Life cycle assessment

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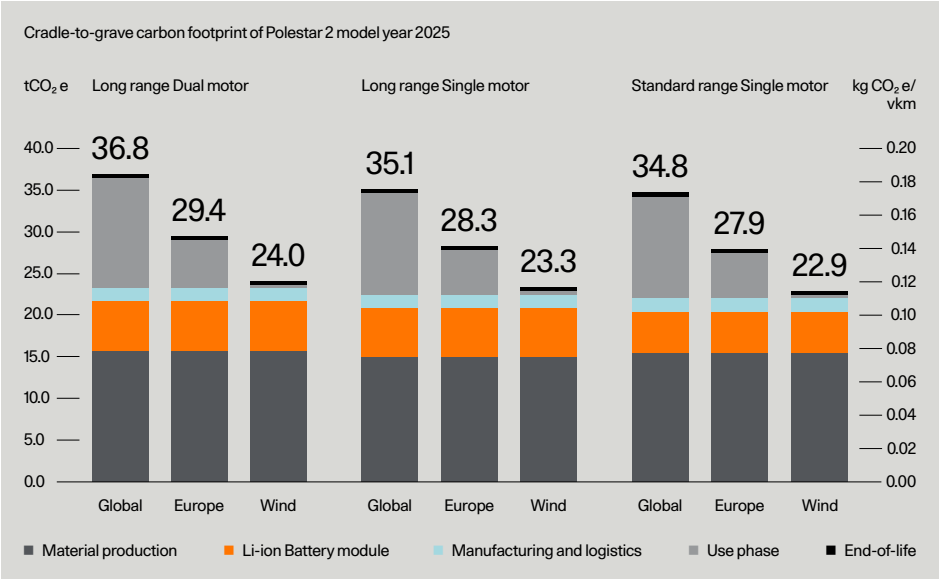
Carbon footprint report of Polestar 2 model years 2023-2025

This report is for information only and is based solely on an analysis of Polestar 2 (model years 2023, 2024 and 2025) “Long range Dual motor”, “Long range Single motor”, and “Standard range Single motor”. Full study methodology including (but not limited to) goal & scope, function & functional unit, allocation, assumptions & exclusions as well as way of working is available via these links: Polestar 2 LCA report and Polestar 2 variants LCA report. To get a full understanding of the methodology used to calculate the carbon footprints in this report, it is recommended to read the previous reports in conjunction with this one.

The result of this study is dependent upon agreed and validated information from Polestars suppliers and sub-suppliers. During the course of a vehicle program life there could arise changes and non-compliances within the supply chain, should such changes or non-compliances arise, Polestar will take corrective actions to achieve the results presented in this report.



← Figure 1

Carbon footprint for Polestar 2 variants, with different electricity mixes in the use phase. The axis to the left, as well as the data labels, presents the result per functional unit (200,000 km lifetime driving distance) in tCO_2e and the axis to the right presents the result in kg CO_2e using a secondary functional unit of 1 vkm (vehicle kilometer).

In 2020, a carbon footprint of Polestar 2 "Long range Dual motor" model year 2021 was published. In 2021 the carbon footprint of the Polestar 2 "Long range Single motor" and "Standard range Single motor " model year 2022 was published. The carbon footprint presented in this report is a continuation of that work. The Polestar 2 model years 2023-2025 including all its variants "Long range Dual motor", "Long range Single motor" and "Standard range Single motor " are assessed and compared to the carbon footprint presented in the two previous reports.

The carbon footprint presented in this report is, as the previous Polestar 2 carbon footprint, based on a Life Cycle Assessment (LCA). The LCA is performed according to ISO LCA standards[1]. In addition, the "Product Life Cycle Accounting and Reporting Standard"[2] published by the Greenhouse Gas Protocol has been used for guidance in methodological choices. Methodological choices and data sources are described in the previous Polestar 2 LCA report and Polestar 2 variants LCA report. Some methodological and data changes have been made, which are described in this report. To get a full understanding of the methodology used to calculate the carbon footprints in this report, it is recommended to read the two previous reports Polestar 2 LCA report, Polestar 2 variants LCA report. These two reports correspond to Polestar 2 model years 2021 and 2022, respectively.

The carbon footprint includes emissions from upstream supplier activities, manufacturing, logistics, use phase of the vehicle and the end-of-life phase. The functional unit chosen is "The use of a Polestar 2 vehicle driving 200,000 km between the full years of 2024 to 2038".

Changes have been made in the Polestar 2 supply chain and manufacturing process which have led to reductions in the cradle-to-gate carbon footprint of all three Polestar 2 variants. The vehicles have been improved in terms of energy efficiency in the use phase leading to reductions in total electricity consumption throughout the life cycle of the vehicles. Methodological changes in the use phase have also been made in this report (for Polestar 2 model years 2024 and 2025) compared to the previous reports, this includes accounting for future reductions of carbon intensity in the electricity grid throughout the life cycle of the vehicles. These changes in the methodology and the carbon footprint reductions they result in are not to be seen as an achievement by Polestar, but rather an improved methodology which correlate to a more realistic future over the course of the vehicles assumed 15-year life cycle. Thereby the cradle-to-grave carbon footprint result is not comparable to previous Polestar 2 LCA reports, however, comparability between cradle-to-gate results remains.

The cradle-to-grave carbon footprint is 37-24 tCO_2e for the "Long range Dual motor", 35-23 tCO_2e for the "Long range Single motor", and 35-23 tCO_2e for "Standard range Single motor". Using a secondary functional unit the result varies between 0.11 and 0.18 kg CO_2e per vkm (vehicle kilometre) driven (assuming a total lifetime driving distance of 200 000 km). The range in results is caused by differences in electricity mix scenarios, where the highest value reflect that a global electricity mix is used in the vehicle use phase while the lowest value reflects that electricity from wind power is used.

1 ISO 14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines" and ISO 14040:2006 "Environmental management – Life cycle assessment – Principles and framework"

2 https://ghgprotocol.org/sites/default/files/standards/Product-Life-CycleAccounting-Reporting-Standard_041613.pdf

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Cradle-to-gate
An assessment that includes part of the product's life cycle, including material acquisition through the production of the studied product and excluding the use or end-of-life stages.

Cradle-to-grave
A cradle-to-grave assessment considers impacts at each stage of the product's life cycle, from the time natural resources are extracted from the ground and processed through each subsequent stage of manufacturing, transportation, product use, recycling, and ultimately, disposal.

Dataset (LCI or LCIA dataset)
A dataset containing life cycle information of a specified product or other reference (e.g. site, process), covering descriptive metadata and quantitative life cycle inventory and/or life cycle impact assessment data, respectively.

End-of-life
End-of-life means the end of a product's life cycle. Traditionally it includes waste collection and waste treatment, e.g. re-use, recycling, incineration, landfill, etc.

Functional unit
Quantified performance of a product system for use as a reference unit.

GHG
Greenhouse gases. These are gases that contribute to global warming, e.g. carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), as well as freons/CFCs. Greenhouse gases are often quantified as a mass unit of CO_2e, where "e" is short for equivalents.

Life cycle
Consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal.

Life Cycle Assessment (LCA)
Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life.

LR / SR / DM / SM
Long range / Standard range / Dual motor / Single motor

MY
Model year.

Raw material
Primary or secondary material that is used to produce a product.

tCO_2e
Metric tonne carbon dioxide equivalents.

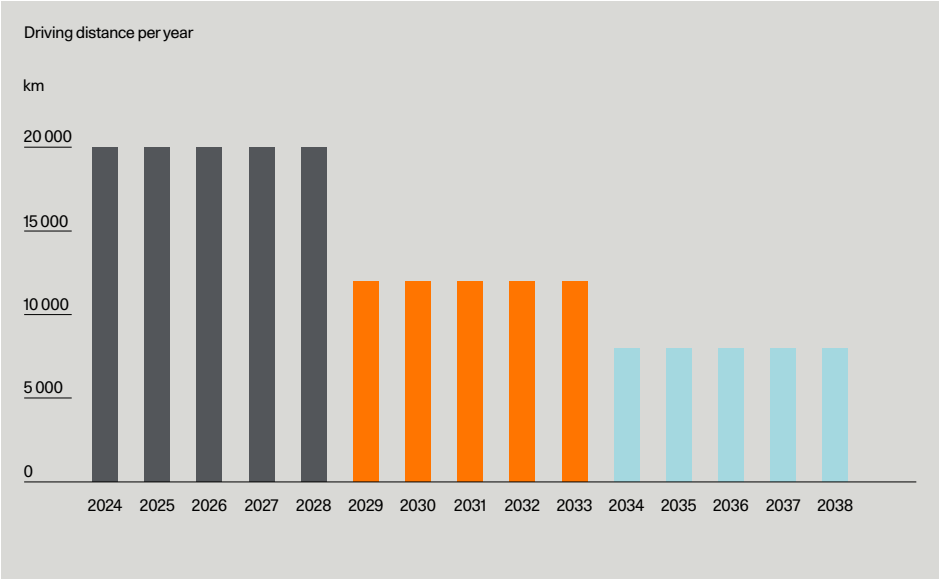
WLTP
Worldwide Harmonised Light Vehicle Test Procedure, used for certification of vehicles in the EU.

In 2023, the Polestar 2 model year 2024 was upgraded with increased range, efficiency and performance while simultaneously reducing its carbon footprint. Polestar 2 can now travel up to 22% further, consume up to 9% less energy, and charge up to 34% faster, thanks to hardware upgrades including larger batteries and new motors. The battery on the Long range variants of the Polestar 2 have been upgraded to 82 kWh, the power and efficiency of the motors have been increased and the charging power has also been increased. While simultaneously reducing the carbon footprint of the vehicles.

