Three Revolutions in Urban Transportation:
How to achieve the full potential of vehicle electrification, automation and shared mobility in urban transportation systems around the world by 2050

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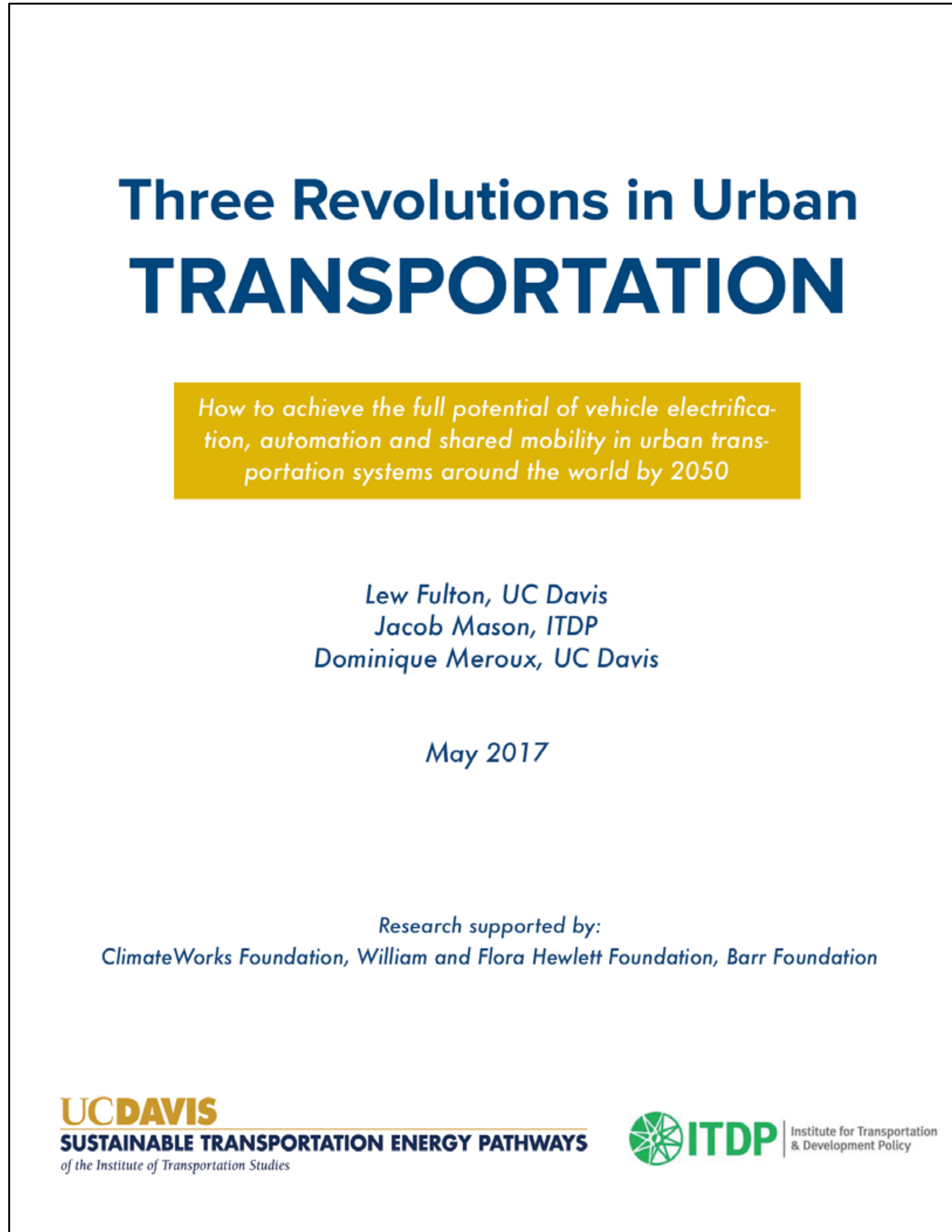
Research undertaken by UC Davis and ITDP, part 3 of a series

Global scenario study to 2050 focused on potential 3 Revs impacts on CO_2, energy use, costs

Study supported by UC Davis STEPS Consortium and by Climate Works, Hewlett Foundation, Barr Foundation

https://steps.ucdavis.edu/three-revolutions-landing-page/


Three Revolutions in Urban TRANSPORTATION

How to achieve the full potential of vehicle electrification, automation and shared mobility in urban transportation systems around the world by 2050

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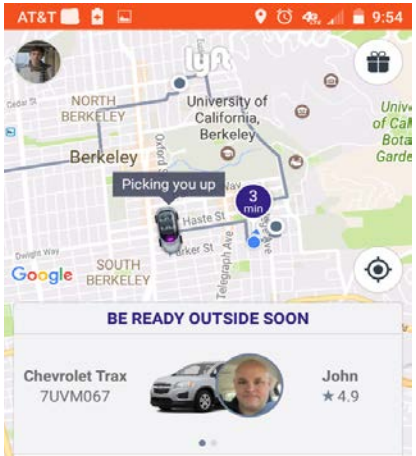
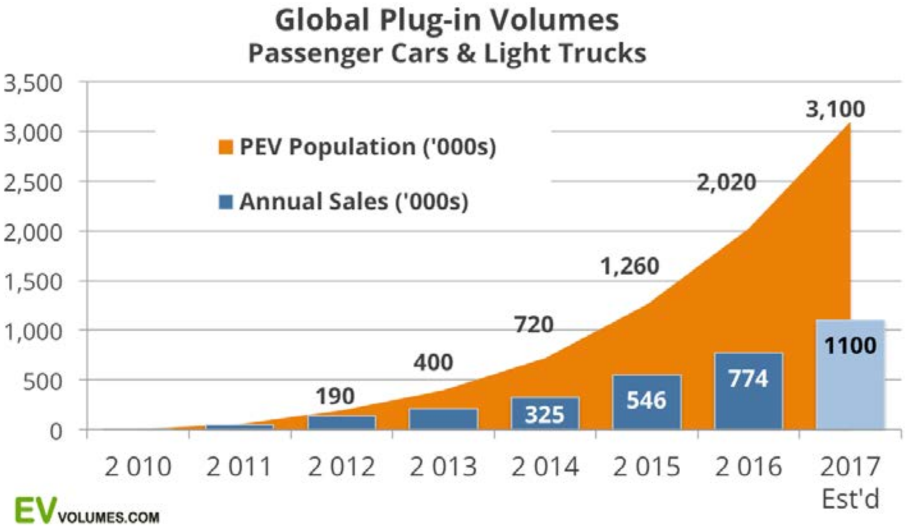
Passenger Transport Revolutions

