

# Autonomous Driving and the Environment: Friend or Foe?

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# Benefits of Autonomous Vehicles

Increased safety

Reduced Traffic congestion

Flexible mobility options

Enhanced comfort and use of time

Improved energy efficiency and emissions

## Increased Safety: Pros

Reduce the number of accidents (currently ca 94% human error)\*

Mitigate the severity of crashes that do occur

Less loss of life, less injury

Fewer traffic jams, because accidents are a major cause of congestion → fuel efficiency

Smaller, lighter-weight vehicles possible

- Because weight for safety systems (e.g. airbags, laminated glass) not needed → fuel efficiency

Increased safety for pedestrians and cyclists → encourages more sustainable mobility

## Increased Safety: Cons

Umm... none

Faster travel due to safer highway operation → Higher drag & fuel efficiency decreases at faster speeds

Can only prevent 1/3 of crashes if they drive like people\*

- Only 1/3 could be avoided due to more accurate perception and less incapacitation
- For the remaining 2/3 they would need to be specifically programmed to prioritize safety over speed and convenience

## CO<sub>2</sub> Increases with Driving Speed (Umweltbundesamt)

Speed Limit in km/h	Average Speed in km/h	Kilometers Travelled in %	CO <sub>2</sub> Emissions per Kilometer in g/km	CO <sub>2</sub> Emissions in Million t CO <sub>2</sub>
	Löhe (2016)		Own Calculations	
≤ 60	60 <sup>2)</sup>	0,4	127,7	0,1
80 (Construction)	80 <sup>2)</sup>	5,3	129,4	1,8
80	87,4	3,3	132,5	1,2
100	103,3	11,0	145,2	4,3
120	115,6	17,2	160,7	7,4
130	118,3	7,4	164,8	3,3
No limit	124,7	55,5	175,4	26,2

# Increased Safety: Additional Side Effects

## Fewer vehicle replacements

- Effect on landfills, fewer oil spills
- Less manufacturing required

## Better use of land (smaller vehicles, repurpose land from parking)

# Pros and Cons: Traffic Congestion

## Pros

- Accidents, which are a common cause of congestion, will be reduced
- AVs can travel closer together, increasing utilization and capacity of the roads
- Less congestion leads to lower emissions

## Cons

- “The Fundamental Law of Road Congestion”: the extension of most major roads is met with a proportional increase in traffic<sup>1</sup>
  - Can we beat this by re-purposing roads (e.g. as bike lanes)?
- Increased traffic rather than parking: drive around in circles rather than pay for parking
  - 30% of the cars in congested downtown traffic are looking for parking<sup>2</sup>

# Flexible Mobility Options: Pros

## Pros

- Provides mobility options for people who are currently unable to drive
  - Don't have a license, physical or age-related constraints, the elderly, disabled, teenagers, children
  - Gives this group more independence in their mobility
  - Reduces social isolation
- Enables easier car sharing
  - Higher occupancy per trip
  - Fewer vehicles in total: saves resources (material and energy) in manufacturing



## Flexible Mobility Options: Cons

### Cons

- Additional trips that would not have been taken otherwise
  - +70% emissions due to additional travel by underserved populations\*
  - 12% to -20% through higher occupancy in shared vehicles\*
- Additional side effects:
  - Increases motorized travel, decreases ridership in public transit

# Effects of Autonomous Driving on the Modal Split

## Scenario 1

### Privately-owned autonomous vehicles

- Use of privately-owned vehicles becomes more attractive
- New user groups



10% more kilometres with privately-owned motor vehicles



11% fewer kilometres with public transit

## Scenario 2

### A mix of privately owned AVs and shared robotaxis

- Moves individual trips with the car, public transit and cycling to the robotaxis



11% more kilometres with motorised vehicles (6% individual vehicles plus 5% robotaxis)



25% fewer kilometres with public transit

# Enhanced Comfort and Use of Time

## Pros

- Occupants can use their travel time for other activities (sleeping, work, social media, ...)
- Overall better travel experience and comfort level, more effective/pleasurable use of the time spent travelling

## Cons

- More travel due to easier, more efficient travel
- People willing to commute longer distances
- Commuters currently on long-distance transit might switch to AVs
- +50% emissions due to more travel\*
- Increased vehicle weight for luxury features (e.g. entertainment)

## Side Effects

- Urban sprawl
- Revival of rural areas

## Improved Energy Efficiency and Emissions: Pros

**-20% to -30% through optimized driving style (e.g. smoother acceleration & braking)**

**-10% to -20% through optimized driving (in addition) with shared ownership**

**-10% to -20% through platooning**

**-20% through efficient routing**

**-45% through lighter vehicles**

**-4% through less time looking for parking**

**-12% to -20% through higher occupancy in shared vehicles**

## Improved Energy Efficiency and Emissions: Cons

The rebound effect...

