Global Electrification of Light-duty Vehicles: Impacts of Economics and Climate Policy

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1. Motivations underlying the research

Achieving the Paris Agreement's long-term goal of keeping global warming well below two degrees Celsius relative to preindustrial levels will require dramatic reductions in greenhouse gas emissions across all economic sectors, including transportation. One pathway to curbing transportation emissions is to transition to electric vehicles along with zero-carbon power sources. At this time, electrification is occurring primarily in private light-duty vehicles (LDVs). In 2018 the global electric vehicle (EV) fleet exceeded 5.1 million, but that's a tiny fraction of the cars and light trucks on the road. How much of the LDV fleet will need to go electric to keep the Paris climate goal in play?

To help answer that question, a team of researchers at the MIT Joint Program on the Science and Policy of Global Change have assessed the potential impacts of global decarbonization on the evolution of LDV fleets over the next three decades.

2. A short account of the research performed

Using an enhanced version of the multi-region, multi-sector MIT Economic Projection and Policy Analysis (EPPA) model that includes a representation of the household transportation sector, we projected changes for the 2020-2050 period in LDV fleet composition, carbon dioxide emissions, and related impacts for 18 different regions. Projections were generated under three increasingly ambitious climate mitigation scenarios: a Reference scenario based on current market trends and fuel efficiency policies, a Paris Forever scenario in which current Paris Agreement commitments are maintained but not strengthened after 2030, and a Paris to 2°C scenario in which decarbonization actions are enhanced to be consistent with capping global warming at 2°C.

While many countries are progressing in fulfilling their Paris pledges for 2030, even more aggressive global emission reductions are needed for reaching the long-term goal of the Paris Agreement related to pursuing efforts to limit the temperature increase to 1.5°C. To evaluate the impacts of increased ambitions, we explore an Accelerated Actions scenario in which countries impose much more aggressive emission targets than those submitted in their NDCs.

3. Main conclusions and policy implications of the work

Based on projections spanning the least *(Reference)* to the most *(Paris to 2°C)* ambitious mitigation scenario, we found that the global EV fleet will likely grow to about 95–105 million EVs by 2030, and 585–823 million EVs by 2050. At this level of market penetration, EVs would constitute one-third to one-half of the overall LDV fleet by 2050, with the stricter carbon constraints required by the *Paris to 2°C* scenario resulting in a larger EV share. We also determined that EV uptake will likely grow but vary across regions over the 30-year study timeframe, with China, the U.S. and Europe remaining the largest markets. Finally, we found that the costs of climate policies considered in the three scenarios range from a GDP loss of about 1.1% to 3.3% in 2050, relative to the *Reference* scenario.

In the *Accelerated Actions* scenario, global EV stock reaches more than 200 million vehicles in 2030, 600 million in 2040, and more than one billion in 2050. Assuming this accelerated deployment of EVs, two-thirds of all global LDVs by 2050 are electric. Our modeling implies that achieving a 67% electrification of the global LDV stock, global EV sales would exceed 30 million in 2030, 60 million in 2040, and 100 million in 2050.

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While we project that EVs will constitute a substantial share of the light-duty fleet by mid-century, more actions are needed to decarbonize LDV fleet. We recommend an increased ambition for climate policy actions because carbon policies will affect the speed of penetration and ultimate number of EVs on the road over the next few decades. The climate impacts of EV deployment depend on progress toward decarbonizing the electric grid. Accordingly, we recommend that policies to support EVs should go hand-in-hand with policies to support low-carbon electricity generation. Hydrogen-based FCEVs offer another pathway for decarbonization, but their potential within the mid-century timeframe depends on substantial cost reductions in terms of both vehicles and fuel production and distribution infrastructure.

We recommend enhancing the support for further research and development (R&D) to advance these and other low-carbon transportation options because they will allow the attainment of more ambitious decarbonization targets. While our paper focuses on EV deployment, we also stress support for all possible decarbonization options related to transportation, including enhancing public transportation, land use planning that encourages compact areas and reducing the use of private motorized transport by mode switching to walking, biking and mass transit. Development of efficient modes of transport, like subways and high-speed rail, can offer low-emitting options for transporting people and goods.