

Heading Toward Zero: California's Transportation Sector

Daniel Sperling

Distinguished Blue Planet Professor and Founding Director
Institute of Transportation Studies
University of California, Davis

and

Board Member, California Air Resources Board

31 January 2018



UC Davis Institute of Transportation Studies

World's Premier University Center for Sustainable Transportation

- 60 faculty and Ph.D. researchers
- 110 graduate students
- 100+ publications/year

Engagement/Sponsorship

- 60+ Company sponsorships
- 15 Government agencies
- Environmental NGO participation

National Center for Sustainable Transportation (w/Georgia Tech, USC, UC Riverside, and Univ Vermont)



Asilomar Conference on Transport and Energy (biennial since 1988)



China-U.S. ZEV Policy Lab



Local and global focus



Governor Schwarzenegger announces California's Hydrogen Highway at UC Davis

California Leadership... Governor Brown State of State Speech 5 Days Ago

“...the science of climate change is not in doubt...All nations agree except one and that is solely because of one man: our current president.

Here in California, we follow a different path. Enlightened by top scientists at the University of California, Stanford and Caltech, among others, our state has led the way. I'll enumerate just how:

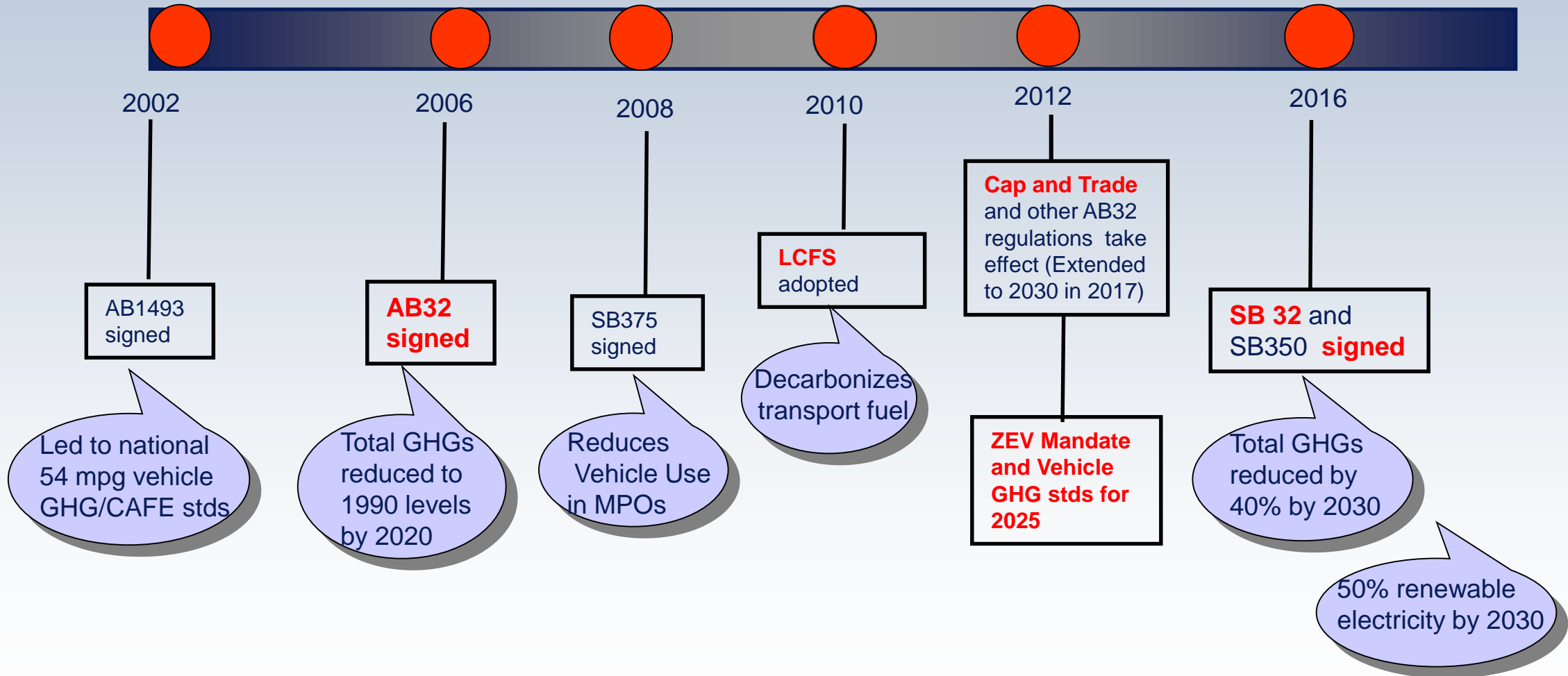
- Building and appliance efficiency standards;
- Renewable electricity --reaching 50 percent in just a few years;
- A powerful low-carbon fuel standard;
- Incentives for zero-emission vehicles;
- Ambitious policies to reduce short-lived climate pollutants like methane and black carbon;
- The nation's only functioning cap-and-trade system.

