

Decarbonizing Transport by 2050: Pressing Needs and Priority Research

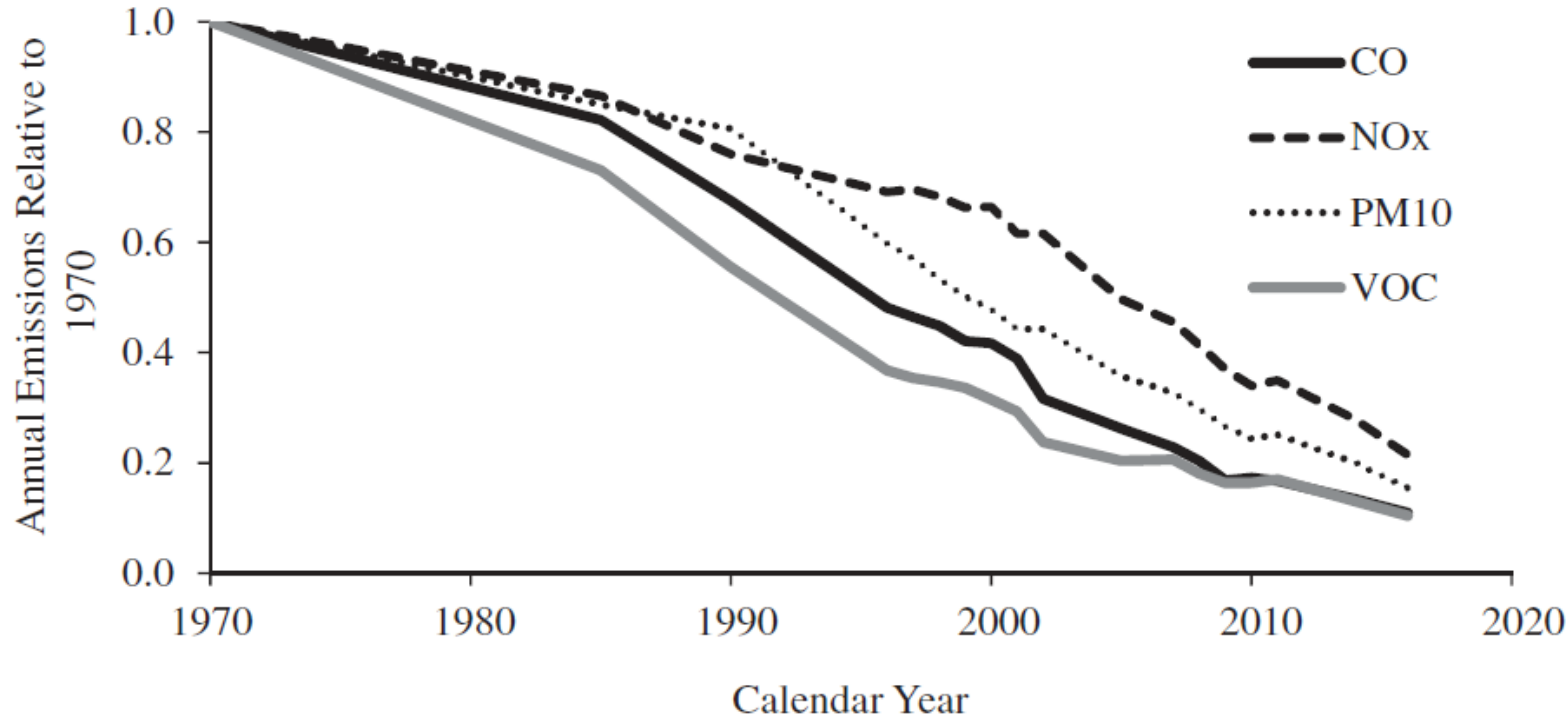
- **Douglas Eisinger**, Sonoma Technology, Univ. of Washington, [AMS10 Chair](#)
- **Marianne Hatzopoulou**, Univ. of Toronto, [AMS10 Research Coordinator](#)

TRB Executive Committee Meeting
January 12, 2022



trbairqualityghg.org

Decarbonization by 2050: Technology Focus



We know what works:

1970-2015 (45 yrs.)

U.S. vehicle emissions fell
~75% to 90%, due largely
to emissions & fuels stds.

