



Planning for Autonomous Vehicles

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WSP | Parsons Brinckerhoff

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‘What we’ve got will blow people’s minds, it blows my mind... it’ll come sooner than people think’

- Elon Musk on Tesla fully autonomous car,
Electrek, August 4, 2016

Uber starts self-driving car pickups in Pittsburgh

- Tech Crunch September 14, 2016

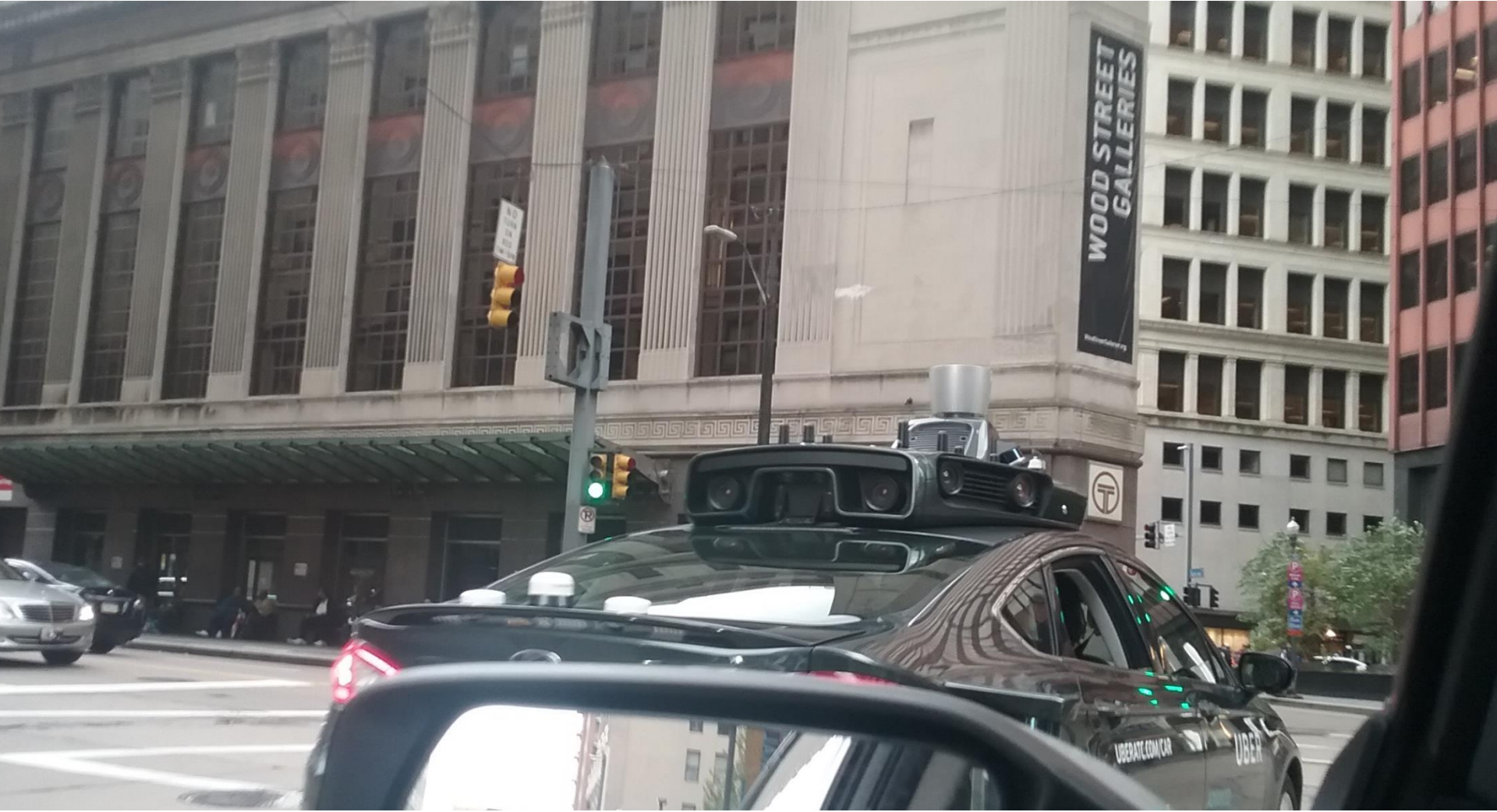
Google starts deploying its self-driving Chrysler Pacifica minivans: first prototypes spotted

- Electrek, October 9, 2016

Attempts at AVs Are Not New







Goals for Today

- **Primer on AVs**
- **Planning for AVs**
- **Work in Toronto**
- **How Cities and Regions Can Prepare**

























Elevate the discussion about why and how cities and regions should be SHAPING the development of AVs

When will we see public use of AVs on our roads?

