DLR greenhouse gas balance 2024 according to the Greenhouse Gas Protocol (GHG)

Deutsches Zentrum
DLR für Luft- und Raumfahrt

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1. Introduction

The German Aerospace Centre (DLR) is Germany's research and technology centre for aerospace. In its core areas, the DLR develops technologies for aerospace, energy and transport, as well as security and defence research. A wide range of results and innovations benefit industry and the economy, public authorities and administration, and public stakeholders. Through intensive knowledge exchange and targeted technology transfer, the DLR fulfils its responsibility to society. To this end, it is funded by the Federal Government. The German Space Agency within the DLR is responsible for planning and implementing German space activities on behalf of the Federal Government. Two DLR project management agencies work as management institutions for research and industrial promotion.
Climate, mobility and technology are changing globally. DLR uses the expertise of its institutes and facilities to develop solutions to the resulting challenges. Our 11,000 employees have a common mission: we explore Earth and space. We develop technologies for a sustainable future and, through technology transfer, contribute to strengthening Germany as a centre of knowledge and business.

With its sustainability strategy, DLR has set itself the goal of achieving greenhouse gas (GHG) neutrality by 2035. In order to move closer to this goal step by step, measures to reduce, avoid and substitute GHG emissions are being taken and continuously implemented across all areas of DLR's sustainability strategy. An important tool on the path to achieving GHG neutrality is the recording of all relevant emission sources.
DLR has been recording its GHG emissions for several years. This greenhouse gas balance covers the accounting period from 1 January 2024 to 31 December 2024. DLR's emission sources include all activities that lead to GHG emissions, including the combustion of fuels in its own facilities, the leakage of volatile gases, the use of electricity and district heating, business travel, employee commuting, some of the emissions from the upstream and downstream value chain, and many other areas.
The DLR uses the consolidation approach of operational control as its accounting boundary. This means that all emissions from operations are attributed 100 per cent to the organisation if it directly controls these operations, regardless of its financial share in them. In line with this approach, the GHG report takes into account the emissions of the sites (including rented space where possible) in Figure 1.

Figure 1 : Overview of DLR locations in Germany that are included in the GHG balance.

2. Greenhouse gas emission sources

The methodology for determining GHG emissions is based on the Greenhouse Gas (GHG) Protocol, which is now being used for the second time at DLR as an accounting framework. This standard defines three categories – known as scopes – for recording GHG emissions. **Scope 1** covers direct GHG emissions from combustion processes in our own facilities (e.g. fuel-powered vehicles and emergency power generators), leaks of volatile gases (e.g. refrigerators, refrigeration machines, etc.) and direct process emissions (e.g. technical gases, leak tests on fire extinguishers, etc.). **Scope 2** takes into account indirect GHG emissions from purchased energy (electricity, district heating and local heating). **Scope 3** covers all other indirect emissions along the upstream and downstream value chain.

Recording **Scope 3** emissions is a challenging task, which DLR is tackling step by step and attempting to make corresponding progress in each balance sheet. For this report, the **Scope** 3 categories for which reliable data was already available or for which a valid data basis could be created at short notice were initially selected. The following **Scope** 3 categories will be taken into account for the DLR in 2024:

Category	Description	Detailed information
3.1	Purchasing	Emissions from computer hardware, Emissions from drinking water supply at the sites
3.5	Waste generated during operation	Emissions from wastewater disposal at the sites
3.6	Business travel	Use of various means of transport and hotels for business travel
3.7	Commuting by employees	Commuting of DLR employees to their place of work

In future, the categories capital goods, rented or leased property, plant and equipment, fuel and energy-related emissions from the upstream chain, transport and distribution (upstream), and waste and wastewater are to be gradually included in the report. The category 'Purchased goods and services' will also be expanded to include all products and services purchased by DLR.

3. Evaluation

The GHG emissions for each scope are summarised below. Figure 2 provides an overview of the total emissions. Detailed explanations of the respective scopes can be found in the following sections. All emission values are given in tonnes of carbon dioxide (CO_2) equivalent. The emission factors used for conversion are listed in Tables 1 to 4 in the appendix.

