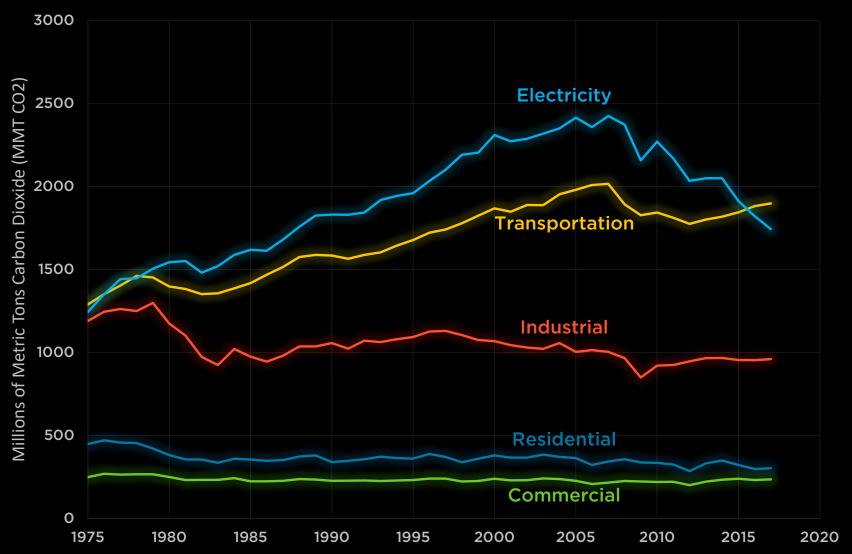
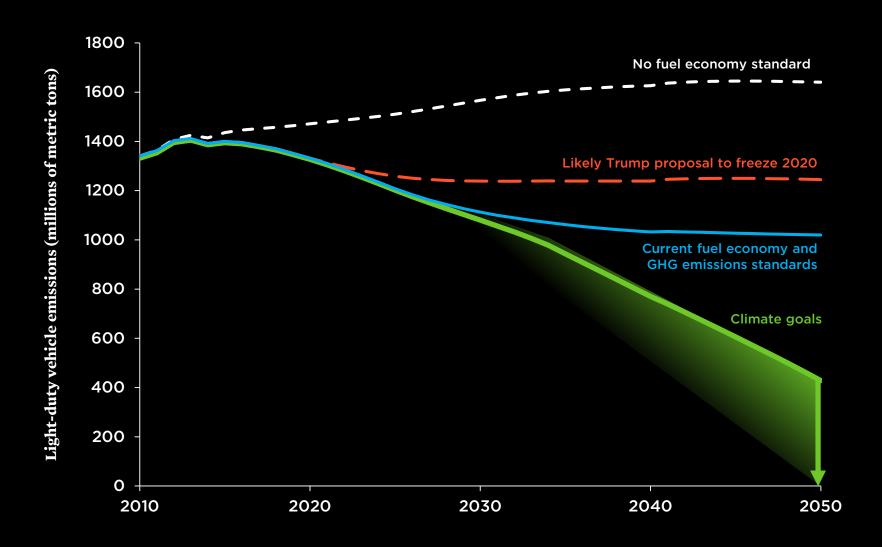


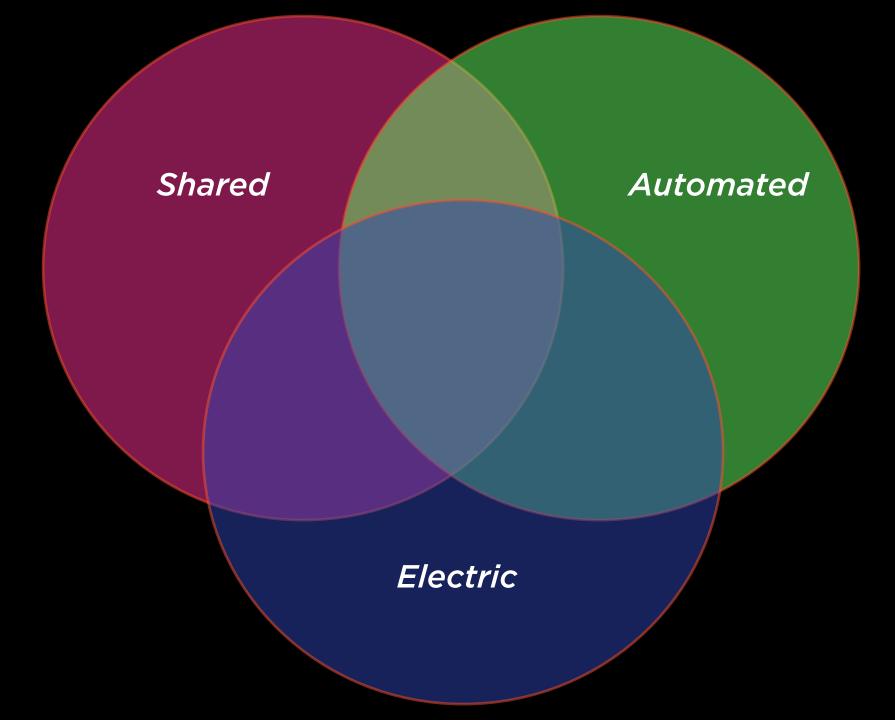
NRC Phase 3 Project Scope

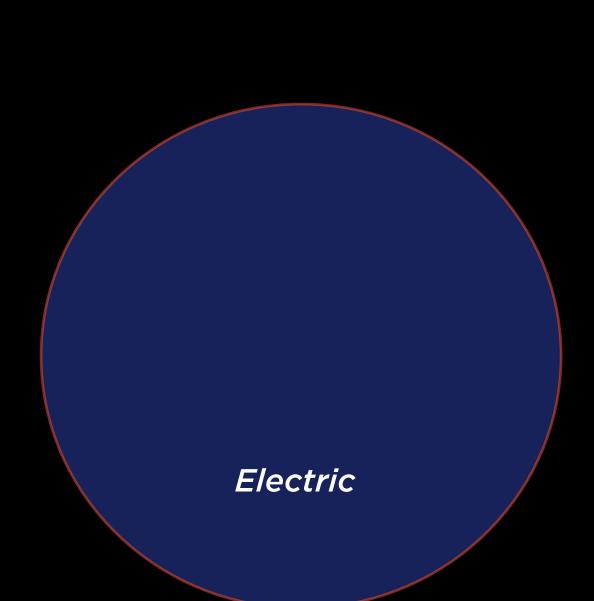
- CAVs: Assess how shifts in personal transportation and vehicle ownership models might evolve out to 2035, how these changes could impact fuel economy-related vehicle technologies and operation, and how these change might impact vehicle scrappage and VMT (with scenarios).
- "Flexibilities": Consider the current and possible future role of flexibilities in the CAFE program on the introduction of new technologies, including credit trading, treatment of AFVs, off-cycle provisions, and flexibilities for small-volume manufacturers.
- Consumers: Examine consumer behavior associated with new fuel efficiency technologies, including acceptance of any utility or performance impacts and cots of new technologies. This could include considerations of consumers' willingness to pay for improvements in fuel economy and other vehicle attributes.