- 0-2 Years
- 2-5 Years
- 5-10 Years
- 10-15 Years
- 15+ Years



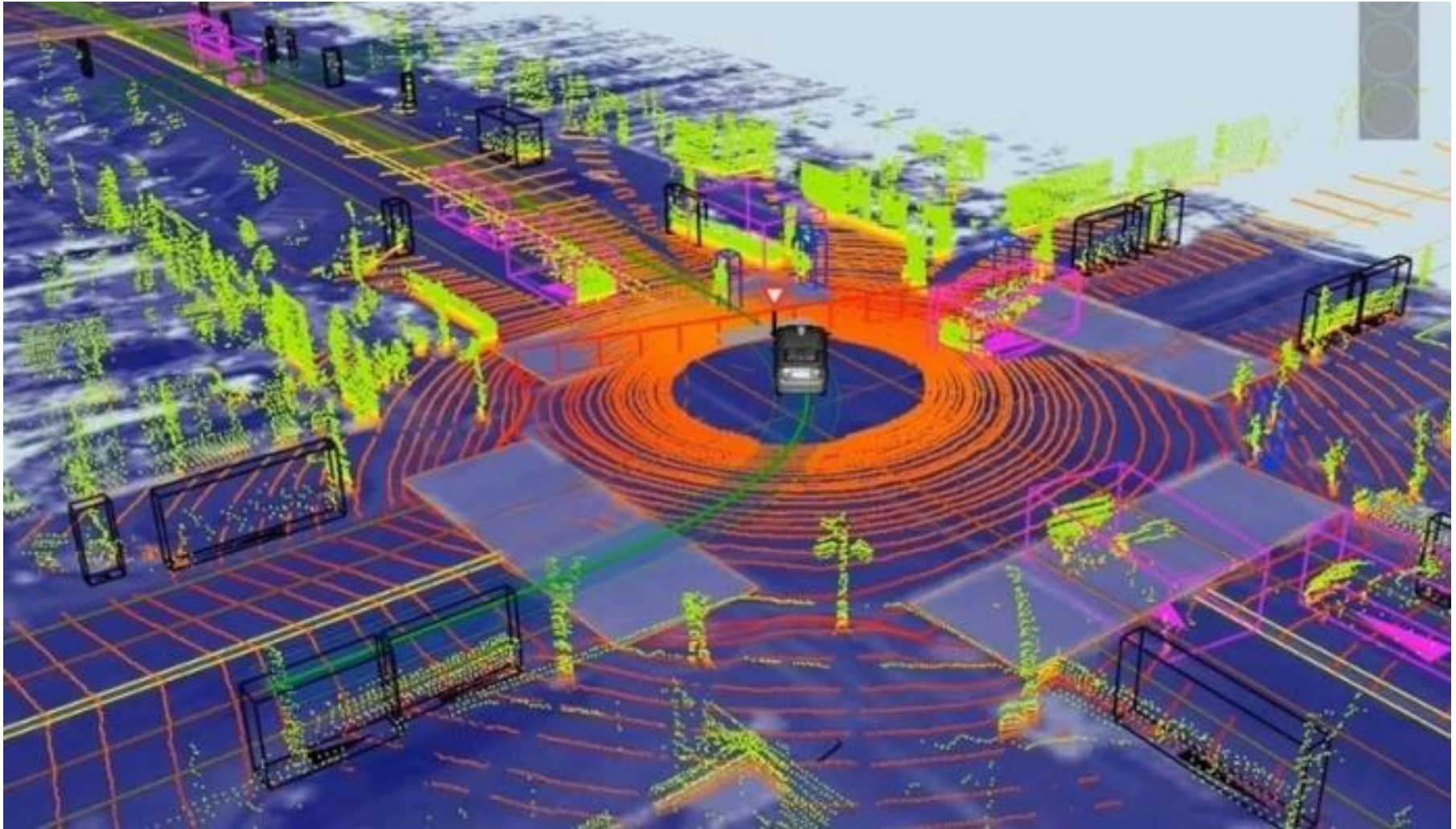
NHTSA Levels of Automation

| | Human Driver Monitors Environment | | | System Monitors Environment | | |
|---|---|--|---|---|---|--|
| | 0 | 1 | 2 | 3 | 4 | 5 |
| | No Automation | Driver Assistance | Partial Automation | Conditional Automation | High Automation | Full Automation |
| | The absence of any assistive features such as adaptive cruise control. | Systems that help drivers maintain speed or stay in lane but leave the driver in control. | The combination of automatic speed and steering control—for example, cruise control and lane keeping. | Automated systems that drive and monitor the environment but rely on a human driver for backup. | Automated systems that do everything—no human backup required—but only in limited circumstances. | The true electronic chauffeur; retains full vehicle control, needs no human backup and drives in all conditions. |
| Who steers, accelerates and decelerates |  Human driver |  Human driver and system |  System |  System |  System |  System |
| Who monitors the driving environment |  Human driver |  Human driver |  Human driver |  System |  System |  System |
| Who takes control when something goes wrong |  Human driver |  Human driver |  Human driver |  Human driver |  System |  System |
| How much driving, overall, is assisted or automated |  None |  Some driving modes |  Some driving modes |  Some driving modes |  Some driving modes |  All driving modes |





Self-contained “seeing”



The Promise of AVs

- Improved road safety
- Economic benefits of less lost productivity
- More equitable access for all
- Increased travel options
- Reduced stress of driving
- Reduced fuel consumption and emissions
- *In the future*, greater throughput, reducing congestion



Two Paths



Private Ownership Model

Driven by Auto Industry
Incremental Moves in Functionalities
Mostly Privately Owned
Here Today



Shared Mobility Model (MaaS/TaaS/Robo-taxis)

Driven by Tech and TNCs
Jump to Fully Automated
Transportation-as-a-Service
A few (or many, many) years away

Complexities of AVs

Communications Systems

Data

Technology

Infrastructure

Standards

Ethics

Managing the Transition

Planning

Liability

Consumer Preference

Impact to Jobs

Privacy

Security

Enforcement

Safety

Regulation

Human Factors

Economics

Business Models

Complexities of AVs

Planning

Planning for AVs

- **It's no longer “if”, but “when”**
- **It will likely be very, very disruptive**
- **Over time, will likely transform mobility as we know it**
- **Will impact how we design, build and operate not only roads, but likely all aspects of our transportation system**

Questions on Planning for AVs

- Will they increase or decrease trip-making?
- Will they increase or decrease the distance of trip-making?
- What will be their impact to transit?
- Will it be complementary or supplementary?
- Will we see more VMT or less VMT?
- Will we see more congestion or less congestion?
- Will they support or undermine land use policies?
- Will they impact locational choices of residents and employers?
- How will they impact the economy, industries and goods movement?

