

OLLI – Clemson University

Driving Change – Autonomous Vehicles' Big Impact

National Economic Education Delegation

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February 13, 2023



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National Economic Education Delegation

- **Vision**

- One day, the public discussion of policy issues will be grounded in an accurate perception of the underlying economic principles and data.

- **Mission**

- NEED unites the skills and knowledge of a vast network of professional economists to promote understanding of the economics of policy issues in the United States.

- **NEED Presentations**

- Are **nonpartisan** and intended to reflect the consensus of the economics profession.



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Who Are We?

• Honorary Board: 54 members

- 2 Fed Chairs: Janet Yellen, Ben Bernanke
- 6 Chairs Council of Economic Advisers
 - Furman (D), Rosen (R), Bernanke (R), Yellen (D), Tyson (D), Goolsbee (D)
- 3 Nobel Prize Winners
 - Akerlof, Smith, Maskin

• Delegates: 652+ members

- At all levels of academia and some in government service
- All have a Ph.D. in economics
- Crowdsource slide decks
- Give presentations

• Global Partners: 49 Ph.D. Economists

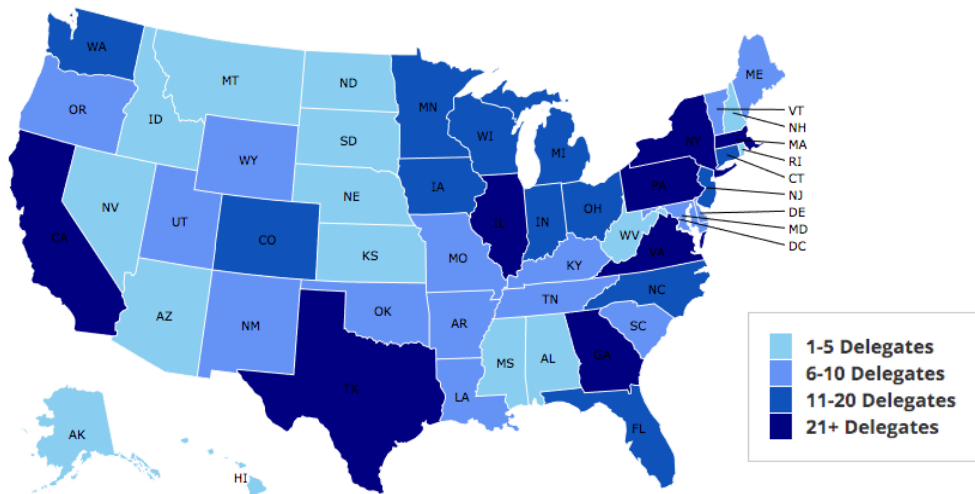
- Aid in slide deck development



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Where Are We?



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Available NEED Topics Include:

- Coronavirus Economics
- US Economy
- Climate Change
- Economic Inequality
- Economic Mobility
- Trade and Globalization
- Minimum Wages
- Immigration Economics
- Housing Policy
- Federal Budgets
- Federal Debt
- Black-White Wealth Gap
- Autonomous Vehicles
- US Social Policy



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Upcoming Course:

• Contemporary Economic Policy Issues

- Week 1 (3/2): Federal Debt (Brian Peterson, Lagrange College)
- Week 2 (3/9): Trade Deficits and Exchange Rates (Alan Deardorff, Univ. Michigan)
- Week 3 (3/16): US Economic Update (Scott Baier, Clemson University)
- Week 4 (3/27): Monetary Policy and Inflation (Geoffrey Woglom, Amherst College)
- Week 5 (4/3): Cryptocurrencies (Geoffrey Woglom)



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Submitting Questions

- **Please submit questions in the chat.**
 - I will try to handle them as they come up, but may take them in a bunch as time permits.
- **We will do a verbal Q&A once the material has been presented.**
 - And the questions in the chat have been addressed.
- **Slides will be available from the NEED website tomorrow (https://needelegation.org/delivered_presentations.php)**



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Credits and Disclaimer

- **This slide deck was authored by:**
 - Jon Haveman, NEED
- **This slide deck was reviewed by:**
 - Ronald Fisher, Michigan State University
 - William F. Fox, University of Tennessee, Knoxville
- **Disclaimer**
 - NEED presentations are designed to be nonpartisan.
 - It is, however, inevitable that the presenter will be asked for and will provide their own views.
 - Such views are those of the presenter and not necessarily those of the National Economic Education Delegation (NEED).



