Transportation Nexus

New Game

Three Drivers

- Dispatchable Transportation (E.g. Uber)
- Low operating costs of EVs
- Autonomous Driving (A.D.)

=> Major disruption in transportation

Is Driving Safe?

~37,000 annual traffic **deaths**;
>3,000 in California

>90% of automobile crashes are caused by human errors


Traffic Deaths from 1st 6 mo.
20000
18000
16000
14000
2013
2014
2015*
2016*

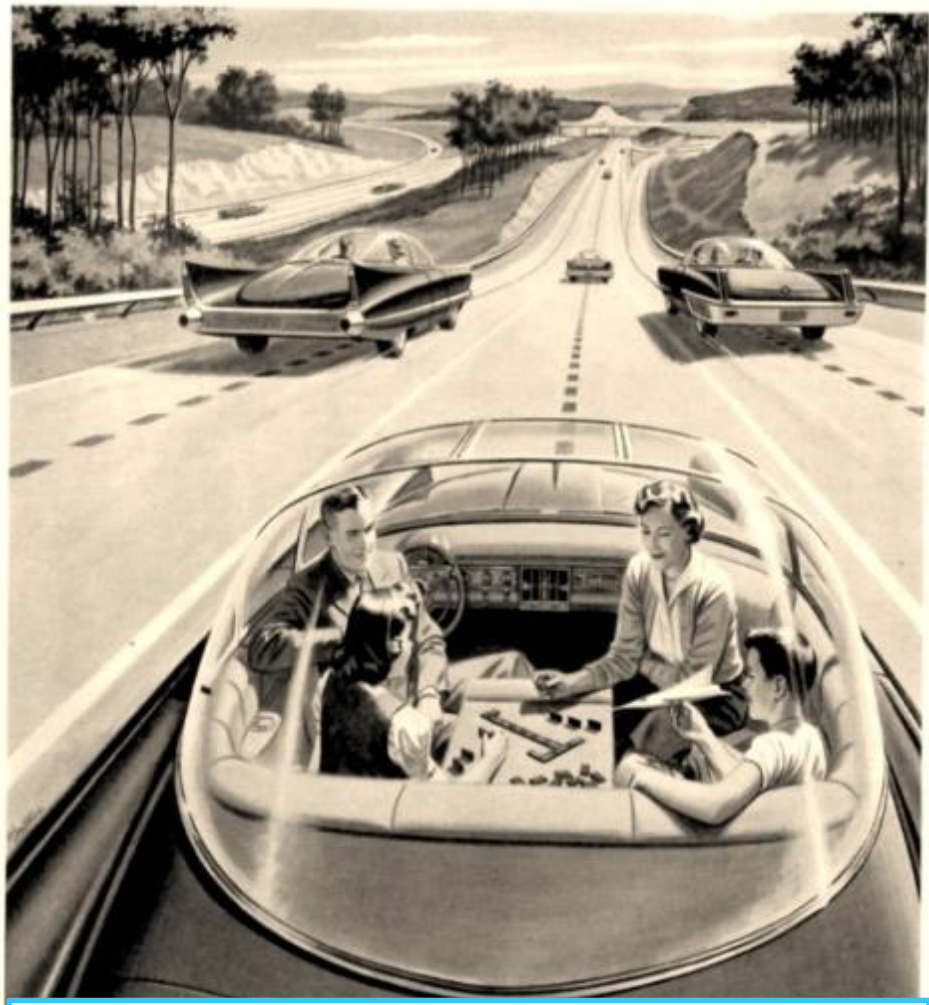
Parking

- 100M to 2B parking places are used to store cars
- Area larger than Delaware and Rhode Island combined

Cars sit ~95% of the time

What if: A Vision

- Cars rapidly available on demand
- A type of your choosing
- 10% to 25% the cost of a cab
- 10's of thousand of acres become available for parks...
- The disabled, impaired, elderly, youth are given transportation.
- Lower risk of accidents.
- Increase public transit use
- Time is given back to us
- 50% reduction in trucking cost



