

5 November 2020

Background:

This annual statistical release contains information on environmental statistics for passenger and freight trains in Great Britain.

This covers:

Energy consumption of electricity and diesel, and Estimates of **normalised CO₂e emissions** from traction energy. Non-traction emissions are not included.

Passenger train data has been normalised to show the average CO₂e emission per passenger kilometre. Freight train data has been normalised to show the average CO₂e emission per net tonne kilometre of freight moved.

Source: Passenger and freight operators

Latest year: 2019-20 (April 2019 to March 2020)

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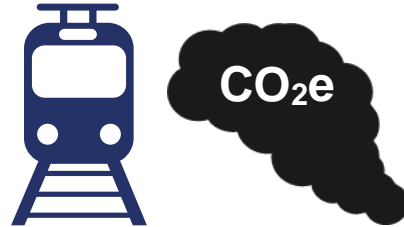
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Next publication:

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Passenger train emissions

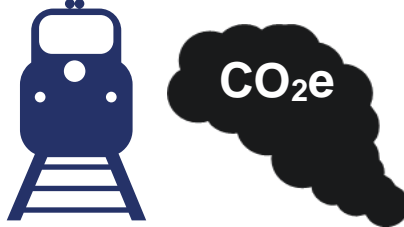


35.1 g CO₂e per passenger km in 2019-20
Decrease of 4.1% compared to 2018-19

For passenger trains, electricity usage increased by 5.3% and diesel usage increased by 1.5% compared to 2018-19. Over the same time period, passenger kilometres decreased by 1.3%.

The resulting CO₂e emissions for passenger trains have fallen to 35.1g CO₂e per passenger km. This is the lowest level since the comparable time series started in 2011-12.

Freight train emissions



27.5g CO₂e per tonne km in 2019-20
Increase of 8.6% compared to 2018-19

The amount of diesel consumed by freight trains in 2019-20 has increased by 12.5% to 172 million litres. This is the highest figure since 2015-16, and the first time that diesel use increased year on year since 2015-16. Electricity usage fell by 6.3% to 70 million kWh.

The resulting CO₂e emissions for freight trains have increased to 27.5g CO₂e per tonne km. This is the highest level since the comparable time series started in 2011-12.

All data tables associated with this release are published on the [rail emissions page](#) of the ORR data portal. Key definitions and information on methodology are in the annexes of this release.

1. Passenger train emissions

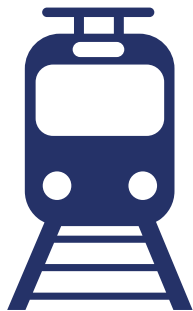
The level of CO₂e emissions per passenger km in 2019-20 was 4.1% lower than the equivalent figure for 2018-19. This continues a general trend of falling emissions per passenger km since the start of the comparable time series in 2011-12.

Despite the increase in electricity and diesel usage, the resulting CO₂e emissions and emissions per passenger km have fallen. This is predominantly due to a transition towards renewable energy sources in the electricity sector in Great Britain.

[Passenger kilometres were increasing steadily](#) from 57.1 billion in 2011-12 to 67.6 billion in 2018-19. The first three quarters of 2019-20 recorded an increase in passenger kilometres. However, there was a large fall passenger kilometres in Q4 (January - March), which can be attributed almost entirely to the measures taken in March 2020 to limit the impact of the coronavirus (COVID-19) pandemic.

Passenger rail usage during the first quarter of 2020-21 was severely affected by the coronavirus (COVID-19) pandemic. This is expected to have a large impact on emissions for 2020-21.

In 2019-20 the consumption and emissions for passenger trains was:



4,186 million kWh of electricity

Increase of 5.3% compared to 2018-19

1,086 KTonnes CO₂e emissions

Increase of 1.4% compared to 2018-19



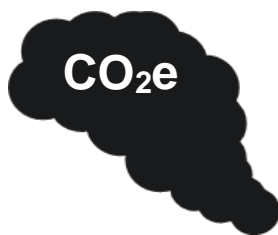
476 million litres of diesel

Increase of 1.5% compared to 2018-19

1,313 KTonnes CO₂e emissions

Decrease of 5.8% compared to 2018-19

This resulted in:



2,400 KTonnes CO₂e emissions

Decrease of 2.7% compared to 2018-19

35.1 g CO₂e per passenger km

Decrease of 4.1% compared to 2018-19

2. Freight train emissions

The level of CO₂e emissions per freight tonne km in 2019-20 was 8.6% higher than the equivalent figure for 2018-19. This is the highest figure since the comparable time series started in 2011-12.

