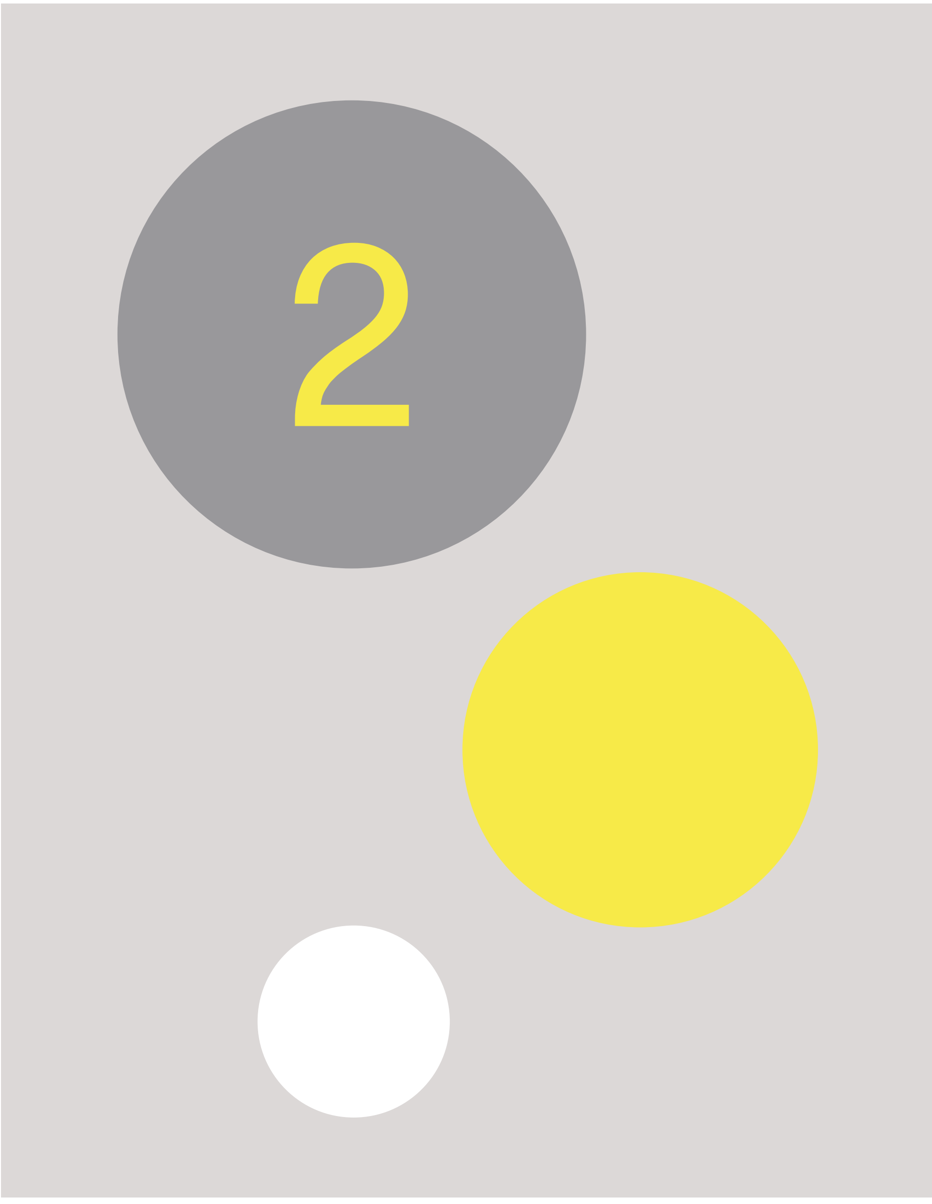
Life cycle assessment 2021

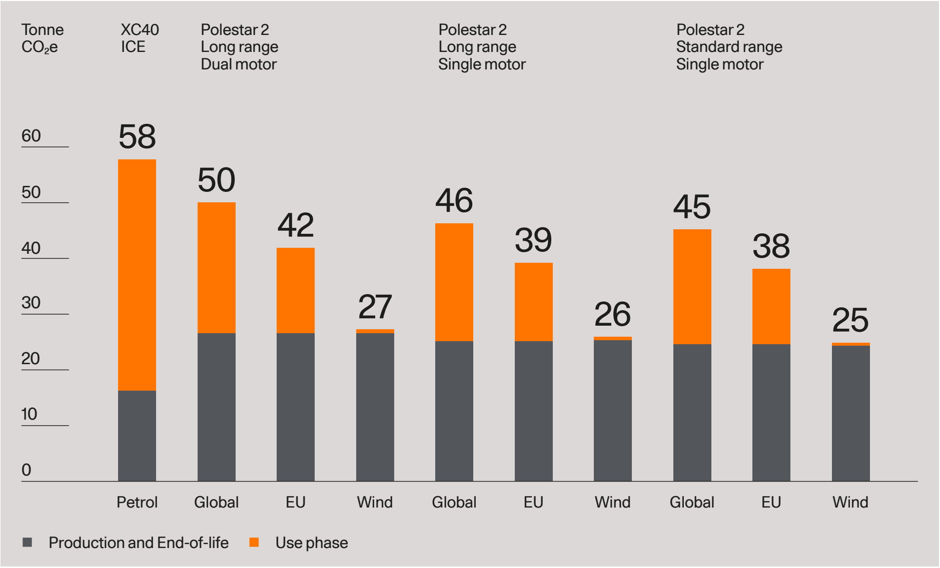
Carbon footprint of Polestar 2 variants



Disclaimer

This report is informational only and (1) is based solely on an analysis of Polestar 2 (model year 2020), the additional variants “Long range Single motor” and “Standard range Single motor”, and Volvo XC40 petrol Internal Combustion Engine (model year 2020), and does not include information regarding any other Polestar or Volvo Cars vehicle and (2) does not create any commitment regarding current or future products or carbon footprint impacts.

