



# Rail environment

## Quality and methodology report

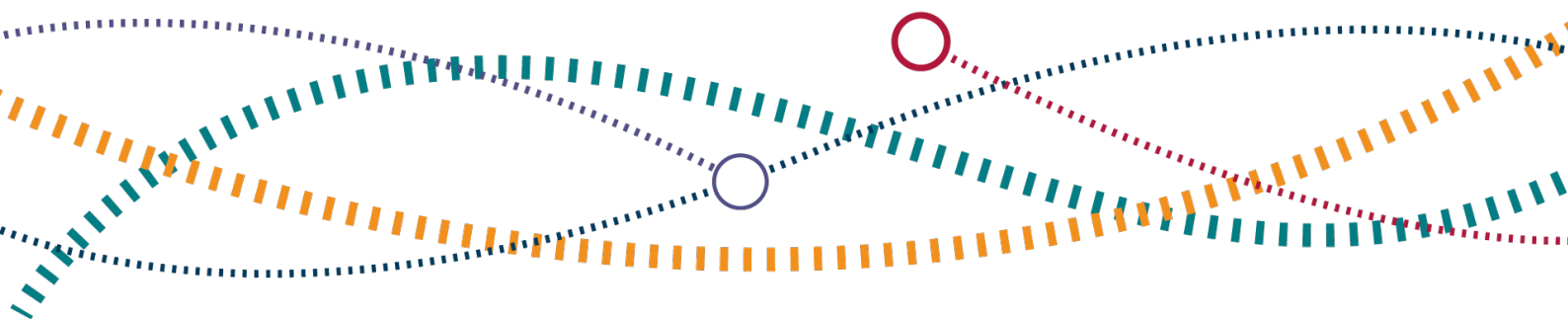
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# Introduction

This is a report on the quality and methodology of the annual Rail environment statistical release and associated data tables. It helps users to understand the quality of our statistics, and also ensures we are compliant with the three quality principles in the [Code of Practice for Official Statistics](#) - Q1: Suitable data sources, Q2: Sound methods, and Q3: Assured quality. This report also provides information on the methodology and data sources used to produce the statistics.

The Rail environment statistical release has been renamed for the April 2023 to March 2024 publication (it was previously titled Rail emissions). It includes **new official statistics in development** on non-traction energy consumption, water consumption and waste generation for passenger and freight operators. For feedback or questions, please email [rail.stats@orr.gov.uk](mailto:rail.stats@orr.gov.uk).

This report covers the following areas:

- Data sources, methodology and definitions – detail on the various data sources, methodology used to compile the statistics and key definitions;
- Historic background – a background to rail environment statistics and details of any changes throughout the time series;
- Relevance to users – the users of the statistics, and our engagement;
- Accuracy and reliability – the accuracy, data coverage and quality assurance of the statistics;
- Timeliness and punctuality – our timescales for the production and publication of the statistics;
- Accessibility and clarity – the format of our statistics and where they can be found;
- Coherence and comparability – similar statistics published elsewhere and the degree in which the statistics can be compared over time.

# Data sources, methodology and definitions

## Data sources

The data contained within the release and data tables are sourced from Network Rail, passenger operators, and freight operators.

- **Traction energy consumption data**

Between April 2005 and March 2010, energy consumption data for traction was provided for passenger operators by the Association of Train Operating Companies (ATOC), and for freight operators by Network Rail.

Since April 2010, energy consumption data (electricity and diesel consumption) has been collected from passenger and freight operators:

- Franchised passenger operators
- Non-franchised (open access) passenger operators
- Freight operators
- Eurostar services (UK side)

- **Non-traction energy usage, waste generation and water usage** has provided by the passenger and freight train operators since April 2022.

- **Passenger kilometre data** is sourced from LENNON (Latest Earnings Networked Nationally Over Night) ticketing and revenue system and supplemented with non-Lennon data.

- **Net tonne kilometres data** is supplied by Network Rail.

- **Vehicle kilometre data** is sourced from the Track Access Billing System (TABS), which is used to bill train operators. TABS captures the actual distances operated on rail infrastructure in Great Britain. This is provided by Network Rail.