Scope 1: Direct GHG emissions

- The DLR's direct GHG emissions amount to **13,185** tonnes of CO_2 equivalents.
- The main sources of direct GHG emissions are fossil fuels, volatile gases and emissions from experimental fuels.

Scope 2: Indirect GHG emissions from energy supply

- DLR's indirect GHG emissions, calculated using a location-based method, amount to **31,907** tonnes of CO_2 equivalents.
- Using the market-based method, in which emissions are calculated using supplier-specific emission factors, emissions amount to **4,129** tonnes of CO_2 equivalents.
- The main sources of indirect GHG emissions are energy consumption from electricity generation and from district heating and cooling supply.

Scope 3: Indirect GHG emissions from the value chain

- The indirect GHG emissions of the DLR amount to **14,957** tonnes of CO_2 equivalents.
- This balance sheet includes the categories of goods and services, wastewater, business travel and commuting by employees to their place of work as indirect greenhouse gas emissions.

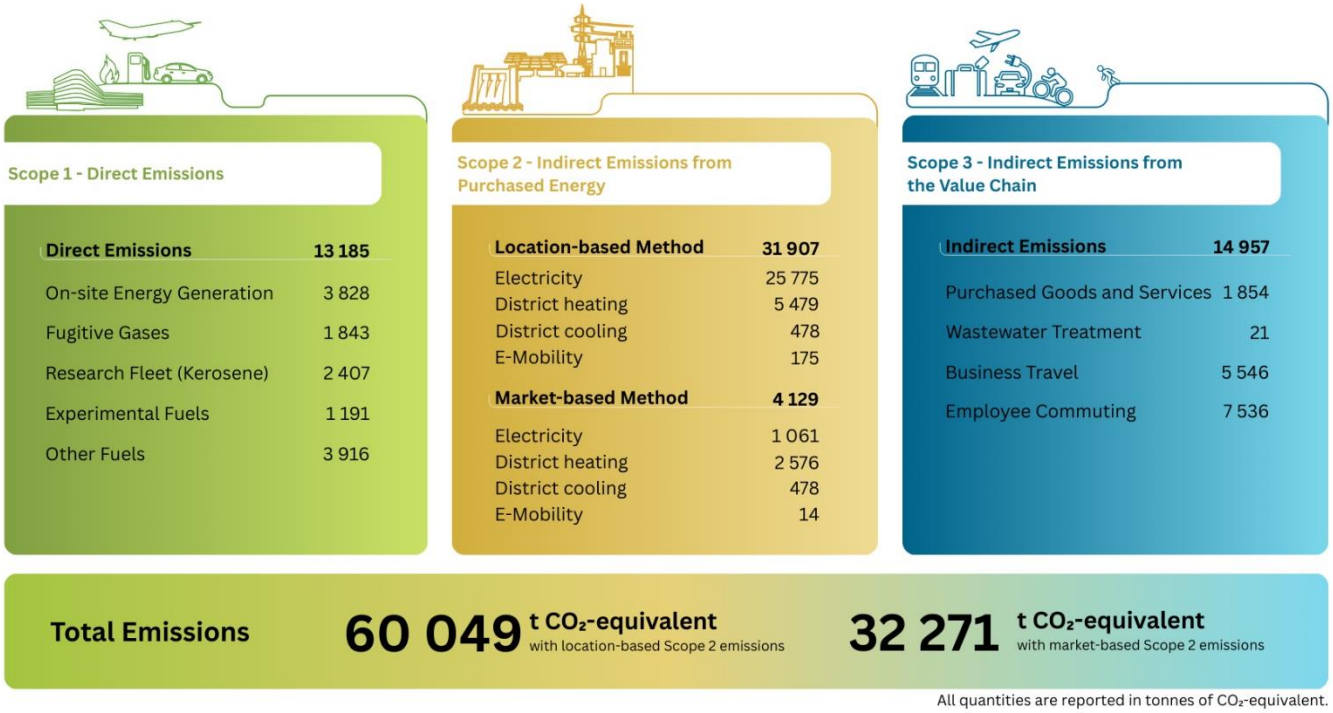

Figure 2 : Overview of GHG emissions in the various scopes.

