A global comparison of life-cycle greenhouse gas emissions from passenger cars

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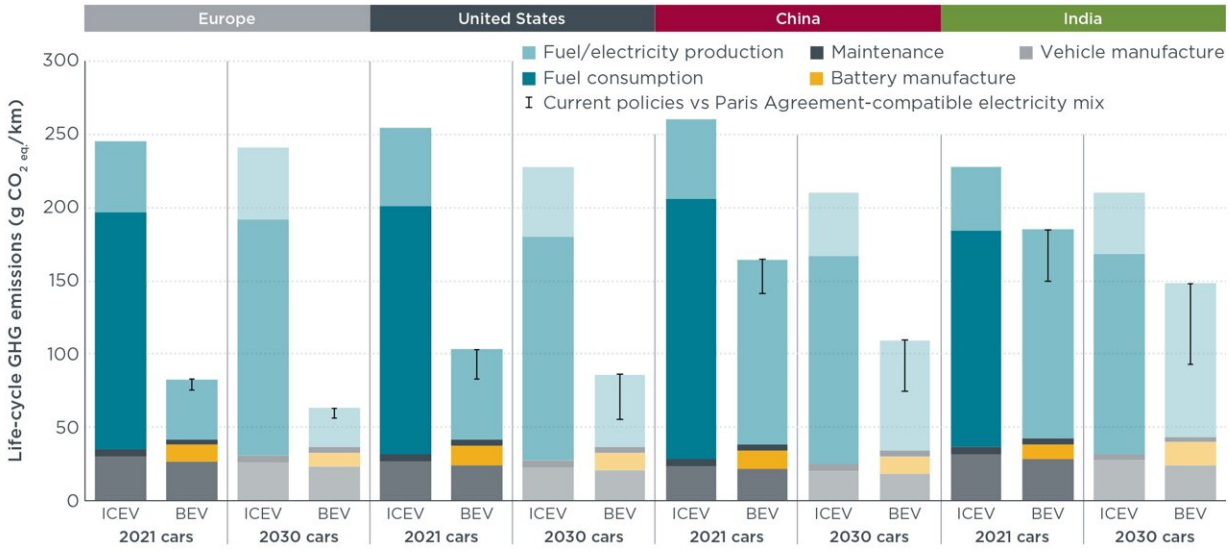

Figure ES.1. Life-cycle GHG emissions of average medium-size gasoline internal combustion engine (ICEVs) and battery electric vehicles (BEVs) registered in Europe, the United States, China, and India in 2021 and projected to be registered in 2030. The error bars indicate the difference between the development of the electricity mix according to stated policies (the higher values) and what is required to align with the Paris Agreement.

Credit: International Council on Clean Transportation

A far-reaching new study of the life-cycle greenhouse gas (GHG) emissions from passenger cars, including SUVs, draws sharp and meticulous distinctions between the climate impacts of battery and fuel cell electric vehicles on one hand and combustion vehicles on the other.

The detailed findings can be summarized straightforwardly. Only battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs) powered by renewable electricity can achieve the kind of deep reductions in GHG emissions from transportation that comport with the Paris Agreement's goal of keeping global warming well below 2 °C. There is no realistic pathway to that goal that relies on combustion-engine vehicles, including hybrids of any sort.

The study, carried out by the International Council on Clean Transportation (ICCT), analyzes present and projected future GHG emissions attributable to every stage in the life cycles of both vehicles and fuels, from extracting and processing raw materials through refining and manufacture to operation and eventual disposal. The analysis was performed separately and in depth for the European Union, the United States, China, and India, and captured the differences among those markets, which together account for about 70% of new car sales worldwide.

"One important result of the analysis is to show that life-cycle emissions trends are similar in all four regions, despite the differences among them in vehicle mix, grid mix, and so on. Already for cars registered today, BEVs have better relative GHG emissions performance everywhere than conventional vehicles," said ICCT Deputy Director Rachel Muncrief.

In addition to its global scope, the study is methodologically comprehensive in considering all relevant powertrain types, including plug-in hybrid electric vehicles, and an array of fuel types including biofuels, electrofuels, hydrogen, and electricity. The life-cycle GHG emissions of cars registered in 2021 are compared with those of cars expected to be registered in 2030.

"Our aim with this study was to capture the elements that policymakers in these major markets need to fairly and critically evaluate different

technology pathways for passenger cars," said ICCT researcher Georg Bieker, the study's author. "We know we need transformational change to avoid the worst impacts of climate change, and the results show that certain technologies are going to be capable of delivering deep decarbonization and others are clearly not."

The study methodology is innovative and distinguished from other life-cycle analyses in additional important ways. It considers lifetime average carbon intensity of fuel and electricity mixes, and accounts for changes in the carbon intensity over vehicle lifetime given present energy policies. It also looks at real-world usage rather than relying on official test values to estimate fuel and electricity consumption; this is especially important in assessing GHG emissions of plug-in hybrid electric vehicles (PHEVs). It uses the most recent data on industrial-scale battery production and considers regional supply chains, which results in significantly lower estimates of GHG emissions from battery production than other studies have found. And it factors in the near-term global warming potential of methane leakage in natural gas and natural gas-derived hydrogen pathways.

"Even for India and China, which are still heavily reliant on coal power, the life-cycle benefits of BEVs are present today," said Peter Mock, ICCT's managing director for Europe. Pointing to the importance of the findings to the European Union's recently proposed changes to its passenger car CO2 emission regulation, he added, "The results highlight the importance of grid decarbonization alongside vehicle electrification. The life-cycle GHG performance of electric cars will improve as grids decarbonize, and regulations that promote electrification are crucial to capturing the future benefits of renewable energy."

More information: The study: theicct.org/sites/default/file … r-cars-jul2021_0.pdf