monumo
motion motivated

Reducing the climate impact of electric mobility

Monumo research paper
May 2022

Introduction

Monumo has an ambitious plan to apply leading digital technology to improve electric motors. The solutions under development have potential to bring massive sustainability and climate benefits that can be deployed across markets spanning personal electric vehicles, commercial transportation, flight and generation.

Monumo has worked with leading sustainability advisory firm, Canopy, to consider the future growth of markets for electric vehicles, the climate impacts of vehicle electrification and the climate related opportunities of its products. In particular, we focus on the opportunity to eliminate rare earth metals from electric vehicle (EV) motor magnets which will deliver significant savings in carbon emissions and other environmental impacts in the motor supply chain.

This brief provides an overview of the findings of this work. It draws from EV market projections published by experts in these markets, including the International Energy Agency and a Canopy model for carbon savings associated with the application of Monumo technology to eliminate rare earth metals from EV motors globally.

Key findings

145m

Markets for EVs are set to grow rapidly.
The International Energy Agency projects that the global EV stock across all transport modes (excluding two/three-wheelers) will expand from over 11 million in 2020 to almost **145 million vehicles by 2030**, an annual average growth rate of nearly 30%[1].

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The shift to electric mobility will bring significant sustainability benefits.
EVs are already delivering significant carbon emissions savings (e.g. equivalent to the entire footprint of the Hungarian energy sector in 2019). IEA projects that by 2030, **the global EV fleet will reduce GHG emissions by more than one-third** compared to an equivalent ICE vehicle fleet.

28bn

Monumo technology which could eliminate rare earth metals from motor magnets and improve vehicle efficiency would deliver significant further sustainability benefits. If adopted across motor verticals by 2040, by 2050, approximate emissions **savings would be equivalent to removing the annual CO_2 emissions of Germany and France combined**. A further 28 billion m^3 of mining waste could be saved – enough to cover California and Texas with 2cm of waste.

1 IEA – Global EV Outlook and Energy Forecasts www.iea.org/reports/global-ev-outlook-2021/trends-and-developments-in-electric-vehicle-markets and www.iea.org/reports/global-ev-outlook-2021/prospects-for-electric-vehicle-deployment; based on the "stated policies scenario" which projects likely growth based on current regulatory frameworks.

The unstoppable growth of electric mobility

More than 10 million electric cars were on the world's roads in 2020 with battery electric models driving the expansion.

In IEA's Stated Policy scenario, the global EV stock across all transport modes (excluding two/three-wheelers) expands from over 11 million in 2020 to almost 145 million vehicles by 2030, an annual average growth rate of nearly 30%. In this scenario, EVs account for about 7% of the road vehicle fleet by 2030. EV sales reach over 25 million vehicles in 2030, representing 15% of all road vehicle sales.