In total, 60,049 tonnes of CO_2 equivalents (location-based) and 32,271 tonnes of CO_2 equivalents (market-based) for 2024. In the previous reporting period, GHG emissions of 61,036 tonnes of CO_2 equivalents (site-based) and 28,899 tonnes of CO_2 equivalents (market-based) were determined.
Compared to the 2023 balance sheet, the categories of own energy generation and volatile gases are included in **Scope 1**, district heating (market-based), district cooling (market-based), e-mobility (site-based and market-based) have been added in **Scope 2**, and the purchase of computer hardware, drinking water supply and wastewater disposal have been added in **Scope 3**.

3.1. Scope 1 emissions

Scope 1 covers the categories of fuel combustion, volatile gases, direct emissions from processes and other direct emissions.
At DLR, the category of fuel combustion includes heating oil, diesel, gas and petrol. These fuels are used to generate energy (electricity, heat and mobility activities). For the first time, the DLR has included GHG emissions from volatile gases in its balance sheet and has been able to collect initial consumption figures for certain locations. Direct emissions from processes at the DLR arise from the use of experimental fuels in scientific experiments. This includes experimental fuels in laboratories and kerosene for the research fleet, which is recorded separately. The experimental fuels are used at the DLR sites in Cologne-Porz, Lampoldshausen and Stuttgart.
A more detailed breakdown of GHG emissions for **Scope 1** can be found at Figure 3.

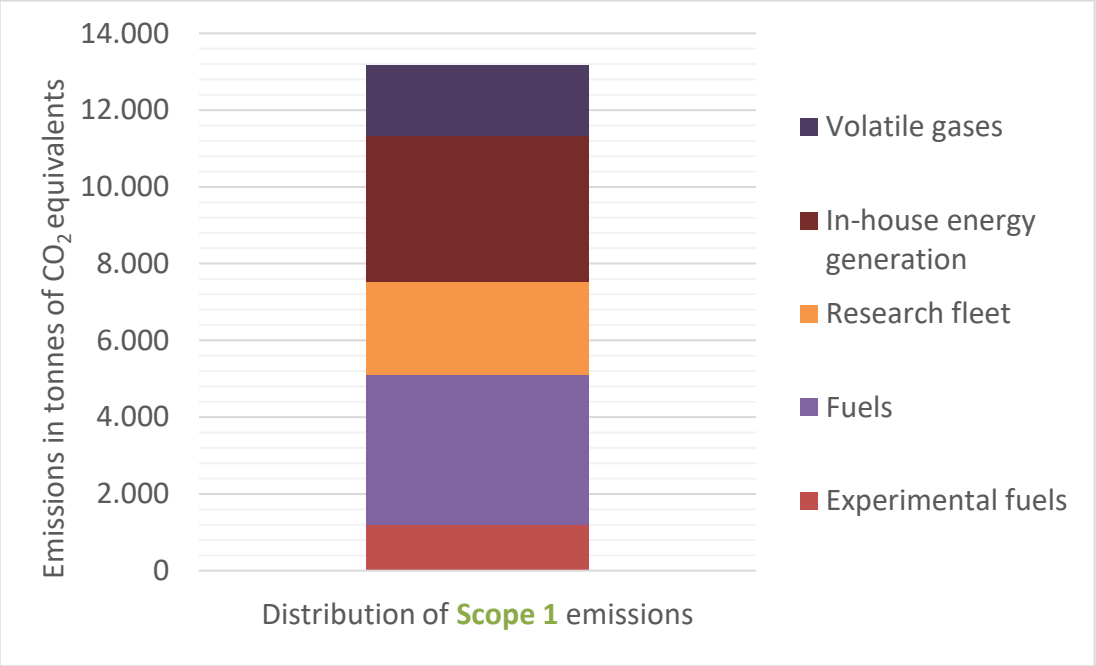

Figure 3 : Detailed breakdown of **Scope 1** emissions.

Figure 4 shows the electrical energy generated at DLR for the year 2024. This is distributed across three areas: photovoltaics, wind power and combined heat and power plants. A total of 18,151,459 kWh of electrical energy was generated and used in-house in 2024. Of this, approximately 56.6 per cent was generated by combined heat and power plants, 43.1 per cent by wind power and 0.3 per cent by photovoltaics.