Content



← Figure 1

Carbon footprint for Polestar 2 variants and XC40 ICE, with different electricity mixes in the use phase used for the Polestar 2 variants. Results are shown in tonne CO_2-equivalents per functional unit (200,000 km lifetime range).

In 2020, a carbon footprint of Polestar 2 was published. The carbon footprint presented in this report is a continuation of that work. Two new Polestar 2 variants, "Long range Single motor" and "Standard range Single motor" are assessed and compared with the original Polestar 2, the "Long range Dual motor", and with the internal combustion engine petrol vehicle Volvo XC40 ICE.

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. These choices and data sources are described in the previous Polestar 2 LCA report. Some small methodological and data changes were 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 also read the previous Polestar 2 LCA report.

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

All three variants, including the Polestar 2 Long range Dual motor, have been calculated according to any new methodology and data, to make results comparable. The XC40 ICE has not been re-calculated, since data is not controlled by Polestar.

As shown in Figure 1, the carbon footprint is 50-27 tonne CO_2e for the "Long range Dual motor", 46-26 tonne CO_2e for the "Long range Single motor", and 45-25 tonne CO_2e for "Standard range Single motor". The range in results is caused by differences in electricity mix scenarios, where the highest value reflects that a global electricity mix is used in the vehicle use phase while the lowest value reflects that wind power is used.

Compared with the XC40 ICE, all the Polestar 2 variants have a lower cradle-to-grave carbon footprint, spanning from a 14% reduction for "Long range Dual motor with global electricity mix" to 57% reduction for "Standard range Single motor with wind power".

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-Cycle-Accounting-Reporting-Standard_041613.pdf

The number of kilometres needed to be driven to reach break-even for the Polestar 2 variants, compared with XC40 ICE changes with variant and electricity mix. “Standard range Single motor” charged with wind power reaches break-even after 40 000 km, while “Long range Dual motor” charged with global electricity mix reaches break-even after 110 000 km. All break-even figures can be seen in Table 1.

Table 1 →

Number of kilometres driven at break-even between Polestar 2 with different electricity mixes and XC40 ICE.

Electricity mix	Global	EU	Wind
Polestar 2 Long range Dual motor	110 000	76 000	49 000
Polestar 2 Long range Single motor	86 000	65 000	49 000
Polestar 2 Standard range Single motor	79 000	58 000	40 000

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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.

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 and landfill.

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

GaBi
GaBi is LCA modelling software, provided by Sphera, which has been used for the modelling in this study.

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 quantifed as a mass unit of CO_2e, where e is short for equivalents.

ICE
Internal Combustion Engine. Sometimes used as a category when referring to a vehicle running with an ICE. An ICE vehicle uses exclusively chemical energy stored in a fuel, with no secondary source of propulsion.

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.

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

1.1 Introduction

In 2021, the Polestar 2 model range expanded to three variants, offering three different powertrains. The existing 300 kW (408 hp) dual motor setup with a large battery pack, was joined by two front-mounted single motor variants – available either with the same long-range battery and a 170 kW motor, or a smaller, standard-range battery and a 165 kW motor.

The goal of this study is to contribute to transparency towards customers and stakeholders, by presenting the carbon footprint of the life cycle of three Polestar 2 variants. Another goal is to present how the vehicles are part of a larger sustainable mobility strategy, by comparing them with a combustion engine petrol vehicle and examining how the transition to a renewable energy system increases the climate performance of electric vehicles.

As the study is a continuation of the previous Polestar 2 LCA, the methodology and data sources are largely the same. The next chapter lists and explains deviations from the previous report.

Table 2 →

Descriptions of the three different Polestar 2 variants.

Variant	Battery cap.	Output	Consumption (WLTP)	Range (WLTP)
Polestar 2 LR DM	78 kWh	300 kW 408 hp 660 Nm	19.5-20.3 kWh/100 km	450-480 km
Polestar 2 LR SM	78 kWh	170 kW 231 hp 330 Nm	17.1-18.3 kWh/100 km	515-540 km
Polestar 2 SR SM	64 kWh	165 kW 224 hp 330 Nm	17.1-18.0 kWh/100 km	420-440 km

Table 3 →

Studied vehicles and their corresponding weight in kg.

Vehicle	Total weight	Li-on battery modules weight
Polestar 2 LR DM	2110	350
Polestar 2 LR SM	2012	350
Polestar 2 SR SM	1958	310
XC40 ICE	1690	–

2.1 Changes in methodology and data since Polestar 2 original LCA

The previously published Polestar 2 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, transport, use phase, and end-of-life treatment.

