Substantial air quality and health benefits from combined federal and subnational climate actions in the United States

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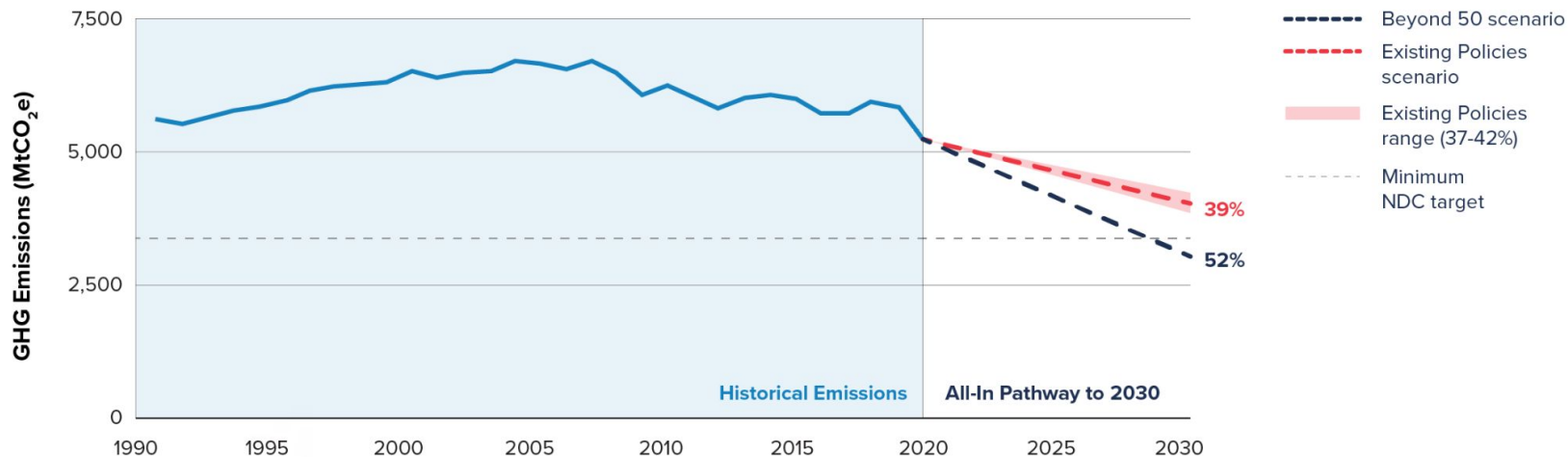
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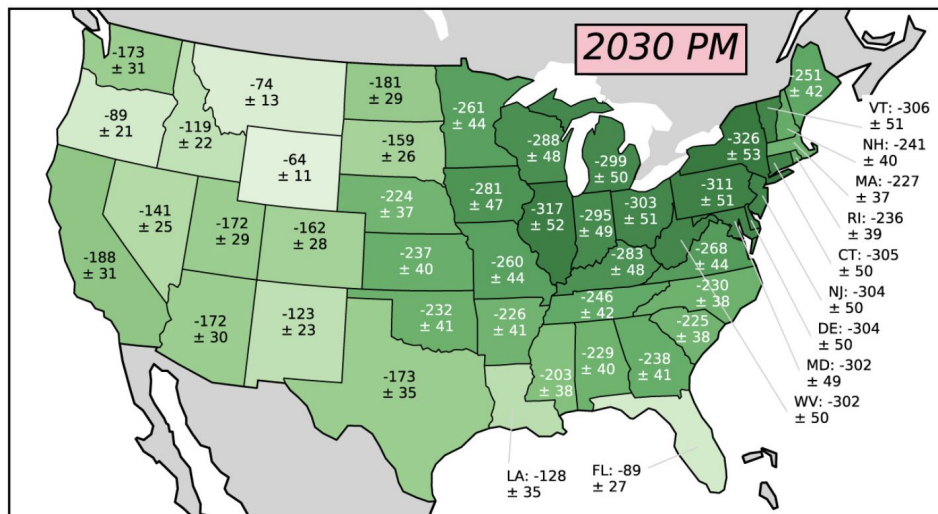
Motivation

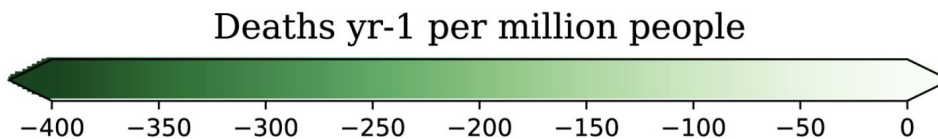## An all-of-society approach to achieving U.S. climate goals

