

3. GLOBAL CLIMATE CHANGERISIS



Photo credit: In These Times

Greenhouse gas (GHG) emissions are primarily associated with the burning of fossil fuels and deforestation, as well as agricultural activity and the decomposition of solid waste. GHG pollution has led to a trend of human-induced warming of the Earth's average temperature, which is causing changes in the Earth's climate. This increasing-temperature phenomenon is known as "global warming," and the climatic effect is known as "climate change." The most common human-produced GHG is carbon dioxide (CO₂).

The California legislature adopted the public policy position that "Global warming poses a serious threat to the economic well-being, public health, natural resources, and the environment of California." Further, the state legislature has concluded that

The potential adverse impacts of global warming include the exacerbation of air quality problems, a reduction in the quality and supply of water to the state from the Sierra snowpack, a rise in sea levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems and the natural environment, and an increase in the incidences of infectious disease, asthma, and other human health related problems...Global warming will have detrimental effects on some of California's largest industries, including agriculture, wine, tourism, skiing, recreational and commercial fishing, and forestry (and)...will also increase the strain on electricity supplies necessary to meet the demand for summer air-conditioning in the hottest parts of the state. (Health and Safety Code §38501)

"The United Nations Intergovernmental Panel on Climate Change (UN IPCC) has recently concluded that to avoid severe climate consequences, GHG emissions must be reduced dramatically as soon as possible. ...The report also shows that human actions still have the potential to determine the future course of climate."

— UN IPCC, 2021

"Globally, (2023) was the warmest year on record by a large margin, with average annual temperatures between 1.34 degrees C and 1.54 degrees C above pre-industrial levels. In the summer of 2023, the world witnessed Earth's highest temperatures on record"

— State of CA, 2023

TRENDS AND PROJECTIONS

Global Impacts of Climate Change

The United Nations Intergovernmental Panel on Climate Change (IPCC) continuously tracks scientific research and policy on climate change impacts. The IPCC released the “Summary for Policymakers” (2023), structured in three parts: current status and trends; future climate change risks; and long-term responses. The summary states, in part:

Future Climate Change: Deep, rapid, and sustained reductions in greenhouse gas emissions would lead to a discernible slowdown in global warming within around two decades, and also to discernible changes in atmospheric composition within a few years (high confidence).

Urgency of Near-Term Integrated Climate Action: Climate change is a threat to human well-being and planetary health (very high confidence). There is a rapidly closing window of opportunity to secure a liveable and sustainable future for all (very high confidence). ... The choices and actions implemented in this decade will have impacts now and for thousands of years (high confidence)

in the “6th Assessment Report” (*Climate Change 2021: The Physical Science Basis*), updated the level of uncertainty of potential climate change in regions around the globe. The authors report that, in the Western North America (WNA) region, we can expect:

- Increases in drought and fire weather in WNA in observations and will continue to increase in the future particularly at higher warming levels (high confidence);
- Projected increase in extreme precipitation (very likely);
- Projected increase in river and pluvial flooding (medium confidence).

From the IPCC “6th Assessment Report” (*Climate Change 2021: The Physical Science Basis*).

Common regional changes in North and Central America include:



🌡️ Temperature change (mean and extremes) in observations in most regions is larger than the global mean and is attributed to human influence. Under all future scenarios and global warming levels, temperatures and extreme high temperatures are expected to continue to increase (virtually certain) with larger warming in northern subregions.

🌊 Relative sea level rise is projected to increase along most coasts (high confidence), and are associated with increased coastal flooding and erosion (also in observations);

💧 Ocean acidification (along coasts) and marine heatwaves (intensity and duration) are projected to increase (virtually certain and high confidence, respectively);

❄️ Strong declines in glaciers, permafrost, snow cover are observed and will continue in a warming world (high confidence), with the exception of snow in northern Arctic (UN IPCC 2021a).

The UN IPCC 6th Assessment authors alert us to the urgency of both the threat and the opportunity we face (as summarized in the New York Times):

Under most of the scenarios discussed in the report, warming will continue well beyond 2040, through the remainder of the century. In the worst cases, where the world does little to reduce emissions,

temperatures by 2100 could be 3 to 6 degrees Celsius (5.5 to 11 degrees Fahrenheit) above preindustrial levels. That would have catastrophic consequences.

"The evidence is clear that carbon dioxide (CO₂) is the main driver of climate change, even as other greenhouse gases and air pollutants also affect the climate."

— United Nations
IPCC, 2021

But the report shows that aggressive, rapid and widespread emissions cuts, beginning now, could limit the warming beyond 2050. In the most optimistic scenario, reaching "net zero" emissions could even bring warming back slightly under 1.5 degrees Celsius in the second half of the century.

Such a scenario would be a mammoth and expensive undertaking for the world. It would also require a level of political will that most governments have so far been unable to muster (Fountain 2021).

Projected Climate Change Impacts on California

The California Climate Adaptation Strategy 2024, as well as the Climate Adaptation Strategy Implementation Report 2023, are some of the

State's most current climate assessments at the time of the 2026 RTP update. The State's associated webpage summarizes some of the recorded and projected impacts, such as:

☐ **Extreme Heat**

- Annual temperature increases have already exceeded 1°F over most of California, with some areas exceeding 2°F.
- The daily maximum average temperature, an indicator of extreme temperature shifts, is expected to rise 4.4°F–5.8°F by mid-century and 5.6°F–8.8°F by late century.
- By midcentury, the Central Valley is projected to experience average Heat-Health Events (HHEs) that are two weeks longer, and HHEs could occur four to ten times more often in the Northern Sierra region.

☐ **Drought**

- Annual precipitation may remain relatively stable on average, (but) droughts will grow more frequent, prolonged, and intense.
- Warming air temperatures will cause moisture loss from soils, which will lead to drier seasonal conditions.
- Snowpack in California's mountains will decline more than a third by 2050 and more than half by 2100, significantly reducing surface and groundwater supply.

☐ **Wildfire**

- In recent years, the area burned by wildfire in California has dramatically increased. Measured by acreages burned or structures destroyed, 2018, 2020 and 2021 and 2025 are the most destructive wildfire seasons on record.
- A model developed for California's Fourth Climate Change Assessment projected up to a 77 percent increase in average area burned and a 50 percent increase in the frequency of fires exceeding 25,000 acres by 2100.

"Between July 1 and July 28, (2023), 117 highest max temperature records were tied, and 241 highest max temperature records were broken, totaling 358 across California. California cities where temperature records were broken included Anaheim, Sacramento, Redding, Merced, and Palm Springs."

— State of CA, 2023

□ **Sea Level Rise**

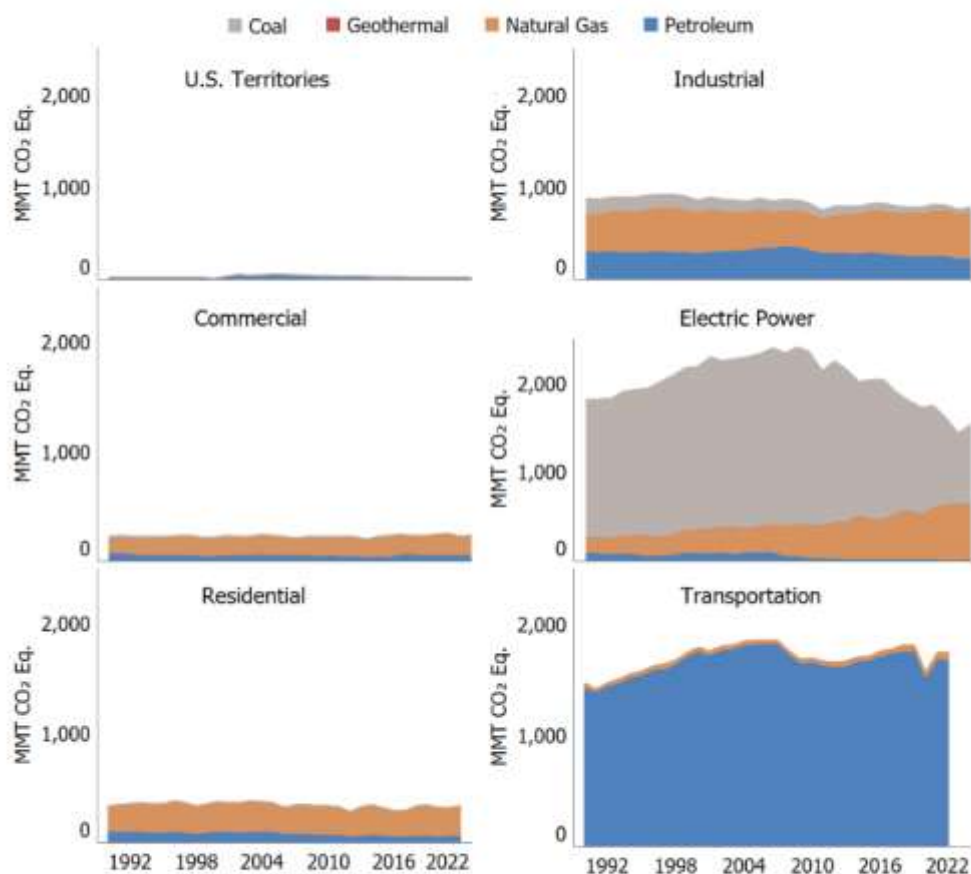
- Sea level has risen 6-8 inches along the California coast in the past century and will rise at a much faster rate in the coming decades.
- The current best available science predicts that California sea level will rise between 1.6 feet and 3.1 feet by 2100, with slim potential for a rise as high as 6.6 feet.
- 31 to 67 percent of Southern California beaches are projected to be lost by the end of the century if adaptation actions are not implemented.