California Leadership... Governor Brown State of State Speech 5 days Ago

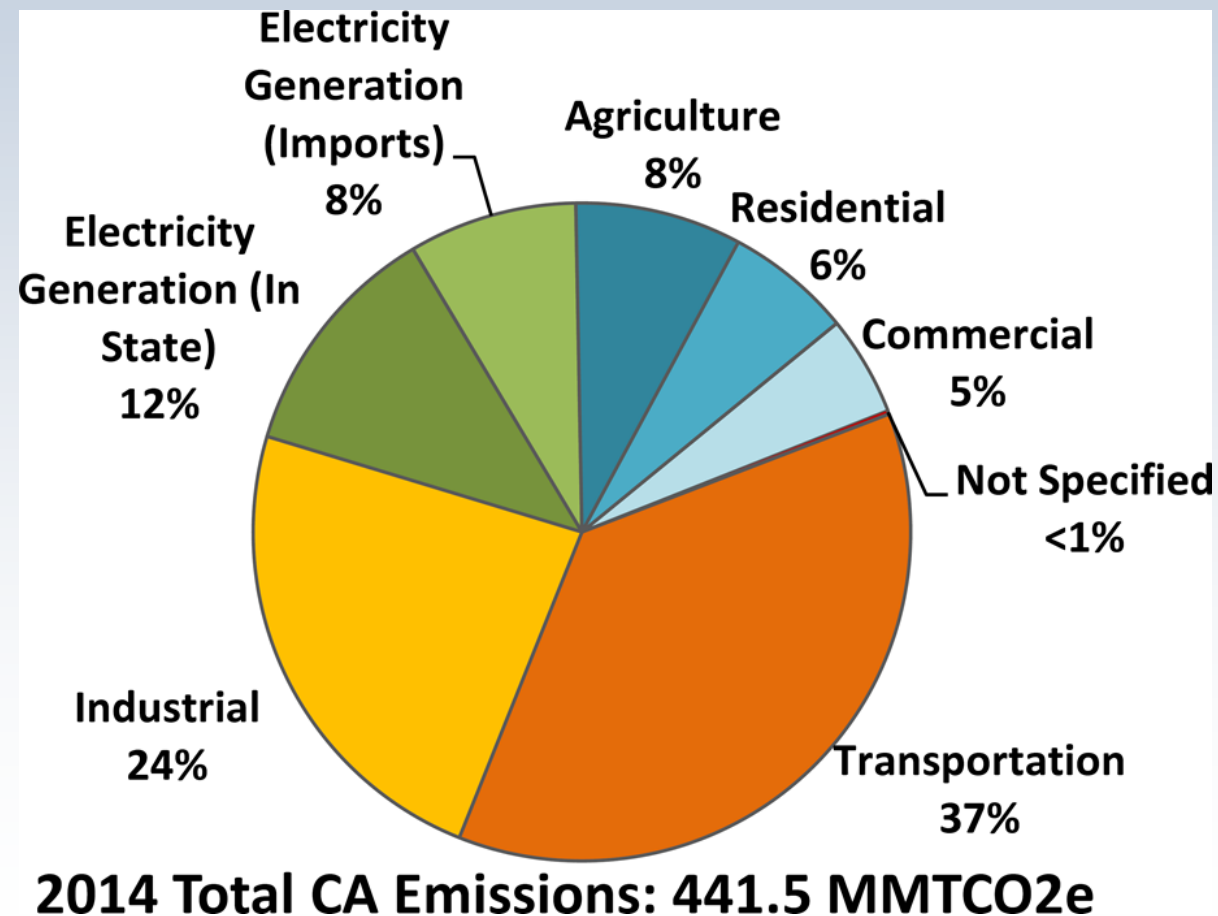
.....The goal is to make our neighborhoods and farms healthier, our vehicles cleaner -- zero emission the sooner the better -- and all our technologies increasingly lowering their carbon output. To meet these ambitious goals, we will need five million zero-emission vehicles on the road by 2030. ... We only have 350,000 today, so we've all got a lot of work.”

California Leadership on Climate Policy for 16 Years

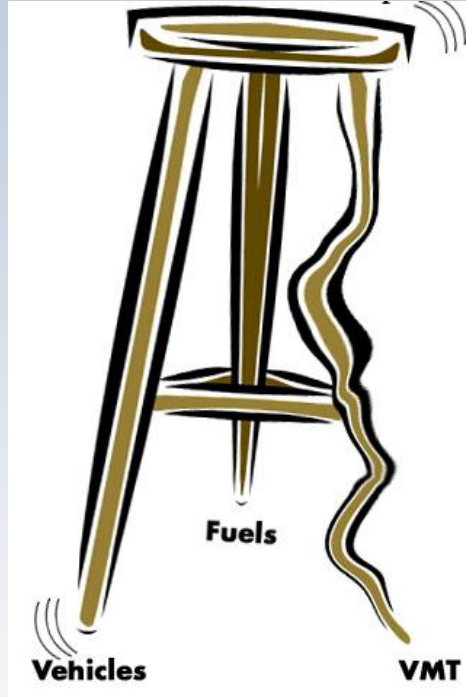
Comprehensive Policy Model



Why California is Focused on Transportation: ~40% of GHG Emissions



Three Principal Strategies to Reduce GHGs from Transportation



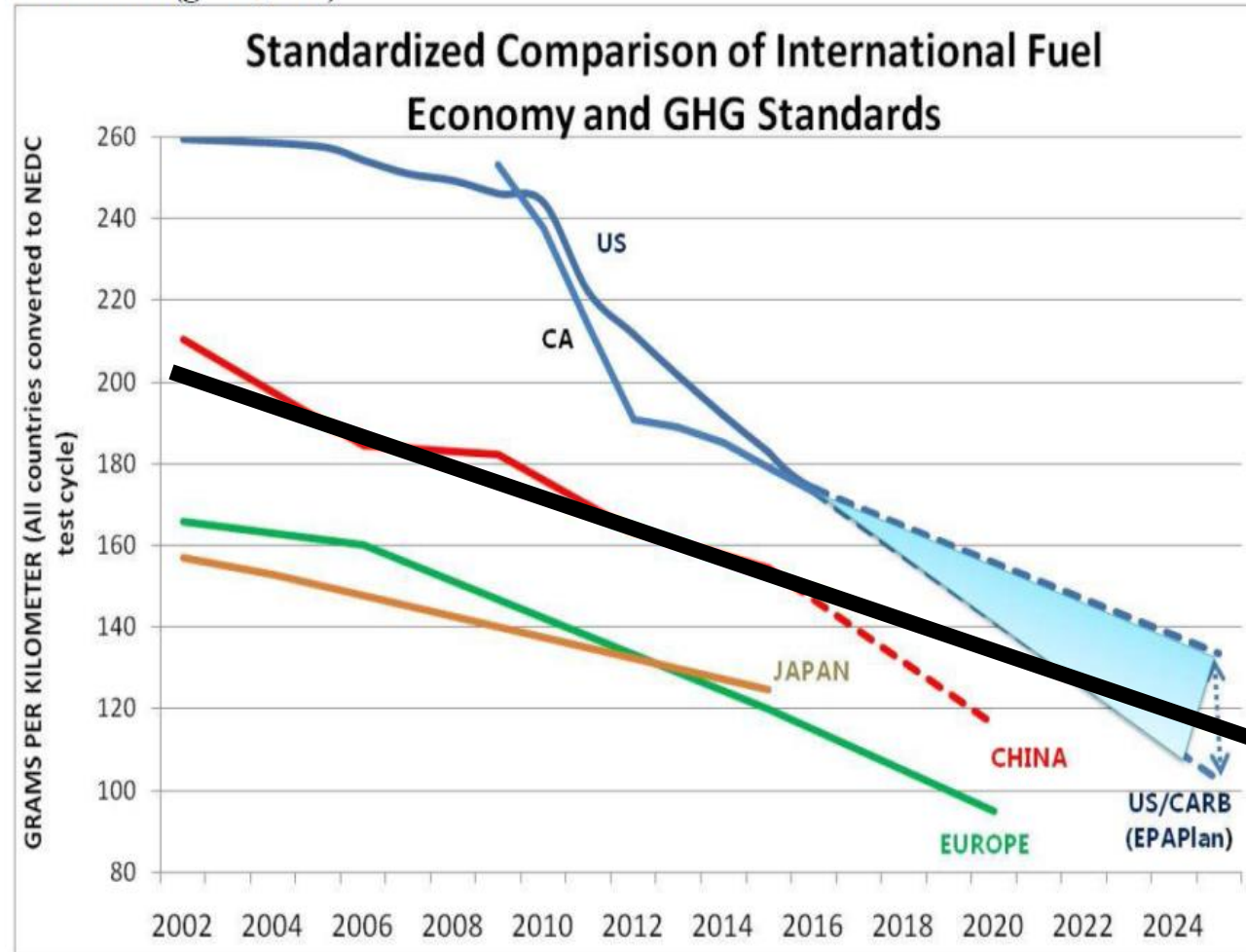
- Zero emission vehicles (including PHEVs)
- Low-carbon fuels electricity, hydrogen, biofuels
- Reduce VKT