Since Polestar 2 deliveries began in 2020, its cradle-to-gate carbon footprint has been continuously reduced. The result is a total CO_2e saving of 11%, or 3 tonnes in 3 years for the Long range Dual motor variant. Low-carbon aluminum in the wheels and the battery tray, a switch to renewable electricity in the factory, and for the MY24, improved battery chemistry, are some of the contributing factors. Model year 2025 Polestar 2 vehicles include all these improvements and the Standard range Single motor have gotten an increased battery capacity to 70 kWh, which has implications on the carbon footprint.

The goal of this study is to contribute to transparency towards customers and stakeholders, by presenting the carbon footprint of the life cycle of the Polestar 2 and all its variants and model years. Another goal is to present how the transition to a renewable energy system increases the climate performance of electric vehicles by presenting three different electricity mix scenarios, Global, European and a specific renewable electricity source: wind power.

As the study is a continuation of the previous Polestar 2 LCA studies, the methodology and data sources are largely the same, the major update concerns the use phase calculations. The next chapter lists and explains updates in methodology from the previous reports.



← Figure 2

Assumed driving distances (km) per year during the lifetime of the vehicle.

Changes in methodology and data since previous Polestar 2 LCA

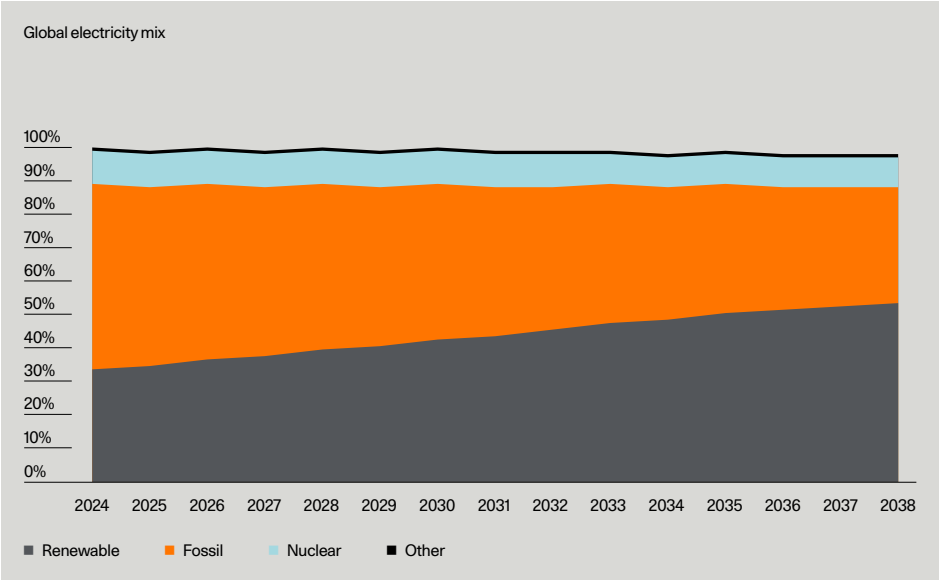
The previously published Polestar 2 LCA report and Polestar 2 variants LCA report describes and motivates the way of working to obtain data, data sources, LCA databases and software, relation to standards, system boundaries, allocation methods, assumptions, and limitations. The original report also describes material categories, manufacturing methods, transports, use phase, and end-of-life treatment. Polestar aims to make continuous improvements to the LCA methodology. Methodological changes can lead to either a higher or a lower carbon footprint of the vehicle.

This chapter only describes the changes made in either methodology or data, from the previous Polestar 2 LCA. All other methodology is the same as in the previous Polestar 2 LCAs and is described in Polestar 2 LCA report and Polestar 2 variants LCA report. The updates in use phase have only been applied to the calculations of the use phase for Polestar 2 model years 2024 and 2025 (two models on sale during 2024), model year 2023 (no longer for sale), which is described in this report, utilizes the same methodology as described in previous Polestar 2 LCAs. The updated use phase methodology increases the overall cradle-to-grave comparability across Polestars three car line-up (see Polestar 3 & Polestar 4 LCAs).

Updated use phase assumptions (only for Polestar 2 MY24 and MY25)

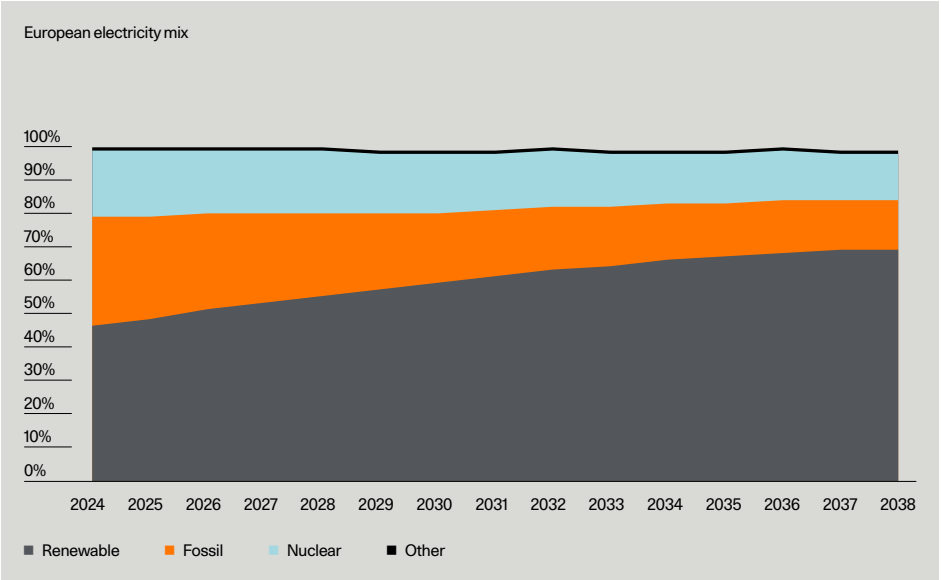
To be able to calculate the emissions in the use phase of the vehicle, the distance driven is needed together with the energy use, as well as emissions from electricity production. The vehicle lifetime driving distance for Polestar vehicles has been set to 200 000 km, and energy use of the vehicle corresponds to driving according to the WLTP driving cycle, according to the lower consumption values in Tables 3 and 9. WLTP does not take all driving conditions into account, for example WLTP assumes a driving condition where heating or cooling is not necessary and no use of infotainment in use. This could, especially for certain markets, lead to an underestimated energy use figure.

The analysis assumes that 50% of a vehicle's total lifetime mileage is covered in the initial five years, equivalent to 20 000 kilometers per year, while 30% is driven in the subsequent five years, amounting to 12 000 kilometers annually. During the last five years of the vehicle's life, it is assumed that the yearly distance driven is 8 000 km, illustrated in Figure 2.



← Figure 3

Predicted share of energy production sectors in the Stated Policies Scenario STEPS for global energy mix.



← Figure 4

Predicted share of energy production sectors in the Stated Policies Scenario STEPS for European energy mix.

Electricity production is modelled according to three cases: global and EU28 grid mix and with a specific source for electricity (wind). Current and future global and EU28 electricity generation mixes are based on the World Energy Outlook 2022 Extended Dataset[3] from IEA between the years 2024-2038. IEA uses the Global Energy and Climate (GEC) Model to explore possible future energy related scenarios based on different assumptions. For this study, STEPS (Stated Policies Scenario) has been used to determine the electricity generation mixes used to charge the vehicles in the use phase. STEPS reflects current policy settings based on a sector-by-sector and country-by-country assessment of the specific policies that are in place, as well as those that have been announced by governments around the world.

Figure 3 and Figure 4 visually represent the development of electricity sources. It is evident that the production of electricity from fossil sources is expected to diminish, gradually replaced by renewable sources based on the IEA STEPS data.

Amounts of electricity from different energy sources have in this study been paired with appropriate LCI datasets from Sphera professional database (see Appendix 1) to determine the total climate impacts from different electricity generation mixes, both direct (at the site of electricity generation) and upstream. On average, the emissions throughout the entire lifespan amount to 0.41 kg CO_2e/kWh for the global electricity mix scenario and 0.18 kg CO_2e/kWh for the European electricity mix scenario.

Considering the anticipated changes in electricity production specifically, the reduction in fossil fuel-based electricity and the concurrent increase in renewable electricity forecasted from 2024, it is expected that yearly emissions from vehicle usage will decline. The distances driven, described in Figure 2, are multiplied by the emission factors corresponding to each year, reflecting the changes in global and European electricity mix.

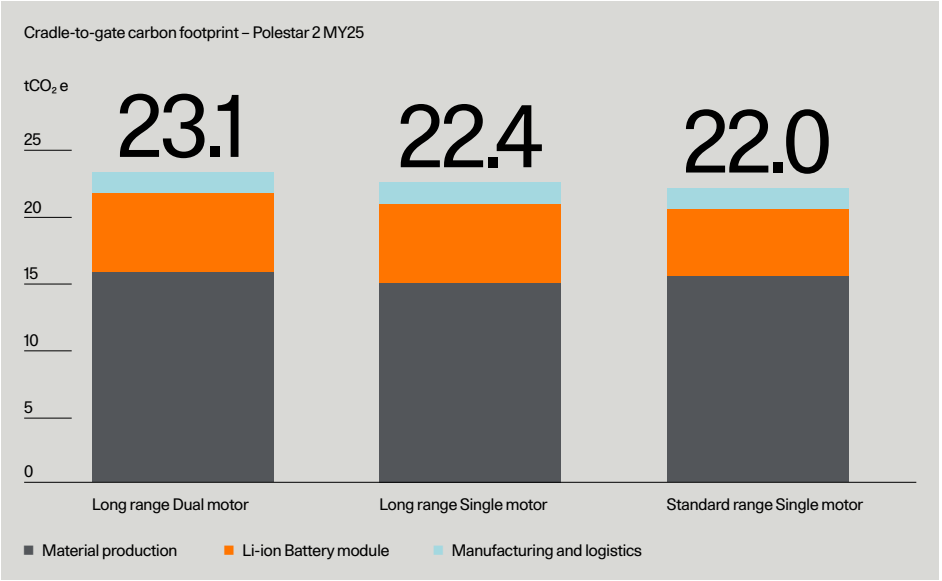
Battery carbon footprint updates

The battery cell modules of the Polestar 2 Long range variants have been updated for MY24 for the Long range variants and for MY25 in the standard range variant. Polestar purchases battery cell modules from suppliers, who, in collaboration with Polestar, perform cradle-to-gate (up until Polestar logistics take over) carbon footprint LCAs of their cell modules. These supplier LCAs have been updated and are included in the carbon footprint calculation of the Long range Polestar 2 variants of MY24 and MY25 and the standard range variant of MY25.

