CENTER FOR CLIMATE PROTECTION

HOW TO SIGNIFICANTLY REDUCE GHG EMISSIONS IN THE TRANSPORTATION SECTOR OF CALIFORNIA

By Allison Piazzoni 14 May 2019

Introduction

Climate change is real and happening now. By the year 2050, global greenhouse gas (GHG) emissions must be cut by 40 to 70 percent to halt global temperature increase at 1.5ºC.[1] This is possible within the laws of chemistry and physics, but doing so requires unprecedented changes.[2] Climate adaptation and mitigation have begun worldwide, but current efforts are not enough. We need a cumulative effort to change societal behavior and support choices that dramatically decrease emissions.

California began pushing major climate initiatives as early as 2005, and continues as a climate leader. The state's transportation sector poses the biggest challenge to reducing its overall GHG emissions. The sector accounts for 41 percent of all GHG emissions, more than any other source, and nearly 50 percent higher than the second highest emitting sector.[3] To continue its climate leadership, California must find a way to make drastic reductions in transportation emissions within the coming decade.

This paper examines the speed-and-scale solutions that will encourage political will, human behavior shifts, and technological advancements in California to reduce GHG emissions and improve the transportation sector. Reducing emissions and mitigating the effects of climate change must become a top priority of governments, cities, corporations, and individuals. The simple answer is that action must be taken swiftly across the state. California's choices have the opportunity to influence global action to halt the effects climate change.

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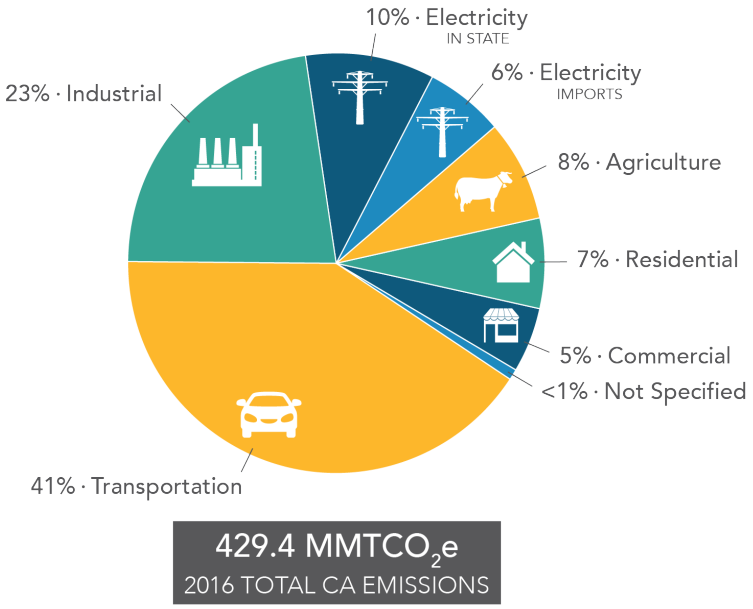
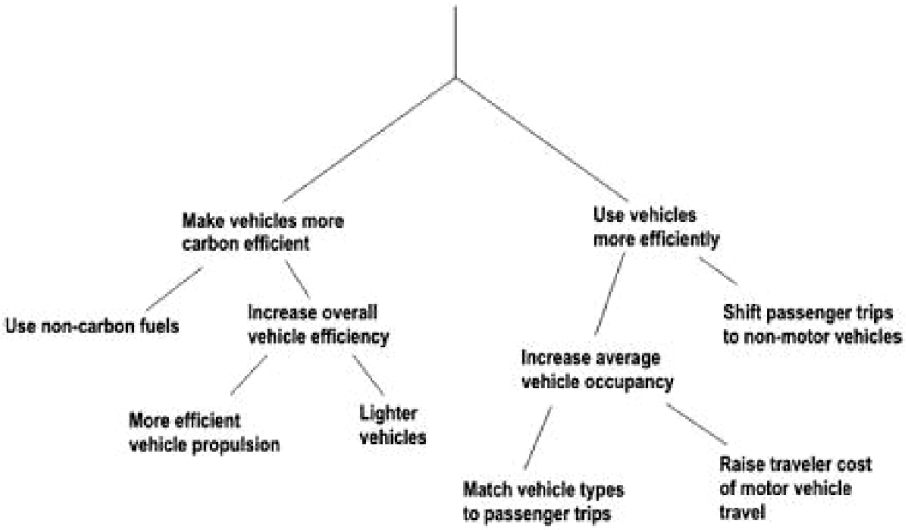
[1] *Global Warming of 1.5°C.* The Intergovernmental Panel on Climate Change. 8 October 2018.
[2] Jim Skea, Co-Chair of the IPCC Working Group III. https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/.
[3] https://www.arb.ca.gov/cc/inventory/data/data.htm