California's North Coast Regional Profile

The State assesses climate-change impacts at a regional level, too. The California Natural Resource Agency, on Earth Day (April 22) 2022, officially released the *Natural and Working Lands Climate Smart Strategy* (CNRA 2022). The Agency used California's 4th Climate Change Assessment as a key resource for developing these strategies. The regional profile for North Coast covers Del Norte, Siskiyou, Trinity, Humboldt, Mendocino, and Lake counties. This "Smart Strategy" identifies the following climate risk project to impact the North Coast region.

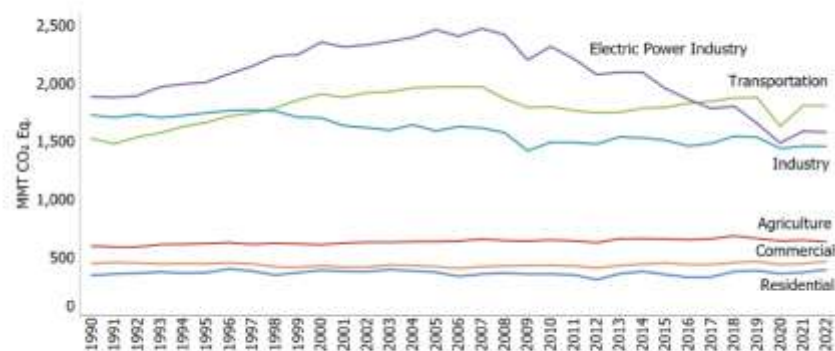
- **Increased temperatures** By the end of the century, average annual maximum temperatures are likely to increase by 5-9°F throughout the region. Interior regions will experience the greatest degree of warming. Summer season temperatures will increase 3-5°F by mid-century and 6-9°F by end of century. Winter season temperatures are expected to warm by a greater magnitude: 5-7°F by mid-century and 8-11°F by end of century.
- **Variable precipitation** Change in overall annual precipitation is expected to be small; however, an "average" rainfall year will become less common as the variability in precipitation is likely to increase with a higher likelihood of extreme wet years and extreme dry years. More intense storms within a shorter wet season are expected.
- **Decreased snowpack** Snow and total snowpack will be a small fraction of its historical average. As a result, the region is expected to experience prolonged dry seasons and reduced soil moisture conditions, even if annual precipitation stays the same or moderately increases. The rise in extreme precipitation events will increase the frequency and extent of flooding, particularly along the coast where flood risk is also enhanced due to sea level rise.
- **Sea level rise** (L)and subsidence (sinking of the ground's surface) is occurring-along the Pacific Northwest coast and driving sea level rise in some places at a rate 34 percent greater than the global average. Recent estimates indicate that Humboldt Bay has the highest local sea level rise rate in California, greater than both global and regional rates, due to land subsidence in and around the bay. This suggests that global sea level rise will impact the Humboldt Bay area faster than other parts of the U.S. west coast.
- **Increased wildfire** Temperature increases are expected to extend fire season throughout the region, especially in higher elevation sites with variable and decreasing snowpack. Increased populations will also increase the probability of human-ignited wildfire.
- **Shifting habitat** As the climate warms and precipitation patterns change, the North Coast's cool, wet habitats may shift or disappear from the landscape.

Figure 2-6: Trends in CO₂ Emissions from Fossil Fuel Combustion by End-Use Sector and Fuel Type



Note: Fossil fuel combustion for electric power also includes emissions of less than 0.5 MMT CO₂ Eq. from geothermal-based generation. Although not technically a fossil fuel, geothermal energy-related CO₂ emissions are included for reporting purposes. The source of CO₂ is non-condensable gases in subterranean heated water.

Figure 2-13: U.S. Greenhouse Gas Emissions Allocated to Economic Sectors



Note: Emissions and removals from Land Use, Land-Use Change, and Forestry are excluded from figure above. Excludes U.S. Territories.

source for graphics: <https://www.epa.gov/system/files/documents/2024-04/us-ghg-inventory-2024-chapter-2-trends.pdf>

GREENHOUSE GAS EMISSIONS ~~BY SECTOR~~

Global & National GHG Emissions

Worldwide, the most greenhouse gas emissions are due to the production of GHG is emitted from producing electricity and heat emits, and; the second largest source most is from the transportation sector. The burning of coal, natural gas, and oil for electricity and heat is the largest single source of global greenhouse gas emissions (25% of 2010 34% of 2019 GHG emissions). The transportation sector primarily emits GHG from fossil fuels burned for road, rail, air, and marine transportation (14% of 2010 15% of 2019 GHG emissions) (EPA 2024 IPCC 2022).

According to the U.S. GHG inventory of 2024, published by the EPA (U.S. EPA 2024),

The primary greenhouse gas emitted by human activities in the United States is CO₂, representing 79.7 percent of total greenhouse gas emissions. The largest source of CO₂—and of overall greenhouse gas emissions—is fossil fuel combustion, primarily from transportation and power generation¹

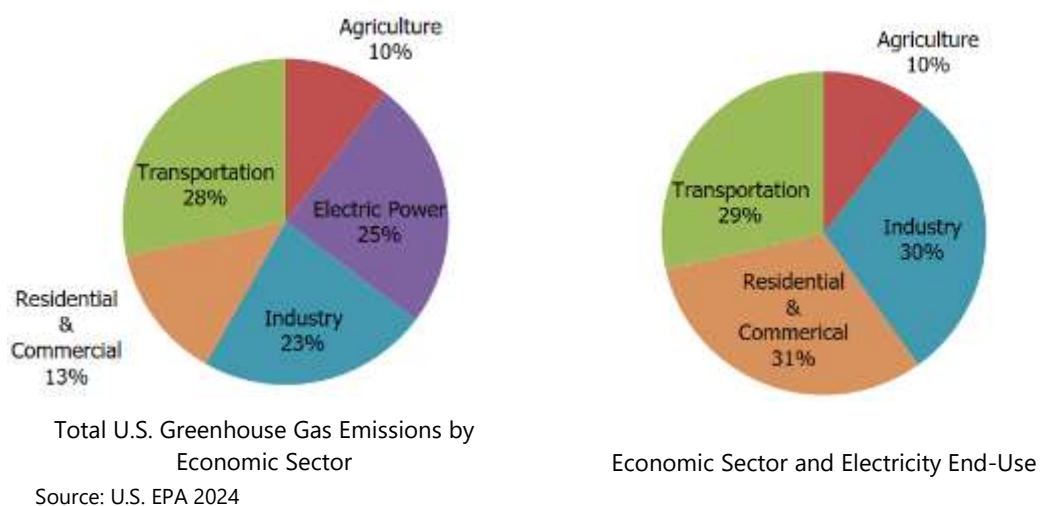


Figure Climate-1. Total U.S. Greenhouse Gas Emissions by Economic Sector in 2022

The graphics below show comparative emission sources for the U.S., California, and Humboldt County.

¹ Percentage based on million metric ton (MMT) CO₂ equivalent.