From Technical Fix to Behavior

- Historically, pollution regulation focused on smokestacks and tailpipes (technical fixes)
- Now need broader policy approach
 1. Innovation (new technologies and institutions)
 - Vehicles, fuels, mobility, institutions
 2. Behavior
 - Vehicle purchase
 - Vehicle use
 - Mobility (new modes, new services, inter-modalism)
 3. Partner with industry (to stimulate innovation and shift consumer behavior)

Auto Industry and Policy on Path to Major Reductions (California, US, EU, World)

Standardised comparison of international fuel consumption standards based on GHG emissions (gCO₂/km)

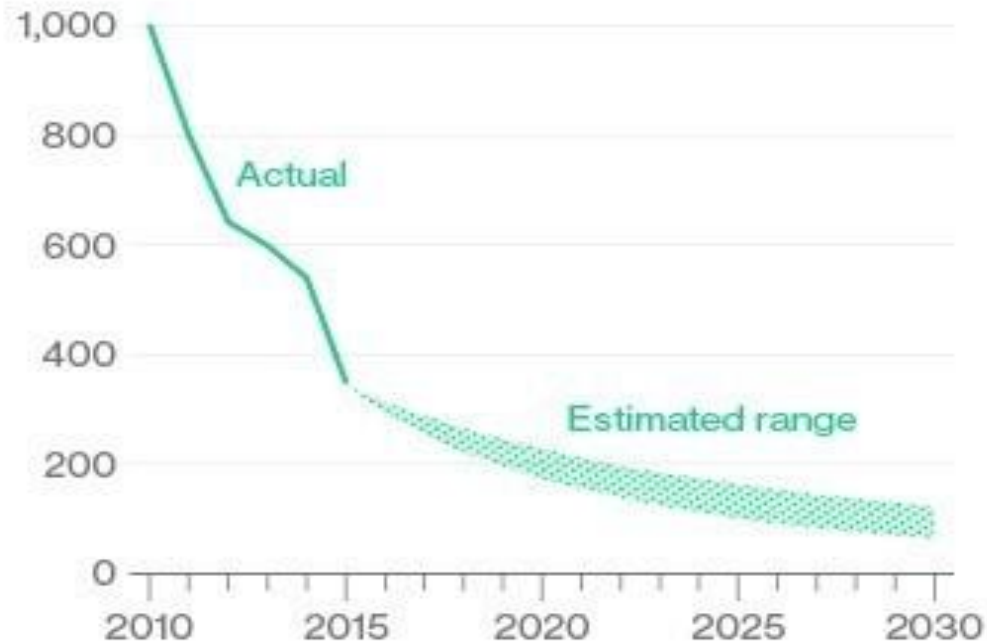


**80%
reduction
by 2050?!**

Continued Battery Improvements Are Key ... for Cars, Buses, Trucks

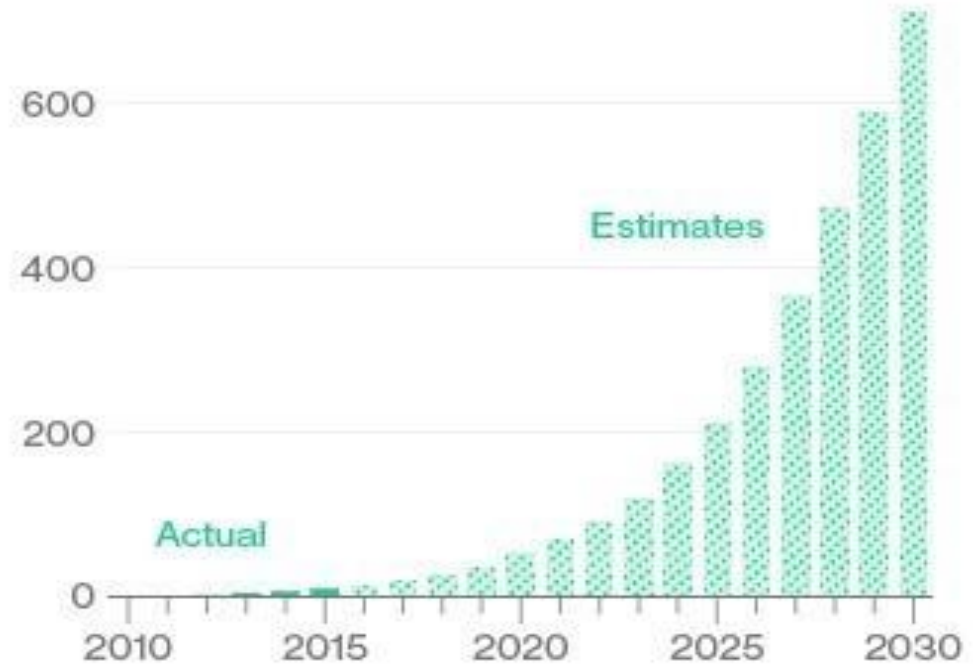
Cost for lithium-ion battery packs

\$1,200 per kilowatt hour



Yearly demand for EV battery power

800 gigawatt hours