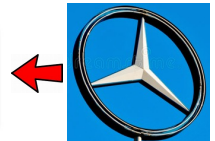
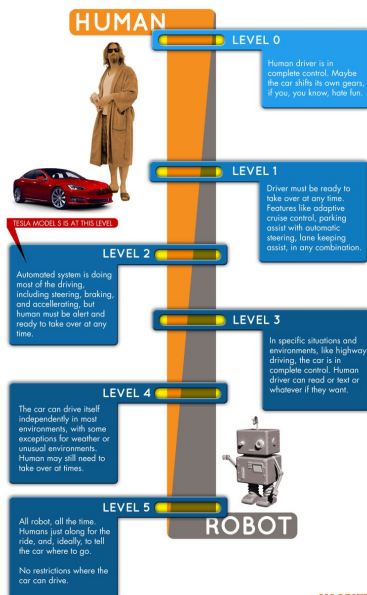
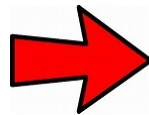
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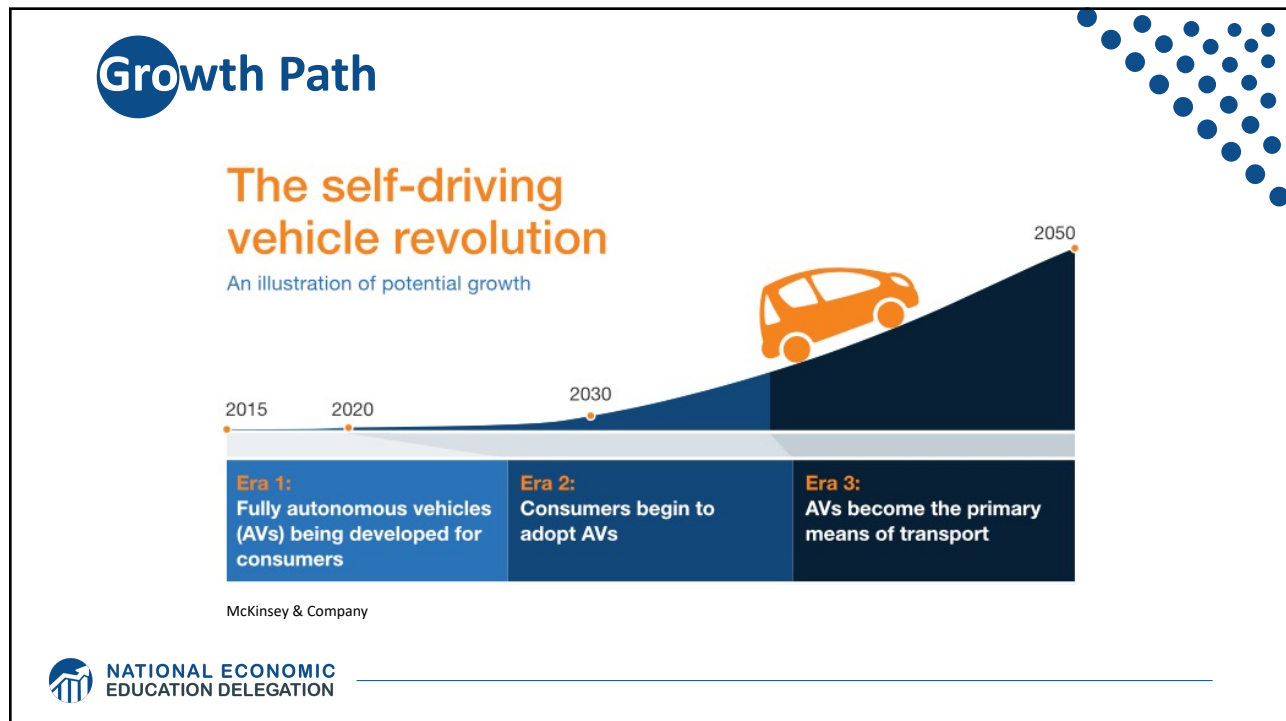
Outline

- Where does the AV path lead?
- Policy/Planning Issues
- Major Economic/Development Changes

Autonomous Taxonomy

SAE AUTONOMY LEVELS






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Three Important Questions:

1. When will Transportation as a Service (TaaS) be available?
2. How quick will the transition be?
3. What will the future look like?

