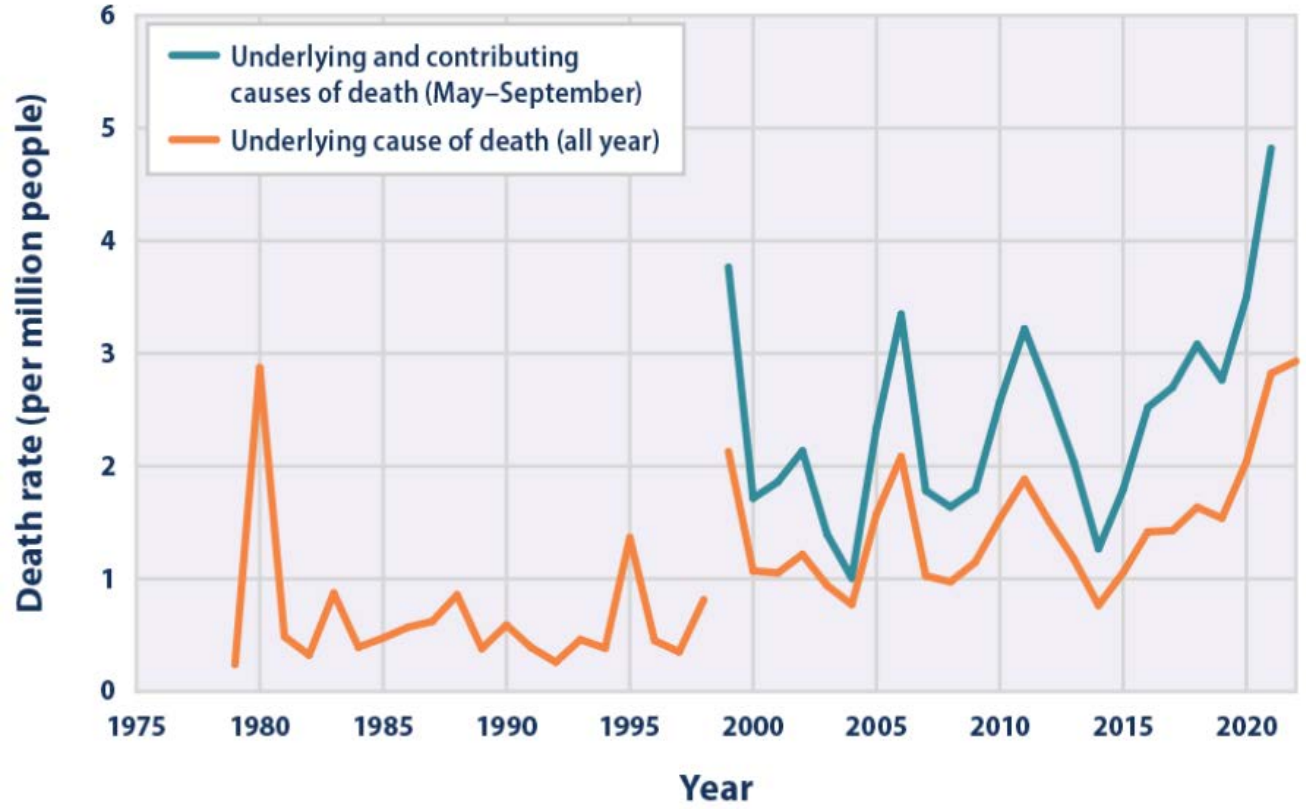
- What successes have you had in improving worker health and safety in heat?

Occupant Exposure

- Increased exposure to heat is associated with excess heat-related deaths in summer months.
- Not all heat-related deaths are classified correctly.

Note: Missing data due to the World Health Organization changing their methodology in 1998–1999.

Deaths Classified as "Heat-Related" in the United States, 1979–2022



Between 1998 and 1999, the World Health Organization revised the international codes used to classify causes of death. As a result, data from earlier than 1999 cannot easily be compared with data from 1999 and later.