Key Unknowns

- **Speed of Technological Advancement**
- **Economics**
- **Public Acceptance/Public Interest/Willingness**
- **Political Support**
- **Market for a Shared Model**
 - **Economics, Public Acceptance, Political Support**

Speed of Technological Advancement

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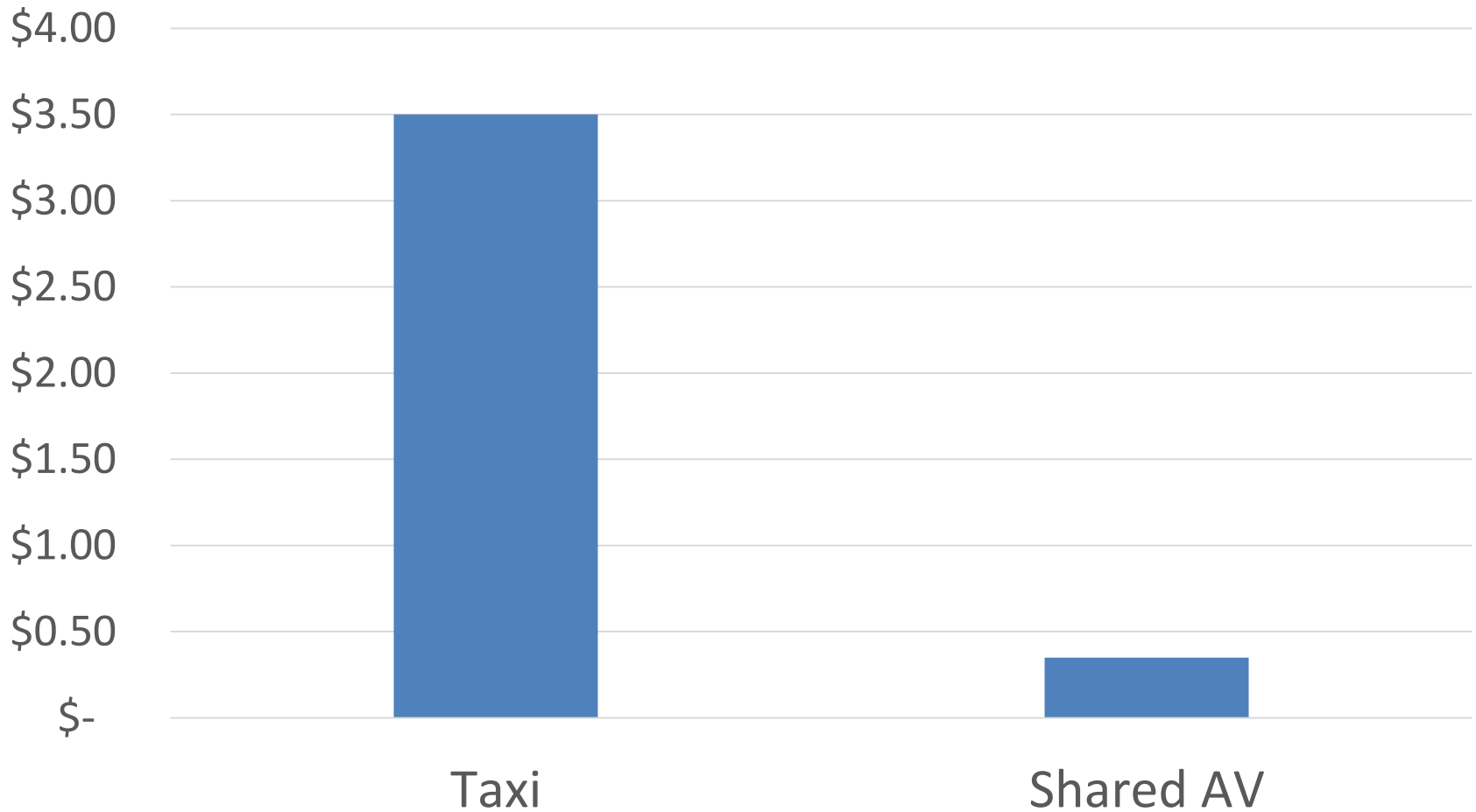
Speed of Technological Advancement

| Manufacturer | 2016 | 2017 | 2018 | 2019 | 2020-25 | 2025-30 | 2030-35 | 2035-40 | 2040+ |
|--|------|------|------|------|---------|---------|---------|---------|-------|
|  Audi | 2 | | 3 | | 3+ | 4/5 | | | |
|  BMW | 2 | | | | 4/5 | | | | |
|  Ford | | | | 2 | 4/5 | | | | |
|  HONDA | 2 | | | | 3 | | | | 3-4 |
|  KIA | | | | | 3 | | 4/5 | | |
|  Mercedes-Benz | 2 | | | | | | | | |
|  NISSAN | 2 | | 3 | | 4/5 | | | | |
|  TESLA | 2 | | 4/5 | | | | | | |
|  VOLVO  UBER | 2 | 4/5 | | | | | | | |