Source: Zhao, A., et al. "An All-In Pathway To 2030: The Beyond 50 Scenario." Center for Global Sustainability, University of Maryland and America Is All In. 16 pp. (2022)
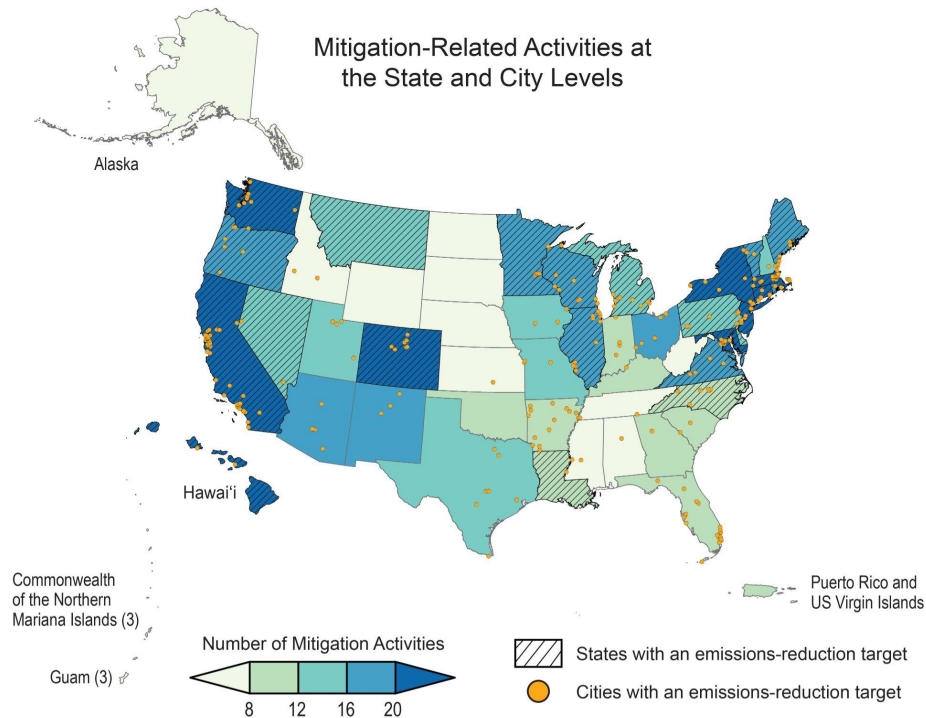
Synergies between emissions reduction of greenhouse gases and local air pollutants

Source: Shindell et al., *PNAS* (2021)

Climate and clean energy actions require combined efforts from a range of actors

Mitigation-Related Activities at the State and City Levels

Alaska

Hawai'i

Commonwealth of the Northern Mariana Islands (3)

Guam (3)

Puerto Rico and US Virgin Islands

Number of Mitigation Activities

8   12   16   20

States with an emissions-reduction target

Cities with an emissions-reduction target

Societal actors

- Federal
- Non-federal
    - State
    - City
    - Business

Source: Davis, S. J. *et al.* Mitigation. *Fifth National Climate Assessment* (2023)

Research question

How will the climate actions from federal and subnational actors influence future air quality and health in the U.S.?

Methods: Summary of scenarios

| Scenario	Description
No Climate Action	A baseline scenario that assumes the absence of existing policies or any new climate actions
Existing Policies	A current policy scenario that considers current climate and clean energy measures including Inflation Reduction Act (IRA) and state initiatives such as the renewable portfolio standards and electric vehicle sales targets;
All-In Policies	A highly ambitious, all-of-society scenario that includes enhanced actions from the federal government, states, cities, businesses, and other non-federal actors1 to achieve the 2030 US climate target