In 5 or 6 years "… you could literally get in the car, go to sleep and wake up at your destination". - Elon Musk

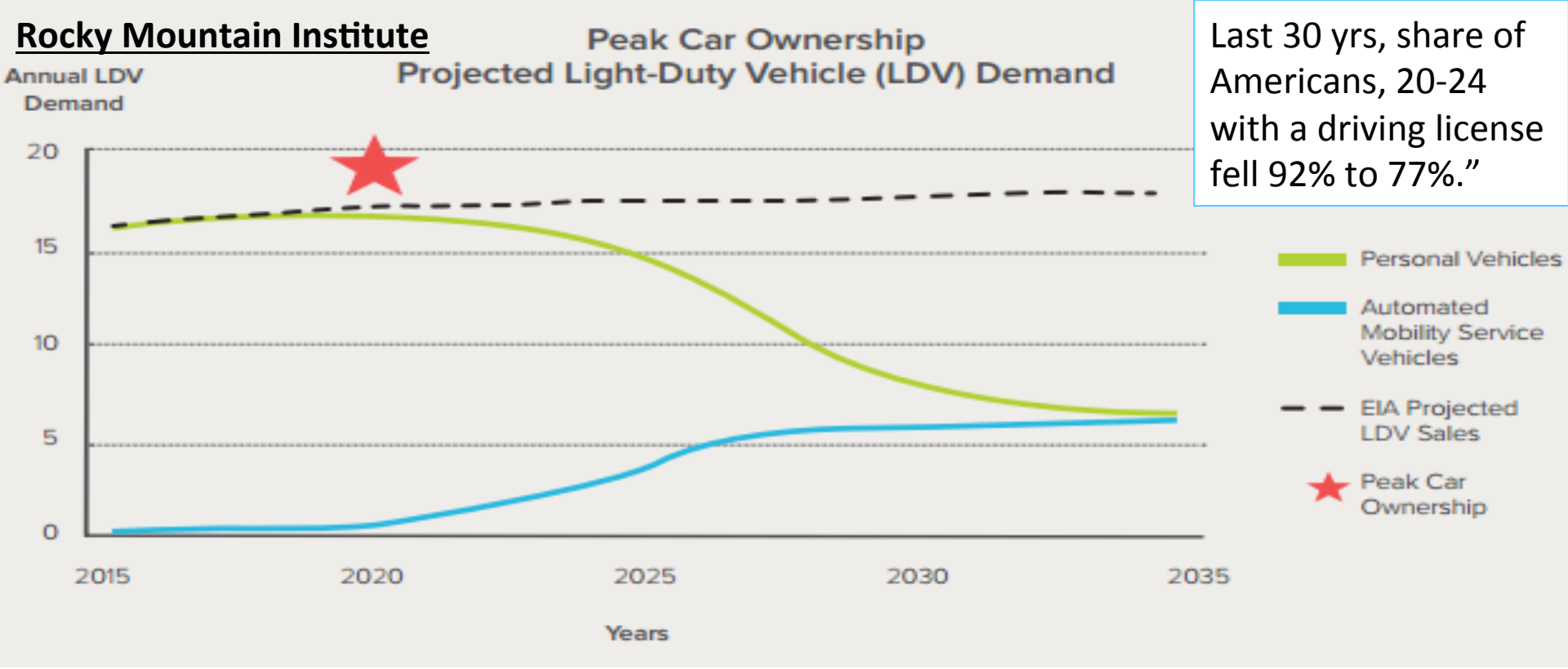

Autonomous Driving
Uber Cost Reductions

Predictions

- VW Jungwirth: “In a few years we’ll see vehicles without a steering wheel or pedals. VW to build self-driving cars 'faster than competition’.
- Ford: Will produce self-driving cars in **high volume by 2021 (w/o steering wheel)**.
- Tesla CEO Elon Musk recently said this future was coming a “**hell of a lot faster**” than you think.
- Baidu’s CEO plans mass production of driverless vehicles in by 2021.
- Nissan planning for A.D. by 2020
- VW self-driving e-Golf be available in 2020.