Source: Mashable

Economics

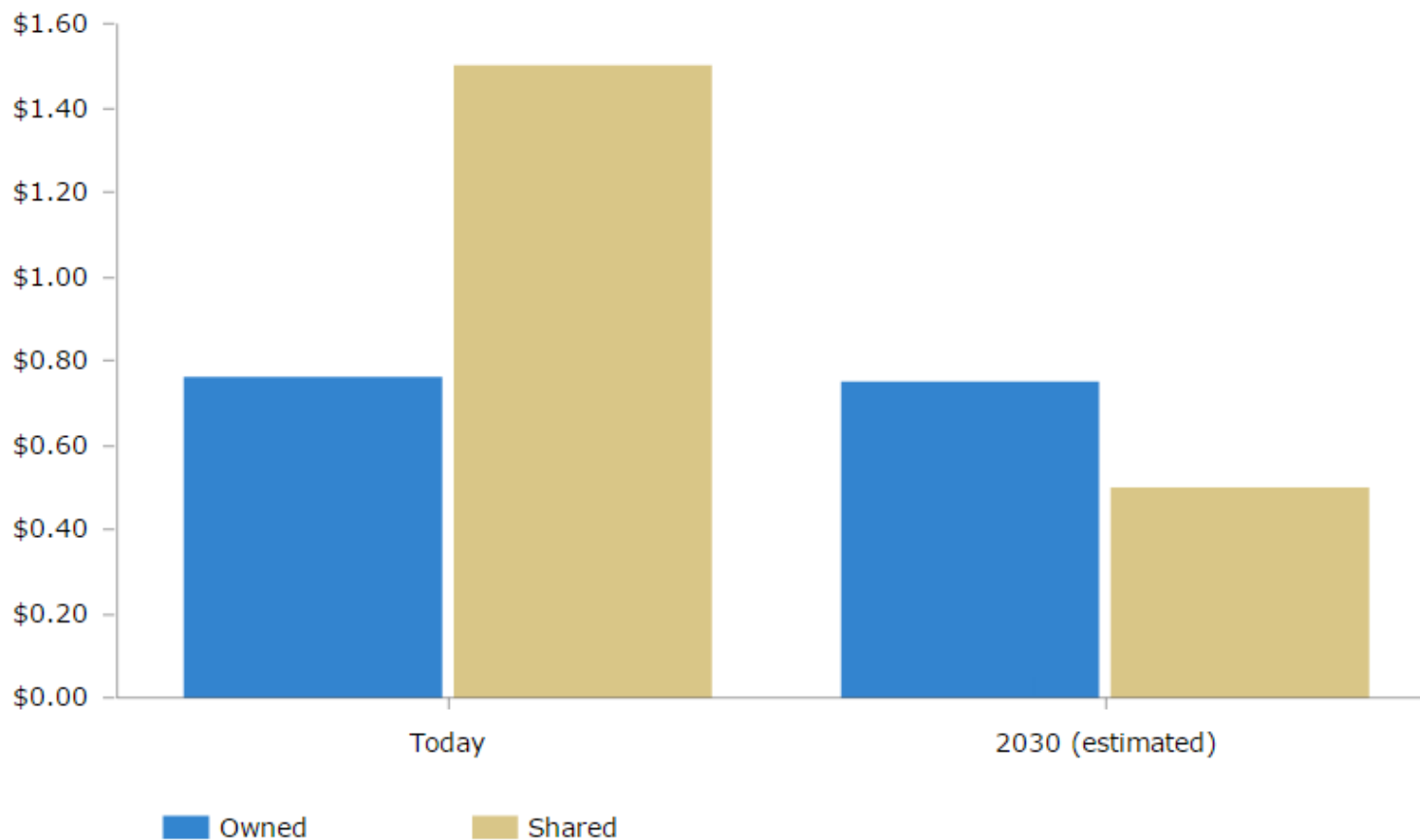
Cost per Mile



Source: ARK Investment Management

Economics

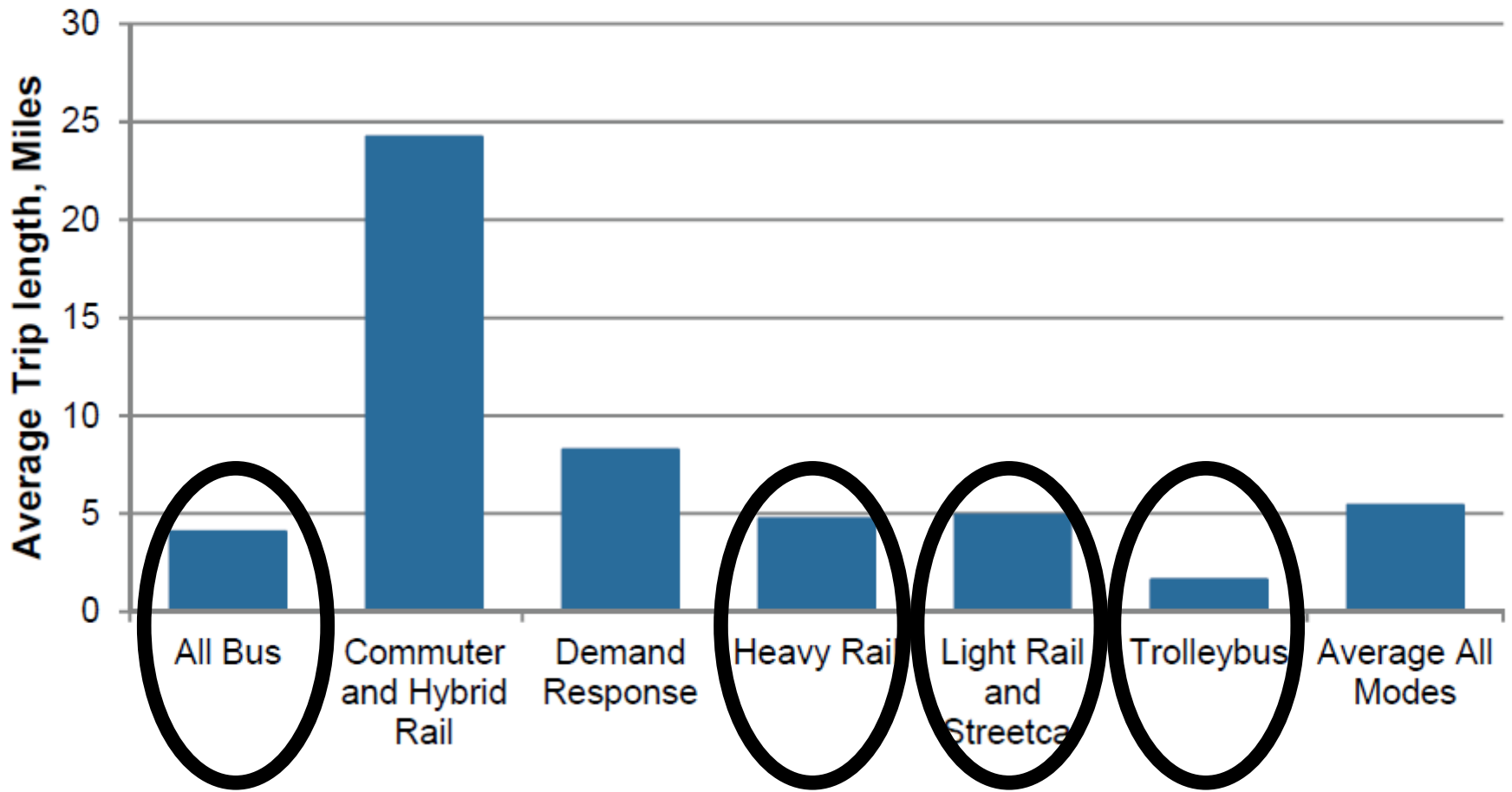
Cost per Mile: Shared vs. Owned



Source: Morgan Stanley (2016)