Material datasets updates

From MY23 (produced from 2022 week 22) low carbon aluminum was introduced in some aluminum parts of the vehicle, replacing parts which was previously produced using standard Chinese aluminum. Thereby an additional dataset for aluminum has been added in this study, available in the appendix.

3 World Energy Outlook 2022 Extended Dataset – Data product – IEA



← Figure 5

Cradle-to-gate carbon footprint for the Polestar 2 MY25 variants, including Materials production, Li-ion battery modules, Manufacturing and Logistics. Results are shown in tCO_2e.

Polestar 2 model year 2025

In 2024 the Polestar 2 MY25 Standard range Single motor received updated battery modules with increased capacity, from 69 kWh to 70 kWh, this and a change in supplier increased the total battery module carbon footprint by 0.4 tCO_2e compared to MY24. The MY25 Long range Dual motor and Long range Single motor variants remain unchanged from MY24. Table 3 and 4 provides a description of the Polestar 2 MY25 Standard range Single motor variant. In Appendix 2 a comparison of the cradle-to-gate carbon footprint of the original Polestar 2 model years and model years 2024/2025 is presented.

In 2024 Volvo Cars Taizhou factory in China, where Polestar 2 is produced, switched from using natural gas to biogas for its heating needs which resulted in a decrease in the manufacturing carbon footprint. Thereby the carbon footprint for manufacturing was decreased to 54 kg CO_2e/produced vehicle.

As stated in previous Polestar 2 LCAs, the carbon footprint for logistics is calculated as an average logistical footprint based on Volvo Cars Corporations total logistics footprint divided by total number of manufactured vehicles. This data point has been updated to 1.5 tCO_2e per vehicle, up from 1.35 tCO_2e in 2020 due to changes in transport patterns and volume changes in markets. This means that the carbon footprint of manufacturing and logistics remains at 1.6 tCO_2e, as in MY24, when including the reductions from heating in manufacturing and the increase from logistics.

Figure 5 and Table 1 present the cradle-to-gate carbon footprint of the three Polestar 2 MY25 variants, the result varies between 22.0-23.1 tCO_2e. Again, the Long range variants remain unchanged from MY24. Figure 6 and Table 2 present the cradle-to-grave carbon footprint of the Standard range Single motor variant. Depending on the electricity mix scenario, the life cycle carbon footprint varies between 22.9-34.8 tCO_2e.

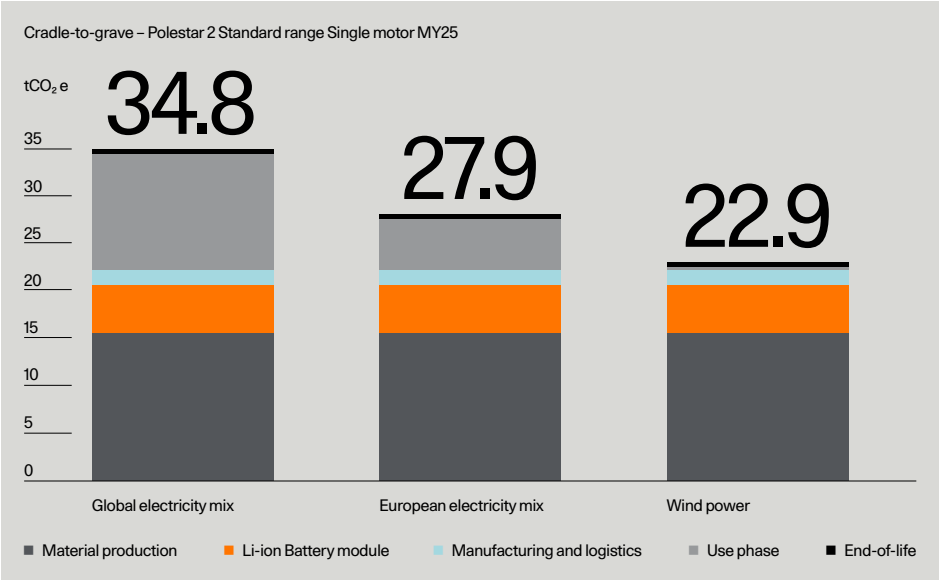
The single motor variants have a lower carbon footprint than the dual motor variant, for all model years. This is due to that they

1. have one less motor and thereby require less materials, resulting in less impact from raw material extraction and production. The lower material volume also leads to
2. a lower total vehicle weight (see Table 10), that increases energy efficiency and lowers the use phase carbon footprint.

Table 1 →

Cradle-to-gate carbon footprint for the Polestar 2 MY25 variants, including Materials production, Li-ion battery modules, Manufacturing and Logistics. Results are shown in tCO_2e.

Polestar 2 MY25	Long range Dual motor	Long range Single motor	Standard range Single motor
Material production	15.7	14.9	15.4
Li-ion battery modules	5.9	5.9	5.0
Manufacturing and logistics	1.6	1.6	1.6
Total	23.1	22.4	22.0



← Figure 6

Carbon footprint for Polestar 2 MY25 Standard range Single motor , with different electricity mixes in the use phase. The use-phase utilizes the STEPS scenario from the IEA. Results are shown in tCO_2e per functional unit (200,000 km lifetime range).

Table 2 →

Carbon footprint for Polestar 2 MY25 Standard range Single motor , with different electricity mixes used in the use phase. Results are shown in tCO_2e per functional unit.

Polestar 2 Standard range Single motor MY25	Global electricity mix	European electricity mix	Wind power
Materials production	15.4	15.4	15.4
Li-ion battery modules	5.0	5.0	5.0
Manufacturing and logistics	1.6	1.6	1.6
Use phase (STEPS)	12.2	5.4	0.4
End-of-life	0.5	0.5	0.5
Total	34.8	27.9	22.9

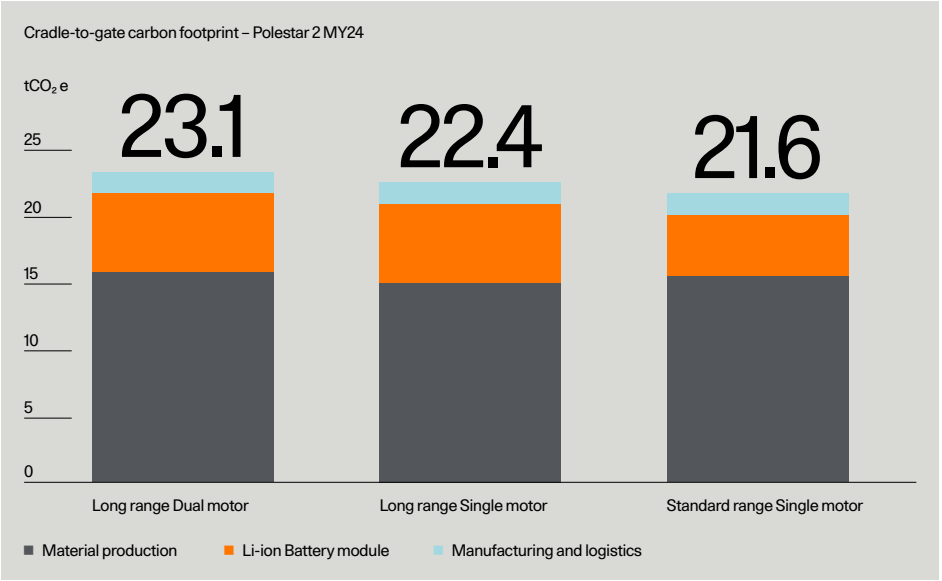
Table 3 →
Descriptions of the Polestar 2 MY25 SRSM variant.

Polestar 2 Standard range Single motor MY25	
Battery capacity	70 kWh
Output	200 kW, 272 hp, 490 Nm
Preliminary consumption (WLTP)	14.9-15.8 kWh/100 km
Preliminary range (WLTP)	520-554 km

Table 4 →

Studied vehicle and its corresponding weight in kg.

Polestar 2 Standard range Single motor MY25	
Total weight (kg)	1949
Li-on battery modules weight (kg)	322



← Figure 7

Cradle-to-gate carbon footprint for the Polestar 2 MY24 variants, including Materials production, Li-ion battery modules, Manufacturing and Logistics. Results are shown in tCO_2e.

Polestar 2 model year 2024

In Polestar 2 MY24 with introduction date 2023 week 19 the Long range variants received updated battery modules with increased capacity, from 78 kWh to 82 kWh, and chemistry which reduced the total carbon footprint of the modules by 1.1 tCO_2e even though capacity increased. The Long range variants also received an updated drivetrain with a change of motors which led to a slight decrease for the Long range Dual motor variant and a slight increase for the Long range Single motor variant. Accounting for these changes, the Long range Dual motor variant decreased its overall cradle-to-gate carbon footprint by 1.3 tCO_2e, and the Long range Single motor decreased by 1 tCO_2e compared to the previous model year.