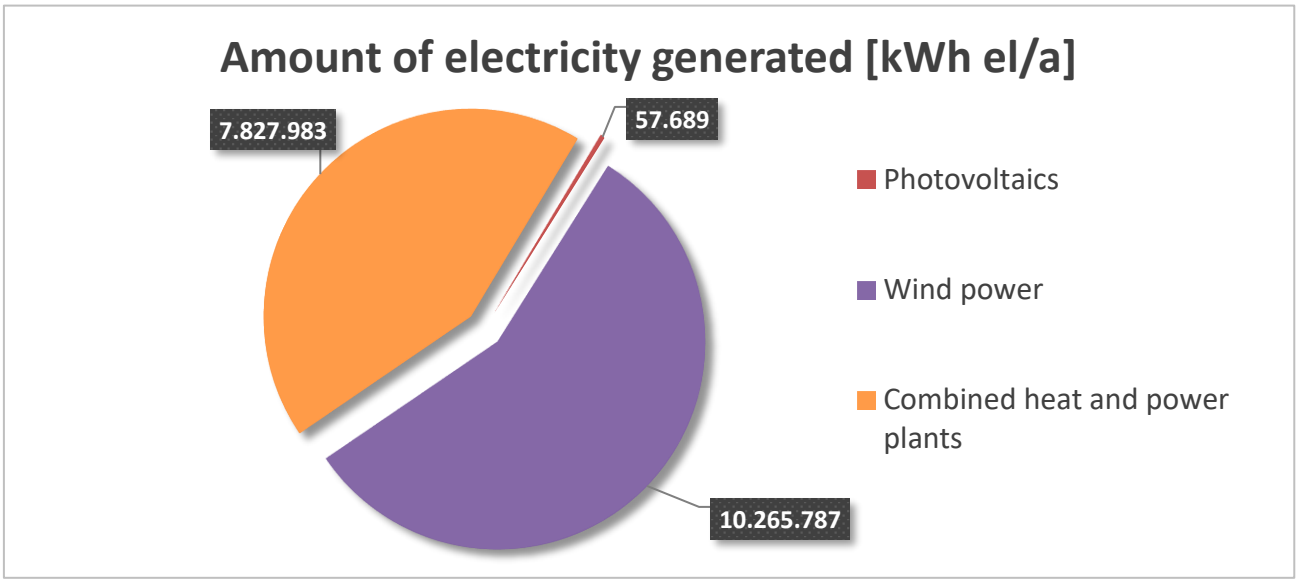

Figure 4 : Overview of electricity generation at DLR.

The DLR's direct GHG emissions amount to 13,185 tonnes of CO_2 equivalents. Despite incomplete data collection at all DLR sites, volatile gases account for approximately 13 per cent of **Scope 1** emissions to date. This is similar to the emissions from experimental fuels. For the next balance sheet, data on volatile gases will be collected for all sites. The biggest emission drivers in **Scope 1** are fuels and emissions from own energy generation, which are produced by combined heat and power plants.

3.2. Scope 2 emissions

Scope 2 considers indirect GHG emissions from energy consumption such as electricity, district heating, district cooling and energy consumption for electromobility. The DLR reports emission quantities using both a location-based and a market-based approach. The **location-based** approach uses average emission factors from the local electricity grid (the German electricity mix), while the **market-based** approach takes into account the specific emissions resulting from individual energy procurement contracts and certificates. Figure 5 provides a detailed breakdown of **Scope 2** emissions (broken down into location-based and market-based emissions).