1. Streetcars (~1890)
2. ICE Automobiles (~1910)
3. Airplanes (~1930)
4. Limited-access highways (1930s….1960s)



2010+

1. Vehicle electrification
   – low carbon vehicles and fuels
2. Real-time, shared mobility
   – less vehicle use
3. Vehicle automation (2025?)
   – Safety benefits
   – Uncertain travel impacts



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Some questions and conflicts

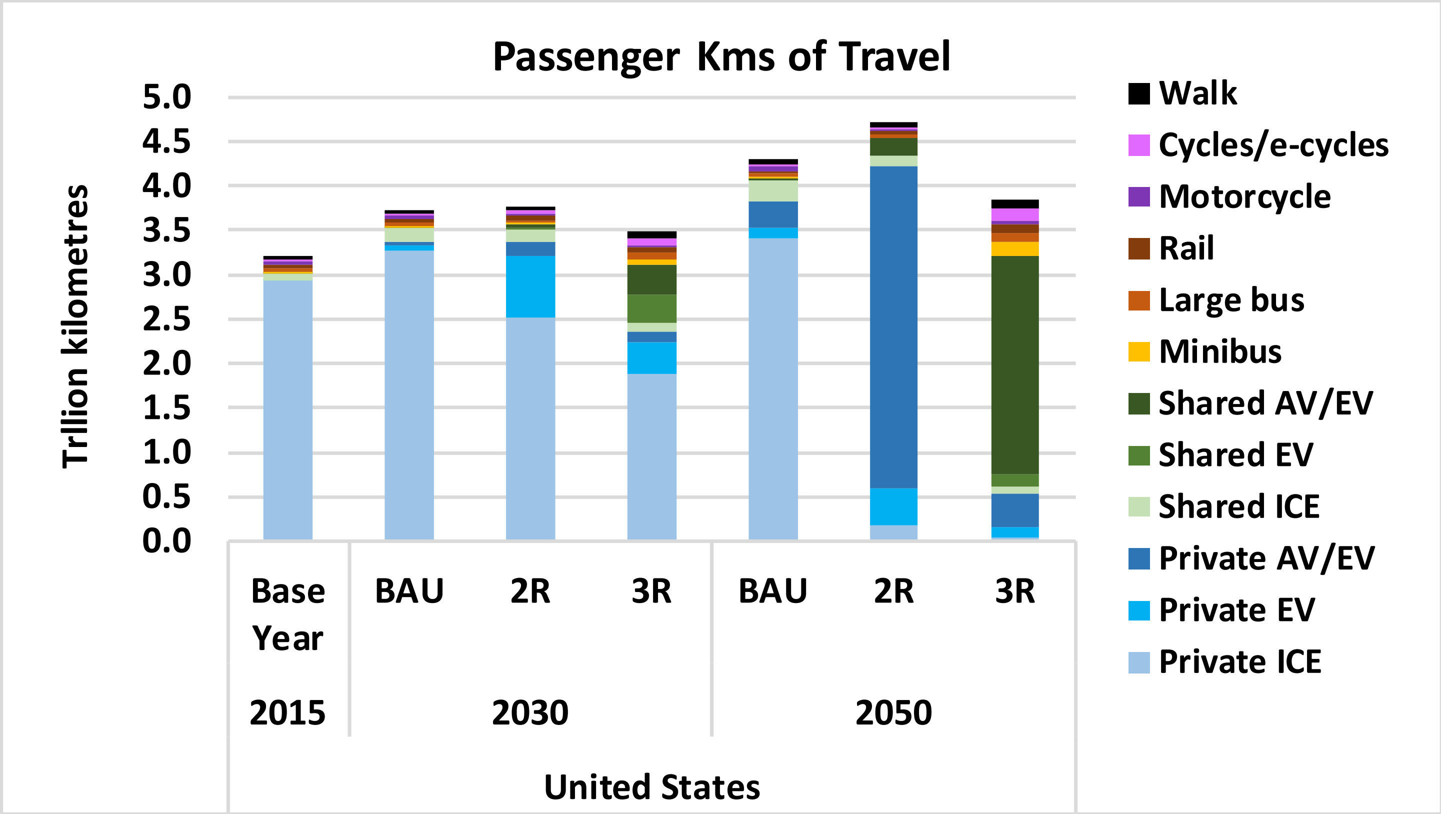
- **Automation: lower per-trip costs, lower "time cost" for being in vehicles**
  - Just how much cheaper will it be?
  - Private automated vehicles = longer trips?
  - Empty running (zero passengers) of vehicles
  - Resulting relative costs of private vehicles, shared mobility, transit?
- **Electrification goes with automation – does it really?**
  - Can get the job done with upgraded electrical system (such as hybrids)
  - But electric running will be much cheaper – and durable?
- **Ride hailing: cost savings v. convenience and risk**
  - Complementary or at conflict with public transit use?
  - Will lower costs reduce the incentive to ride share?