The standard range variant received updated battery modules in MY24 with introduction date 2023 week 34 which decreased the carbon footprint of the battery. The standard range variant also received a drivetrain update which slightly increased the carbon footprint. Accounting for these changes, the Standard range Single motor variant decreased its overall cradle-to-gate carbon footprint by 0.9 tCO_2e compared to the previous model year. Tables 9 and 10 provides a description of the Polestar 2 MY24 variants.

The largest variability in the results is due to the variation of electricity mix. In the case of global electricity mix, the use phase accounts for over 35% of the cradle-to-grave carbon footprint, while in the case of wind power, the use phase accounts for only 2%.

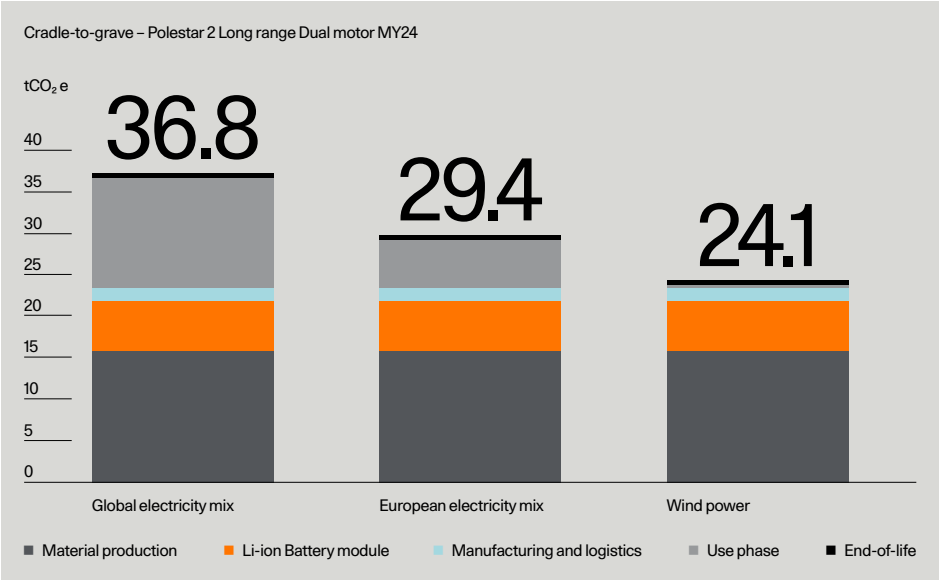
Figure 1-3 in Appendix 2 present the material breakdown of the three Polestar 2 MY24/MY25 variants. Battery modules represent the highest share of the carbon footprint of materials production and refining, with 25-28%. Aluminum represents 26-28% while steel and iron represent 19-20%, depending on variant.

Figure 7 and Table 5 present the cradle-to-gate carbon footprint of the three Polestar 2 MY24 variants, the result varies between 21.6-23.1 tCO_2e. Figures 8-10 and Tables 7-9 present the cradle-to-grave carbon footprint of the Standard range Single motor variant. Depending on electricity mix scenario and variant, the life cycle carbon footprint varies between 22.5-36.8 tCO_2e.

Table 5 →

Cradle-to-gate carbon footprint for the Polestar 2 MY24 variants, including Materials production, Li-ion battery modules, Manufacturing and Logistics. Results are shown in tCO_2e.

Polestar 2 MY24	Long range Dual motor	Long range Single motor	Standard range Single motor
Material production	15.7	14.9	15.4
Li-ion battery modules	5.9	5.9	4.6
Manufacturing and logistics	1.6	1.6	1.6
Total	23.1	22.4	21.6



← Figure 8

Carbon footprint for Polestar 2 MY24 Long range Dual motor, with different electricity mixes in the use phase. The use-phase utilizes the STEPS scenario from the IEA. Results are shown in tCO_2e per functional unit (200,000 km lifetime driving distance).

Table 6 →

Carbon footprint for Polestar 2 MY24 Long range Dual motor, with different electricity mixes used in the use phase. Results are shown in tCO_2e per functional unit.

Polestar 2 Long range Dual motor MY24	Global electricity mix	European electricity mix	Wind power
Materials production	15.7	15.7	15.7
Li-ion battery modules	5.9	5.9	5.9
Manufacturing and logistics	1.6	1.6	1.6
Use phase (STEPS)	13.2	5.8	0.4
End-of-life	0.5	0.5	0.5
Total	36.8	29.4	24.1

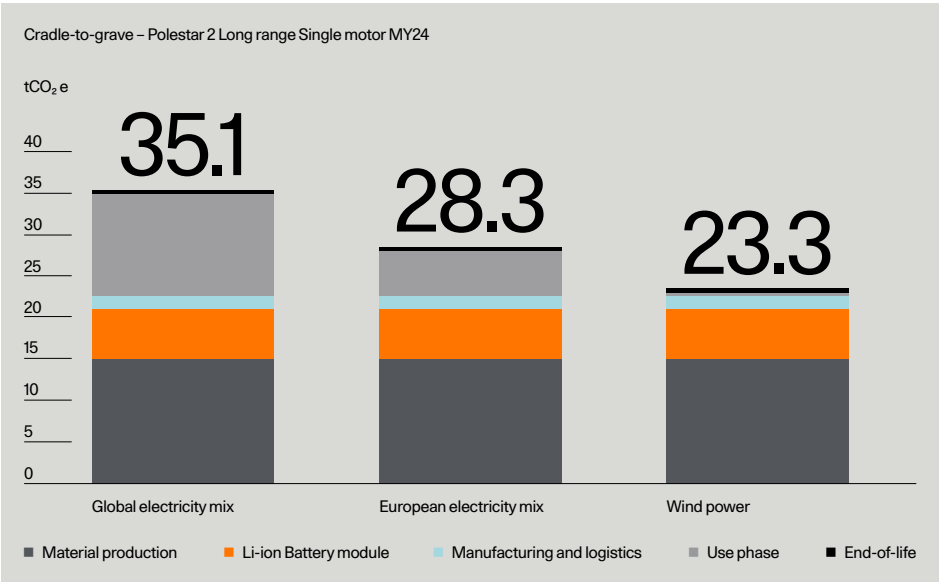


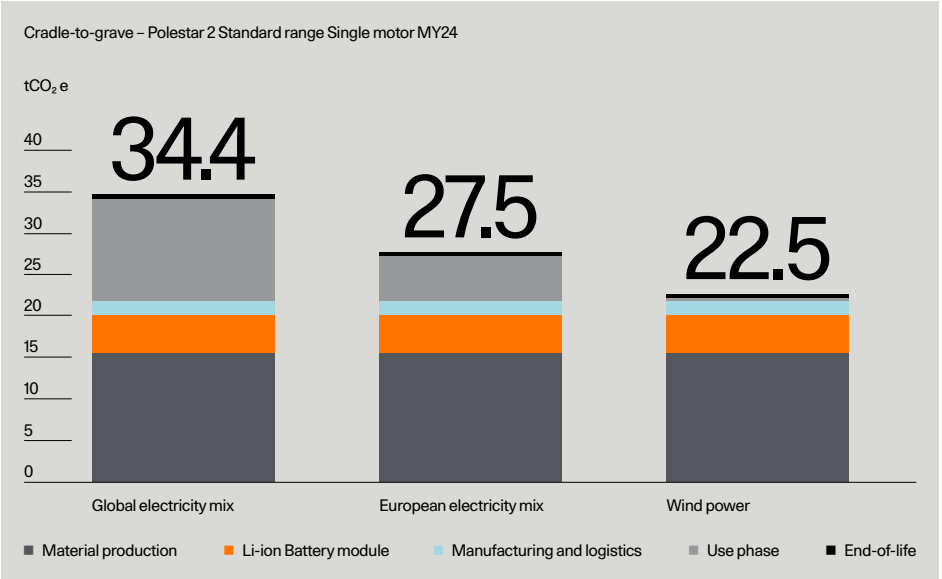
Table 7 →

Carbon footprint for Polestar 2 MY24 Long range Single motor, with different electricity mixes used in the use phase. Results are shown in tCO_2e per functional unit.

Polestar 2 Long range Single motor MY24	Global electricity mix	European electricity mix	Wind power
Materials production	14.9	14.9	14.9
Li-ion battery modules	5.9	5.9	5.9
Manufacturing and logistics	1.6	1.6	1.6
Use phase (STEPS)	12.2	5.4	0.4
End-of-life	0.5	0.5	0.5
Total	35.1	28.3	23.3

← Figure 9

Carbon footprint for Polestar 2 MY24 Long range Single motor, with different electricity mixes in the use phase. The use-phase utilizes the STEPS scenario from the IEA. Results are shown in tCO_2e per functional unit (200,000 km lifetime driving distance).



← Figure 10

Carbon footprint for Polestar 2 MY24 Standard range Single motor , with different electricity mixes in the use phase. The use-phase utilizes the STEPS scenario from the IEA. Results are shown in tCO_2e per functional unit (200,000 km lifetime driving distance).

Table 8 →

Carbon footprint for Polestar 2 MY24 Standard range Single motor , with different electricity mixes used in the use phase. Results are shown in tCO_2e per functional unit.