US Sources of Carbon Dioxide Emissions (EIA)

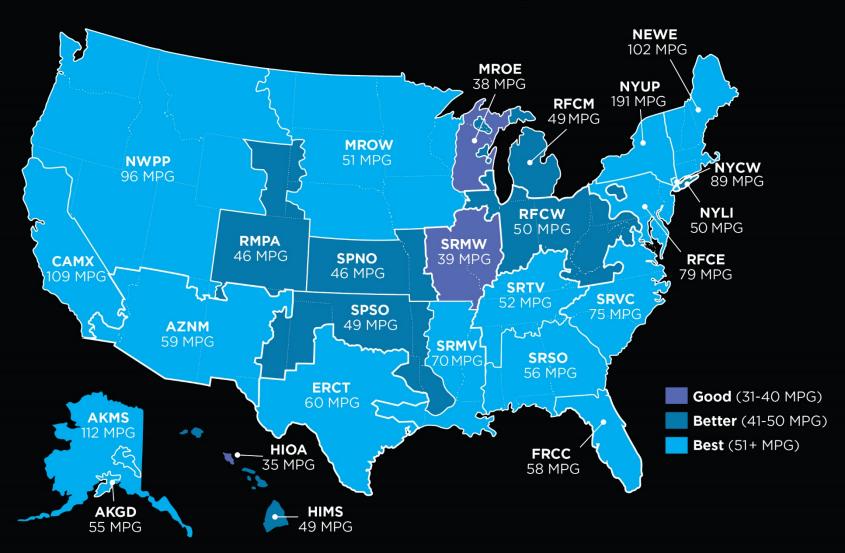




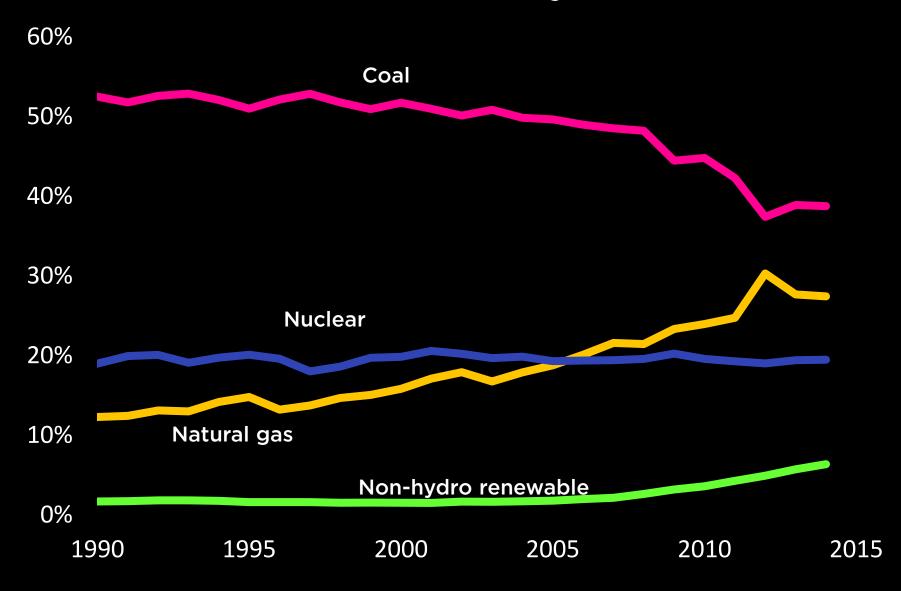


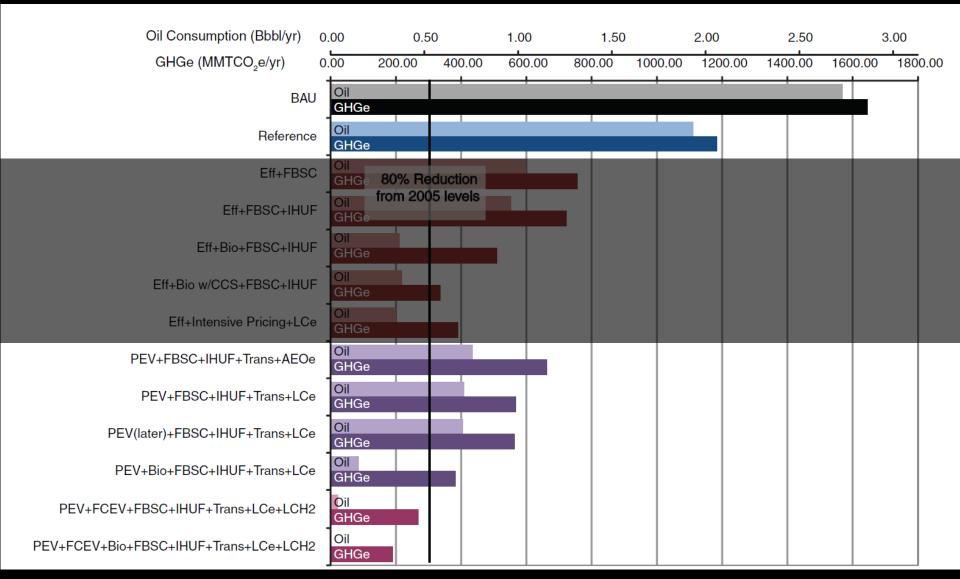


EV Global Warming Emissions

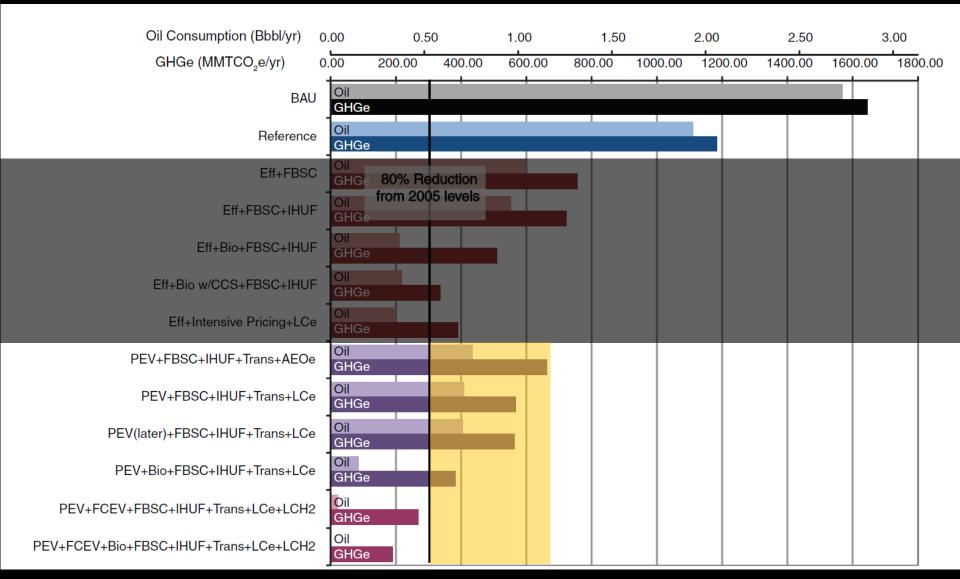


U.S. Share of Electricity Generation

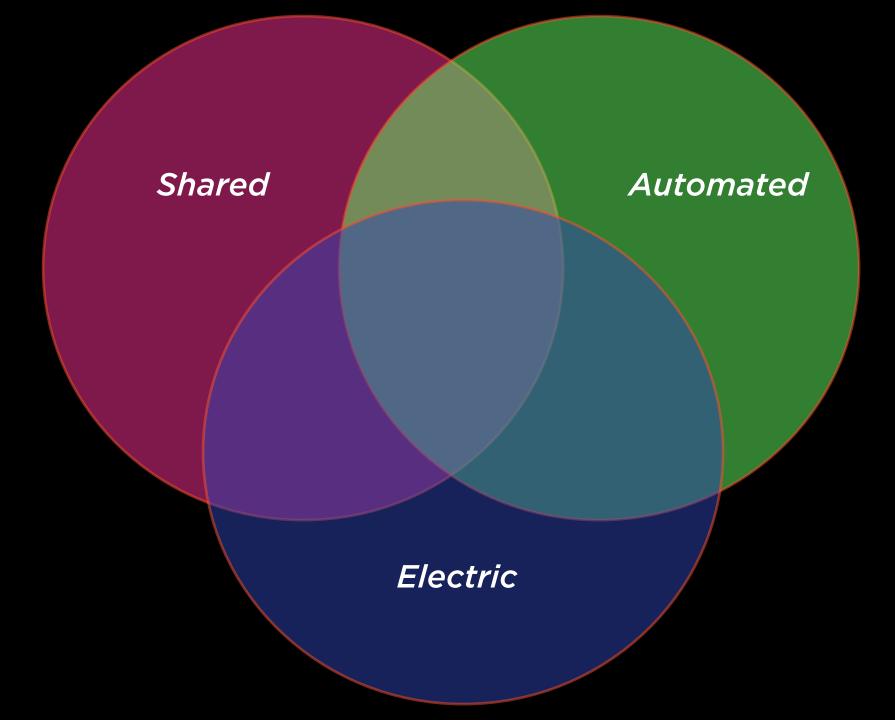




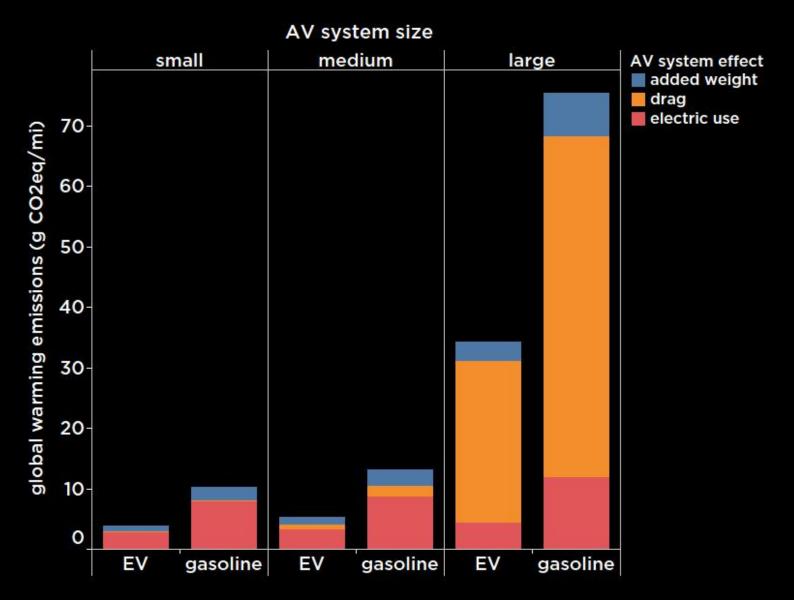
2050 Climate/Oil Target



2050 Climate/Oil Target

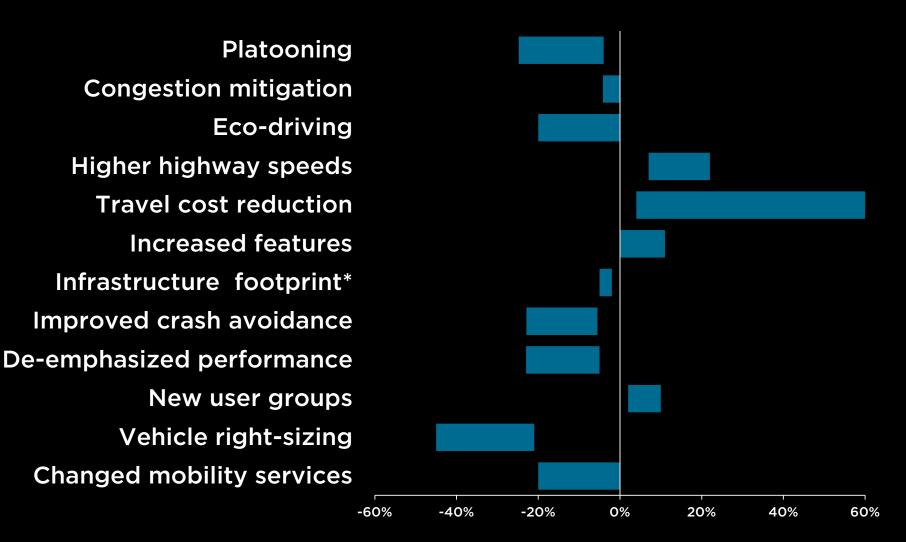






Adapted from: Gawron et al., "Life Cycle Assessment of Connected and Automated Vehicles: Sensing and Computing Subsystem and Vehicle Level Effects". ES&T, 2018

