



Rail Emissions

Quality and Methodology Report

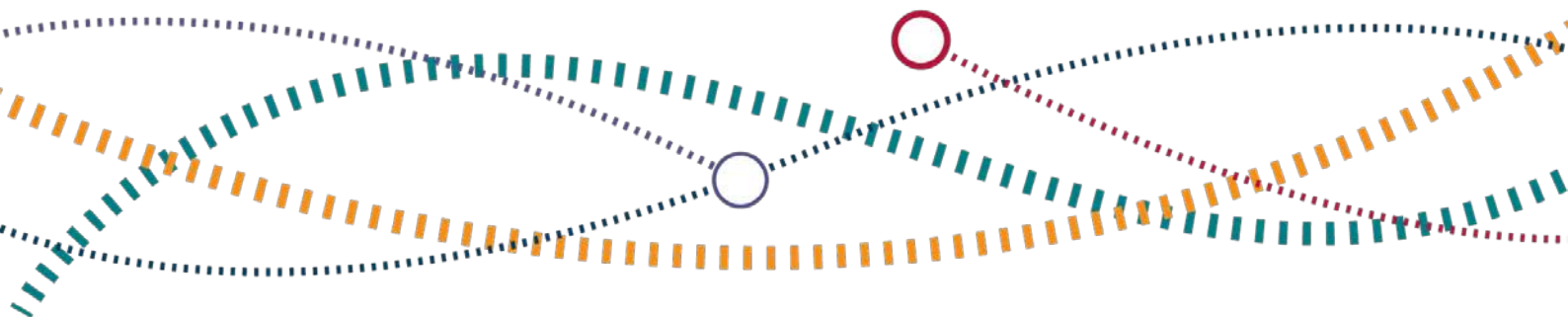
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Introduction

This is a report on the quality and methodology of the annual Rail Emissions 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.

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 emissions 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

Between 2005-06 and 2009-10, energy consumption data was provided for passenger operators by the Association of Train Operating Companies (ATOC), and for freight operators by Network Rail.

Since 2010-11, 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).

Passenger kilometre data is sourced from LENNON (Latest Earnings Networked Nationally Over Night) ticketing and revenue system and supplemented with data from train operators who have passenger journeys and kilometres recorded outside of LENNON.

Net tonne kilometres data for the normalisation of freight emissions are sourced from Network Rail.

Methodology

Carbon dioxide equivalent (CO_{2e}) emissions are calculated from energy consumption data. Train operators provide ORR with their total traction electricity (kWh) and diesel (litres) consumption, this can be actual or estimated.

Energy consumption data is converted into CO_{2e} using [standard conversion factors](#) from the Department for Business, Energy and Industry Strategy (BEIS). The emission conversion factors allow activity data (for example, litres of fuel used or kWh consumed) to be converted into kilograms of carbon dioxide equivalent (CO_{2e}). This is a universal unit of measurement that allows the global warming of different greenhouse gases (GHGs) to be compared. These emission conversion factors are activity-weighted averages, and emissions will vary for the same fuel depending on the use. For example, the CO_{2e}

emission factor for gas oil (diesel) used in rail can be different from other uses such as shipping.

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 the factor depends very heavily on the relative prices of coal and natural gas as well as fluctuations in peak demand and renewables. The conversion factors for electricity and diesel both decreased between 2019-20 and 2020-21. The conversion factor for electricity fell by 9%, and the conversion factor for diesel fell by 0.02%.

For more detail on the latest conversion factors please see the [2020 methodology paper for emissions factors and the list of major changes](#) produced by BEIS.

Prior to conversion into CO_{2e}, electricity consumption is uprated to assume 1.5% of electricity generated is lost during transmission. In some instances, consumption data is not provided by operators. In these cases, an estimate of CO_{2e} is made based on the number of train kilometres each operator runs. This is done by working out an average level of CO_{2e} emissions per train kilometre for the operators who have provided data and applying this factor to the train kilometres for operators that require estimation. From these an estimate of actual emissions can be calculated.

To calculate the final normalised output, the total CO_{2e} emissions for passenger and freight operators were normalised by passenger kilometres and net tonne kilometres respectively.

It is not possible to produce separate normalised emissions estimates for electric and diesel trains, as we do not have passenger kilometre or freight net tonne kilometre data split by electric/diesel/bi-mode trains.

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. Non-traction emissions are excluded, such as heating and lighting in buildings, depots and stations.
- **Diesel** refers to gas, oil, diesel or biofuel volume (in litres) consumed in train movements.
- **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.
- **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. There are seven greenhouse gases covered under the Kyoto Protocol: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF₆) and nitrogen trifluoride (NF₃).

Historical background

This was first published in the [2007-08 National Rail Trends yearbook](#).

Between 2005-06 and 2009-10, energy consumption data was provided for passenger operators by the Association of Train Operating Companies (ATOC), and for freight operators by Network Rail.

No data was collected in 2010-11. Since 2011-12, energy consumption data is collected directly from the operators meaning there is a break in the time series between 2009-10 and 2011-12.