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WHEN?

What do the headlines say?



NVIDIA to introduce level-4 enabling system by 2018



First autonomous Toyota to be available in 2020



Volkswagen

Volkswagen expects first self driving cars on the market by 2019



Audi

Audi to introduce a self-driving car by 2020



TESLA MOTORS

Elon Musk now expects first fully autonomous Tesla by 2019, approved by 2021



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40+ Corporations Working On Autonomous Vehicles



TOYOTA



WAYMO



HONDA



Audi



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WHEN?

What is possible?

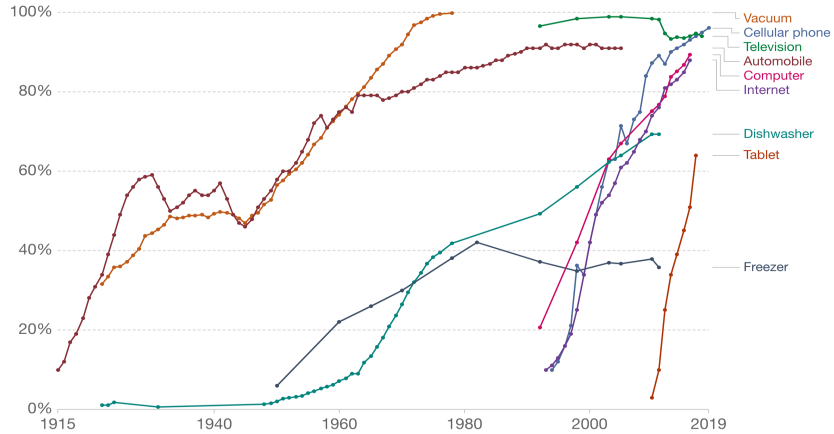
- **By 2025 (?)**
- **Potentially 95% of VMT by 2035.**
 - Last 5% may be very difficult to achieve.
- **Is this possible?**
 - Horses to cars: 10 years – early 1900s
 - But adoption of EVs is so slow!
 - Adoption of AVs will be rapid.



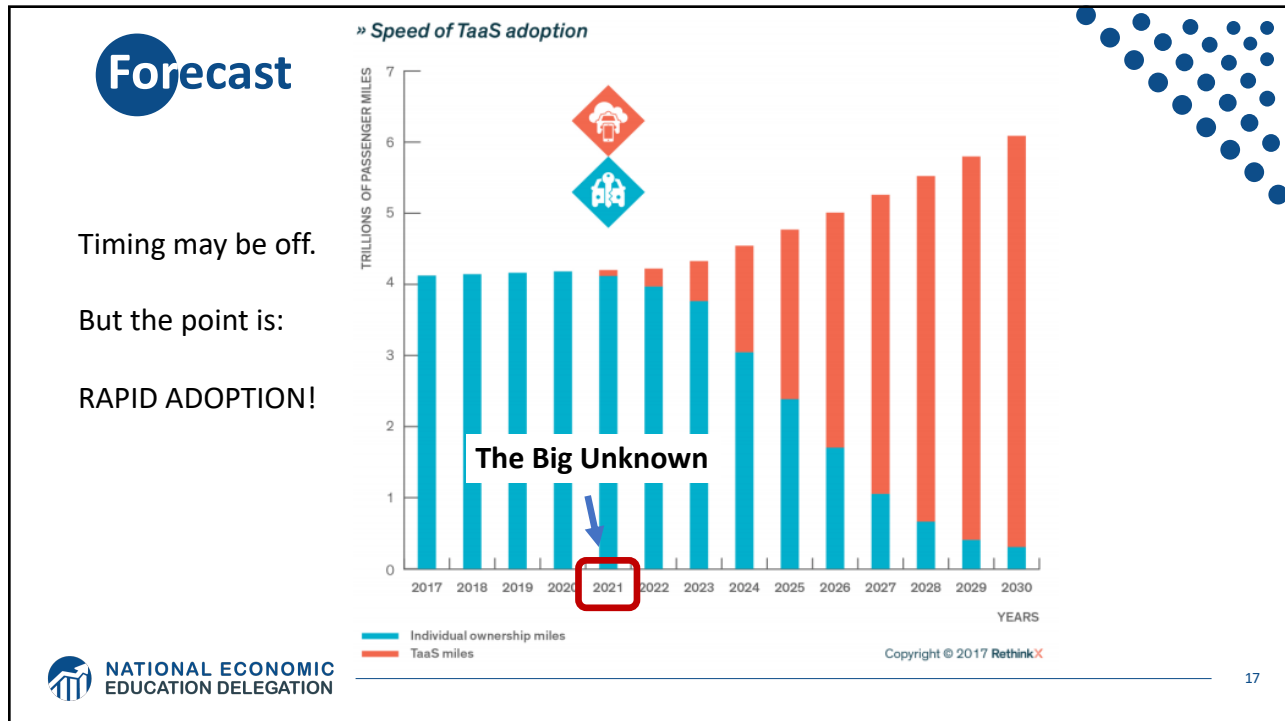
Rate of Technology Adoption – Faster!

