



# 2024 Pennsylvania Climate Impacts Assessment and Climate Action Plan

**Presentation to Climate Change Advisory Council**



Adam Agalloco  
Project Manager

Martha Hart  
Deputy Project Manager

August 22, 2023



# Agenda

1. Project status & schedule update
2. 2024 Climate Impacts Assessment (CIA)
  - High Level Outcomes & Updated Projections
  - Annotated Bibliography & Current State of the Science
  - Review of Feedback on Initial Draft CIA
  - Q&A and Discussion
3. 2024 Climate Action Plan
  - Review of Approach
    - Modeling
    - Legislative Recommendations Framework
  - Draft 2024 CAP Strategies
  - Q&A and Discussion

# Project Status & Schedule Update

Task	2023						2024					
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Kickoff	●											
Climate Impact Assessment (CIA)	Initial Draft CIA ●			Updated Draft CIA ●		Draft Final CIA ●		Final CIA ●				
Climate Action Plan (CAP)		Initial Draft CAP ●			Updated Draft CAP ●		Draft Final CAP ●				Final CAP ●	
Climate Change Advisory Committee (CCAC) Coordination		●		●		●		●		●		●

A report that is **shaped**, **populated**, and **refined** throughout the process



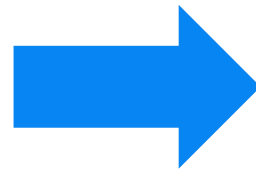
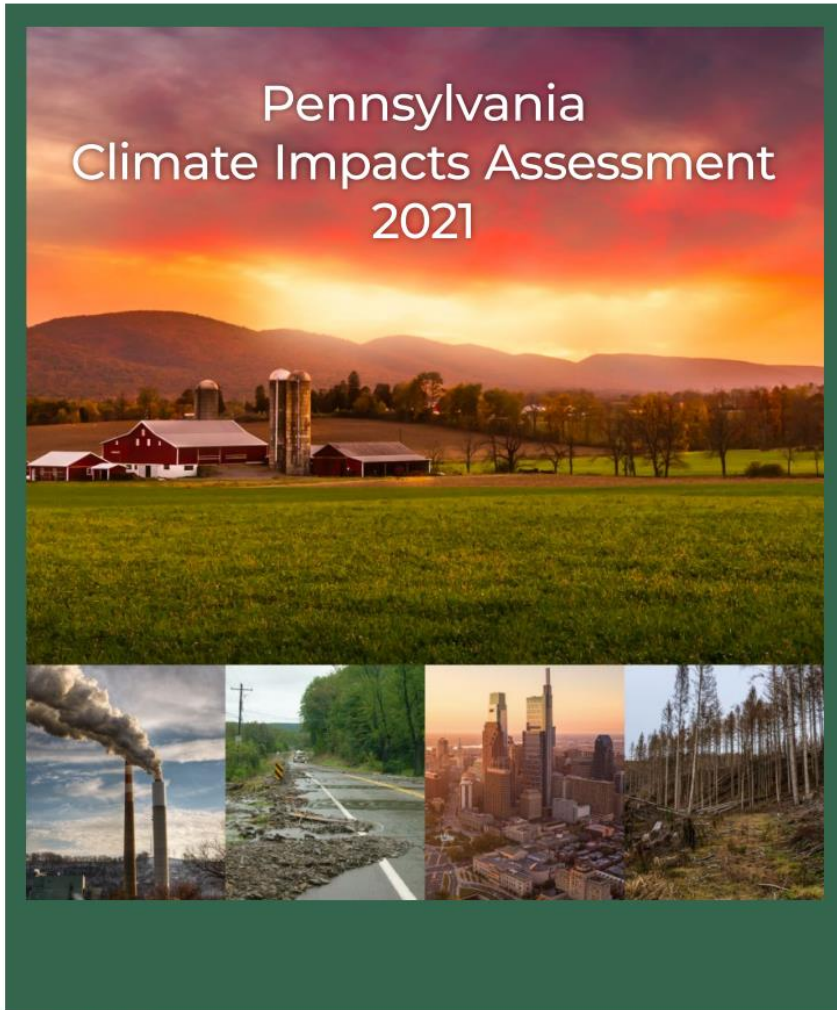
# → 2024 Climate Impacts Assessment

---

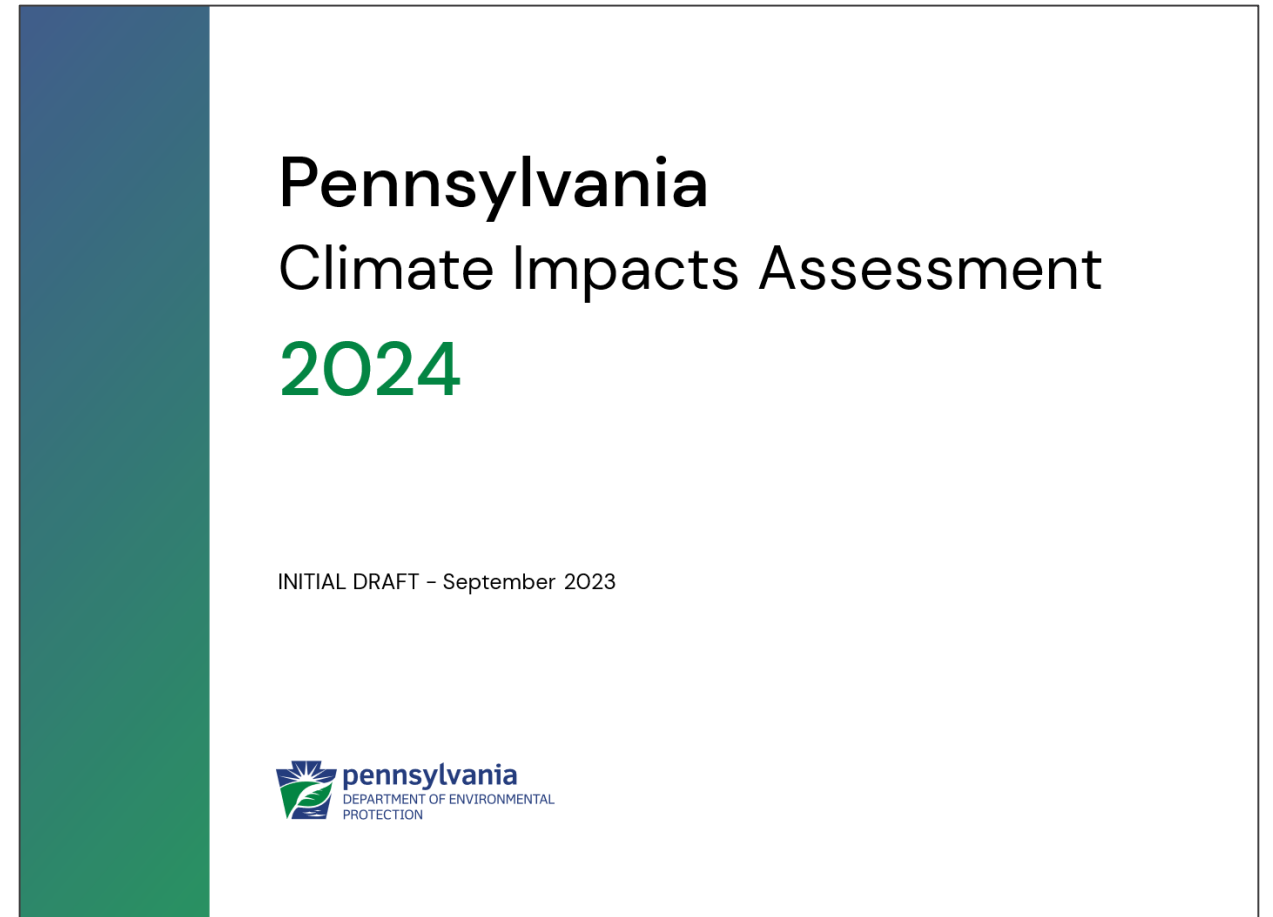
An opportunity to further enhance the risk-based approach to evaluating climate change impacts pioneered in the 2021 CIA.



