

Cross OEM LCA for EV vehicles, method applied by A2MAC1 and M@Air for the 2023 project for China at Provincial level.

The LCA calculation was performed to address the inquiries of a customer who has opted to purchase a new car to replace their internal combustion engine (ICE) model.

- Question: What will be the CO₂ emissions from this electric vehicle model under typical usage conditions?

We evaluated the 12 of the top selling electric vehicle models in China in 2022/23.

The evaluation of the manufacturing impact was performed at **Provincial level** and separated into four steps:

- **Vehicle without HV battery:**
We applied a conventional rate of 5 kg CO₂ per kg, which was derived from existing literature. This assumption considered the final assembly of the vehicle in a region with low electricity carbon emissions (~100g CO₂eq/kWh), and it excluded the utilization of aluminum in the car's body.
Information regarding the aluminum quantity in the vehicle body was derived from the A2MAC1 database. In cases where aluminum was included in the body structure, adjustments were also made by considering the regional sources of aluminum in Europe, the USA, and Asia.
- **Vehicle Assembly:**
The calculation for CO₂ impact during final assembly is determined by considering the specific location of the manufacturing plant in China, assuming a consumption of one megawatt-hour (MWh) per vehicle. In cases where the OEM reports a portion of renewable energy usage in the production plant, it was factored into the calculation.
The emission already included in the first step are considered.
- **HV Battery:**
For the HV battery the plant location for the cells was considered, as it has a major impact on the CO₂ emissions. Based on the chemistry the following formulas were used
 - LFP: $\sim 80 * \text{Province Electricity emissions kg/kWh} + 12 = \text{GHG emissions in kg CO}_2\text{eq}$
 - NMC: $\sim 95 * \text{Province Electricity emissions kg/kWh} + 19 = \text{GHG emissions in kg CO}_2\text{eq}$Modules and packs are estimated by adding 20% to the cell emissions.
- **Recycling and Second life:**
To assess the recycling and second-life environmental impact, we derived a standard calculation based on comparative studies. Our assumed values for the recycling and second-life impact are 0.8 kg CO₂eq/kg.

To determine the electricity emissions in China per province, we referred to the publication by the Argonne National Laboratory. The changes in emissions between 2017 and 2022 were calculated using data from the EMBER³ source at the national level in China.

The use of the car related emissions were based on The actual vehicle consumption data (obtained from sinaapp⁴). Use of the car was assumed overall China.

¹⁾ Xu, Chengjian und Steubing, Bernhard und Hu, Mingming und Harpprecht, Carina und van der Meide, Marc und Tukker, Arnold (2022) Future greenhouse gas emissions of automotive lithium-ion battery cell production. Resources, Conservation and Recycling. Elsevier. doi: 10.1016/j.resconrec.2022.106606. ISSN 0921-3449.

²⁾ Provincial Greenhouse Gas Emissions of Gasoline and Plug-in Electric Vehicles in China: Comparison from the Consumption-Based Electricity Perspective, Yu Gan, Zifeng Lu, Xin He, Chunxiao Hao, Yunjing Wang, Hao Cai, Michael Wang, Amgad Elgowainy, Steven Przesmitzki, and Jessey Bouchard, Environmental Science & Technology 2021 55 (10), 6944-6956, DOI: 10.1021/acs.est.0c08217

³⁾ <https://ember-climate.org/>

⁴⁾ https://androil.sinaapp.com/page_rank_chexi_ev/byCarType/1.html