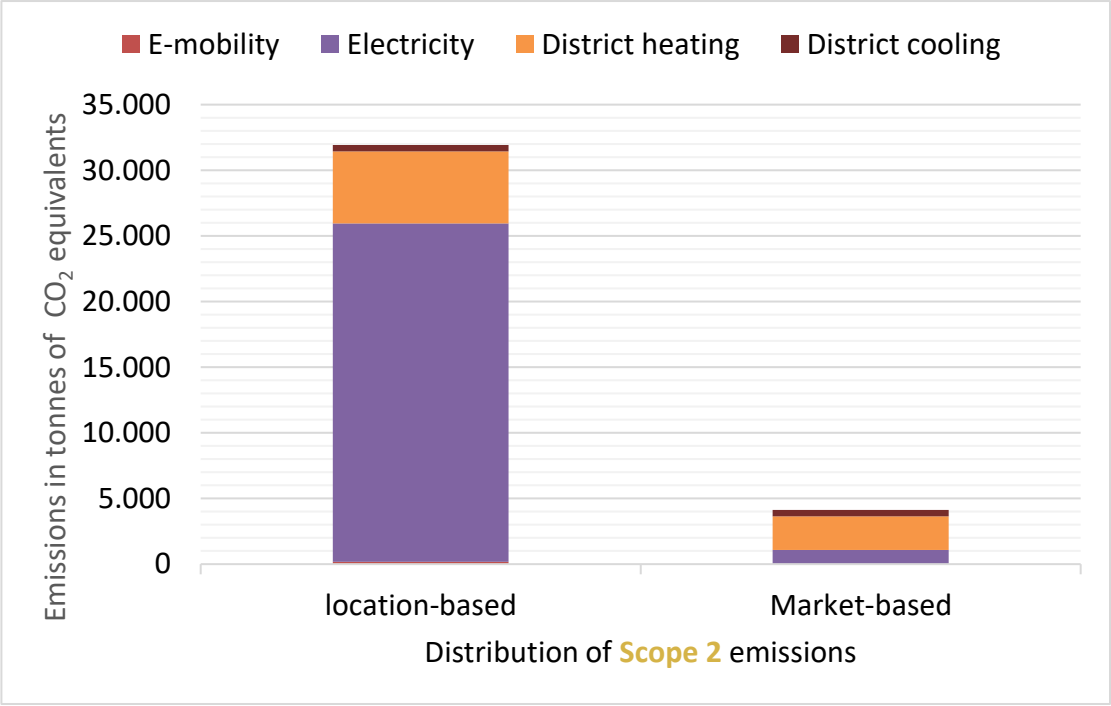

Figure 5 : Detailed breakdown of **Scope 2** emissions.

According to the location-based approach, DLR generates a total of 31,907 tonnes of CO_2 equivalents and, according to the market-based approach, 4,129 tonnes of CO_2 equivalents. At almost all of its locations, the DLR obtains electricity from renewable sources via Stadtwerke Magdeburg. Some rented premises are also supplied with this electricity from renewable sources, but these are included in the balance sheet under the location-based approach, as the relevant data is not available from the landlords. The purchase of electricity generates 25,775 tonnes of CO_2 equivalents on a location-based basis. However, the purchase of electricity from renewable sources avoids 24,714 tonnes of CO_2equivalents according to the market-based approach.

The remaining emissions in the area of electricity are generated by the purchase of location-based electricity. The DLR obtains district heating at some locations from suppliers who generate district heating in accordance with GEG 2020 (electricity credit procedure). This means that this district heating is generated in a GHG-neutral manner in accordance with the market-based approach. This is reflected in the balance sheet with corresponding emissions of 5,479 tonnes of CO_2 equivalents (location-based approach) and 2,576 tonnes of CO_2 equivalents (market-based approach). This meant that 2,903 tonnes of CO_2 equivalents were avoided. For district cooling, suppliers were asked to provide corresponding market-based emission factors. No location-based emission factor can be determined for Germany as a whole, so the corresponding emissions from the market-based approach are used for this purpose. This results in emissions of 478 tonnes of CO_2 equivalents for district cooling. The DLR enables electric vehicles to be charged at its own charging stations. According to the location-based approach, 175 tonnes of CO_2 equivalents are generated. By purchasing electricity from renewable sources, 161 tonnes of CO_2 equivalents were also avoided here, which corresponds to 14 tonnes of CO_2 equivalents in the market-based approach.

3.3. Scope 3 emissions

Scope 3 considers indirect GHG emissions from the categories of wastewater, purchasing, commuting and business travel. The categories of capital goods, rented or leased property, plant and equipment, fuel and energy-related emissions from the upstream chain, transport and distribution (upstream) and waste are excluded for the time being. A total of 14,894 tonnes of CO_2 equivalents were generated in **Scope 3**. A breakdown of the emission quantities can be found in Figure 6.