# Introduction



- Latest climate models, updated projections, and data sources
- Latest literature
- New sections and considerations



7200-RE-DEP4494 5/2021 G2502



# Climate Impacts Assessment (CIA) Initial Draft

---

Executive Summary

Chapter 1: Introduction

## Chapter 2: Expected Climate Changes in Pennsylvania

2.1 Key Findings

2.2 Overview of Key Updates

2.3 Temperature Changes

2.4 Precipitation Changes

2.5 Coastal Changes

2.6 Extreme Weather Events

2.7 Landslides and Sinkholes

2.8 Climate Change Attribution Science and Extreme Weather in Pennsylvania (**NEW**)

2.9 Climate Change Impacts Outside of Pennsylvania (**NEW**)

Chapter 3: Risk Assessment Overview

Chapter 4: Risk Assessment Details

Chapter 5: Economic Opportunities (**NEW**)

Chapter 6: Conclusions and Recommendations

Appendix A: Key Terms

Appendix B: Risk Assessment Methodology

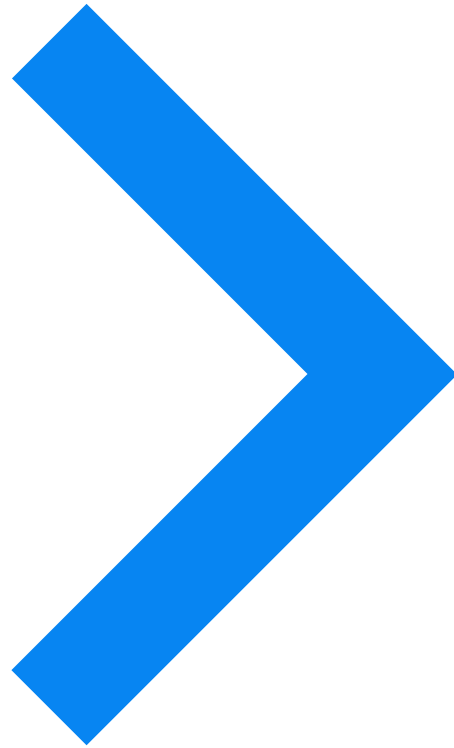
## Appendix C: Climate Analysis Details

[Annotated Bibliography: Literature Updates since 2021 CIA\\*](#)

[Community Input\\*](#)

Endnotes

*\*Only for the initial draft; to be integrated throughout subsequent drafts*



## Key Findings & Updated Climate Projections

# Updated Climate Projections: Latest Climate Models

---

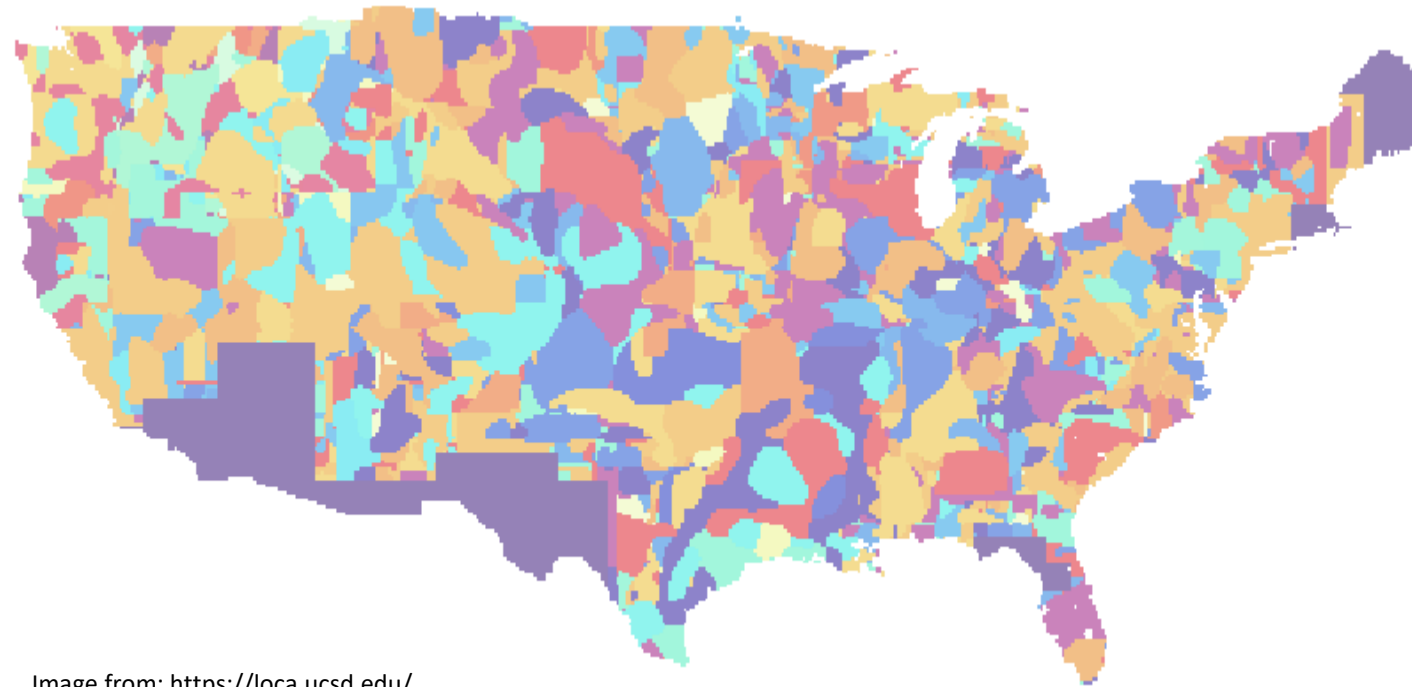


Image from: <https://loca.ucsd.edu/>

The 2024 CIA is based on updated climate projections that leverage the [latest downscaled Global Climate Model \(GCM\) data](#) for the state of Pennsylvania.

The projections are calculated using the Localized Constructed Analogs Version 2 ([LOCA2](#)) downscaled Coupled Model Intercomparison Project Phase 6 ([CMIP6](#)) GCMs, which includes [daily temperature and precipitation projections](#) for 23 model simulations at a 6x6 km spatial resolution.

The [23-model ensemble](#) was used to [reduce uncertainty by aggregating](#) the projections from all individual models into one projection.