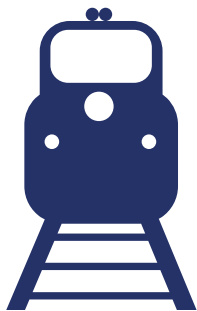
From 2015-16, diesel usage was falling for freight year on year. However diesel usage increased by 12.5% in 2019-20 from the previous year. Electricity usage fell 6.3%, from 75 million kWh in 2018-19 to 70 million kWh.

Despite an increase in diesel usage, [freight moved in tonne km](#) dropped to 16.6 billion net tonne kilometres. This was the lowest total in 23 years, and a fall of 4.6% from 2018-19. Total freight moved has remained low since the peak of the time series in 2013-14.

The number of freight trains that ran in 2019-20 decreased by 5.2% to 209,281, the lowest number since the time series began in 2003-04.

To normalise freight data, the total emissions are divided by total freight moved in the year. As the level of freight moved was lower and the emissions have increased, these factors have both led to the increase in emissions to 27.5g CO₂e per tonne km.

In 2019-20 the consumption and emissions for freight train was:



70 million kWh of electricity

Decrease of 6.3% compared to 2018-19

18 KTonnes CO₂e emissions

Decrease of 15.4% compared to 2018-19



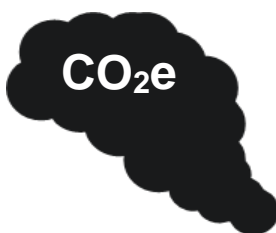
172 million litres of diesel

Increase of 12.5% compared to 2018-19

475 KTonnes CO₂e emissions

Increase of 4.5% compared to 2018-19

This resulted in:



493 KTonnes CO₂e emissions

Increase of 3.6% compared to 2018-19

27.5g CO₂e per tonne km

Increase of 8.6% compared to 2018-19

3. Transport emissions in context

This section provides sources of other data on transport emissions, to show rail emissions in context. The Department for Business, Energy & Industrial Strategy (BEIS) produce statistics on [greenhouse gas emissions](#). Please note that these figures are for a different time period (calendar year 2018), with a different methodology and cover the United Kingdom. ORR data covers the rail network in Great Britain.

In 2018, UK emissions from the seven greenhouse gases covered by the Kyoto Protocol were estimated to be 451.5 million tonnes carbon dioxide equivalent (MtCO_{2e}). Greenhouse gas emissions in 2018 are estimated to be 43.1% lower than they were in 1990.

Transport was the largest emitting sector of UK greenhouse gas emissions in 2018. Transport emissions are only 3.0% lower than in 1990, as increased road traffic has largely offset improvements in vehicle fuel efficiency. The main source of emissions from this sector is the use of petrol and diesel in road transport. Carbon dioxide makes up over 99% of greenhouse gases from transport.

Figure 3.1: Proportion of greenhouse gas emissions by sector, UK, 2018



The transport sector consists of emissions from road transport, railways, domestic aviation, shipping, fishing and aircraft support vehicles.

Source: [Final UK greenhouse gas emissions national statistics: 1990 to 2018, BEIS](#)

There are seven greenhouse gases covered under the Kyoto Protocol: carbon dioxide (CO₂), methane (NH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF₆) and nitroge n trifuroide (NF₃). Some gases have a higher global warming potential then others, so greenhouse gas emissions are expressed in terms of the million tonnes of carbon dioxide equivalent (MtCO_{2e}).