VW reckons autonomous fleet would save a million lives per year.

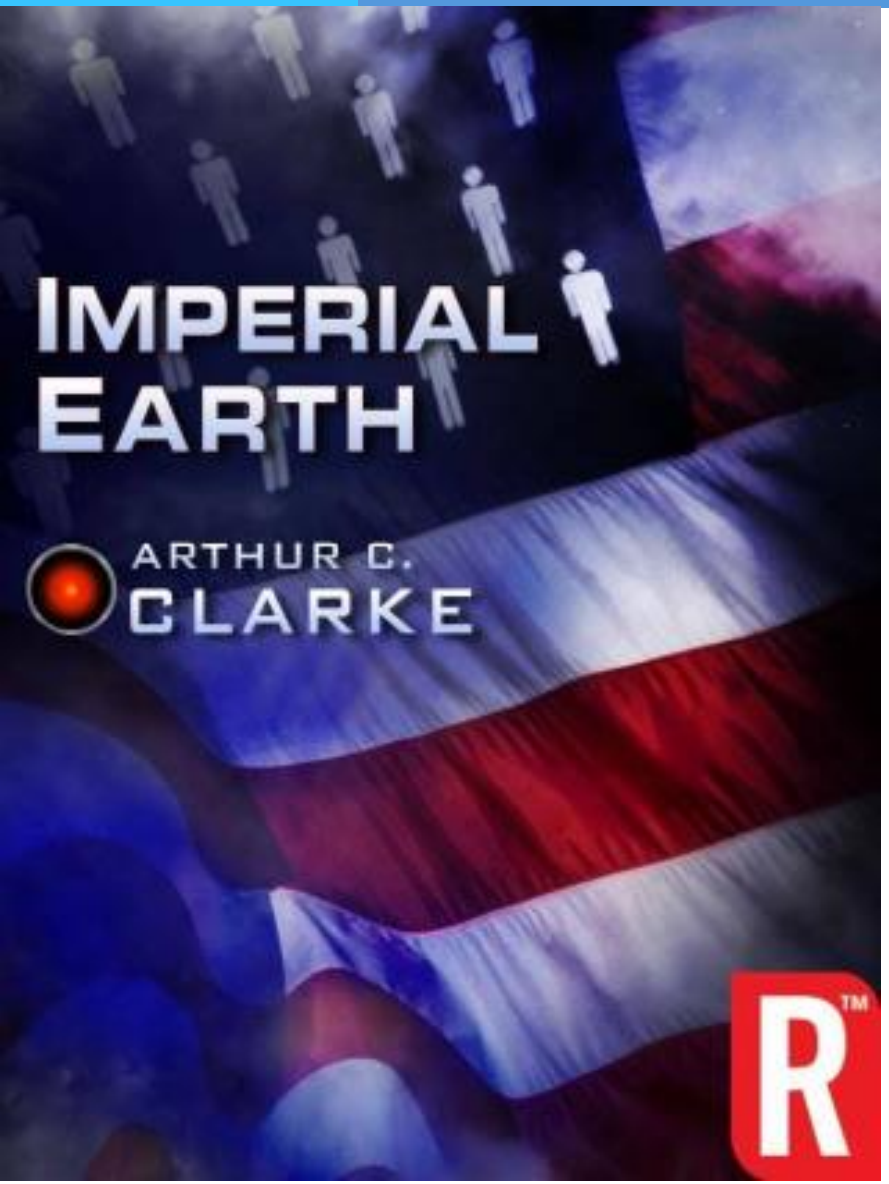
Rocky Mountain Institute



Last 30 yrs, share of Americans, 20-24 with a driving license fell 92% to 77%."