Polestar 2 Standard range Single motor MY24	Global electricity mix	European electricity mix	Wind power
Materials production	15.4	15.4	15.4
Li-ion battery modules	4.6	4.6	4.6
Manufacturing and logistics	1.6	1.6	1.6
Use phase (STEPS)	12.3	5.4	0.4
End-of-life	0.5	0.5	0.5
Total	34.4	27.5	22.5

Table 9 →

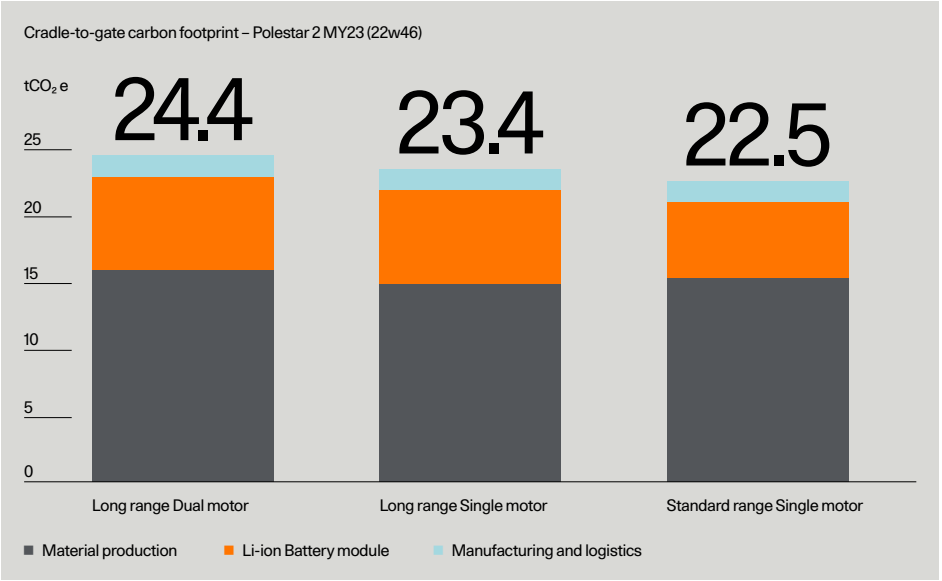
Descriptions of the three different Polestar 2 MY24 variants.

Polestar 2 MY24	Long range Dual motor	Long range Single motor	Standard range Single motor
Battery capacity	82 kWh	82 kWh	69 kWh
Output	310 kW 421 hp 740 Nm	220 kW 299 hp 490 Nm	200 kW 272 hp 490 Nm
Preliminary consumption (WLTP)	15.9-17.2 kWh/ 100 km	14.8-15.8 kWh/ 100 km	14.9-15.9 kWh/ 100 km
Preliminary range (WLTP)	555-593 km	610-655 km	505-546 km

Table 10 →

Studied vehicles and their corresponding weight in kg.

Polestar 2 MY24	Long range Dual motor	Long range Single motor	Standard range Single motor
Total weight (kg)	2108	2009	1944
Li-ion battery modules weight (kg)	362	362	310



← Figure 11

Cradle-to-gate carbon footprint for the Polestar 2 variants MY23 with introduction date 22w46, including Materials production, Li-ion battery modules, Manufacturing and Logistics.

Polestar 2 model year 2023 (22w46)

In the Polestar 2 model year 2023 with introduction date 2022 week 46, low carbon aluminum was introduced in the 19" rims (the most sold rims) of the vehicle. Aluminum was identified as having the largest climate impact of all materials in the first Polestar 2 LCA. This resulted in a decrease in cradle-to-gate carbon footprint of 0.5 tCO_2e for all variants of the Polestar 2. The emission factor for low carbon aluminum represents aluminum smelting using electricity from hydropower in China. Table 19 and 20 provides a description of the Polestar 2 MY23 variants.

Another change with significant impact on carbon footprint was confirming 100% solar power electricity in Taizhou (previously called Luqiao), resulting in a in a decrease in cradle-to-gate carbon footprint of 0.5 tCO_2e for all variants of the Polestar 2.

Figure 11 and Table 11 present the cradle-to-gate carbon footprint of the three Polestar 2 variants, the result varies between 22.5-24.4 tCO_2e. Figures 12-14 and Tables 12-14 present the cradle-to-grave carbon footprint. Depending on variant and electricity mix scenario, the life cycle carbon footprint varies between 23.3-47.0 tCO_2e.

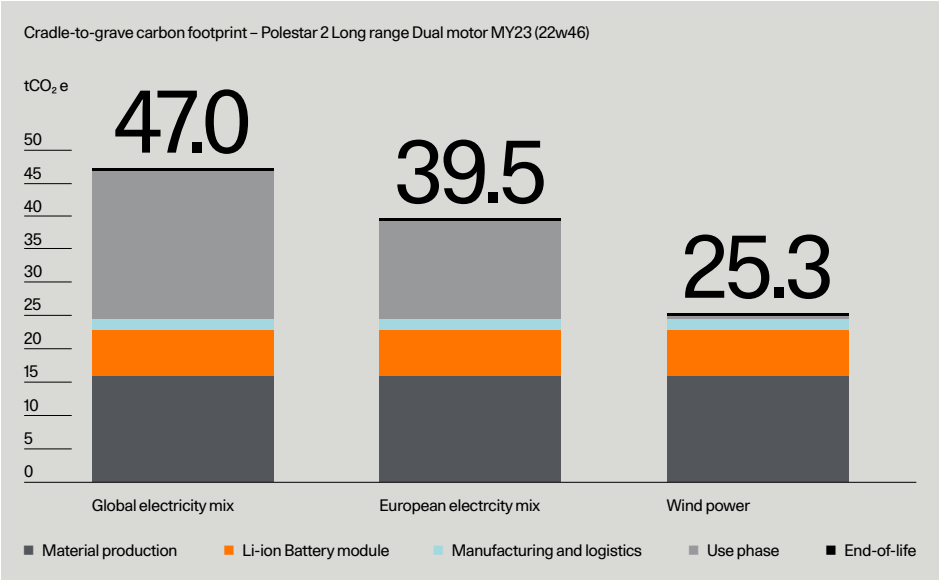
The largest variability in the results is due to the variation of electricity mix. In the case of global electricity mix, the use phase accounts for over 45% of the cradle-to-grave carbon footprint, while in the case of wind power, the use phase accounts for 2%. This is the case for both Polestar 2 model year 2023 with introduction date 2022 week 22 and week 46.

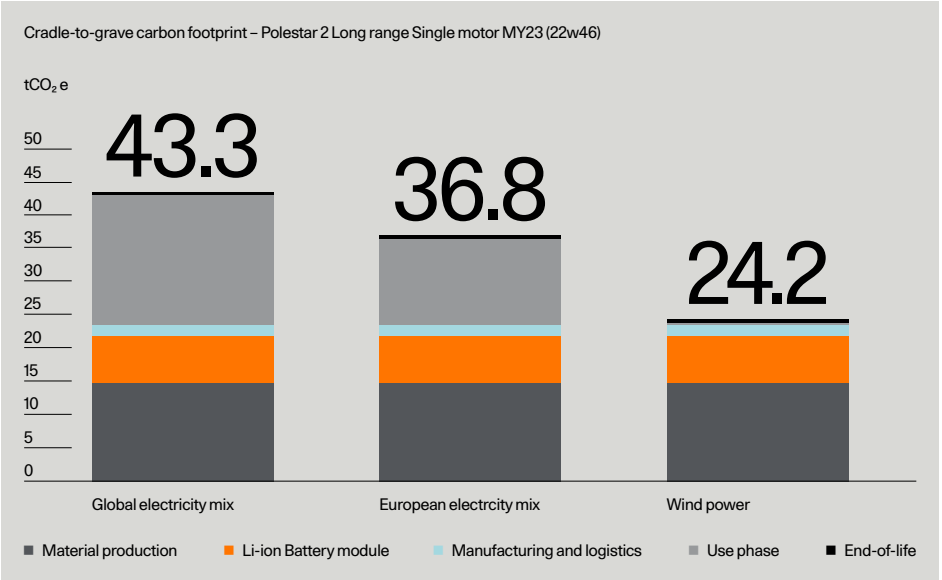
There have been no changes to the technical specifications of the Polestar 2 MY23 with introduction date 2022 week 46, these are the same as for the Polestar 2 MY23 with introduction date 2022 week 22, described in Table 19 and 20.

Table 11 →

Cradle-to-gate carbon footprint for the Polestar 2 variants MY23 with introduction date 22w46, including Materials production, Li-ion battery modules, Manufacturing and Logistics.

Polestar 2 MY23 (22w46)	Long range Dual motor	Long range Single motor	Standard range Single motor
Material production	15.8	14.8	15.2
Li-ion battery modules	7.0	7.0	5.7
Manufacturing and logistics	1.6	1.6	1.6
Total	24.4	23.4	22.5





← Figure 12

Cradle-to-grave carbon footprint for Polestar 2 MY23 LRDM with introduction date 22w46, with different electricity mixes in the use phase. Results are shown in tCO_2e per functional unit (200,000 km lifetime driving distance).

Table 12 →

Cradle-to-grave Carbon footprint for Polestar 2 MY23 LRDM with introduction date 22w46, with different electricity mixes used in the use phase. Results are shown in tCO_2e per functional unit.