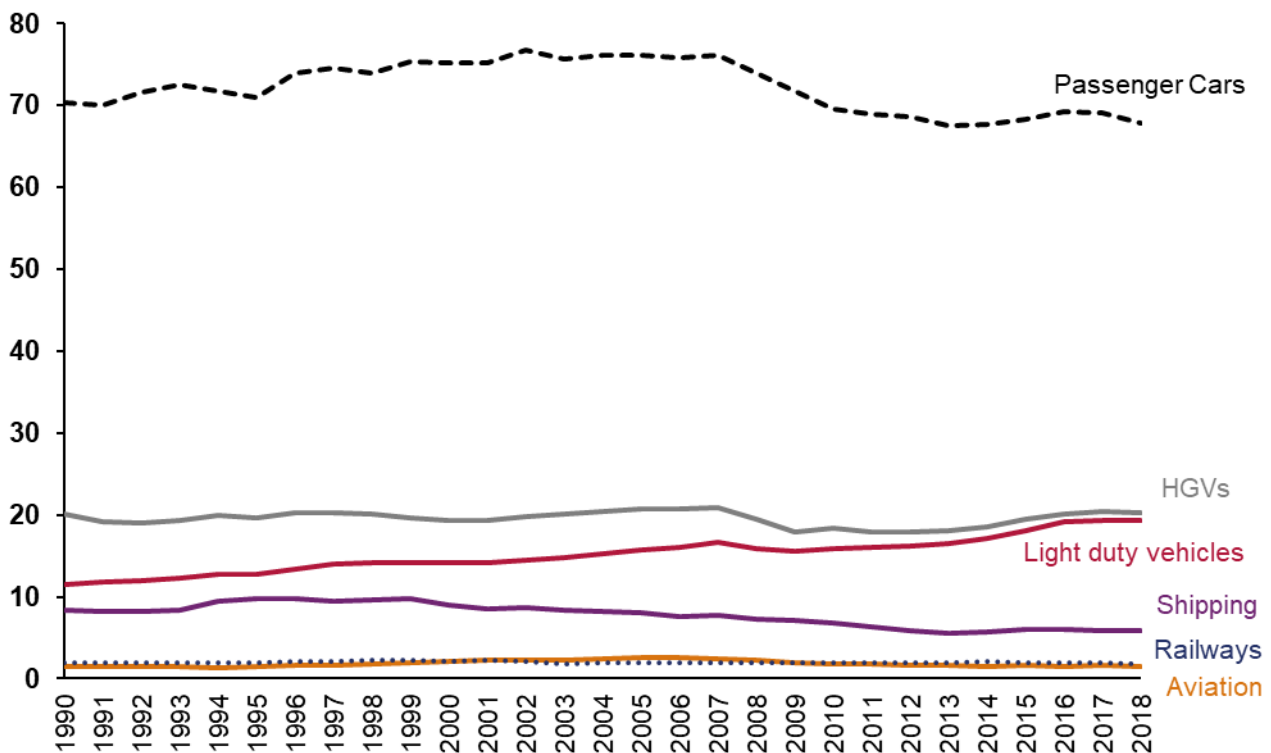
The largest contributor to global warming is carbon dioxide.

Figure 3.2 shows CO₂ emissions for the different sectors in transport. In total, transport made up over a third of all the UK's CO₂ emissions (33.6%). The transport sector has historically been the second most emitting sector; however reductions over time in what was the largest sector (energy supply) mean that since 2016 transport has been the most emitting sector.

Road transport is the largest source of emissions in this sector, with passenger cars making up the majority of this. In 2018, emissions from transport were estimated to be 123.0 MtCO_{2e} and road transport made up over 90% of this (111.7 MtCO_{2e}).

Railways made up 1.4% of the UK's transport CO₂ emissions in 2018, but in comparison [10% of all passenger kilometres were made using rail](#). Rail emissions account for 0.5% of the UK's total CO₂ emissions.

Figure 3.2: Estimated emissions of carbon dioxide (MtCO_{2e}) by transport category, UK, 1990 to 2018



Source: [Final UK greenhouse gas emissions national statistics: 1990 to 2018](#) BEIS (Table 4)

Not shown on graph: Buses, Mopeds & motorcycles, Road vehicle LPG and biofuel uses (all vehicles), Incidental lubricant combustion in road engines, Other mobile (Military aircraft and shipping, Aircraft support vehicles). Only includes emissions from vehicles and not from transport related infrastructure or from air conditioning. Aviation is for domestic aviation only.