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 LCA, and is described in that report.

2.2 Added material categories

The list of categories used to sort the bill of material of the cars according to materials has been extended by five categories, namely:

- Aramid
- Polyester
- Friction (used in brake pads)
- Glass fibre
- Elastomers

This leads to a higher accuracy, as more materials are sorted into a more specific material category.

An explanation of how the categories Friction and Elastomers have been modelled, as well as all material categories and the datasets used for them, can be found in the Appendix.

2.3 Update of composition of average filled polymers

A more comprehensive investigation into filled polymers has been done, which has resulted in an update on the average composition of the filled polymers.

Table 4 →

Changes made in the composition of filled polymers.

	Previously used data	Updated data
Polymer resin	81%	78%
Glass fiber	11%	14%
Talc	8%	8%

2.4 Update of share of wrought versus casted aluminium

The assumption of how much of the aluminium in the car that is wrought versus casted has been updated according to the figures for 2019, in “Aluminium content in European passenger cars”[3].

	Previously used data	Updated data
Casted aluminium	59%	65%
Wrought aluminium	41%	35%

← Table 5

Changes made in share of wrought versus casted aluminium.

2.5 Update of GaBi-professional database and Ecoinvent database

Most background data for raw materials, fuels and electricity mixes comes from the two LCA databases GaBi professional and Ecoinvent 3.7. Both these databases have been updated since the release of the original Polestar 2 LCA. For many datasets this update means no or a minimal change to the previous value. In Table 6 we have listed the datasets that changed more than 5%, together with the percentage of increase or decrease of the dataset's carbon footprint.

Data set name	Change
DE: Silicone rubber (RTV-2, condensation) sphera	18%
GLO: market for ferrite ecoinvent	49%
GLO: market for permanent magnet, electric passenger car motor ecoinvent	29%
GLO: market for zinc ecoinvent	-9%
RoW: polyethylene production, low density, granulate ecoinvent	-62%

← Table 6

Used datasets with a deviation larger than 5% compared to previous LCA of Polestar 2 Long range Dual motor.

2.6 Inbound and outbound transport and emissions from manufacturing

For manufacturing figures, May 2020 to April 2021 was used (because of two unrepresentative months in 2020 caused by pandemic production stop), to avoid underestimating the emissions from manufacturing.

The changes in emissions due to the Covid-19 pandemic were not considered to be as large for logistics as for manufacturing, which is why logistics figures for 2020 were used.

2.7 Electricity mix used in the manufacturing and use phases

The electricity mix used in the manufacturing of components of Polestar vehicles has been changed to an average global mix from EIA[4]. The electricity mix used previously was an average between electricity mixes in Volvo cars production regions. With a global electricity mix, the risk of underestimating the electricity emissions is lower, and it is also more in line with the general methodology of using global data.

For the use phase the electricity mix has been updated to more recent data from IEA[4].

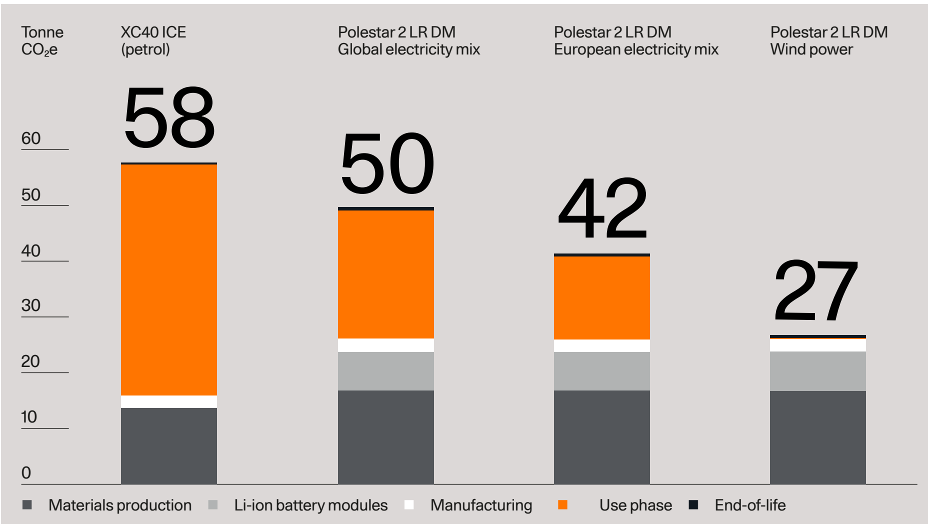
Table 7 →

Changes made in electricity emission factors in manufacturing and use phase.