Technology adoption in US households, 1915 to 2019

Technology adoption rates, measured as the percentage of households in the United States using a particular technology.



Source: Comin and Hobijn (2004) and others. OurWorldInData.org/technology-adoption/ - CC BY. Note: See the sources tab for definitions of household adoption, or adoption rates, by technology type.



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Waymo's self-driving cars are now available on Lyft's app in Phoenix

Lyft and Motional's all-electric robotaxi service is now live in Las Vegas

Singapore's self-driving cars can now be hailed with a smartphone

NuTonomy joins forces with 'the Uber of Southeast Asia'

Cruise is now charging for rides in its driverless vehicles in San Francisco

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Waymo is Headed to New York!



Waymo driving territory

New York City

Image courtesy of Waymo

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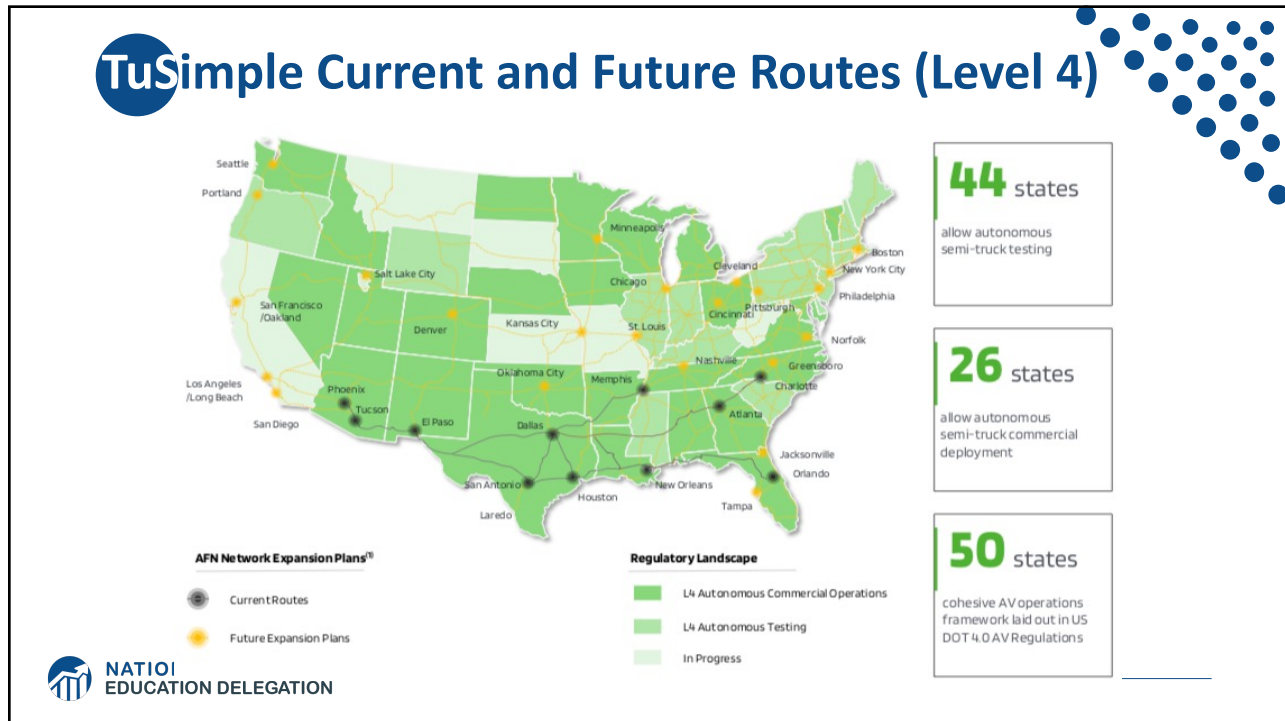
Trucking – Highly Fertile Ground

