1990-2030

Environment Strategy Reporting System

Methodology and Policy

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This document has been elaborated by UIC (International Union of Railways).

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List of abbreviations

CER	Community of European Railways
CH_4	Methane
CO_2	Carbon Dioxide
CO_2-eq	Carbon Dioxide equivalent (allowing other greenhouse gas accounting)
ESRS	Environment Strategy Reporting System
EPD	Environmental Performance Database
EC	European Commission
GHG	Greenhouse gas
GWh	Gigawatt Hours, a million of Watt Hours
KPI	Key Performance Indicators
kWh	Kilowatt Hours, a thousand of Watt Hours
N_2O	Nitrous oxide
NGO	Non-Governmental Organisation
NOx	Nitrogen Oxides
PMXX	Particulate Matter of diameter below XX micrometre(s)
RU	Railway Undertaking
UIC	International Union of Railways
UN	United Nations
WTW	Well to Wheel

INTRODUCTION

UIC and CER General Assemblies, in order to provide a unified approach to environmental and sustainability topics for the European railway sector, voted in December 2010 the document "*Moving towards Sustainable Mobility: Rail Sector Strategy 2030 and beyond – Europe* (UIC-CER 2010)[1].

The strategy outlined in the document describes how the rail sector should be performing in environmental terms in **2030** and **2050** and it is built on four key environmental topics: **climate protection, energy efficiency, exhaust emissions and noise**. It sets out specific objectives to be met by 2030 and, as uncertainties make prediction for the longer timeframe of 2050 more difficult, more general "visions" for 2050.

Moreover, the Strategy builds on the commitment already voted by CER and UIC European members in 2008 to commit to a sector-wide cut of 30% specific emissions from rail traction over the 1990- 2020 period.

An overview of the environmental targets to be met by the European railway sector in 2020, 2030 and the vision for 2050 is shown in **Table 1**.

	Target	Baseline	Horizon
Climate Protection	• -30% pkm and tkm	**1990**	**2020**
	• -50% pkm and tkm • Not exceed total GHG emissions (1990)	**1990**	**2030**
	• Carbon free train operation	**-**	**2050**
Energy Efficiency	• -30% pkm and tkm	**1990**	**2030**
	• -50% pkm and tkm	**1990**	**2050**
Exhaust Emissions	• -40% Total PM and NOx	**2005**	**2030**
	• Zero emissions of NOx and PM	**-**	**2050**
Noise and Vibrations	• No longer a problem for railways	**-**	**2050**

Table 1: Overview of environmental targets for European railway sector

In order to ensure that progress is being made in reaching those objectives, direct data on energy and CO_2 emissions[2] performance are collected and analysed by UIC through its Energy & CO_2 emissions database[3] since 2005. The database, nowadays, represents a unique source in terms of quality and amount of direct data showing the environmental performances related to the railway sector.

Subsequently, different factors led to the to the necessity of providing the overall procedure with a more comprehensive instrument able to regulate in a clear and transparent structure every different aspect of the process: data collection, analysis and reporting, key performance indicators construction and data sharing.

The new "**Environment Strategy Reporting System (ESRS)"** has then been created. Aims of the

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[1] The document can be downloaded at: http://www.uic.org/spip.php?rubrique1638

[2] According to the UIC Energy and CO_2 Network decisions (UIC Network meeting n° 34, 5th October 2017) the ESRS railway emissions will be calculated in CO_2-eq starting from the 2017 Data Collection. Nonetheless, the collection of CO_2 data will be carried out for a period of transition.

[3] The UIC Energy and CO_2 database from now on referred to as the UIC Environmental database, as indicators for PM and NOx emissions have been introduced in addition to Energy and GHG data.

ESRS, besides tracking the environmental objectives, are the following:

- Collect, analyse and verify the consistency of key environmental performance data from all European operators;

- Provide correct information about environmental performance of railways, internally and externally, to all stakeholders such as institutions, customers, media etc.;

- Understand the trend of the sector for comprehension, improvement and benchmarking purposes;

- Provide data to the on-line environmental calculators Ecopassenger[4] and EcoTransIT World[5].