## Methodology

### CO<sub>2</sub>e emissions from traction

Passenger and freight operators provide ORR with their total traction electricity and diesel consumption. The electricity energy usage is generally provided by Network Rail and is based on modelled consumption rates or actual metered usage.

Carbon dioxide equivalent (CO<sub>2</sub>e) emissions are estimated from energy consumption data. The consumption data is converted into CO<sub>2</sub>e using [standard conversion factors](#) from the Department for Energy Security and Net Zero. The emission conversion factors allow activity data (for example, litres of fuel used or kilowatt hours consumed) to be converted into grams of carbon dioxide equivalent, CO<sub>2</sub>e. This is a measure covering the seven main greenhouse gases which weights each gas based on its potential to cause global warming

The UK national grid electricity factor changes from year to year as the fuel mix consumed in UK power stations changes, and as the proportion of net imported electricity also changes. These annual changes can be large as they depend very heavily on the relative prices of coal and natural gas as well as fluctuations in peak demand and renewables.

The conversion factor for electricity increased by 7.1% between 2022 and 2023. This was caused by an increase in natural gas usage, and a decrease in renewables usage compared to the previous year. The conversion factor for diesel decreased very slightly by 0.1% between 2022 and 2023.

Prior to conversion into CO<sub>2</sub>e, electricity consumption is uprated to assume a certain percentage of electricity generated is lost during transmission and distribution. This figure changes every year. Since April 2021 the uprating has been based on the transmission and distribution factor from the Department for Energy Security and Net Zero.

For more information on the latest conversion factors and transmissions losses, please see the [collection produced by the Department for Energy Security and Net Zero](#).

In some instances, consumption data is not provided by operators. In these cases, an estimate of CO<sub>2</sub>e is produced based on the number of vehicle kilometres run for passenger operators and the amount of freight moved (measured by net tonne kilometres) for freight operators. This is done by calculating the average level of CO<sub>2</sub>e emissions per vehicle and net tonne kilometre respectively for the operators who have provided data and applying this factor to the vehicle kilometres for operators that require estimation. Using these, an estimate of actual emissions can be calculated.

## **Normalised emissions**

To calculate the normalised emissions, total CO<sub>2e</sub> emissions for passenger and freight operators were divided by one of the following:

- Passenger kilometres
- Net tonne kilometres
- Total vehicle kilometres
- Diesel vehicle kilometres (emissions from diesel only)
- Electric vehicle kilometres (emissions from electricity only)

## Definitions

- **Traction energy** refers to rolling stock (railway vehicles, including both powered and unpowered vehicles, such as locomotives, carriages and freight wagons) on the rail network, and the energy used to power passenger and freight train movements.
- **Diesel** refers to gas, oil, diesel or biofuel volume (in litres) consumed in train movements.
- **Non-traction energy** is the electricity and gas used to power non-rolling stock on the network. This includes energy consumption in stations, offices, workshops, depots, and service buildings, as well as maintenance activities. It also covers heating of points and switches, along with energy needed for technical railway operations such as lighting, signalling, telecoms, traffic control, and data centres.
- **Water** is measured in total cubic metres (m<sup>3</sup>) of mains water used for activities including domestic and sanitary use, washing fleet vehicles, and rolling stock.
- **Waste** is measured in total tonnes of all waste generated, including waste for disposal, recycling, transfer, or reuse.
- **Electricity** measures the amount of electricity consumed (in kWh) in train movements. **Kilowatt hour (kWh)** is a unit of energy by calculating electricity usage - one kWh is the electric energy converted by a one kW appliance used for one hour.
- **Passenger kilometres** are calculated by multiplying the number of passenger journeys on a particular flow by the number of corresponding train kilometres between stations.
- **Net tonne kilometres** measures the amount of freight moved on the railway network, taking into account the weight of the load and distance carried.
- **Vehicle kilometres** measures the distance travelled by an individual vehicle (locomotives, carriages, wagons, etc.) on the rail network. It includes vehicle kilometres travelled on Network Rail infrastructure and other railways such as HS1. For example a ten vehicle train travelling one kilometre is measured as one train kilometre, but ten vehicle kilometres.
- **Greenhouse gases** are gases in the Earth's atmosphere which trap heat. They allow sunlight to pass through the atmosphere, but prevent heat from sunlight leaving the atmosphere. This creates a 'greenhouse effect', where the Sun's energy is trapped, which causes the Earth and in particular the oceans, to warm, the higher the amounts of greenhouse gases in the atmosphere, the warmer the Earth becomes.