Rough guide to the three scenarios

	Auto-mation	Electrifi-cation	Shared Vehicles	Urban Planning/ Pricing/TDM Policies	Aligned with 1.5 Degree Scenario
Business as usual, Limited Intervention	Low	Low	Low	Low	No
1R Automation only	HIGH	Low	Low	Low	No
2R With high Electrification	HIGH	HIGH	Low	Low	Maybe
3R With high shared mobility, transit, walking/cycling	HIGH	HIGH	HIGH	HIGH	YES

Urban passenger kilometers by scenario, USA

- US travel grows significantly except in 3R
- Travel remains fairly car dominated to 2050 – transit travel triples but remains below 20% of pkm.



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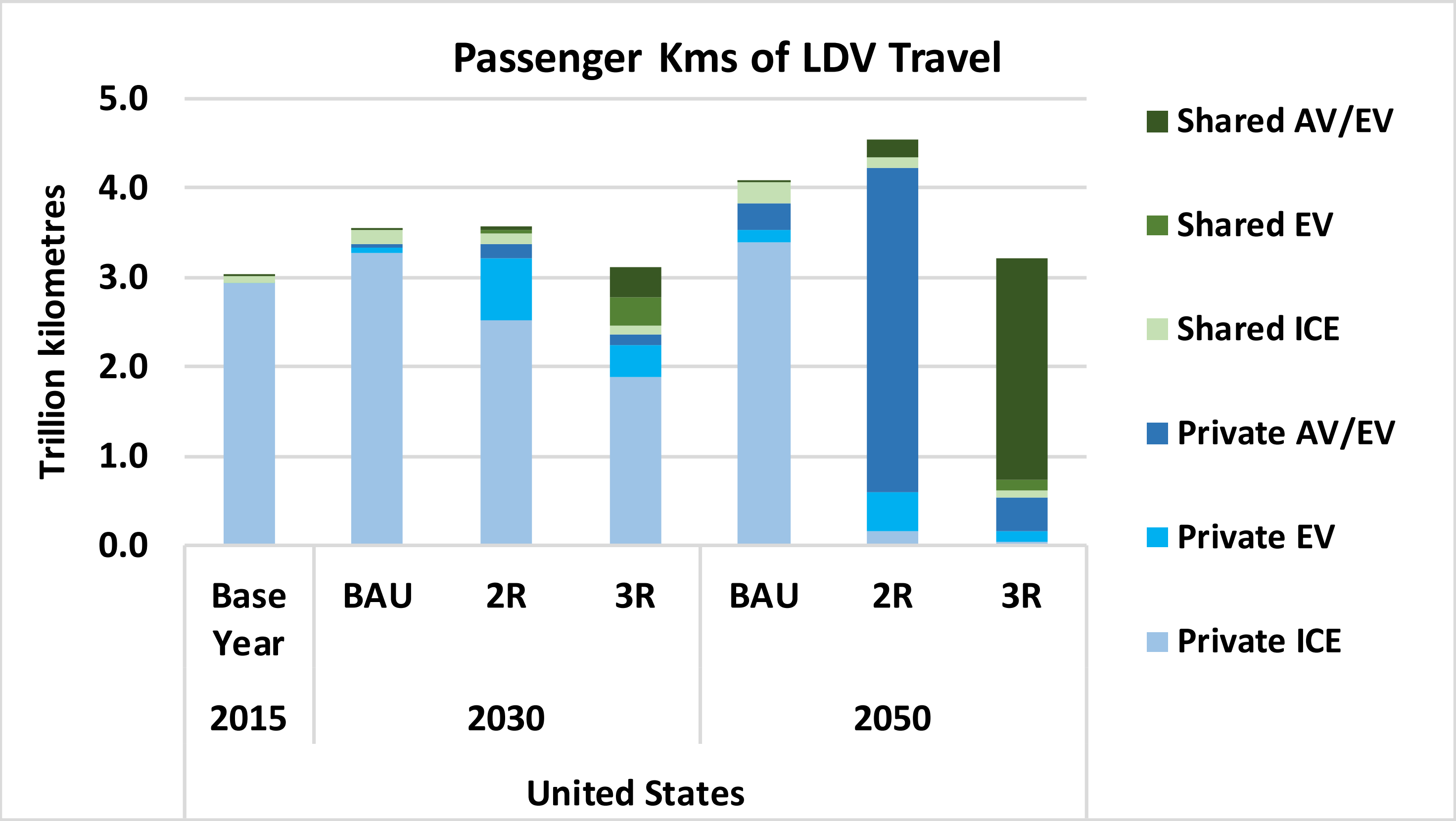
Urban LDV passenger kms by scenario, USA

- Electric vehicle travel reaches nearly 1/3 of PKMs by 2030
- Automated vehicle travel not significant by 2030 in any scenario, but dominates in 2R and 3R 2050. Results in much higher travel in 2R