Figure 1. Greenhouse Gas Emissions by Sector in California[4]



The flowchart below outlines the framework for improving the efficiency of the transportation sector and lowering total emissions.

Figure 2. Reduce GHG emissions of transportation system[5]



[4] Ibid.

[5] Woodhull, J. et al., Transportation: Opportunities for Greenhouse Gas Emission Reduction in Sonoma County, Center for Climate Protection, 2008.

The Survey

To analyze the current research, behaviors, and stance toward reducing GHG emissions, I organized a survey of transportation experts, authorities, and researchers. I drafted four comprehensive questions to investigate solutions, challenges, and further resources:

1. In your opinion, what are the top three speed-and-scale solutions to reducing GHG emissions in the transportation sector for the state of California?
2. What are the greatest challenges to implementing these solutions?
3. How can we overcome these challenges?
4. What are the best resources for further research?

The table below lists the results of the survey. There were six major ideas shared by many or all of the experts. The speed-and-scale solutions reach all aspects of the issue and follow the logic framework in Figure 2. The solutions are structural, behavioral, and technological.

Figure 3. Expert Speed-and-Scale Solutions to Transportation Emissions

Speed-and-Scale Solution	Challenges	How to overcome the challenges
Shared mobility & micro-mobility	Societal behavior shift, politics	Encourage the generational changes in perception, need new ways of thinking, make shared mobility a competitive option to personal vehicle ownership
More EVs and more EV infrastructure	Cost	Complete cost-benefit analyses including indirect benefits such as healthier lifestyles and time benefits, incentivize EVs through systems like the carpool lane, increase mass production of EVs, more investment in infrastructure
Shift the gas tax to a VMT tax	Politics	Increase discussion, lobbying, cost benefit analyses
Free public transportation	Difficulty surrounding federal and state funding	More education and outreach, more taxes on personal automobile use to subsidize free public transportation service, eventual

		autonomous busses will increase safety and decrease funding needs
Incentivize mode shift	Requires an economic shift, societal fear of change	People make the changes, policy makers will follow the influence, change overall transportation options to create modes to incentivize, implement rewards for choosing alternatives
Massive improvements to public transportation infrastructure	Long lifespan of buses, extremely high initiation costs, current societal impression of public transit, extremely high cost of living	Better connections to biking and walking options, more efficient travel time or more direct routes, better integration with land use planning, parking and congestion pricing to increase ridership, bus only lanes, more partnerships between transportation authorities