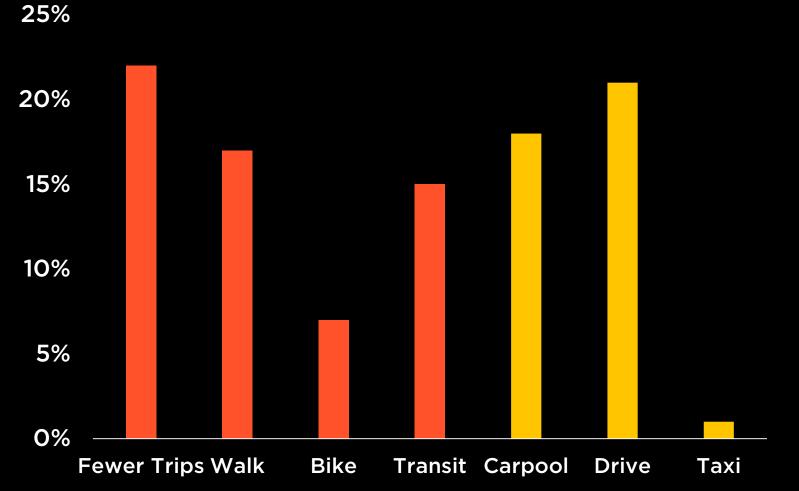
Potential Energy Impacts of Self-Driving Cars



% changes in energy consumption due to vehicle automation

Wadud, Mackenzie, and Leiby. "Help or Hinderance? The travel, energy and carbon impacts of highly automated vehicles," February 2016.

How would you get there without Lyft or Uber?



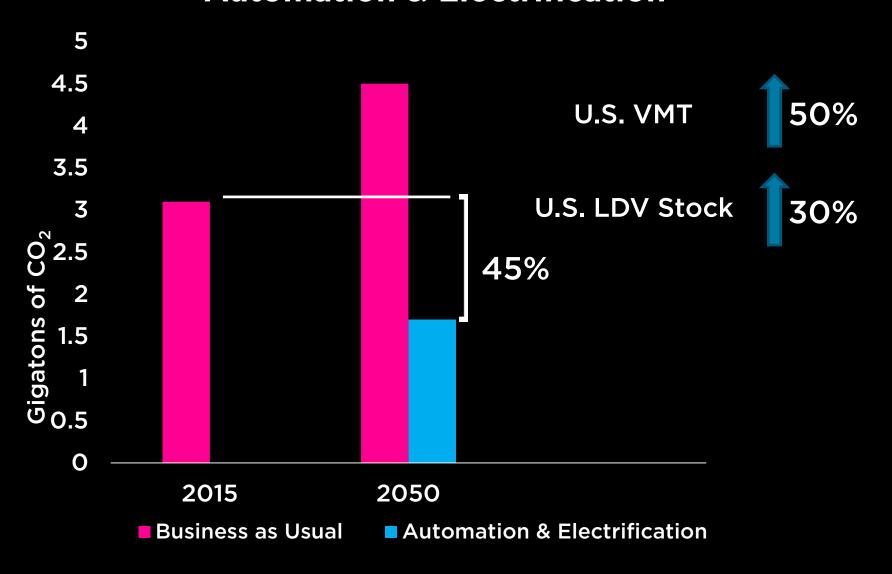
"Ride-hailing is currently likely to contribute to growth in vehicle miles traveled (VMT) in the major cities represented in this study".