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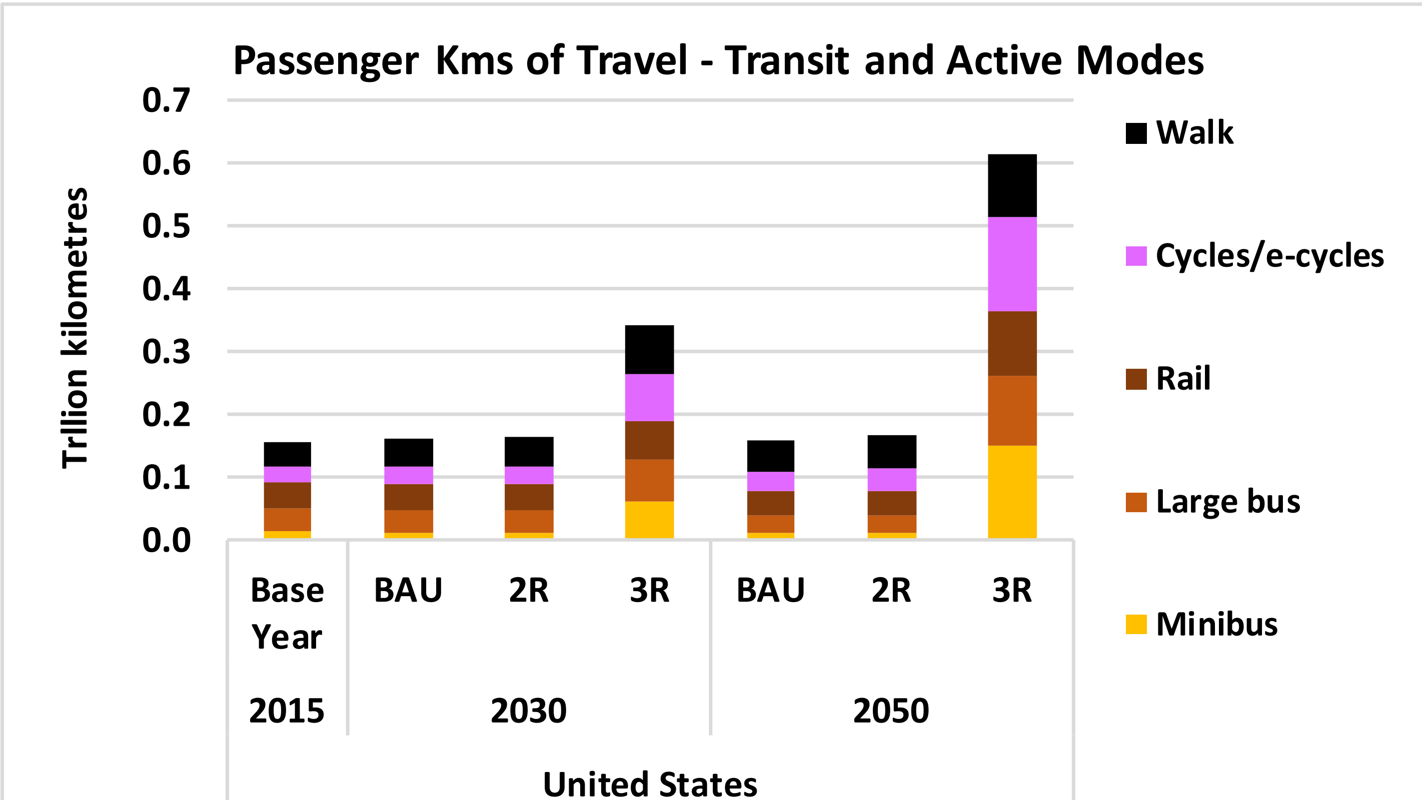
Urban non-LDV passenger kms by scenario, USA

- US transit, walking and cycling is flat into the future in BAU and 2R
- Travel in these modes grows dramatically in 3R, doubling by 2030 and nearly doubling again by 2050.



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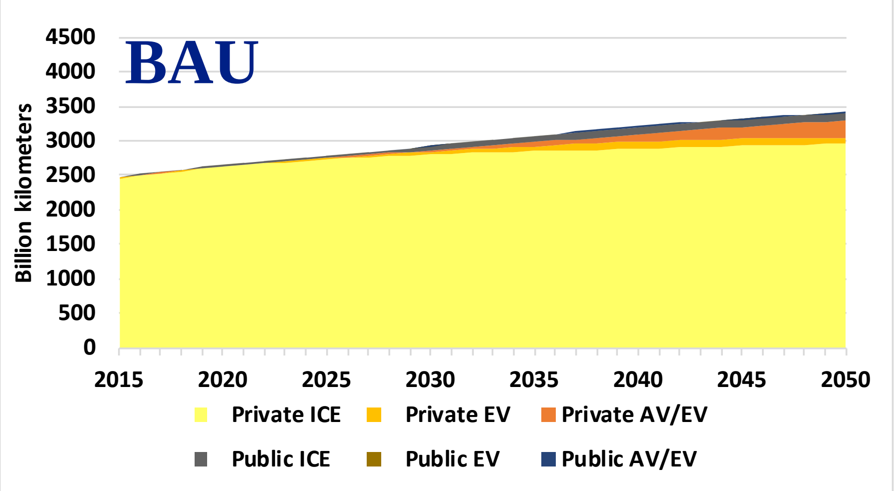
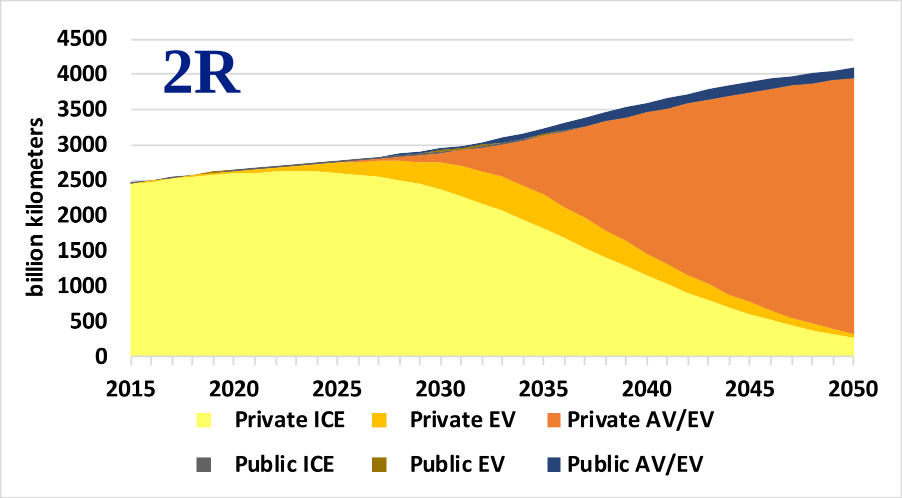
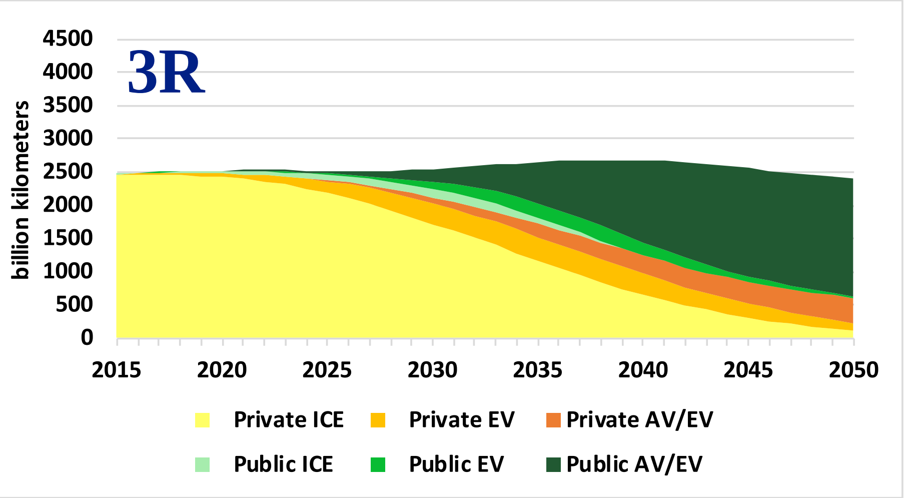
Urban LDV travel (VKm) by scenario, USA