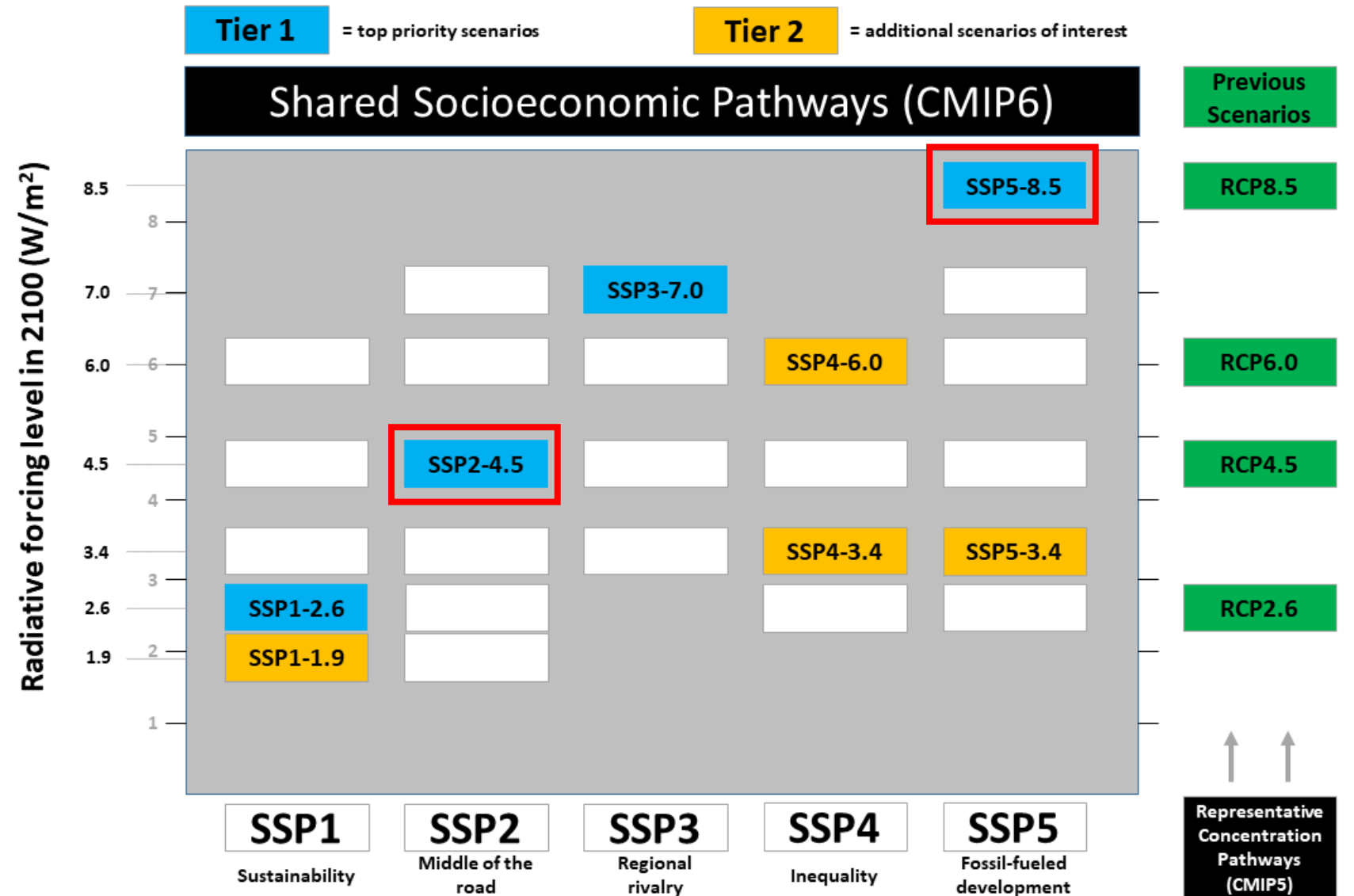
# Updated Climate Projections: Latest Climate Projections

CMIP6 projections use future GHG emission scenarios known as **Shared Socioeconomic Pathways (SSPs)**, which have replaced Representative Concentration Pathways (RCPs) as the global standard of climate model pathways.

SSPs are future narratives that reflect different socioeconomic development strategies and climate policies that may be undertaken globally.

This report utilized two SSPs to represent the range of possible climate futures:

- **SSP2-4.5**: A “middle of the road” scenario where warming is limited to 3°C. (CO<sub>2</sub> emissions are maintained at current-day levels until approximately 2050 and then decline to near zero by 2100.)
- **SSP5-8.5**: An “unabated” emissions scenario where warming exceeds 4°C. (CO<sub>2</sub> emissions continue to increase until late into the 21<sup>st</sup> century when CO<sub>2</sub> emissions begin to level off.)



Source: CMIP6 and Shared Socio-economic Pathways overview (<https://climate-scenarios.canada.ca/?page=cmip6-overview-notes>)

# Key Findings

*The latest climate projections are similar to those in previous assessments, and Pennsylvania is projected to see **increased temperatures, rainfall, and variability** over the coming decades.*



Warming average temperatures will translate to **more frequent and extreme heat events**, such as the heat waves experienced in the summer of 2023.



Precipitation patterns are expected to change, resulting in **periods of drought** as well as more frequent or **extreme heavy rain events** and associated flooding.



**Coastal flooding** will also continue to increase in Pennsylvania's coastal areas, both in the Delaware River Estuary and along Lake Erie.

Impacts Assessment Projections: 2021 vs. 2024

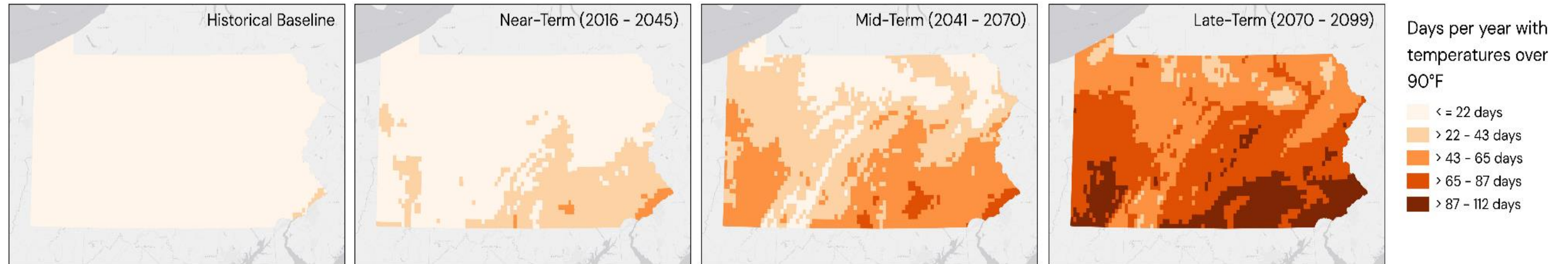
	2021	2024
Average annual temperature	+5.9°F	+6.7°F
Average annual precipitation	+8%	+9%

*Projections are statewide averages for a mid-century time period of 2041-2070 vs. a baseline time period of 1971-200.*



# Key Findings: Extreme Heat

Hot days are expected to become more common in Pennsylvania.



Observed and projected annual days with temperatures above 90°F.

Based on 50th percentile of 23-model ensemble of LOCA downscaled data, SSP 5-8.5. The legend shows the full range of observed and projected values divided into equal increments.

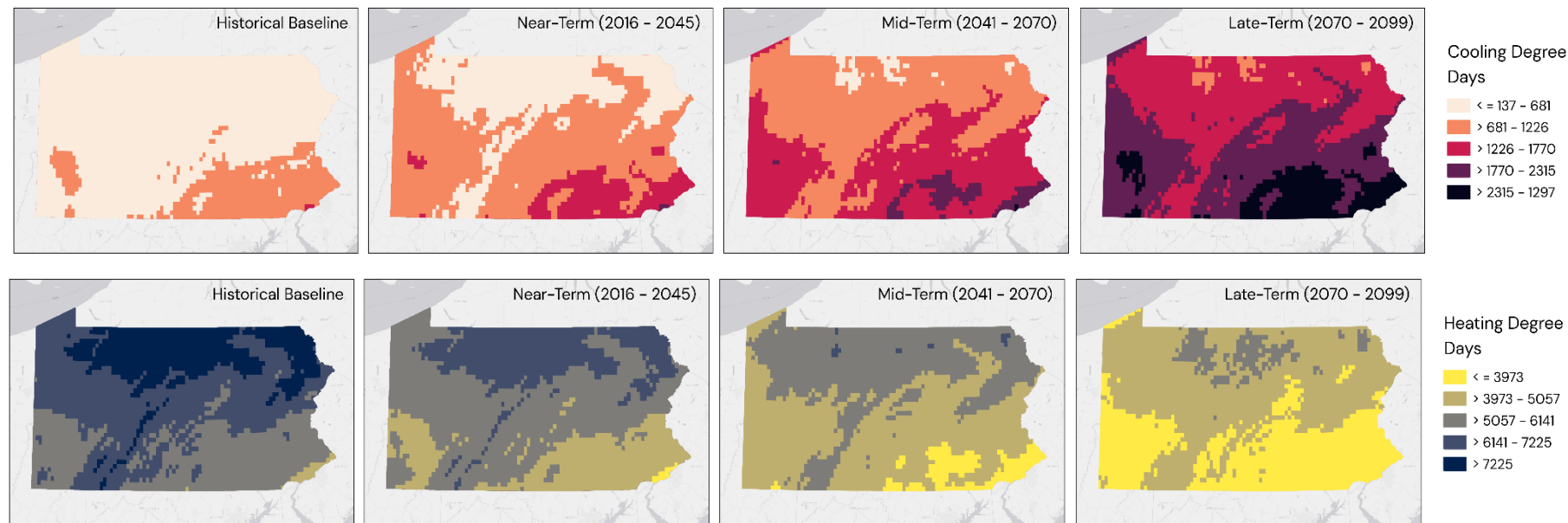
## Days ≥ 90°F

Time Period	“Middle of the road” emissions (SSP2-4.5)	Unabated emissions (SSP5-8.5)
Baseline (1971-2000)	5	5
Mid-century (2041-2070)	24 (15-39)	36 (19-53)
End-of-century (2070-2099)	35 (19-51)	70 (37-97)