- **Long haul trucking is likely the first place we will see it adopted.**
 - Reduces costs associated with drivers.
 - End run around limits on hours of driving.
- **Where does it stand?**
 - Lots of trials underway.
 - TuSimple – actively building a long haul network.
 - Waymo – focused more on last mile/local delivery.

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Actively Pursuing Autonomous Local Delivery

- **Dominos**
- **Walmart**
- **Amazon**
- **CVS Pharmacy**
- **Stop and Shop**
- **Postmates**
- **Kroger**

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What will the future look like?



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This:



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But, will it be:



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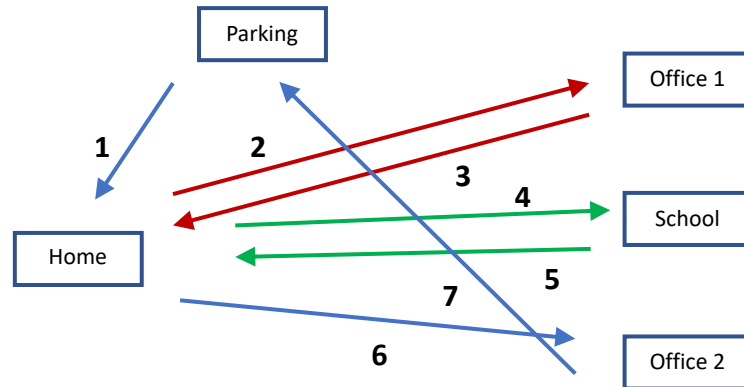
Hell

- **Primarily individual private car ownership**
 - Much as today.
- **Internal combustion engines**
- **Why Hell?**
 - Dramatically increased VMT and pollution.
 - Potentially increased congestion.
 - Parking



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Two Adults and a Child: Morning Miles



And this is just the morning.....

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Heaven



- **Vehicle ownership will be very limited**
 - Private ownership for those with specialized vehicle needs.
 - Fleet ownership will serve everybody else.
- **Engines: electric**
- **Insurance: product liability**
- **Not clear when we will get there, but this is the likely model.**
 - 2030 for widespread adoption in many regions.

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Why is this Heaven?

- **Not only autonomous, but:**
 - Shared
 - Connected
 - Green
- **Far fewer cars in existence.**
 - Better resource utilization: steel, rubber, aluminum, and land!
- **VMT could go up or down, but more productive than in Hell.**
- **Congestion effects – unclear, but likely reduced.**
 - Right-sized vehicles, platooning, sharing, V2V communication
- **Minimal need for parking.**



Economics Drives Transition: Private

- **Adoption dividend for private individuals**
 - Eliminate car ownership
 - Ave annual cost of owning a car: \$10,728 (2022)
 - Cost per mile will fall: \$0.72 to \$0.19
 - Repurpose your garage
 - \$50,000 from transition to bedroom
- **Time recovery**
 - 50% of the SF Bay Area workforce has a commute in excess of 30 minutes.