Source: Data compiled by Bloomberg New Energy Finance

Role for Hydrogen Fuel Cell Vehicles



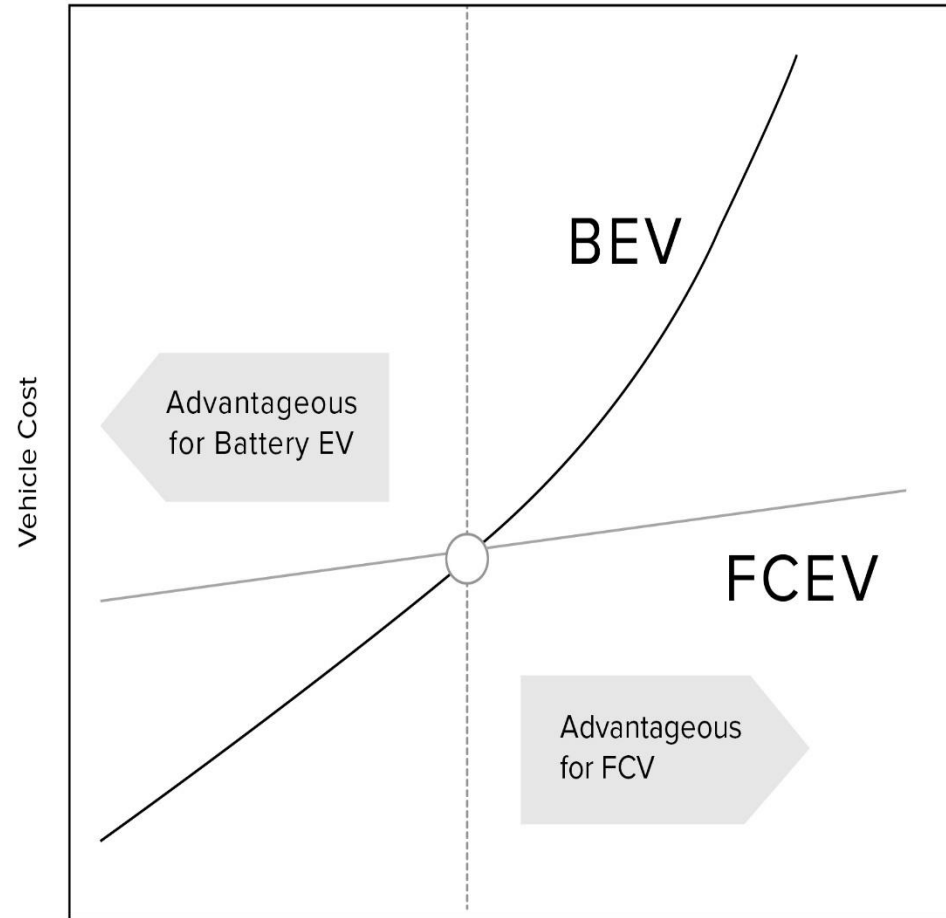
Tesla Model 3



Nissan Leaf



Chevy Bolt

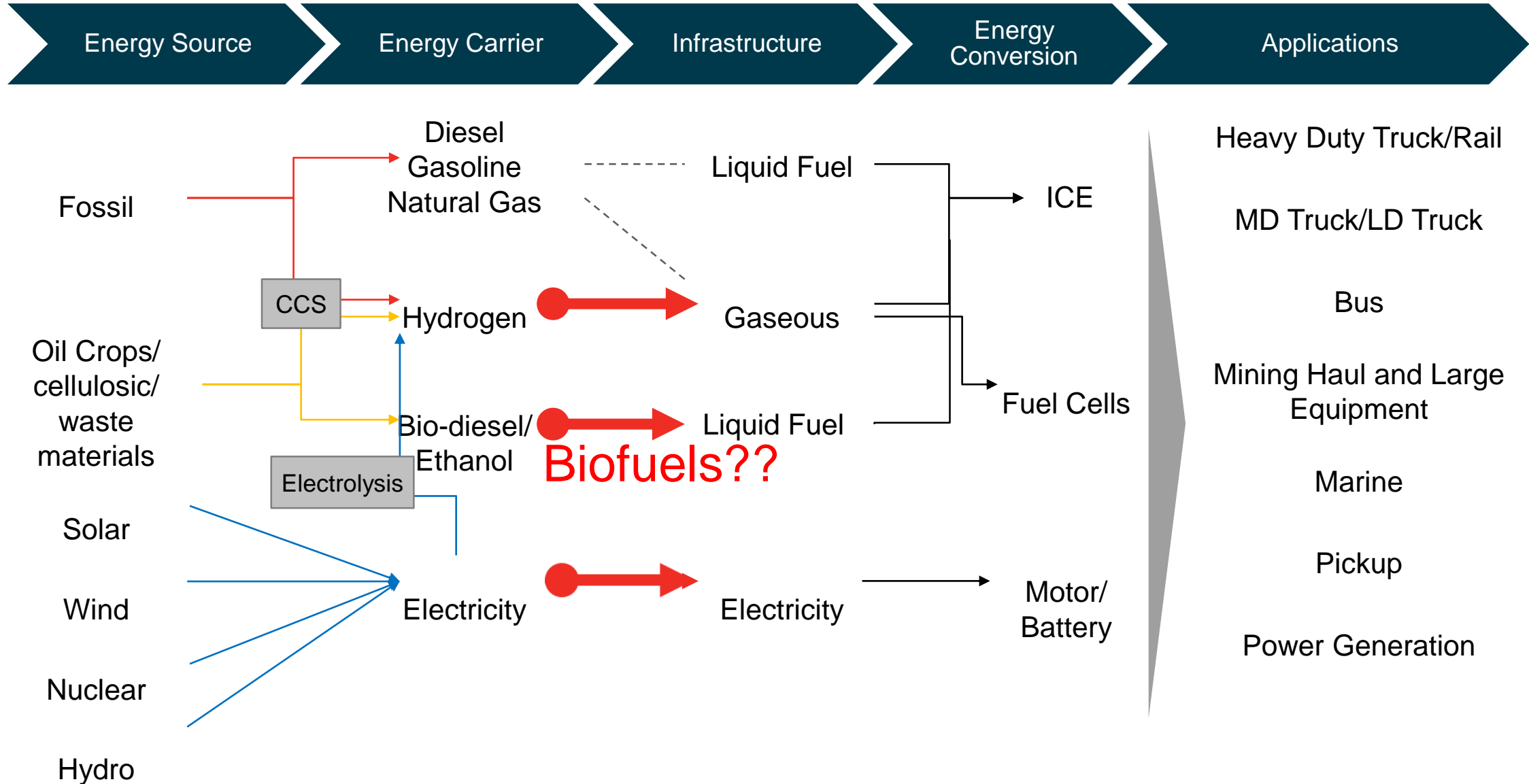


*Mercedes-Benz
Citaro E-CELL*



Toyota Fuel Cell Truck

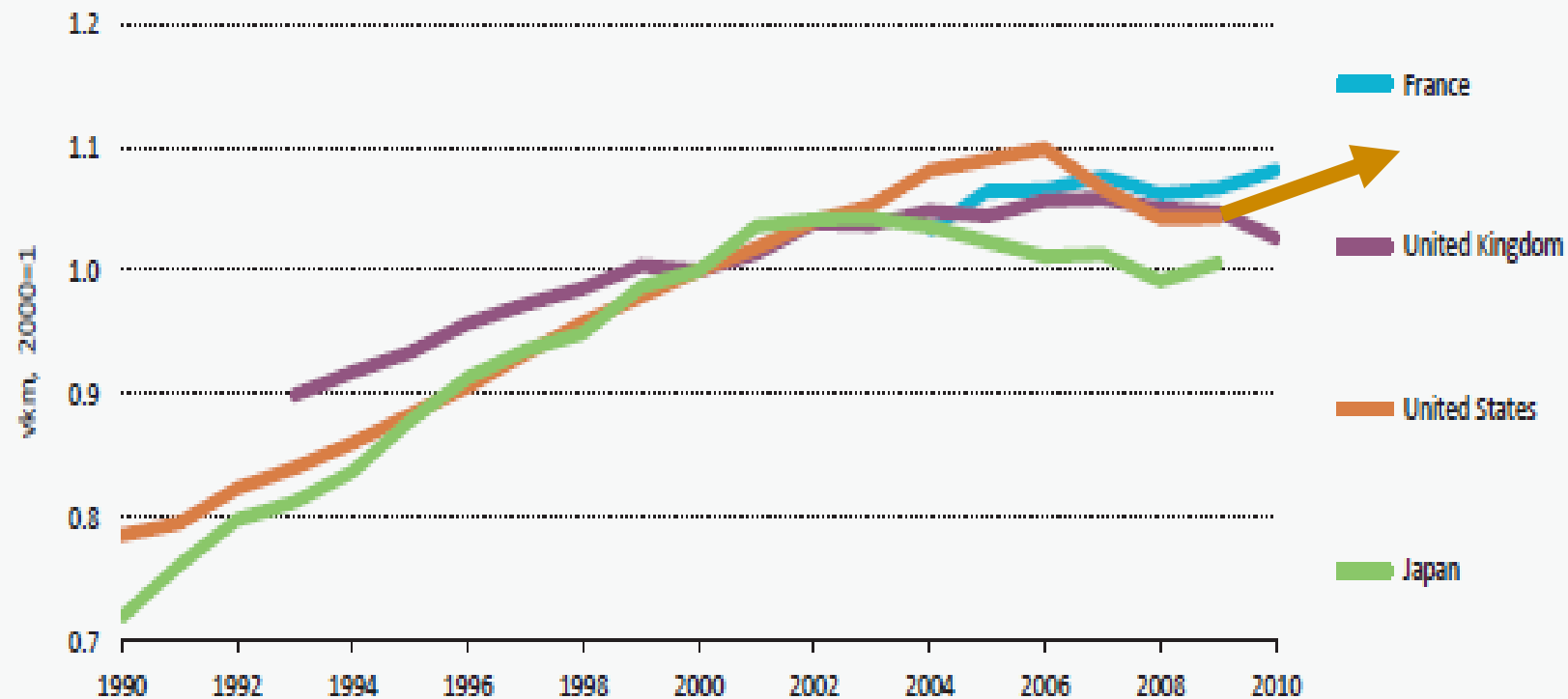
Energy Pathways for Trucks More Uncertain



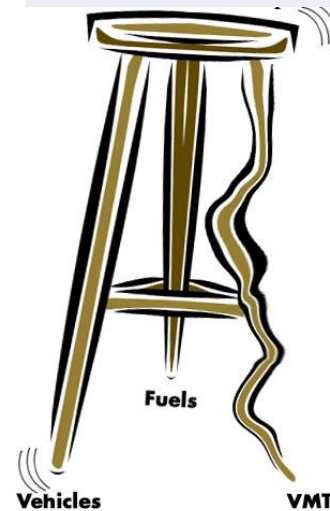
VKT (3rd Leg) is Most Difficult—and now INCREASING