# Historical background

This was first published in the [National Rail Trends yearbook for the year 1 April 2007 to 31 March 2008](#).

Between 1 April 2005 and 31 March 2010, energy consumption data was provided for passenger operators by the Association of Train Operating Companies (ATOC), now known as the Rail Delivery Group (RDG), and for freight operators by Network Rail.

No data was collected between 1 April 2010 to 31 March 2011. Since 1 April 2011, energy consumption data has been collected directly from the operators meaning there is a break in the time series between 31 March 2010 and 1 April 2011.

Data for energy usage, emissions and normalised measures for each operator are available from April 2021. Prior to this, the data was published at an aggregate level only for all passenger operators, and all freight operators.

Data for non-traction energy usage has been collected directly from the operators since April 2022.

Historically, rail emissions statistics were included in the [Rail infrastructure, assets and environmental statistical release](#). From 1 April 2018, a separate statistical release has been published. It was previously titled Rail emissions, but has been renamed to Rail environment as it includes additional environmental metrics.



# Relevance to users

The degree to which the statistical product meets the user needs in both coverage and content.

As with all industries, there is continued and growing interest and emphasis on the environmental sustainability of the rail industry. Normalised emissions data provides a measure of the success of policy on reducing the environmental impact of the rail industry, as well as providing a measure against which other modes of transport can be compared.

The data published in this release is used for many purposes, including [UK greenhouse gas emissions](#) published by Department for Energy Security and Net Zero. It is also used for the [National Atmospheric Emissions Inventory \(NAEI\)](#) – data is split by intercity rail, regional, freight and coal (in use in heritage rail). The NAEI also publishes rail emissions estimates for England, Wales, Scotland and Northern Ireland. However, these estimates for rail do not include emissions from electricity produced for traction usage.

The Department for Environment, Food & Rural Affairs (Defra) also use ORR data for their publication of [UK emissions of air pollutants](#) (sulphur dioxide, nitrogen oxides, non-methane volatile organic compounds, ammonia and particulate matter).

ORR's last [user survey](#) took place from mid-January to mid-April 2020. The aim of the survey was to gather feedback on ORR's new data portal; this includes statistical releases, data tables and other supplementary material. There were 42 responses to the survey. ORR created an [implementation plan](#) following the 2020 user survey.

More detailed information on users of ORR statistics and meeting the needs of users is available on our [user engagement webpage](#).

## How these statistics can be used



- Monitoring traction electricity and diesel consumption by passenger and freight trains over time
- Monitoring estimated CO<sub>2</sub>e emissions from traction energy by passenger and freight trains over time
- Monitoring and comparing normalised CO<sub>2</sub>e emissions for passenger and freight trains over time
- Monitoring non-traction energy consumption, water consumption, and waste generation by passenger and freight train operators

## How these statistics cannot be used



- Comparing emissions for a specific train type or route (refer to [DfT journey emission comparisons data](#))
- Identifying emissions for heritage or other non-mainline operators
- Calculating emissions for non-traction energy such as stations, buildings or depots
- Identifying expenditure on diesel fuel for passenger operators (refer to [rail industry finance](#))

# Accuracy and reliability

The proximity between an estimate and the unknown true value.

## Data coverage

The data in this release covers all passenger and freight mainline operators in Great Britain. This includes Eurostar, who submit energy consumption data for usage on the UK-side only. The data does not include London Underground, light rail, heritage and charter services.

The data covers both traction and non-traction energy consumption, with traction energy defined as the energy used to power train movements.

## Estimates of traction electricity consumption

Network Rail recover the cost of electric current for traction (EC4T) through traction electricity charges, which are charged to all electric train operators. From April 2010 some operators moved to metered electricity billing, also known as on-train metering (OTM). This means their charges are not based on modelled consumption rates, but are based on the actual metered consumption and usage. As a result operators may sometimes supply estimates rather than actuals for electricity consumption, depending on the metering for their fleet.