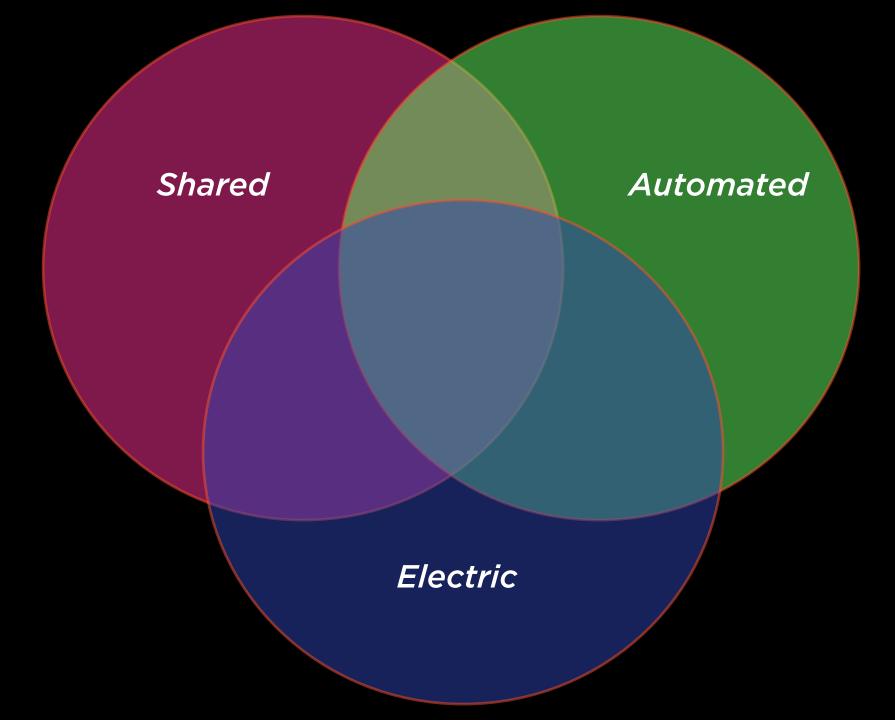
Clewlow and Shankar, "Disruptive Transportation: The Adoption, Utilization, and Impacts, of Ride-Hailing in the U.S.", 2017

Autonomous

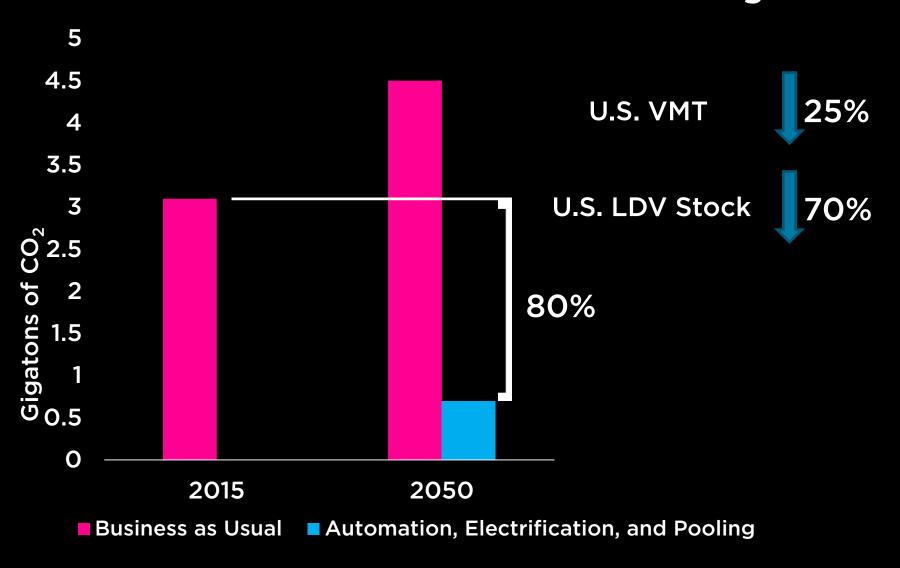
Electric

Global Urban Passenger Transport CO₂ Emissions Automation & Electrification





Global Urban Passenger Transport CO₂ Emissions Automation & Electrification & Sharing



Concerned Scientists

POLICY BRIEF

Maximizing the Benefits of Self-Driving Vehicles

HIGHLIGHTS

Self-driving vehicles have the potential to improve the safety, accessibility, and convenience of transportation substantially, but they also may increase energy use, transportation-related pollution, and roadway congestion. Public policy must take into account both the positive and negative potential of this emerging technology on communities and the environment. Doing so will help ensure that the introduction and use of self-driving vehicles reduce oil consumption and global warming emissions, improve public health and safety, and enhance mobility for all.

Principles for Public Policy

Autonomous, or self-driving, vehicle technology may be the most significant innovation in transportation since the mass introduction of automobiles in the early 20th century. Whether the widespread adoption of self-driving vehicles results in positive outcomes in the years ahead will depend largely on how public policy guides the introduction of this emerging technology today. The potential benefits include safer roads, more affordable transportation, improved access to jobs, and a cleaner, healthier environment. Without well-crafted policy, though, self-driving vehicles could increase vehicle miles traveled and global warming emissions, worsen congestion, exacerbate air pollution, and put millions of Americans out of work (Litman 2016).

UCS has outlined a set of principles that policymakers, businesses, and other stakeholders can follow to shape the introduction of self-driving vehicles in ways that reduce oil consumption and global warming emissions, protect public health, and enhance mobility for all.

1. Make Transportation Safer for Everyone, Not Just Motorists

While self-driving vehicles have the potential to reduce vehicle-related fatalities, this is not a guaranteed outcome (Kockelman et al. 2016). Vehicle computer systems must be secure from hacking, and rigorous testing and regulatory oversight of vehicle programming are essential to ensure that self-driving vehicles protect both their occupants and those outside the vehicle. Therefore, public policy related to self-driving vehicles must improve safety for all Americans, whether they are driving, walking, or biking.



Well-crafted policy is critical to ensuring that self-driving vehicles—such as the one being tested by ridehalling service Uber, above—make a positive contribution to the US transportation sector, including safer roads, more affordable transportation, improved access to jobs, and a cleaner, healthier environment.

Off-cycle Credits

1. Benefits must be rigorous and fully documented.

2. OC credits should be limited to new and innovative technologies.

3. A technology must reduce emissions from the vehicle receiving the credit.

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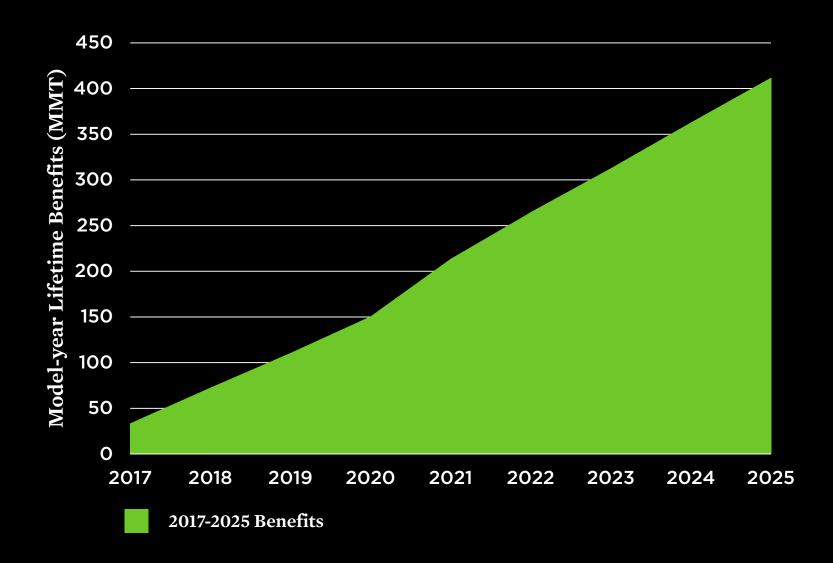
Automaker implementation varies
Non-standard test/data increases uncertainty