Discussion

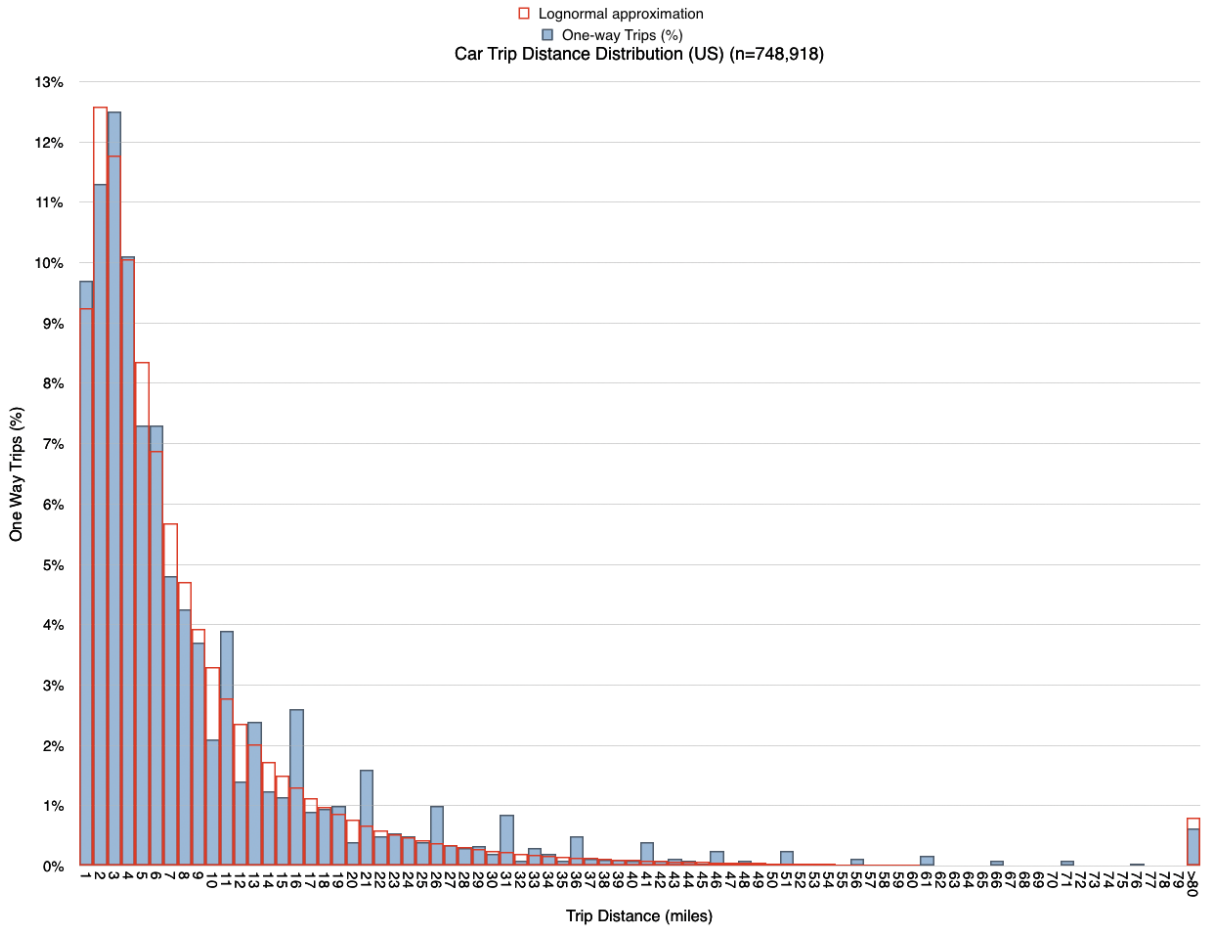
The transportation sector of California presents an opportunity for dynamic policy shift and technology adoption. To further the research done in the primary survey, three topics were chosen based on the quality and quantity of existing research. The six solutions can also be consolidated into three main ideas due to relevancy and similarities to one another. The top three speed-and-scale solutions to transportation emissions discussed in this section are focused on shifting human behaviors, societal norms, and some current policies.

Micromobility & Shared Mobility

Micromobility is a recent term coined by Horace Dediu, an industry-analyst most regarded for his analysis and predictions of Apple Inc. The term micromobility came to Dediu after a compelling experience surrounding microcomputing. Micromobility is a concept that involves vehicles weighing less than 500 kg and supplying transportation options for the small trips that humans make the most. The concept of light, small vehicles presents a magnificent opportunity for technological advancements. Smaller vehicles are quicker to manufacture, less expensive to create, and a shorter lifespan means rapid evolution of models. Dediu argues that micromobility will take five forms -- scooter/bike, e-bikes, moped, light quad, and heavy quad. These vehicles range from 25 - 500kg in weight and provide the opportunity for shared services. A light, efficient, practical light vehicle presents a competitive marketing

strategy to get people out of personal vehicles and into shared modes of transportation that are fully electric, quick, and safe for completing shorter trips.[6]

Figure 4. Car Trip Distance Distribution from Micromobility.io



The graph shows total car miles traveled per one way trip[7]. The graph can be split up into five sections of equal miles. Each quintile represents 3.4 million miles traveled. The first quintile is between 1-2 miles, the second 2-4, the third 4-7, then 7-14, and finally greater than 14 miles traveled. This graph is an excellent example of the niche micromobility could fill as a competitive option for short trips.