- 2R vehicle travel rises sharply after 2030 due to lower travel costs from automated vehicles
- 3R vehicle travel flat despite declining vehicle stock, given higher travel per vehicle of public vehicles

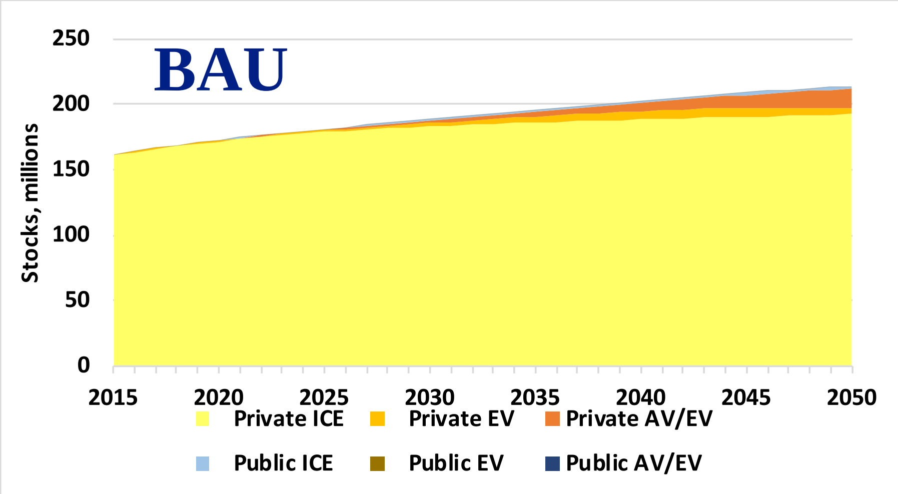


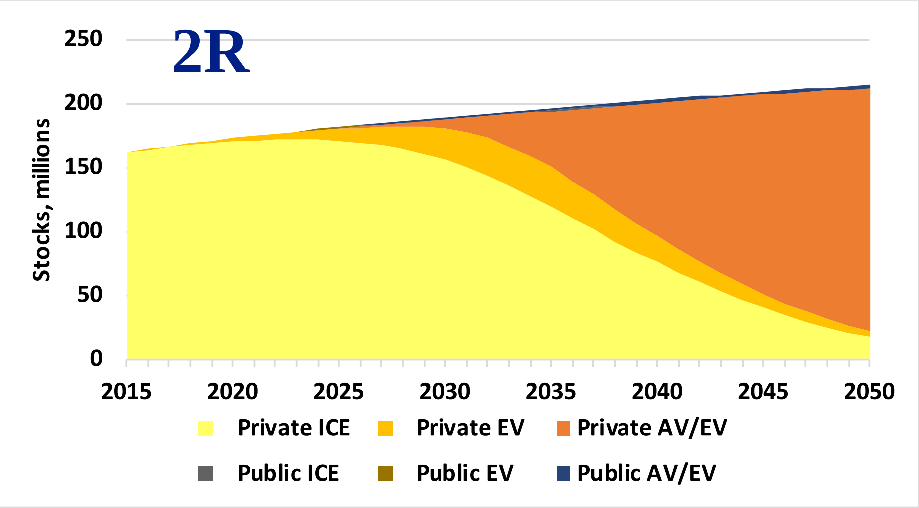


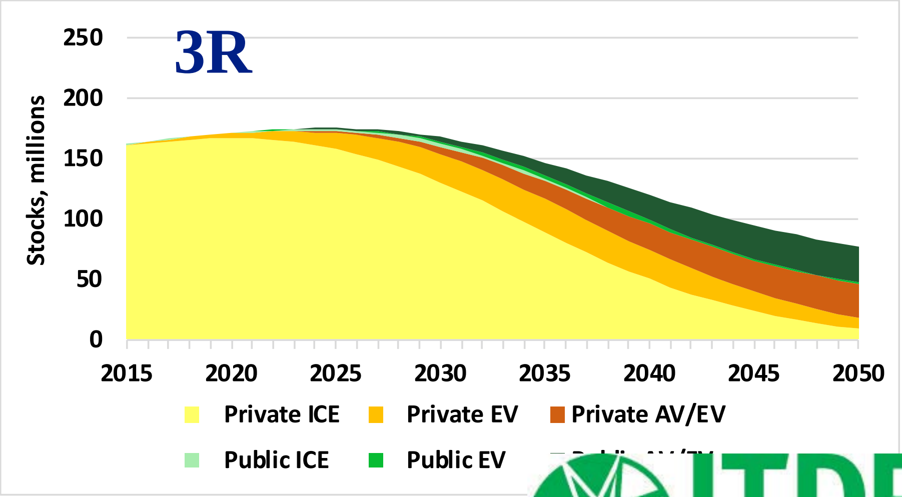