Data sources:

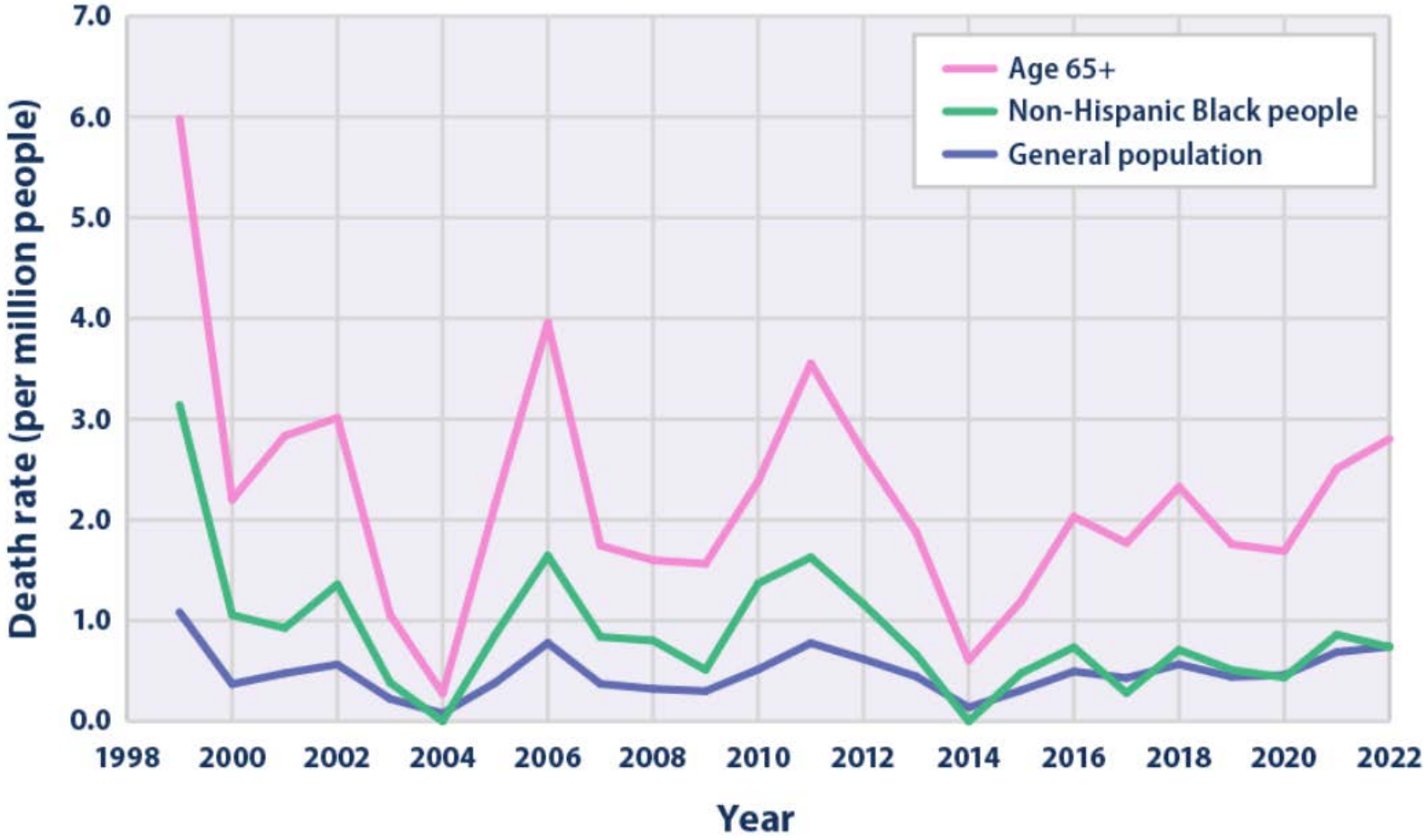
- CDC (U.S. Centers for Disease Control and Prevention). (2024). *CDC WONDER database: All ages deaths by underlying cause* [Data set]. Retrieved May 22, 2024, from https://wonder.cdc.gov/Deaths-by-Underlying-Cause.html
- CDC (U.S. Centers for Disease Control and Prevention). (2024). *Indicator: Heat-related mortality* (Annual national totals provided by National Center for Environmental Health staff in June 2024) [Data set]. National Center for Health Statistics. https://ephtracking.cdc.gov

Illustration from the U.S. Environmental Protection Agency (EPA) [6]

Occupant Exposure

- Elderly and non-Hispanic Black populations are at greater risk of death with concurrent cardiovascular disease and exposure to heat.