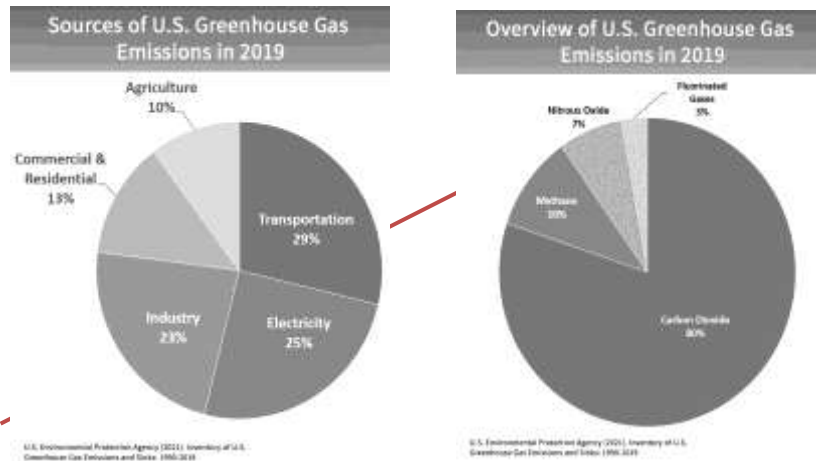


Figure Climate-1. U.S. Greenhouse Gas Emission in 2019

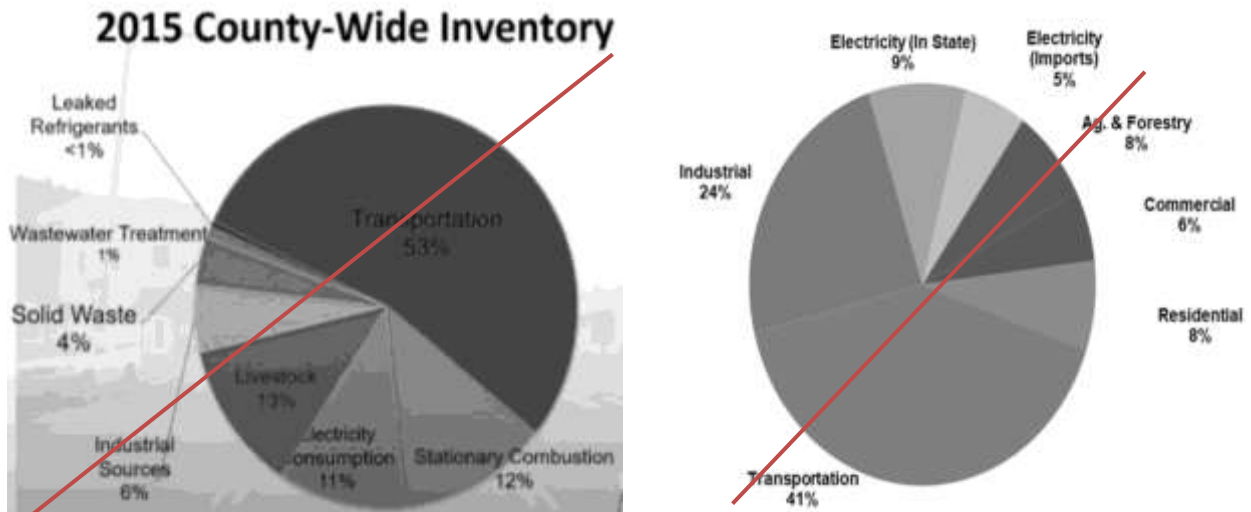


Figure Climate-3. 2015 Humboldt County Greenhouse Gas Emissions (Draft County CAP3)

Figure Climate-2. Sources of California Greenhouse Gas Emissions

California GHG Emissions

California's overall GHG emissions peaked in 2004, and have generally trended down since. The transportation sector remains the state's largest source of GHG emissions. Transportation emissions declined from 2007 to 2013, then increased for four consecutive through 2017, and again decreased in 2018 and in 2019 (CARB 2021). In 2019,

direct emissions from vehicle tailpipe, off-road transportation sources, intrastate aviation, etc., account for almost 40 percent of statewide emissions. When emissions from extracting, refining and moving transportation fuels in California are included, transportation is responsible for over 50 percent of statewide emissions in 2019 (CARB 2021).

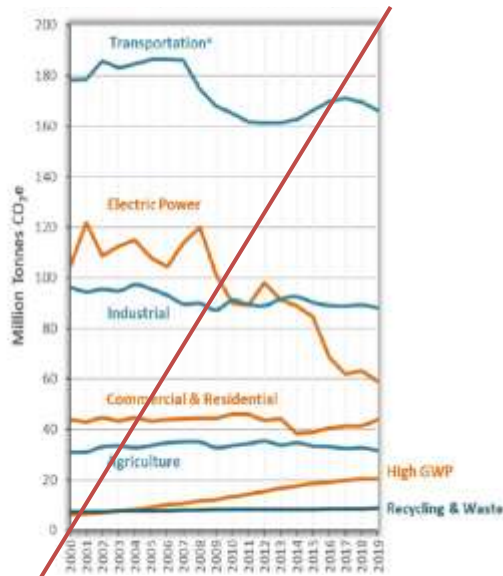


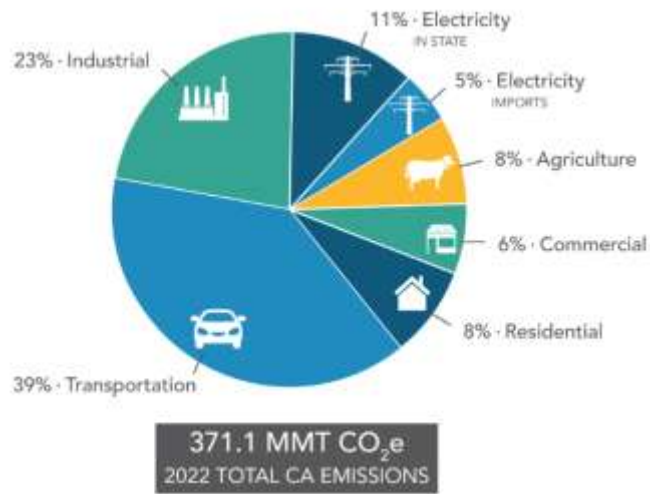
Figure Climate 4. Trends in California GHG

Graphic: California's greenhouse gas emissions in 2022 broken out by economic sector

Source: 2000-2022 GHG Inventory (2024 Edition) (<https://ww2.arb.ca.gov/ghg-inventory-data>)

STATEWIDE TRENDS

California GHG Emissions



NEEDS ASSESSMENT

IPCC SIXTH ADAPTATION REPORT

The Intergovernmental Panel on Climate Change (IPCC), [established in 1988, is the United Nations body for assessing the science related to climate change. The IPCC publishes comprehensive scientific assessments every six to seven years.](#)

[In 2018, IPCC highlighted the unprecedented scale of the challenge required to keep warming to 1.5°C. Five years later, that challenge has become even greater due to a continued increase in greenhouse gas emissions. The pace and scale of what has been done so far, and current plans, are insufficient to tackle climate change.](#)
[...Emissions should be decreasing by now and will need to be cut by almost half by 2030, if warming is to be limited to 1.5°C. \(Press release March 6, 2023\)](#)

STATE ASSESSMENTS & PLANS

California's Fourth Climate Change Assessment

The State finished releasing all reports of *California's Fourth Climate Change Assessment* in 2021. Since 2022, the State has been progressing on preparing [California's Fifth Climate Change Assessment](#), which the Governor's Office of Land Use and Innovation (LCI) is slated to complete in mid-2026. [<https://lci.ca.gov/climate/icarp/climate-assessment/>] The Assessment includes [Regional Synthesis Reports](#), which should be released in summer 2026. The Regional Coordinating Lead Authors for the *North Coast Regional Report* are Cal Poly Humboldt professors Andrew Stubblefield, PhD, and Rosemary Sherriff, PhD.

California's Climate Adaptation Strategy

The Strategy is California's overarching framework for building community, economic, and environmental resilience to climate impacts. The Strategy, as well as three-year updates, is required by Assembly Bill 1482 (Gordon, 2015). It was last updated and adopted in 2021. The California Natural Resources Agency released a draft update in May 2024. Final adoption of the 2024 update was still pending at the time this writing. The 2024 Strategy integrates and connects key elements of the most current specific State action plans such as the *Climate Smart Lands Strategy*, *Wildfire and Forest Resilience Action Plan*, *Extreme Heat Action Plan*, *Water Supply Strategy*, and *Climate Action Plan for Transportation Infrastructure*.

California's six climate resilience priorities. *California's Climate Adaptation Strategy* encompasses six key priorities that drive all resilience actions in California:

1. Strengthen protections for climate-vulnerable communities
 2. Bolster public health and safety to protect against increasing climate risks
 3. Build a climate-resilient economy
 4. Accelerate nature-based climate solutions and strengthen climate resilience of natural systems
 5. Make decisions based on the best available climate science
 6. Partner and collaborate to leverage resources
- These resilience priorities are California's climate adaptation "north stars" — they guide our collective efforts, connect the dots between our sector-specific work, and reflect the outcomes we are seeking to achieve.

2018 For the statewide transportation sector:

- The increase in annual average and maximum temperatures is expected to raise the **costs of road construction** between 3% and 9%. Adapting roadway materials to withstand higher temperatures is needed to avoid potential costs of over \$1 billion by 2070; and
- Over 3,750 additional miles of **highway** will be exposed to temporary **flooding** due to a 100-year storm event (Thorne 2018).