Polestar 2 Long range Dual motor MY23 (22w46)	Global electricity mix	European electricity mix	Wind power
Material production	15.8	15.8	15.8
Li-ion battery modules	7.0	7.0	7.0
Manufacturing and logistics	1.6	1.6	1.6
Use phase (non-steps)	22.1	14.6	0.4
End-of-Life	0.5	0.5	0.5
Total	47.0	39.5	25.3

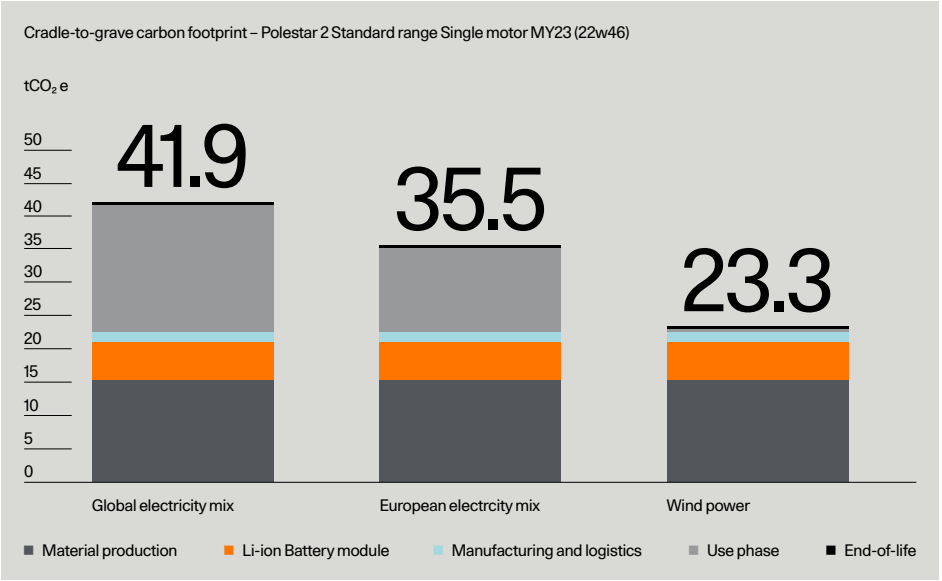
Table 13 →

Cradle-to-grave Carbon footprint for Polestar 2 MY23 LRSM with introduction date 22w46, with different electricity mixes used in the use phase. Results are shown in tCO_2e per functional unit.

Polestar 2 Long range Single motor MY23 (22w46)	Global electricity mix	European electricity mix	Wind power
Material production	14.8	14.8	14.8
Li-ion battery modules	7.0	7.0	7.0
Manufacturing and logistics	1.6	1.6	1.6
Use phase (non-steps)	19.4	12.9	0.3
End-of-Life	0.5	0.5	0.5
Total	43.3	36.8	24.2

← Figure 13

Cradle-to-grave carbon footprint for Polestar 2 MY23 LRSM with introduction date 22w46, with different electricity mixes in the use phase. Results are shown in tCO_2e per functional unit (200,000 km lifetime driving distance).



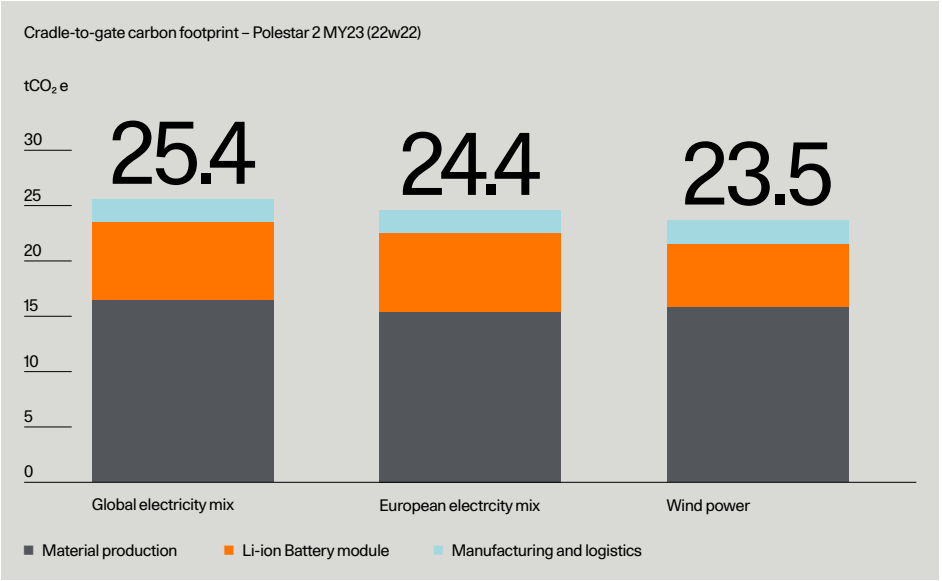
← Figure 14

Cradle-to-grave carbon footprint for Polestar 2 MY23 SRSM with introduction date 22w46, with different electricity mixes in the use phase. Results are shown in tCO_2e per functional unit (200,000 km lifetime driving distance).

Table 14 →

Cradle-to-grave Carbon footprint for Polestar 2 MY23 SRSM with introduction date 22w46, with different electricity mixes used in the use phase. Results are shown in tCO_2e per functional unit.

Polestar 2 Standard range Single motor MY23 (22w46)	Global electricity mix	European electricity mix	Wind power
Material production	15.2	15.2	15.2
Li-ion battery modules	5.7	5.7	5.7
Manufacturing and logistics	1.6	1.6	1.6
Use phase (non-steps)	18.9	12.5	0.3
End-of-Life	0.5	0.5	0.5
Total	41.9	35.5	23.3



← Figure 15

Cradle-to-gate carbon footprint for the Polestar 2 variants MY23 with introduction date 22w22, including Materials production, Li-ion battery modules, Manufacturing and Logistics.

Table 15 →

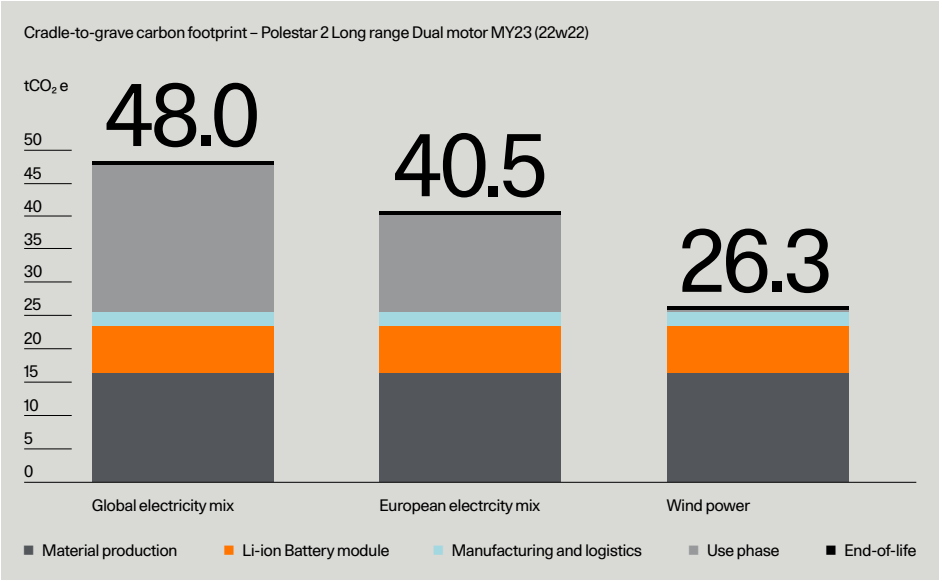
Cradle-to-gate carbon footprint for the Polestar 2 variants MY23 with introduction date 22w22, including Materials production, Li-ion battery modules, Manufacturing and Logistics.

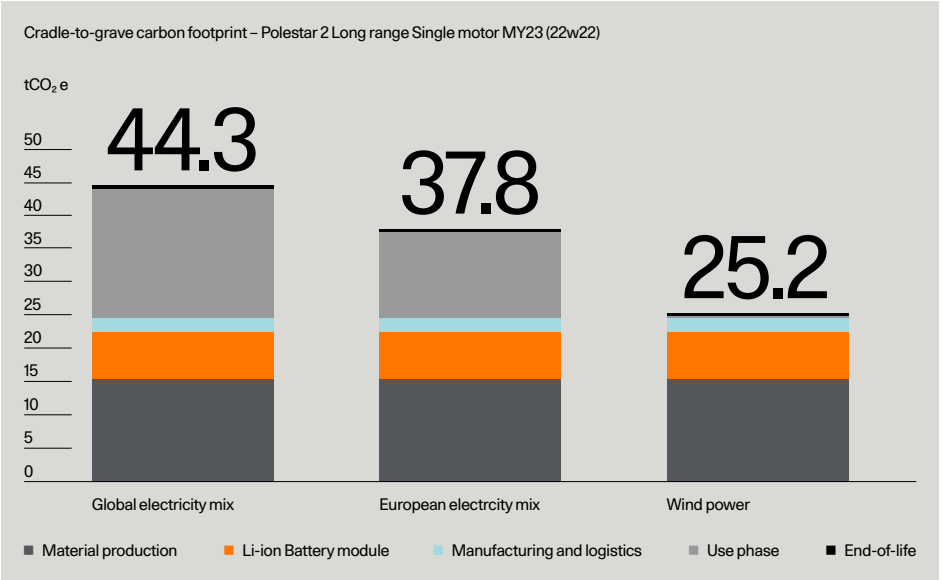
Polestar 2 model year 2023 (22w22)

In the Polestar 2 model year 2023 with introduction date 22w22, low carbon aluminum was introduced in the battery tray of the vehicle. Aluminum was identified as having the largest climate impact of all materials in the first Polestar 2 LCA. This resulted in a decrease in cradle-to-gate carbon footprint of 0.7 tCO_2e for all variants of the Polestar 2. The emission factor for low carbon aluminum represents aluminum smelting using electricity from hydropower in China. Table 19 and 20 provides a description of the Polestar 2 MY23 variants.

Figure 15 and Table 15 present the cradle-to-gate carbon footprint of the three Polestar 2 variants MY23 with introduction date 22w22, the result varies between 23.5-25.4 tCO_2e. Figures 16-18 and Tables 16-18 present the cradle-to-grave carbon footprint. Depending on variant and electricity mix scenario, the life cycle carbon footprint varies between 24.3-48.0 tCO_2e.