Urban LDV stock evolution by scenario, USA

- 2R stocks nearly completely autonomous by 2050
- 3R stocks strongly decline after 2030, due to lower passenger travel levels, intensive vehicle use and higher load factors







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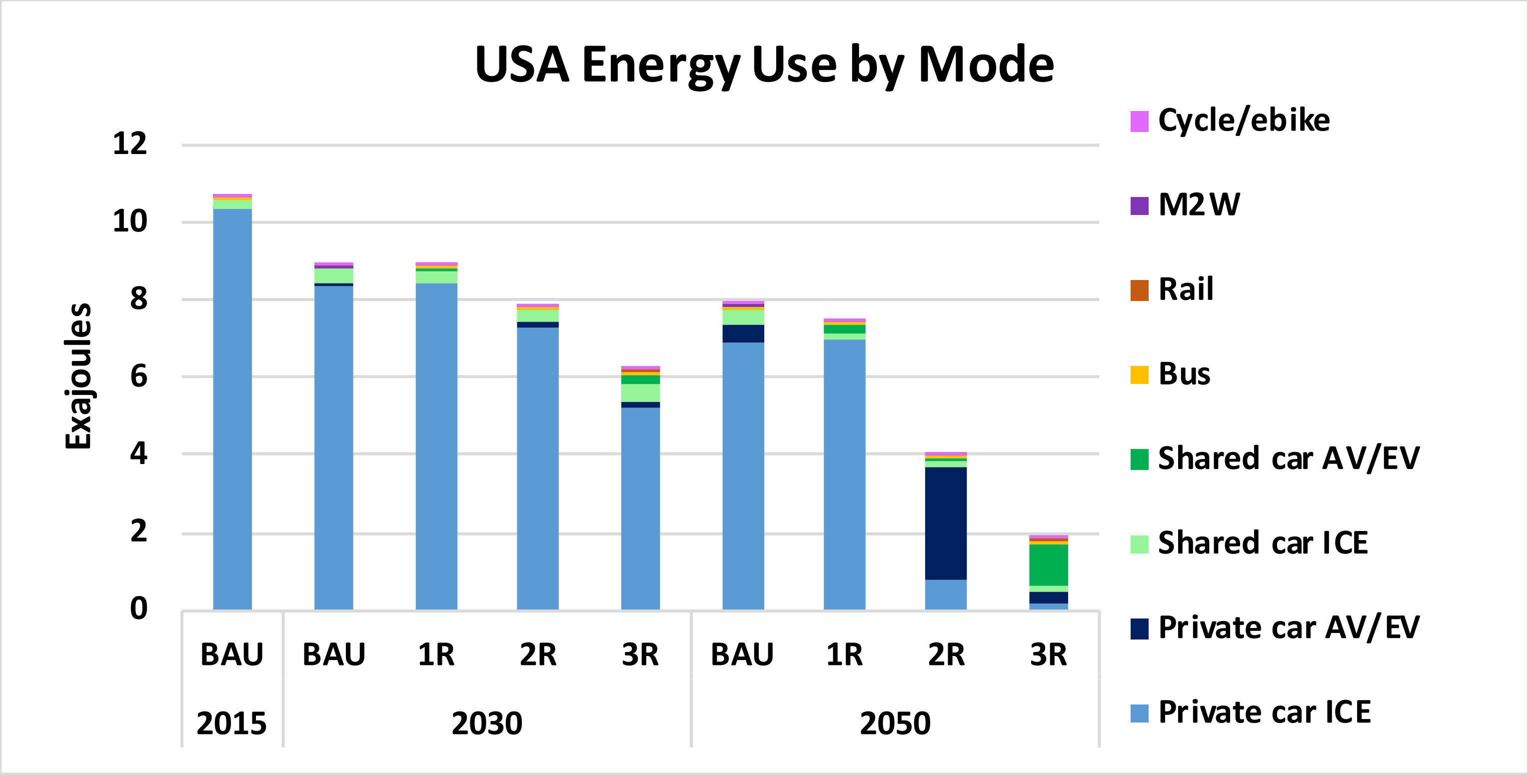
Energy use by scenario, USA

