Impact of California Ban on Combustion Engines (Proposal)

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PROPOSAL

PROJECT STRUCTURE

I will create a Data Journalism style piece with a combination of text and interactive infographics that tell a narrative. This piece will be more report style with embedded graphics and tables that help tell the story (as you might see on the NYTimes or other media sites). The final layout is to be determined and will depend on storyboarding, available graphics, and necessary copy that provide context. The theme will center on the California ban on combustion engine vehicles set to start in 2035. Within this theme, I'll explore data that both support this policy and potentially challenges it. I've cited several data sources but may reduce this since there is overlap. Data is all published as CSV files and freely available from public sources (e.g., US Government, Research Organizations, etc.).

I've included a brief outline below, including the narrative I plan to explore with placeholders for graphics. I've also included placeholders for specific statistics, to be replaced when I obtain actual numbers from references. Charts will consist of static images (generated with `ggplot`) and interactive graphs (generated with `plotly`).

As with most Journalism projects, I'm starting with a script and will then fill in the visuals. This approach ensures the visuals stay on message and are relevant. Once I have visuals, I'll update the text copy to more directly speak to the images, so they work together. Ultimately, the chunks of text may get embedded into figures, accompany figures, or serve as transitions between figures.

Ultimately this project will be hosted and delivered via the web, but I've not decided on the final publication media. I plan to build charts, graphs, and interactive infographics in R (RMarkdown). The final deliverable will either be a Shiny App (hosted on shinyapp.io), RPubs (hosted on rpubs.org), or a standalone website. Ultimately, I'll pick the medium based on the best presentation and UI/UX experience for viewers.

I will host all source code, datasets, embedded images, and text on GitHub for easy access and submission. I'll also submit a URL to the live interactive version.

INTRODUCTION

In September 2020, California Governor Gavin Newsom signed an executive order that will ban all new internal combustion engine (ICE) vehicles in California starting in 2035 and with all new combustion-powered commercial vehicle sales by 2045 (Gavin & Alex, 2020). This ban parallels the efforts by other countries with timetables ranging from 2025 to 2050. Norway leads this effort to eliminate new ICE vehicles by 2025, with a projected 55% electric vehicle market share in 2020 (Wikipedia, 2020).

It's probably a fair statement to say, "Any policy that reduces our carbon footprint is a good idea;" however, not all policies have the same impact, and many have unintended consequences. This begs the question -- how might this new policy in California impact the stated goal to reduce carbon emissions, or as Governor Newsom said, "*Californians shouldn't have to worry if our cars are giving our kids asthma.*" Carbon emissions are directly linked with both energy production and consumption (ref). To understand emissions, we also need to consider energy usage.

In this analysis, we explore three primary questions through a series of visuals and discussion:

1. What is the current state of energy production and consumption in California?
2. What is the historical and current impact of combustion engines in California?
3. What is the potential Return on Investment (ROI) of this policy when considering other opportunity costs?

I will use and combine a variety of data sources from the following:

- US Energy Information Administration (https://www.eia.gov)
- Environment and Energy Study Institute (https://www.eesi.org)
- Environmental Protection Agency (https://www.epa.gov)
- U.S. Department of Energy: Office of Energy Efficiency and Renewable Energy (https://www.fueleconomy.gov/)
- Our World in Data (Ritchie & Roser, 2017)

HISTORY AND BACKGROUND

California is the most populous US state with a current population of [insert] and an annual growth rate of [insert] (ref). California currently represents [x%] of national GDP, including [x%] of all agriculture, technology, and manufacturing (ref). Since California has the highest population and such a large percentage of the industry, even small impacts per capita can add up to significant gain compared with a smaller state aiming for more ambitious goals.

California has traditionally been at the forefront of progressive policy changes, and many other states look to California as a template. With this in mind, policy changes in California should also be considered in the broader context of how they might impact other states. [Insert examples & map] (ref)

DISCUSSION

A challenge when considering policies at a state level is that states can have very different energy production and consumption patterns, which can profoundly alter the impact of policies targeted at the simple goal to "reduce carbon emissions." For example, in some states, the total CO_2 emissions for an all-electric vehicle over its lifespan can be equal to that of a combustion engine vehicle! Yes, an electric car has no tailpipe emissions. Still, we need to account for the bigger picture: emissions of CO_2 during manufacture, emissions from electric power plants, and emissions related to recycling or decommissioning lithium-based batteries (ref). That said, estimates are that over its lifespan, the average emission savings independent of location are approximately [x%] or [x kg] of total CO_2 released (ref).

[Insert chart - total CO_2 Emissions: Gas vs. Electric by State]

For context, California already has one of the best track records for both energy consumed per capita and CO_2 emission per capita across all states and the District of Columbia (ref).

[Insert tables showing CA Consumption and Emission relative to other states]

Let's explore CO_2 emissions in California as a function of industry and energy sources and compare those with the US as a whole.

[Insert graphic - Illustrate sources of emissions]

[Insert charts - CA Emission by Industry (over time); CA Energy Consumption by Fuel source]

We see that [x%] of all energy consumption comes from the Transportation sector, which accounts for [x%] of all tracked emission in California. If we look at Wyoming, Texas, or Louisana, we see that industry (especially in the energy sector) is the leading contributor to their emissions. For those states, policies related to reducing vehicle emissions would have far less impact. Stepping back, the Transportation Sector includes not only personal (light vehicles), but also commercial (heavy vehicles), mass transit (buses, trains), and airplanes (passenger and commercial).

[Insert chart - Transportation Sector Breakout - Energy and Emission over time]

[Insert discussion over chart]

Since this policy only affects new vehicle sales, and the average vehicle's usable life is [x] years, potential emission reductions may not be realized for some time and could be smaller than expected.