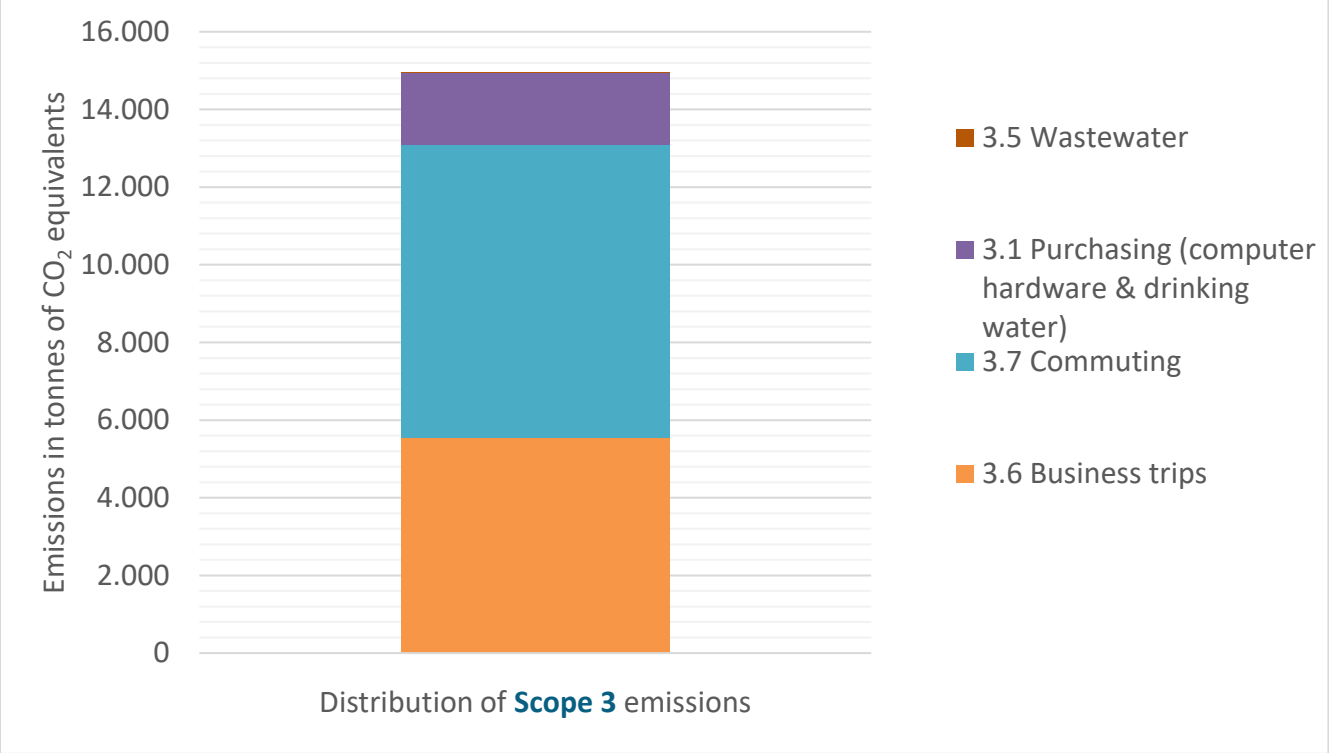

Figure 6 : Detailed breakdown of **Scope 3** emission quantities.

In future, the category of purchased goods and services will be expanded to include all products and services acquired by DLR. In this balance sheet, only emission values from computer hardware, purchases for employees

and drinking water supply at specific DLR locations can be used for the purchasing category. This category totals 1,854 tonnes of CO_2 equivalents. In the commuting category, 7,536 tonnes of CO_2 equivalents were generated. Of these, 6,168 tonnes of CO_2 equivalents were generated by the use of cars, 1,346 tonnes of CO_2 equivalents by public transport and 23 tonnes of CO_2 equivalents were generated by other means of transport. These emission values were estimated based on a recent employee survey. The business travel category accounts for a total of 5,546 tonnes of CO_2 equivalents. Of this, 5,139 tonnes of CO_2 equivalents are generated by air travel (only emissions generated by the combustion of kerosene are taken into account here) and 407 tonnes of CO_2 equivalents by travel in hire cars. Wastewater disposal generates 21 tonnes of CO_2 equivalents and therefore plays only a minor role in the balance sheet.