	Previously used data (g CO_2e/ kWh)	Updated data (g CO_2e/ kWh)
Manufacturing electricity	135	572
Global electricity in use phase	650	572

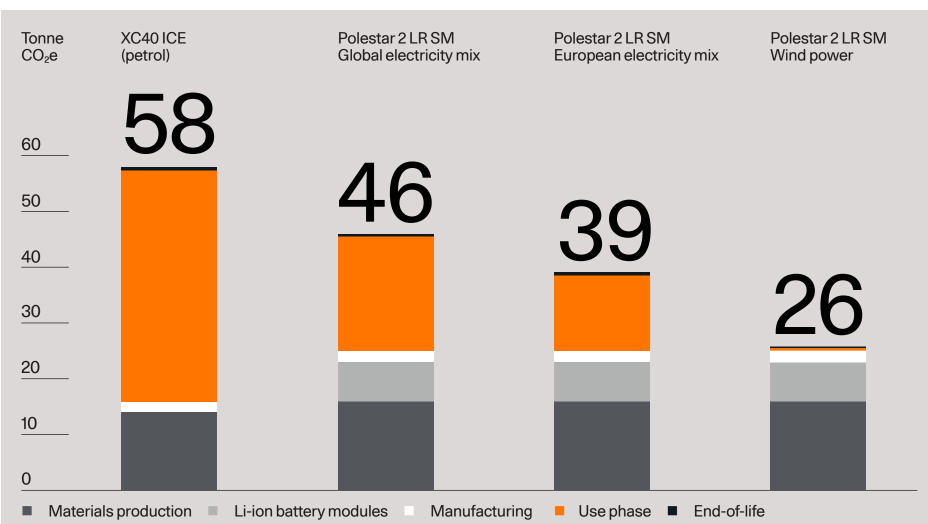
3 Aluminium Content in European Cars (european-aluminium.eu)

4 https://www.iea.org/data-and-statistics/charts/world-gross-electricity-production-by-source-2019



← Figure 2

Carbon footprint for Polestar 2 Long range Dual motor and XC40 ICE, with different electricity mixes in the use phase used for Polestar 2. Results are shown in tonne CO_2 -equivalents per functional unit (200,000 km lifetime range).



← Figure 3

Carbon footprint for Polestar 2 Long range Single motor and XC40 ICE, with different electricity mixes in the use phase used for Polestar 2. Results are shown in tonne CO_2 -equivalents per functional unit (200,000 km lifetime range).

While the Polestar 2 Long range Dual motor using a global electricity mix has a 14% lower carbon footprint compared with XC40 ICE (petrol) (Figure 2), the difference increases to 21% for the Long range Single motor (Figure 3) and 22% for the Standard range Single motor (Figure 4). If the Polestar vehicles are charged with wind power during the use phase, the carbon footprints are 53% (Figure 2), 55% (Figure 3) and 57% (Figure 4) lower than the ICE. The electric vehicles all perform better than the ICE from a climate perspective, regardless of electricity scenario and vehicle variant. However, the less carbon intensive electricity scenarios, and the vehicle variants with one motor less and reduced battery capacity, have the lowest carbon footprints.

Table 8 →

Carbon footprint for Polestar 2 Long range Dual motor and XC40 ICE, with different electricity mixes used in the use phase for Polestar 2. Results are shown in tonne CO_2-equivalents per functional unit.

	XC40 ICE petrol	PS2 LR DM Global	PS2 LR DM EU28	PS2 LR DM Wind
Materials production	14	17	17	17
Li-ion battery modules	0	7	7	7
Manufacturing	2.1	2.1	2.1	2.1
Use phase emissions	41	23	15	0.4
End-of-life	0.6	0.5	0.5	0.5
Total	58	50	42	27

Table 9 →

Carbon footprint for Polestar 2 Long range Single motor and XC40 ICE, with different electricity mixes used in the use phase for Polestar 2. Results are shown in tonne CO_2-equivalents per functional unit.

	XC40 ICE petrol	PS2 LR SM Global	PS2 LR SM EU28	PS2 LR SM Wind
Materials production	14	16	16	16
Li-ion battery modules	0	7	7	7
Manufacturing	2.1	2.1	2.1	2.1
Use phase emissions	41	20	14	0.3
End-of-life	0.6	0.5	0.5	0.5
Total	58	46	39	26

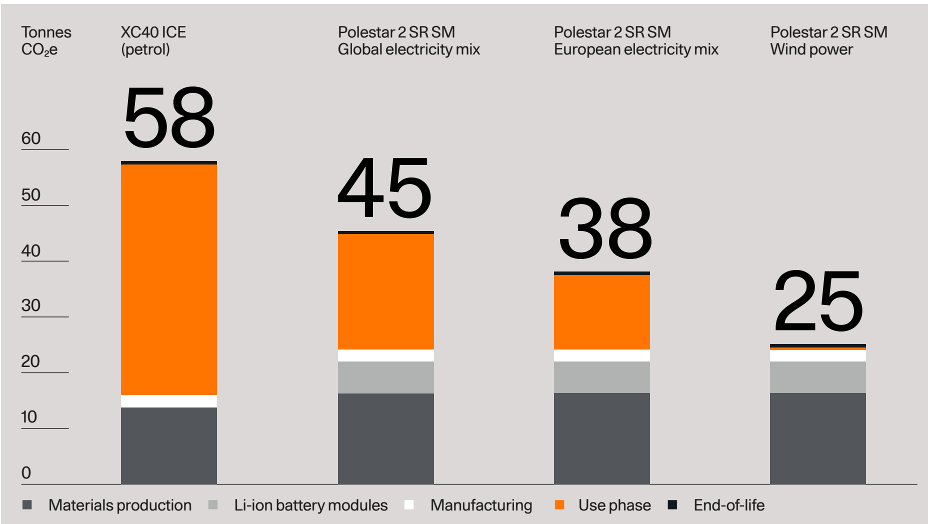


Table 10 →

Carbon footprint for Polestar 2 Standard range Single motor and XC40 ICE, with different electricity mixes used in the use phase for Polestar 2. Results are shown in tonne CO_2-equivalents per functional unit.

