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Title

California Environmental Policy; Combating Climate Change

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California Environmental Policy; Combating Climate Change

Research Question:

What are the carbon emission hotspots in California, and how do emission levels differ regionally? What do carbon emission hotspots have in common, and what effects do emissions have in these counties?

Introduction: California has established ambitious environmental policies to directly combat environmental degradation in California, such as the 2006 California Global Warming Solutions Act (AB 32). This bill required a reduction in greenhouse emissions to create a sustainable and more energy-efficient future for California AB 32 was the first program in the United States to make a long-term plan for combating climate change. More recently, Governor Gavin Newsom has enacted an executive order to require all new cars and passenger trucks sold in California to have zero emissions by 2030. Nationally, the Biden Administration has made Climate Change a leading focus, aiming to shift away from Fossil Fuels towards renewable energy.

In response to Trump's Environmental Protection Agency's proposal to freeze the federal vehicle economy standards for ten years, California invoked grants under the Clean Air Act to opt-out of the federal standard. California has its vehicle standards.

The Department of Energy strategically uses enhancements in vehicle efficiency as an incentive for saving energy resources and conserving the natural environment. Given that gas-powered vehicles are a significant contributor to Greenhouse emissions, the Vehicle Technologies Office aims to reduce carbon emissions sourced from vehicles by supporting research on new

technologies, modernizing standard practices, and ultimately finding ways to minimize the impact of gas-powered vehicles.

The primary source of human-caused climate change is greenhouse emissions, caused by chemicals that contribute to the Greenhouse Effect when released into the atmosphere. The Greenhouse Effect describes how greenhouse gasses such as carbon monoxide and methane absorb infrared radiation upward from the Earth's surface (Peters et al., 1985). The radiation cannot escape from Earth's atmosphere, and, as a result, the lower portion of the atmosphere heats up (Peters et al., 1985). The effects of climate change point to negative impacts on welfare, health, and the economy and increased unpredictability in weather (Haines et al., 2004).

Given California's ambitious policies and progressive initiatives towards mitigating climate change, it is essential to focus on how excessive carbon emissions impact California and how it currently combats these issues. These issues affect environmental resources, public health, and the Californian economy. It is crucial to understand where the highest carbon emissions originated and what these carbon hot spots in California all have.

Distribution of Carbon Emissions Throughout California: The California Air and Resource Board (CARB) Pollution Mapping Tool provides an interactive map that showcases the emission of Greenhouse Gases in California. The quantity of Carbon Emissions is measured using the Metric Ton of CO₂ Equivalent (MTCO₂e). MTCO₂e represents an amount of GHG that has the atmospheric impact of one standardized unit of carbon dioxide.

The GHG sources demonstrated in the CARB Mapping tool are a combination of cement plants, refineries, hydrogen plants, cogeneration, and oil & gas production. The largest single emitter of Greenhouse Gas in California is the Tesoro Refinery located in Carson, followed by the Chevron Refinery located in Richmond. The Tesoro Refinery released a total of 6,367,797 MTCO_{2e}, and the Chevron Refinery released 4,549,709 MTCO_{2e} in 2018 (CARB, 2017).

Within the range of 750,000 and 6,500,000 MTCO_{2e}, it is easy to see the condensed GHG emissions throughout the state. In terms of the quantity of GHG emitters, most emissions are a result of Electricity Generation. The GHG emissions are generally concentrated in three central regions of California; Los Angeles-San Bernardino area, the East Bay area, and the Bakersfield area.

The main emitters of GHG emissions vary depending on the geographic location. In Northern California and Southern California, the significant sources of GHG result from refineries and electricity generation. However, in the central valley, most emissions are attributed to oil and gas production.

Figure (1) Emissions by Facility:

Facility	Location	Total GHG (MTCO _{2e})
Tesoro Refining & Marketing Company, LLC	Carson, CA	6,367,797
Chevron Products Company	Richmond, CA	4,549,706