- Far lower energy use in 2R due to EVs, and in 3R due to low LDV mode shares



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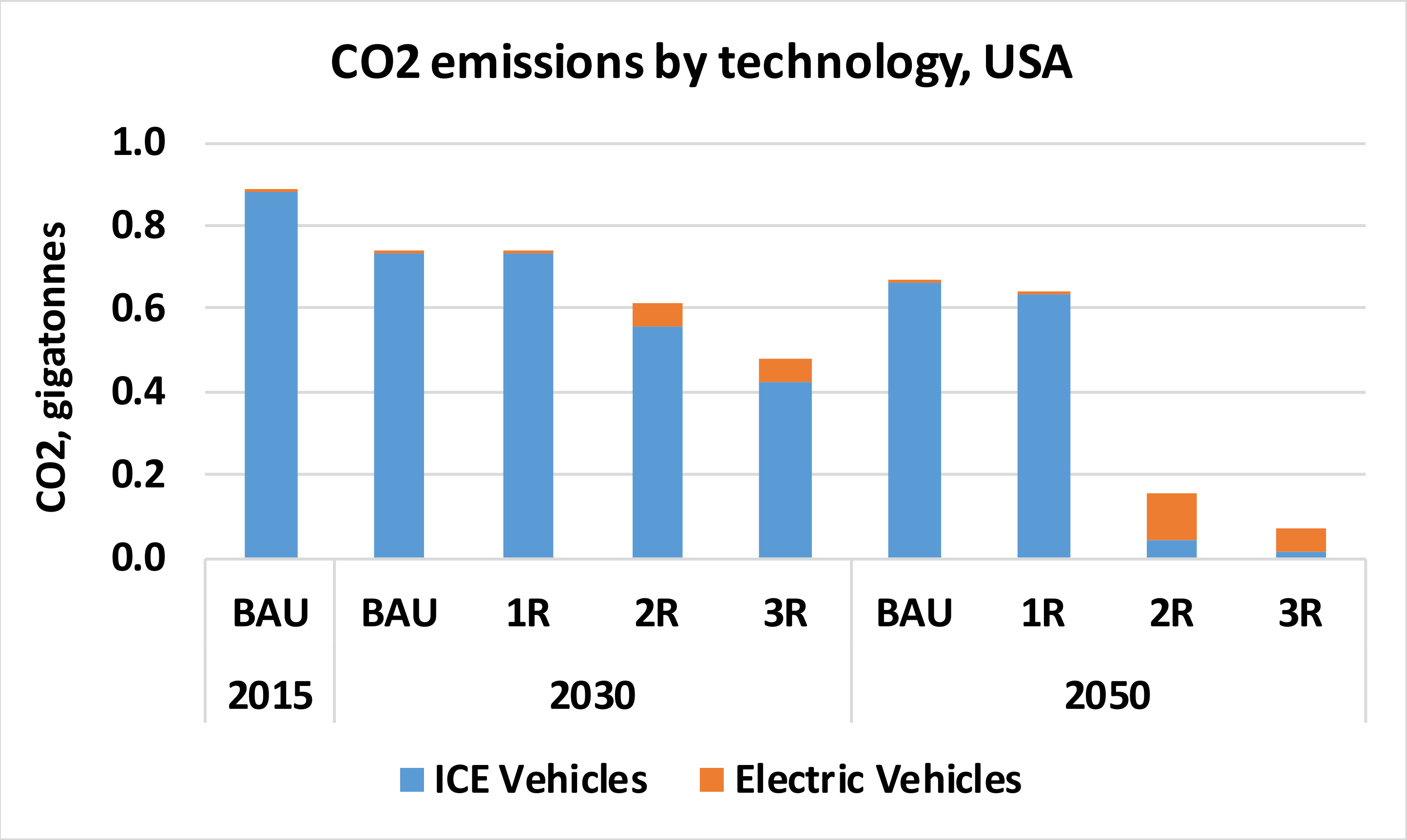
Well-to-wheels CO_2 by scenario/technology, USA