	XC40 ICE petrol	PS2 SR SM Global	PS2 SR SM EU28	PS2 SR SM Wind
Materials production	14	16	16	16
Li-ion battery modules	0	5.7	5.7	5.7
Manufacturing	2.1	2.1	2.1	2.1
Use phase emissions	41	21	13	0.3
End-of-life	0.6	0.5	0.5	0.5
Total	58	45	38	25

← Figure 4

Carbon footprint for Polestar 2 Standard range Single motor and XC40 ICE, with different electricity mixes in the use phase used for Polestar 2. Results are shown in tonne CO_2-equivalents per functional unit (200,000 km lifetime range).

The previous Polestar 2 LCA report presents the contribution from different material categories to the overall carbon footprint. The difference between the original Polestar 2 variant and the new variants is a reduction in material usage from the removal of one motor (both new variants) and decrease of battery capacity (the standard range variant). The reduction in material usage leads to a weight reduction of 5% (Long range Single motor) and 7% (Standard range Single motor), while the carbon footprint reduction, excluding use phase, is 4% and 7% respectively.

The single motor variants both have a slightly lower WLTP number than the dual motor variant. This leads to slightly lower emissions during the use phase. In scenarios where the carbon intensity from the electricity is high, the energy efficiency of the car will have a higher impact on the results. When using global electricity mix the emissions from the use-phase decreases by 10% when driving the Standard range Single motor compared with the Dual motor.

The number of kilometres needed to be driven to reach break-even for the Polestar 2 variants, compared with XC40 ICE changes with variant and electricity mix. “Standard range Single motor” charged with wind power reaches break-even after 40 000 km, while “Long range Dual motor” charged with global electricity mix reaches break-even after 110 000 km. All break-even figures can be seen in Table 11.

Table 11 →

Number of kilometres driven at break-even between Polestar 2 with different electricity mixes and XC40 ICE.

Variants	Global	EU	Wind
Polestar 2 Long range Dual motor	110 000	76 000	49 000
Polestar 2 Long range Single motor	86 000	65 000	49 000
Polestar 2 Standard range Single motor	79 000	58 000	40 000

Using LCA for assessing the carbon footprint of different Polestar 2 variants gives insights into how design choices influence the overall carbon footprint of the vehicle. Reducing the number of motors from two to one, and reducing battery capacity, means that material production is avoided, and lower vehicle weight, resulting in decreased energy demand in the use phase. Expanding a vehicle model to several drivetrain options offers a broader performance and price range to customers, making the electric vehicle market increasingly accessible, and is a strategy for reducing carbon footprints.

The reduction of battery capacity with about 20% and motor capacity with about 40% both contribute to similar carbon footprint reductions (Polestar 2 Long range Single motor and Polestar 2 Standard range Single motor have a 4 and 7% lower carbon footprint repectively.) However, as the previous Polestar 2 LCA report pointed out, there are many material categories contributing to the overall carbon footprint of the vehicle. Reducing the number of motors, and reducing battery capacity, are only two of many measures that can be taken to lower carbon footprints. A range of different measures should be taken both when it comes to material production technology and material reduction. More information about Polestar's strategic initiatives and projects to minimise climate impact can be found in Polestar Sustainability Report.

Compared with the XC40 ICE, vehicle production of the Polestar variants has a higher carbon footprint, but that changes when the use phase is taken into account. In this report, three different electricity mix scenarios were explored, which influence results massively. What is important to note, is that the electricity market is shifting rapidly toward renewable energy sources, which will contribute to a constantly decreasing electric vehicle use phase carbon footprint. The International Energy Agency (IEA) states in its world energy outlook 2020[6] that ”Renewables meet 80% of global electricity demand growth during the next decade and overtake coal by 2025 as the primary means of producing electricity. By 2030, hydro, wind, solar PV, bioenergy, geothermal, concentrating solar and marine power between them provide nearly 40% of electricity supply. China leads the way, expanding electricity from renewables by almost 1 500 TWh to 2030.”

The original Polestar 2 LCA report discusses sensitivity of the method and suggests future work. As the methodology used in this report is mainly the same, the sensitivity discussion and future work suggestion still hold true.

6 https://www.iea.org/reports/world-energy-outlook-2020/outlook-for-electricity

5

Conclusions

In this study, the carbon footprints of the Polestar 2 variants “Long range Dual motor”, “Long range Single motor”, and “Standard range Single motor” have been calculated and compared with the carbon footprint of XC40 ICE, including all life cycle phases, i.e. materials production and refining, manufacturing, use phase and end-of-life.

According to the methodology described in this report, the carbon footprints are 50-27 tonne CO_2e for “Long range Dual motor”, 46-26 tonne CO_2e “Long range Single motor”, and 45-25 tonne CO_2e “Standard range Single motor”. 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 wind power is used.