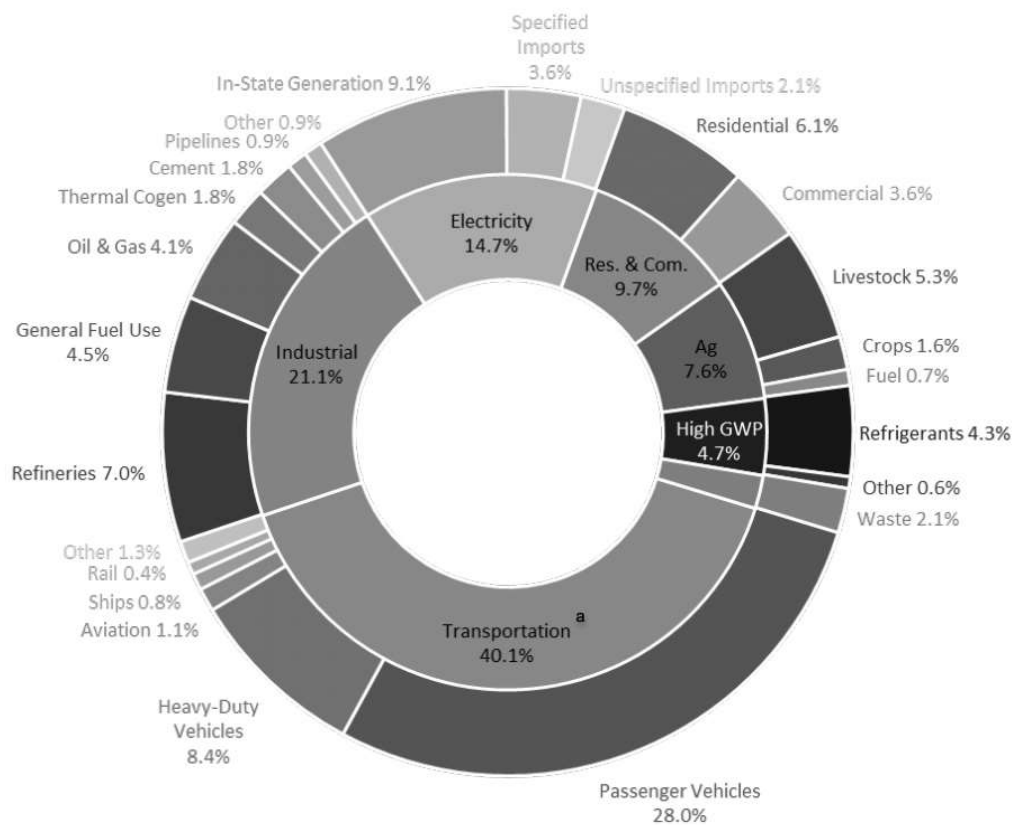
Figure (2) Description: The two markers showcase the Tesoro Refinery located in Carson, followed by the Chevron Refinery located in Richmond, the greatest individual greenhouse gas emitters in California.



Figure (3) Description: This shot captures greenhouse gas emissions within the range of 750,000 and 6,500,000 MTCO₂e. Within this range most emissions are a result of Electricity Generation.



Figure 4 Description: According to CARB, the major contributors to GHG emissions in California can be divided into seven main Categories: Transportation (40.1%), Industrial (21.5%), Electricity (14.7%), Residential and commercial (9.7%), Agriculture (7.6%), High Global warming Potential (4.7%), and Waste (2.1%). This was calculated by CARB using data from 2000 to 2017.



GHG Emissions in California by Section:

Transportation (40%): Carbon emissions from the transportation sector are attributed to emissions from gasoline combustion, which releases nitrogen oxides, carbon monoxide, and other pollutants into the air that contribute to the Greenhouse Effect. Gas combustion is responsible for fueling "on-road and off-road vehicles, aviation, rail, and water-borne vehicles." Of the 40 percent of total GHG emissions stemming from transportation, 28% are attributed to passenger vehicles, and 8.4% are attributed to heavy-duty vehicles (Union of Concerned Scientists).

Electricity (15%): Electricity was responsible for 15 percent of the 2017 total greenhouse emissions. This percentage represents the emissions within the state of California and those emissions pertaining to imported electricity. Regarding trends, there was a 6 percent decline in electricity usage in 2017 compared to 2016. California has faced a significant decrease in the carbon intensity of electricity generation due to a substantial increase in renewable sources of energy. These reductions were attributed to policies such as California's Renewable Portfolio Standard and the Cap-and-Trade Program.

Residential and commercial (9.7%): The greenhouse gas contributions from residential and commercial areas are mainly attributed to the combustion of natural gas and other fuels for standard heating and cooking purposes. Since 2000 the average greenhouse gas emission from individual residential units has steadily declined. However, since the year 2000, fuel emissions in the commercial sector have increased while the quantity of commercial area has increased, resulting in a decline in fuel use regarding the square footage in the commercial sector.