145m

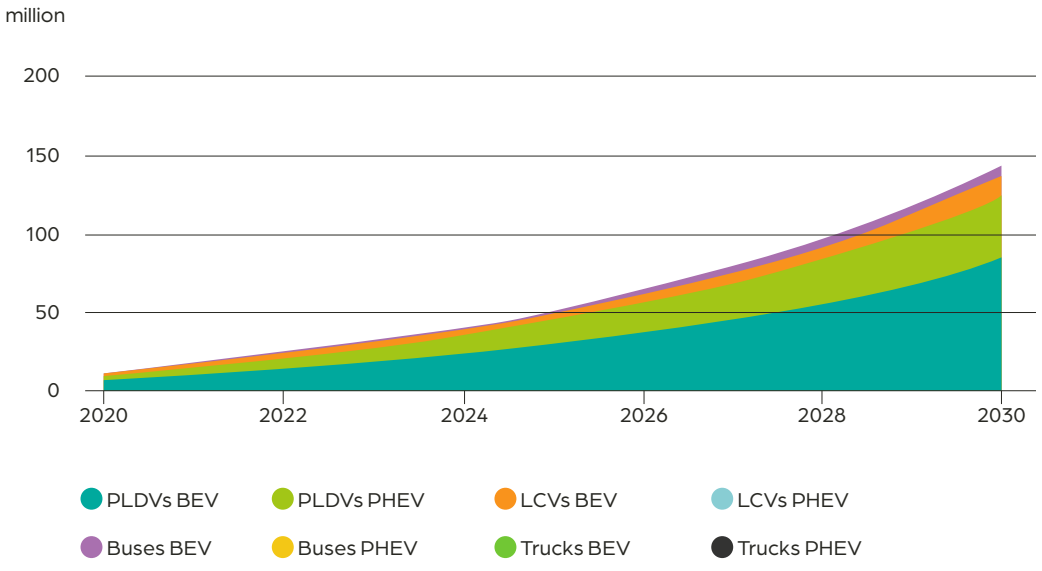
EVs by 2030

EV penetration is greatest into the 2/3 wheelers market, with more than 20% of the global fleet electrified today.

Looking out to 2030, they will continue to be the largest EV market by volume. Other markets are expected to grow rapidly. The market for passenger EVs will grow at approximately 30% per year out to 2030 with government policy and OEM strategy driving growth.

Growing private sector demand is expected to push the Light Commercial EV market to grow by approximately 40% per year to 2030. At that point EVs will represent more than 20% of the market by value. Electrification of Heavy Commercial Vehicle markets is more challenging and penetration of EVs into the global fleet is only expected to be 1–3% by 2030.

EV Growth: IEA Stated Policies Scenario



Transport electrification is driving carbon emission reductions

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Reduced GHG emissions by 2030 compared to an equivalent ICE fleet

Transportation is responsible for 24% of direct CO_2 emissions from fuel combustion, and one fifth of total global carbon dioxide emissions[2]. Road vehicles – cars, trucks, buses and two- and three-wheelers – account for nearly three-quarters of transport CO_2 emissions[3].

EVs are already delivering significant carbon emissions savings (e.g. equivalent to the entire footprint of the Hungary energy sector in 2019). IEA projects that by 2030, the global EV fleet will reduce GHG emissions by more than one-third compared to an equivalent ICE vehicle fleet[4].

The transition to EVs will also shape global electricity demand. IEA expect that electricity demand for EVs will reach 525 TWh in 2030 in its Stated Policies Scenario. By 2030, electricity demand for EVs will account for at least 2% of global electricity consumption.

While significant carbon emission savings will be delivered from the electrification of transport, a significant acceleration in deployment is necessary to meet our net zero aspirations and deliver on the Paris targets to limit warming to 1.5C. The electrification of Heavy Commercial Vehicles is a particular gap.

2 https://ourworldindata.org/co2-emissions-from-transport
3 https://www.iea.org/reports/tracking-transport-2020
4 Based on the IEA "Stated Policies Scenario"