Compared with the XC40 ICE, all the Polestar 2 variants have a lower cradle-to-grave footprint, spanning from a 14% reduction “Long range Dual motor with global electricity mix” to 57% reduction “Standard range Single motor with wind power”.

Polestar will continue to improve the LCA methodology to create an even more robust methodology. To follow up more closely on how different sourcing decisions and material choices impact the results, Polestar also aims at increasing the supplier-specific data used in the LCAs.

In the LCA a large number of generic datasets are used. In this appendix the datasets used are listed.

Table 12 shows the composition used for the material category Elastomer, while table 13 shows the composition of the material category Friction (used in brake pads).

Table 12 →

Modelling of Elastomer material category:	
Calcium carbonate	30%
Limestone	20%
Carbon black	7%
Polymer with ethene estimated with polyethylene	5%
Zinc oxide	3%
Rest (estimated with synthetic rubber)	35%

Table 13 →

Modelling of Friction material category:	
Cast iron part (automotive) – open energy inputs	48%
market for zirconium oxide	12%
market for graphite	11%
market for barium sulfide	10%
market for barite	7%
market for aluminium hydroxide	5%
market for magnesium oxide	4%
market for expanded vermiculite	2%
Calcined petroleum	2%

The table below shows a list of all generic datasets used to model the components in the vehicles.

Material	Location	Name	Type	Source	Date used
ABS	GLO	market for acryloni-trile-butadiene-styrene copolymer	agg	ecoinvent 3.7	2021-07-13
ABS (filled)	GLO	market for acryloni-trile-butadiene-styrene copolymer	agg	ecoinvent 3.7	2021-07-13
ABS (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
ABS (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
ABS (unfilled)	GLO	market for acryloni-trile-butadiene-styrene copolymer	agg	ecoinvent 3.7	2021-07-13
AdBlue	EU-28	urea (46% N)	agg	Fertilizers Europe	2021-07-13
AdBlue	EU-28	tap water from surface water	agg	ts	2021-07-13
Aluminium, cast (matcat)	GLO	aluminium ingot mix IAI 2015	agg	IAI/ts	2021-07-13
Aluminium, wrought (matcat)	GLO	aluminium ingot mix IAI 2015	agg	IAI/ts	2021-07-13
Aramid	DE	aramide fibre (para-aramid)	agg	ts	2021-07-13
ASA	GLO	market for acryloni-trile-butadiene-styrene copolymer	agg	ecoinvent 3.7	2021-07-13
ASA (filled)	GLO	market for acryloni-trile-butadiene-styrene copolymer	agg	ecoinvent 3.7	2021-07-13
ASA (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
ASA (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13

Material	Location	Name	Type	Source	Date used
ASA (unfilled)	GLO	market for acryloni-trile-butadiene-styrene copolymer	agg	ecoinvent 3.7	2021-07-13
Brake fluid	GLO	market for diethylene glycol	agg	ecoinvent 3.7	2021-07-13
Cast iron (matcat)	DE	cast iron part (automo-tive) – open energy inputs	p-agg	ts	2021-07-13
Catalytic coating	ZA	market for platinum group metal concentrate	agg	ecoinvent 3.7	2021-07-13
Copper	EU-28	copper wire mix (Europe 2015)	agg	DKI/ECI	2021-07-13
Copper alloys	GLO	copper mix (99.999% from electrolysis)	agg	ts	2021-07-13
Copper alloys	GLO	market for zinc	agg	ecoinvent 3.7	2021-07-13
Copper alloys	GLO	tin	agg	ts	2021-07-13
Cotton	GLO	market for textile, woven cotton	agg	ecoinvent 3.7	2021-07-13
Damper	RER	polymethylmethacrylate sheet (PMMA)	agg	Plastics Europe	2021-07-13
Damper	RoW	market for lime	agg	ecoinvent 3.7	2021-07-13
Diesel	EU-28	diesel mix at filling station	agg	ts	2021-07-13
E/P	RoW	polyethylene production, low density, granulate	agg	ecoinvent 3.7	2021-07-13
E/P (filled)	RoW	polyethylene production, low density, granulate	agg	ecoinvent 3.7	2021-07-13
E/P (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
E/P (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13

Material	Location	Name	Type	Source	Date used
E/P (unfilled)	RoW	polyethylene production, low density, granulate	agg	ecoinvent 3.7	2021-07-13
Elastomer	RoW	market for calcium carbonate, precipitated	agg	ecoinvent 3.7	2021-07-13
Elastomer	RoW	market for lime	agg	ecoinvent 3.7	2021-07-13
Elastomer	GLO	market for carbon black	agg	ecoinvent 3.8	2021-07-13
Elastomer	GLO	market for polyethylene terephthalate, granulate, amorphous	agg	ecoinvent 3.9	2021-07-13
Elastomer	GLO	market for zinc oxide	agg	ecoinvent 3.10	2021-07-13
Elastomer	GLO	market for synthetic rubber	agg	ecoinvent 3.11	2021-07-13
Electronics	GLO	market for printed wiring board, surface mounted, unspecified, Pb containing	agg	ecoinvent 3.7	2021-07-13
EPDM	DE	Ethylene Propylene Diene Elastomer (EPDM)	agg	ts	2021-07-13
Epoxy	RoW	market for epoxy resin, liquid	agg	ecoinvent 3.7	2021-07-13
EVAC	RoW	market for ethylene vinyl acetate copolymer	agg	ecoinvent 3.7	2021-07-13
EVAC (filled)	RoW	market for ethylene vinyl acetate copolymer	agg	ecoinvent 3.7	2021-07-13
EVAC (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
EVAC (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
EVAC (unfilled)	RoW	market for ethylene vinyl acetate copolymer	agg	ecoinvent 3.7	2021-07-13
Ferrite magnet	GLO	market for ferrite	agg	ecoinvent 3.7	2021-07-13

