



Sustainable Transportation

Transportation Today

 **29 Million** registered vehicles in California¹


 Transportation accounts for almost **40% of greenhouse gas (GHG) emissions** in California. In G20 countries, GHG emissions account for an average of 23 %.³

On average, new, privately owned cars account for **17% of the household budget** in the U.S.⁴




Since mass-production of automobiles started in the beginning of the 20st century, we developed a very inefficient, expensive, and resource intensive transportation system that is highly dependent on the use of privately owned vehicles.

Most cars are occupied by only one person and in actual use for only 5% of the time. These vehicles require parking for the other 95% of time, using valuable public space.

Society also assumes responsibility for the costs of car ownership by increased traffic congestion, air pollution, carbon emissions, accidents and reduced mobility.

Although private vehicle ownership offers flexibility to the owner, the costs of such are more than equally shared with society.

Now, with the development of new technologies, we have the opportunity to transform transportation. We could create a new system that provides access for everyone at low cost and is environmental friendly. Find out more about the future of transportation on the following pages.⁴



California's Climate Goals⁵

1. Reduce GHG emissions by 40 % until 2030 compared to 1990.
2. Reduce GHG emissions by 80 % until 2050 compared to 1990.

Sources:

¹ [Vehicle Registration](#)
² [Veloz](#)
³ [CARB, Agora](#)
⁴ [D. Sperling](#)
⁵ [Executive Order](#)



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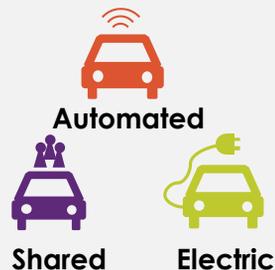


Transportation in the Future

Three Revolutions in Transportation

based on D. Sperling's 2018 book *Three Revolutions*

New technological developments lead to three revolutions in transportation: automated, shared and electric vehicles. These three revolutions are intended to reduce costs to less than \$0.10 per mile compared to \$0.57 with a conventional car today. This could have positive or negative effects for society and environment, depending on how they are used:



How could Future Transportation look?

The Nightmare

Driverless cars with little pooling and electrification

Privately owned automated vehicles increase congestion and urban sprawl due to more vehicle miles traveled. It will be cheaper to send the vehicle around the block than to pay for parking. This leads to a higher energy demand and even higher greenhouse gas emissions, if the vehicles are not electrified.



+15-20%
vehicle use



+ 50%
GHG emissions
until 2050

The Dream

Driverless cars are pooled and electrified

Autonomous, electric vehicles are shared and integrated with transit to solve first/last mile problem. At low costs, this system can provide equitable mobility for all, reducing congestion and greenhouse gas emissions from transportation. Valuable public space can be used again since the total number of vehicles decreases.



- 60%
vehicle use



- 80%
GHG emissions

Policies needed to direct innovation to public interest



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Electric Vehicles

California is leading in transportation policies since decades. Some of the most effective policies to shift from conventional gasoline-fueled vehicles to electric vehicles are explained here.

- ✓ **Zero Emission Vehicle (ZEV) mandates**, established in 1990, require car manufacturers to sell zero- or near-zero-emission vehicles (Battery Electric, Plug-In Hybrid or Fuel Cell Vehicles) to reduce air pollution and GHG emissions.¹
- ✓ **The Low Carbon Fuel Standard**, established in 2007, aims at reducing the carbon intensity of California's passenger vehicle fuels by at least 10% by 2020.²



376,184 Electric Vehicles on the road in California³

43 Models available in California³

California's Goals⁴

2025

1.5 million zero-emission vehicles on the road

2030

5 million zero-emission vehicles on the road



21,943 charging stations in California³



48 % of U.S. Electric Vehicle market share is in California³

U.S. Average:

1% of all light duty vehicles sold were EVs (2016)⁵

San Francisco Average:

6% of all light duty vehicles sold were EVs (2016)⁵

Drive Clean and Save

California residents get up to **\$7,000** for the purchase or lease of new, eligible Electric Vehicles with California's Clean Vehicle Rebate Project.⁶

Sources:

1 [CARB\(2011\)](#)

2 [CARB\(2018\)](#)

3 [Veloz](#)

4 [G.Brown](#)

5 [ICCT](#)

6 [CSE](#)



Shared Vehicles

Shared vehicles play a major role to create livable cities and reduce GHG emissions.