For context, *14 days* above 90°F in Harrisburg in *summer 2023*

Values shown are: Ensemble 50<sup>th</sup> percentile (10<sup>th</sup>-90<sup>th</sup> percentile)

# Key Findings: Temperature

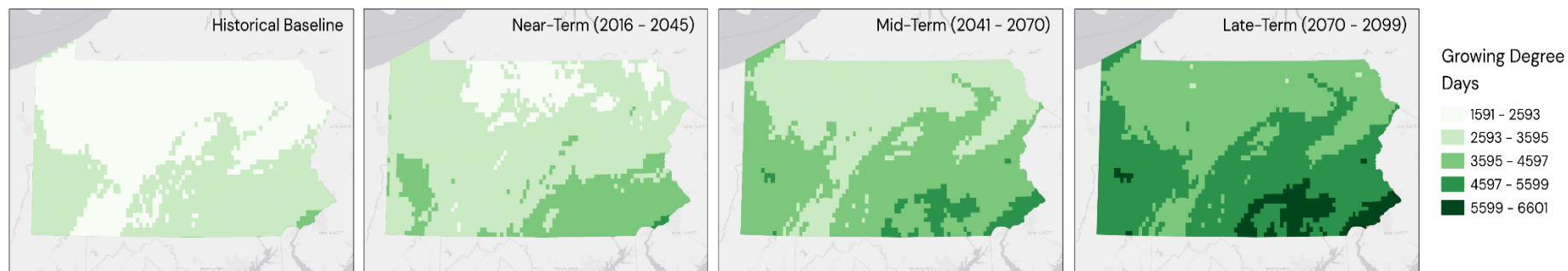


**Figure 4. Observed and projected average annual cooling and heating degree days.**

Based on 50th percentile of 23-model ensemble of LOCA downscaled data, SSP 5-8.5. The full range of observed and projected values is shown divided into equal increments.

*Heating and cooling degree days are indicative of energy needed to heat and cool buildings, respectively.*

Annual total **heating degree days** are anticipated to **decrease** by 26% by mid-century and 36% by end-of-century compared to the baseline. Annual total **cooling degree days**, however, are projected to **increase** by almost **150%** by mid-century and by **285%** by end-of-century.



**Figure 5. Observed and projected average annual growing degree days**

Based on 50th percentile of 23-model ensemble of LOCA downscaled data, SSP 5-8.5. The full range of observed and projected values is shown divided into equal increments.

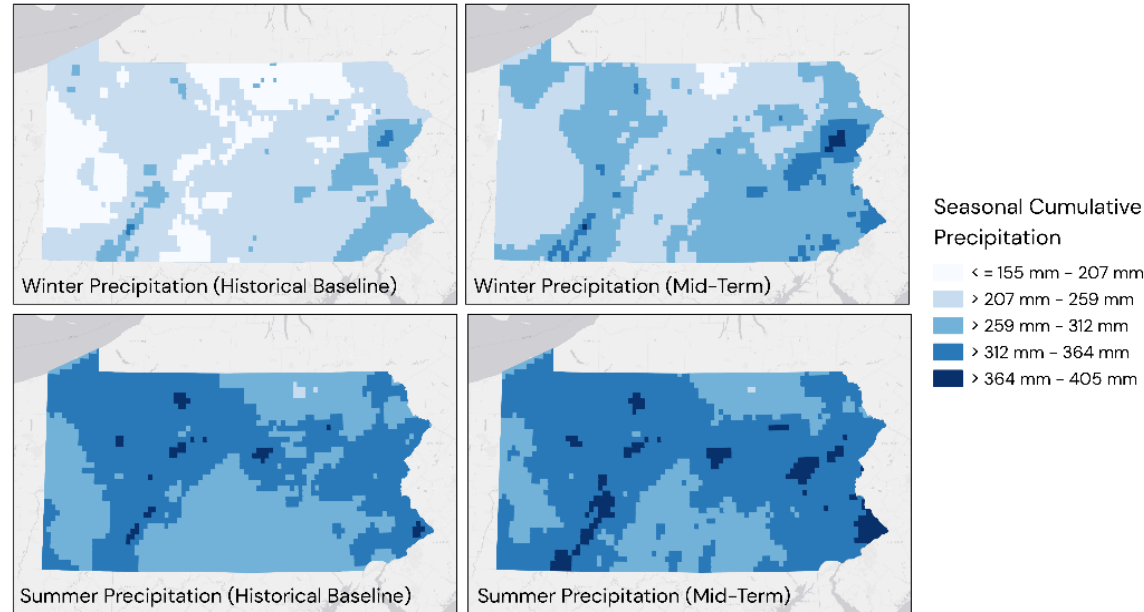
*Growing degree days: annual number of days where average temperature is >50°F; good indicator for the length of the growing season, but they are not a direct correlation.*

On average, the state is projected to see **growing degree days increase** by **34%** by mid-century and **57%** by end-of-century.



# Key Findings: Precipitation

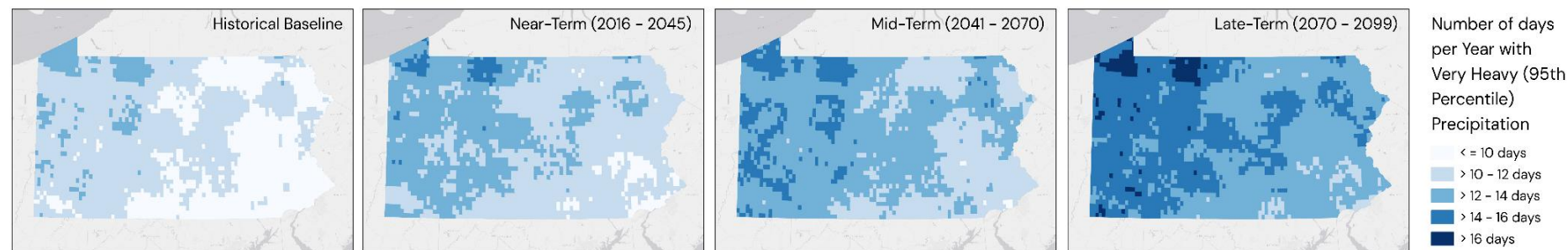
Annual average precipitation is projected to continue to increase, and extreme rainfall events are projected to increase in magnitude, frequency, and intensity as the century progresses.



Most increases in precipitation will occur in the **winter and spring**, with future precipitation conditions remaining similar to historic patterns during summer and fall.

**Figure 8. Observed and projected winter and summer seasonal cumulative precipitation**

Based on 50th percentile of 23-model ensemble of LOCA downscaled data, SSP 5-8.5. The legend shows the full range of observed and projected values divided into equal increments.