Methods: Model coupling framework
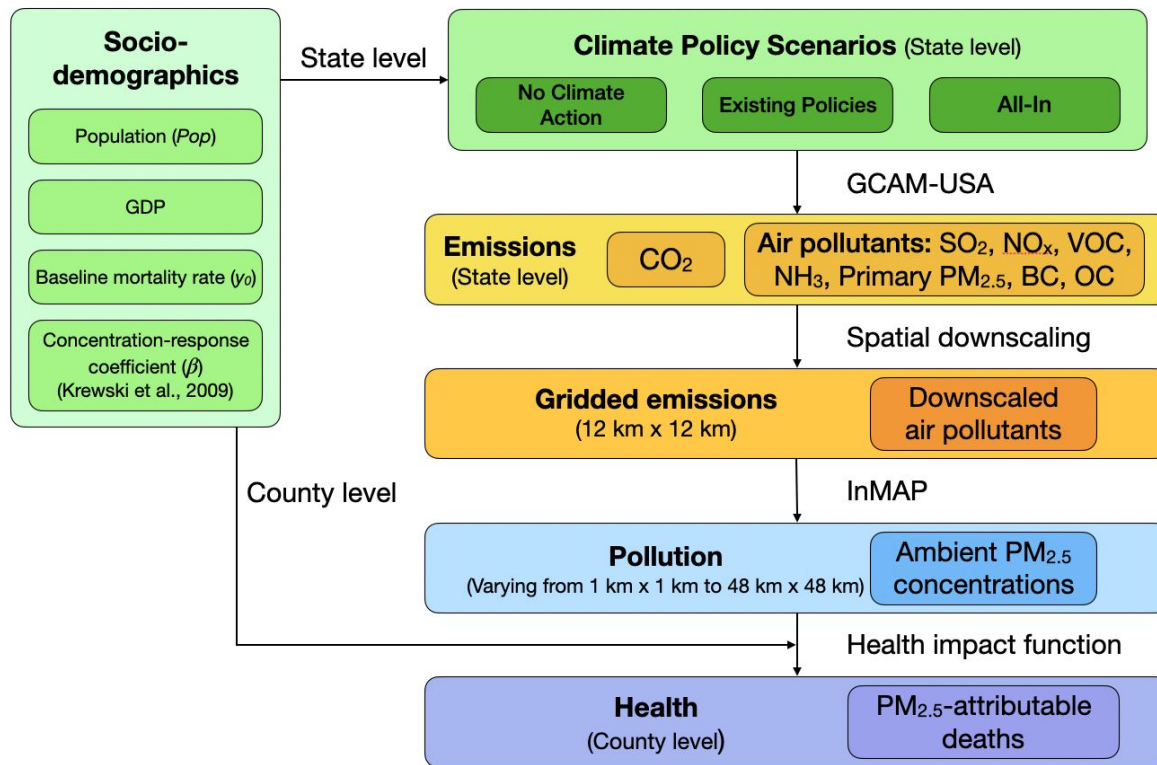
Methods: More details of models

1. Emissions project: GCAM-USA
2. Emissions downscaling (Based on National Emissions Inventory 2017)
   a. For each air pollutant species, each aggregate sector, and each state, we calculate the share of emissions of each county
   b. Downscale the state-level emissions to county level by the shares
   c. The aggregate sectors are: agricultural, industrial, power, residential/commercial, transportation, wildfire
3. Air quality modeling: Intervention model for air pollution (InMAP)
   a. Annual level modeling
   b. Variable resolution from 1 km x 1 km to 48 km x 48 km
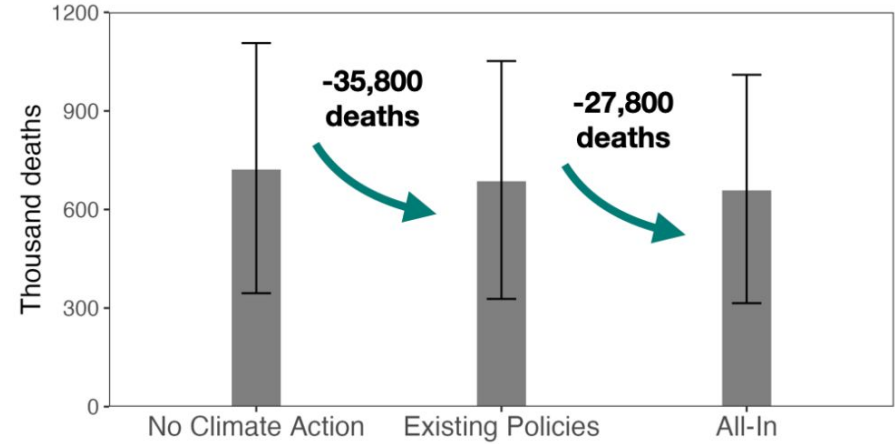4. Health impact assessment: Krewski et al. (2009)

$$\Delta Mort = y_0 \times AF(c) \times Pop, \qquad where \; AF(c) = \frac{RR(c) - 1}{RR(c)}$$

Key Finding 1: Substantial nationwide health benefits from all-of-society climate actions