- Lyft CEO: majority of Lyft's rides will be autonomous within 5 years, all within 10 years. Car ownership "will all but end" by 2025.
- Head of Uber Self Driving Cars, "... I really believe that the most important things that computers are going to do in the next 10 years is drive cars."
- Kalanick, Uber CEO, "… an impeding technology that is going to **change our society in unimaginable ways**: the driverless car "

Predictions



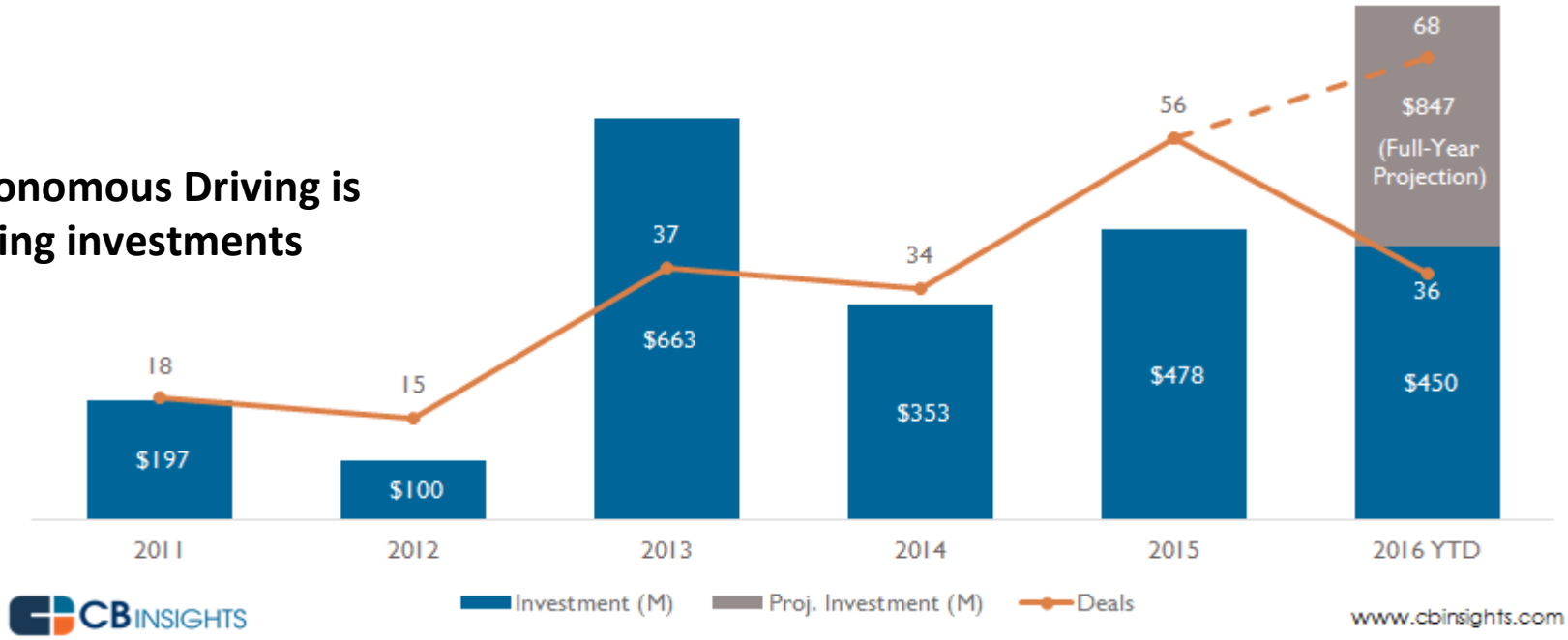
A future that it's a crime to manually operate a car on public roads.