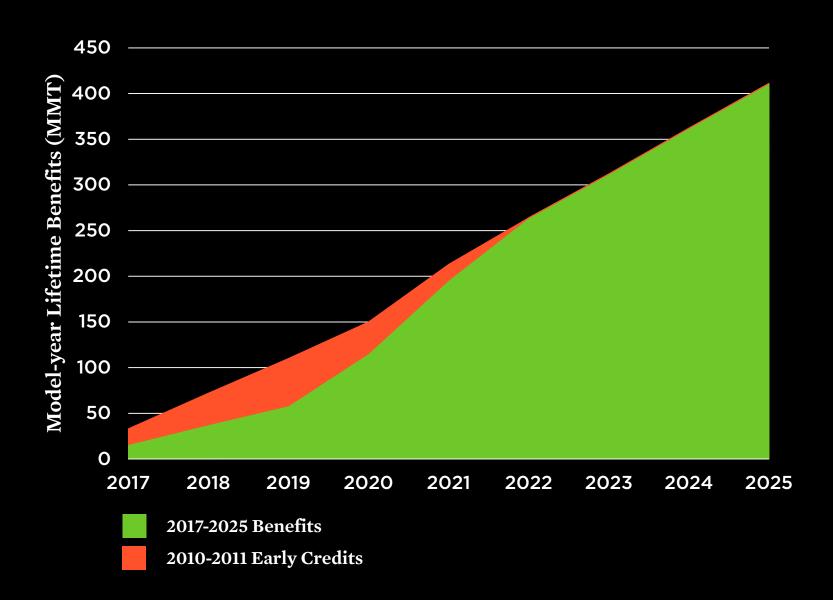
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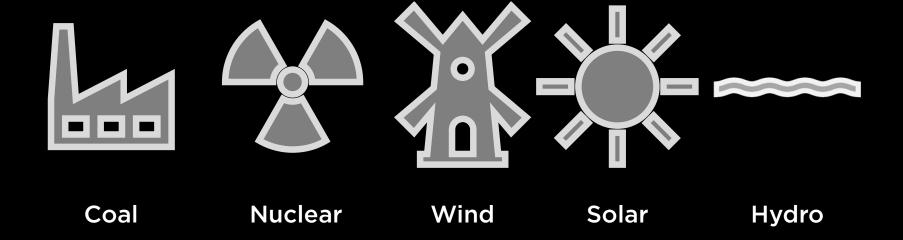
Off-cycle tech excluded from 2008 baseline

3. A technology must reduce emissions from the vehicle receiving the credit.

Enforcement See #1









0 g/mi

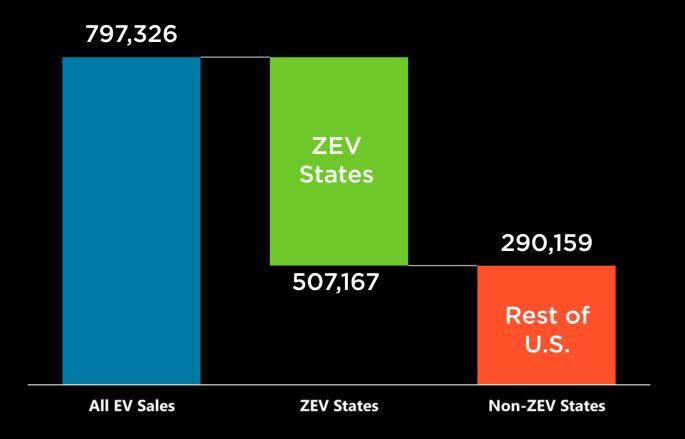


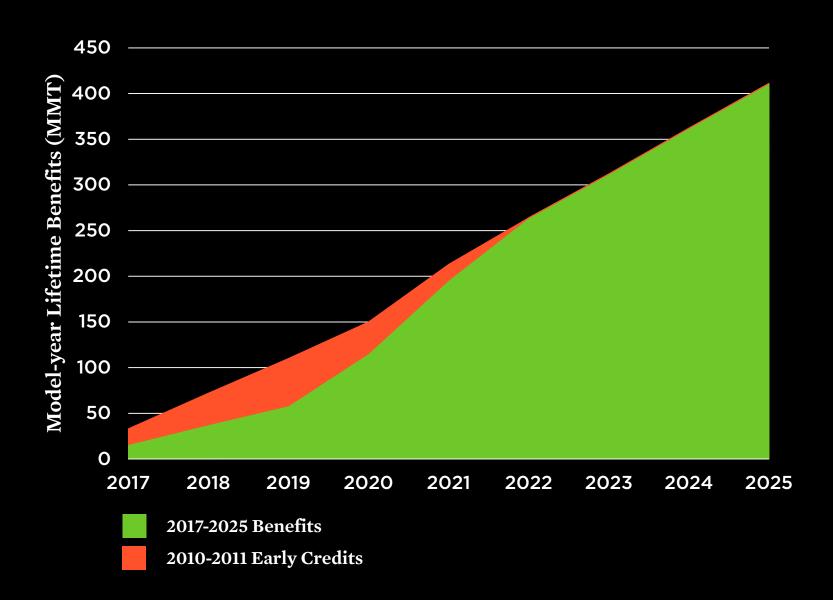
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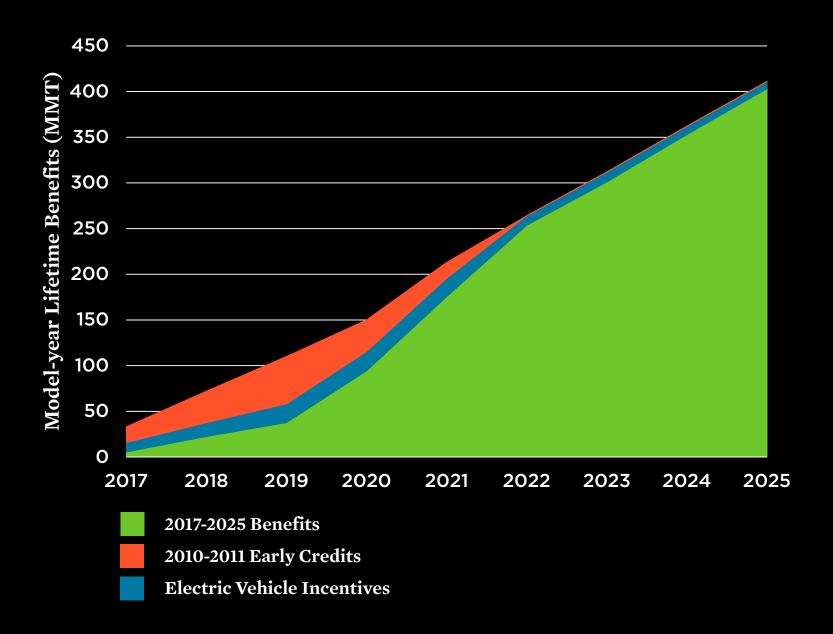