Image source: Frey, 2018. Trends in onroad transportation energy and emissions, *JAWMA*, 68:6, 514-563, Figure 7: relative trends in U.S. annual highway vehicle CO, NO_x, VOC, and PM₁₀ emissions, based on EPA data.

Decarbonization by 2050: Technology Focus

- **Last 30 years:** technology best reduced emissions
- **Next 30 years:** decarbonization will be function of
 - **Fleet electrification (largely): zero-emission vehicles (ZEVs)**
 - “Fuels” management (esp. decarbonizing power grid)
 - Some VMT management (difficult, modest outcomes)
- **Acknowledge:** other long-term societal goals beyond just GHG emissions reductions (next slide)



The Art of Michael Kerbow:
Critical Mass

Ultimate
extrapolation of
technology-only
solution !

Artwork courtesy of
[Michael Kerbow &
Desta Art Gallery](#)

Top 10 factors to accelerate light-duty ZEV adoption

Need or Key Factor	Comments
1. Achieve purchase cost parity, ZEVs vs. ICE	Current path: by ~2025-2030
2. Increase gasoline prices	Limited political support
3. Achieve longer driving range	MY 2020 BEV: 250 mi. median
4. Improve public charging power (decrease time)	Level 2 typically "fills" overnight
5. Improve charging availability at key destinations	"BIL" = ~250k stations by 2030
6. Expand purchase rebate durations / coverage	Until purchase parity @ min.
7. Provide HOV lane access in large metro areas	Was key early driver for EVs
8. Increase availability of ZEV models for sale	Issue on path to diminish soon
9. Increase home charging access	Multi-unit dwelling charging
10. Overcome ZEV knowledge gaps / attitudes	For consumers & dealerships

Example sources: [NCHRP 25-25 Task 115](#); [MIT Mobility of the Future](#); [Slowik & Lutsey 2018](#); [EIA 2017](#).

Top Research Needs to Support Decarbonization

LDV Topic	Research Needs Focus
1. Achieve purchase cost parity, ZEVs vs. ICE	Effective incentives
2. Increase gasoline prices	
3. Achieve longer driving range	
4. Improve public charging power (decrease time)	Effective infrastructure buildout Effective incentives
5. Improve charging availability at key destinations	Effective infrastructure buildout Effective incentives
6. Expand purchase rebate durations / coverage	Effective incentives
7. Provide HOV lane access in large metro areas	
8. Increase availability of ZEV models for sale	
9. Increase home charging access	Effective infrastructure buildout Effective incentives
10. Overcome ZEV knowledge gaps / attitudes	

“5-minute” summary (time is of the essence):

Research needed to support practice:

- How do we best structure **incentives** to
 - Reduce up-front ZEV cost (cost parity & beyond)
 - Improve charging infrastructure (speed, locations)
 - Increase home charging access, esp. multi-units
- How do we best support **infrastructure** buildout to
 - Improve public access to high-speed recharging
 - Improve recharging access at key destinations
 - Improve home charging, esp. multi-unit dwellings



Good News: We know it's possible.



Electric BMW in downtown Oslo (NPR image).



October 8, 2001

“Norway just hit a record in its move to phase out cars that rely on fossil fuels...

Around 8 in 10 new passenger vehicles [registered in Sept. 2021] were all-electric...”