Fifth Carbon Budget

The government has a legally binding Fifth Carbon Budget which aims to reduce emissions by 57% in 2032 compared to 1990 levels, and net-zero by 2050. Net-zero means any emissions would need to be balanced by schemes to offset an equivalent amount of greenhouse gases from the atmosphere, such as planting trees or using technology like carbon capture and storage.

Moving freight from road to rail is part of the solution and has the potential to help [reduce emissions](#), as part of this [a study](#) showed that shifting from HGV road freight to rail could reduce greenhouse gas emissions by nearly a fifth (19%). In 2018, [ORR rail freight statistics](#) show that 79% of all tonne km of domestic freight was moved by road, 13% by water and 9% by rail.

Decarbonisation

In 2018 the Department for Transport (DfT) challenged the rail industry remove all diesel-only trains from the network by 2040. The Scottish Government has set a target to decarbonise domestic passenger rail services by 2035. As rail traction accounts for the largest proportion of rail emissions, to achieve net-zero, diesel traction will need to reduce. The alternatives to diesel passenger trains are battery, electric or hydrogen rolling stock.

Network Rail have published a [Traction Decarbonisation Network Strategy](#), which aims to provide recommendations for Government 'to inform decisions required to remove diesel trains from the network, achieve net-zero legislative targets, and identify the capital works programme required to achieve this'.

Rail Safety and Standards Board (RSSB) have published as part of the Rail Industry Decarbonisation Taskforce a [Final Report for the Minister for Rail](#). This looks at the challenge set by DfT to remove diesel only trains from service by 2040, and produces a vision for how the rail industry will decarbonise.

DfT have published a report [Decarbonising Transport: Setting the Challenge](#).

The aim of the Transport Decarbonisation Plan (TDP) is to 'set out in detail what government, business and society will need to do to deliver the significant emissions reduction needed across all modes of transport, putting us on a pathway to achieving carbon budgets and net-zero emissions across every single mode of transport by 2050'. There are predictions that rail GHG emissions could rise by 19% between 2018 and 2050. However there is a level of uncertainty for this prediction (and the prediction was made before the current coronavirus (COVID-19) pandemic).

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. It is estimated that 76% of passenger and 45% of freight journeys in Scotland run on electric traction.

4. Annexes

Annex 1 – 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
- **Diesel** – gas, oil, diesel or biofuel volume (litres) consumed in train movement (separate volumes for each fuel type used).
- **Electricity** – electricity consumed (kWh) in train movements.
- **Passenger kilometre** – moving one passenger, one kilometre. This is calculated by multiplying the number of passenger journeys on a particular flow by the number of corresponding track kilometres between stations.
- **Net tonne kilometre** – moving one tonne of freight, one kilometre. This shows the amount of freight which is moved on the railway network, taking into account the weight of the load and the distance carried.
- **Greenhouse gases** – these 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, and this 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.

Annex 2 – Quality and methodology

Data sources

For the time period between 2005-06 and 2009-10, energy consumption data was provided for passenger and freight operators by the Association of Train Operating Companies (ATOC) and Network Rail respectively. Since 2011-12, energy consumption data have been collected directly from the operators themselves:

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

Passenger kilometre data is taken from LENNON ticketing database and train operator data submissions (including Eurostar and Heathrow Express).

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

Estimates for missing data

For 2019-20 the following were estimated due to freight operators not providing data:

- Emissions from four freight operators. More than 99.6% of freight tonne kilometres are covered by the five freight companies who provided data.
- All passenger train operators provided data, so no estimates were needed.

Methodology

CO₂e emissions are calculated from actual and estimated data for energy consumption. Train operators provide ORR with their total traction electricity (kWh) and diesel usage (litres) consumption.

Actual energy consumption data is converted into CO₂e 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, kWh consumed) to be converted into kilograms of carbon dioxide equivalent (CO₂e). 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 CO₂ emission factor for gas oil used in rail can be different from other uses such as shipping.

The UK grid electricity factor changes from year to year as the fuel mix consumed in UK power stations (and autogenerators) 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 2018-19 and 2019-20.

For more detail on the conversion factors please see the [2019 methodology paper for emissions factors and the list of major changes](#) produced by BEIS.