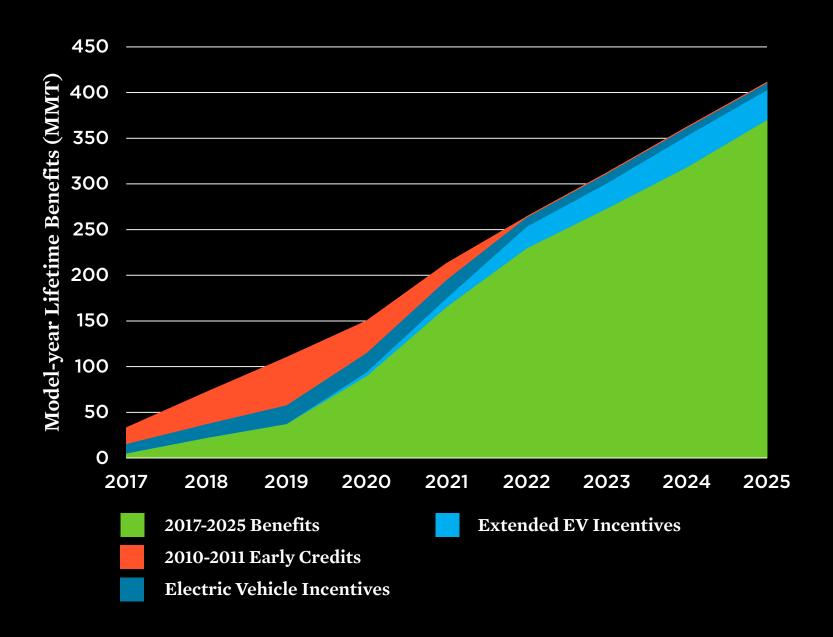
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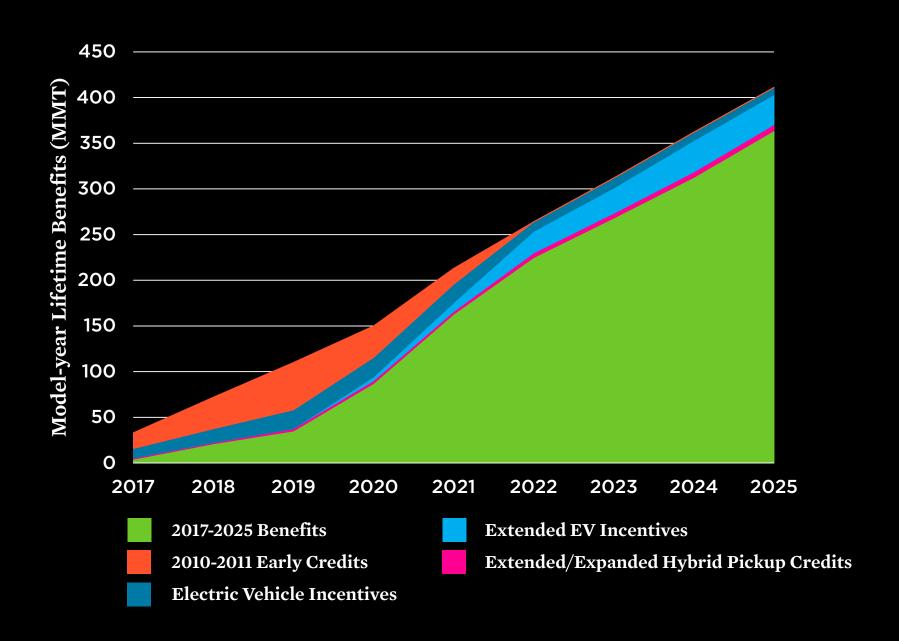