Shared mobility complements micromobility, and can be broken up into three categories - ride hailing, car sharing, and bike sharing.[8] Ride hailing options like Uber and Lyft have demonstrated service effects

[6] Greenwald, J.M. et al. It's up to us: Policies to improve climate outcomes from automated vehicles. *Energy Policy.* Volume 127. 2019.

[7] https://micromobility.io/blog/2019/3/20/the-five-categories-of-micromobility

[8] Circella, G., Alemi, F., Tiedeman, K., Handy, S. and Mokhtarian, P. (2018). The Adoption of Shared Mobility in California and Its Relationship with Other Components of Travel Behavior.

such as flexible alternatives to driving, first and last-mile options between public transportation, and an increased ridership of public transportation.[9]

Carsharing, through companies like ZipCar, allows individuals to borrow a vehicle without the upfront costs of purchase or associated costs like vehicle insurance or maintenance. Carsharing, especially in urban areas, is an opportunity to reduce vehicle ownership and VMT significantly.

The third shared mobility option, bikesharing, has reduced overall driving and ride hailing use in nearly every area where it exists.[10] Bikesharing, electric or manual, presents the reality of zero emissions for those trips that replace transit and personal vehicles. These options also serve as a catalyst to change human behavior and perception surrounding car ownership. Reducing the importance of car ownership through shared mobility could impact emissions by lowering VMT, decreasing multiple car ownership, and encouraging an overall mode shift.

All three shared mobility options, when paired with micromobility, can be marketed as a service to provide low emission, efficient travel options for individuals and groups attempting to complete those short distance trips. In urban areas, where shared mobility use is highest,[11] swift technological advancements in electric vehicles and smaller travel options poses a major opportunity to drastically reduce greenhouse gas emissions in high density and perimeter areas.

A Tax on Vehicle-Miles-Traveled

As societal behavior shifts to electric vehicles as the main mode of travel, the current fuel tax will become obsolete. In California, the combined gas and excise tax will rise to 47.3 cents per gallon on July 1, 2019, with an estimated annual revenue of $2.4 billion.[12] Tax on diesel fuel rose to 5.75% on November 1, 2017 and have an estimated annual revenue of $1.08 billion.[13] Currently, there are no taxes on Zero Emission Vehicles (ZEVs), but owners will pay a $100 “road improvement fee” beginning July 2020, with an estimated $20 million annual revenue.[14] This revenue, along with a few other contributors, is distributed to support the Road Maintenance and Rehabilitation Program, bridge and

[9] Ibid.
[10] Ibid.
[11] Ibid.
[12] Miller, Jim. “California gas tax increase is now law. What it costs you and what it fixes”. The Sacramento Bee. 28 April 2017.
[13] Ibid.
[14] Ibid.

culvert maintenance, increasing bike and pedestrian transportation, transportation research, sustainable community planning, and several other aspects of the transportation sector. The total revenue is expected to be $5.72 billion.[15]

As the state adjusts its policies to reflect more aggressive climate goals, it is likely that the number of ZEVs on the road will increase significantly[16]. Electrification of personal vehicles, shared vehicles, and public transit vehicles have the opportunity to drastically reduce GHG emissions from transportation. But the shift in fuel source from fossil fuels to an electric battery will diminish the amount of funding for roads and highways from the state and federal fuel taxes. The state must replace that funding source with something new that will proportionally support our roadways, bike paths, and transportation research. The Vehicle-Miles-Traveled (VMT) Tax idea is a viable switch that could be structured to encourage mode shift, reduce overall VMT, and reduce emissions. The state of Oregon has initiated a pilot program to analyze VMT and could be used as a model for future VMT tax implementation. In the OreGO program, individuals can opt to place a mileage device in their vehicle and submit their annual mileage. If vehicle miles traveled is less than the amount paid in fuel taxes, participants will receive a refund for the difference.[17]

In combination with vehicle electrification and automation, increased fuel efficiency, and tight emission policy, the VMT tax will support a new model for California transportation. Taxing VMT has the possibility to reduce overall VMT, though by how much requires further research.[18] A study by the RAND Corporation proposes three conceptual frameworks for implementing a VMT tax.