Prior to conversion into CO₂e, electricity consumption is uprated to assume 1.5% of electricity generated is lost during transmission. In some instances actual consumption data is not provided by operators. In these cases an estimate of CO₂e is made based on the number of train kilometres each operator runs. This is done by working out an average level of CO₂e 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 CO₂e emissions for passenger and freight operators were normalised by passenger kilometres and net tonne kilometres respectively. It is not possible to produce separate emissions estimates for electric and diesel trains, as the passenger kilometre data is not disaggregated into these categories.

Historic background

First published in the [2007-08 National Rail Trends yearbook](#), normalised passenger and freight carbon dioxide equivalent (CO₂e) emissions provide a measure of energy consumption. 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.

Revisions

There have been no revisions to historic data. Further details on historic revisions can be found in the [Revisions log](#).

Annex 3 – List of data tables associated with this release and other related statistics

Data tables

All data tables can be accessed on the [ORR data portal](#) free of charge in OpenDocument Spreadsheet (.ods) format. We can also provide data in csv format on request.

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

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

There is no separate methodology and quality report for this release. All this information is contained within this statistical release.

Other related statistics

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, freight moved by commodity and freight train km by operator.

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

The [Department for Business, Energy & Industrial Strategy \(BEIS\)](#) publish estimates of UK territorial greenhouse gas emissions. BEIS also publish estimates of emissions from other types of rail. The 2019 estimates were 6.0 g CO_{2e} per passenger km for international rail (Eurostar), 35.1g CO_{2e} per passenger km for light tram and rail, and 30.8g CO_{2e} per passenger km for London Underground.

The Office for National Statistics publish [UK emissions](#) of the different greenhouse gases, and total emissions by industry. This covers the period 1990 to 2018. This data is used in [UK Environmental Accounts](#), which measures the impact of economic activity on the environment. In 2018 the greenhouse gas emissions from rail, underground and metro were 2 MtCO_{2e}.

The [National Atmospheric Emissions Inventory](#) publish the Greenhouse Gas Inventory, which is an annual report for submission under the Framework Convention on Climate Change. There is also an [interactive map](#) which shows CO₂ emissions by local authority, with an option to filter for emissions from diesel railways.

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

Annex 4 – ORR’s statistical publications

Statistical Releases

This publication is part of ORR’s [National Statistics](#) accredited releases, which consist of six annual publications: **Rail Finance**; **Rail Fares Index**; **Rail Safety Statistics**; **Rail Infrastructure and Assets**; **Rail Emissions**; **Regional Rail Usage**; and four quarterly publications: **Passenger Rail Performance**; **Freight Rail Usage and Performance**; **Passenger Rail Usage**; **Passenger Rail Service Complaints**.

In addition, ORR also publishes a number of Official Statistics, which consist of four annual publications: **Estimates of Station Usage**; **Train Operating Company Key Statistics**; **Rail Statistics Compendium**; **Occupational Health**; and four quarterly publications: **Signals passed at danger (SPADS)**; **Delay Compensation Claims**; **Disabled Person’s Railcard (DPRC)**; **Passenger assistance**.

All the above publications are available on the [ORR data portal](#) along with a list of [publication dates](#) for the next 12 months.

National Statistics

The United Kingdom Statistics Authority designated these statistics as National Statistics, in accordance with the Statistics and Registration Service Act 2007 and signifying compliance with the Code of Practice for Official Statistics. National Statistics status means that official statistics meet the highest standards of **trustworthiness**, **quality** and public **value**.

Our [statistical releases were assessed in 2012](#) and hold National Statistics status. Since our assessment we have improved the content, presentation and quality of our statistical releases. In addition, in July 2019 we launched our new data portal. Therefore, in late 2019 we worked with the OSR to conduct a compliance check to ensure we are still meeting the standards of the Code. On 4 November 2019, [OSR published a letter](#) confirming that ORR’s statistics should continue to be designated as National Statistics. OSR found many positive aspects in the way that we produce and present our statistics and welcomed the range of improvements made since the statistics were last assessed.

For more information on how we adhere to the Code please see our [compliance statements](#). For more details or to provide feedback, please contact the Statistics Head of Profession (Lyndsey Melbourne) at rail.stats@orr.gov.uk.



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