Material	Location	Name	Type	Source	Date used
Filled thermoplastics (matcat)	RoW	market for nylon 6	agg	ecoinvent 3.7	2021-07-13
Filled thermoplastics (matcat)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
Filled thermoplastics (matcat)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
Float glass	EU-28	float flat glass	agg	ts	2021-07-13
Friction	DE	cast iron part (automotive) – open energy inputs	agg	ts	2021-07-13
Friction	GLO	market for graphite	agg	ecoinvent 3.7	2021-07-13
Friction	GLO	market for zirconium oxide	agg	ecoinvent 3.7	2021-07-13
Friction	GLO	market for barium sulfide	agg	ecoinvent 3.7	2021-07-13
Friction	GLO	market for barite	agg	ecoinvent 3.7	2021-07-13
Friction	GLO	market for aluminium hydroxide	agg	ecoinvent 3.7	2021-07-13
Friction	GLO	market for magnesium oxide	agg	ecoinvent 3.7	2021-07-13
Friction	GLO	market for expanded vermiculite	agg	ecoinvent 3.7	2021-07-13
Friction	EU-28	calcined petroleum	agg	ts	2021-07-13
GF-fibre	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
Glycol	EU-28	Ethylene glycol	agg	Plastics Europe	2021-07-13
Lead, battery	DE	lead (99.995%)	agg	ts	2021-07-13
Leather	DE	cattle hide, fresh, from slaughterhouse (economic allocation)	agg	ts	2021-07-13
Leather	DE	leather (varnished; 1 sqm/0.95 kg) – open input cattle hide	p-agg	ts	2021-07-13
Lubricants (matcat)	EU-28	lubricants at refinery	agg	ts	2021-07-13

Material	Location	Name	Type	Source	Date used
Magnesium	CN	magnesium	agg	ts	2021-07-13
NdFeB	GLO	market for permanent magnet, electric passenger car motor	agg	ecoinvent 3.7	2021-07-13
NR	DE	natural rubber (NR)	agg	ts	2021-07-13
PA	RoW	market for nylon 6	agg	ecoinvent 3.7	2021-07-13
PA (filled)	RoW	market for nylon 6	agg	ecoinvent 3.7	2021-07-13
PA (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
PA (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
PA (unfilled)	RoW	market for nylon 6	agg	ecoinvent 3.7	2021-07-13
PBT	DE	polybutylene terephthalate granulate (PBT) mix	agg	ts	2021-07-13
PBT (filled)	DE	polybutylene terephthalate granulate (PBT) mix	agg	ts	2021-07-13
PBT (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
PBT (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
PBT (unfilled)	DE	polybutylene terephthalate granulate (PBT) mix	agg	ts	2021-07-13
PC	GLO	market for polycarbonate	agg	ecoinvent 3.7	2021-07-13
PC (filled)	GLO	market for polycarbonate	agg	ecoinvent 3.7	2021-07-13
PC (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
PC (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
PC (unfilled)	GLO	market for polycarbonate	agg	ecoinvent 3.7	2021-07-13

Material	Location	Name	Type	Source	Date used
PC+ABS	GLO	market for polycarbonate	agg	ecoinvent 3.7	2021-07-13
PC+ABS	GLO	market for acrylonitrile-butadiene-styrene copolymer	agg	ecoinvent 3.7	2021-07-13
PC+ABS (filled)	GLO	market for polycarbonate	agg	ecoinvent 3.7	2021-07-13
PC+ABS (filled)	GLO	market for acrylonitrile-butadiene-styrene copolymer	agg	ecoinvent 3.7	2021-07-13
PC+ABS (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
PC+ABS (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
PC+ABS (unfilled)	GLO	market for polycarbonate	agg	ecoinvent 3.7	2021-07-13
PC+ABS (unfilled)	GLO	market for acrylonitrile-butadiene-styrene copolymer	agg	ecoinvent 3.7	2021-07-13
PE	RoW	polyethylene production, low density, granulate	agg	ecoinvent 3.7	2021-07-13
PE (filled)	RoW	polyethylene production, low density, granulate	agg	ecoinvent 3.7	2021-07-13
PE (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
PE (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
PE (unfilled)	RoW	polyethylene production, low density, granulate	agg	ecoinvent 3.7	2021-07-13
PET	GLO	market for polyethylene terephthalate, granulate, amorphous	agg	ecoinvent 3.7	2021-07-13
PET (filled)	GLO	market for polyethylene terephthalate, granulate, amorphous	agg	ecoinvent 3.7	2021-07-13
PET (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
PET (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
PET (unfilled)	GLO	market for polyethylene terephthalate, granulate, amorphous	agg	ecoinvent 3.7	2021-07-13