Summer Deaths Due to Heat *and* Cardiovascular Disease in the United States, 1999–2022



Data source: CDC (U.S. Centers for Disease Control and Prevention). (2024). *CDC WONDER database: Multiple cause of death file* [Data set]. Retrieved May 22, 2024, from https://wonder.cdc.gov/mcd-icd10.html

Illustration from the U.S. Environmental Protection Agency (EPA) [6]

Weatherization and Home Resilience

- A recent analysis found that major power outages were two times more common from 2014–2023 than they were from 2000–2009 (Climate Central 2023).
- A 2023 study found that efficiency measures (insulation, better windows) can improve habitability in outages in single-family and multifamily homes (Franconi, Hotchkiss, and Hong 2023).
  - In assisted living facilities, operable windows or ventilation equipment with backup power improve habitability.
  - Air leakage reductions ***without*** operable windows may worsen resilience by reducing infiltration by cooler evening air.

Importance of Air Conditioning

- According to a recent report on summer shutoff protections (CEPC 2024):
  - 45.2 million people with incomes below 200% of the Federal Poverty Level live in states with no summer shutoff protections.
  - 20% of very low-income families have no air conditioning.
  - 31% of low-and-moderate income families kept homes at temperatures that they felt were unsafe or unhealthy to save money
  - 51% forewent basic necessities to pay energy bills.

Importance of Air Conditioning

- Reports of heat-related deaths in Maricopa County, Arizona (MCPHD, 2023) revealed:
  - Of deaths where air conditioning was present, 85% of units were not functioning, 12% were not in use, and 2% had no electricity.
  - 9% of indoor deaths were in homes with no air conditioning.

- Manufactured homes make up 5% of the building stock in Maricopa County, but their residents accounted for 29% of indoor heat-related deaths from 2006–2019 (Phillips et al. 2020), (MCPHD 2015).

- 76.2% of mobile home residents don't participate in any utility or subsidy programs to help pay energy bills despite potentially qualifying (KER n.d.)

Discussion

- How do/could you take climate-related health and safety considerations into account when scoping weatherization jobs?

Impacts to the Building

Inoperable/Inappropriate Equipment

- Not running the air conditioner.
  - Potential issues with mold, humidity, rot, etc.

- Future climate considerations when sizing space conditioning equipment.
  - More intense heat can shorten air conditioner life.
  - Less severe winters could cause oversizing and short cycling of heating equipment

Readiness and Resilience

- Extreme weather can damage buildings or shorten equipment lifespans.
  - Winter power outages can cause frozen/burst pipes.
- Potential impacts to Weatherization Readiness Fund use.
- Uninsured/underinsured clients.
  - Limited financial resources may lead to delayed repairs/replacements.

