Shared Autonomous Electric Vehicles:

Their Impact on GHG Emissions and Global Cobalt Reserves

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INTRODUCTION

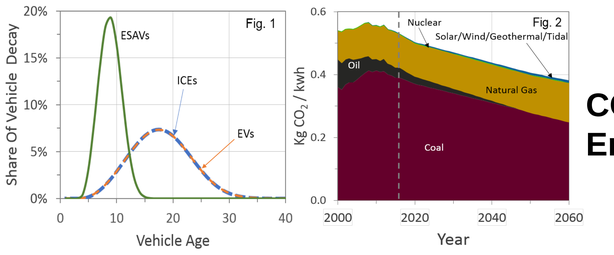
Global personal vehicles accounted for 4.5 Gt of CO_2 emissions in 2016. In this project, we will assess how the introduction of autonomous electric vehicles may affect the future of global vehicle CO_2 emissions. Two scenarios in which electric autonomous vehicles are either personally owned (EPAV) or shared (ESAV) are compared to a reference scenario where electric vehicles (EV) are projected to make up 30% of global vehicle stock by 2060.

The introduction of electric vehicles has increased pressure on cobalt reserves used in battery cathodes. Of all cobalt mined today, 60% of this is sourced from the Democratic Republic of Congo (DRC), a place that is known to use child labor. A shared vehicle service has been shown to replace 6 personally owned vehicles which may reduce the stress on global cobalt reserves [1].

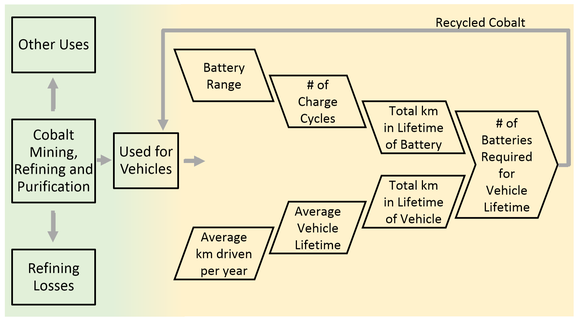
METHODS

A graph of CO_2 emissions for each scenario was created using:

- Vehicle stock data, market share, and decay curves (Fig. 1) [1]
- Gasoline and diesel CO_2 emissions (production and combustion) [2,3]
- LCA for ICEs and EVs [4]
- Global grid CO_2 emission intensity (Fig. 2) [5,6]
- Efficiency projections for ICEs, EPAVs, and ESAVs [7,8,9]



The map below shows the method used to determine the cobalt demand per electric autonomous vehicle.



