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Life-cycle greenhouse gas emissions of combustion engine and electric passenger cars and two-wheelers in India

If the global transportation sector is to align with efforts supporting the best chance of achieving the Paris Agreement's goal of limiting global warming to below 2 °C, the greenhouse gas (GHG) emissions from road transport in 2050 need to be dramatically lower than today's levels. As the fifth largest new passenger car market in the world and the largest market for two-wheelers, India plays an important role in reducing these emissions. It is therefore important to understand which powertrain and fuel technologies are most capable of shrinking the carbon footprint of passenger cars and two-wheelers in India—and not only the emissions from the tailpipes, but also from fuel and electricity production and vehicle manufacturing.

A recent ICCT study included a life-cycle assessment (LCA) of the GHG emissions of passenger cars in India. It also covered cars in China, Europe, and the United States and considered the most relevant powertrain types—internal combustion engine vehicles (ICEVs), including hybrid electric vehicles (HEVs); plug-in hybrid electric vehicles (PHEVs);[1] battery electric vehicles (BEVs); and fuel cell electric vehicles (FCEVs). Also included were a variety of fuel types and power sources including fossil gasoline, diesel, and natural gas (each of these with the current and future biofuels or biomethane blend rate), e-fuels, and various hydrogen and electricity pathways. Here we highlight results and additionally present our LCA results for two-wheelers in India, for which we compared gasoline combustion engine and electric motorcycles and scooters.

- Across the hatchback, sedan, and SUV segments, average new **diesel and compressed natural gas (CNG) cars exceed** the life-cycle GHG emissions **levels of gasoline cars** registered today in India (Figure 1), especially when considering the methane leakage from natural gas extraction, processing, and transport. In Europe, **HEVs** are found to reduce life-cycle GHG emissions of conventional gasoline cars, but **only by about 20%**.[2]
- When limiting policy support to **sustainable energy crop-, residues- and waste-based biofuel feedstocks** and considering a fast ramp up of the respective production capacities, biofuels can reduce the life-cycle GHG emissions of gasoline,

1 PHEVs were only assessed for Europe, China, and the United States.

2 Based on a comparison of segment average HEVs and conventional gasoline cars in Europe.

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diesel, and CNG cars **by 1%–3% for cars registered in India in 2021** and by 3%–8% for cars projected to be registered in 2030. The very high production cost of **e-fuels** means they are **not likely to contribute substantially to decarbonization** of the fuel mix within the lifetimes of 2021 or 2030 cars.

» **BEVs** have the lowest life-cycle GHG emissions. Already for cars registered in India today, they are **19%–34% lower** than for average new gasoline cars, depending on whether the electricity mix will develop according to current policies or what is required to meet the Paris Agreement. For BEVs projected to be registered in 2030, the life-cycle GHG emissions benefit over gasoline cars **increases to 30%–56%.** When entirely powered by renewable energy, BEVs correspond to **80% lower** life-cycle GHG emissions than gasoline cars, and this is including the emissions from the construction of additional renewable electricity installations.

» **Electric motorcycles and scooters** have **33%–45% and 38%–50% lower** life-cycle GHG emissions, respectively, than average new gasoline models (Figure 2, left), depending on the development of the electricity mix. For motorcycles and scooters projected to be registered in 2030, the life-cycle GHG emissions benefit is at **45%–66% and 50%–70%** (Figure 2, right).

» Life-cycle emissions of **FCEVs** registered in 2021 are **only about 16% less** than for average new gasoline cars if they are powered by hydrogen produced through reforming methane from natural gas ("grey hydrogen"). Utilizing hydrogen produced from renewable electricity ("green hydrogen"), instead, would result in **68% lower** life-cycle GHG emissions for FCEVs. Renewable energy powered FCEVs show slightly higher life-cycle emissions than BEVs powered by the same renewable electricity, though; this is because the electricity-based FCEV pathway is approximately **three times as energy intensive** as the BEV pathway, and as such, emissions from the construction of additional renewable electricity installations were taken into account.