4DS electricity shown; in 2DS, CO_2 from electricity drops to near zero in 2050



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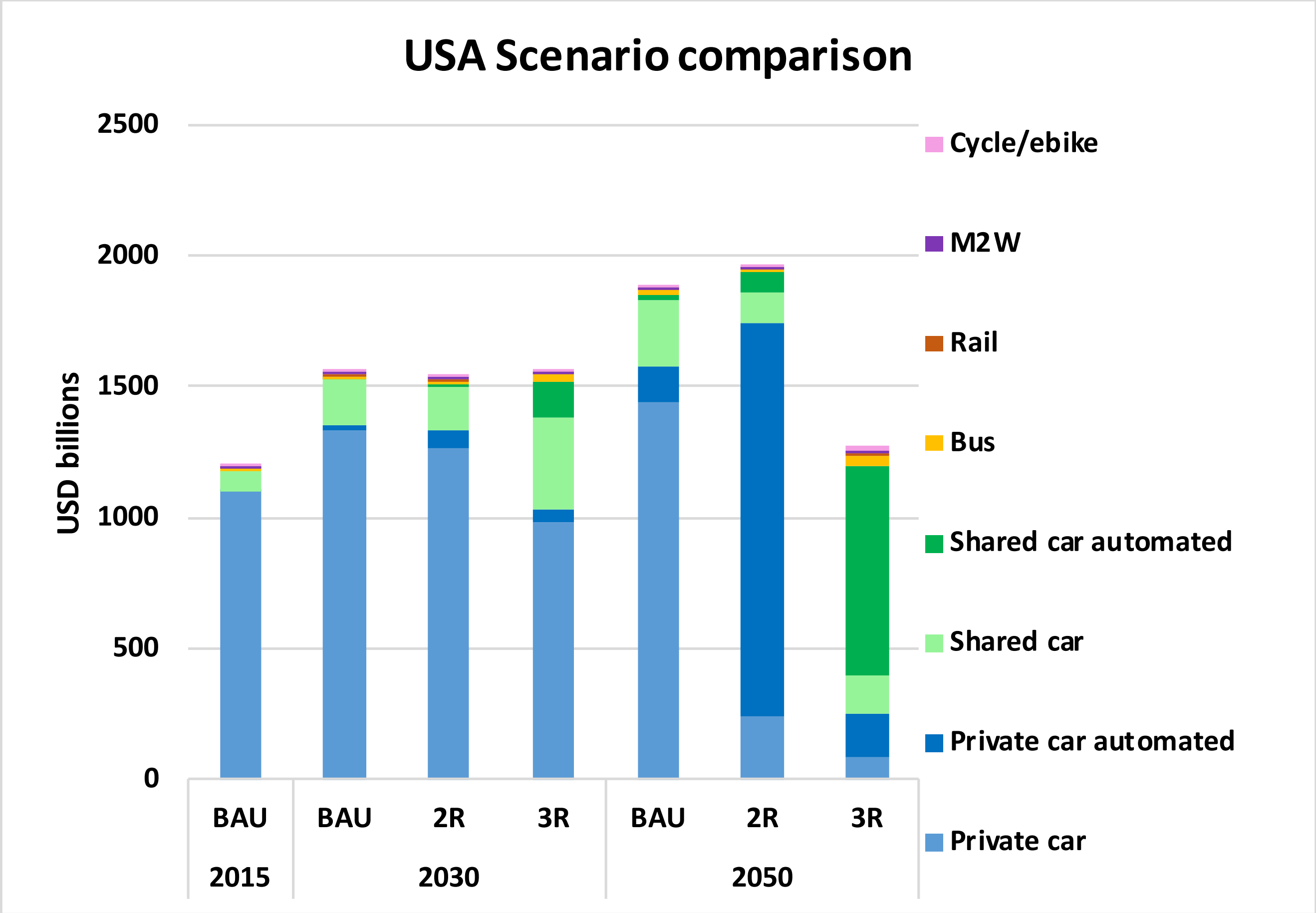
Total cost by scenario and mode, USA

- Total societal (out-of-pocket) 3R cost in 2050 is only 2/3 of BAU or 2R cost, thanks to deep cuts in car ownership, energy use, and road/parking requirements



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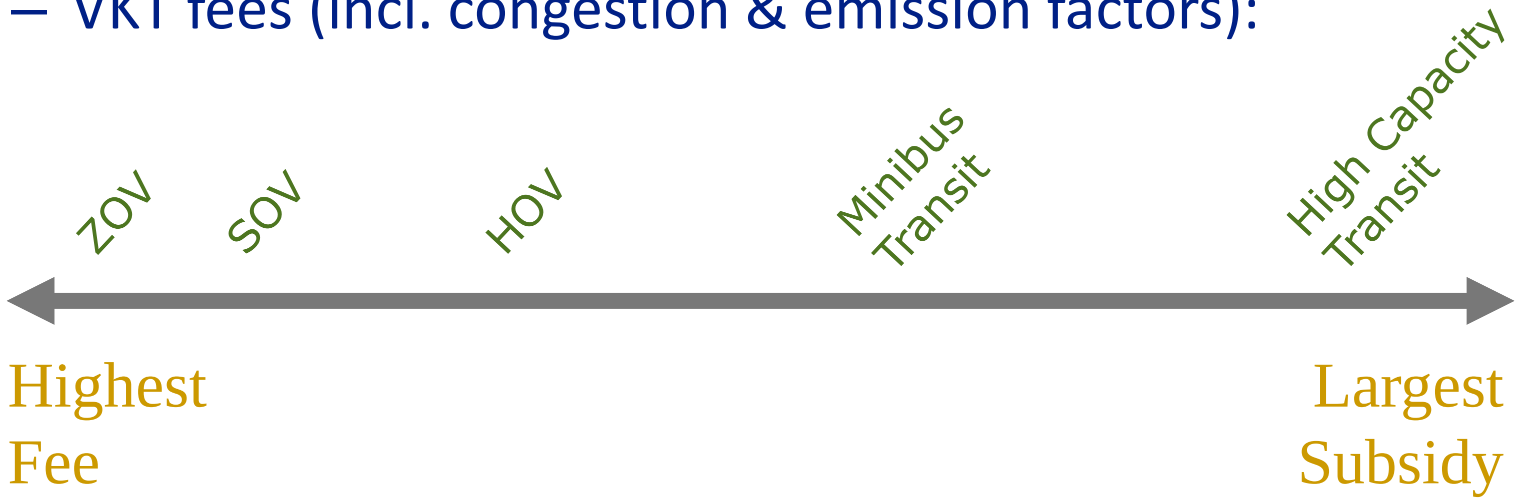
Supportive Policies – critical to success of the scenarios

- 3R Scenario (Automation + Electrification + **Sharing**):
  - Compact Urban Development policies
  - Efficient parking policies
  - Heavy investment in transit/walking/cycling
  - VKT fees (incl. congestion & emission factors):



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A few takeaways

- 2R without 3R could be a traffic nightmare, even with automation traffic benefits.
  - The rebound travel effects of automation should be carefully managed
- A 2R scenario could lead to deep CO_2 reductions IF grid electricity is deeply decarbonized
  - A 3R scenarios provides more robust emissions reductions
  - Automation without electrification could increase CO_2
- 3R: Sharing must be strongly incentivized, probably through pricing
- Even a super-rapid transition will take 3 decades to complete
  - Private “legacy” vehicles could be an issue; scrappage incentives could be interesting