Economics

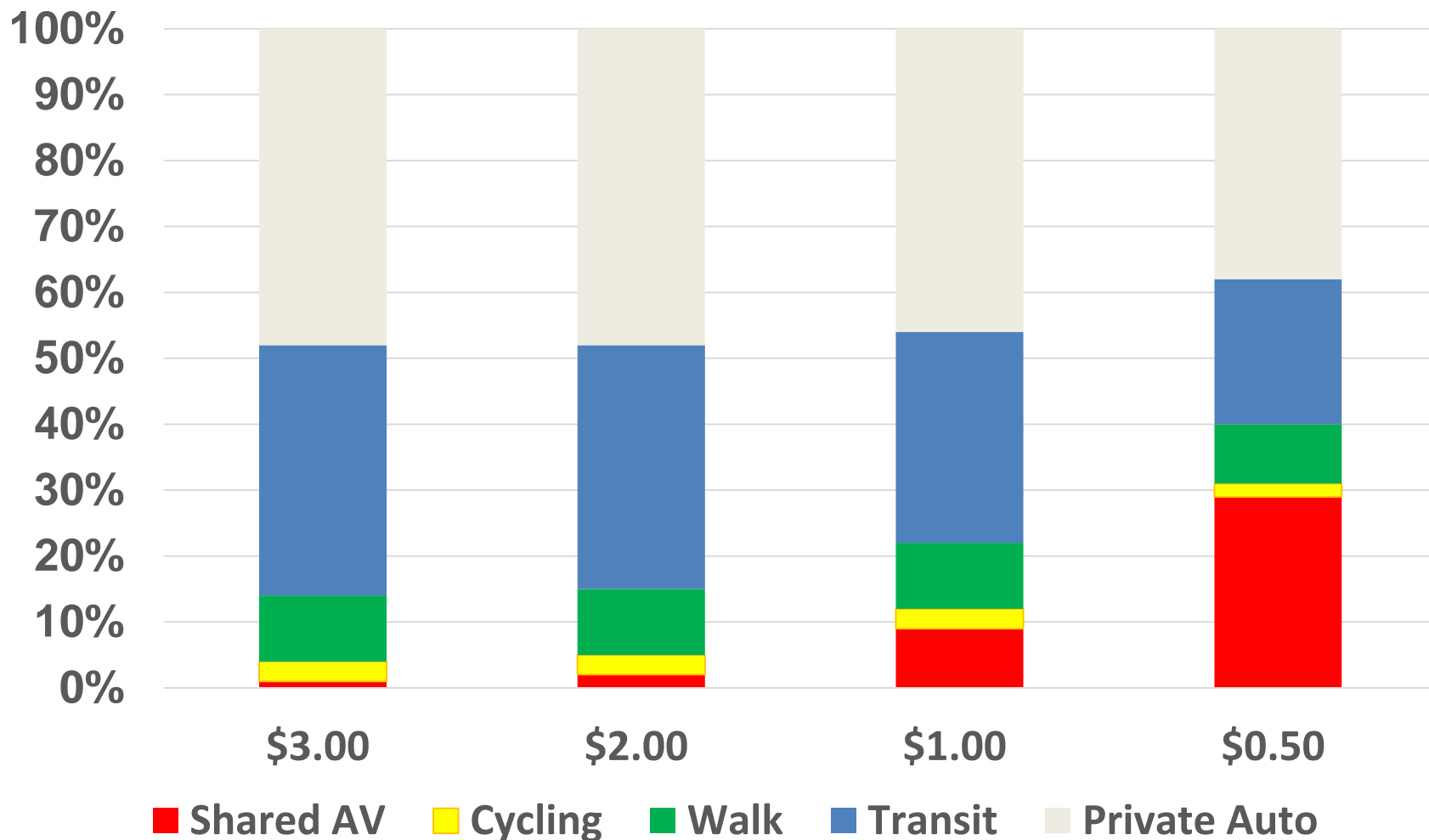
Figure 3: Average Unlinked Passenger Trip Length, 2011