Polestar 2 MY23 (22w22)	Long range Dual motor	Long range Single motor	Standard range Single motor
Material production	16.3	15.3	15.7
Li-ion battery modules	7.0	7.0	5.7
Manufacturing and logistics	2.1	2.1	2.1
Total	25.4	24.4	23.5





← Figure 16

Cradle-to-grave carbon footprint for Polestar 2 MY23 LRDM with introduction date 22w22, with different electricity mixes in the use phase. Results are shown in tCO_2e per functional unit (200,000 km lifetime driving distance).

Table 16 →

Cradle-to-grave Carbon footprint for Polestar 2 MY23 LRDM with introduction date 22w22, with different electricity mixes used in the use phase. Results are shown in tCO_2e per functional unit.

Polestar 2 Long range Dual motor MY23 (22w22)	Global electricity mix	European electricity mix	Wind power
Material production	16.3	16.3	16.3
Li-ion battery modules	7.0	7.0	7.0
Manufacturing and logistics	2.1	2.1	2.1
Use phase (non-steps)	22.1	14.6	0.4
End-of-Life	0.5	0.5	0.5
Total	48.0	40.5	26.3

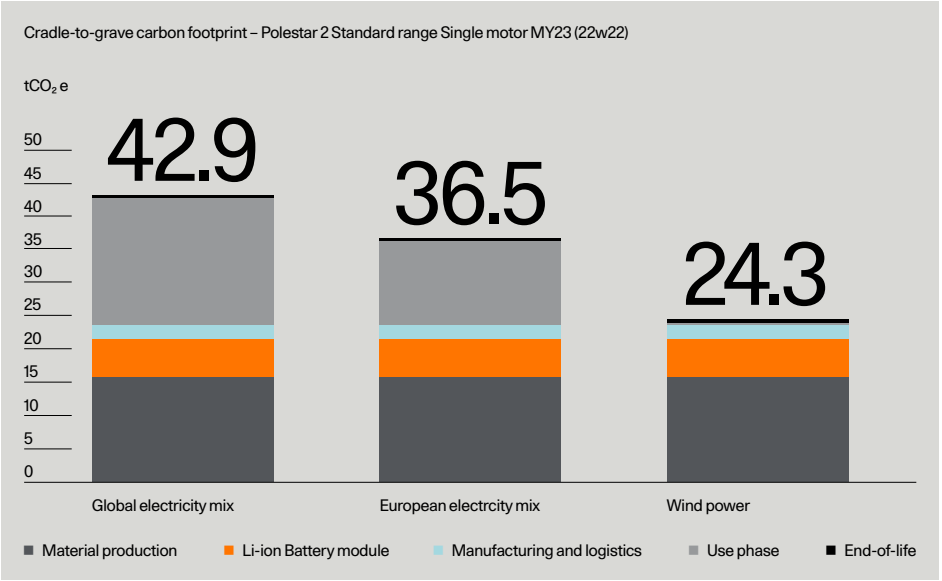
Table 17 →

Cradle-to-grave Carbon footprint for Polestar 2 MY23 LRSM with introduction date 22w22, with different electricity mixes used in the use phase. Results are shown in tCO_2e per functional unit.

Polestar 2 Long range Single motor MY23 (22w22)	Global electricity mix	European electricity mix	Wind power
Material production	15.3	15.3	15.3
Li-ion battery modules	7.0	7.0	7.0
Manufacturing and logistics	2.1	2.1	2.1
Use phase (non-steps)	19.4	12.9	0.3
End-of-Life	0.5	0.5	0.5
Total	44.3	37.8	25.2

← Figure 17

Cradle-to-grave carbon footprint for Polestar 2 MY23 LRSM with introduction date 22w22, with different electricity mixes in the use phase. Results are shown in tCO_2e per functional unit (200,000 km lifetime driving distance).



← Figure 18

Cradle-to-grave carbon footprint for Polestar 2 MY23 SRSM with introduction date 22w22, with different electricity mixes in the use phase. Results are shown in tCO_2e per functional unit (200,000 km lifetime driving distance).

Table 18 →

Cradle-to-grave Carbon footprint for Polestar 2 MY23 SRSM with introduction date 22w22, with different electricity mixes used in the use phase. Results are shown in tCO_2e per functional unit.

Polestar 2 Standard range Single motor MY23 (22w22)	Global electricity mix	European electricity mix	Wind power
Material production	15.7	15.7	15.7
Li-ion battery modules	5.7	5.7	5.7
Manufacturing and logistics	2.1	2.1	2.1
Use phase (non-steps)	18.9	12.5	0.3
End-of-Life	0.5	0.5	0.5
Total	42.9	36.5	24.3

Table 19 →

Descriptions of the three different Polestar 2 MY23 (both introduction date 2022 week 22 and week 46) variants.

Polestar 2 MY23	Long range Dual motor	Long range Single motor	Standard range Single motor
Battery capacity	78 kWh	78 kWh	69 kWh
Output	300 kW 408 hp 660 Nm	170kW 231 hp 330 Nm	170 kW 231 hp 330 Nm
Preliminary consumption (WLTP)	19.3-20.2 kWh/ 100 km	17.0-18.4 kWh/ 100 km	16.5-17.8 kWh/ 100 km
Preliminary range (WLTP)	455-487 km	515-551 km	445-478 km

Table 20 →

Studied vehicles and their corresponding weight in kg (both introduction date 2022 week 22 and week 46).

Polestar 2 MY23	Long range Dual motor	Long range Single motor	Standard range Single motor
Total weight (kg)	2113	1994	1938
Li-ion battery modules weight (kg)	350	350	310

Electricity Use phase	Location	Name of LCI dataset	Year	Type	LCI database
Electricity from solar power	RER	Electricity from photovoltaic	2019	agg	Sphera professsional database
Electricity from wind power	RER	Electricity from wind power	2019	agg	Sphera professsional database
Electricity from geothermal	RER	Electricity from geothermal	2019	agg	Sphera professsional database
Electricity from hydro power	RER	Electricity from hydro power	2019	agg	Sphera professsional database
Electricity from bioenergy	RER	Electricity from biomass (solid)	2019	agg	Sphera professsional database
Electricity from nuclear power	RER	Electricity from nuclear	2019	agg	Sphera professsional database
Electricity from unabated coal	RER	Electricity from lignite	2019	agg	Sphera professsional database
Electricity from unabated gas	RER	Electricity from natural gas	2019	agg	Sphera professsional database
Electricity from oil	RER	Electricity from heavy fuel oil (HFO)	2019	agg	Sphera professsional database

← Table 1

Chosen data sets for electricity for use phase of STEPs scenario for Polestar 2 MY24 & MY25.

Electricity Manufacturing	Location	Name of LCI dataset	Year	Type	LCI database
Thermal energy from biogas	ROW	Thermal energy from biogas	2019	agg	Sphera professsional database
Electricity from solar power	CN	Electricity from photovoltaic	2019	agg	Sphera professsional database

← Table 2

Chosen data sets for electricity for manufacturing phase of Polestar 2 MY23, MY24 & MY25 in Taizhou.

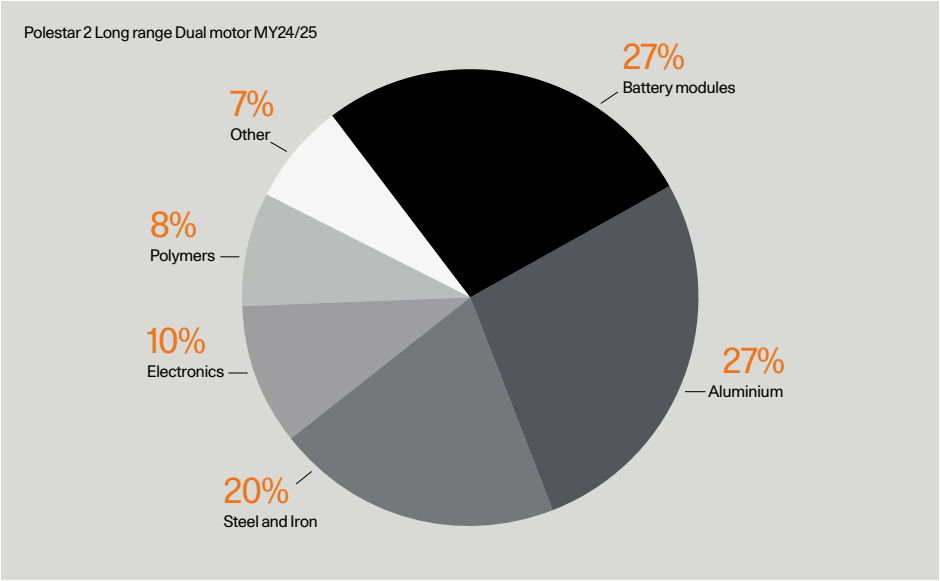
Electricity Material production	Location	Name of LCI dataset	Year	Type	LCI database
Low carbon aluminium	CN	Aluminum from smelters using hydro electricity	2022	agg	Polestars own investigations

← Table 3

Chosen data sets for materials in Polestar 2, only includes updates from previous LCAs.

Chosen datasets

In the LCA a large number of generic datasets from databases are used. In this appendix the datasets used are listed in Tables 1-3. This appendix only presents changes to the datasets used from the two previous LCA studies on Polestar 2. The two original Polestar 2 LCAs contain all other datasets used.