1975

Auto Tech Annual Global Financing History

2011 - 2016 YTD (7/13/2016)

Autonomous Driving is driving investments



Investments:

- GM - $1B on self-driving tech center in Detroit. Ford $75M in a maker of LIDAR sensors
- Boston Global Consulting predicts that the 2025 autonomous driving market will hit $42B
- Bosch Dedicates More Than 2,000 Engineers To Driver-Assistance Technology
- German consortium — including Audi, Daimler and BMW bought Nokia's precision mapping assets for $3.1B.

Pilots already started:

- Public self-driving taxi rides in Singapore
- Public able to summon self-driving cars from phones in downtown Pittsburgh
- Delphi sent an AV Audi SQ5 SUV on a coast-to-coast drive in March 2015.
- Budweiser/UBER Ft Collin to Colorado Springs
- Convoy of AD trucks drove across Europe and arrived at the port of Rotterdam

A.D. Trucking

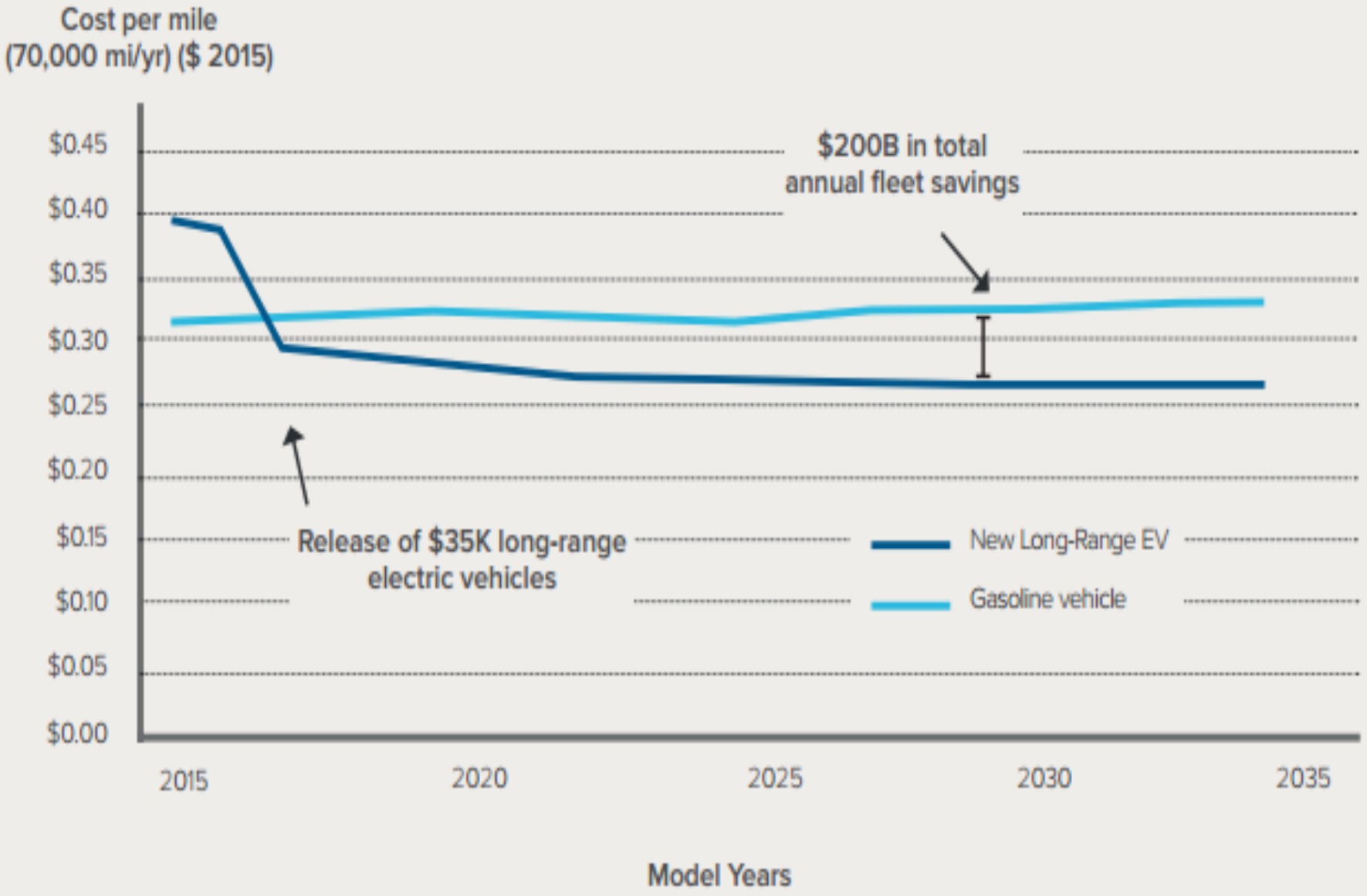
- Budweiser/UBER Beer shipment – 120 miles Ft Collins to Colorado Springs
- Convoy of AD trucks drove across Europe and arrived at the port of Rotterdam