Figure 5. Conceptual Framework for VMT Taxation[19]

Framework	Strengths and Limitations/Risks
State—Help States Help Themselves: Help interested states, or groups of adjacent states, develop their own systems, with the federal government potentially developing a national system at a later date based on the lessons learned in state programs	**Strengths:** Could be easier to gain public acceptance for VMT fees in an individual state than at national level, thus increasing odds of actual implementation **Limitations/Risks:** Would not, in near term, help address federal transportation funding shortfalls; could pose risk that the systems

[15] Ibid.
[16] Greenwald, J.M. et al. 2019.
[17] http://www.myorego.org/about/.
[18] Jaffe, Eric. "Is a VMT tax a good idea?". *Citylab.* August 2012.
[19] RAND. "Moving Towards Vehicle Miles of Travel Fees to Replace Fuel Taxes". https://www.rand.org/pubs/research_briefs/RB9576/index1.html. 2011.

	developed in different states would not be interoperable; would reduce opportunities to drive down costs through economies of scale
Federal—Carefully Plan a National System: Help the federal government plan and develop a national system of VMT fees to replace or augment current federal fuel taxes, making the system flexible enough for states to levy their own VMT fees if they choose	**Strengths:** Would directly address need to augment federal transportation revenue; would maximize opportunity to reduce costs through economies of scale; would ensure interoperability **Limitations/Risks:** Would require some degree of national consensus to implement national VMT fees, a significant challenge to surmount; would likely involve some form of mandatory adoption, compounding the difficulty of gaining public acceptance
Market—Foster Market for In-Vehicle Travel Services: Foster the emergence of a market for in-vehicle metering devices that can levy federal, state, and potentially local VMT fees and simultaneously provide additional value-added services; this would culminate in an operable system in which the adoption of VMT fees is initially voluntary	**Strengths:** Would reduce government cost for collecting VMT fees; would maximize the social value of the investment in metering devices by providing value-added services; could circumvent public acceptance challenges through the voluntary opt-in period **Limitations/Risks:** Assumes an unproven market for value-added services; would require an initial set of interoperability standards and corresponding certification process to be developed in advance of the trials

Based on the research, a VMT tax is a viable approach to reducing VMT, supplementing the switch to electric vehicles, and encouraging alternate modes of transportation. A VMT tax will have to be comprehensive enough to address ZEVs as well as combustion engine vehicles with varying levels of fuel efficiency -- for example, a different tax should be placed on vehicles with comparatively low fuel efficiency.[20]

Massive Improvements to Public Transit Infrastructure

About 5.3 percent of California's population commutes to work using public transportation.[21] To decrease transportation emissions, ridership on public transit systems must increase. The public transit systems of California must also adapt to new policies and emission standards by adopting new vehicles such as zero emission buses, decreasing vehicle switches and trip time, and expanding service. Looking forward to 2020, the Federal Transit Administration is estimating a $12.4 billion budget to "address the

[20] McMullen, B.S. et al. Distributional impacts of changing from a gasoline tax to a vehicle-mile tax for light vehicles: A case study of Oregon. *Transport Policy.* Volume 17. 2010.
[21] https://www.energy.ca.gov/almanac/transportation_data/transit.html

capital needs of both urban and rural transit systems, while also moving transit into the future by embracing innovation.[22] The budget report claims to support infrastructure improvement, investments in new technologies, safety, and accountability.[23] The Federal Railway Administration has an estimated budget of $2.0 billion for 2020, and its goals follow the same four themes. These goals, if reached, would support a shift in California's public transit ridership and decreased emissions.