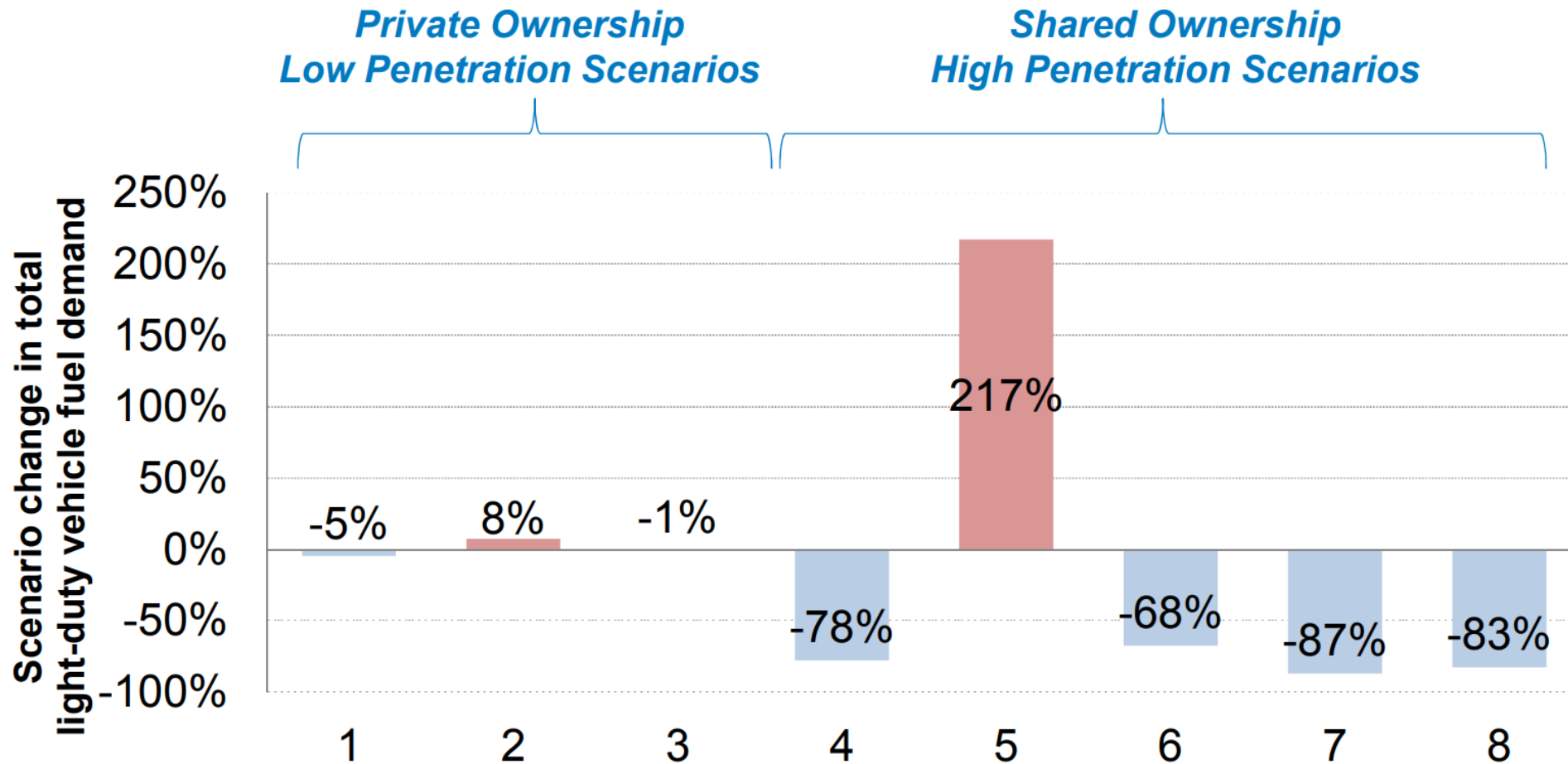
+70% due to additional travel by underserved populations

+30% due to faster travel

+50% due to more travel

Depends very much on  
**HOW**  
the autonomous vehicles are used.

# Fuel Demand Depends on a Wide Range of Factors





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