## Estimates of traction emissions

Passenger and freight operators provided ORR with either actual electricity and diesel traction consumption data, or their own estimates. Energy consumption data is converted into estimated carbon dioxide equivalent emissions using standard conversion factors from the Department for Energy Security and Net Zero. The emission conversion factors allow activity data (for example, litres of fuel used or kilowatt hours consumed) to be converted into kilograms of CO<sub>2</sub>e.

There are uncertainties associated with all estimates of greenhouse gas emissions. The uncertainty of emissions varies considerably by gas and sector. The conversion factor for electricity varies each year, which affects the emissions calculation.

## Estimates for missing energy consumption data

For the year April 2023 to March 2024, all operators provided data for traction energy consumption so ORR did not need to produce any estimates.

In addition, we produce an estimate for the smaller freight operating companies that we do not request data from. These include operators for the purpose of infrastructure maintenance and other rail-related activities (e.g. transport of rolling stock). These operators represent less than 1% of total freight moved (measured by net tonne kilometres).

## Quality assurance

All data supplied is subject to an extensive quality assurance process, including validation checks to ensure the data meets the required specification and is in line with previous trends. Any arising issues are highlighted with the operator who must confirm the anomalies or correct the data and re-submit if necessary.

The energy consumption data is converted to CO<sub>2</sub>e emissions estimates, using the process described in the Methodology section. These calculations are quality assured and tested to ensure they are accurate.

These data are then prepared for publication. The process includes quality assuring the tables and charts produced and providing supporting commentary regarding the key trends, methodology and quality measures. These reports are subject to peer review. The final stage of the quality assurance process is a sign off by the statistics Head of Profession confirming the data meets the quality standards and are fit for publication.

## Revisions policy

Our statement on [orderly release and revisions policy](#) outlines ORR's revision policy. Details of any revisions are available in the [revisions log](#). Further information on revisions and data series breaks can also be found in the data tables.

# Timeliness and punctuality

Timeliness refers to the time gap between publication and the reference period.  
Punctuality refers to the gap between planned and actual publication dates.

ORR aims to publish these statistics as soon as possible after the end of the financial year. This is usually around seven months after the end of the financial year.

The [publication schedule](#) available on the data portal outlines the publication dates for [‘accredited official statistics’](#) quarterly and annual statistical releases and other official statistics up to 12 months in advance.

ORR is committed to releasing our statistics in an open and transparent manner that promotes confidence.

# Accessibility and clarity

Accessibility is the ease with which users are able to access the data, also reflecting the format in which the data are available and the availability of supporting information. Clarity refers to the quality and sufficiency of the metadata, illustrations and accompanying advice.

Statistics need to be presented in a clear and understandable form. All our rail statistics data tables can be accessed free of charge on the ORR [data portal](#). Commentary about the statistics and trends are provided in the statistical releases. Interactive dashboards (PowerBI) are also available.

Our data portal and its content meet the accessibility standards of the [Public Sector Bodies Website Accessibility Regulations](#). We support our users by providing the information they need in a way that is clear and accessible. Our statistical releases use plain language, and any technical terms, acronyms and definitions are clearly defined and explained when this is appropriate, to ensure that the statistics can be used effectively. Our data tables are available at the highest level of detail that is practical and in accessible formats. All data tables are available in OpenDocument Spreadsheet (.ods) format. We can also provide data in csv format on request.

Please see the ORR [accessibility statement](#) for further details, including any non-accessible content.

## Data tables

All tables associated with this release can be found under the Data tables heading at the bottom of the [Rail environment page](#).

- Estimates of normalised passenger carbon dioxide equivalent emissions – Table 6100
- Estimates of normalised passenger carbon dioxide equivalent emissions by operator – Table 6103
- Estimates of passenger energy consumption and carbon dioxide equivalent emissions – Table 6105
- Estimates of passenger energy consumption and carbon dioxide equivalent emissions by operator – Table 6108

- Estimates of normalised freight carbon dioxide equivalent emissions – Table 6110
- Estimates of normalised freight carbon dioxide equivalent emissions by operator – Table 6113
- Estimates of freight energy consumption and carbon dioxide equivalent emissions – Table 6115
- Estimates of freight energy consumption and carbon dioxide equivalent emissions by operator – Table 6118
- Estimates of non-traction energy consumption by passenger operator – Table 6123 **(New)**
- Estimates of non-traction energy consumption by freight operator – Table 6133 **(New)**
- Water consumption by passenger operator – Table 6143 **(New)**
- Water consumption by freight operator – Table 6153 **(New)**
- Waste generation by passenger operator – Table 6163 **(New)**
- Waste generation by freight operator – Table 6173 **(New)**

# Coherence and comparability

Coherence is the degree to which data that are derived from different sources or methods, but refer to the same topic, are similar. Comparability is the degree to which data can be compared over time and domain.

