

# Life Cycle Assessment

## Methods and independent verification

### Life Cycle Assessment (LCA) based on DIN EN ISO 14040 and DIN EN ISO 14044

We are currently particularly observing the global warming potential as impact category that converts certain environmental impacts into CO<sub>2</sub> equivalents. Volkswagen AG commissioned TÜV NORD CERT Prüf- und Umweltgutachtergesellschaft mbH as an independent external body to carry out the critical review of this LCA study in accordance with the applicable standards DIN EN ISO 14040 and DIN EN ISO 14044. In accordance with the standard, the manufacturing phase from raw material extraction, the use phase comprising passenger transportation over 200,000 km in the WLTP driving cycle and the dismantling for recycling (without battery system) were used as framework. The environmental impacts were assessed via a special software including a database with average upstream chain values. For selected parts like the battery cells separate analyses were carried out.



With regard to the state of the art of LCAs, it should be noted that the calculation methods for LCAs in the automotive industry are subject to constant further development. Amongst others generic data and assumptions are increasingly being replaced by vehicle- and company-specific data, thus future calculations may lead to significant deviations from previous LCA values. Therefore LCAs are to be understood as a status at the time of execution (snapshot of the respective assumptions), do not represent a guaranteed product property in a legal sense and are not suitable for comparisons with LCAs from other car manufacturers. Respective harmonizing EU standards are expected to be published in 2025.

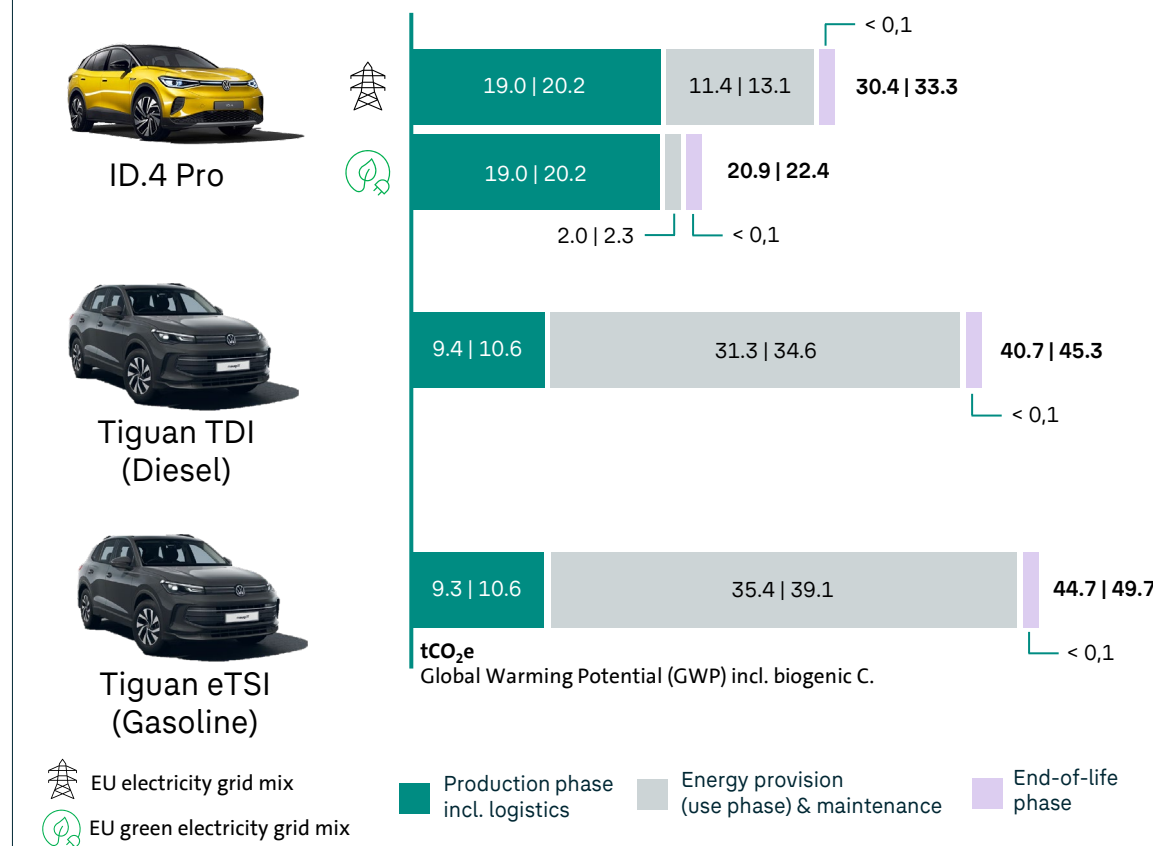
# Example of ID.4 and Tiguan LCA Comparison