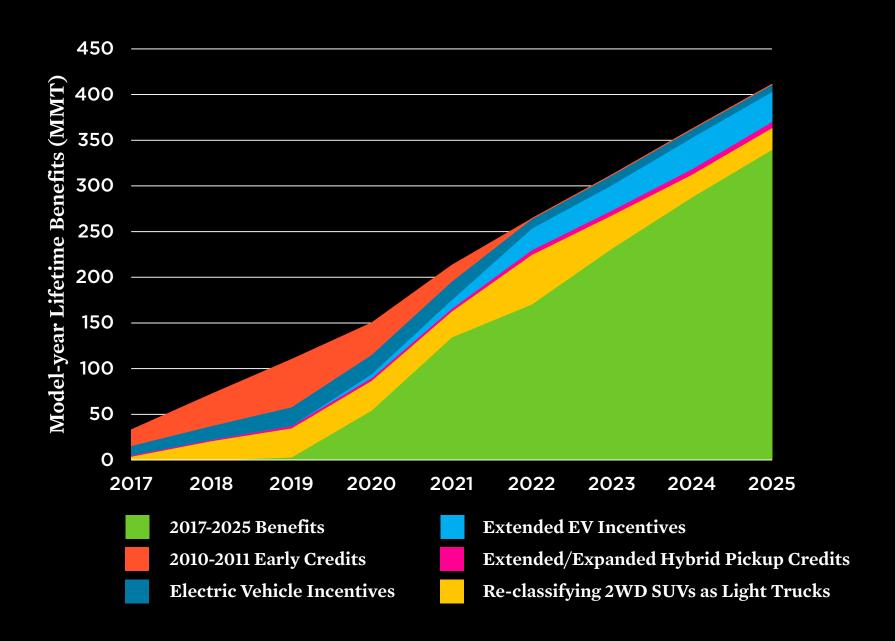


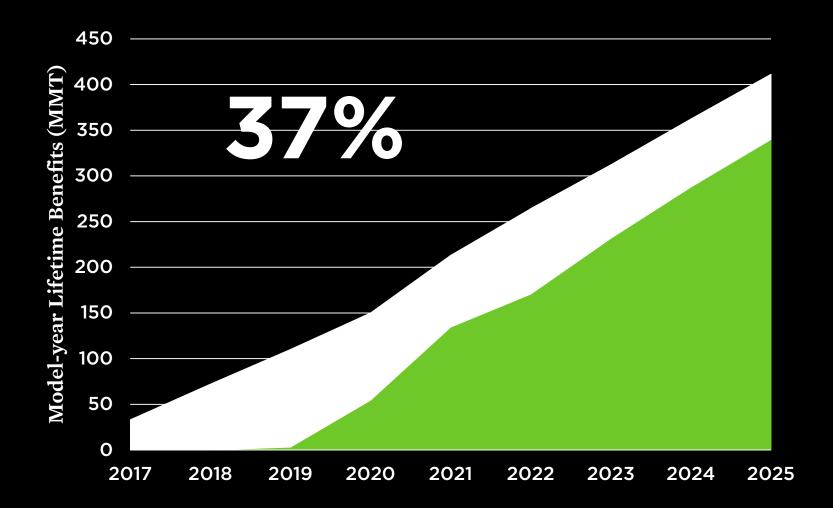


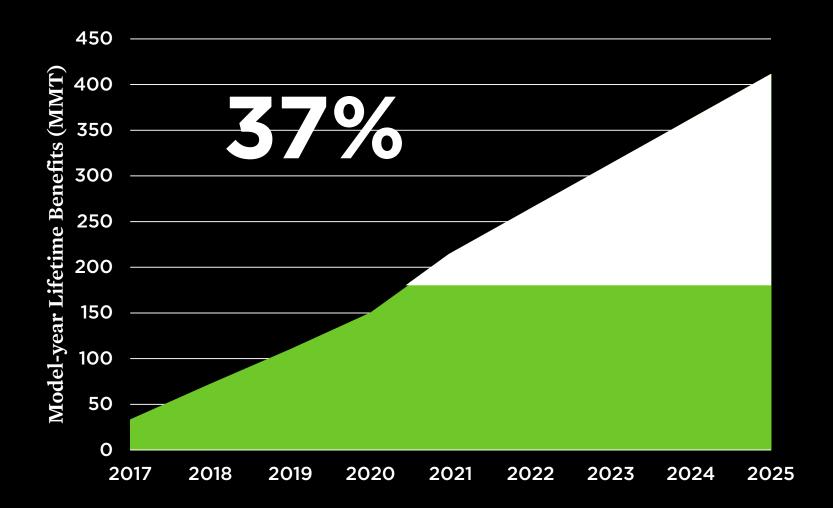


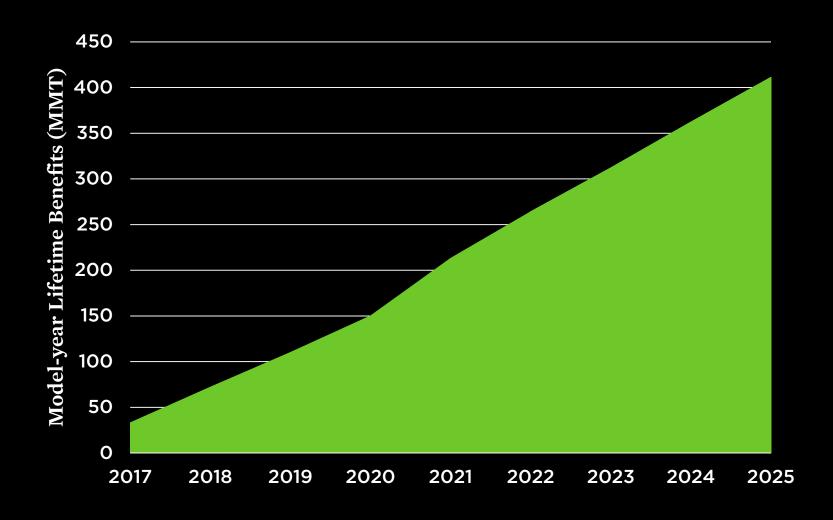












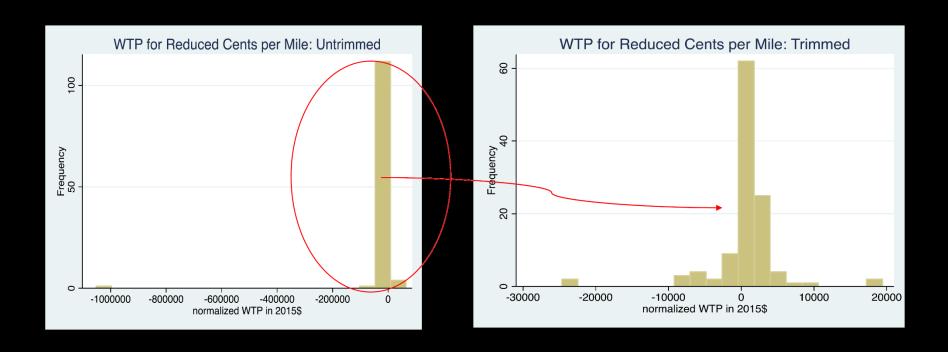
Consumer Choice

NRC Phase 2 Finding 9.3:

"Manufacturers *perceive* that consumers require relatively short payback periods of 1 to 4 years for fuel economy improvements."

"The results of recent studies find that consumers' responses vary from requiring payback in only 2 to 3 years to almost full lifetime valuation of fuel savings."

Willingness to Pay?



					Ra	W		Trim	18031 -26779 9544 4177 479 546 1194 -1147 50 -6 18740 -580 14477 -4216 281 64 17191 -16837 18441 2796 3851 5006 1886 -1916 627 -1183 13 10 2126 346 58 75	
Grouping	Attribute	N	Units	Outliers	Mean	SD	Mean	SD	Median	Skew
Comfort	Auto-transmission	9	0/1	1	1760	3669	823	2518	1111	0.74
	Front wheel drive	6	0/1	0	-32031	18031	-32031	18031	-26779	1.20
	Air conditioning	13	0/1	0	3521	9544	3521	9544	4177	0.84
	Shoulder room	12	\$/inch	1	1085	1394	705	479	546	1.29
Fuel costs	Cost per mile	58	\$/cpm	2	-1251	3441	-1291	1194	-1147	1.13
	Cost per year	13	\$/(\$/yr)	1	-67	156	-26	50	-6	4.47
	Gallons per mile	20	\$/0.01gpm	4	14354	76395	-7972	18740	-580	13.74
	Miles per dollar	8	\$/(10mi/\$)	1	-20181	27869	-11542	14477	-4216	2.74
	Miles per gallon	10	\$/mpg	1	365	659	174	281	64	2.70
Fuel type	Electric vehicle	24	0/1	1	-16515	21283	-13851	17191	-16837	0.82
	Hybrid	28	0/1	2	-11727	44322	-852	18441	2796	-0.30
	Natural gas	7	0/1	2	-5620	23691	6187	3851	5006	1.24
Performance	Acceleration (0-30)	11	\$/s	0	-1756	1886	-1756	1886	-1916	0.92
	Acceleration (0-60)	8	\$/s	0	-1096	627	-1096	627	-1183	0.93
	Horsepower	11	\$/hp	4	54	109	13	13	10	1.32
	HP/weight	29	0.01hp/lbs	1	1861	3523	1334	2126	346	3.85
	Top speed	9	\$/mph	0	100	58	100	58	75	1.33
AFV Range	Range	23	\$/mi	2	89	41	97	32	98	1.00
Size	Footprint	17	\$/ft^2	1	43401	163103	3856	4442	3273	1.18
	Luggage space	12	\$/ft^3	1	4209	9655	1445	1310	1100	1.31
	Weight	19	\$/lb	1	10	20	6	8	1	11.14

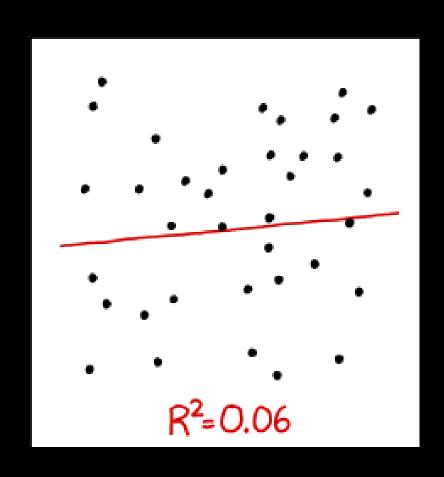
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Consumer Choice Modeling



Consumer Choice Modeling

NHTSA MY2011-2015 NPRM:

- Not successful in calibrating a logically consistent set of coefficients for their multinomial logit model.
- 2) Not confident that baseline sales prices can be reliably predicted.
- 3) Not confident "cost allocation" for manufacturers could be reasonably modeled.

NHTSA NRC Presentation 2014:

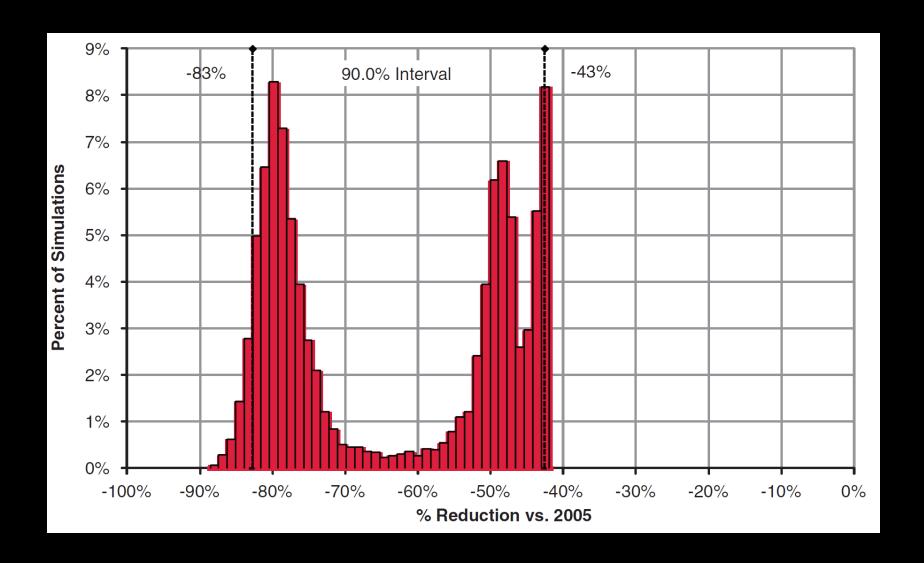
"Suitable for short-term (2-3 MY) forecasting of market response to higher standards, but longer-term forecasts require projecting changes in joint distributions of household characteristics."