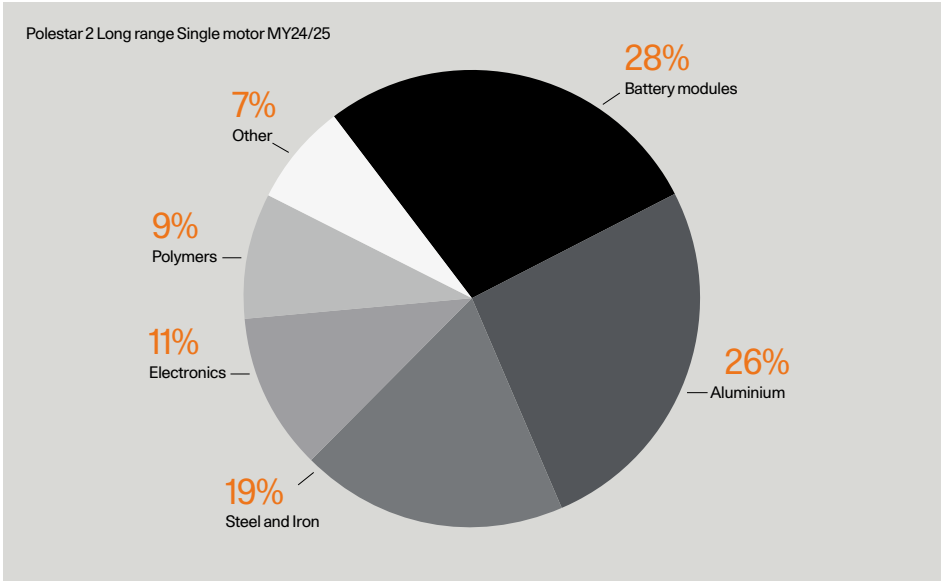


← Figure 1

CO_2e contribution from different material groups, including battery modules, to the carbon footprint from materials production and refining for Polestar 2 MY24/25 Long range Dual motor. The distribution looks very similar for all model years.

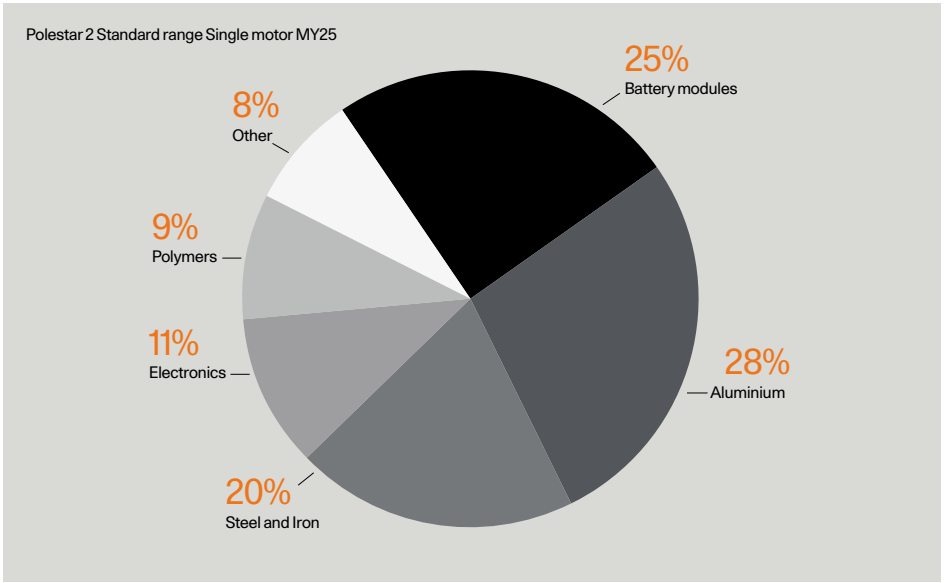
Material breakdown

Figure 1-3 presents how the different material groups, including the battery modules, contribute to the carbon footprint from materials production and refining for the three Polestar 2 variants. The group “other” consists of all the material groups that have an individual contribution of 2% or less, which are fluids and undefined, other metals, copper, natural materials, tires, and glass.



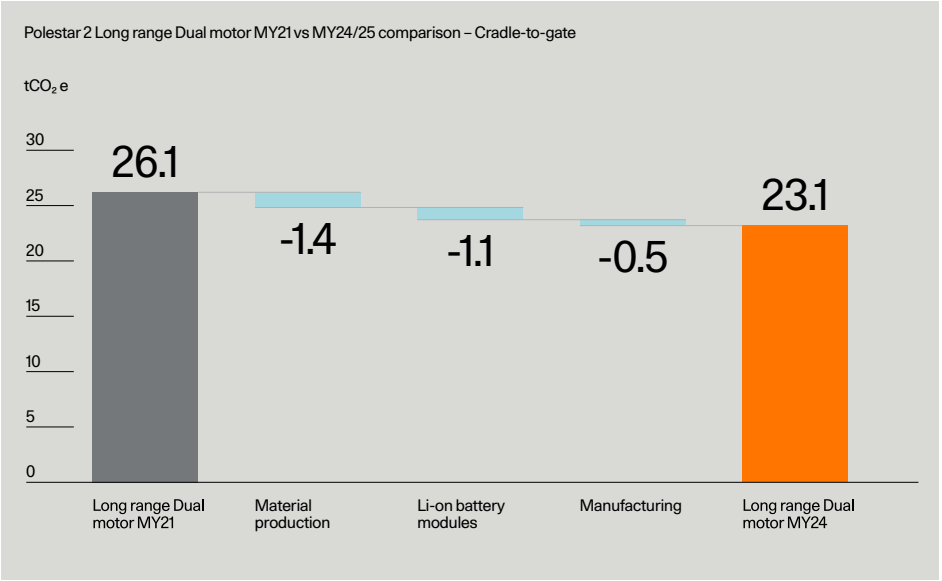
← Figure 2

CO_2e contribution from different material groups, including battery modules, to the carbon footprint from materials production and refining for Polestar 2 MY24/25 Long range Single motor. The distribution looks very similar for all model years.



← Figure 3

CO_2e contribution from different material groups, including battery modules, to the carbon footprint from materials production and refining for Polestar 2 MY25 Standard range Single motor. The distribution looks very similar for all model years.

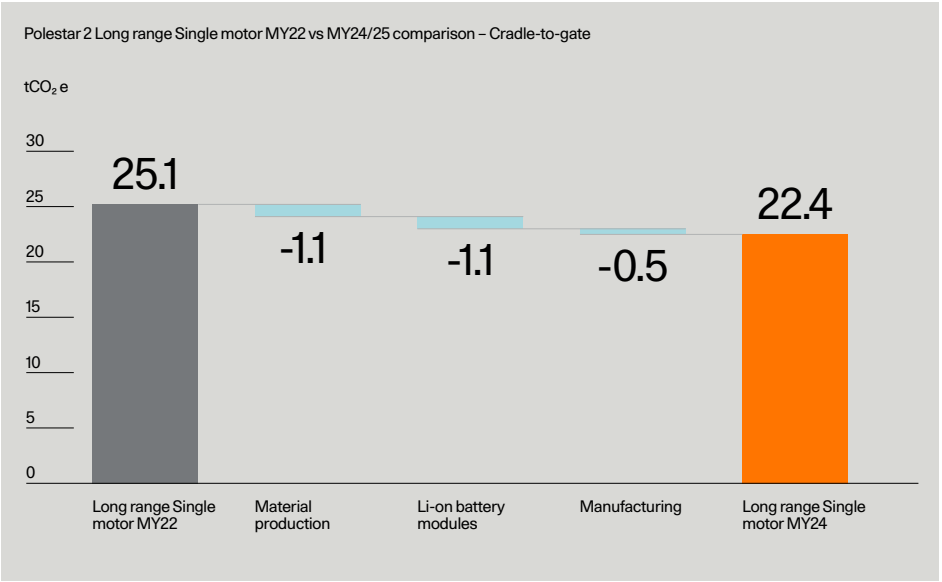


← Figure 4

Cradle-to-gate carbon footprint for the Polestar 2 LRDM, developments between model year 2021 and 2024/2025.

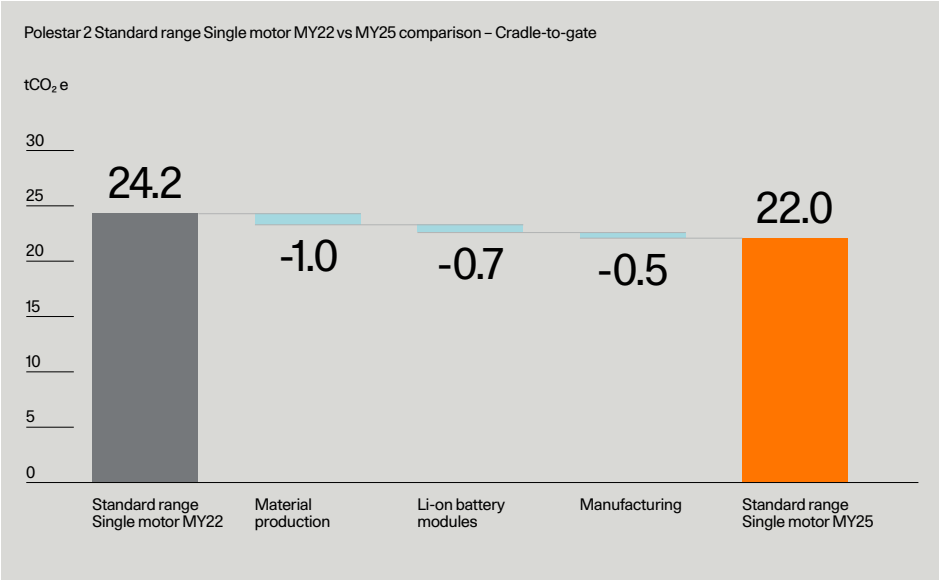
Model year comparison

Figure 4-6 present the changes in cradle-to-grave result between initial model years up to model years 2024 and 2025.



← Figure 5

Cradle-to-gate carbon footprint for the Polestar 2 LRSM, developments between model year 2022 and 2024/2025.



← Figure 6

Cradle-to-gate carbon footprint for the Polestar 2 SRSM, developments between model year 2022 and 2025.