Useful Resources

Social Cost of Carbon Fuel Price Modifiers

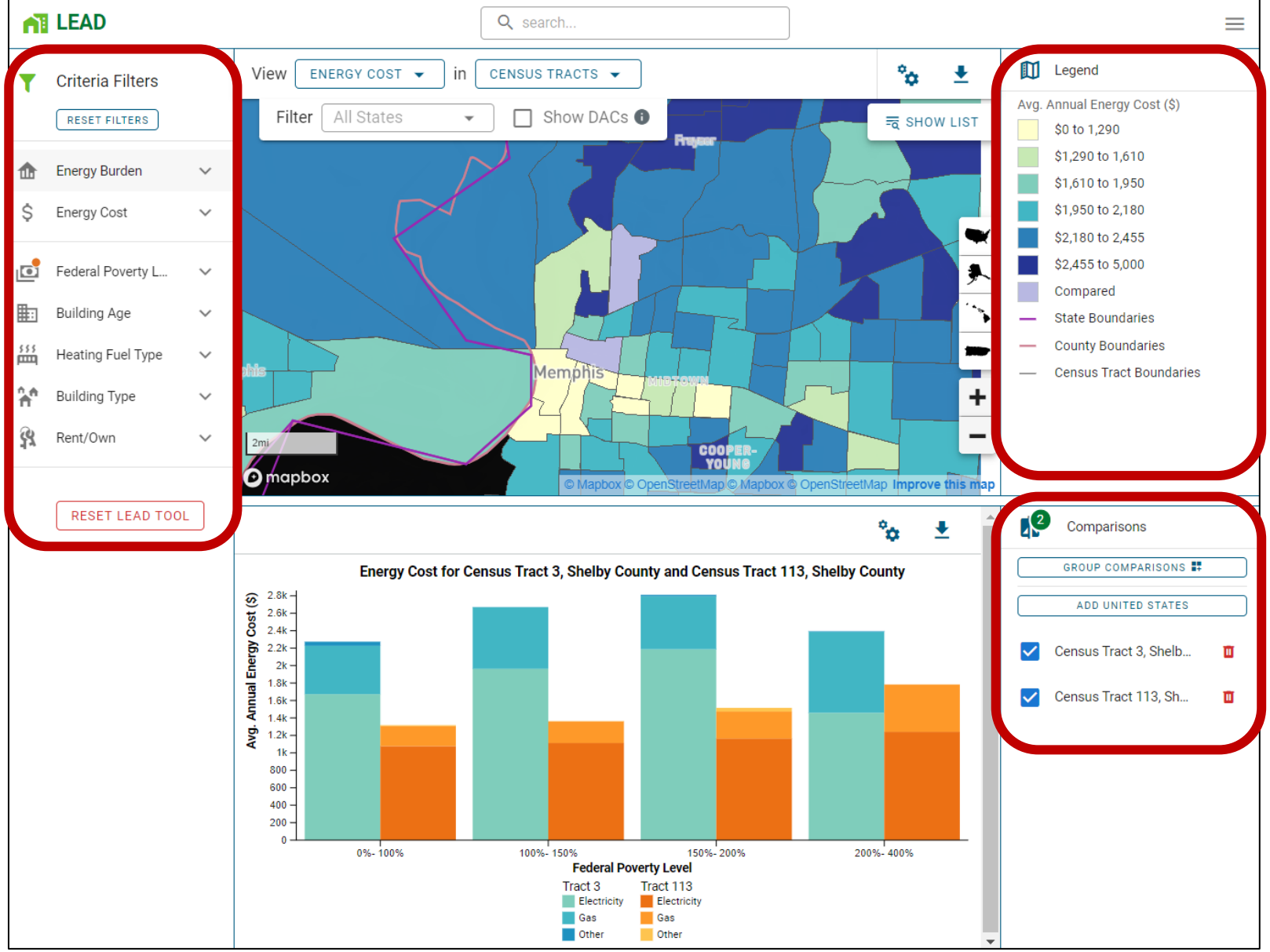
- DOE issued social cost of carbon fuel price modifiers to account for social costs related to GHG emissions for savings to investment ratio calculations.
  - Can be used to modify fuel prices in energy audit tools.
  - Refer to Oak Ridge National Laboratory's Framework for Incorporating Social Cost of Carbon in Weatherization for special considerations relating to appropriate inclusion and fuel switching impacts.
  - NREL can provide technical assistance to grantees wishing to have state-specific modifiers for their state's electric grid emissions.