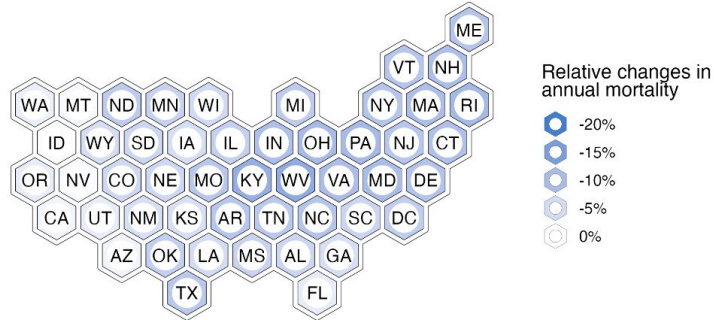a) National total PM$_{2.5}$-attributable deaths in 2015 and 2030
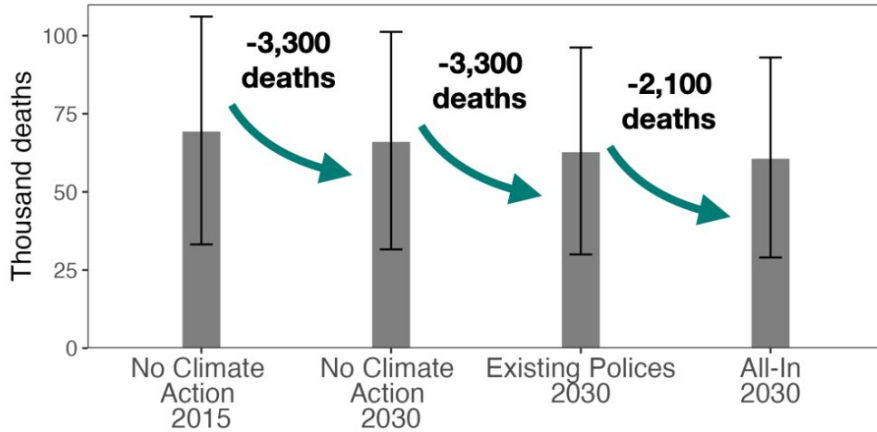
b) National total cumulative PM$_{2.5}$-attributable deaths from 2024 to 2035
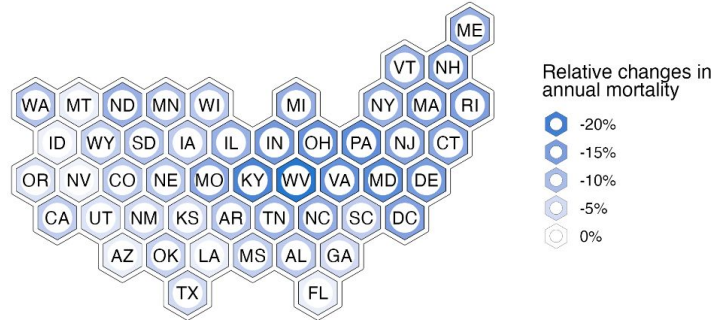
Key Finding 2: Emissions and health effects are unevenly distributed across states and counties

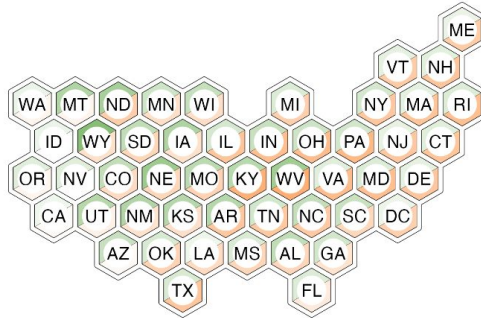a) Changes in "Existing Policies" relative to "No Climate Action" in 2030

b) Changes in "All-In" relative to "No Climate Action" in 2030

Relative changes in annual mortality
-20%
-15%
-10%
-5%
0%

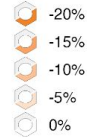# Key Finding 2: Emissions and health effects are unevenly distributed across states and counties (continued)

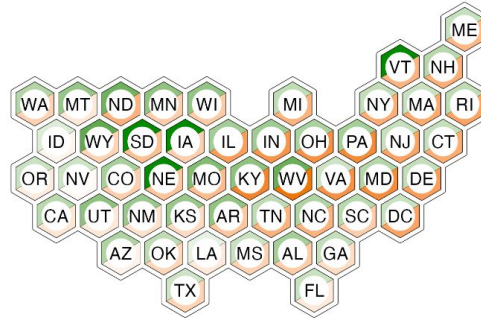a) Changes in "Existing Policies" relative to "No Climate Action" in 2030
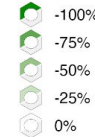
Relative changes in annual total CO_2 emissions ($MTCO_2$/year)
- -100%
- -75%
- -50%
- -25%
- 0%

Relative changes in annual average $PM_{2.5}$ concentration ($\mu g/m^3$)
- -20%
- -15%
- -10%
- -5%
- 0%

b) Changes in "All-In" relative to "No Climate Action" in 2030

Relative changes in annual total CO_2 emissions ($MTCO_2$/year)
- -100%
- -75%
- -50%
- -25%
- 0%

Relative changes in annual average $PM_{2.5}$ concentration ($\mu g/m^3$)
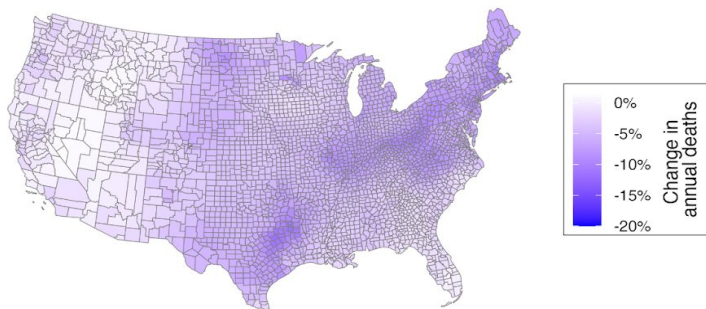- -20%
- -15%
- -10%
- -5%
- 0%