- Reduction in cost of over 50%
- Plus:
  - Lower Fuel and Gas costs
  - Platoon Savings of 6%
  - Safer

6 Reasons A.D. and EVs Go Together

1. Removing both gas and the driver can deliver a very low cost of service
2. Wireless EV charging integrates seamlessly with autonomy: easier, cheaper and safer than gassing up
3. It is easier to implement autonomous features on EVs, EV are easier for computers to drive.
4. Both technologies will mature at around the same time (2030)
5. EVs have lower failure rate – important as utilization goes up without driver to manage problems
6. Cities are beginning to place restrictions on use air polluting gas vehicles in metro areas (bans, congestion charges, …).

Relative Cost of Electric vs. Gasoline Vehicles for Mobility Service



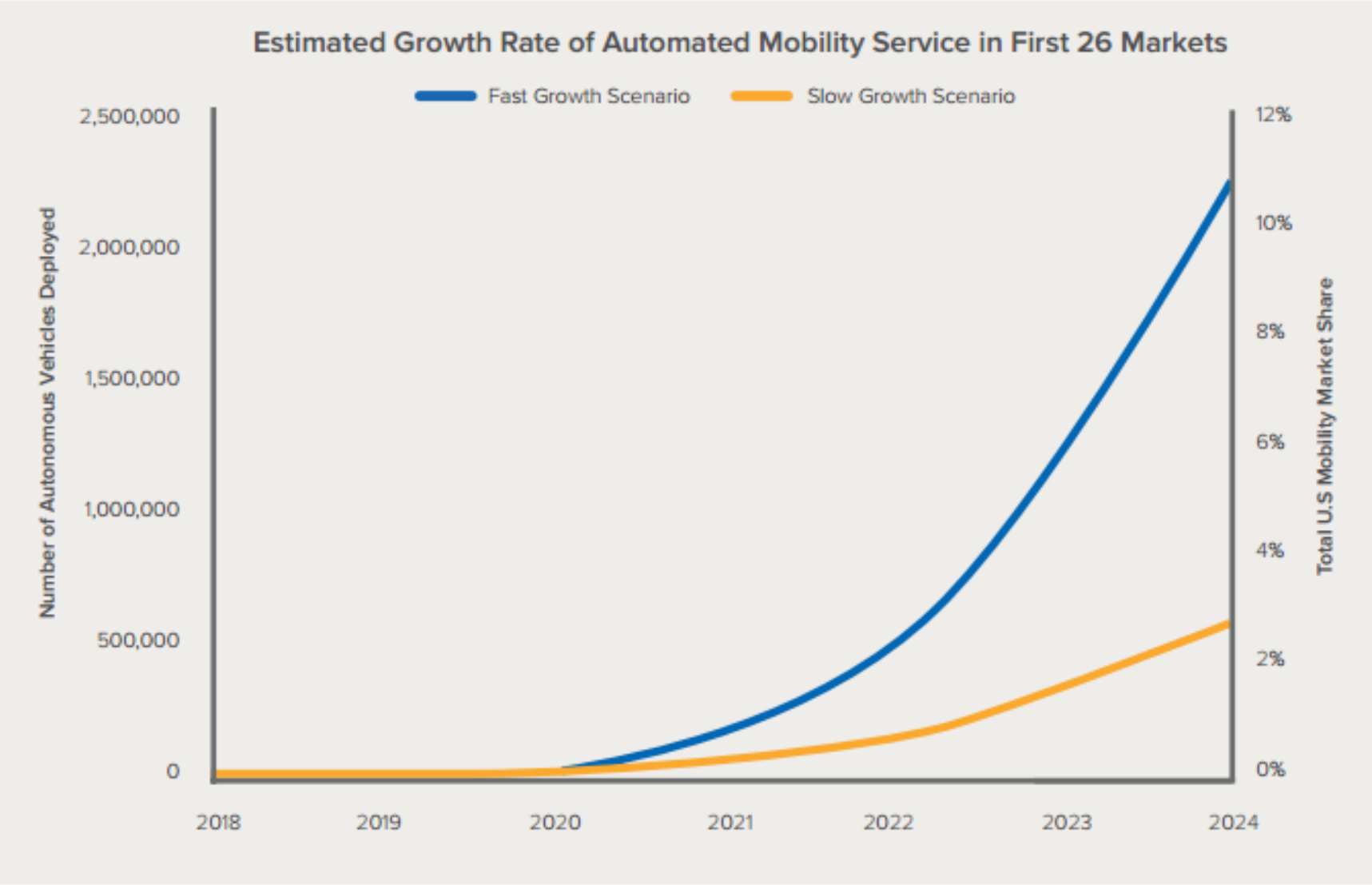
A.D. + Dispatchable Transportation Costs