The Low-Income Energy Affordability Data (LEAD) Tool

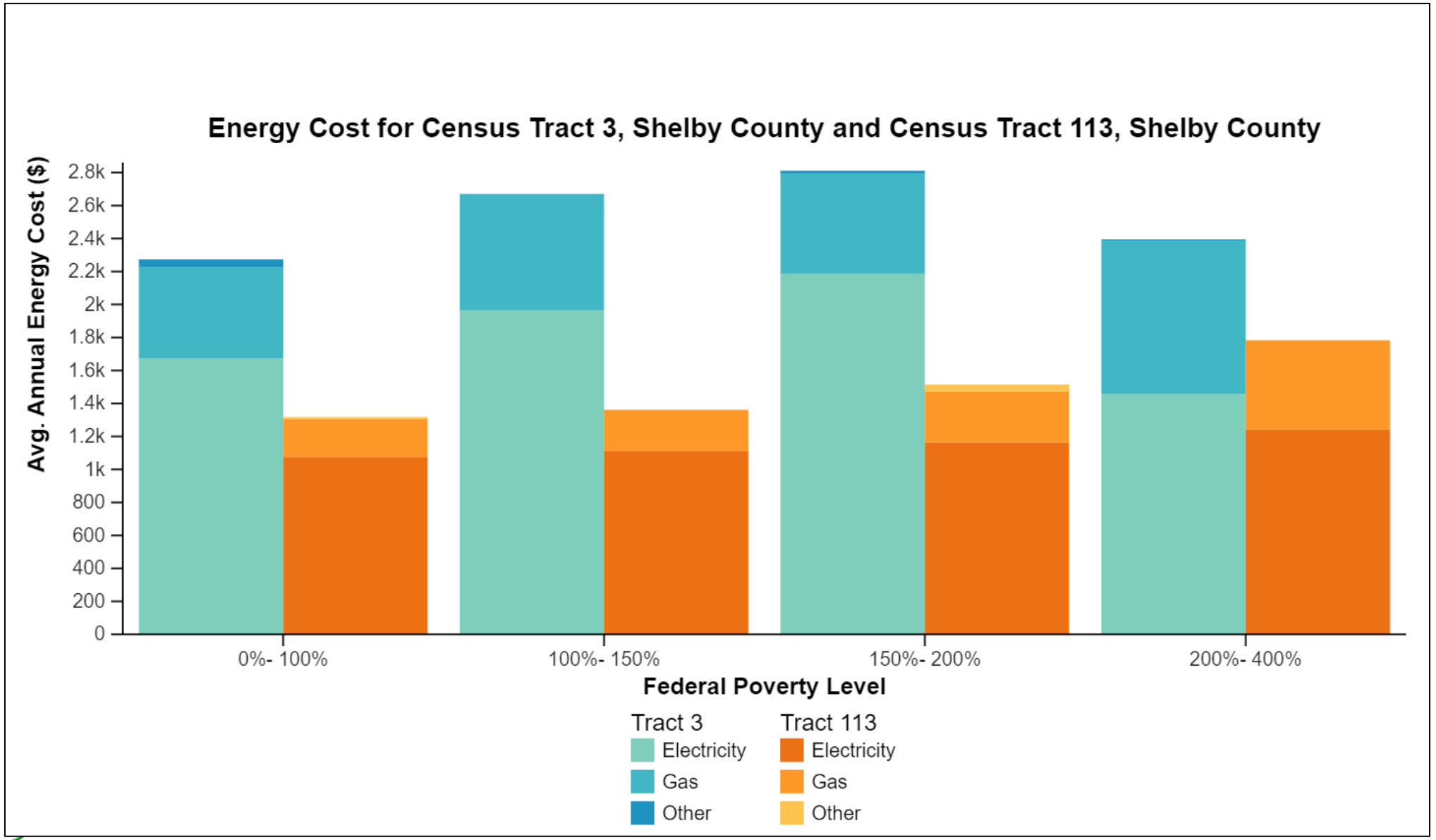
The LEAD Tool

- Provides detailed nationwide energy data designed to help energy programs improve understanding of low-income housing characteristics.
  - Helpful for geographic targeting.
  - Can identify areas with high energy burden.
  - Homes with higher energy costs and consumption are likely have higher potential energy savings.