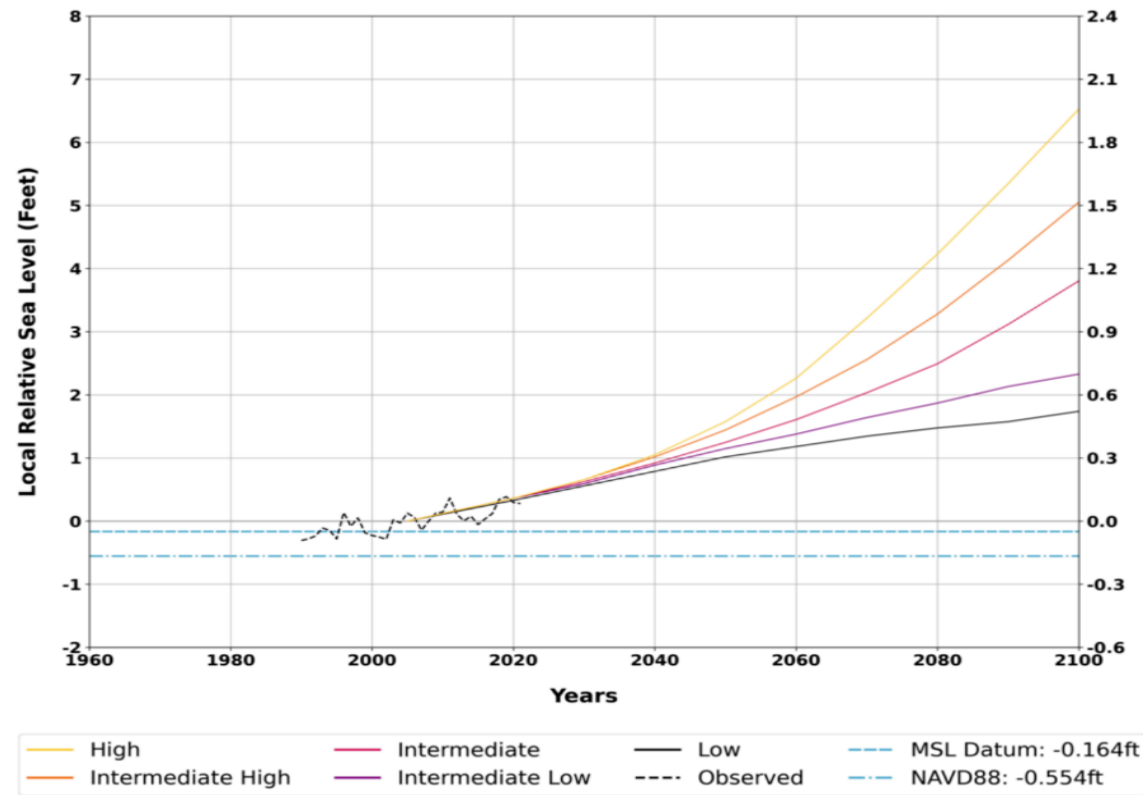
**Figure 10. Observed and projected annual days with "very heavy" precipitation**

Based on 50th percentile of 23-model ensemble of LOCA downscaled data, SSP 5-8.5. The "very heavy" threshold varies by grid cell, based on the 95th percentile of observed rainy days. The full range of observed and projected values is shown divided into equal increments.

The number of days with **"very heavy" precipitation** days are projected to rise: **+15%** by mid-century and **+33%** by end-of-century compared to baseline.

The number of days with **"extremely heavy" precipitation** days are also projected to rise: **+36%** by mid-century and **+74%** by end-of-century.

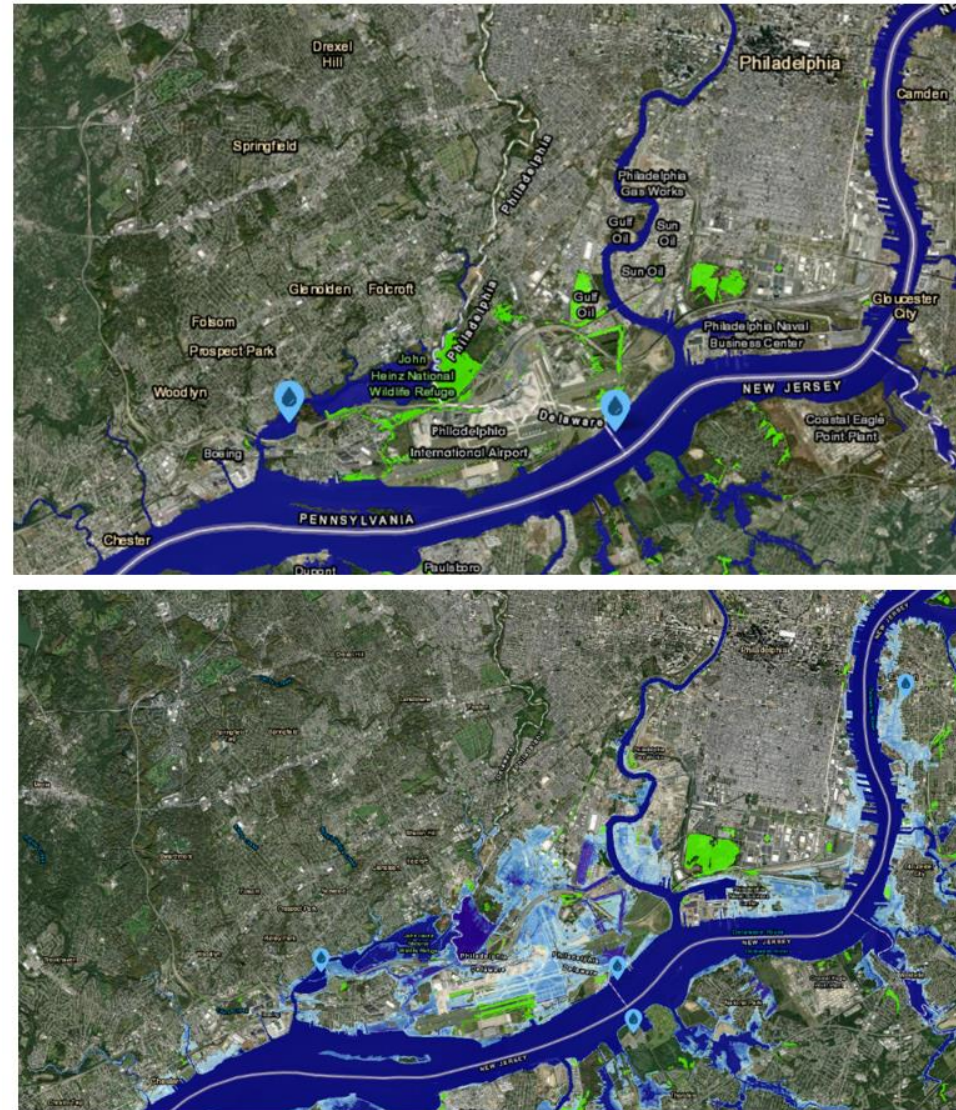
# Key Findings: Updated SLR Projections



**Figure 14. Sea level rise scenarios for Philadelphia tide gauge.**  
Source: NOAA Tides and Currents. <https://tidesandcurrents.noaa.gov>

Storm surge has previously led to coastal flooding from the Delaware River and rising sea levels are expected to exacerbate this risk.

In an intermediate sea level rise scenario, water levels are expected to rise by **2.0 feet by mid-century**, and **5.1 feet by the end-of-century**.



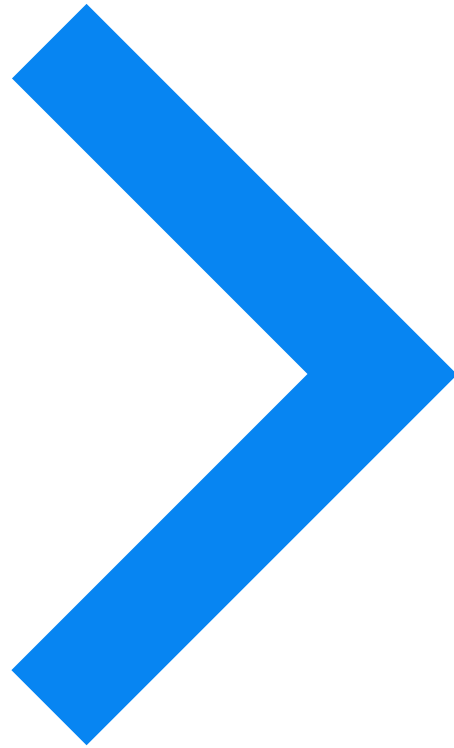
**Figure 15. Current areas at risk from tidal flooding**  
Areas shaded in lime green represent low-lying areas, dark blue areas describe existing water bodies, and light blue areas highlight inundated areas. Source: NOAA Sea Level Rise Viewer. <https://coast.noaa.gov/slr/>

**Figure 16. Areas at risk from tidal flooding from a 5-foot rise in sea levels**  
Areas shaded in lime green represent low-lying areas, dark blue areas describe existing water bodies, and light blue areas highlight inundated areas. Source: NOAA Sea Level Rise Viewer. <https://coast.noaa.gov/slr/>

The top image shows low-lying areas (light green) that are currently at risk from tidal flooding.

The bottom image shows areas (light blue) that would be inundated from tidal flooding with a 5-foot rise in sea levels.