4. Outlook

The DLR will continue to work on reducing GHG emissions so that it can achieve its self-imposed goal of greenhouse gas neutrality by 2035. The DLR is aware that the data used to calculate GHG emissions is solid in many areas, but that there is still room for improvement. Therefore, work is continuously being done to collect data in order to gradually improve the remaining data gaps and quality and thus be able to compile a comprehensive balance sheet for DLR. With appropriate measures, this will enable even more targeted control in order to continuously reduce GHG emissions.
An important step in this direction will be the expansion and conversion of the DLR's own energy supply. The DLR will continue to pursue the expansion of electrical energy generation through photovoltaic systems in the coming years. Air travel will also be examined in greater detail. Until now, only emissions generated by the combustion of kerosene have been taken into account. Non-CO_2 effects are not currently included in the calculations and will be estimated with the help of the DLR's own research results.

Appendix
Conversion factors for calculating emissions

The following conversion factors were used to calculate CO_2 equivalents:

Conversion factors for determining greenhouse gas equivalents – base year 2024

The corresponding sources can be found in the bibliography.

Conversion factors in kilograms CO_2 equivalents per kilowatt hour

Energy carrier/source	**Emission factor [kgCO_2equivalents/kWh]**	**Source**
Kerosene	0.26	DEFRA 2024
Petrol	0.23	DEFRA 2024
Diesel	0.25	DEFRA 2024
Heating oil (EL)	0.29	DEFRA 2024
Liquefied natural gas (LNG)	0.20	BAFA 2024
Natural gas (L)	0.20	DEFRA 2024
Natural gas (H)	0.20	DEFRA 2024
Butane	0.24	DEFRA 2024
German electricity mix	0.36	UBA 2024
District heating	0.28	BAFA 2024
Local heating	0.28	BAFA 2024

Table 1

Conversion factors in kilograms of CO_2 equivalents per kilogram

Energy carrier/source	**Emission factor [kgCO_2 equivalents/kg]**	**Source**
Ethane (C_2H_6)	1.15	BAFA 2024
Ethene (C_2H_4)	1.45	BAFA 2024
Propane (C_3H_8)	1.11	BAFA 2024
Propene (C_3H_6)	1.49	BAFA 2024
Nitrogen, liquid (N_2)	0.20	BAFA 2024
Hydrogen (renewable source)	0.00	BAFA 2024
Hydrogen (H_2)	12.82	BAFA 2024
Methanol (CH_4O)	0.76	BAFA 2024
Acetylene (C_2H_2)	2.74	DEFRA 2024
Ethanol	1.91	Calculated based on stoichiometric values

Table 2

Conversion factors in kilograms of CO_2 equivalents per cubic metre

Service	Emission factor [kg CO_2 equivalents/m^3]	Source
Wastewater disposal	0.19	DEFRA 2024
Drinking water supply	0.15	DEFRA 2024

Table 3

Conversion factors in kilograms of CO_2 equivalents per kilometre travelled

Vehicle type	Emission factor [kg CO_2 equivalent/km]	Source
Car	0.164	UBA 2025
Public transport	0.064	UBA 2025
Bicycle	0.00	UBA 2025
Other	0.027	UBA 2025

Table 4

Bibliography

Federal Office of Economics and Export Control (BAFA). (2024). Information sheet CO_2factors, https://www.bafa.de/SharedDocs/Downloads/DE/Energie/eew_infoblatt_co2_faktoren_2024.pdf?__blob=publicationFile&v=4 (accessed on 01.12.2025)

Department for Environment, Food & Rural Affairs (DEFRA). (2024). Greenhouse gas reporting: conversion factors 2024 [Data set]. https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024 (Accessed on 01.12.2025)

Federal Environment Agency (UBA). (2025, February). Emissions data: Transport. Federal Environment Agency. https://www.umweltbundesamt.de/themen/verkehr/emissionsdaten#hbefa (Accessed on 01.12.2025)

Federal Environment Agency (UBA). (2025, September). CO_2 emissions per kilowatt hour of electricity fell in 2024. https://www.umweltbundesamt.de/themen/co2-emissionen-pro-kilowattstunde-strom-2024 (Accessed on 01.12.2025)

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