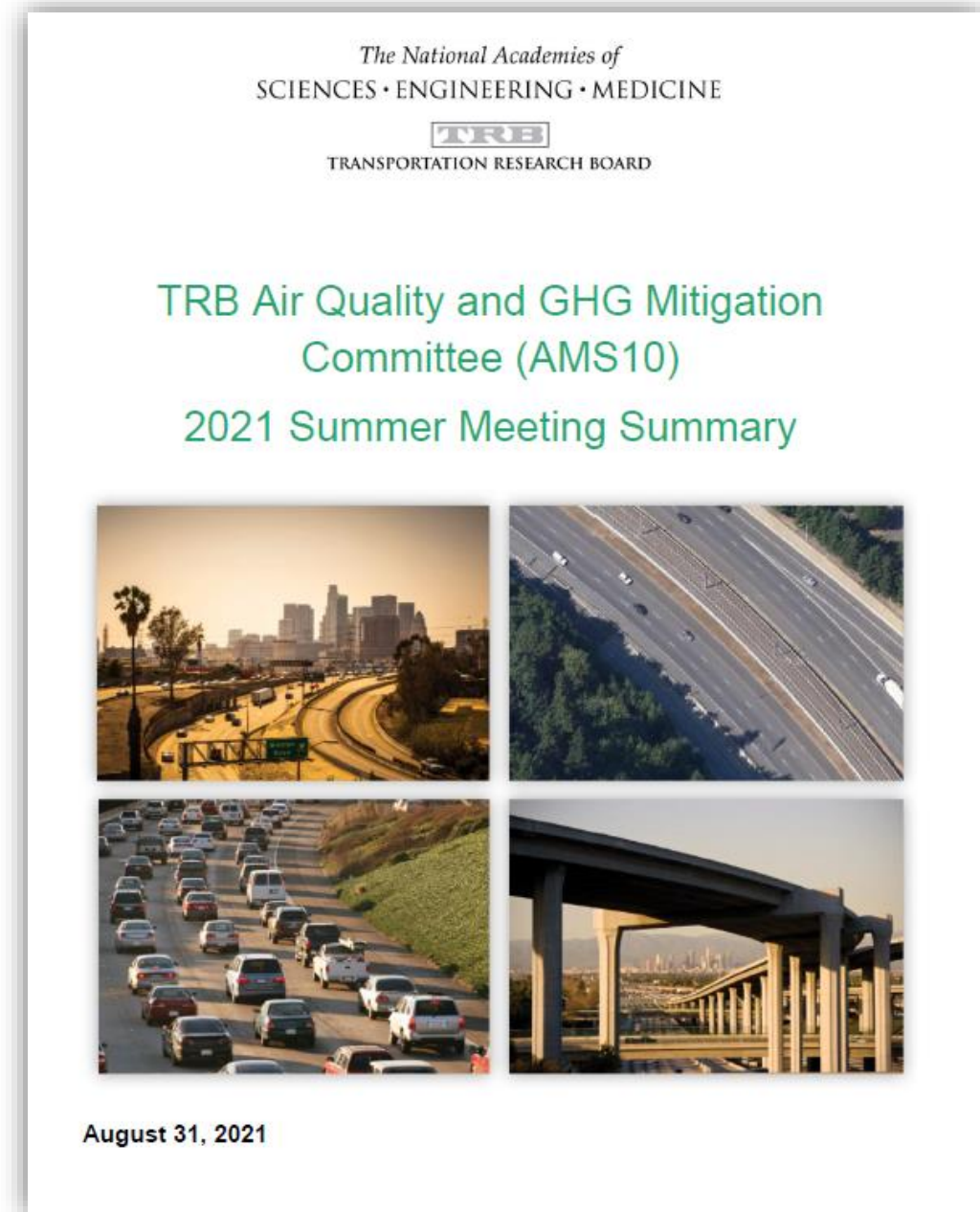
Source: NPR (<https://www.npr.org/2021/10/08/1044330824/norway-electric-vehicle-car-sales-evs>)

Supplemental Material

AMS10 Research Priorities

Digest of

- January 2021 annual meeting (breakouts with attendees)
- Spring 2021 AMS10 Leadership Team discussions
- June 2021 summer planning meeting (~40 participants)
- Results included here are drawn from the AMS10 2021 Summer Meeting Summary



Top Research Needs: Baker's Dozen

1. **Existing policies:** what actions are working well to accelerate ZEV adoption?
2. **Freight:** what "base case" electrification is likely; what more needs to be done to accelerate it?
3. **Indirect effects:** from gas stations to chargers – community impacts?
4. **ZEV co-benefits:** GHG reductions, air quality, EJ impacts?
5. **Infrastructure:** how to optimize (where/what) increased charging?
6. **Travel behavior:** how can we transform behavior to reduce GHGs?
7. **Economic tools:** what practical incentives encourage ZEV adoption and change travel behavior?
8. **Equity:** what policies will advance equity as decarbonize the fleet?
9. **CAVs:** what policies will encourage electrification of, and reduce VMT from, CAVs?
10. **Shared mobility:** how do we encourage electrification and reduce transit erosion?
11. **Land use:** what VMT reductions can best practices ("smart growth") enable?
12. **Lifecycle GHG/AQ analysis:** what tools and methods should be adopted?
13. **International:** how do we address motorization and growth in China, India, sub-Saharan Africa?