Agriculture (7.6%): The greenhouse gas emissions resulting from their agriculture production in California are mainly in the form of methane and nitrous oxide. Livestock was responsible for 70 percent of the greenhouse gas emissions in the agriculture sector; these emissions were methane, which resulted from enteric fermentation and manure management.

High Global warming Potential (4.7%): This category is used to describe the gas emissions from ozone-depleting substances. These substances are found in refrigeration and air conditioning equipment, as well as aerosols and fire retardants.

Waste (2.1%): In decomposition, carbon emissions are released; although it is only 2 percent of the overall carbon emission in California, it is significant.

(GHG Trends): Regarding trends in carbon emissions, the release of GHG emissions was relatively consistent throughout 2002 and 2007. From 2007 to 2013, the GHG emission rate declined; however, it increased by 6 percent from 2013 to 2017. This increase resulted from an improvement in fuel efficiency at a state-level due to government regulations. Even though the use of zero-emission vehicles did increase significantly, the rate of the population grew, lower fuel prices and the increase of consumer and economic activity increased the reliance on fuel.

The California Renewable Portfolio Standard: The California Renewable Portfolio Standard is a California renewable energy program that aims to advance the obtainment of renewable energy within the state. The Renewable Portfolio Standard was established due to Senate Bill

1078 from 2002, requiring 20% of retail electricity sales to be fueled by renewable sources by 2017. However, Senate Bill SB 350 of 2015 mandated that the California Renewable portfolio standard increase to 50% by 2030 (California Energy Commission).

Cap-and-Trade Program: The Cap-and-Trade Program aims to reduce carbon emissions at a sustainable rate in an economic and environmental sense. The program establishes a declining "cap" for carbon emissions and provides a monetary incentive for significant greenhouse gas emitters to implement sustainable sources and technologies (California Air Resources Board).

Policies such as California Renewable Portfolio Standard and the Cap-and-Trade Program aim to reduce the carbon emissions in California overtime progressively. The Renewable Portfolio Standard acted as a goal established by the senate for California to meet, while the Cap-and-Trade Program realized a monetary incentive to motivate major greenhouse emitters to make changes to decrease their carbon footprint.

Policy: California has established its goals to reduce GHG emissions to the 1990 levels by 2020 through Assembly Bill 32. California also established its plan to reduce its GHG emissions 40 percent below 1990 emissions by 2030 through Assembly bill 32 . In 2017 GHG emissions were reported to exceed 424 million metric tons. The GHG emissions in California have reduced over the years, and the reduction in carbon emissions is an ongoing mission that the state is committed to. For instance, in 2004 the emissions per person in California was 14.1 tons per person, this has dropped to 10.7 tonnes per person in 2017.

It is essential to consider the economic impact of carbon emissions. The amount of carbon produced due to every million dollars of gross domestic product in California is declining. Between the years 2000 and 2017, the carbon intensity of California's economy decreased 41 percent while the GDP increased by 52 percent. This trend is still visible; in 2017, the GDP increased 4.5 percent compared to 2016, while GHG emissions per GDP were reduced by 4.5 percent (CARB, 2017).

Conclusion: California has a diverse range of policies aimed to mitigate the effect of greenhouse emissions. California Approach mainly involves holding major contributors accountable and encouraging new technologies to minimize greenhouse gas emissions. California has been slowly reducing its dependence on greenhouse emissions. Regarding the Carbon emission hotspots in California, the locations with the highest release of metric tons of Carbon are Richmond, California, and Carson, California. These emissions are a result of refineries. However, although these two locations have the highest emissions in California, refineries only account for 7% of total emissions in California. The majority of Greenhouse emissions are attributed to transportation; passenger vehicles contribute to 28% of total emissions in California, while heavy-duty vehicles contribute to 8.6% of the total emission in California. Another contributor to greenhouse gas emissions in the industrial sector of California is responsible for 21.1% of greenhouse gas emissions. The emissions coming from the industrial sector stem from industrial locations such as the central valley and within major counties such as Los Angeles County and Contra Costa County. Ultimately the emissions in California are correlated with the consumption of goods. The hotspots of California don't necessarily correspond to the areas in which the most goods are consumed. The major cities are not the significant emitters of carbon emissions;

however, people's economic demands create the high carbon emission in the industrial, electricity, and transportation sectors. The production and transportation of goods produce greenhouse emissions. The implementation of sustainable technologies and ambitious environmental policy has helped California reduce its greenhouse emissions over time.

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