Key Finding 2: Emissions and health effects are unevenly distributed across states and counties (continued)
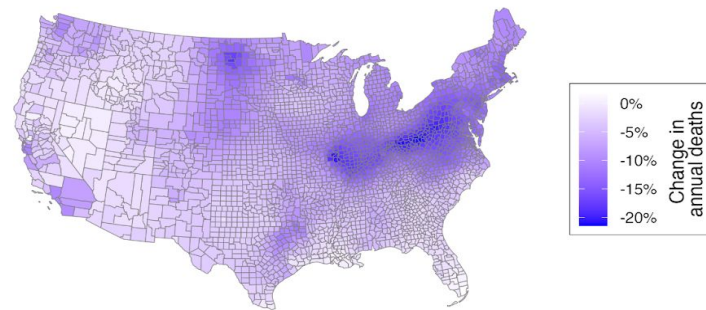

a) County-level PM$_{2.5}$-attributable deaths, No Climate Action, 2030
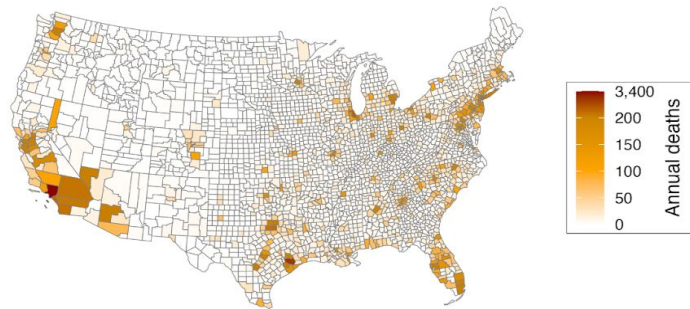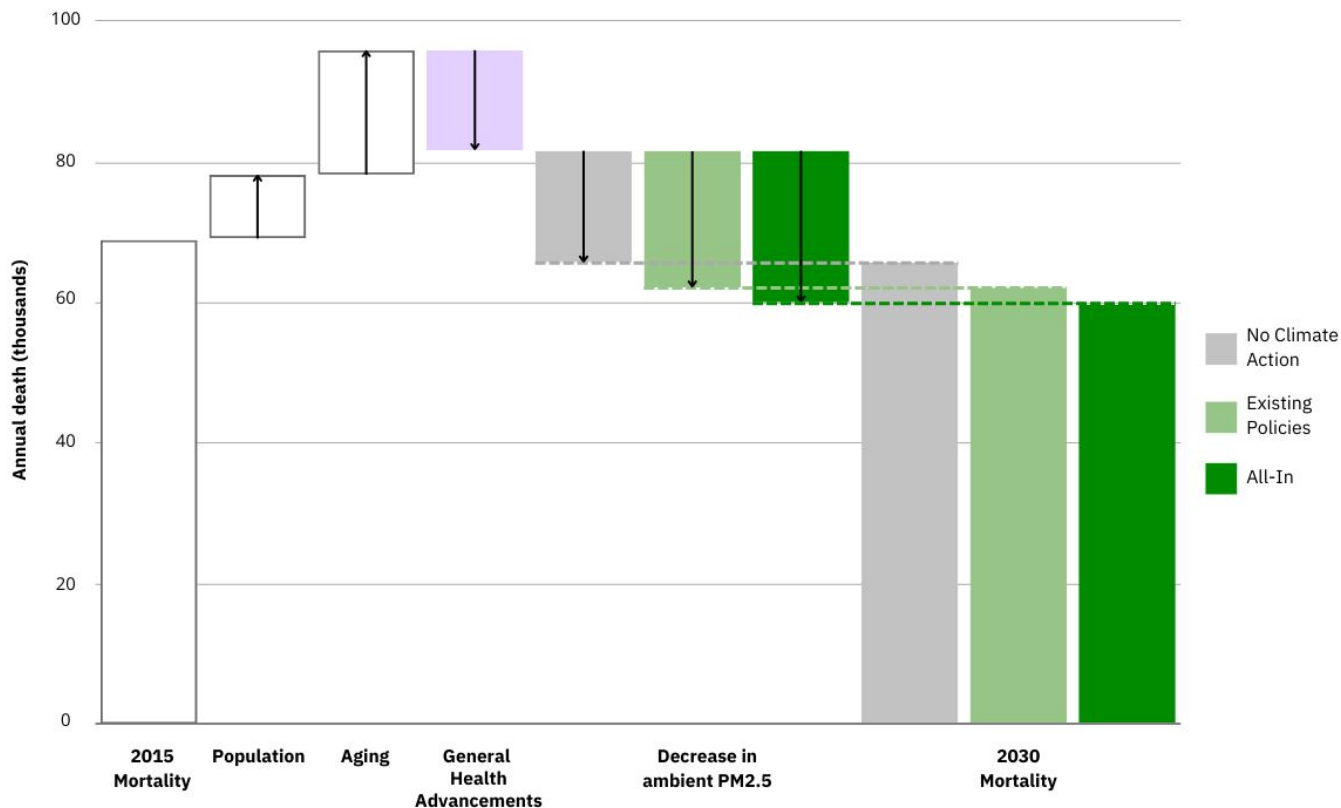
b) County-level PM$_{2.5}$-attributable deaths, Existing Policies vs. No Climate Action, 2030
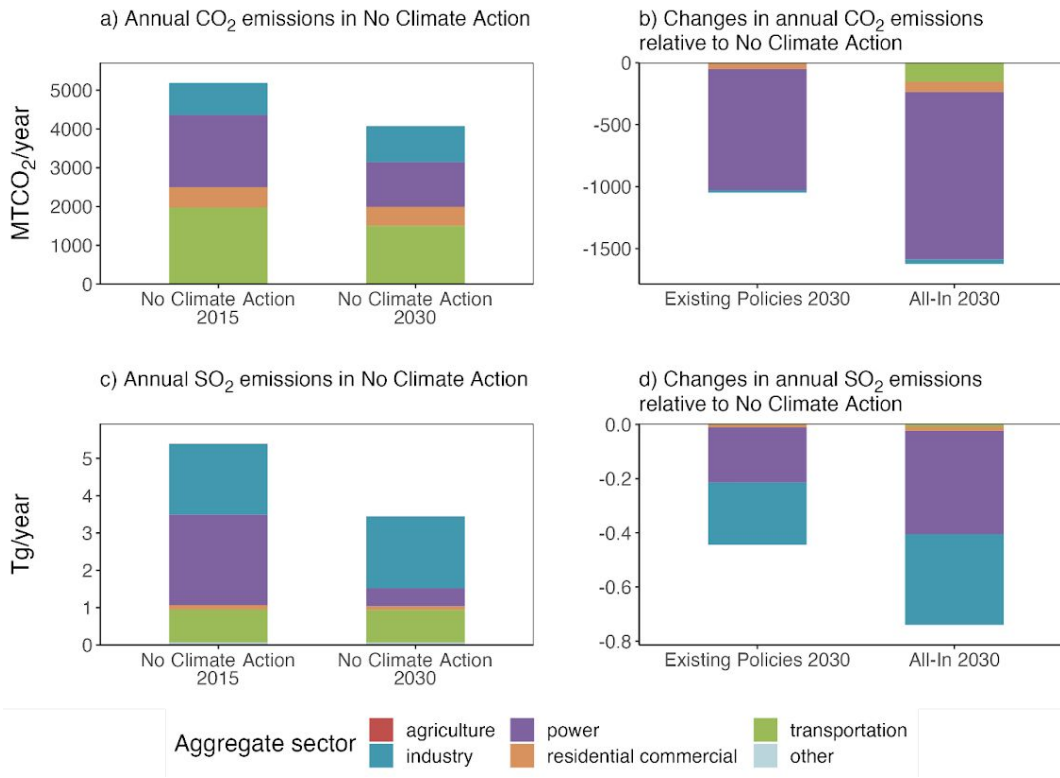
c) County-level PM$_{2.5}$-attributable deaths, All-In vs. No Climate Action, 2030