Figure 13.11

Passenger LDV travel for selected OECD countries, indexed to 2000



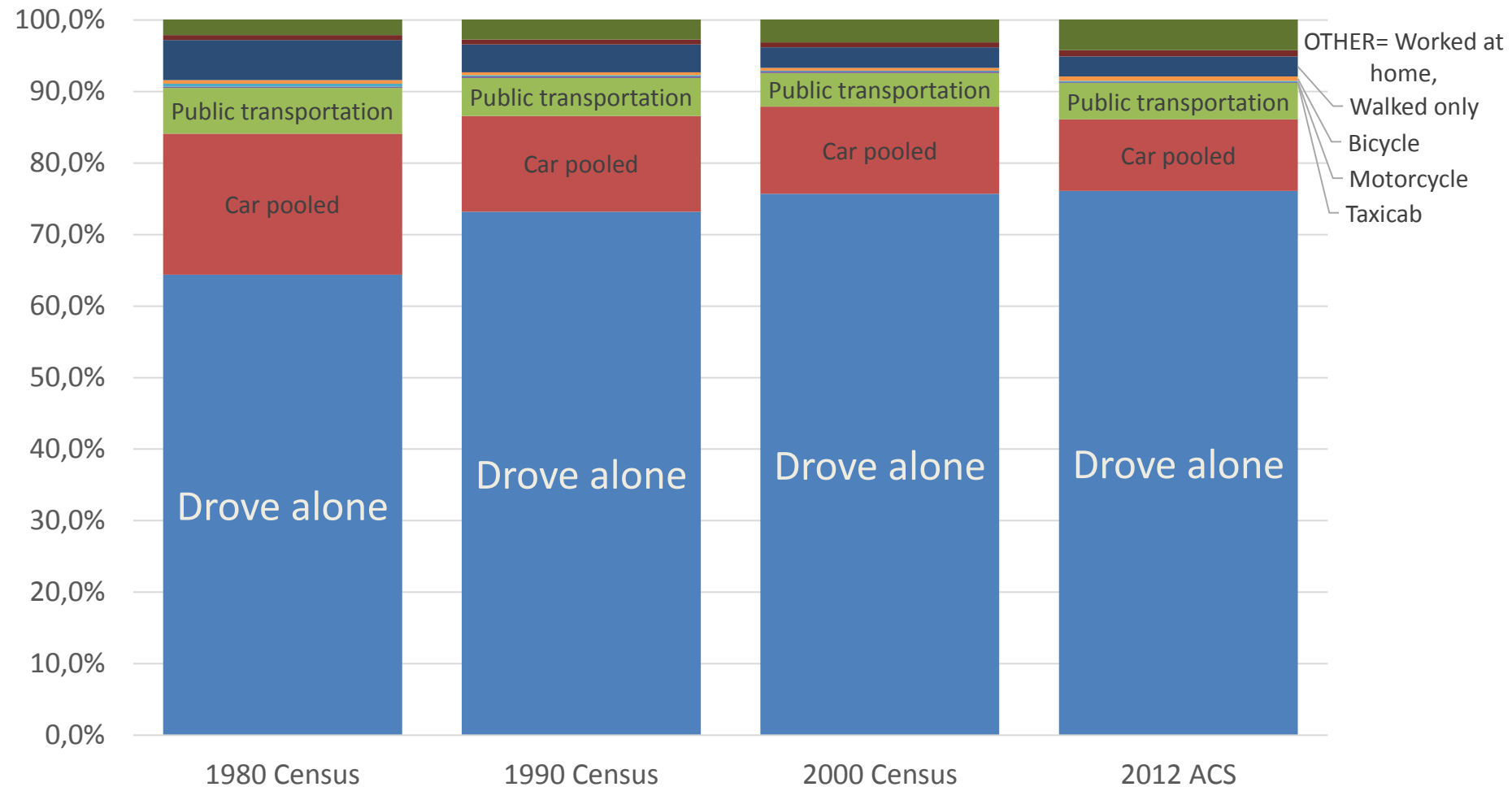
Source : IEA, 2012 (ETP 2012)



US/California Can Learn from Germany

... How to Eradicate the US Transport Monoculture

Means of Transportation to Work, 1980, 1990, 2000, and 2012



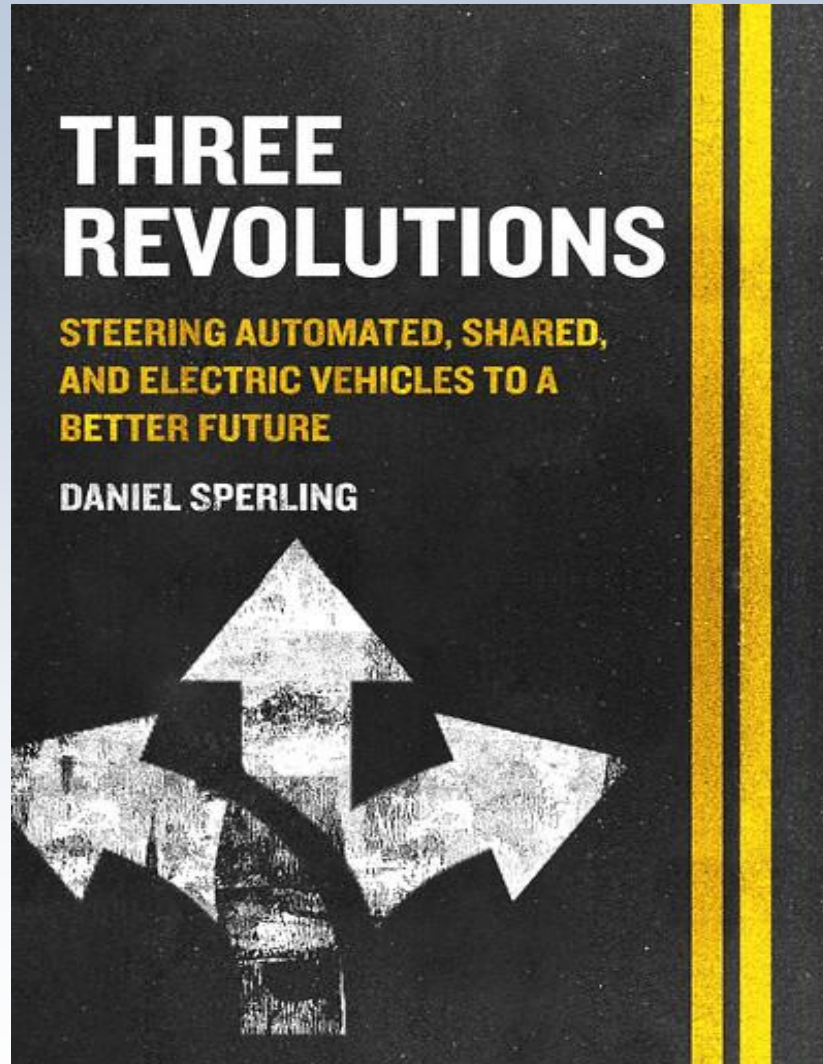
Revolution: REDUCE Car Use?!