Topic 1- Passenger Fleet Electrification

Key ideas discussed around the following topics/ applications:

- State Authority
- Fleet Companies
- Pricing

Research priority:

What local, state, and national policies are adopted to incentivize EV adoption and educate consumers and policy makers? How are they working? What else can be done?

- Review: deployment of existing policies
- Assess: how far will electrification get us, and at what cost? What emissions reductions must other policies address?
- Recommend: needed implementation of new strategies

Topic 2- Freight Electrification

Key ideas discussed around the following topics/ applications:

- Source of power
- Policies
- Technology

Research priority:

- What truck-fleet electrification is reasonably likely in coming years?
- What incentives or other policies will effectively accelerate electrification?
- What climate and social co-benefits result from reducing diesel exhaust (trucks, marine, rail): air quality, public health, EJ.
- What areas are most affected by diesel exhaust and what is the potential for targeted electrification to help them (equity, EJ)?

Topic 3- Electric power generation and on-road fleet electrification

Key ideas discussed around the following topics/ applications:

- Incentives
- Equity
- Battery/Retrofit
- Emissions

Research priority:

- Indirect effects of changing the refueling structure: gas stations in small communities, emissions, impact of charging stations on land-use, community fabric
- New policies regarding economic opportunities for gas stations

Topic 4- Co-benefits for GHG reductions and urban air quality

Key ideas discussed around the following topics/ applications:

- Strategies
- Health
- Programmatic approach

Research priority:

- How will EV market penetration impact GHG emissions/air quality in local and regional contexts (esp. EJ areas)?
- How can we integrate EVs with travel and traffic management strategies to maximize benefits for health, safety, accessibility?
- How will tire and brake wear and road dust emissions change with EVs (quantification, speciation, toxicity)? What will impacts be on air quality and health?
- How can we best reduce near-road pollution exposure in near-term, while we wait for vehicle fleet to turn over? How effective are mitigation techniques?
- Can geofencing keep trucks out of overburdened areas – rerouting them based on pollution levels and EJ status?

Topic 5- EV Infrastructure and Off-road EVs

Key ideas discussed around the following topics/ applications:

- Non-highway
- Air quality Impacts
- Infrastructure

Research priority:

- Where do we prioritize infrastructure needs to support fleet electrification? What are costs and benefits of different EV charging networks? How does the distribution of charging stations in an area affect travel patterns?
- Can we electrify off-road/construction equipment and what are the co-benefits?

Topic 6- Behavior-based approaches

Key ideas discussed around the following topics/applications:

- International perspectives
- COVID
- Equity
- Messaging for driving GHG reductions

Research priority:

- Are there opportunities for transformational behavior changes that would reduce emissions?
- How is travel behavior changing (e.g., Covid, transit, TNCs, shared mobility), are these changes long-term, and how do these changes affect emissions?
- What feasible actions would influence (substantially) travel choices towards options that reduce emissions as we come out of the pandemic?
- What long-term scenarios make sense for land-use/travel behavior forecasting, and what are their implications for emissions/air quality/equity?

Evaluation of forecasting assumptions and implications

Performance of EV scenarios under alternative futures

Performance of CAV scenarios under alternative futures

Topic 7- Economic tools

Key ideas discussed around the following topics/ applications:

- Incentives for new alternative fuelled vehicles
- Equity
- Incentives for charging vehicle locations
- Tools for different levels of government
- Removing parking minimums

Economic as well as social-equity aspects are integrated within most research priorities

Research priority:

- What is the comparative effectiveness (dollars per ton reduced) of incentives such as EV purchase rebates, pooling promotions, transit use subsidies?
- What are the most feasible and acceptable ways to reduce VMT via pricing and road use charges?
- Can we quantify economic development and job creation benefits of new technologies?
- As funding changes from gas taxes towards other fees, how do those changes affect travel behavior, vehicle choices, and emissions?
- Are there effective ways to layer national, state, local fees to reduce emissions and fund cleaner travel?
- What are costs/benefits of GHG reduction policies?