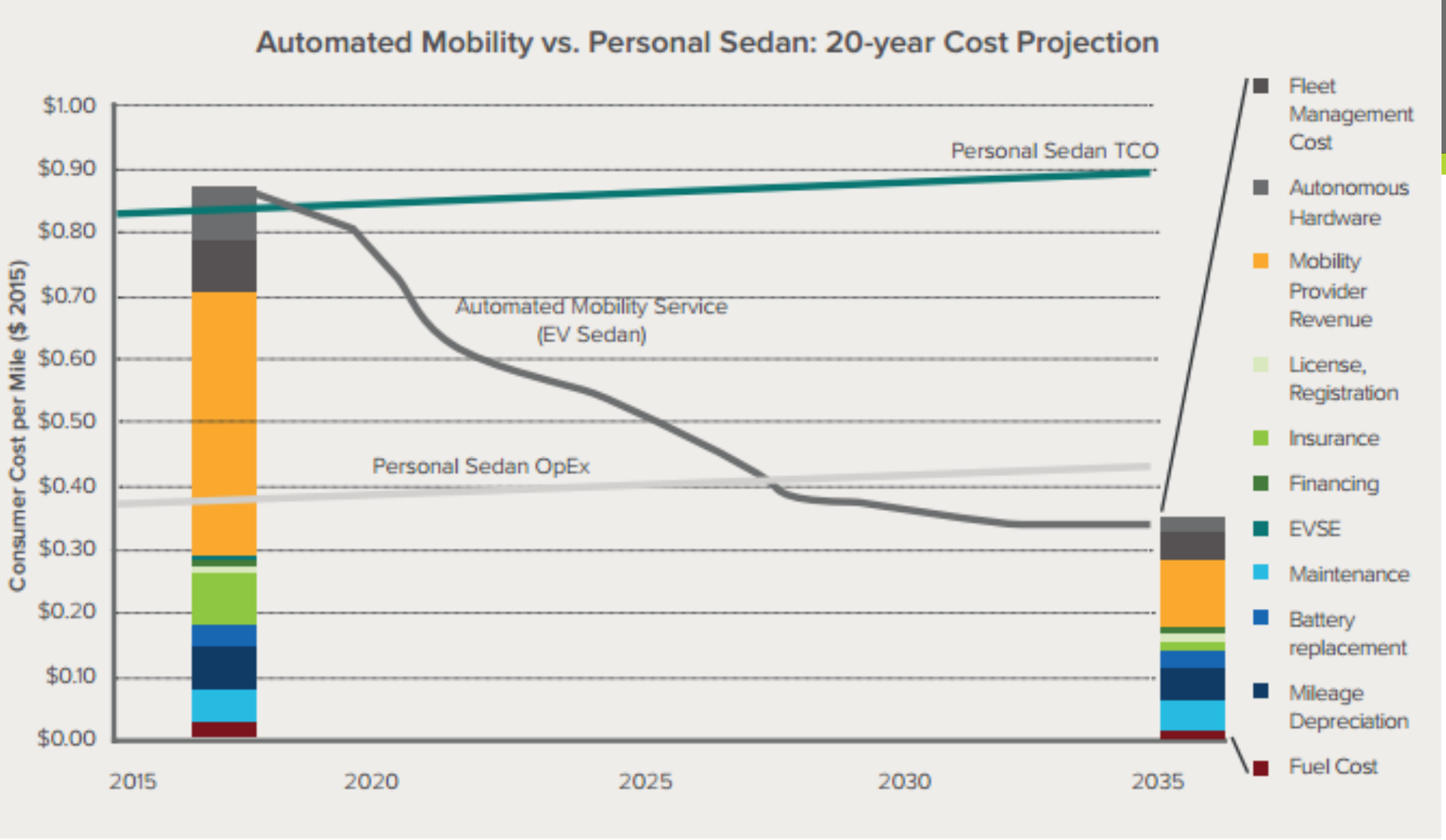
- The cost of providing the yellow taxicab service is ~$4.00 per trip mile.
- Similar service via a shared, driverless vehicle fleet cost is estimated to be $0.50 - $1.00 per mile.