Historically, rail emissions statistics were included in the [Rail infrastructure, assets and environmental statistical release](#). From 2018-19 onwards, a Rail emissions statistical release has been published separately.

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.

Department for Transport (DfT) published their [Transport decarbonisation plan](#) in July 2021, which sets out plans to achieve a net zero emission rail network by 2050. This could be achieved by further electrification of the rail network, leading to a removal of diesel passenger trains and investment in new electric locomotives for freight.

Transport Scotland have published a [Rail Services Decarbonisation Action Plan](#). This looks at how to decarbonise passenger rail services and continue to reduce carbon emissions. Scotland have emissions reduction targets set in law to reach net-zero greenhouse gas emissions by 2045.

The data published in this release is used for many purposes, including [UK greenhouse gas emissions](#) published by BEIS. 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.

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](#).

Accuracy and reliability

The proximity between an estimate and the unknown true value.

Data coverage

The data cover all 24 passenger and nine freight operators in Great Britain. This includes Eurostar services, who submit energy consumption data based on usage in Great Britain only. The data do not include London Underground, light rail, heritage and charter services. It also does not include trains ran by Network Rail, such as maintenance trains. However, energy consumption data and emissions are not published by individual operators and are instead aggregated for all passenger operators and all freight operators.

Energy consumption and emissions data are for tractions only, i.e. rolling stock on the rail network, and the energy used to power passenger and freight train movements. Non-traction emissions, for example from heating and lighting in buildings, depots and stations, are excluded.

Estimates of emissions

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. This is due to increased decarbonisation of the UK National Grid.

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. This means that operators may sometimes supply estimates rather than actuals for electricity consumption, depending on the metering for their fleet.

Estimates for missing data

For 2020-21 the following were estimated by ORR due to operators not providing data:

- Energy consumption and emissions from four freight operators. However, more than 99.8% of freight tonne kilometres are covered by the five largest freight operators who provided data.

- All 24 passenger train operators provided actual or estimated energy consumption data, so no estimates from ORR were needed.

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.

Due to variation in the fuel consumption figures for 2020-21, further quality assurance was carried out. The train kilometres for each operator were compared for 2019-20 and 2020-21, and this was also compared with the change in electricity and diesel consumption.

The energy consumption data is converted to CO₂e 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. Historically rail emissions statistics have been available on the data portal approximately seven or eight months after the end of the year. However, for 2020-21 statistics we have published within five months and aim to continue to do so in future.

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

We are 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.

All rail statistics data tables can be accessed free of charge on the [Data Portal](#).

Commentary about the statistics and trends are provided in the statistical release.

The rail emissions tables currently published on the data portal are:

Rail emissions

- Estimates of normalised passenger and freight carbon dioxide equivalent (CO_{2e}) emissions – Table 6100
- Estimates of passenger and freight energy consumption and carbon dioxide equivalent (CO_{2e}) emissions – Table 6105

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.

Related ORR data

Passenger usage data is published on the [Passenger rail usage](#) page on the data portal. This includes the number of passenger journeys, passenger kilometres by operator and train kilometres by operator.

Passenger performance data is published on the [Passenger rail performance](#) page on the data portal. This includes the number of trains planned every quarter.

Freight usage data is published on the [Freight rail usage and performance](#) page on the data portal. This includes the number of annual freight trains ran, freight moved by commodity and freight train kilometres by operator.

The [Rail infrastructure and assets](#) page on the data portal contains information on track and route length, including the proportion of the rail network which is electrified.

Environmental data

The Department for Business, Energy & Industrial Strategy (BEIS) publish [estimates of UK territorial greenhouse gas emissions](#).

BEIS publish [estimates of emissions from other types of rail](#) (Table in Conversion factors 2020 condensed set (for most users): Business travel- land). The 2020 estimates were 5.0 g CO₂e per passenger kilometre for international rail (Eurostar), 29.9g for light tram and rail, and 27.5g for London Underground.

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 CO₂ emissions by local authority with an option to filter for emissions from diesel railways.

The Office for National Statistics publish [UK estimates](#) of the different greenhouse gases and total emissions by industry, This covers the period 1990 to 2019. This data is used in [UK Environmental Accounts](#), which measures the impact of economic activity on the environment.

DfT publish [experimental statistics](#) comparing the environmental impact of various journeys in the UK by different modes of transport, including rail. This includes direct emissions produced by the vehicle, and indirect emissions (emissions produced by the extraction, refining, and transportation of the fuel used to power the vehicle).

There is a list on [GOV.UK](#) of resources relating to historical UK greenhouse gas emissions.

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 CO ₂ e emissions (Table 6100)	2005-06	No data for 2010-11. Change in collection from 2011-12, i.e., energy consumption data is collected directly from the operators.
Energy consumption (electricity and diesel usage) and CO ₂ e emissions (Table 6105)	2005-06	No data for 2010-11. Change in collection from 2011-12, i.e., energy consumption data is collected directly from the operators.



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