Average Ownership Costs Per Mile

Miles per Year	10k	15k	20k
Average Cost	76¢	72¢	70¢



Economics Drives Transition: Public

- Economic and social costs associated with human drivers are enormous:

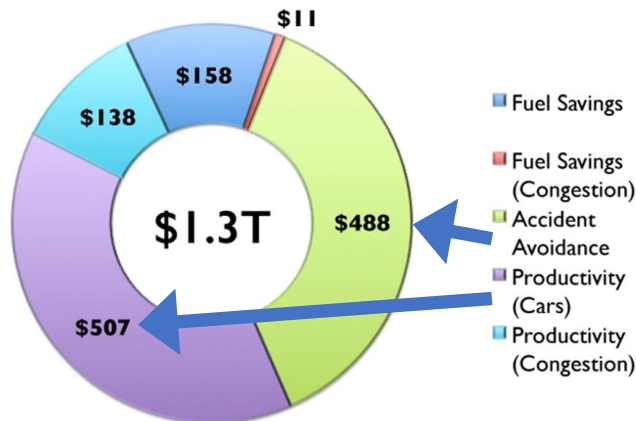
- ACCIDENTS:
 - Drive 25% of congestion.
 - Result in 40,000 deaths.
 - And 2 million injuries.
 - 90+% caused by human error.
- Increased productivity from not driving.
- Costs of human drivers estimated at up to \$1.3 TRillion each year



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Potential Savings

Potential US Savings (\$B)

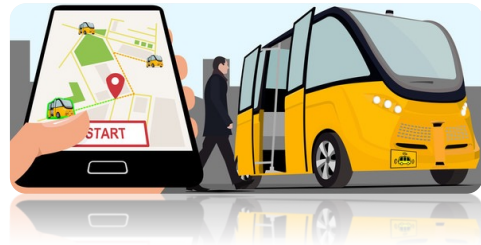


Morgan Stanley

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Public Policy/Planning Issues

- **Government buy-in:**
 - Essential – gov't must encourage progress
 - Difficult – because of displacement issue
- **Important transitional issues:**
 - What infrastructure should be developed?
 - What to do about public transportation?
 - What to do with all of the parking spaces?



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Encourage Change

- **Mobility and equity considerations**
 - Elderly/disabled/impovertished
- **Safety:** only way to reduce traffic fatalities is by coordinated effort
- **Productivity:** reduced congestion
- **Environment:** speed transition to electric vehicles

These are all societal benefits that come about too slowly
if the private market is left to itself.



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Mobility and Equity

- **Mobility**

- Handicapped
- Elderly
- Lower income

- **Equity**

- Public Transportation often does not work well for low-income workers/residential workers
 - Does not go from residential to residential, but from residential to commercial



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Safety and Productivity



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Environment



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Environmental Implications Depends: Heaven or Hell

- **Improved resource utilization**
- **More efficient travel**
 - Right sized vehicles
 - Optimized routes
 - Reduced congestion
 - No searching for parking
- **Increased VMT**
- **Cleaner technologies**
 - Electric
 - Lighter vehicles
- **Energy use of onboard electronics**
 - Weight and functional
- **Increased urban sprawl**

Bottom line: push governments at all levels to embrace and to implement policies deterring private vehicle ownership and zero passenger miles



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What Changes Will This Bring?

- Disposable income
- Government finances
- Transportation demand
- Infrastructure
- Housing
- Public transportation
- Employment
- Parking

Potentially dramatic improvements in infrastructure planning and maintenance -
Data sharing and integration

Disposable Income



- Costs \$10,728 to own a car
- Will cost \$3,000 to use TaaS
- Net increase in disposable income of > \$7,000
- Spread across all households: more than \$1 trillion in new spending in the economy
- Major boost to economic activity
 - CREATING JOBS!