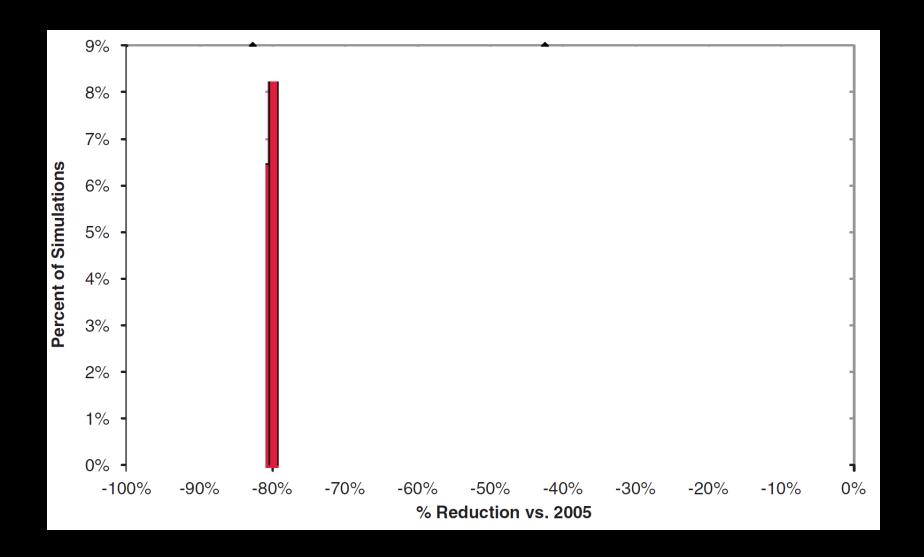
Consumer Choice Modeling

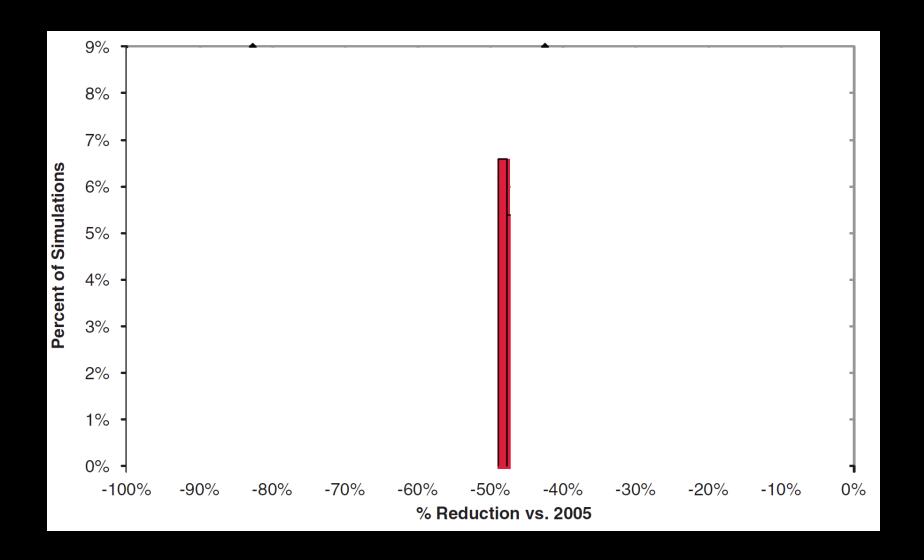
Haaf, et al. (2014): Naïve model (previous year's sales share) outperforms all forecasts in near-term, loses predictability over time due to new/redesigned vehicles.

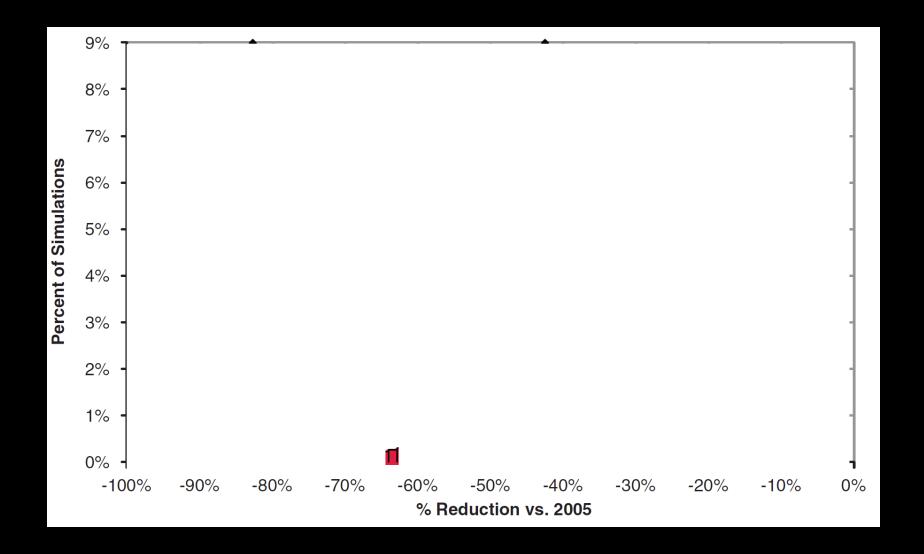
EPA (2015): "In the few cases where models with forecasting ability have been tested against market outcomes, results are still not very strong, especially for market share predictions."

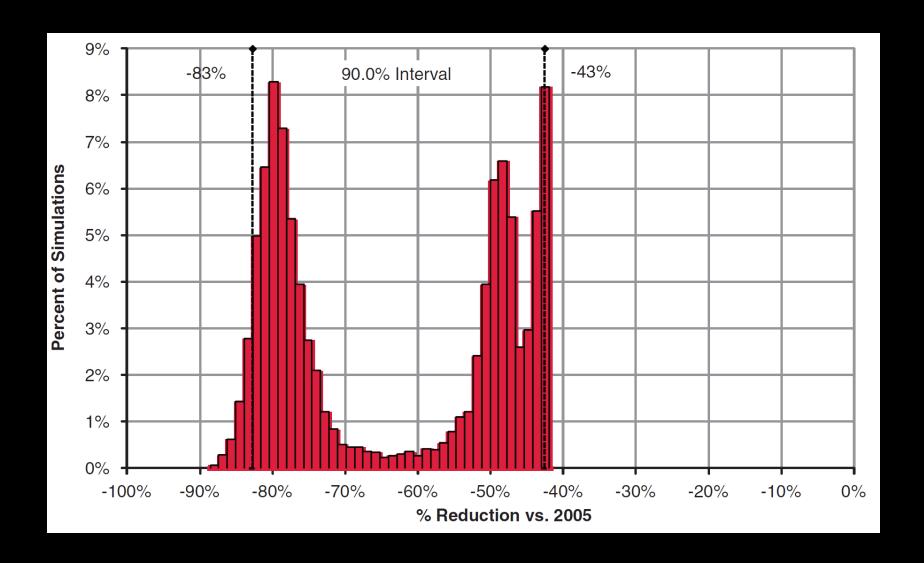
"The test of [a model developed for EPA] against actual market outcomes suggests that the model is not suitable for forecasting changes in the vehicle fleet when social and economic conditions are also changing."











Summary

- Impacts of CAVs are wildly uncertain and not necessarily positive. Good policy is needed, but that policy is not necessarily CAFE.
- Fuel economy standards are working to promote tech advancement, but policies should be designed to yield real-world benefits.
- Data on consumer response to vehicle attributes mixed—basing a policy on such uncertain data risks poor policy judgment, especially if not accounting for uncertainty.