WHY?

- Fewer taxis, less empty miles and eliminated labor costs of the driver.
- EVs bring down fuel and maintenance costs by $0.10 per mile (1/2 ICE costs)
- Other potential savings: lower insurance (fewer accidents, hostilities, …)

ESTIMATED GROWTH RATE OF AUTOMATED MOBILITY SERVICE IN FIRST 26 MARKETS





Why own your own car?

A.E. Levels

Level 1	• Driver Assistance • Specific Functions (steering, speed, parking)
Level 2	• Both steering and acceleration using environment information • Driver ready to take control
Level 3	• Shift "safety-critical functions" to the vehicle • Known limited environments (SAE) • Driver still present
Level 4	• All critical driving functions and monitoring conditions for a trip. • Under most conditions (exception example: severe weather)
Level 5	• Every driving scenario • Fully autonomous

Other Challenges

1. Job Loss
2. Liability and Safety concerns
3. Regulation
4. Hackability
5. Impact on VMT

Employment

- Approaching 2M heavy-truck and tractor-trailer drivers.
- Approaching 1.5M delivery truck drivers for small regional shipments.
- 233,700 taxi drivers and chauffeurs in 2014, growing at 13% annually
- Over 500,000 rideshare drivers are estimated in the US and growing. Half of them worked 15 hours or less per week.

4.1 million people drive for a living.

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Congestion / VMT

Stupid

- Repositioning miles
- Lower mass transit use (Private Bus)
- Lower pain for slow commutes
- Lower parking rates

Smart

- Multiple rates by car type
- Peak rates
- Caravans, Platoons
- Reduce metro time 30% (no parking search)
- A.D. feeders to / from mass transit
- Reduced emissions, electricity use
- Lower accident rate -> less congestion