Many of these changes will need to come from within the government system. The Metropolitan Transportation Commission (MTC) has already published a set of goals to achieve CARB's Innovative Clean Transit regulation. By 2029, all transit agencies must be operating a fleet of 100 percent zero emission buses (ZEB). This is a lofty goal, but it is achievable with proper distribution of funds and participation. Challenges lie in the lifespan of traditional buses as well as the high upfront costs that most smaller transit agencies are not able to cover. But the shift to alternative fuel sources has been steadily occurring since in the last few decades, from 82 percent diesel fueled buses in 1990 to 63 percent in 2012 across the United States.[24] Currently, public transportation agencies in California operate a total of 153 ZEBs. The shift to a 100 percent ZEB fleet has the potential to reduce GHG emissions by 19 million metric tons by 2050. That is the equivalent of taking 4 million personal cars off the road.[25]

Along with infrastructure, ridership must be considered to achieve necessary GHG reduction goals from California's transportation sector. Most of the barriers to ridership do not stem from factors under agency control such as fare rates.[26] Instead, ridership is heavily related to socio-economic factors, societal perception of public transit, travel behavior, and urban development.[27] According to a 2016 study by Ercan et al., a transportation sector that is both desirable for riders and environmentally sustainable will require a radical shift in transportation structure as well as society's perception of those transportation structures.[28] The transportation sector must overcome perceptual barriers while simultaneously changing societal standards of personal vehicle ownership. By complementing policy that

[22] U.S. Department of Transportation. Budget Estimates Fiscal Year 2020 Federal Transit Administration.
[23] Ibid.
[24] Ercan, T. et al. Investigating carbon footprint reduction potential of public transportation in United States: A system dynamics approach. *Journal of Cleaner Production.* Volume 133. 13 June 2016.
[25] Guess, M. California transit agencies have 21 years to build zero-emissions bus fleets. *Ars Technica.* 16 December 2018.
[26] Ercan, T. et al.
[27] Ibid.
[28] Ercan, T. et al. Public transportation adoption requires a paradigm shift in urban development structure. *Journal of Cleaner Production.* Volume 142. 18 November 2016.

addresses fuel efficiency, urban planning, road usage, public transit operations, and alternative fuel sources, California can continue to improve public transportation infrastructure and ridership while drastically reducing GHG emissions.

Conclusion

By the year 2050, California must reduce its GHG emissions from the transportation sector to 80 percent below 1990 levels. This ambitious goal requires participation from all players -- government, corporations, and individuals. Drastic shifts in policy, perception, and production must begin quickly to achieve this goal and reduce the impacts of climate change moving forward. After combining both primary and secondary research, it is very clear that the transportation sector will not be successful without the full involvement of travelers. The top three concepts -- shared mobility/micromobility, a VMT tax, and public transit improvements -- must be complemented by a shift in human behavior towards a new method of transportation. It must be a priority to implement education alongside aggressive policies to get the public on board and willing to shift a life of comfortable, static options to one that embraces innovation, change, and low-to-zero emissions. People must accept that personal combustion-engine vehicles are no longer acceptable for the world we live in. By including the top three speed-and-scale solutions into future transportation and urban planning, the state of California can reduce the importance of personal vehicle ownership, shift behaviors towards public transit and shared mobility, and continue to lead the country towards climate change mitigation and reversal. Reductions in GHG emissions will ultimately improve global health, economies, and biodiversity. Society must adapt to the effects of climate change and work to mitigate and reverse future damage due to GHG emissions. For the state of California, this must include the transportation sector.

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About the Author

Allison Piazzoni is a graduate of Sonoma State University with a Bachelor of Arts in Environmental Studies, Conservation & Restoration and a minor in Biology. She spent a year abroad at the University of Queensland studying Australian marine and terrestrial biology, coastal management, and environmental policy. She is passionate about wildlife and ecosystem conservation, environmental policy, and the outdoors. She was a research intern for the Center for Climate Protection in Spring 2019, during which she completed this study. She hopes to pursue a career that combines wildlife ecology, conservation, and communication. Allison loves to hike, swim, write, paint, and travel.

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