– California's 4th Climate Change Assessment

- **Season temperatures** will increase 3-5°F by mid-century (2040-2069) and 6-9°F by end-century (2070-2099). Winter season temperatures are expected to increase by a greater magnitude: 5-7°F by mid-century and 8-11°F by end-century. Interior regions will experience the greatest degree of warming.
- The North Coast region already experiences the most **intense storms** in the state in terms of three-day maximum precipitation. Climate change projections indicate that the intensity of individual storms will increase in the future (Pall et al. 2017, Prein et al. 2017, Risser and Wehner 2017).
- The frequency of **extremely dry years** is expected rise, on the order of 80% across most of northern California (Swain et al. 2018)
- **Annual precipitation** is not expected to change significantly, but will likely be delivered in more intense storms and within

- A rise in extreme precipitation events will increase the frequency and extent of **flooding** in low-lying areas, particularly along the coast where flood risk will be enhanced with rising sea levels.
- **Sea-level rise** projections differ along the coast, but are greatest for the Humboldt Bay region and Eel River delta, threatening communities, prime agricultural land, critical infrastructure, and wildlife habitat.
- **Wildfires** will continue to be a major disturbance in the region. Future wildfire projections suggest a longer fire season, an increase in wildfire frequency, and an expansion of the area susceptible to fire.
- The impacts of these and other climate-driven disruptions will be disproportionately experienced by **vulnerable populations** in the North Coast Region. These include but are not limited to: low-income individuals, families, and people of color, women, the young, the elderly, people with disabilities, people with existing health issues including mental health issues, and people with limited-English proficiency. These populations will often not only feel the immediate impacts of climate change more significantly, but also are less able to adapt to climate changes or recover from their impacts. (Grantham 2018)

CLIMATE CHANGE & SEA-LEVEL RISE IMPACTS TO HUMBOLDT

In Humboldt County, sea-level rise from global warming is compounded by local tectonic activity that causes downward vertical land movement, or tectonic subsidence. “Combining subsidence on Humboldt Bay with sea level rise over the last 100 years, tidal elevations have increased approximately 1.5 feet—the most of any area on the West Coast” (Russell and Griggs 2012 as cited by Trinity Associates 2015). Areas of former tidelands around the Bay are thus “as much as three feet lower than when they were salt marsh in the late 1800s/early 1900s” (Trinity Associates 2015).

Table *Climate-1. North Coast Region: Projected Average Annual Maximum Temperatures to 2099*

	HISTORICAL (1950-2005)	EARLY CENTURY (2020-2039)	MID-CENTURY (2040-2069)	END CENTURY (2070-2099)
Mendocino	65.4	68.1	69.9	72.8
Humboldt	60.4	63.2	65.1	68.2
Del Norte	57.4	60.0	61.8	64.8
Lake	68.0	70.9	72.9	75.8
Trinity	61.5	64.7	66.7	69.9
Siskiyou	60.0	63.5	65.9	69.4

Historical and future modeled annually averaged maximum daily temperatures (°F) for North Coast region counties under a business-as-usual (RCP 8.5) emissions scenario (Source: regional LOCA-downscaled data from ten priority global climate models).

Source: Grantham 2018

From the dual factors of land subsidence and global warming, in the Humboldt Bay region relative sea-level is rising at a rate two- to three-times greater than anywhere else in California. In fact, sea-level change at the Humboldt Bay North Spit tide gauge is much greater than any other tide gauge in the Pacific Northwest (Patton et al., 2017)” (Anderson 2017).

The areas at risk of tidal inundation are multiplied by Humboldt’s miles of coastline, making Humboldt one of the most vulnerable counties in California.

Caltrans District 1, in partnership with HCAOG, led a regional climate change assessment, focusing on transportation assets and vulnerabilities. That report states that climate change is expected to increase sea levels in Humboldt Bay by a high-end estimate of up to 26 inches by 2050, and up to 70 inches by 2100. Precipitation is predicted to increase by up to 11% by 2050, and up to 14% by 2100, with estimated extreme runoff increases by up to 9% by 2050 and 12% by 2100 (Caltrans District 1 and HCAOG 2014).

TRANSPORTATION ASSETS AT RISK

"Transportation sector emissions vastly outweigh other carbon-producing areas of California's economy, and the recent spike should alert policy-makers that despite our best efforts, more must be done..."

— Adam Fowler,
Beacon Economics

Around Humboldt Bay there are approximately 57 miles of shoreline structures—dikes, railroad, and highway/roads—that were constructed across former tidelands and function as barriers to bay waters. If these shoreline structures are overtopped (breached), the land uses, structures, and critical utility and transportation infrastructure located on these former tidelands are at risk of being inundated by tidal waters. Sea level rise would increase the risk to land uses and assets located on these former tidelands. (Trinity Associates, 2018)

Nearly 75% of Humboldt Bay's (almost 77 miles of the 102-mile shoreline) is covered by artificial shorelines. For example, U.S. 101 and State Route 255 are constructed on former tidelands that are protected by earthen shoreline structures (such as dikes). However, only 36% of the bay's shoreline (27.6 miles) is fortified. Nearly ten miles of low-lying shoreline, which currently protects US 101, has been rated highly vulnerable to breaching (overtopping) under current conditions during extreme tides (100-year event), or during annual king tides and/or storm surges that raise the tide by two feet or more above tidal baseline elevation (Trinity Associates 2015).

Dikes alone skirt almost 41 miles of the bay, and railroad approximately another 10, covering half of Humboldt Bay shoreline. The barriers are currently protecting thousands of acres of low-lying former tideland from tidal inundation. The man-made structures are providing barriers for transportation assets such as gas transmission lines, optical fiber lines, electrical transmission towers and distribution poles, highways, roads, city service streets, and a county airport (as well as other important regional infrastructure, agricultural lands, and tribal cultural resource sites) (Trinity Associates 2018).

Table *Climate-2*. **Surface transportation infrastructure (miles) vulnerable to 0.9 to 4.9 feet of sea level rise in the Humboldt Bay Area Plan (HBAP) planning area**

Surface Transportation Type	0.9 Ft.	1.6 Ft.	3.3 Ft.	4.9 Ft.	HBAP Total Miles
Local Roads	9.8	11.0	16.5	22.6	90.1
Collector Roads	1.0	1.6	3.4	5.6	23.6
Highways 101 & 255	5.4	6.1	8.1	9.6	16.2
Total	16.2	18.7	28.0	37.8	129.9

Source: Laird 2018

When the vulnerability to tidal inundation was assessed in 2014, the following transportation infrastructure (and associated water bodies) were reported to be the most at risk for flooding/inundation due shoreline structures (dikes, railroad beds, or other) being breached. The transportation systems (and associated water body) thus identified are:

Years 2015 to 2050, near-term conditions:

- Highway 101 (South Bay and Lower Arcata Bay)
- Highway 255 (North Arcata Bay)
- City of Eureka, City of Arcata, and County local streets and roads (Mad River Slough, Arcata Bay, Eureka Slough, Eureka Bay, Elk River Slough and South Bay)

Years 2050 to 2100, long-term conditions:

- Highway 101 (Upper Arcata Bay and Elk River Slough)
- Highway 255 (West Arcata Bay)
- City of Eureka, City of Arcata, and County local streets and roads (Mad River Slough, Arcata Bay, Eureka Slough, Eureka Bay, Elk River Slough and South Bay) (Trinity Associates 2015)

In the Humboldt Bay Area, the vulnerable roads and streets are concentrated in the City of Eureka and unincorporated communities of King Salmon, Fields Landing, Fairhaven, Samoa, and Manila (Trinity Associates 2018).

Caltrans District 1 Climate Change Vulnerability Assessment (2014)

Caltrans District 1 (Del Norte, Humboldt, Mendocino, and Lake Counties) was one of the first districts to complete a climate change vulnerability assessment. They assessed nearly 1,000 miles of the District's 23 roadways. Overall, the assessment concluded that the majority of the road network had low vulnerability to climate change, but several road segments were considered at risk, having both high criticality and a high potential for impact. Among the vulnerable road segments, high criticality scores were related to their limited redundancy (i.e., lack of alternative road routes) and presence of infrastructure assets such as bridges and stormwater facilities. (Caltrans and HCAOG 2014)

The Vulnerability Assessment identified the top three most vulnerable segments in each county in Caltrans District 1. The most vulnerable locations ("assets") did not change when different climate models predicted different impacts. The transportation assets in Humboldt County that the report found most vulnerable to climate change impacts are three segments of U.S. 101 in the greater Humboldt Bay Area:



Source: Caltrans District 1 and HCAOG 2014

Figure Climate-5. Highway 101 Vulnerability to Sea-Level Rise Along Humboldt

- **Rated most vulnerable: US 101** between Rio Dell and Eureka’s southern urban boundary. Several portions of this segment are at low elevations and close to the coast/bay, creating a high potential for tidal inundation. This segment is deemed highly vulnerable in part due to its number of bridges, low redundancy (e.g., the bridge over the Eel River), and relatively high volumes of traffic (i.e., average daily trips, ADT).
- **Rated 2nd most vulnerable: US 101** between Eureka’s northern city limits and the junction with State Route 255 (south Arcata). Some of the factors that make this segment critical are its high ADT and proximity to large population centers. Its low elevation and proximity to the coast make it more vulnerable to impacts from tidal inundation.
- **Rated 3rd most vulnerable: US 101** between Richardson Grove and Weott. The criticality and impact factors that make this segment vulnerable include having bridges over water, having many stormwater facilities, and the segment’s drainage issues that have historically caused frequent slope movement (Caltrans District 1 and HCAOG 2014).