Material	Location	Name	Type	Source	Date used
Petrol	EU-28	gasoline mix (regular) at refinery	agg	ts	2021-07-13
PMMA	RER	Polymethylmethacrylate sheet (PMMA)	agg	Plastics Europe	2021-07-13
PMMA (filled)	RER	polymethylmethacrylate sheet (PMMA)	agg	Plastics Europe	2021-07-13
PMMA (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
PMMA (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
PMMA (unfilled)	RER	polymethylmethacrylate sheet (PMMA)	agg	Plastics Europe	2021-07-13
Polyester	GLO	market for fibre, polyester	agg	ecoinvent 3.7	2021-07-13
Polyurethane (matcat)	RoW	market for polyurethane, rigid foam	agg	ecoinvent 3.7	2021-07-13
POM	EU-28	polyoxymethylene (POM)	agg	Plastics Europe	2021-07-13
POM (filled)	EU-28	polyoxymethylene (POM)	agg	Plastics Europe	2021-07-13
POM (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
POM (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
POM (unfilled)	EU-28	polyoxymethylene (POM)	agg	Plastics Europe	2021-07-13
PP	GLO	market for polypropylene, granulate	agg	ecoinvent 3.7	2021-07-13
PP (filled)	GLO	market for polypropylene, granulate	agg	ecoinvent 3.7	2021-07-13
PP (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
PP (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13

Material	Location	Name	Type	Source	Date used
PP (unfilled)	GLO	market for polypropylene, granulate	agg	ecoinvent 3.7	2021-07-13
PS	GLO	market for polystyrene, general purpose	agg	ecoinvent 3.7	2021-07-13
PS (filled)	GLO	market for polystyrene, general purpose	agg	ecoinvent 3.7	2021-07-13
PS (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
PS (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
PS (unfilled)	GLO	market for polystyrene, general purpose	agg	ecoinvent 3.7	2021-07-13
PVB	DE	polyvinyl butyral gran-ulate (PVB) by-product ethyl acetate	agg	ts	2021-07-13
PVB (filled)	DE	polyvinyl butyral gran-ulate (PVB) by-product ethyl acetate	agg	ts	2021-07-13
PVB (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
PVB (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
PVB (unfilled)	DE	polyvinyl butyral gran-ulate (PVB) by-product ethyl acetate	agg	ts	2021-07-13
PVC	RoW	polyvinylchloride production, suspension polymerisation	agg	ecoinvent 3.7	2021-07-13
PVC (filled)	RoW	polyvinylchloride production, suspension polymerisation	agg	ecoinvent 3.7	2021-07-13
PVC (filled)	EU-28	talcum powder (filler)	agg	ts	2021-07-13
PVC (filled)	GLO	market for glass fibre	agg	ecoinvent 3.7	2021-07-13
PVC (unfilled)	RoW	polyvinylchloride production, suspension polymerisation	agg	ecoinvent 3.7	2021-07-13

Material	Location	Name	Type	Source	Date used
R-1234yf	DE	R-1234yf production (estimation)	agg	ts	2021-07-13
R-134a	GLO	market for refrigerant R134a	agg	ecoinvent 3.7	2021-07-13
SBR	DE	styrene-butadiene rubber (S-SBR) mix	agg	ts	2021-07-13
Silicone rubber	DE	silicone rubber (RTV-2, condensation)	agg	ts	2021-07-13
Steel, sintered	GLO	steel hot dip galvanised	agg	worldsteel	2021-07-13
Steel, stainless, austenitic	EU-28	stainless steel cold rolled coil (304)	p-agg	Eurofer	2021-07-13
Steel, stainless, ferritic	EU-28	stainless steel cold rolled coil (430)	p-agg	Eurofer	2021-07-13
Steel, unalloyed	GLO	steel hot dip galvanised	agg	worldsteel	2021-07-13
Sulphuric acid	EU-28	sulphuric acid (96%)	agg	ts	2021-07-13
Thermoplastic elasto-mers (matcat)	DE	polypropylene / ethylene propylene diene elastomer granulate (PP/EPDM, TPE-O) mix	agg	ts	2021-07-13
Thermoplastics (matcat)	RoW	market for nylon 6	agg	ecoinvent 3.7	2021-07-13
Tyre	DE	styrene-butadiene rubber (S-SBR) mix	agg	ts	2021-07-13
Tyre	EU-28	water (deionised)	agg	ts	2021-07-13
Tyre	GLO	vulcanisation of syn-thetic rubber (without additives)	u-so	ts	2021-07-13
Undefined	RoW	market for nylon 6	agg	ecoinvent 3.7	2021-07-13
Unfilled thermoplastics (matcat)	DE	polypropylene / ethylene propylene diene Elastomer granulate (PP/EPDM, TPE-O) mix	agg	ts	2021-07-13

Material	Location	Name	Type	Source	Date used
Washer fluid	DE	ethanol	agg	ts	2021-07-13
Wood (paper, cellulose ...)	EU-28	laminated veneer lumber (EN15804 A1-A3)	agg	ts	2021-07-13
Zinc	GLO	special high grade zinc	p-agg	IZA	2021-07-13