## Other related ORR data

Passenger usage data is published on the [Passenger rail usage](#) page on the data portal. This includes passenger kilometres by operator and passenger vehicle kilometres by operator.

Freight usage data is published on the [Freight rail usage and performance](#) page on the data portal. This includes the freight vehicle kilometres by operator.

The [Rail infrastructure and assets](#) page on the data portal includes information on track and route length, including the proportion of the rail network which is electrified. It also includes detail on the passenger operators' rolling stock and the proportion of each traction time (electric, diesel, bi-mode or loco hauled).

Links to other data sources are available in our new [Rail emissions data catalogue](#).

## Other related environmental data

The Department for Energy Security and Net Zero publish [estimates of UK territorial greenhouse gas emissions](#).

The Department for Environmental, Food & Rural Affairs (Defra) publish [data on emissions of air pollutants](#) in the UK. This includes data for transport and railways.

The National Atmospheric Emissions Inventory (NAEI) publish the [Greenhouse Gas Inventory](#). It covers the UK's greenhouse gas emission estimates since 1990, broken down by industry. Rail data is included in the inventory, split into emissions from coal, freight diesel, intercity diesel and regional diesel (gas oil). There is also an interactive map which shows CO<sub>2</sub>e emissions by local authority with an option to filter for emissions from diesel railways.

The Office for National Statistics publish [UK greenhouse gases and total emissions](#) by industry, This covers the period 1990 to 2020. This data is used in [UK Environmental Accounts](#), which measures the impact of economic activity on the environment.



## European data

The United Nations Framework Convention on Climate Change (UNFCCC) publishes [national inventory submissions](#) for greenhouse gas emissions.

The European Environment Agency (EEA) publishes [data on greenhouse gas emissions](#) for transport from the EU. Railway emissions (which only include emissions from diesel trains) have halved since 1990, but they constitute a small proportion of overall transport emissions.

## Length of comparable time series

Measures	Start of time series	Any break in time series
Normalised passenger carbon dioxide equivalent emissions (table 6100)	1 April 2005	No data for 1 April 2010 to 31 March 2011 From 1 April 2011 From 1 April 2021
Normalised passenger carbon dioxide equivalent emissions by operator (table 6103)	1 April 2021	None
Passenger energy consumption and carbon dioxide equivalent emissions (table 6105)	1 April 2005	No data for 1 April 2010 to 31 March 2011 From 1 April 2011 From 1 April 2021 (emissions data only)
Passenger energy consumption and carbon dioxide equivalent emissions by operator (table 6108)	1 April 2021	None
Normalised freight carbon dioxide equivalent emissions (table 6110)	1 April 2005	No data for 1 April 2010 to 31 March 2011 From 1 April 2011 From 1 April 2021

Measures	Start of time series	Any break in time series
Normalised freight carbon dioxide equivalent emissions by operator (Table 6113)	1 April 2021	None
Estimates of freight energy consumption and carbon dioxide equivalent emissions (Table 6115)	1 April 2005	No data for 1 April 2010 to 31 March 2011 From 1 April 2011 From 1 April 2021 (emissions data only)
Estimates of freight energy consumption and carbon dioxide equivalent emissions by operator (Table 6118)	1 April 2021	None
Estimates of non-traction energy consumption by passenger operator (Table 6123)	1 April 2022	None
Estimates of non-traction energy consumption by freight operator (Table 6133)	1 April 2022	None
Water consumption by passenger operator (Table 6143)	1 April 2022	None
Water consumption by freight operator (Table 6153)	1 April 2022	None

Measures	Start of time series	Any break in time series
Waste generation by passenger operator (Table 6163)	1 April 2022	None
Waste generation by freight operator (Table 6163)	1 April 2022	None



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