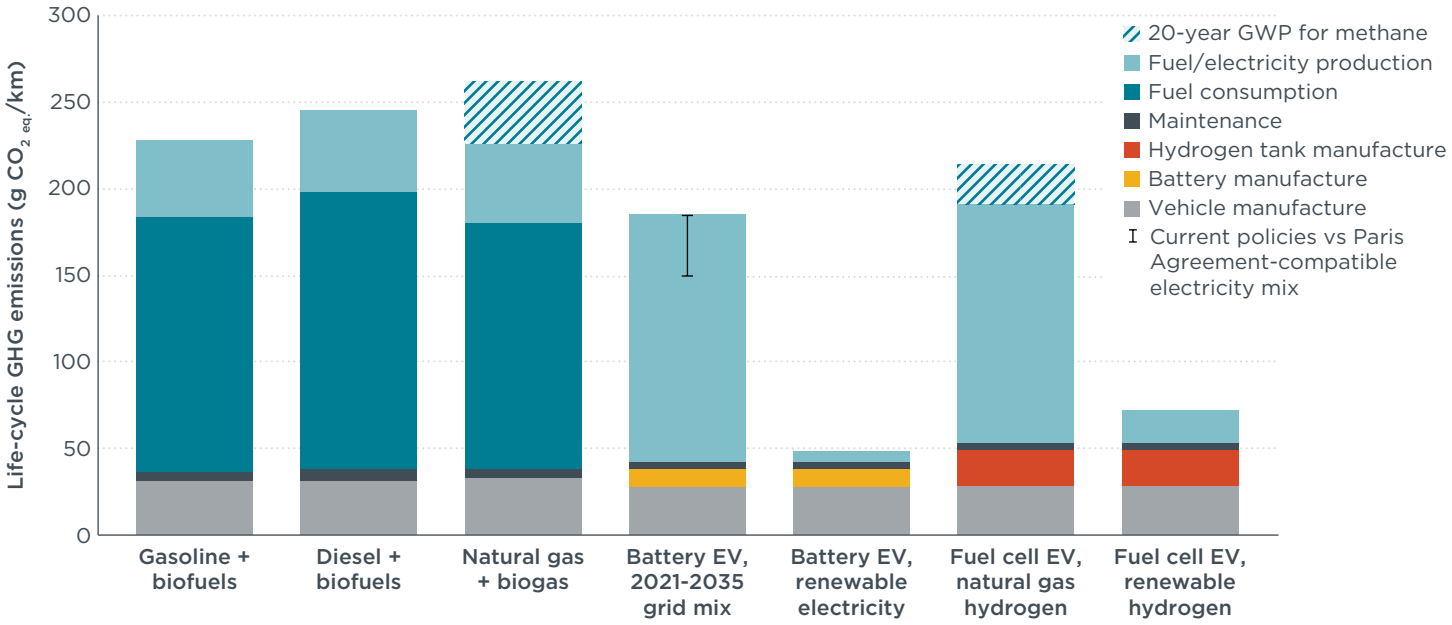

Figure 1. Life-cycle greenhouse gas (GHG) emissions of average new sedan segment gasoline, diesel, and compressed natural gas (CNG) cars, battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs) registered in India in 2021. The error bars indicate the difference between the development of the electricity mix according to stated policies (the higher values) and what is required to align with the Paris Agreement. GWP = global warming potential.