Source: APTA 2011 Fact Book

Economics

Illustrative Mode Share at Various per Mile Prices

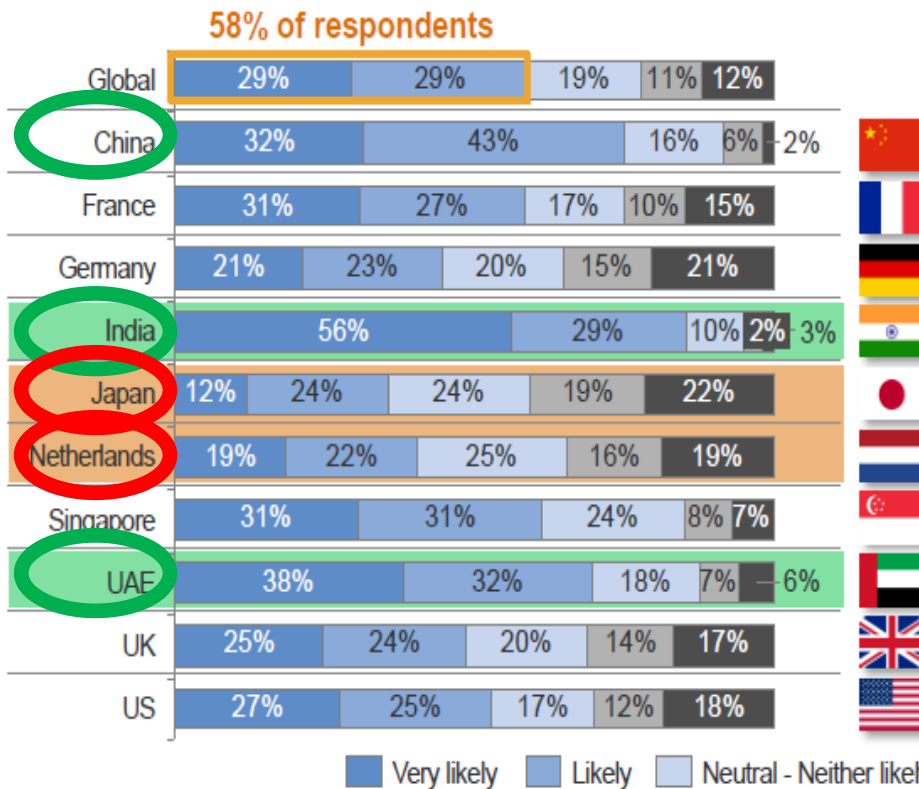


Public Acceptance – Trust of AVs

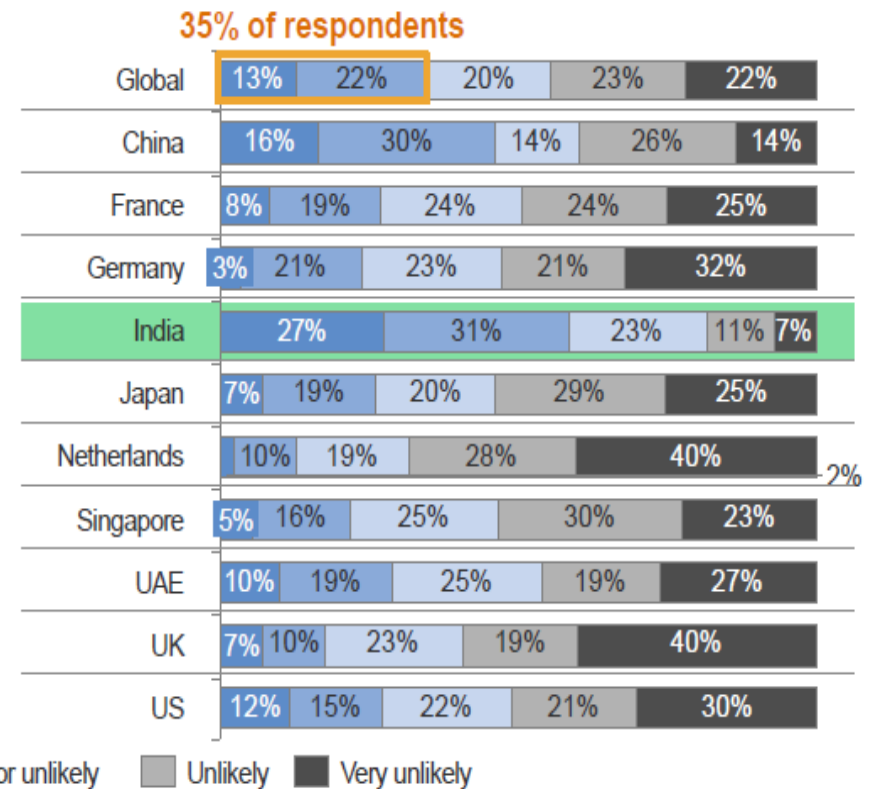
58% say they would take a ride in a fully self-driving car

... but only 35% of parents would let their children ride alone in one

In % of respondents per country



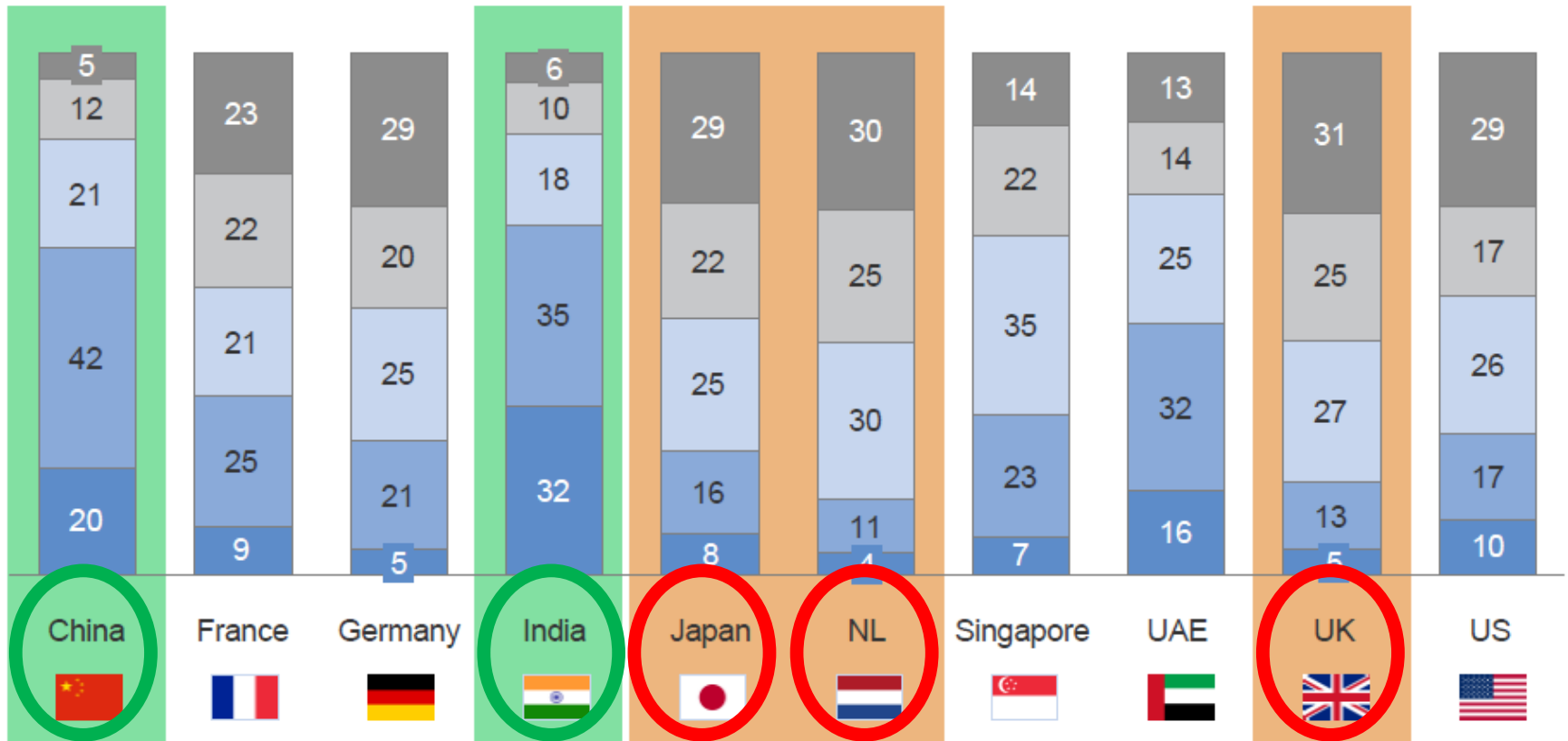
In % of respondents per country



Source: World Economic Forum/Boston Consulting Group, 2015.

