Global transportation decarbonization pathways considering lifestyle change and mineral availabilities

LOCOMOTION
Low-carbon society:
an enhanced modelling tool for the transition to sustainability

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INTRODUCTION

The global increase in greenhouse gas (GHG) emissions and the depletion of good quality oil reserves are two of the greatest challenges facing humanity today. Globally and throughout 2019, the transport sector emitted 20% of all GHG emissions. This has caused various institutions to promote cleaner and more efficient mobility systems than those currently in place, including electric mobility. But, electric mobility, a priori more respectful of the environment, has associated the problem that some of the materials that are present in this technology, are critical elements, it may present problems of exhaustion in the near future.

GHG emissions + Oil depletion + Policies = Electric mobility + Lifestyle change → Minerals

OBJECTIVES

- To estimate the electric mobility technologies that will stand out in the future, what infrastructures are associated with them, and what minerals they demand.
- Show possible alternatives or solutions in the use of materials and transport to avoid future shortages.
- Obtain the results and interpret which materials may be critical in the future.
- Show how different socio-economic behaviors through policy adoption can affect the demand for technologies and minerals.

METHODOLOGY

An exhaustive bibliographic review has been carried out in order to obtain the most precise information about the technologies used in electrified transport, which materials are demanded and in what quantity, to later use the system dynamics model MEDEAS-World in order to know the viability of the use of these minerals or if their world reserves could be finished prematurely.

DATA COLLECTION → MEDEAS-W → RESULTS

DATA COLLECTION



Electrified vehicles
- Batteries
- Copper in the vehicle
- Charging Infrastructure

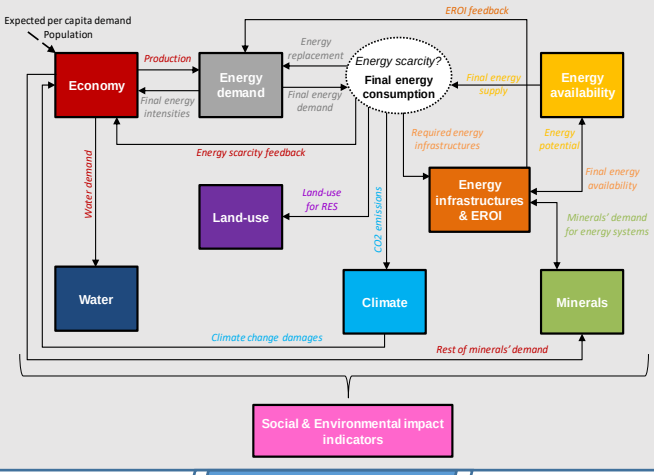
Railroad infrastructure
- Catenary
- Electrical Transformers

Availability and recycling rate of minerals
- Resources
- Reservations
- Recycling Ratio

These data have been entered into the MEDEAS-World database and the modeling structures have been modified to dynamically compute the associated mineral requirements, so that, together with various policies or scenarios [2] that we will establish in order to mimic the various physical, political regulations, we can obtain the temporal evolution of the demand for mineral resources.

MODEL: MEDEAS-W

The open source dynamic systems model MEDEAS-World [1], allows to consider the feedbacks between the different economic and energy sectors. MEDEAS has been developed with the objective of informing decision making to achieve the transition to sustainable energy systems, focusing on biophysical, economic, social and technological constraints.



SCENARIOS

EV TRENDS
This scenario projects the current and expected trends.