Reducing Car and Truck VKT in California ... Work in Progress

- Each urban region must have plan to reduce VKT
 - Effective at focusing cities on VKT reduction (successful because aligns with goals to reduce parking/road infrastructure, congestion, pollution, etc)
 - But no carrots nor sticks (yet)
- Sustainable Freight Action Plan
 - Regulations in development for electric trucks
 - Efforts underway to reduce truck VKT.... Improve Freight Efficiency!
 - urban delivery, logistics, warehouses

Directing transportation revolutions toward the public interest



Goal:

- More PKT
 - Less VKT
- ... plus electrification*

Minimize:

- Individually owned AVs (& zero-occupant vehicles)
- Refrigerators that call Amazon to replace beer

3 Revolutions Could Increase or Decrease Energy Use and GHG Emissions

+ 200 %



Factors that could increase energy consumption and associated emissions:

+ Reduced In-Vehicle Time Cost ➡ **+ Increased Vehicle Miles Traveled (VKT)**

+ Zero-Occupancy Vehicle operation

+ Access for New User Groups

+ Faster Driving Speeds (vs congested speeds)

+ Shipment of Goods

Factors that could decrease energy consumption and associated emissions:

– Pooling of rides (MaaS)

--Platooning or Drafting

– Eco-Driving

– Congestion Mitigation (smoother driving)

– De-emphasized Performance

– Improved Crash Avoidance

– Electrified Vehicles (PEVs and FCVs)

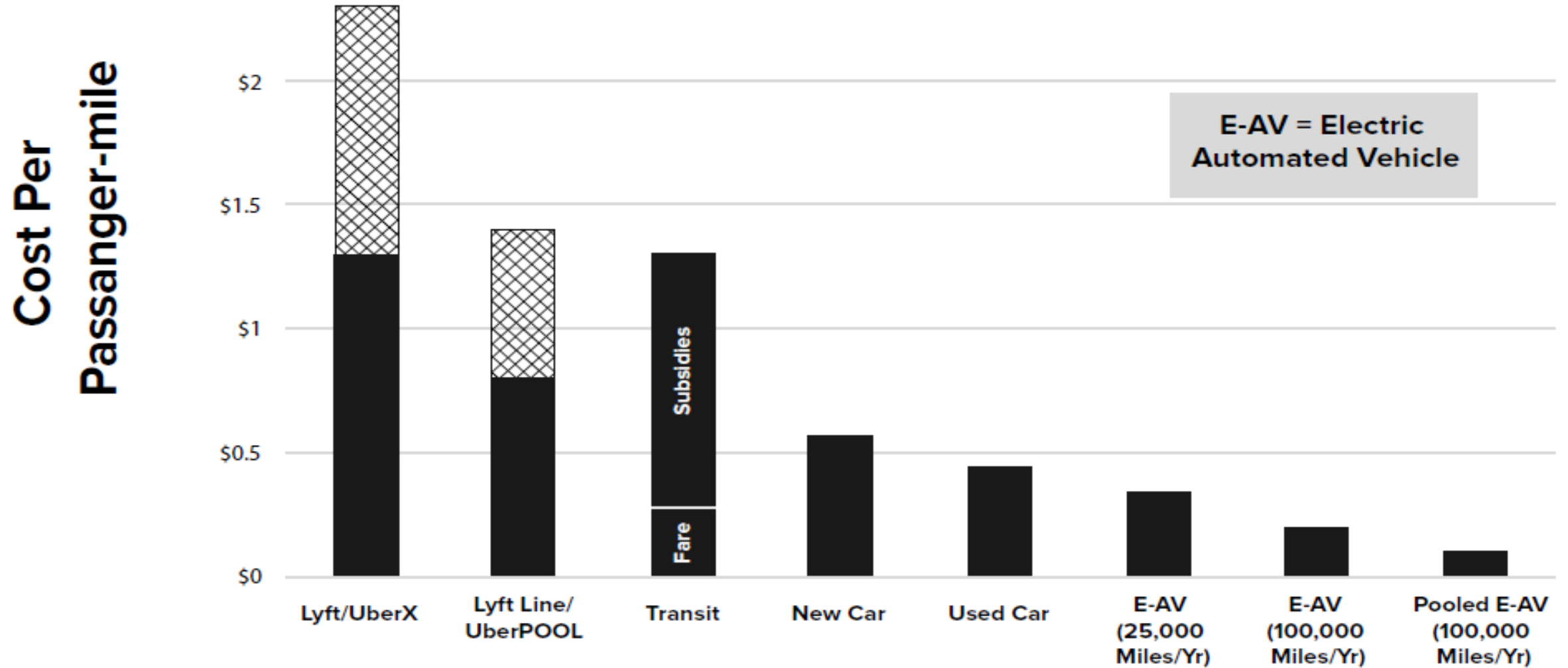
– Less Hunting for Parking

– Vehicle Right Sizing

- 60 %



Automation + Pooling = Free Mobility (?)



Ideas to Fix Transit... which is in decline in CA/US

- Replace low-density routes with private “mobility” companies
- Use new mobility companies for first/last mile service
- Withdraw to dense corridors/markets where transit works best
- Embrace micro-transit!
- Restructure public transit funding (for microtransit, private mobility company partnerships)!
- Embrace automation (for fixed shuttle routes)

➤ *Many reforms needed in governance, public finance, management, partnerships—especially in suburbs and small cities*

Creating Transport Systems That Are Cheaper, Better, and More Sustainable

- Less expensive
- Less resource intensive
- Less carbon intensive
- More accessible