Key Finding 3: Improving general health conditions and reducing exposure to ambient PM$_{2.5}$ are key to lowering future PM$_{2.5}$-attributable deaths

Key Finding 4: Sectoral impacts – CO_2 reductions in the power sector; SO_2 reductions in the power and industry sectors

a) Annual CO_2 emissions in No Climate Action

b) Changes in annual CO_2 emissions relative to No Climate Action

c) Annual SO_2 emissions in No Climate Action

d) Changes in annual SO_2 emissions relative to No Climate Action

Aggregate sector: agriculture, power, transportation, industry, residential commercial, other

(Continued) Sectoral impacts – NO_2 reductions in the power and transportation sectors; Primary $PM_{2.5}$ reductions in the residential/commercial sector
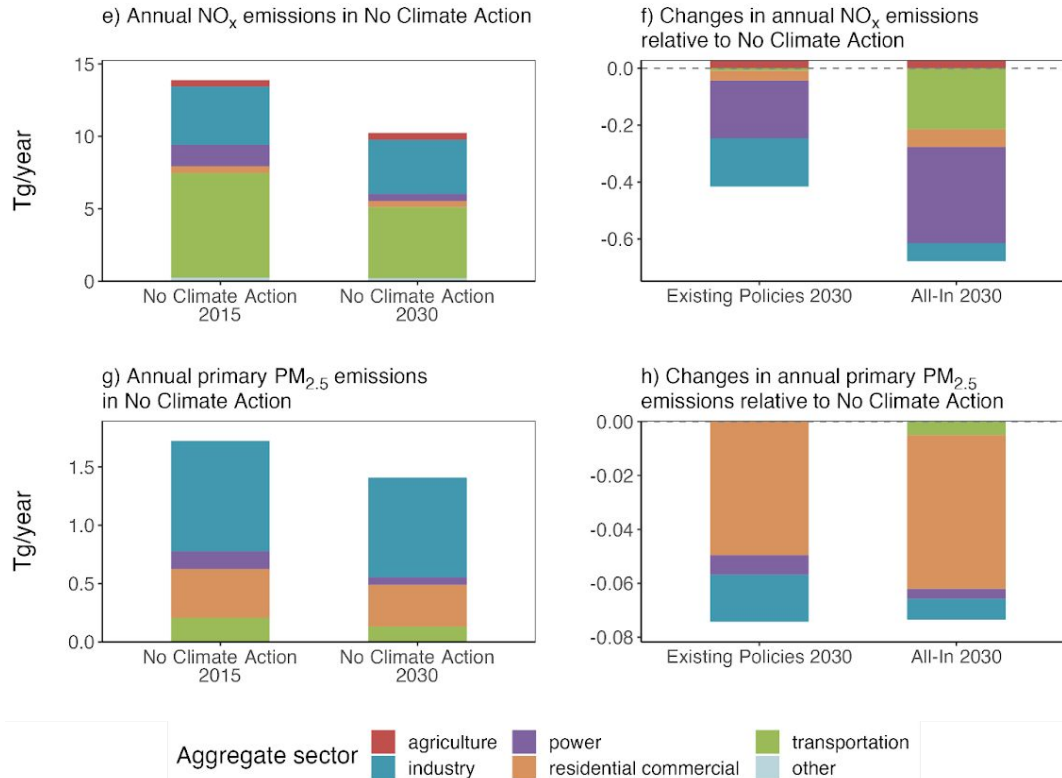
**New results 1:** The power, industry, and transportation sectors are all contributing to the emissions reduction

a) Changes in air pollutant emissions, "All-In" relative to "No Climate Action"

b) Changes in PM$_{2.5}$ concentration, "All-In" relative to "No Climate Action"