[Insert chart - Forecast energy production and needs]

Considering that vehicle emissions only account for [x], it's fair to ask whether policymakers would see more direct benefits from additional or alternative policies directed at other sources of emissions. That said, the auto manufacturing industry supports this ban on combustion engines. While many consumers and businesses may not appreciate regulations, there is an advantage that it allows all manufacturers to make changes on an equal playing field with clear expectations.

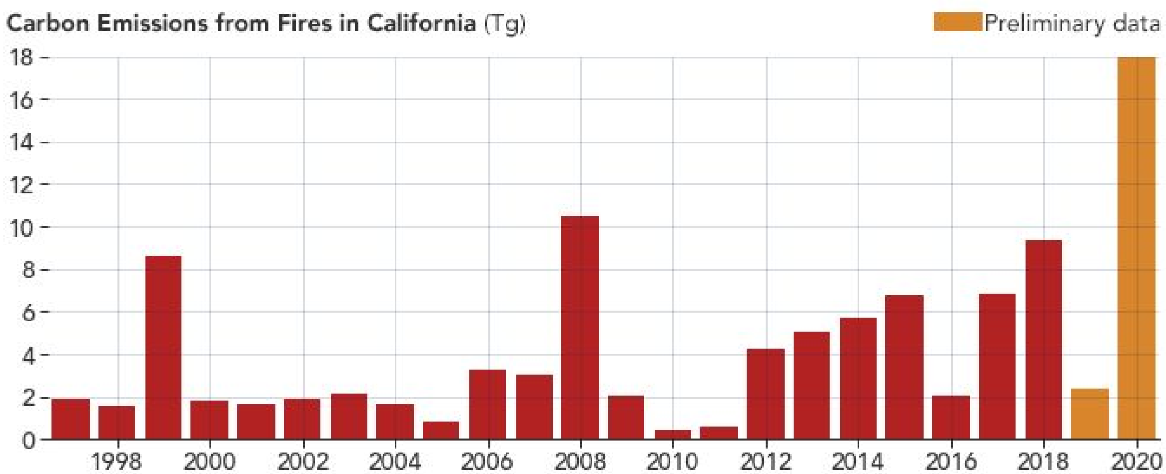
While a switch from combustion-based vehicles to electric vehicles will reduce the direct burning of petroleum products, electric power plants across California will have to make up this energy consumption difference. Here we see how electricity production has changed over the years with shifts towards natural gas and renewable sources. An additional challenge will be the necessary upgrades required to meet additional electricity demands and distribute that power to consumers across the state. California is already facing other statewide challenges related to aging power infrastructure, widespread power outages, and wildfires -- all impacting the distribution of its electricity (ref). This leads to a fair question, "Is this particular policy doable, and can it yield anticipated results?"

[Insert chart - Forecast increase in Electricity Usage & # of Power Plants needed]

A recent study suggested that improvements to the overall US power grid might help at the state level by allowing the distribution of renewable energy more efficiently from the location of production to consumption. Wind and Solar are great, but we cannot rely on that power 24x7. Solar has a clear daily cycle, and wind power fluctuates based on weather patterns. However, it's always windy somewhere in the US, and solar could be available for an additional 3-6 hours if that power could come from the east coast in the early morning and west coast in the evening. (ref)

[Insert chart - Energy Production by Source (e.g., Coal, Natural Gas, ..., Solar, wind]

Policymakers should also consider the bigger picture when considering the most effective ways to combat CO_2 emissions. For example, the wildfires in California during Oct 2020 alone released more CO_2 than all petroleum-based sources for the entire state of California for a whole year! Not only that, but impacts from those wildfires are expected to lead to additional emissions over time (ref).



(NASA, 2020)

[Insert chart - Other CO_2 Emission Sources]

CONCLUSION

[I'll write my conclusion once I've finished the charts, wordsmithed copy, and established the final presentation.]

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APPENDIX

I. CONVERSIONS

1 pound	0.454 kg
1 metric ton	1,000 kg

II. FACTS AND NUMBERS

CO_2 Emissions from a gallon of gasoline	8,887 g CO2 / gallon
CO_2 Emissions from a gallon of diesel	10,180 g CO2 / gallon
MPG for average gasoline passenger vehicle	22.0 miles per gallon
CO_2 Emissions per mile	404 g CO_2 per mile
CO_2 Emission for average vehicle per year	4.6 metric tons of CO2 per year

(US Environmental Protection Agency (EPA), 2018)

III. GREENHOUSE GAS EQUIVALENTS

Greenhouse Gas	Abbreviation	GWP
Carbon Dioxide	CO_2	1
Methane	CH_4	25
Nitrous Oxide	N_2O	298
Air Conditioning Refrigerant	HFC-134a	1,430

(US Environmental Protection Agency (EPA), 2018)

IV. OTHER IDEAS (possibly include in discussion):

- Carbon Emission Reduction Goals:
  - International (Paris Agreement)
  - US (CAFE Standards)
  - California
- Would move to shared ride sources reduce the number of necessary vehicles - since 46% of total life emission come from the manufacture of the vehicle (esp. The batteries), reducing the number of vehicles might reduce the total carbon footprint.
- Switching to electric vehicles moves the carbon emission from the end consumer to the manufacturer - possibly increasing carbon emissions elsewhere.
- Each gallon of gas burned directly leads to ~9 kg of CO_2 emitted. However, when we add indirect emissions related to drilling, refining, and transportation, each gallon of gas leads to a total of ~11 kg of CO_2 emission. (Schildgen, 2017)
- Gasoline mixed with Ethanol (up to 10%) has a similar carbon footprint as regular gasoline. Ethanol reduces fuel efficiency slightly but also contains less carbon. This offset leads to similar tailpipe emissions across Ethanol blends. (US Environmental Protection Agency (EPA), 2018)