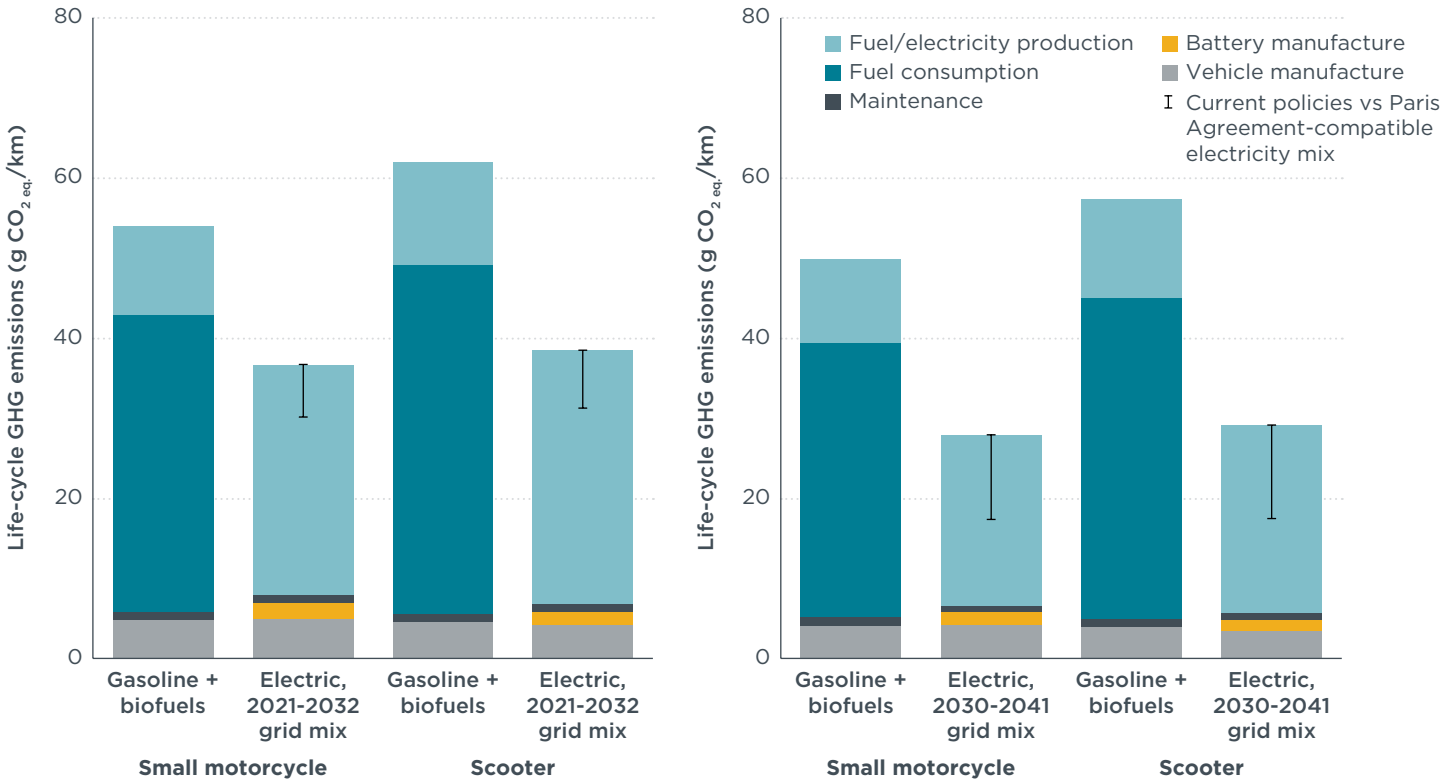

Figure 2. Life-cycle greenhouse gas (GHG) emissions of average new gasoline combustion engine and battery electric motorcycles and scooters registered in India in 2021 (left) and projected to be registered in 2030 (right). The error bars indicate the difference between the development of the electricity mix according to stated policies (the higher values) and what is required to align with the Paris Agreement.

Flowing from the analysis, ICCT recommends considering the following policy actions:

» The **registration of new combustion engine passenger cars** in India should be **phased out in the 2035–2040 time frame**. Given average vehicle lifetimes of 15 years, only those technologies that can achieve a deep decarbonization of the India passenger car fleet by 2050 should be produced and registered from 2035–2040. BEVs powered by renewable electricity and FCEVs fueled by green hydrogen are the only two technology pathways that qualify. Hybridization can be utilized to reduce the fuel consumption of new internal combustion engine vehicles registered over the next decade, but neither HEVs nor PHEVs provide the magnitude of reduction in GHG emissions needed in the long term.

» Similarly, the registration of new combustion engine two-wheelers should be phased out by 2035. Setting corporate average **fuel consumption standards for two-wheelers** soon would be effective in continuously increasing the share of electric two-wheelers and in capturing their GHG emissions reduction potential prior to the ICE phase out. A two-wheeler fuel consumption standard set at a level equal to or below 20 g CO_2/km for 2030 would likely ensure that at least 60% of new two-wheeler sales are electric that year.

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FOR MORE INFORMATION:

A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric passenger cars, https://theicct.org/publications/global-LCA-passenger-cars-Jul2021

Fuel consumption standards for the new two-wheeler fleet in India, https://theicct.org/publications/fuel-consumption-2w-india-aug2021

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