RESULTS

New Vehicles Produced

-

Vehicles Retired

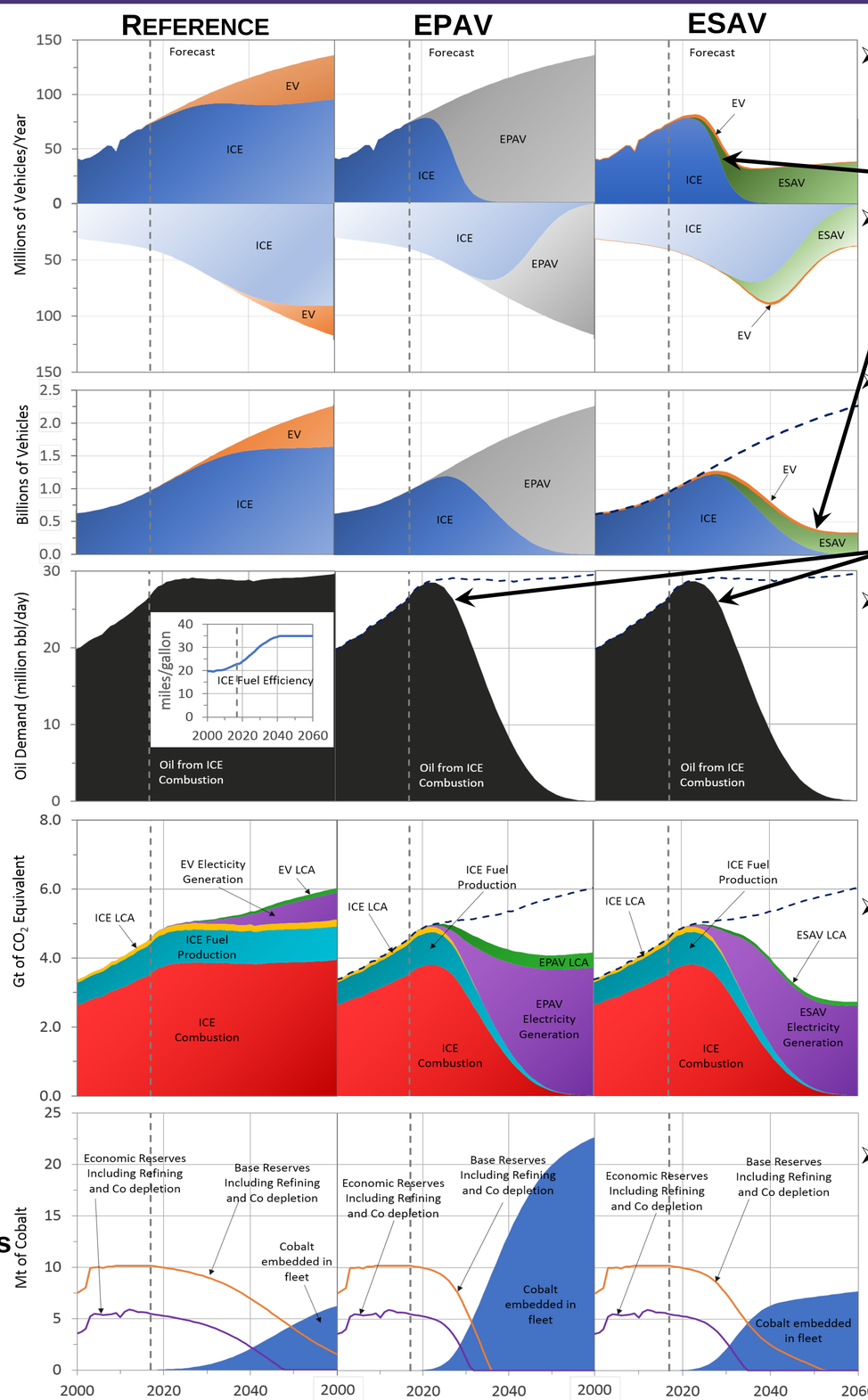
=

Vehicle Stock

Oil Demand

CO_2 Emissions

Cobalt Constraints



NOTE:

- ICE's are displaced from shifting market demand towards ESAV's
- ESAV's reduce the global vehicle stock by about 2 billion vehicles by 2060
- This 2 million barrel decrease per day in oil demand will create a shock in oil based economies
- Autonomous Vehicles are projected to drive more than ICE vehicles, resulting in more CO_2 emissions associated with electricity generation
- The total reductions over the course of our forecasts are 41Gt in the EPAV scenario and 62Gt in the ESAV scenario
- An average demand of 10kg of cobalt per vehicle results in a shortage when the cobalt reserve curves intersect the x-axis

DISCUSSION

In the EPAV scenario, we see a peak in vehicle CO_2 emissions at the year 2025 (~5 Gt/year). After 2025, yearly emissions are projected to decrease, reaching ~4.2 Gt in 2060. The ESAV scenario shows peak CO_2 emissions in 2025 (~5 Gt) with a reduction to ~2.7 Gt in 2060. In each scenario, we see a transition of the major contributor to emissions, from primarily ICE combustion to electricity generation. The EPAV scenario projects a cobalt shortage of economic reserves in 2032, while the ESAV scenario projects a shortage of economic reserves in 2035, considering 90% battery recycling and including cobalt from the Democratic Republic of Congo. This increased pressure on cobalt reserves could allow base reserves, which are currently too costly to mine, to become more economical. It may also promote further exploration for new reserves.

CONCLUSIONS

The adoption of ESAVs has the potential to reduce global GHG while providing a new, more convenient form of transportation for a larger portion of the population. This projected decrease in global CO_2 emissions provides significant motivation to move the transportation industry towards ESAV adoption. However, projections of future global cobalt shortages constrain the feasibility of this industry transformation. The implications of this result urges ESAV producers to develop new, alternative technologies for battery production. Additionally, a continued greening of the global electricity grid has the potential to further augment the decrease in CO_2 emissions projections explored in this project. Considering the results of this project, potential areas of future research include how fluctuating prices of cobalt influence economic reserves and how the DRC will influence the economic reserves.

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