## New Sections & Content

## Core Science Updates

- Latest [climate science](#) (CMIP6) and [recent trends](#)
- Discussion of [attribution science](#)
- Incorporate [new literature](#) in the analysis of impacts and risks
- Incorporate [community engagement](#) materials in the dissemination of impacts and risks

# Attribution Science

**Climate attribution** is the process of discerning whether, and to what extent, human versus natural influences are responsible for observed changes in the Earth's climate system and the extent to which extreme weather events might be influenced by climate change.

For many years, climate scientists were only able to capture general trends on a global basis, but increasingly, **attribution science can address the extent to which specific extreme weather events might have been influenced by human-induced climate change.**

While Pennsylvania itself is a relatively small area for the purposes of extreme weather attribution studies, several of these studies covering the eastern and northeastern US have suggested that **human factors are a contributor to the risk of extreme precipitation/flooding events and extreme heat.**



*EX: Cities such as Philadelphia, Harrisburg, and Allentown experienced **heat events during the summer of 2023** that one analysis judged to be **twice as likely** as they would have been in the absence of climate change.*



# Climate Change Impacts Outside of Pennsylvania

Climate change is a global phenomenon with highly local impacts. Though the CIA focuses on the impacts of climate variables within the boundaries of Pennsylvania, it is important to remember that the state exists within an interconnected natural and socioeconomic network and **climatic changes outside the borders could have impacts within the Commonwealth.**

Examples include:

- Wildfire smoke from other parts of the continent
  - June 2023: Smoke from Canadian wildfires caused the Air Quality Index to reach “Hazardous” levels in parts of PA
- Transportation disruptions that impact the region
- Supply chain disruptions stemming from extreme events across the globe
- Potential climate migration into/out of the state

FIRST ALERT WEATHER

## Smoky haze hovers over Philly skyline as Canadian wildfires impact air quality

NBC10's cameras across the Philly area showed the impact of wildfire smoke on air quality and visibility.

By Travis Hughes • Published June 7, 2023 • Updated on June 7, 2023 at 8:48 pm



A Code Red Air Quality Alert remains in effect for our region as hazy smoke from Canadian wildfires continue to blanket the area, causing low visibility. When will the smoke clear? NBC10 First Alert Weather meteorologist Brittney Shipp has the details.

# Community Engagement

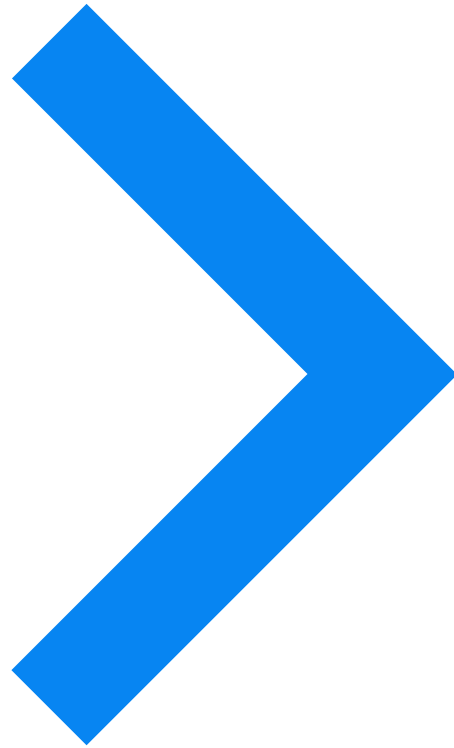
The Pennsylvania Energy Programs Office conducted outreach to identify needs and strategies that can reduce climate impacts for environmental justice communities through:

- Live open discussions (with both in-person and virtual attendees) within seven cities across PA.
- Online surveys that were open to any individual in the state and were expressly shared across various communities likely to experience environmental justice issues.

Open Discussion Participation	
Location	Attendees
Meadville	10 attended (7 registered)
Pittsburgh/Forest Hills	24 attended (20 registered)
Scranton	21 attended (25 registered)
Reading	15 attended (27 registered)
Harrisburg	23 attended (32 registered)
Norristown	10 attended (18 registered)
Philadelphia	9 attended (33 registered)

## Key Recommendations

1. The state should **unify communications** across agencies, focus on climate change impacts to everyone, and develop specialized messaging for younger audiences.
2. State agencies should use **common language** and limit acronyms when discussing climate impacts and adaptation strategies.
3. The state should utilize certain strategies to require **greater transparency from industries** to communities about their environmental impact and contribution to climate change.
4. State agencies should **integrate air quality with climate change** when evaluating whether regulations should change given higher impacts of air pollution.
5. Project evaluations should include **health impacts of environmental infrastructure**.
6. Planning, decision-making, and education should be included to substantiate **how natural environmental strategies will impact local communities**.



## Next Steps



# Update Chapters 3 and 4 (Risk Assessment)

---

ICF will update the Impact Assessment based on the latest literature (summarized in the Annotated Bibliography).

We will apply the same risk-based methodology to evaluate the relative likelihood and consequences of key climate hazards across sectors.

Focus on **six primary hazards** expected to affect Pennsylvania:

1. Increasing average temperatures
2. Heavy precipitation and inland flooding
3. Heat waves
4. Landslides
5. Sea level rise
6. Severe tropical and extra-tropical cyclones

The **likelihood of each hazard** occurring is evaluated, and the severity of each consequence is evaluated for the following categories:

1. Human health
2. Environmental justice and equity
3. Economy
4. Agriculture
5. Recreation and tourism
6. Energy and other economic activities
7. Forests, ecosystems, and wildlife
8. Built infrastructure

# Economic Opportunities and Deep Dive Analysis

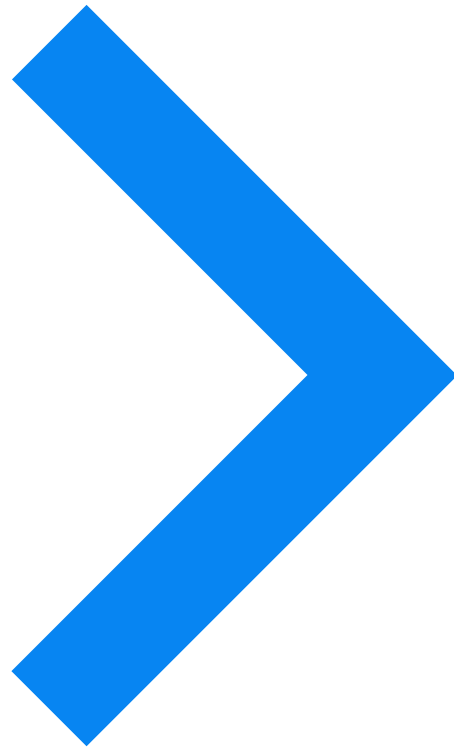
---

ICF will enhance the discussion of **economic opportunities** for Pennsylvania created by the potential need for adaptation and mitigation strategies. This is based on a qualitative analysis of the quality of jobs across sectors and the earning potential created by the need for adaptation to reduce climate risk.

---

ICF will **deep dive** into three areas for further analysis:

1. Flooding and Environmental Hazards
  - The combined risk of flooding and air quality impacts, water borne diseases, and chemical/biological contamination.
2. Health and Worker Safety
  - The impact of extreme heat on vulnerable working groups in Pennsylvania
3. Energy Resilience
  - Summary of various climate threats facing energy grids and affecting reliability in Pennsylvania.



# Climate Impacts Assessment Q&A and Discussion





## → 2024 Climate Action Plan

---

An opportunity for DEP to create a bold vision that exceeds goals; dives deeper into assessing the costs, benefits, co-benefits, and impacts for Pennsylvanians, particularly those in disadvantaged communities; and takes a stronger implementation focus with the aim of being a blueprint for action and potential legislative changes.

