Three Revolutions in Urban Transportation: 
How will these affect the costs of trips?

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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 CO2, 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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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

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Automation</th>
<th>Electrification</th>
<th>Shared Vehicles</th>
<th>Urban Planning/Pricing/TDM Policies</th>
<th>Aligned with 1.5 Degree Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business as usual, Limited Intervention</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>No</td>
</tr>
<tr>
<td>1R Automation only</td>
<td>HIGH</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>No</td>
</tr>
<tr>
<td>2R With high Electrification</td>
<td>HIGH</td>
<td>HIGH</td>
<td>Low</td>
<td>Low</td>
<td>Maybe</td>
</tr>
<tr>
<td>3R With high shared mobility, transit, walking/cycling</td>
<td>HIGH</td>
<td>HIGH</td>
<td>HIGH</td>
<td>HIGH</td>
<td>YES</td>
</tr>
</tbody>
</table>

**UC Davis:** Sustainable Transportation Energy Pathways

**ITDP:** Institute for Transportation & Development Policy
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
A more detailed cost comparison: California in 2025

• Junia Compostella working on this with me (see her poster)
• Following presentation assumes widespread availability of electric vehicles (EVs) and electric, connected automated vehicles (or AV/EVs)
• Comparison here is the cost per mile of:
  – Private ICEs, EVs, and AV/EVs
  – MaaS (Mobility as a Service, such as Uber) versions of EVs and AV/EVs
  – Pooled services included, in later slides
• Start with looking at vehicle costs per mile, then consider passengers
• For some aspects need to assume specific trip lengths
STEP 1: Purchase cost of vehicles

- Midsize car, $30k in 2025, 40 MPG
- EVs cost about $10,000 more than ICEs
  - EV battery costs at $150/kWh, 0.25 kWh/mi, 65 kWh capacity, 250 mile range
- AV/EVs $5000 more than EV, 10% better efficiency
- Private vehicles travel 13,000 miles per year, MaaS vehicles 50,000
- Some residual value for private vehicles after 5 years, none for MaaS vehicles

![Amortized purchase cost graph]

- Private car, ICE
- Private car, EV
- Private Car, AV/EV
- MaaS, EV, driven
- MaaS, AV/EV

$\$/mile
2: add fuel costs

- Gasoline: $4.00/gal; Private electricity: $0.17/kWh; Public electricity: $0.25/kWh
- ICE: 40 MPG; EV: 0.25 kWh/mi; AV/EV: 0.22 kWh/mi
3: add insurance and maintenance

- Insurance cost is about $1900 per vehicle/yr for ICE and EV; 1/3 less for AV/EV
- MaaS similar as private (lower rate per mi but 4x miles/yr)
- Maintenance cost (motor, oil, tires, etc) 40% lower for EV and AV/EV than ICE
4: add parking and cleaning

- Assumes parking at $5/day, 200 days per year = $1000 for private ICEs and EVs
  - 50% less for MaaS vehicles
  - 50% less again for AV/EVs
- Cleaning about $150 for private vehicles, $1000 for MaaS vehicles
Drivers assumed to earn about $1.00/mile ($50k for 50,000 miles) after all expenses

- For an average speed of 20 MPG, this is $20/hr

MaaS fees assumed to be 20% of revenues (which equal all the costs in the figure)

- This rises to 30% with no driver
7: add passengers

- Assume 1.5 passengers per private car and MaaS trip
- Assume 2 passengers at 60% price each for MaaS pooled trip; trip 10% farther
8: Add a value of time for driving, travelling, parking

- Time cost for drivers set to $20/hr, or $0.80/mi for a 15 minute, 6 mile trip
  - Time cost for non-drivers (whether AV or not) 50% lower
- Parking search / walking to destination if not door-to-door: 5 minutes
  - Thus $1.67 per trip, or $0.28/mi for a 6 mile trip
Include only variable costs (daily decision)

- Ignore private car purchase, insurance cost
Next STEPS

• More use cases, (more modes, more trip lengths, city vs. suburban trips?)
• More sensitivity analysis with assumptions
• Do for different countries
• Deeper exploration of non-cost attributes
  – Possible survey work to better understand how people value both cost and non-cost aspects, how they might travel in AVs?
• Add these data into a spatial model to better test real mode choices?