In the Bay Area, ridesharing has a long history from the 1970's with gas shortages to current casual carpooling. Now, new mobility services and transportation network companies (TNCs) like Uber or Lyft come to the market. To evaluate their impact on society and environment, it is important to differentiate between ride hailing and ride pooling, both often referred to as ridesharing:



Ride Hailing

Examples such as UberX or Lyft

Customers hail a driver to take them exactly where they want to go, like hailing a traditional taxi but mostly based on smartphone apps.

According to a study from UC Davis:¹

- 91 % of ride hailing users have not made any changes to car-ownership.
- The use of transit declined by 6% in major U.S. cities after using ride hailing.
- Ride-hailing is likely to contribute to more vehicle miles traveled in major cities.



Ride Pooling

Examples such as UberPool or Lyft Line

Customers share their ride with other riders that have a similar route. Software pools the riders according to their route and optimizes travel time. Lower costs compared to ride hailing incentivize people to use pooled rides.

Pooled rides have a potential to reduce congestion in cities as well as air pollution and GHG emissions.

However, to prevent a competition between public transit and ride pooling, an integration in the system is necessary. Especially first- and last-mile services could increase accessibility of public transit and reduce the need for a private car.

Carpool Matching Services

New app-based services like Scoop or Waze offer carpool matching. [Click here](#) to find a new and easy way to commute.

Sources:
¹ [UC Davis](#)



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Automated Vehicles



On February 26, 2018, the Office of Administrative Law approved driverless Testing and Deployment of Autonomous Vehicles on public roads in California.¹

The term “automated vehicle” is used very broadly in public today. To specify the degree of automation, the following levels of automation, established by SAE International, are commonly used and important to answer the question when automated vehicles will be on public roads.

Levels of driving automation^{2,3}

0	No Automation	Full-time operation by human driver.
1	Driver Assistance	Driving-mode specific execution by a driver assistance system of either steering or acceleration/deceleration, human driver performs all other tasks (for example adaptive cruise control).
2	Partial Automation	Driving-mode specific execution by one or more driver assistance systems of both, steering and acceleration/deceleration, human driver performs all other tasks (for example Tesla Autopilot).
3	Conditional Automation	Automated driving system performs all parts of driving but human operator required to intervene at all times (for example Audi Traffic Jam Pilot).
4	High Automation	Automated driving system performs all parts of driving and no human operator is required under certain conditions (for example on highways).
5	Full Automation	No human driver required under any driving conditions.

Sources:

1 [DMV](#)

2 [CIS](#)

3 [Caranddriver](#)



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When will automated vehicles be on the road?



Today, most vehicles have some sort of driver assistant systems. When self-driving and driverless cars (level 4 and level 5) will be on the road is highly uncertain.

Recently, many automakers announced the launch of automated vehicles in the next years. According to driverless car market watch, Ford announced deployment of fully automated vehicles by 2021, Tesla and GM already by 2020.¹

According to Gartner, a company that analyzes hype cycles, autonomous vehicles have just passed the "peak of inflated expectations" in 2017 and will need more than 10 year to reach mainstream adoption.²

How do you want our city to look like in the future?

Seoul demonstrates how public space can be restored.

Before



The Chenoggye freeway in the center of Seoul...

After



... was removed and the Chenoggye river restored.

Find better options for your commute at [TMASF Connects](#) and make our city more livable.

Sources:
1 [Driverless Car Market Watch](#)
2 [Gartner](#)

Images:
[Freeway](#)
[River](#)