# 2024 CAP Focus Areas and Updates

---

## Existing CAP Strategies

Build upon and refine with a focus on **bolder actions**

Opportunities for the commonwealth to **meet and exceed climate goals**

## Impacts of Mitigation and Adaptation Strategies

Dive deeper into the **cost effectiveness, co-benefits, and energy rate** impacts

Evaluate impacts on communities with a focus on **environmental justice communities**

## Updated GHG Modeling

Inclusion of CO<sub>2</sub>Sight data/approach

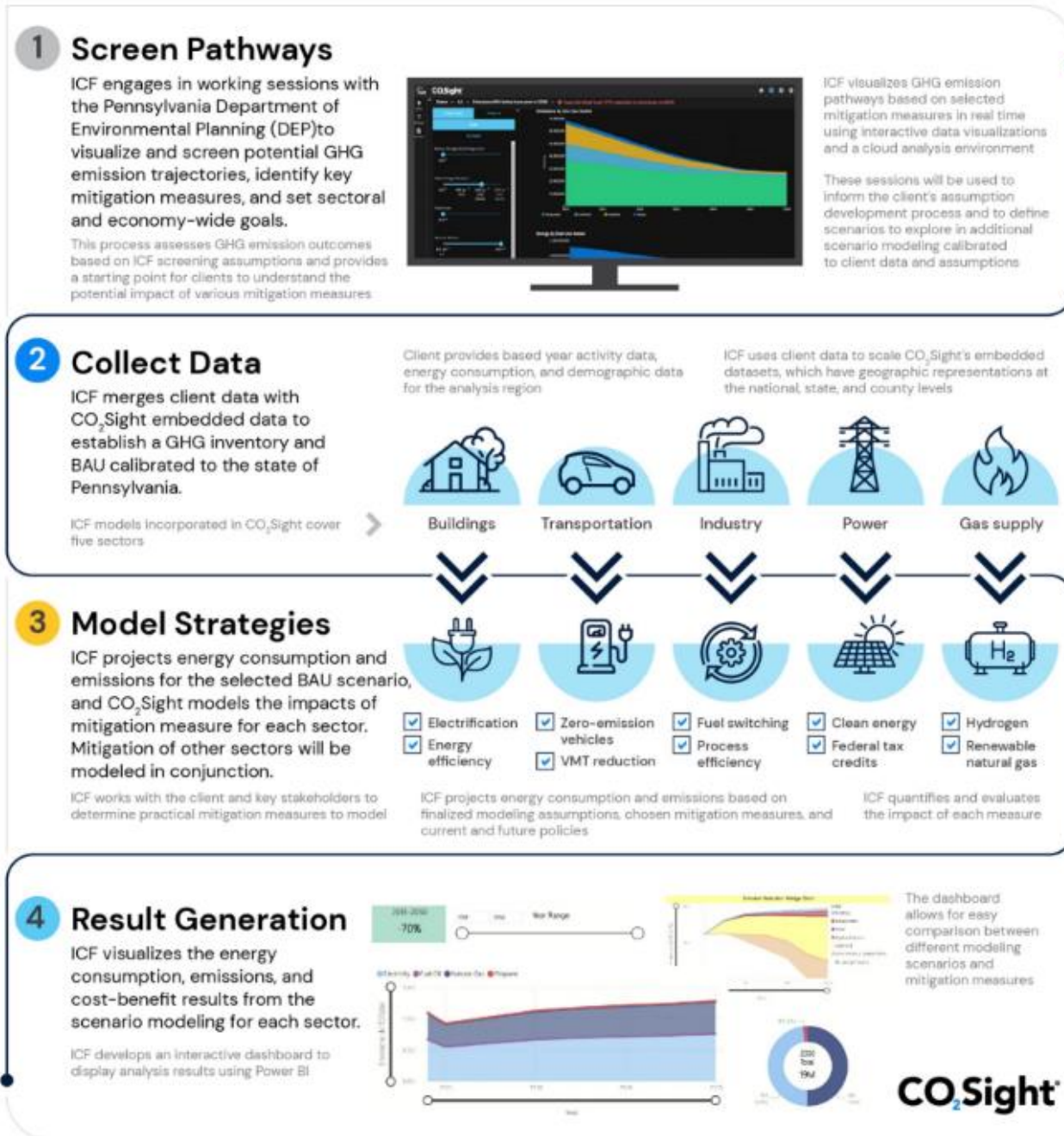
Evaluation of the impacts of key emerging technologies such as **hydrogen fuels and carbon capture**

## Focus on Implementation

Provide a stronger focus on the implementation of CAP strategies to serve as a blueprint for **potential legislative changes**

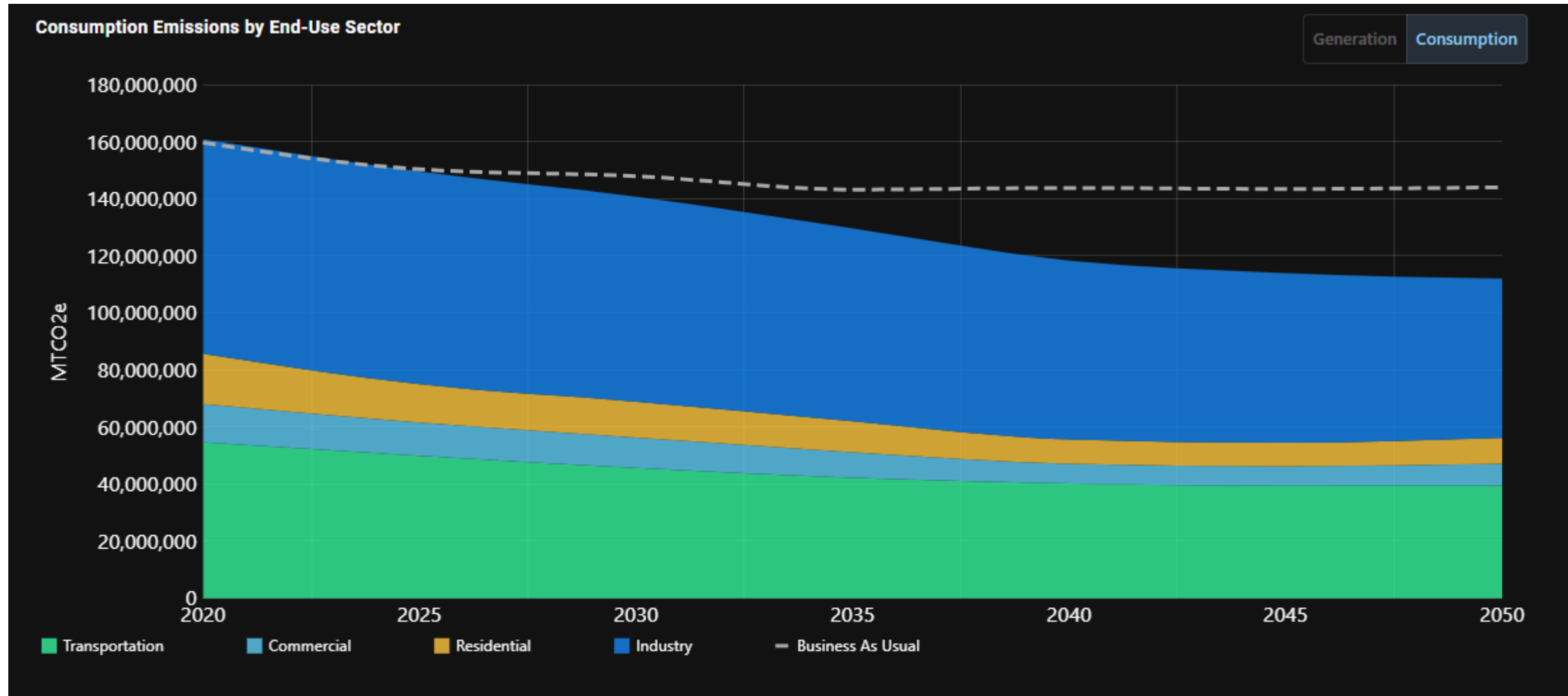


# Modeling GHG Reduction Pathways- CO<sub>2</sub>Sight



- ICF will use CO<sub>2</sub>Sight, ICF's decarbonization modeling platform to screen potential pathways (i.e., a collection of GHG reduction strategies) that align with the strategies selected to be modeled.
- CO<sub>2</sub>Sight allows ICF to more quickly provide trajectory toward decarbonization results.
- Using the CO<sub>2</sub>Sight process will help the Commonwealth focus on areas of interest and to further develop assumptions on strategies to model reductions from GHG emissions.