Image from DOE

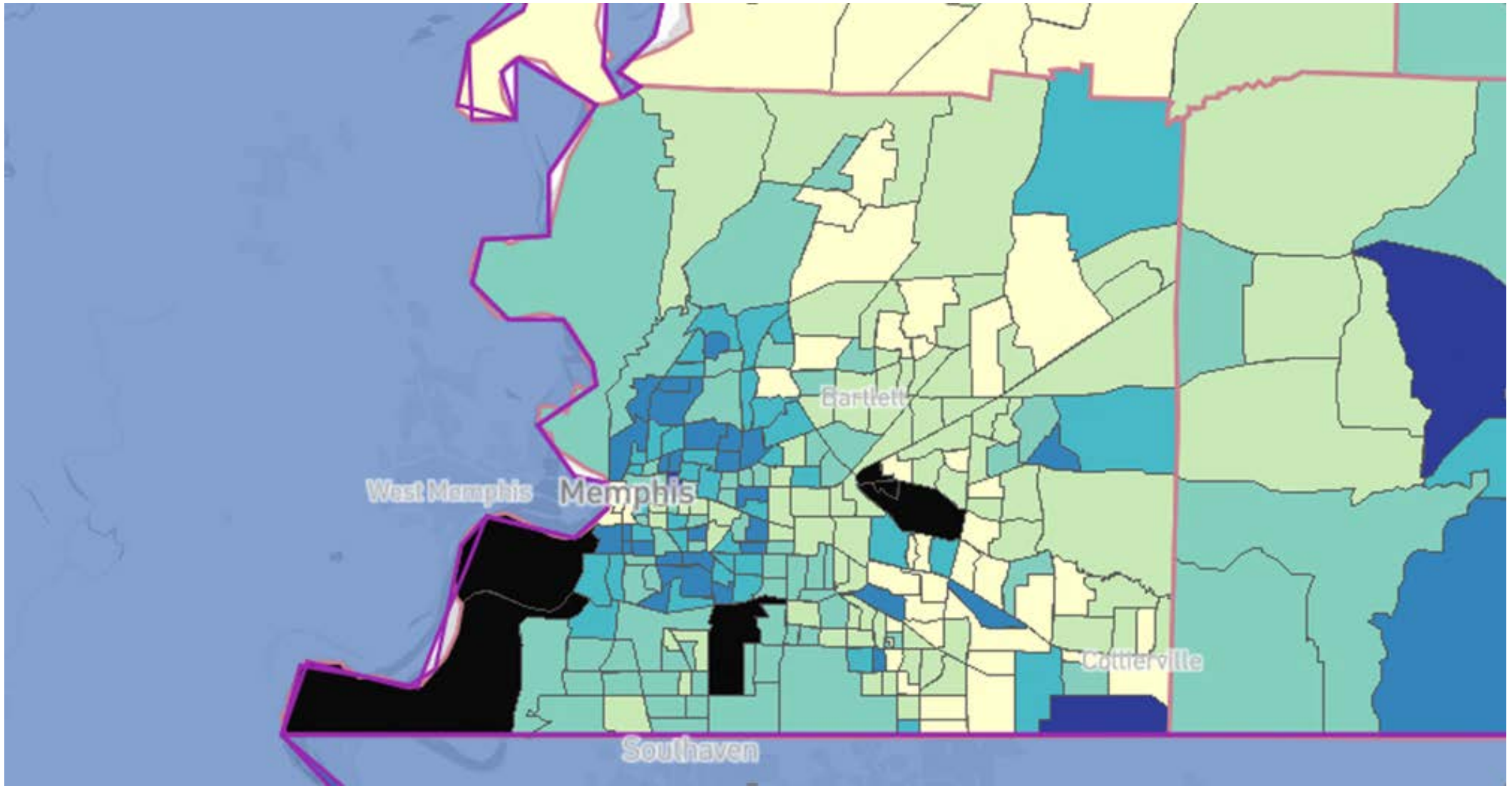


The LEAD Tool is available at https://www.energy.gov/scep/low-income-energy-affordability-data-lead-tool-and-community-energy-solutions.



The LEAD Tool is available at https://www.energy.gov/scep/low-income-energy-affordability-data-lead-tool-and-community-energy-solutions.