For the Vulnerability Assessment, stakeholders considered concepts for addressing sea-level rise along Highway 101 on Humboldt Bay. Concepts considered included increasing armoring/flood walls, elevating the roadway, and relocating structures. The six adaption options that were ultimately ranked highest (in this assessment process) are summarized in the table below.

CLEAN CARS & FLEETS: ZERO-EMISSION VEHICLES (ZEVs)

The State of California set ambitious targets for the number of zero-emission vehicles (ZEVs) on the road. ZEV technologies refer to battery electric vehicles, hydrogen fuel cell vehicles, and “transitional” plug-in hybrid electric vehicles—all of which can support the goal to reduce tailpipe emissions (CTP 2050). As the technology, market and funding for ZEVs is shifting rapidly, VROOM is

Table Climate-3 Summary of Humboldt County-US 101 Prototype-Location Adaptation Options

Rank	Adaptation Approach & Option	Project Description	2050 Cost Estimate (000s)*
1	“Defend” approach: Provide protection at existing elevations/ locations	Strengthen/add protection to existing protective structures (RR berm, dikes, fill areas) for 10 miles, including increasing height to 1 foot above 2050/2100 water level at a King tide	\$121,000

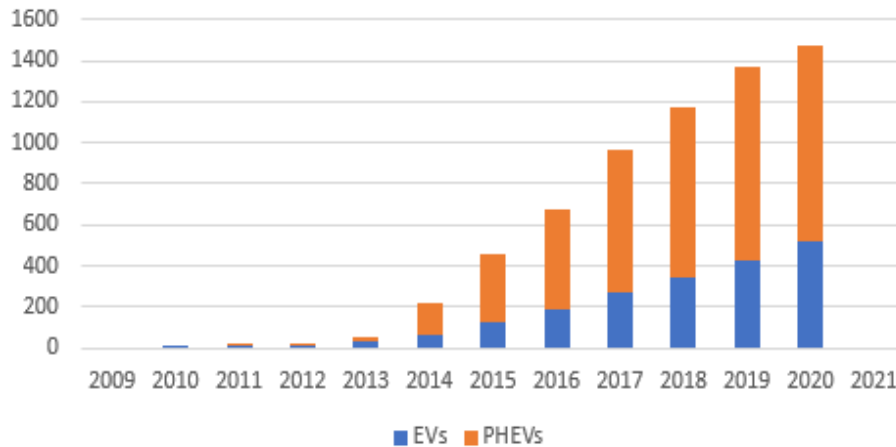
2	"Accommodate" approach: Elevate the infrastructure above the impact zone	Increase height of the roadway by building up the fill prism 1 foot above 2050/2100 water level at a King tide for 6 miles	\$61,000
3	"Accommodate" approach: Elevate the infrastructure above the impact zone	Construct a causeway, 6 miles, at a height of 5 feet above 2050 water level at a King tide	\$174,000
4	"Retreat" approach: Relocate infrastructure (horizontally)	Assumed 8 mile re-route to the east of the existing Hwy 101	\$350,000
5	"Changes in policies or practices" approach: Increase the interval for infrastructure maintenance & inspection and continue to monitor/evaluate	Equivalent to the No-Project alternative. Only temporary measures enacted and repairs made on an as-needed basis.	\$950
6	"Retreat" approach: Temporarily restrict use of infrastructure	Install ITS infrastructure to recommend use of alternate route and increase signage and warning information	\$1,000
*Order of magnitude, 2014 dollars.			Source: Caltrans District 1 and HCAOG 2014

agnostic as to the particular type of zero-emission vehicle and infrastructure developed in Humboldt County. New vehicle types and their fuel sources should be considered with a full lifecycle analysis to ensure the least possible impact while still meeting regional transportation needs. In addition, ZEV policies and incentives must be distributed so that everyone, regardless of income or location, can benefit from clean cars.

The shift to ZEVs involves several vehicle classes. Federal and state incentives help drive the purchase of personal ZEVs. As more vehicles are manufactured and get to market, costs come down. Meanwhile, advances in battery technology are providing longer driving ranges. Models of pick-up trucks are expected to be on the market soon. Freight trucking is another class with dedicated state funding to support charging infrastructure and vehicle development for long-haul trucking. While much of the focus of ZEV policy is on cars and trucks, electric bikes are also gaining in popularity and market shares.

Zero-emission vehicles are at the forefront of advanced technologies such as autonomous driving. The California Office of Planning and Research published the guidance document, "Automated Vehicle Principles for Healthy and Sustainable Communities," which details strategies to manage the adoption of Connected and Autonomous Vehicles (CAVs). The adoption of CAVs should be focused on electric, shared-use vehicles that are part of efficient land use patterns.

Electric Vehicle and Plug-in Hybrid Electric Vehicle Adoption in Humboldt County



Source: California Energy Commission Zero Emission Vehicle and Infrastructure Statistics, June 30, 2021.

Figure Climate-6. **Electric and Plug-in Hybrid Electric Vehicles on the Road in Humboldt**

Widespread adoption of ZEVs will require ample charging and alternative fueling infrastructure. According to the CEC, there are [a total of 134 311 public charging stations in Humboldt \(231 Level 2 and 80 DC fast charging ports\) plus 17 Level 2 shared private ports.² \(The 311 public charging ports is up from 134 in 2021.\)](#) There needs to be coordination with local land use authorities to support ZEV charging stations at residential developments, job centers, and public buildings (CTP 2050). The use of the public right-of-way for charging stations will also be critical for broad transition to EVs.

HCAOG has partnered with Schatz Energy Lab, HTA and Redwood Coast Energy to better understand the technical limitations of charging a fleet of battery-powered public transit vehicles (HTA Battery Optimization Study). HTA ~~and A&MRTS, and Blue Lake Rancheria Transit each~~ have battery electric busses in their fleet. ~~HTA is primarily incorporating hydrogen fuel-cell busses into its fleet. The first HFC bus is currently operating, while ten others are on order. HTA is permitting and constructing an over-the-fence hydrogen fueling station at its yard. HTA's zero emission bus rollout is further described in Chapter 9. HTA is actively pursuing grants to further study hydrogen fuel-cell bus technology in the rural context, with the goal of building hydrogen fueling infrastructure and purchasing hydrogen fuel-cell busses.~~

² [Electric Vehicle Chargers in California, August 2024 update, CEC website: www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics-collection/electric. Accessed Oct. 27, 2025.](#)

RTP GOAL, OBJECTIVES, & POLICIES

To strive for these goals, HCAOG shall support policies that help achieve the RTP's main ~~objectives/planning priorities:~~ objectives/planning priorities:

GOAL: *Reduce greenhouse gas emissions contributed by transportation while building and maintaining a transportation system that is truly multimodal and equitable.*

GOAL: *Minimize the negative health, social, economic, and environmental impacts caused by global climate change and sea-level rise.*

MAIN OBJECTIVES:	GLOBAL CLIMATE CHANGE <u>RISIS</u> SUB-OBJECTIVES (♦) & POLICIES
Active Transportation Mode Share/Complete Streets	POLICY CLIMATE-1. Carbon-neutral modes: HCAOG will work and collaborate on efforts to promote non-motorized travel and the rapid transition to zero-emission motorized vehicles. POLICY CLIMATE-2. Safe alternative modes: HCAOG will support and plan transportation projects that provide safe and convenient travel modes for people who cannot or choose not to drive.
Efficient & Viable Transportation System	♦ Reduce motor-vehicle miles traveled (VMT) and lower GHG emissions. POLICY CLIMATE-3. Clean fuels: HCAOG will support efforts, including through public-private partnerships, to equitably expand transportation electrification, to optimize development and use of the electric grid, and to expand clean-fuel supply infrastructure.
Environmental Stewardship & Climate Protection	POLICY CLIMATE-4. Adaptations for sea-level rise: HCAOG shall encourage partnerships to develop adaptation strategies that address sea-level rise in Humboldt County. POLICY CLIMATE-5. Traditional ecological knowledge: HCAOG acknowledges the value of indigenous sciences and knowledge and the need for indigenous perspectives in responding to the climate change crisis. HCAOG shall work to support indigenous-led climate adaptation approaches, and shall work collaboratively with tribes and tribal governments for mitigation, adaptation, and resilience to climate change.
Equitable & Sustainable Use of Resources	♦ Recognize the connections between transportation and land use. POLICY CLIMATE-6. Land use-transportation resilience strategies: HCAOG will support local communities in developing integrated transportation and land use strategies for responding resiliently to climate change, and codifying such strategies in General Plans, Regional Transportation Plans, Local Coastal Programs, and other long-range plans. (<i>CTP 2040 recommended policy</i>) POLICY CLIMATE-7. Equity for resilience: HCAOG strives to assure that individuals and communities at greatest risk from climate-change related threats in Humboldt County, including low-income communities and communities of color, receive resources necessary to achieve sustainable resilience, mitigation, and/or adaptation.