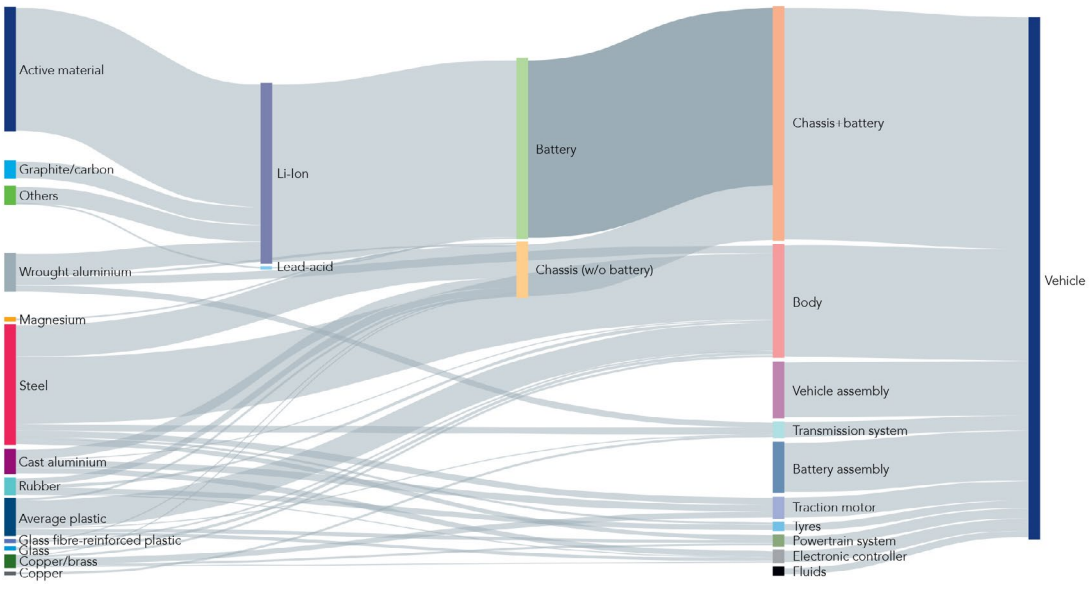
The footprint of the EV motor

While the use of EV motors reduces greenhouse gas emissions, their production and use have important environmental impacts.

Environmental impacts are greatest in the use phase, driven by carbon emissions from electricity generation. Environmental impacts of EV motor use are less in countries that have low carbon electricity grids (e.g. Iceland, Norway, France). The global warming impact of EV use will fall in line with grid decarbonisation and as a result other lifecycle impacts will become relatively more important.

When compared to other EV components, the contribution of the production of EV motors to global warming is small (<5% total EV production CO2 footprint). The impacts associated with the use of rare earth metals are important contributors to the environmental impact of EV motor production. In 2019 over 80% of EVs sold used permanent magnet motors. These magnets are typically made with rare-earth materials such as neodymium and dysprosium, which have a very geographically constrained supply chain with China accounting for the vast majority of rare-earth production worldwide. The ores that rare-earths are extracted from are often laced with radioactive materials such as thorium. Separating the materials requires huge amounts of toxic materials like sulphate, ammonia and hydrochloric acid. Rare earth metal consumption is projected to grow by more than 500% as the world transitions to a 100% EV economy.

Breakdown of the production emissions profile of an average BEV



Source: Federated Hermes (internal analysis), GREET2 2020

Monumo solutions will drive significant GHG emission savings

Monumo is exploring solutions that can transform electric motor technology. We see the elimination of rare earth permanent magnets as a particular opportunity.

1.4 bn

TCO_2e reduced by 2050

While a number of OEMs have made progress in reducing rare earth metal consumption in their motors, overall there has been a shift to rare earth based motor technology reflecting the dominance of rare earth based technologies in the Chinese EV market.

Monumo also sees opportunities to improve the efficiency of EV motors and has solutions under development that could improve motor efficiency in every respect.

Our modelling suggests that these two changes have the potential to deliver dramatic savings to global carbon emissions. Assuming the technology is applied globally in all new vehicles from 2040, by 2050 they would deliver savings of 1.4 billion TCO_2[5] – equivalent to the annual CO_2 emissions of Germany and France combined or to taking 300 million cars off the road for a year.

Alongside the carbon emission savings, environmental benefits will include eliminating 42 billion Tonnes of mining waste from rare earth metal production. Enough waste to cover the entire states of California and Texas in a thick layer of mining waste.

5 Our model assumes EV growth in line with the IEA "sustainable development scenario", a transition in line with the Paris climate targets.

Monumo is the electromagnetic engineering company for a sustainable future. By combining human ingenuity with deep tech intelligence, we generate transformative technologies out of reach by conventional means.

Our focus is currently on the engineering design of electric motors – a mature but increasingly vital technology with plenty of room for improvement. There is little doubt that the problems we are trying to solve are incredibly hard, but the objective is worth it.

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Canopy provided research and analysis work to support this briefing. Canopy works with ambitious organisations, leading thinkers and advisors to accelerate corporate sustainability solutions. We help clients understand and act on their most urgent sustainability challenges and opportunities. We focus on impact, applying our sustainability strategy and implementation expertise with communications know-how to help our clients deliver outstanding performance. We work with organisations from leading start ups, to influential trade bodies, to some of the most respected FTSE 100 businesses.

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