Energy Burden for Households at or Below 200% of the Federal Poverty Level for all of Shelby County



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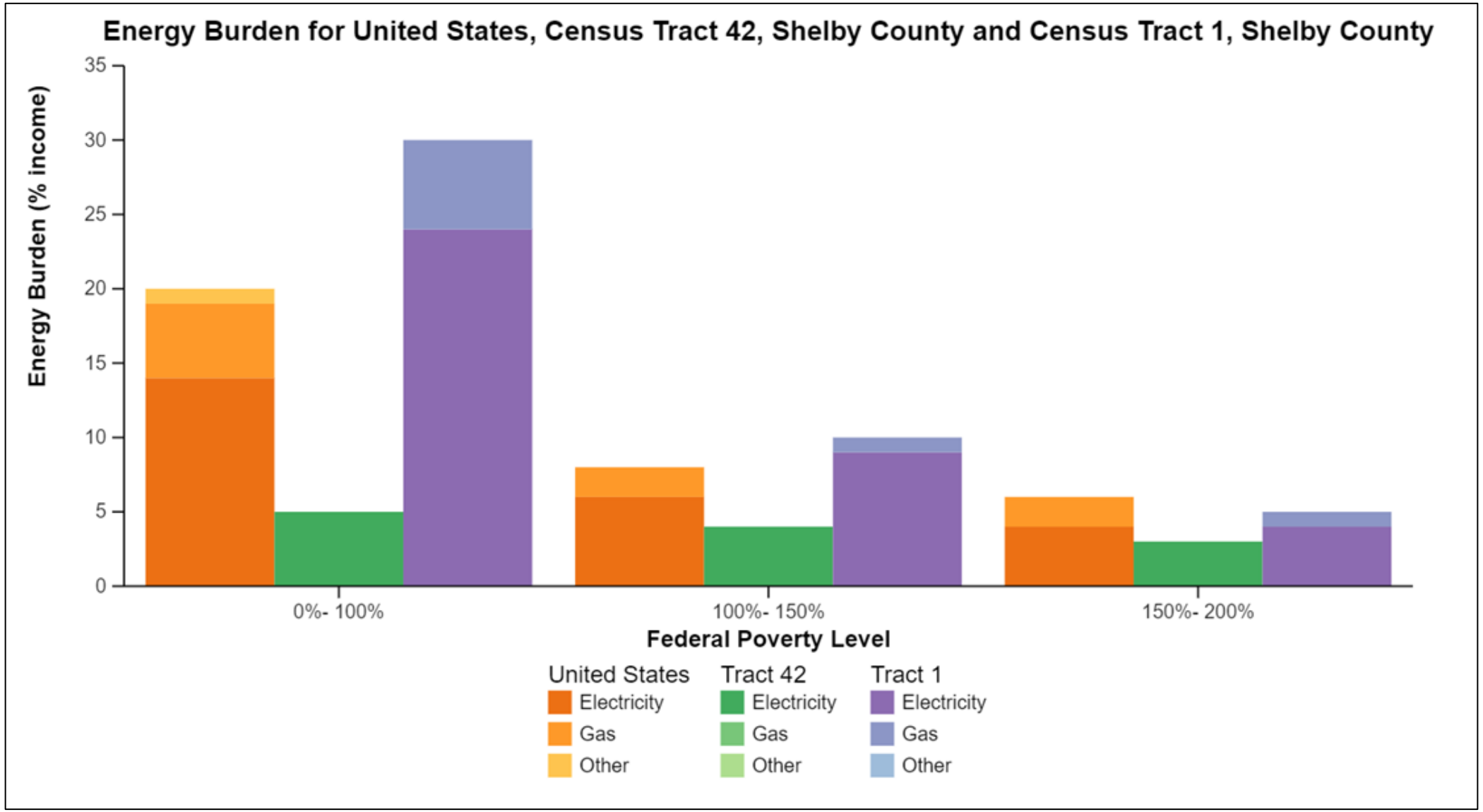

The LEAD Tool is available at https://www.energy.gov/scep/low-income-energy-affordability-data-lead-tool-and-community-energy-solutions.

What's Next?

- Consult with DOE project officer on social cost of carbon and non-energy impacts.
  - NREL and Oak Ridge National Laboratory are conducting ongoing work to better define non-energy impacts for inclusion.
- Use the LEAD Tool or Climate and Economic Justice Screening Tool to consider geographic targeting.
- Possible consideration of climate risks in prioritizing health and safety or readiness measures.

Questions?

www.nrel.gov

NREL/PR-5500-90988

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