LONG-TERM IMPACTS OF THE EU BAN ON THE SALE OF NEW THERMAL CARS ON CRITICAL MATERIAL NEEDS AND ENERGY TRANSITION

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Overview

In the European Union (EU), in 2019, about a quarter of total CO_2 emissions were coming from the transport sector, with 71.7% generated by road transportation [1]. Having set an objective of reducing its transport sector GHG emissions by 90% in 2050 compared with 1990 [1], the EU has adopted a ban on the sale of new ICEVs within its borders from 2035 [2]. Transport demand management and the adoption of new technologies such as electromobility are needed solutions to achieve this objective. Indeed, when charged with low-carbon electricity, battery electric vehicles (BEVs) emit less GHG than internal combustion engine vehicles (ICEVs) during their lifecycle [3]. However, disseminating BEVs will increase battery demand [4], implying a possible sharp increase in the transport sector's material requirements, especially minerals [5]. Electric vehicles (EVs) use approximately six times more minerals than ICEVs [6]. Copper, cobalt, lithium, manganese, nickel, graphite and rare-earth elements (REEs) can be cited among them [6]. This growing dependency to mineral flows to achieve the energy transition has sparked a lot of discussion for the past years [5], [7], [8], [9], fuelling the field of material criticality studies. The aforementioned minerals are all deemed critical by the European Commission [10], meaning they are essential for strategic industrial sectors, as well as at risk of potential shortages. Given the economic, geopolitical, technological and environmental implications of these growing needs for materials, how will the ban on the sale of new ICEVs affect critical material demand? This study aims to assess future critical materials needs entailed by the electrification of the transport sector and to place them in the context of EV supply chains to highlight the challenges the EU will face. Long-term modelling is used to this end.

Methods

To study the transport sector's future developments, we employ TIAM-FR, the CMA's version of the TIMES Integrated Assessment Model. This bottom-up linear programming model is part of the TIMES model generator , which is developed by the International Energy Agency's (IEA) Energy Technology Systems Analysis Program (ETSAP). TIMES generates partial equilibrium techno-economic models which represent regional energy systems on a long-term horizon. As TIAM-FR is a "bottom-up" model, it includes a detailed representation of the energy system technologies, which are described by techno-economic parameters set by the user. These parameters form the constraints of the optimization problem the model solves, which is the minimization of the total discounted cost for all 15 regions' net present value. This work unfolds on a 2018–2100-time span, on a global scale.

The first part of this study consists in assessing the optimal repartition between the different types of batteries used in passenger cars and vans, specifically the share of different cathode chemistries, under various constraints. We focused on passenger cars and vans, as the EU ban affects them. Several scenarios will be considered, with varying assumptions on the EU ban on the sale of new ICEVs and long-term trends on the battery market. The reference set of scenarios does not consider the ban. Among them, one follows the current trends in terms of battery chemistry aligned with the IEA's base case projections. The others are assumptions on the breakthrough of nowadays alternative battery technologies, for example nickel-rich cathode batteries. Then, for each scenario, we estimate the demand for critical materials from EVs and ICEVs in the EU. This study is limited to materials listed as critical by the EU in its 2023 Critical Raw Material Act (CRMA). Data on the material intensities of the cars and batteries comes from EcoInvent 3.11, a lifecycle inventory database, following the "cut-off by classification" allocation method. From these results, we highlight future potential geopolitical dependencies the EU might face regarding the battery supply chains, in particular their upstream.

Results

For each studied scenario, TIAM-FR provides the total discounted cost of the energy system, the volume of GHG emitted, newly installed technological capacities and their activity levels, and future investments. It also determines an optimal energy mix respecting the constraints set by the scenarios, as well as an optimal repartition of vehicle fleet, on global and European scales. As other non-EVs low-carbon vehicles are also modelled in TIAM-FR, the EU ban on the sale of new ICEVs might affect their adoption in our results. Therefore, these results will highlight the long-term effects of this policy in the EU, and of various techno-economic parameters on EV batteries, not only on the vehicle fleet but also on the energy mix.

Subsequently, the second part of the analysis estimates the volume of critical materials necessary to produce the new cars sold during the studied period. Looking at past and current trends in terms of critical materials producing and refining countries, as well as other steps of battery supply chains, we conjecture the organization of future material flows. Concerning the EU, this may underscore new dependencies to exterior exporting actors.

Conclusions

This work emphasizes the material reality of decarbonizing the transport sector, thanks to a long-term linear programming model following scenarios on policy implementation and techno-economic assumptions on battery markets. The way battery supply chains are organized results in new geopolitical challenges, concomitant with the emergence of new economies. This contributes to geopolitical multipolarisation. We conclude this study by putting forward political recommendations covering future investments in batteries and mineral commodities and international cooperation on mineral governance.

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