Public Acceptance – Shared Use

In % of respondents per country



Source: World Economic Forum/Boston Consulting Group, 2015.

Political Support

Helsinki “announced plans to transform its existing public transport network into a comprehensive, point-to-point “mobility on demand” system by 2025”

July 10, 2014 theguardian.com

L.A. Mayor Eric Garcetti:

We Will Be the First City to Do Autonomous Vehicles Right

September 29, 2014 citylab.com

Regulations Force Uber, Lyft out of Austin...

May 15, 2016 Cointelegraph.com

Key Unknowns

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Key Unknowns

***Without a clear understanding of the future,
how do we plan?***

Toronto Experience

Driving Changes: Automated Vehicles in Toronto

Discussion paper

David Ticoll
Distinguished Research Fellow
Innovation Policy Lab
Munk School of Global Affairs
University of Toronto

October 15, 2015



Driving Changes: Automated Vehicles in Toronto

- David Ticoll, University of Toronto

Three Scenarios



**Ownership
Leads**



Mixed



**Shared
Leads**

Impacts of Private vs. Mixed vs. Shared

| | Private | Mixed | Shared |
|---|---------|-------|--------|
| Collisions | ↓ | ↓ | ↓ |
| Congestion | ↓ | ? | ↓ |
| Vehicular Mobility | ↑ | ↑ | ↑ |
| Equitable Mobility | ? | ↑ | ↑ |
| Cost of Private/Semi-private Vehicular Travel | ? | ↓ | ↓ |
| Carpooling | ? | ↑ | ↑ |
| Passenger Kilometers Travelled | ↑ | ↑ | ↑ |
| Vehicle Kilometers Travelled | ↑ | ? | ↓ |
| Fixed Route Transit Demand | ↓ | ↓ | ↓ |
| Active Transportation | ↓ | ? | ? |
| Trend of Intensification | ↓ | ? | ? |
| Parking Demand | ? | ↓ | ↓ |
| Right-of-way allocated for vehicles | ↓ | ↓ | ↓ |
| Residential Building/Lot Size | ? | ↓ | ↓ |
| Impervious Areas | ? | ↓ | ↓ |

How is this Unfolding?

- **Discussions are happening primarily at the federal and state levels**
- **Economic development considerations have seemed to be a significant driver of the policy discussions**
- **Because of the potential “winner take all”, stakes are high, companies are moving fast....**

Goals of Cities and Regions

- **Safety**
- **Accessibility**
- **Mobility**
- **Economic Opportunity**
- **Quality of Life**
- **High-Quality Natural and Built Form**
- **Environmental Sustainability**
- **Social Inclusion**
- **Financial Sustainability**