Government Finances



- **Government finances thrown for a loop:**

- Revenues up and down:
 - Parking revenue, tickets, traffic violation revenues
 - More commercial, retail and residential space
- Less spending on road development
- More (maybe less) spent on road maintenance
 - Fewer road miles
 - but perhaps more VMT

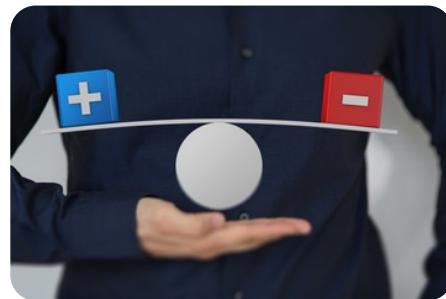
Transportation Demand

- **Demand for transportation will likely increase significantly:
price falls, demand rises**

- Commutes may increase in distance, but not necessarily in duration
- Zero passenger trips will arise
 - Deliveries

- **At the same time, demand for roadway lane-miles will likely decrease**

- AVs make significantly more efficient use of space
- Front to back and side to side



Infrastructure

- **Focus of transportation infrastructure:**

- Currently on expansion
- Will turn toward:
 - Maintenance
 - Signage and striping has to be robust
 - TaaS providers push for fewer potholes?
 - Adding technology
 - Stop lights will be digital as well as visual
- Some will disappear: Signs!



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Housing



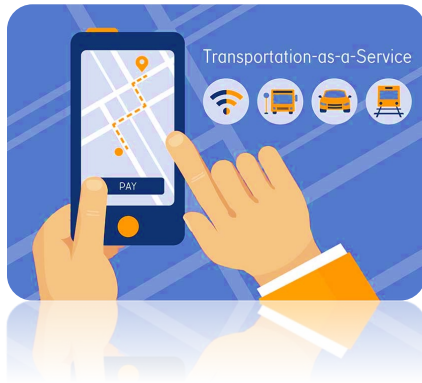
- **Housing is suddenly easier to build**
 - Issue of traffic congestion is significantly reduced.
 - Space for new housing is available where parking lots used to be.
- **Existing houses can now accommodate more people: garage to bedroom conversions.**



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Public Transportation



- **Ambiguous implications for public transportation**
- **Demand may:**
 - Shrink because of low cost of TaaS
 - Grow because last mile problem is solved
- **Extensions may be added through contract with TaaS company**

Employment

- **Massive job displacement/relocation (Millions!):**
 - Drivers of all varieties: truck, taxi, delivery...
 - Car production jobs, car parts production jobs
 - Gas station, vehicle repair, and body shop
 - Police and fire
 - Health care workers
 - And so on...



Employment (con't)



- **What jobs will be created?**
 - IT jobs
 - Retail/Production jobs
 - ??
- **Always easier to identify things that will go away than to identify what will pop in its place.**
- **Regardless of where they are created, training programs will be crucial to the transition.**



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Parking

- **Greatly reduced demand for parking lots.**
- **Service providers will own parking lots in strategic places.**
- **Street parking will largely be a thing of the past.**
 - More green space in cities
- **Shopping mall and apartment parking?**
 - Converted to housing?



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Freeing Up Urban Space from Parking

- **Los Angeles: 14% of incorporated land area**
 - 200 Square miles
- **San Francisco: 275,450 on-street parking spaces**
 - Enough to parallel-park a line of cars 60 miles longer than California's entire 840-mile coastline
- **Nationwide: (estimate) 500 million spaces**
 - That's larger than Delaware and Rhode Island combined.
 - Could be as many as 2 billion (add in Connecticut and Vermont).



Potential Problems and Concerns

- **Expansion of the electric grid to provide sufficient capacity.**
- **Mining for rare earth minerals for batteries.**
- **Hacking of autonomous vehicles for nefarious purposes.**
- **Competition in service provision in some markets.**
- **And many more...**



Summary of Change

- Massive employment upheaval.
- Local government finances will look very different.
- Housing will be easier to build and more plentiful.
- Parking conversions will be commonplace.
- Demand for transportation infrastructure will likely decline.
 - Transportation infrastructure technology will be a booming business.
- Demand for public transportation may well decline.
- Coming likely sooner rather than later!



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Thank you!

Any Questions?

www.NEEDelegation.org

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Contact NEED: info@NEEDelegation.org

Submit a testimonial: www.NEEDelegation.org/testimonials.php

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