Topic 8- Economic and social equity

Key ideas discussed around the following topics/ applications:

- Incentives for new alternative fuelled vehicles
- Equity
- Incentives for charging vehicle locations
- Tools for different levels of government
- Removing parking minimums

Economic as well as social-equity aspects are integrated within most research priorities

Research priority:

- What emissions reduction policies can best reduce economic and air quality disparities?
- How do we incentivize emissions reductions and EV adoption and use in EJ communities?
- Will new vehicle technologies bring economic development and job creation benefits to disadvantaged communities?
- What policies will advance equity as we incentivize fleet electrification?
- How will the transition to cleaner (electric) vehicles affect small businesses and fleets?

Topic 9- Connected and autonomous vehicles

Key ideas discussed around the following topics/ applications:

- Pricing
- Would Autonomous vehicles increase VMT and GHG?
- Personal vehicle ownership
- Equity
- Rural
- Travel behavior analysis
- Data availability
- Broader policy implications

Research priority:

- How will CAVs and shared mobility (e.g., TNCs, e-scooters) impact GHG emissions/air quality?
- What policies will be effective to ensure automation supports GHG reduction?
- Can we forecast EV charging needs, and needed charging station infrastructure, under scenarios of shared electric AVs?
- How do forecasted EV charging infrastructure needs change if electric CAVs substantially increase VMT?

Topic 10- Shared mobility

Key ideas discussed around the following topics/ applications:

- Demand and emissions
- Impact of the pandemic
- Shared and electric
- Goods and commercial services
- Vehicle age and type for fleets used by TNCs

Research priority:

- What actions would slow or reverse the erosion of transit use due to TNCs, COVID, and other factors? What emissions reductions are feasible from such actions?
- What policies would enable the efficient integration of sharing, pooling, and transit?
- Can a “clean mile standard” for TNCs support GHG reduction from these services?
- What challenges slow shared fleet electrification, and what effective actions will overcome those challenges?
- Given recent rapid disruptions in travel activity (e.g., TNCs, COVID), do we need substantially changed modeling tools and methods to prepare TIPs, RTPs, and emissions reduction plans? If so, what improvements are needed?

Topic 11- Land use planning*

Key ideas discussed around the following topics/ applications:

- Effects on VMT
- Impacts of automation
- Working/learning from home
- Public participation/community engagement in land use planning
- Integrated mobility pricing and land use planning

Research priority:

- Do we need VMT reductions to complement the emissions reductions feasible from fleet electrification?
- [if yes to above] What portion of needed VMT reductions are achievable, and by when, from better community design?
- Are there feasible rural-area land use changes that can contribute meaningfully to VMT and emissions reductions?

*AMS10 recognizes the significant past work on this topic, including, for example, TRB Special Report 298: *Driving and the Built Environment: Effects of Compact Development on Motorized Travel, Energy Use, and CO₂ Emissions*.

Topic 12- Lifecycle analysis and embodied GHG emissions

Key ideas discussed around the following topics/ applications:

- Electric vehicles
- Costs and benefits of lifecycle emission reductions
- Lifecycle assessment of infrastructure construction
- Natural gas

Research priority:

- How do EV construction / embodied emissions compare with EV operational emission reductions?
- Can we refine understanding of the lifecycle emissions of EVs vs. ICE vehicles?
- What tools best assess lifecycle emissions from constructing/maintaining infrastructure? What data are needed to support use of those tools?
- How can DOTs integrate lifecycle emissions in construction and maintenance decisions?
- What construction methods or materials changes best reduce lifecycle emissions? What policies facilitate these changes?

Topic 13- International Issues

Key ideas discussed around the following topics/ applications:

- Effects on VMT
- Developing world
- Impacts of automation
- Working/learning from home
- Public participation/community engagement in land use planning
- Integrated mobility pricing and land use planning

Research priority:

- What fraction of future GHG emissions will originate from rapidly motorizing countries such as China and India, and from regions with fast-growing populations (sub-Saharan Africa).
- What are the most effective actions that can be taken in these countries to reduce GHG emissions and transportation-related air pollution?