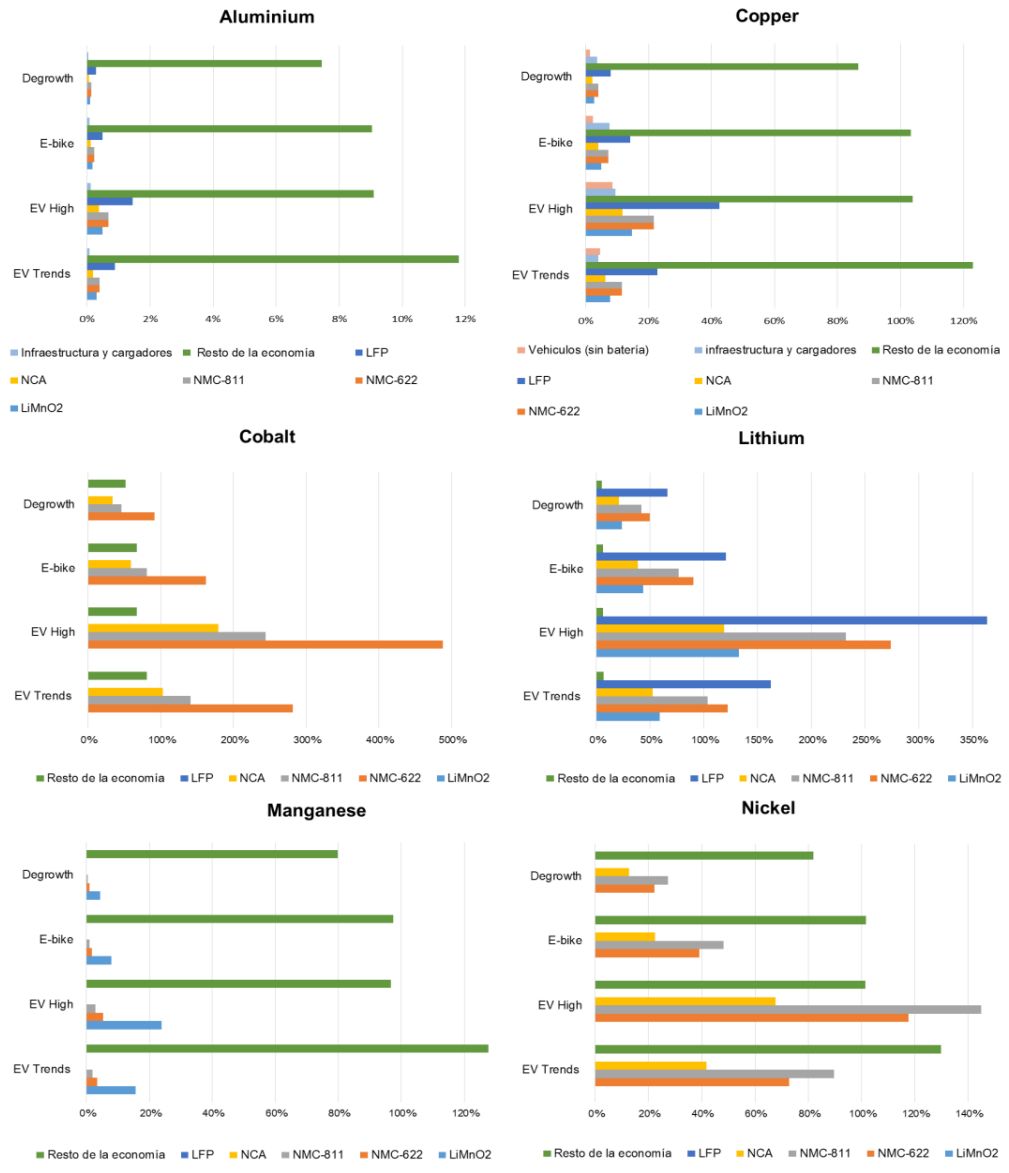
EV HIGH
Scenario of very high electrification in land transport. In 2050, all personal cars, buses and motorcycles will be battery electric vehicles and 80% of heavy vehicles will be hybrids.

E-BIKE
This is a scenario in which mobility based on very light electric vehicles is promoted. Most personal cars are replaced by two-wheeled electric vehicles, electronic bicycles and non-motorized vehicles.

DEGROWTH
This scenario complies with the objectives of decarbonization. The proportion of vehicles is the same as in the E-bike scenario, but reducing transport demand. A steady state economy is imposed.

RESULTS

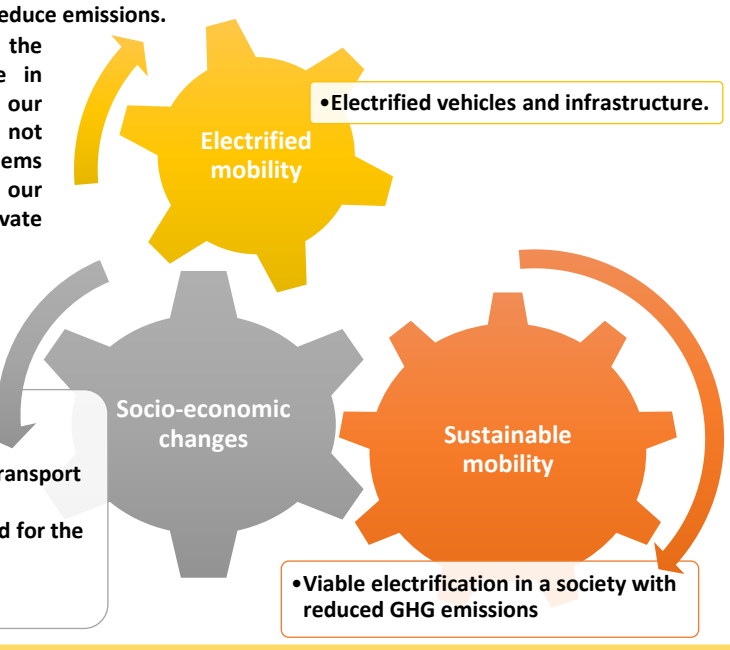
The graphs show the percentage of demand for minerals by the different technologies of transport electrification and in the rest of the economy with respect to their reserves in the different scenarios in 2050:



CONCLUSIONS

The results show that alternatives must be sought, since electric mobility technology uses a large amount of minerals at the present time. The alternatives that can be taken lie in adopting different socio-economic behavioral changes such as those assumed in the Degrowth scenario [2]. The application of these alternatives in the model together with solutions such as circular economy or massive recycling shows that it is possible to control the expenditure of certain minerals in the field of transport and also reduce emissions.

We can finally reach the conclusion that a change in mobility without changing our habits and customs would not serve to reduce our problems with the environment and our planet, but rather to aggravate them.



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[2] I. de Blas, M. Mediavilla, I. Capellán-Pérez, y C. **Duce.The limits of transport decarbonization under the current growth paradigm.** doi: 10.1016/j.esr.2020.100543.

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