# CO<sub>2</sub>Sight Screen Trajectory





# Draft Strategy Options- Mitigation

---

## Built Environment (Residential and Commercial Buildings)

- B1. Building Codes: Improve energy efficiency of new buildings and major retrofits through codes.
- B2. Electricity Efficiency in Buildings: Deploy electricity efficiency in existing buildings.
- B3. Gas Efficiency in Buildings: Deploy gas efficiency in existing buildings.
- B4. Electrification: Deploy gas and fuel oil alternatives in existing buildings.
- B5. Onsite Solar: Deploy onsite solar, distributed energy resources and battery systems in buildings.

## Power Sector

- P1. Net Zero Grid: Build a net zero carbon electricity grid.
- P2. Distribution and Transmission Grids: Ensure that electricity grid is ready for electrification related to peak load impacts and reliability.

# Draft Strategy Options- Mitigation

## Transportation Systems

- T1. Increase Fuel Efficiency: Increase the fuel efficiency of vehicles.
- T2. Transit & Multimodal Improvements: Expand transit, transit-oriented design, and multimodal transportation.
- T3. Light Duty Vehicle Electrification: Deploy electric vehicles and associated infrastructure. T4. Zero Carbon Medium- and Heavy-duty Vehicles : Implement a low carbon fuels and deploy zero carbon medium- and heavy-duty vehicles and associated infrastructure.

## Industrial Sector

- I1. Industrial Efficiency: Deploy electricity and gas efficiency in the industrial operations.
- I2. Gas, Fuel, & Process Decarbonization: Electrify industrial uses, change processes and deploy gas and fuel oil alternatives in industrial operations.

# Draft Strategy Options- Mitigation

---

## Fuel and Gas Systems

- F1. Operational Efficiency: Reduce methane emissions across oil and gas operations.
- F2. Renewable Natural Gas: Expand the use and generation of RNG fuels.
- F3. Hydrogen Fuels: Expand the use and generation of hydrogen fuels.
- F4. Inactive and Marginal Wells: Reduce methane emissions from inactive and marginal conventional oil and gas wells.

## Carbon Capture & Sequestration

- C1. CCS Technologies: Deploy and continue to pursue new carbon capture technologies for power and industrial systems.

# Draft Strategy Options- Mitigation

---

## Land Use and Agriculture

- L1. Agriculture Best Practices: Implement agriculture best practices for carbon management.
- L2. Land and Forest Management: Increase natural sequestration in Pennsylvania's land and forests.

## Waste

- W1. Waste Reduction: Reduce waste generated by citizens and businesses.
- W2. Land and Forest Management: Improve waste management practices.



# Example Strategy Options- Adaptation

## Example Adaptation Measures

- Encourage the disclosure of flood risk by landlords/sellers to tenants/buyers if a home is within the 100 or 500 year floodplain
- Explore climate resilience action as part of state-subsidized Brownfield redevelopment
- Identify and disclose climate risks for electric utilities and file a plan to address the most pressing risks through resilience measures; provide state funding for resilience measures
- Study the climate risks to water utilities associated with maintaining clean drinking water supplies; provide state funding for resilience measures

***These are example measures. Draft measures will be determined after additional analysis and coordination with other agencies regarding adaptation priorities and ongoing actions.***

# Strategy Template

1



## B1. Strategy Name (1 pg. max)

Strategy Description (1-2 paragraphs). Briefly describe key concepts and actions, responsible stakeholder. Reference the applicable legislative recommendation as a final paragraph/sentence in the description.

2

## Resulting Impacts

### Environmental

1 paragraph description.

### Economic

1 paragraph description.

### Social and Health

1 paragraph description.

3

## KEY METRICS

GHG emissions:

2030:

2050:

Cost (or benefit) per ton  
MTCO<sub>2e</sub>/reduced):  
\$X/MTCO<sub>2e</sub>

NPV: \$X

Average annual gross state  
product: \$X

Average annual disposable  
personal income: \$X

1

## Introduction & Description

2

## Impact Narrative

Details modeling results and how the strategy will impact environmental, economic, and social/ health considerations.

3

## Key Metrics

Highlights GHG reductions and other KPIs for easy comparison across strategies

# Strategy Template Cont.

## 4 Implementation Considerations (1 pg. max)

- Describe necessary actions to implement the strategy
  - Include a likely timeframe for implementation
  - Discuss phasing
- Describe actors and partners
  - Include what potential implementers and specific responsible agencies where applicable

### Financial

### Equity

- Offer considerations or actions to ensure equitable implementation and outcomes

## 5 RELATED FUNDING OPPORTUNITIES

Key IRA/BIL funding opportunities that could support implementation of this strategy

IMAGE PLACEHOLDER

## 4 Implementation Considerations

Discusses actions, actors, financial aspects, and equity matters to consider for successful implementation of the strategy.

## 5 Funding Opportunities

Key federal funding initiatives that could align with/support implementation of the strategy.

# Framework for DEP's Legislative Recommendations

Conduct background research and review the 2021 CAP for a baseline to identify Pennsylvania climate change priorities.

Prepare a literature review including:

- Review of existing Pennsylvania legislation.
- Benchmarking best practices of other states and industries.
- Additional research on in-state and regional policies.

Draft initial legislative recommendations based upon draft 2024 CAP strategies and findings from the literature review memo.

Submit initial legislative recommendations to CCAC as part of the updated draft 2024 CAP in January.

Iterate off CCAC feedback to update and refine legislative recommendations, supporting graphics and analysis as a part of the CAP deliverable schedule.

## OPPORTUNITIES FOR CCAC FEEDBACK

- 10/24** October CCAC Meeting
  - Review framework
- 11/15** Literature Review Memo
  - Submitted with the Initial Draft CAP
- 12/19** December CCAC Meeting
  - Present initial recommendations
- 01/31** Updated Draft CAP
  - Including written recommendations & supporting graphics
- 03/31** Draft Final CAP
  - Refined recommendations
- 05/31** Final CAP
  - Finalized recommendations



# Framework for DEP's Legislative Recommendations- Criteria

---

Meets a need established in the 2024 CAP to achieve GHG reduction goals.

(e.g., clean energy grid, building decarbonization, EV deployment, etc.)

Meets a need communicated to DEP by stakeholders.

Sources include:

- Identified impacts to/opportunities for EJ communities, provided from recent *Pennsylvania Climate Action: Strategies for Environmental Justice Communities* report
- Input received via upcoming CPRG outreach
- Input from other applicable existing outreach received by DEP

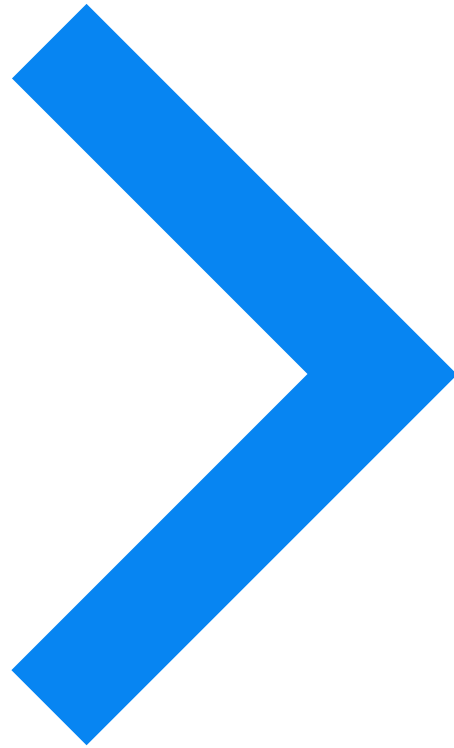
Advances a cost-effective strategy recommendation that shows a net benefit to stakeholders and/or the public.

Demonstrates practice of similar policies in other states and jurisdictions.

- Benchmark best practices of climate and energy policies in other neighboring states (MD, NJ, DE, OH and NY)
- Benchmark industrial and energy production best practices in other states nationwide
- In-state policies from local governments

Leverages existing regional clean energy and other climate programs and policies.

Introduces a new consideration or fills a gap left by existing and currently proposed legislation.



# Climate Action Plan Q&A and Discussion