HOW COST-EFFECTIVE ARE ELECTRIC VEHICLE SUBSIDES IN REDUCING TAILPIPE-CO_2 EMISSIONS? AN ANALYSIS OF MAJOR ELECTRIC VEHICLE MARKETS

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Overview

Global transport was the fourth largest source of greenhouse gas (GHG) emissions in 2018, producing about 24% of global energy-related CO_2 emissions. About 75% of transport emissions come from road vehicles including cars and trucks. The majority of GHG emission reductions in the transport sector are projected to come from electrification of light-duty vehicles (LDVs), where technology is already commercial.

Governments globally have adopted various policies to support electrification of LDVs. Demand-side fiscal policies - in particular, incentives to reduce the upfront price of plug-in electric vehicles (PEVs), represent one of the most commonly used policy levers. This paper explores the PEV subsidy impact and cost-effectiveness in reducing CO_2 emissions across a range of major PEV markets. In particular, we utilize detailed micro-level data from 2010 to 2017 for 11 countries including China, the U.S. and nine major European countries, which are currently leaders in the PEV market. By comparing countries with a wide range of PEV market shares (from <1-40 percent), this paper provides a broad view of how the trends and subsidy performance metrics might evolve as PEV adoption increases in countries with currently low PEV market shares.

Methods

To estimate the tailpipe-CO_2 emissions avoided by PEV adoption, we assume that a PEV buyer would have bought an average ICEV of the same body type as the PEV in the counterfactual case of no PEVs. We couple this counterfactual vehicle assumption with insights from the choice modeling literature to allow for more realistic substitution patterns and more realistic estimates for tailpipe-CO_2 savings.

To estimate the cost per tonne of tailpipe-CO_2 avoided, we divide the total subsidy cost by the total tailpipe-CO_2 avoided over the lifetime of the vehicle. To estimate the cost-effectiveness of the subsidy, we account for the fact that taking away the subsidy would not result in zero PEV sales. In other words, we account for the fact that some consumers would have bought a PEV even in the absence of the subsidy. We do so by incorporating values from the literature on the extent of PEV sales induced by the subsidy. Finally, we also incorporate the CO_2 emissions from the combustion of fuels associated with the generation and distribution of electricity used for PEV charging. This gives us the actual cost per tonne of CO_2 avoided from subsidizing PEVs.

Results

We find that reducing tailpipe-CO_2 emissions by PEV adoption subsidies is expensive. We find that a conservative estimate of the cost per tonne of tailpipe-CO_2 avoided can be as high as $1,600 (on PPP basis in 2010 USD), with the highest cost per tonne for China, followed by Denmark and Norway. The policy cost is more than an order of magnitude higher than the social cost of carbon. The estimated cost per tonne of CO_2 avoided becomes even higher when taking into account the actual extent of electric vehicle sales induced by the subsidies and the emissions assoicated with electricity generation.

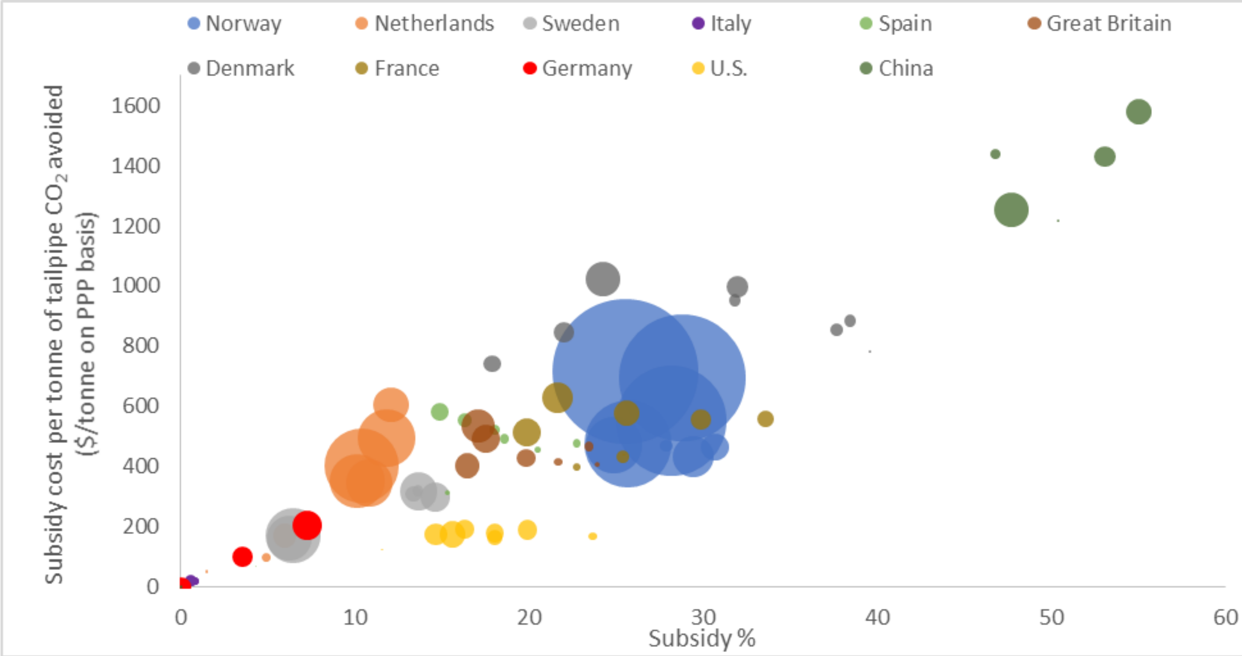

Figure 1. Variation in subsidy cost per tonne of tailpipe-CO_2 avoided (y-axis) with subsidy percentage on electric vehicles (x-axis). The size of the bubble for each country is proportional to the market share of electric vehicles in new vehicle sales in that country corresponding to each year over the 2010-2017 time period. The largest bubble size represents a market share of ~38%.

Conclusions

The high tailpipe-CO_2 emissions reduction costs of PEV subsidy policies warrants research into and adoption of innovative subsidy designs to improve their cost-effectiveness. Targeted designs based on either consumer income or vehicle price represent viable cost-effective alternatives. Real world pilot tests involving targeted subsidy designs for vehicle retirement and replacement have also proven to be more cost-effective in inducing additional PEV sales. Despite potential improvements that can be achieved through targeted designs, PEV subsidies are likely to remain much less cost-effective compared to a gasoline tax and even supply-side policies such as fuel economy standards, which the literature suggests costs between $18–47 and $48-310 per tonne of CO_2 avoided respectively.