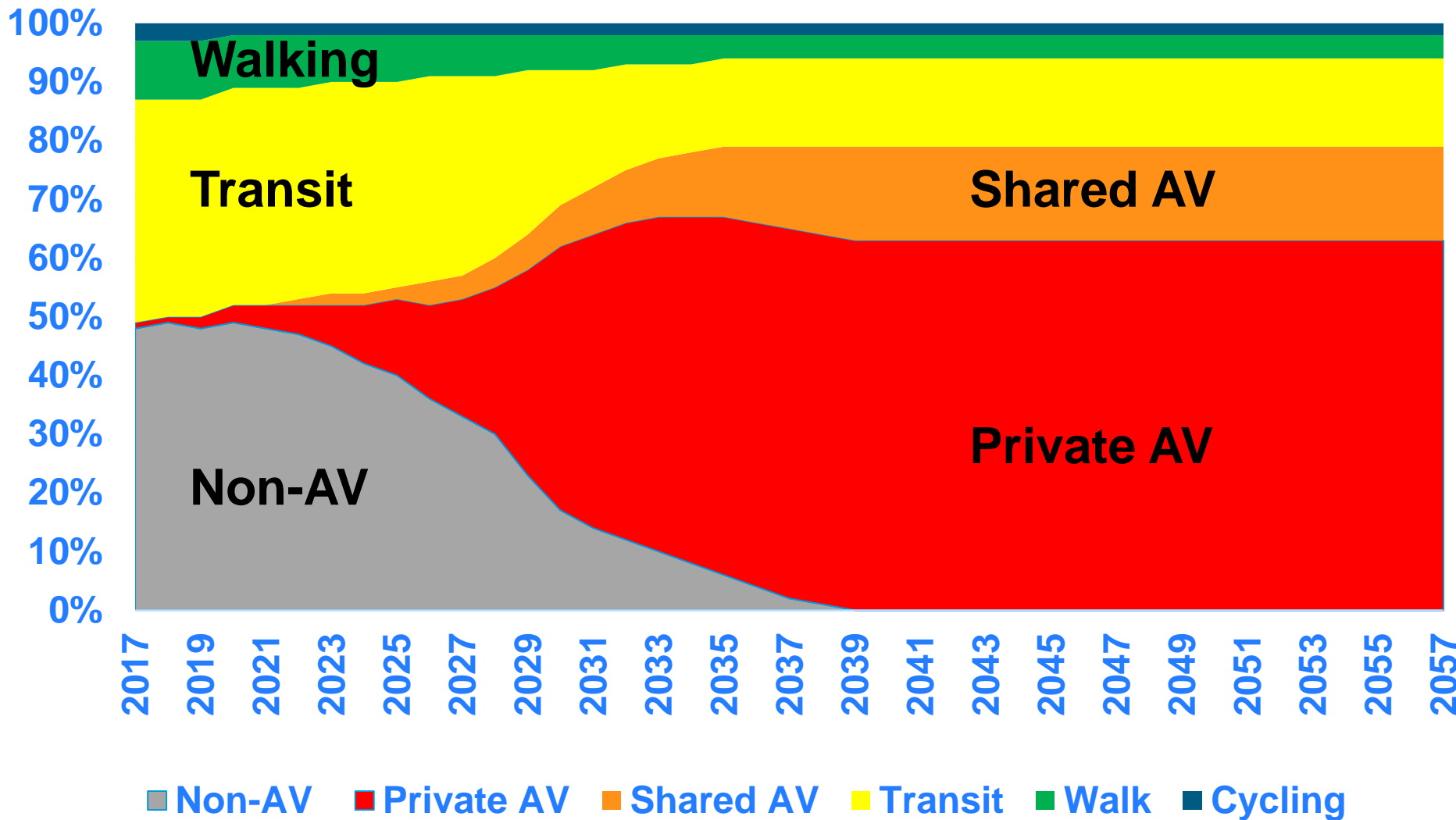
Toronto's Draft Vision Statement

**Toronto needs to harness the potential of AVs
to help us create the City that we want.**

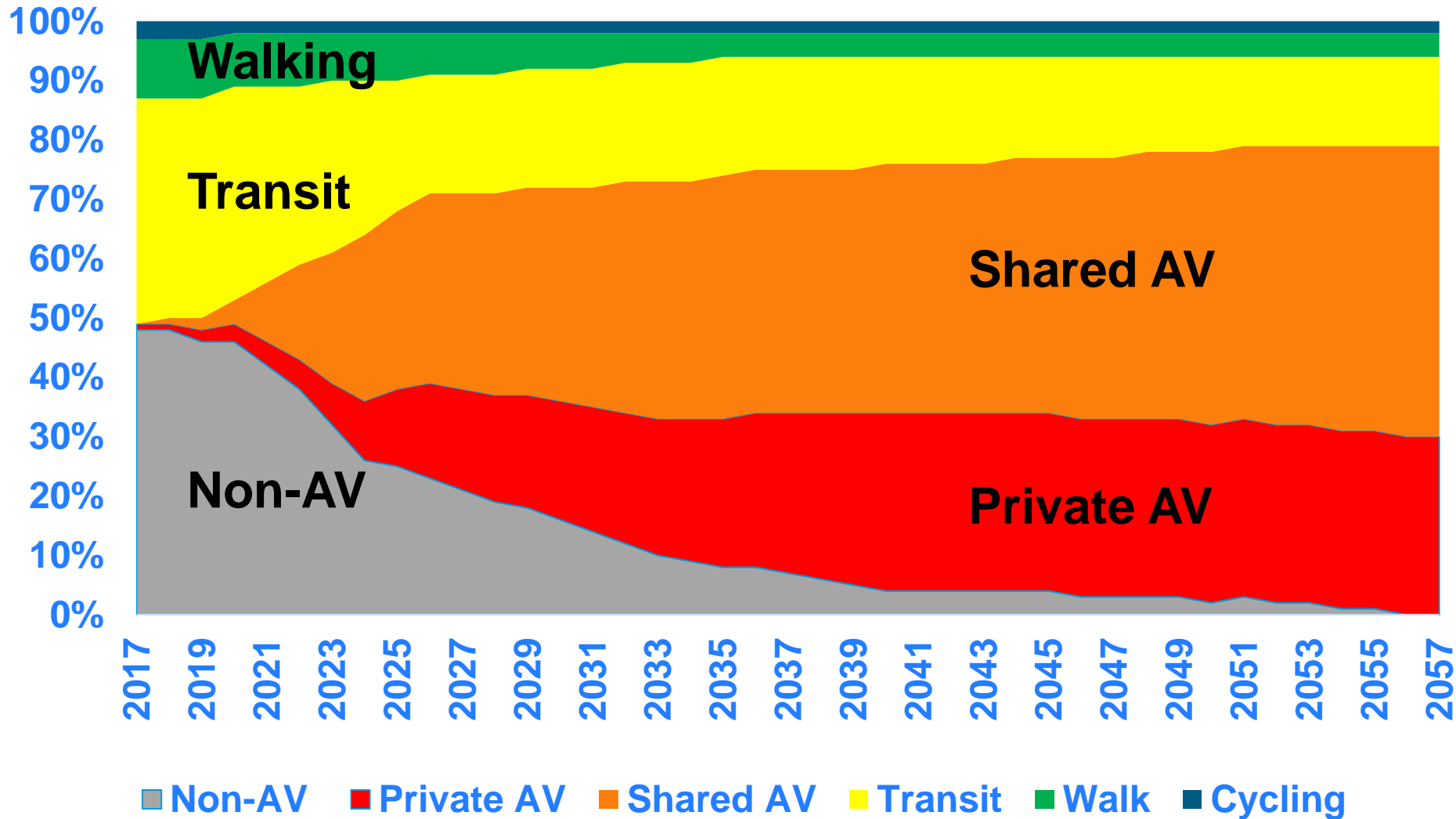
Toronto Transportation Services Work Plan



Scenarios – Private Leads



Scenarios – Shared Leads



Takeaways

- **This is coming fast – guide it or respond to it**
- **Cities and regions have a chance to shape this, but need to move**
- **While still many unknowns, we need to start factoring AVs into long-range planning**
- **Don't let the unknowns and complexities paralyze us**



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Tesla Video

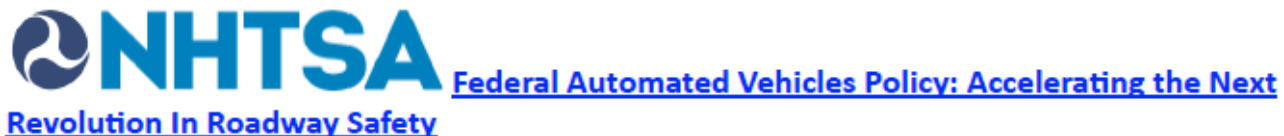
→ <https://electrek.co/2016/11/18/tesla-self-driving-demonstration-video-real-time-tesla-vision/>

Resources



<http://smartdrivingcar.com/GreenLight-092316>

Friday, September 23, 2016



September 2016, "Executive Summary...For DOT, the excitement around highly automated vehicles (HAVs) starts with safety. (p5)

...The development of advanced automated vehicle safety technologies, including fully self-driving cars, may prove to be the greatest personal transportation revolution since the popularization of the personal automobile nearly a century ago. (p5)

...The benefits don't stop with safety. Innovations have the potential to transform personal