## CO<sub>2</sub>e-emissions by life cycle phases

Overview LCA ID.4 Pro & Tiguan

	ID.4 Pro 210 kW 82 kWh <sup>3</sup>	Tiguan 2.0 TDI 110 kW <sup>4</sup> DSG	Tiguan 1.5 eTSI 110 kW <sup>5</sup> DSG
Configurations <sup>1</sup>	standard (std.)   maximum (max.), market Germany, MY 24		
Functional unit	200,000 km passenger transportation in WLTP test cycle		
System boundaries	production in Europe (not site-specific)		
	avg. logistics Zwickau & Emden	avg. logistics Wolfsburg	
WLTP energy / fuel consumption <sup>2</sup>	16.0   18.4 kWh per 100 km	5.3   5.8 liter per 100 km	6.2   6.8 liter per 100 km
Maintenance	tires, brake pads and disks, starter batteries, wiper blades, additionally for Tiguan engine oil and AdBlue in case of TDI		
End-of-life phase	dismantling (without battery), no credits for recovery (cut-off)		
Critical Review	TÜV NORD CERT, date of validity statement: 2024-04-16		

Comparison of CO<sub>2</sub>e-emissions (std. | max.)



All figures shown in the report are rounded, minor discrepancies may arise from addition of these amounts

<sup>1</sup>standard configuration: standard equipment in representative line | maximum configuration: one feasible parameter set for additional equipment for maximum weight <sup>2</sup>values rounded to first decimal place

Information in accordance with 1999/94/EC for the German market as of April 2024: <sup>3</sup>energy consumption combined 18.41 - 15.93 kWh/100 km; CO<sub>2</sub> emissions combined 0 g/km; CO<sub>2</sub> class: A <sup>4</sup>fuel consumption combined 5.9 - 5.3 l/100 km; CO<sub>2</sub> emissions combined 154 - 139 g/km; CO<sub>2</sub> class: E; <sup>5</sup>fuel consumption combined 6.9 - 6.2 l/100 km; CO<sub>2</sub> emissions combined 156 - 140 g/km; CO<sub>2</sub> classes: F-E

# Impact Reporting based on ID.4

Clean Transportation Portfolios	Signed Amount in EUR bn	Share of Total Project Financing	Eligibility for Green Finance Instruments	Allocated Amount in EUR bn	Potentially saved CO <sub>2</sub> emissions ID.4 vs Tiguan TDI over life cycle (200,000km) in t CO <sub>2</sub> e <sup>1</sup>	Number of ID.4 delivered in the EU including the UK, Norway and Iceland (#)	Calculated potentially avoided CO <sub>2</sub> emissions ID.4 vs Tiguan TDI over life cycle (200,000km) in t CO <sub>2</sub> e
	a/	b/		c/	d/		d/
Projects related to the manufacture of electric vehicles							
2023	11,027	100%	100%	0.5	10.3	85,714	882,854
<b>Total</b>							<b>882,854</b>

Portfolio date: 2023

**General:** The ID.4 and Tiguan are compared via the given standard versions and by only taking into account the Tiguan TDI to ensure a conservative approach.

a/ Signed amount represents the amount legally committed by the issuer for the portfolio of projects or is eligible for green bond financing

b/ This is the share of the total project cost that is financed

c/ This represents the amount of green debt instruments proceeds that has been allocated for disbursements to the portfolio

d/ Eligible Categories impact indicators

Vehicle basis: ID.4 Pro (standard configuration) and Tiguan TDI (Diesel, standard configuration)

both A-Segment with similar dimensions, comparable purpose and usability, both produced mainly in Germany

comparison in accordance with requirements of the standards DIN EN ISO 14040 and DIN EN ISO 14044 for comparative LCAs (critical review by TÜV NORD CERT, date of validity statement: 2024-04-16)

<sup>1</sup>impact of electricity grid mixes in Norway and Iceland not considered

<https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/Handbook-Harmonized-Framework-for-Impact-Reporting-December-2020-151220.pdf>

# ID.4 and Tiguan

## LCA methodology



### Software, Data Basis and Scope

#### Software

- Sphera LCA for Experts version 10.7.1.28

#### LCA database and data sets

- Sphera LEAD database content version 2023.2 with extension databases and data-on-demand datasets, respective VW Group mapping list
- VW Group datasets: final assembly, paint shop, press-quenched steel, tires, vehicle windows, recovery, printed circuit boards, high-voltage battery cell
- Logistics via VW logistic system (only GWP)

#### Calculation Rules

- DIN EN ISO 14040/44
- VW Group LCA Guidelines version 2.0 and VW Group LCA Manual version 8.0

#### Scope

- According to the life cycle approach the system boundaries comprise the entire product life span (from production to use phase and end-of-life). Emissions from further scope 3 categories like business travel, employee commuting, franchises etc. as defined in the greenhouse gas protocol are not covered and are considered for the calculation of the VW group KPI "Decarbonization Index".