c) Changes in PM$_{2.5}$-attributable death rates, "All-In" relative to "No Climate Action"
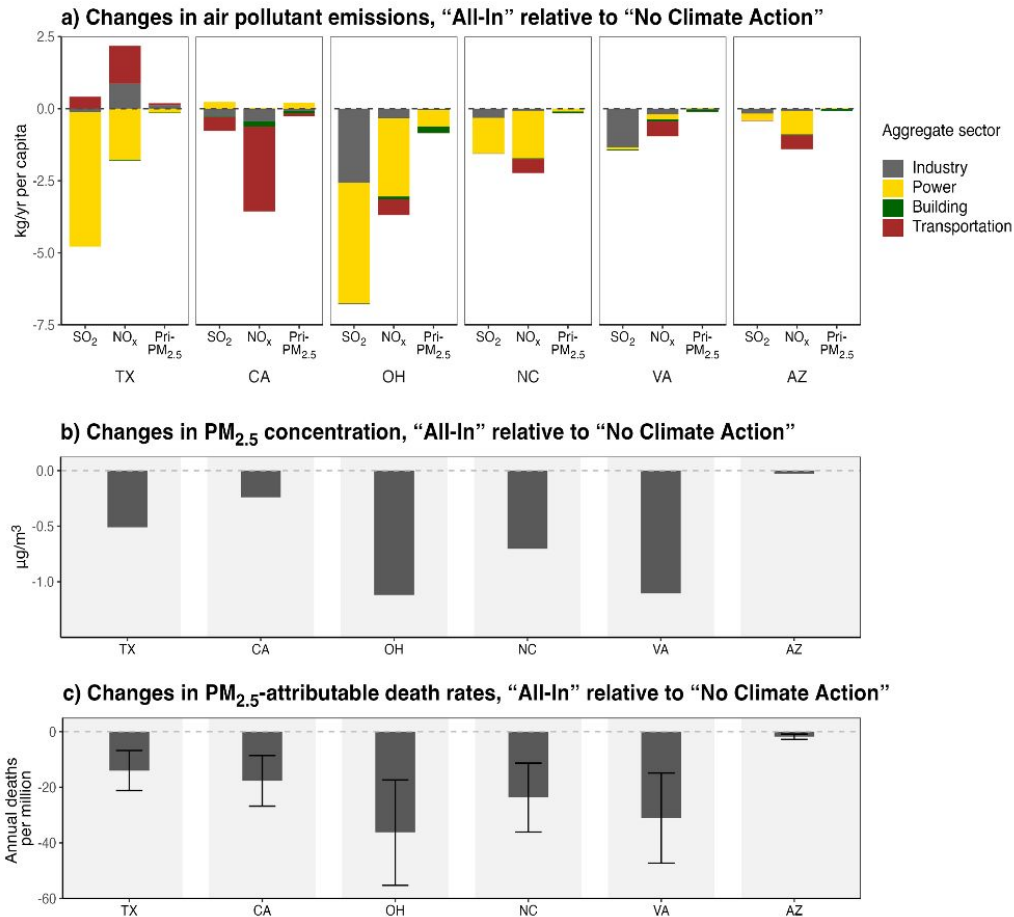
New results 2: Importance of coordinated policy efforts across climate, air quality, and health dimensions
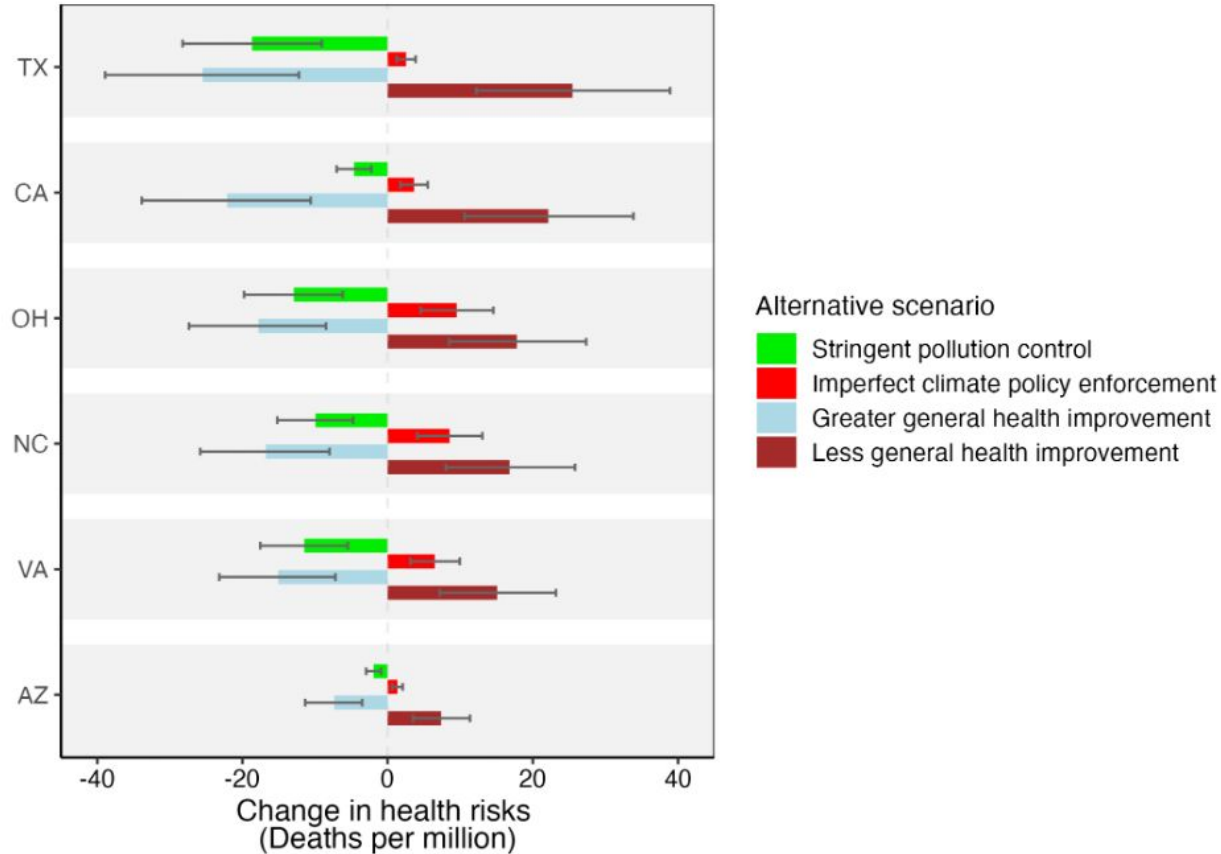
Conclusion and Open Question

Conclusion:

An all-of-society action where all societal actors – federal, state, city, and business actors – take actions to mitigate climate change and transition to clean energy can lead to substantial air quality and health co-benefits. The magnitude and distribution of the health co-benefits is influenced by the stringency of actions to tackle climate, air quality and health issues, which vary by regions and states.

Future directions:

1. Model improvements
2. More detailed representations of policy actors and actions
3. Analysis beyond 2030
4. Equity-equity tradeoffs