Safety & Health	POLICY CLIMATE-8. Health and safety: HCAOG shall work to identify and implement critical mitigation, adaptation, and resiliency actions to protect Humboldt communities from health and safety threats from transportation-related impacts from extreme weather events (such as flooding, landslides, inundation, wildfire, windstorms, and heatwaves).
----------------------------	--

Facing the global climate ~~changersis~~, California's governors and legislatures have passed laws enacting policies to actively address both the causes and the risks of climate change. Two of the foundational/early actions were Governor Schwarzenegger's Executive Order S-3-05 (2005) and the *California Global Warming Solutions Act of 2006* (AB 32, 2006), which set targets to limit GHG emissions equivalent to 2000 levels by 2010; and limit GHG emissions equivalent to 1990 levels by 2020.

California's GHG emissions targets for the next decades are:

By 2030	Reduce GHG emissions to 40 percent below 1990 levels	<i>Executive Order B-30-15 (Governor Brown 2015), SB 32 (Pavley 2016)</i>
	Renewable energy 60% of procurement portfolio	<i>SB 100 (De León 2018)</i>
By 2035	100% zero-emission vehicle sales (passenger cars and trucks)	<i>Executive Order N-79-20 (Governor Newsom 2020).</i>
By 2045	Carbon neutrality statewide and net-negative emissions thereafter	<i>Executive Order B-55-18 (Governor Brown 2018)</i>
	Renewable energy 100% of procurement portfolio	<i>SB 100 (De León 2018)</i>
By 2050	Reduce GHG emissions to 80% below 1990 levels	<i>Executive Order S-3-05 (Gov. Schwarzenegger 2005), AB 32 (Nunez 2006)</i>

In 2019, Governor Newsom signed Executive Order N-19-19 requiring California agencies to redouble efforts to reduce GHG emissions. The California State Transportatin Agency (CalSTA) is directed to leverage the more than \$5 billion in annual state transportation spending for construction, operations, and maintenance to help reverse the trend of increased fuel consumption and reduce greenhouse gas emissions associated with the transportation sector.

RTPA's have a role in meeting these goals by conducting proactive, collaborative, and "adaptive" transportation planning that always considers the real threats of global climate change, and the large role fossil-fuel-based transportation plays in it. This RTP promotes integrating transportation and land use to reduce CO₂ emissions from the regional transportation system. The RTP's goal and targets to curb greenhouse gas emissions from the transportation sector complement the State's goals and targets in AB 32 and SB 375 and align with the state's climate goals.

ACTION PLAN: PROPOSED PROJECTS

Table *Climate-4*. **Regional Climate-~~Changeris~~ Planning Projects**

Agency	Project Description	ST or LT*
--------	---------------------	-----------

HCAOG	ZEV Infrastructure: Work with agencies on infrastructure planning to optimize development and use of the electric grid and clean-fuel supply infrastructure, and to make more public right-of-way available for ZEV charging infrastructure.	ST
	Support State efforts to strategically place charging stations, for battery electric and hydrogen-fuel cell vehicles, along California’s designated Alternative Fuel Corridors, and advocate for Humboldt and other rural areas to receive fair benefits of the alternative fuel transportation corridors. (<i>California Transportation Plan 2050</i> recommended action)	
HCAOG	Promote Electric Bikes: Explore partnerships and incentive programs to support expanded use of e-bikes, such as programs that reduce the total cost of EV ownership. Support educating agencies, businesses, schools, and residents about the benefits of electric vehicles. (<i>California Transportation Plan 2050</i> recommended action.)	ST

* ST = short-term: one to 10 years; LT = long-term: 10+ to 20 years.

RESEARCH AND PLANNING

STATE-LEVEL PLANNING

California Transportation Plan (CTP) 2050

The *California Transportation Plan 2050* (CTP 2050) must show, among other climate-response strategies, how California can reduce transportation sector GHG emissions to 80 percent below 1990 levels by 2050. *CTP 2050* sets policies and actions to collectively reduce transportation emissions through: clean fuel technologies; continued shifts toward active travel, transit, and shared mobility; more efficient land use and development practices; and continued shifts to telework.

State agencies must take climate change into account when prioritizing investment (per Executive Order B-30-15 and other climate legislation). Whenever applicable, agencies must use full life-cycle cost accounting to evaluate relative merits of infrastructure investments and alternatives.

“The CTP 2050 also reinforces long-held values such as improving system safety, improving mobility and accessibility, advancing environmental health and justice, and enhancing quality of life.

— *California Transportation Plan 2050*

Climate Action Plan for Transportation Infrastructure (CAPTI)

The California State Transportation Agency (CalSTA) and the California Transportation Commission (CTC) adopted the *Climate Action Plan for Transportation Infrastructure* (CAPTI) in 2021. CalSTA answers the question “Why is CAPTI necessary?” by stating:

As the largest contributor to California’s greenhouse gas emissions (GHG), reducing emissions throughout all aspects of the transportation sector is urgently needed to address ~~the~~ climate ~~changerisis~~.

Even under the most aggressive scenarios for zero-emission vehicle adoption and a transition to cleaner fuels, California cannot meet its climate goals relying solely on a shift in transportation

technologies. This means we must work to reduce our dependence on driving and reduce overall vehicle miles traveled to meet our climate goals.

Moreover, reducing our dependence on driving is also key for our state's equity, healthy, and safety goals—not just climate. (CalSTA 2021a)

Adopting CAPTI, the state has committed that, “where feasible and within existing funding program structures,... the state will invest discretionary transportation funds in sustainable infrastructure projects that align with its climate, health and social equity goals.” [CAPTI communicates how the State recommends investing billions of discretionary transportation dollars annually to aggressively combat and adapt to climate change while supporting public health, safety and equity.](#) To steer those investments, the plan has 10 guiding principles. Foremost is to “invest to create new clean transportation options,”

1. Building toward an integrated, statewide **rail and transit network**;
2. Investing in networks of safe and accessible **bicycle and pedestrian** infrastructure;
3. Advancing investments in light-, medium- and heavy-duty **zero-emission vehicle** infrastructure; and to encourage people to adopt and use these clean transportation modes by:
4. Strengthening the commitment to social and racial equity by reducing public health and economic harms and maximizing community benefits
5. Making safety improvements to reduce fatalities and severe injuries of all users toward zero
6. Assessing physical climate risk for transportation infrastructure projects
7. Promoting projects that do not substantially increase passenger vehicle travel
8. Promoting compact infill development while protecting residents and businesses from displacement
9. Developing a zero-emission freight transportation system
10. Protecting natural and working lands.” (CalSTA 2021b)

“(T)he state commits to investing billions of discretionary transportation dollars annually to aggressively combat and adapt to climate change while supporting public health, safety and equity.”

— California State Transportation Agency 2021

[CAPTI was adopted with 34 original actions. The agency reported, in annual reports, that all have been implemented as of July 2024.](#)

REGIONAL/LOCAL STUDIES & PLANNING

Some local jurisdictions joined the International Council on Local Environmental Initiatives (ICLEI), and resolved to participate in the Cities for Climate Protection campaign, such as the City of Arcata in 2000, and the County of Humboldt in 2007. Local jurisdictions have developed planning and policy documents designed to guide and prioritize measures to reduce GHG (and other air pollution) emissions:

- The **City of Arcata** prepared a *Community Greenhouse Gas Reduction Plan* in 2006, and has prepared subsequent GHG emissions inventories (the latest in 2014). In October, 2017, the City promoted Sea Level Rise Awareness Month, kicking off the first phase of a public awareness campaign to inform the community about current and potential effects of sea level rise in Arcata.
- The **City of Eureka** prepared a *Sea Level Rise Adaptation Planning Report* and an *Addendum No. 1* (December 2016). The Report provides draft goals and policies that could potentially be included in the City's Local Coastal Plan, as well as potential strategies that could be utilized to protect those priority assets. The City will prepare a GHG Reduction Plan as part of the EIR analysis of the General Plan. The GHG Reduction Plan will have measures that the City will implement to reduce GHG emissions.
- The **City of Trinidad** prepared a Draft Trinidad Climate Action Plan (2010) as background for updating the General Plan; the draft plan was designed to provide a framework for creating a CAP. In 2016, the City prepared a draft *Climate Change Vulnerability Report and Adaptation Response* as part of the its Local Coastal Program Update Project. The City will incorporate climate change considerations and adaption responses into their General Plan/Coastal Land Use Plan as appropriate.
- The **County of Humboldt** prepared a *Draft Climate Action Plan* (January 2012) as part of the Draft General Plan. The Draft General Plan includes the air quality policy AQ-P9 and implementation measure AQ-IM3 which direct that the County shall develop and implement a Climate Action Plan to reduce GHG emissions consistent with AB 32 and SB 32.
- The unincorporated County and the seven cities are partnering to develop and adopt the **Humboldt Regional Climate Action Plan** (draft), with strategies to meet legislative and executive orders to reduce countywide emissions by 40% of 1990 levels by 2030 and make progress toward zero net greenhouse gas emissions by 2045.³ From 2030 to 2045, our community will need to fully transition from fossil fuels and make even deeper cuts in emissions from non-fossil sectors. A key outcome for the transportation sector is:

"More accessible communities: Implementing this CAP will make it easier, cheaper, and more fun to get around by improving accessibility of public transit; expanding shared mobility; expanding and increasing the safety of active transportation modes like walking and biking; and making communities more compact and connected."
- **Humboldt State University** (HSU) completed its initial Climate Action Plan in December, 2016, and met its first target to reduce their facility GHG emissions to or below 1990 levels by 2020. The campus is preparing "CAP 2.0," to be adopted in 2022, to prioritize policies and projects to meet the goal of achieving carbon neutrality by 2045. HSU will "build climate resilience while addressing basic needs, equitable transportation and other social challenges while prioritizing the most vulnerable of our population."
- The **Humboldt Bay Municipal Water District** (HBMWD) discusses climate change in *Humboldt Bay Municipal Water District Urban Water Management Plan 2020* (June 2020) They conclude, based on the 2014 "Climate Change Vulnerability Assessment" and

³ Governor Edmund G (Jerry) Brown, Jr., Executive Order B-55-18 to Achieve Carbon Neutrality. (9/10/18)



Figure Climate-7. **US 101 Eureka to State Route 255 Possible Inundation**

Inundation map of northeastern Eureka and Highway 101 with a half-meter of sea-level rise, which is predicted for the year 2050.

Source: NHE 2015

"California's Fourth Climate Change Assessment: North Coast Region Report" (2018), that "Overall, water supply and demand are projected to be of low to moderate vulnerability of climate change in the north coast region in general, and even less so in the Mad River watershed."

- The **Redwood Coast Energy Authority** (RCEA, a local government joint powers authority) has a goal to achieve net-zero greenhouse gas emissions countywide by 2030, which they outline in *RePower Humboldt: The Redwood Coast Energy Authority's Comprehensive Action Plan for Energy* (2019 Update). To advance low-carbon transportation, "RCEA will decarbonize regional transportation through efforts to reduce vehicle miles travelled, increase advanced fuel vehicles adoption and fuel efficiency, and expand advanced fuel infrastructure." RCEA also administers Humboldt County's Community Choice Energy program, which they turned on in 2017. Through the CCE, Humboldt customers can opt for a power mix of up to 100% renewable energy.

Figure Climate-4, depicts area around Humboldt Bay near Eureka (the second-most vulnerable transportation segment in Humboldt, according to the Caltrans District 1 Assessment), as it would be inundated based on projections (circa 2015) of SLR in 2050. This segment of US 101 is currently protected from inundation by the natural shoreline, dikes or berms, and railroad or road grades, but it is vulnerable to existing and future sea levels (NHE 2015).

Figures Climate-8 and Climate-9 show existing flooding conditions (published 2015) of the north segment and middle segment around Humboldt Bay. Figure Climate-10 shows projected inundation areas of upper Arcata Bay Reach (north segment) for 2015–2050.



Assuming tidal elevation is 9.99 feet (MMMW+100-year stillwater level) and that protective shoreline structures are compromised north of Airport Road, extensive flooding of south and north bound lanes.

Source: Laird 2015

Figure Climate-8. North segment, lower Arcata Bay Reach existing flooding conditions (2015)



Assuming tidal elevation is 9.99 feet (MMMW+100-year stillwater level) and that protective shoreline structures are compromised, the land adjacent to the road prism is flooded to the west and east of Highway 101, with limited flooding of south and north bound lanes.

Source: Laird 2015

Figure Climate-9. Middle segment, south of Eureka flooding conditions (2015)

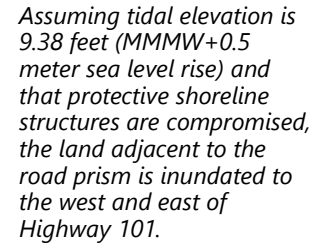


Figure *Climate*-10. **North segment, upper Arcata Bay Reach projected inundation 2015–2050**

- Estimated length (in miles) and capital cost of required defenses needed to guard against flooding from a 1.4 m sea-level rise, by county; and
- Population vulnerable to flood and erosion from a 1.4 m sea-level rise along the Pacific coast, by county.

Three tables from CCCCs paper are reproduced below in Tables *Climate-5* through *Climate-7*.

Table *Climate-5*. Miles of roads and railways vulnerable to erosion and flood from a 1.4-meter sea-level rise along the Pacific Coast, by county and type

County	Highways (miles)		Roads (miles)		Railways (miles)	
	Erosion-risk	Flood-risk	Erosion-risk	Flood-risk	Erosion-risk	Flood-risk
Del Norte	4.3	8.2	14	80	-	-
Humboldt	6.0	58	20	190	-	28.0
Marin	2.1	4.1	19	27	-	-
Mendocino	13.0	7.9	25	41	-	4.0
Monterey	11.0	31	15	110	2.1	23.0
San Francisco	0	8.0	17	25	-	-
San Luis Obispo	2.5	0.4	18	22	-	0.3
San Mateo	9.8	11	18	67	-	-
Santa Barbara	0.7	7.4	12	21	6.4	7.0
Santa Cruz	2.4	5.0	20	30	1.6	5.5
Sonoma	6.2	8.0	8.4	57	-	-
Total	58		180		10	

Note: Numbers may not add up due to rounding.

Source: CCCC 2016 (Table 27)

Table *Climate-6*. Miles of roads and railways vulnerable to a 100-year flood in 2000 and with a 1.4-meter sea-level rise along the Pacific Coast, by county and type

County	Highways (miles)		Roads (miles)		Railways (miles)	
	Current Risk	Risk with 1.4-m SLR	Current Risk	Risk with 1.4-m SLR	Current Risk	Risk with 1.4-m SLR
Del Norte	6.6	8.2	59	80	-	-
Humboldt	37	58	120	190	21.0	28.0
Los Angeles	14	31	42	140	5.6	14.0
Marin	1.2	4.1	22	27	-	-
Mendocino	5.6	7.9	28	41	2.7	4.0
Monterey	27.0	31.0	85	110	19	23.0
Orange	32.0	48.0	340	490	5.3	6.6
San Diego	0.6	8.0	12	57	3.0	9.8
San Francisco	0.2	0.4	17	22	-	-
San Luis Obispo	5.3	7.4	10	21	0.02	0.3
San Mateo	3.4	5.0	23	30	-	-
Santa Barbara	1.5	8.0	9.1	25	3.4	7.0
Santa Cruz	9.4	11	52	67	4.2	5.5
Sonoma	4.5	5.9	14	20	-	-
Ventura	2.4	11.0	69	150	3.7	10.0
Total	150	250	910	1,500	68	110

Note: Counties with borders on the Pacific coast and San Francisco Bay (e.g., San Mateo) were separated based on the shoreline affected. Numbers may not add up due to rounding. Source: CCCC 2016 (Table 15)

Table *Climate-7. Replacement value of buildings and contents at risk of a 100-year flood event along the Pacific coast, by county*

County	Current risk, in millions \$	Risk with 1.4-meter sea-level rise (in millions \$)	Percent increase
Del Norte	240	350	+ 43%
Humboldt	680	1,400	+ 110%
Los Angeles	1,400	3,800	+ 180%
Marin	220	260	+ 16%
Mendocino	120	150	+ 22%
Monterey	1,700	2,200	+ 36%
Orange	11,000	17,000	+ 63%
San Diego	690	2,000	+ 190%
San Francisco	670	890	+ 33%
San Luis Obispo	220	360	+ 67%
San Mateo	730	910	+ 26%
Santa Barbara	460	1,100	+ 140%
Santa Cruz	2,400	3,300	+ 34%
Sonoma	170	200	+ 20%
Ventura	980	2,200	+ 120%
Total	21,000	37,000	+ 71%

Note: All values are shown in millions of year 2000 dollars. Counties with borders on the Pacific coast and San Francisco Bay (e.g., San Mateo) were separated based on the shoreline affected. Source: CCCC 2016 (Table 21)

REFERENCES

CITATIONS

Anderson 2017. Anderson, J., L. Aldaron, and J. Patton. Letter to Ocean Protection Council, State of California, dated 6 June 2017.