### Input variables

#### Production phase

- Vehicle configurations in dominant market with standard equipment in representative line and with one feasible parameter set for additional equipment for maximum weight
- Supply chain and in-house production in Europe (not site-specific)
- Battery: one traction battery (if applicable) covering the functional unit
- If applicable inclusion of reduction measures on part level confirmed by respective validation reports and validity statements

#### Use Phase

- Energy and fuel provision: European electricity, gasoline and diesel datasets of 2019 (the most current data available in the applied Sphera LEAD database)
- Energy and fuel consumption: Worldwide Harmonized Light Vehicles Test Procedure (WLTP) for 200,000 km
- Maintenance: tires, brake pads and disks, starter batteries, wiper blades, if applicable engine oil and AdBlue

#### End-of-life

- Generic vehicle segment specific model for dismantling without battery system and without credits for recovery (cut-off approach)



### Verification

- Critical Review by TÜV NORD CERT: validity statement from 2024-04-16 (Audit Report No. 3535 7825) for LCA background report from 2024-03-22



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# ID.4 and Tiguan

## LCA methodology - glossary

### **CML methodology**

The Life Cycle Impact Assessment (LCIA) and the characterization model are based on the CML methodology (as of August 2016), which has been developed at the University of Leiden at the Centrum voor Milieukunde Leiden (CML) in the Netherlands. With this methodology, the assessment of environmental impact potentials is based on accepted scientific models.

### **Critical Review**

Process described in ISO 14044 intended to ensure consistency between a life cycle assessment and the principles and requirements of the International Standards on life cycle assessment as described in ISO 14040, carried out by independent experts.

### **Cut-off approach**

For the secondary materials emerging from vehicle recovery processes at the end of life, no credits are issued within the life cycle assessment. Only the expenditures and emissions of the recovery processes are considered. For vehicles with a high-voltage battery, the end of life of the battery including thermal deactivation and shredding is not assessed.

### **Global Warming Potential (GWP)**

The global warming potential describes the emission of greenhouse gases, which lead to an increase of the heat absorption of solar radiation within the atmosphere and thus can contribute to climate change, e.g. an increase of global average temperatures. The reference substance for the global warming potential is carbon dioxide. All other greenhouse gases (e. g. CH<sub>4</sub>, N<sub>2</sub>O, SF<sub>6</sub>) are projected to carbon dioxide in terms of their impact on global warming (CO<sub>2</sub> equivalents or CO<sub>2</sub>e). GWP values including biogenic carbon (biogenic C) basically consider the uptake of greenhouse gases from the atmosphere by respective processes.

### **Greenhouse Gas Protocol (GHG Protocol)**

A partnership between the World Resources Institute and the World Business Council for Sustainable Development providing accounting and reporting standards, sector guidance and calculation tools for emissions reporting. It establishes a comprehensive, global, standardized framework for measuring and managing emissions and divides emissions into three scopes: scope 1 - direct GHG emissions (of company), scope 2 - energy related indirect GHG emissions, scope 3 - other indirect GHG emissions

### **ISO 14040/44**

ISO 14040 and ISO 14044 define the standard for an ISO-compliant Life Cycle Assessment (LCA) and respective comparative LCAs. ISO 14040 provides the 'principles and framework' of the standard, while ISO 14044 provides an outline of the 'requirements and guidelines'.

### **Life Cycle Assessment (LCA)**

LCA addresses the environmental aspects and potential environmental impacts (e.g. use of resources and environmental consequences of releases) throughout a product's life cycle from raw material acquisition through production, use and end-of-life treatment (i.e. cradle-to-grave). An LCA study consists of the phases (1) goal and scope definition, (2) inventory analysis, (3) impact assessment and (4) interpretation.

### **Sphera LCA for Experts**

The software LCA for Experts (common name: GaBi, "Ganzheitliche Bilanzierung") from Sphera is a LCA modelling and reporting application. The content databases include many raw materials and processes in every phase from extraction to end-of-life across the supply chain.

### **Worldwide Harmonized Light Vehicles Test Procedure (WLTP)**

The WLTP is a globally harmonized standard for determining the levels of pollutants, CO<sub>2</sub> emissions and fuel consumption of traditional and hybrid cars, as well as the range of fully electric vehicles.

Information in accordance with 1999/94/EC:

The figures for fuel consumption, power consumption, CO<sub>2</sub> emissions and electric range were determined in accordance with the legally required "Worldwide Harmonized Light Vehicles Test Procedure" (WLTP) in accordance with Regulation (EC) 715/2007. Additional equipment and accessories (add-on parts, tyre format, etc.) can change relevant vehicle parameters, such as weight, rolling resistance and aerodynamics, and influence a vehicle's fuel consumption, power consumption, CO<sub>2</sub> emissions, electric range and mileage values in addition to weather and traffic conditions as well as individual driving behaviour.