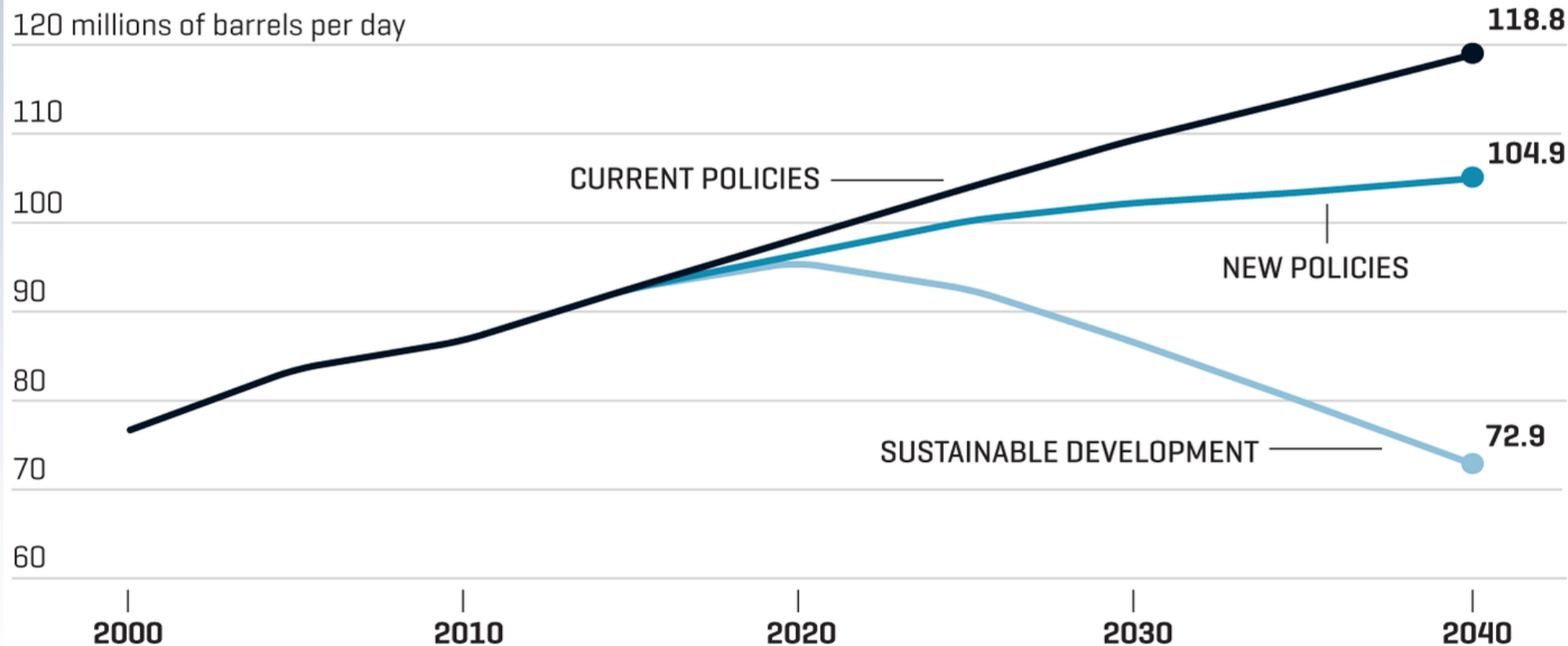
....3 Revolutions: VKT↓ PKT↑ + electrified

....and more efficient, low emission freight

RADICAL UNCERTAINTY

Depending on how quickly the world adopts new technologies, oil demand could peak within a decade or in the 2040s. The wide range of possible outcomes is a planning challenge for Shell and other oil giants.

WORLD OIL DEMAND UNDER THREE SCENARIOS



SOURCE: IEA

Why Gov't Initiative is Needed ... and why prices are not enough

A Long List of Market “Failures”

- **Environmental and energy externalities**
- **Principal agent problem** (rental cars, truck trailers, leased vehicles, cars for legislators/execs)
- **Network externality.** Complementary products requiring large *non-recoverable* investments and investments that cannot be made by individual consumers—such as when different vehicles or different infrastructures are required (H2, bike paths for biking, smart paratransit, etc)
- **Technology lock-in**
- **Market power** (cartels, oligopolies, etc)
- **High entry barriers in auto industry**
- **R&D under-investment** due to:
 - industry diffusion (ag industry)
 - R&D spillovers. When R&D findings cannot be fully captured (leading to under-investment in R&D)
 - Learning-by-doing spillovers where mfg savings not fully captured
- **Consumer cognition** (eg, buying cars), resulting in under-investment in efficiency (related to information and loss-aversion)
- **Volatile oil prices** create uncertainty which leads to under-investment in alternatives

Climate Policy Must Be Complex Mix of Initiatives

(laws, regulations, incentives, R&D)



+



California spending ~\$1.5 billion/year in incentives for cleaner transportation (vehicles, buses, fuels)

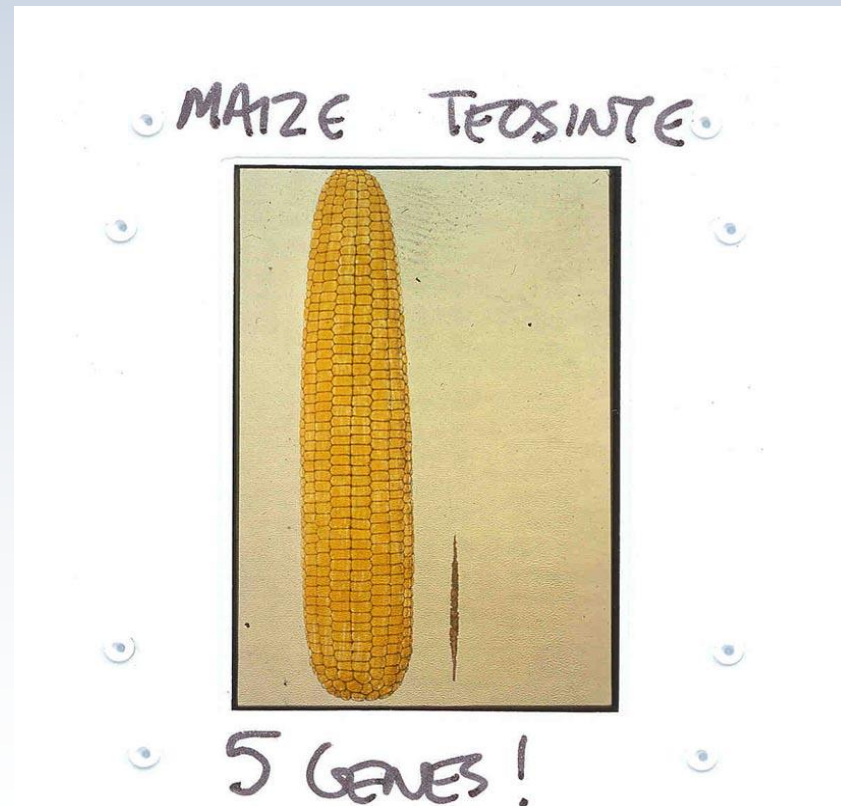
Shift “Populist” Narrative

...From Government Intervention to Helping Consumer/Citizen

- “Pooling” is cheaper and easier (eg UberPool)
 - Helps everyone
- Vehicle automation is good for “people” when “pooled” (MaaS)
 - Helps everyone
- EVs are better and cheaper (lower energy cost, less maintenance)

Question of Focus and Priority

Humans are incredibly creative, when they focus attention and resources—
such as low-carbon fuels, vehicle automation, batteries, fuel cells?



“We can not solve our problems with the same thinking [and institutions and research] we used when we created them.”

- Albert Einstein

Thank You

