Innovation in Transportation: Opportunities & Challenges
Energy-related CO₂ emissions by sector
AEO2022 Reference case
billion metric tons

Source: U.S. Energy Information Administration, Annual Energy Outlook 2022, March 2022
Future of Transportation

Source: autonews.com
Electrification

Pooling

Automation
Opportunities

Electrification

- Large potential for GHG reductions
- Complementarity with decarbonizing electric grid
- National, state, and local policy support
- Automakers are on board
- Cost of batteries declining, TCO parity by 2035 (Chakraborty, Buch, & Tal 2021)
Challenges

**Electrification**

- Behavioral factors
  - Driven less than ICEVs? (Burlig et al, 2021; Davis, 2021)
  - Heterogeneous environmental benefits (Archsmith, Kendall, & Rapson, 2015; Holland et al., 2016)

Source: Archsmith, Kendall, & Rapson, 2015
Challenges

Electrification

- Behavioral factors
- Driven less than ICEVs? (Burlig et al, 2021; Davis, 2021)
- Heterogeneous environmental benefits (Archsmith, Kendall, & Rapson, 2015; Holland et al., 2016)
- Charging access (Nicholas, Hall, & Lutsey, 2019)
Figure ES-1. Public and workplace charging infrastructure in place in 2017 as a percentage of infrastructure needed by 2025 by metropolitan area

Source: Nicholas, Hall, and Lutsey, 2019
Challenges

• Behavioral factors
  • Driven less than ICEVs?  (Burlig et al, 2021; Davis, 2021)

• Heterogeneous environmental benefits  (Archsmith, Kendall, & Rapson, 2015; Holland et al., 2016)

• Charging access  (Nicholas, Hall, & Lutsey, 2019)

• Poor cost-effectiveness of subsidies  (DeShazo, Sheldon, & Carson, 2017)

• Equity (policy & benefits)  (Holland et al., 2019; Sheldon, 2022)
Opportunities

Pooling

• Engineering estimates -> major potential (Hasan et al., 2020)
  • 57% decrease in vehicle usage
  • 46% decrease in VMT
  • Only 22% increase in ride time
• Complementarity with electrification
  • 3x greater emissions reductions for switching to EV for ride-hailing (Jenn, 2020)
Challenges

Pooling

- People don’t want to carpool with others!
• Ride time constant, consumers WTP $3.66 (median) and $23.45 (mean) less to carpool

Source: Sheldon and Dua, working paper
Challenges

Pooling

• People don’t want to carpool with others!

• Public transit users and commuter (versus leisure) trips more willing to carpool (Asgari, Jin, & Corkery, 2018; Lavieri & Bhat, 2019)
Opportunities

Automation

- Increased access (Fagnant & Kockelman, 2015)
- Lower operating cost of on-demand services (reduce demand for private cars) (Bösch et al., 2018)
  - 88% of conventional taxi cost due to labor
  - 0.41 CHF per km for autonomous taxi (vs. 2.73)
- More energy efficient (Liu et al., 2019)
- Complementarity with electrification & pooling
Challenges

- Safety concerns
- Regulations, liability, and cybersecurity (Fagnant & Kockleman, 2015)
- Consumer aversion to driverless cars
Source: Sheldon and Dua, working paper

kernel = epanechnikov, bandwidth = 1.0269
Challenges

- Safety concerns
- Regulations, liability, and cybersecurity (Fagnant & Kockleman, 2015)
- Consumer aversion to driverless cars
- Increased VMT & congestion (Wadud, MacKenzie, & Leiby, 2016; Oh et al., 2020)
  - Increased access
  - Lower cost (& lower disutility?)
  - Substitute for public transit
  - Empty trips

Automation
Innovating for climate solutions- it’s not just about technology, but also about behavior.
Thank you!

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Bibliography