CCCC 2016 (California Climate Change Center). "The Impacts of Sea-Level Rise on the California Coast." Prepared for the CCCC by Heberger, M., H. Cooley, P. Herrera et al. (http://research-Climate Chg/sea-level-rise. Pacific Institute_2016.12.12download.pdf)

Beacon Economics 2017 *2017 California Green Innovation Index*. (www.next10.org/2017-gii, accessed August 23, 2021)

CalSTA 2021a (California State Transportation Agency) CAPTI Frequently Asked Questions. <https://calsta.ca.gov/subject-areas/climate-action-plan/faq>, accessed September 29, 2021.

CalSTA 2021b "California adopts plan for sustainable transportation funding" News Release, July 12, 2021.

CARB 2021 (California Air Resources Board) "California Greenhouse Gas Emissions for 2000 to 2019: Trends of Emissions and Other Indicators" July 28, 2021 (https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2019/ghg_inventory_trends_00_19.pdf, accessed September 19, 2021.)

CARB 2024 California Greenhouse Gas Emissions from 2000 to 2022: Trends of Emissions and Other Indicators Date of Release: September 20, 2024 (https://ww2.arb.ca.gov/sites/default/files/2024-09/nc-2000_2022_ghg_inventory_trends.pdf, accessed Oct. 22, 2025.)

Caltrans 2020 *California Aviation System Plan*. November 2020.

Caltrans 2021 *California Transportation Plan 2050*. (Adopted February 2021.) (<https://dot.ca.gov/programs/transportation-planning/state-planning/california-transportation-plan>, accessed August 23, 2021.)

Caltrans District 1 and HCAOG 2014 "District 1 Climate Change Vulnerability Assessment and Pilot Studies: FHWA Climate Resilience Pilot Final Report (Prepared by GHD, ESA, PWA, Trinity Associates) (December 2014) (<https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/ccps-a11y-.pdf>, accessed December 16, 2021.)

Cascadia Geosciences 2013 as cited in *Trinity Associates 2015*. "Tectonic land level changes and their contributions to sea-level rise, Humboldt Bay region, Northern California: 2013 Status Update."

CNRA 2022 (California Natural Resources Agency) *Natural and Working Lands Climate Smart Strategy*. April 2022. (https://resources.ca.gov/-/media/CNRA-Website/Files/Initiatives/Expanding-Nature-Based-Solutions/CNRA-Report-2022---Final_Accessible.pdf, accessed Oct. 4, 2025)

The Climate Center 2020. Cohen, Ellie. "On the Path by 2025 to a Climate-Safe California. We can do it!" (Keynote presentation), February 6, 2020. (<https://theclimatecenter.org/wp-content/uploads/2020/02/Climate-Safe-CA-Keynote-Livermore-Feb-6-2020-FIN-Cohen-The-Climate-Center.pdf>, accessed September 22, 2021.)

Fountain, Henry 2021. "5 takeaways from the major new U.N. climate report," *New York Times*, August 9, 2021. (<https://www.nytimes.com/2021/08/09/climate/un-climate-report-takeaways.html>, accessed September 17, 2021.)

Grantham, Theodore 2018 (University of California, Berkeley). North Coast Region Summary Report. *California's Fourth Climate Change Assessment*. Publication number: SUM-CCC4A-2018-001.

Griggs and Russell 2012 as cited in *Trinity Associates 2015*. "Adapting to sea level rise: A guide for California's coastal communities." Russell, Nicole and Gary Griggs. University of California, Santa Cruz.

NHE 2015 (Northern Hydrology Engineering). "Final HBSLR Modeling Inundation Mapping Report." Prepared for the Humboldt Bay Sea Level Rise Vulnerability Assessment Project. (April 2015.) (www.humboldtkeeper.org/climate-change-impacts-sea-level-rise/69-in-the-news/986-humboldt-bay-sea-level-rise-inundation-mapping.html, accessed August 8, 2017)

OPR 2018 Governor's Office of Planning and Research. "California's Changing Climate 2018: A Summary of Key Finding from California's Fourth Climate Change Assessment." (https://www.energy.ca.gov/sites/default/files/2019-11/20180827_Summary_Brochure_ADA.pdf, accessed August 24, 2021)

State of California 2024 California Natural Resources Agency (Accessed 10.6.25)

□ [California Climate Adaptation Strategy website, "Summary of Projected Climate Change Impacts on California."](https://climateresilience.ca.gov/overview/impacts.html) State of California, 2025. (<https://climateresilience.ca.gov/overview/impacts.html>)

□ [California Climate Adaptation Strategy 2024.](#)

State of California 2023 California Climate Adaptation Strategy Implementation Report 2023.

(https://climateresilience.ca.gov/overview/docs/20250801-2023_Climate_Adaptation_Strategy_Implementation_Report.pdf)

Thorne 2018 Thorne, James H., Joseph Wraithwall, Guido Franco. "California's Changing Climate 2018." *California's Fourth Climate Change Assessment*, California Natural Resources Agency.

Trinity Associates 2015 "Humboldt Bay Sea Level Rise Adaptation Plan."

Trinity Associates 2018 "Humboldt County, Humboldt Bay Area Plan Sea-level rise Vulnerability Assessment."

UN IPCC 2021 (United Nations Intergovernmental Panel on Climate Change) Press Release, August 9, 2021, “Climate change widespread, rapid, and intensifying – IPCC.” (https://www.ipcc.ch/site/assets/uploads/2021/08/IPCC_WGI-AR6-Press-Release_en.pdf, accessed September 17, 2021)

UN IPCC 2021a Sixth Assessment Report -Working Group I –The Physical Science Basis, “Regional fact sheet –North and Central America.”

UN IPCC 2022 Referenced by the U.S. EPA website: IPCC (2022), *Emissions Trends and Drivers*. In IPCC, 2022: *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK and New York, NY, USA. <https://www.epa.gov/ghgemissions/global-greenhouse-gas-overview>, accessed Oct. 22, 2025.

UN IPCC 2023 “Summary for Policymakers.” In: *Climate Change 2023: Synthesis Report*. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 1-34.

U.S. EPA 2021 2024. (Environmental Protection Agency) *Graphs of U.S. Greenhouse Gas Emissions in 2019:* <https://www.epa.gov/sites/default/files/2021-04/sources-of-greenhouse-gas-emissions-2021-caption.png> <https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data> (Accessed September 19, 2021) *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022* U.S. Environmental Protection Agency, EPA 430R-24004. <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2022>.

RESOURCES

Assembly Bill 32 (AB 32) (2006) Global Warming Solutions Act of 2006 California Statute, Chapter 488, California Health & Safety Code §38500- 38599.

Ball, Geoff and Mytels, Debbie (2021) “Work through community conflict on climate change by confronting fears,” Northern News, March 2021. (<https://norcalapa.org/2021/02/work-through-community-conflict-on-climate-change-by-confronting-fears/>, accessed 3/11/21)

“Biomass Power in Humboldt County - Summary of Workshops, Consultations, and Research.” January 2020; updated March 2021. Prepared by Michael J. Furniss, consultant to Redwood Coast Energy Authority

California Transportation Plan 2040. California Department of Transportation. (Adopted June, 2016.) (www.dot.ca.gov/hq/tpp/californiatransportationplan2040/2040.html)

Executive Order B-55-18 to Achieve Carbon Neutrality. Governor Edmund G (Jerry) Brown, Jr. 2018. . (www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf)

“Humboldt Bay Sea Level Rise Adaptation Planning Project, Phase I: Humboldt Bay Shoreline Inventory, Mapping, and Sea-Level Rise Vulnerability Assessment.” January 2013. Prepared for the California State Coastal Conservancy by Laird, A., Powell, B. and Anderson, J.

“Humboldt Bay Sea Level Rise Adaptation Planning Project, Phase II: Final Report” 2015. Prepared for the California State Coastal Conservancy by Laird, A. (www.coastalecosystemsinstitute.org/humboldt-bay-slr-vulnerability-and-adaptation-planning/)

International Energy Agency, 2019. Laura Cozzi and Apostolos Petropoulos, “Growing preference for SUVs challenges emissions reductions in passenger car market” (<https://www.iea.org/commentaries/growing-preference-for-suvs-challenges-emissions-reductions-in-passenger-car-market>, accessed September 22, 2021).

Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments. (<http://cses.washington.edu/db/pdf/snoveretlgb574.pdf>)

Climate Change Impacts in the United States: The Third National Climate Assessment, 2014. J. M. Melillo, Terese Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 130-149. (“Ch. 5: Transportation,” by Schwartz, H. G., M. Meyer, C. J. Burbank, et al (<http://nca2014.globalchange.gov/report/sectors/transportation>).