After an in-depth study and evaluation, and ample discussions among members, the UIC Environment, Energy and Sustainability Platform has approved a variation of some of the environmental targets. The new targets are shown in **Table 2**, with the changes highlighted in bold:

	Target	Baseline	Horizon
Climate Protection	• **-40%** pkm and tkm	**1990**	**2020**
	• -50% pkm and tkm • **-30%** total GHG emissions (1990)	**1990**	**2030**
	• Carbon free train operation	**-**	**2050**
Energy Efficiency	• -30% pkm and tkm	**1990**	**2030**
	• -50% pkm and tkm	**1990**	**2050**
Exhaust Emissions	• -40% Total PM and NOx	**2005**	**2030**
	• Zero emissions of NOx and PM	**-**	**2050**
Noise and Vibrations	• No longer a problem for railways	**-**	**2050**

Table 2: New Environmental Targets for European Railway Sector

The CER General Assembly and UIC Regional Assembly Europe will officially adopt these targets in 2015.

[4] Ecopassenger (http://ecopassenger.org/) is an on-line calculator of energy consumption and greenhouse gas emissions of different means of passenger transportation (planes, cars and trains) in Europe.

[5] EcoTransIT World (http://www.ecotransit.org/) is a tool akin to Ecopassenger for freight transportation, calculating energy consumption and emissions for a worldwide transport chain and different transport modes (truck, train, plane and ship).

The ESRS

Elements of the ESRS

The Environment Strategy Reporting System is composed of 6 main elements, as shown in **Fig.1**.

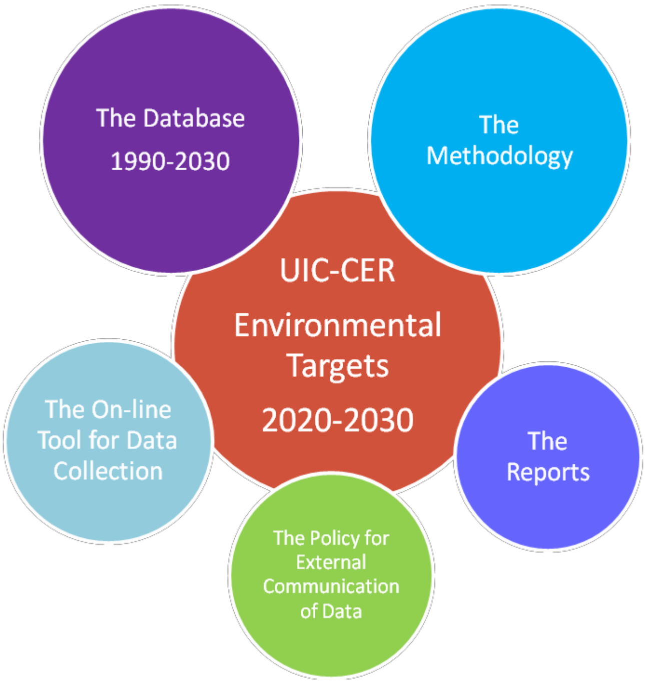


Fig. 1: Elements of the UIC Environmental Strategy Reporting System

1. **The Environmental Targets** (see Table 1) are central to the whole system, as they are the final objective.

   The targets can be modified or updated by the General Assemblies of UIC and CER, following a proposal of the UIC Environment, Energy and Sustainability (EES) Platform and the CER Transport, Environment & Energy Strategy Group.

2. **The Environmental Performance Database** contains the data collected annually from each Railway Undertaking (RU): energy consumption data, production data and emissions data (GHG, PM10 and NOx).

   The data is vital for the whole system, as it allows the calculation of the indicators used in the monitoring process of the 2020-2030-2050 targets and it provides all the values that are used by Ecopassenger and EcoTransIT World, the UIC on-line environmental calculators.

3. **The Methodology** includes methods of calculation, principles and key concepts definitions. These rules are a vital compendium to the environmental performance database as all data has to be consistent in order to provide comparable and scientifically based results. A guideline to data entry for UIC railway members is attached to the Methodology (see Annex I).
4. **The On-line Tool for Data Collection** allows the collection of data from all railways in a safe and consistent way, and assists the railways in calculating some key indicators from the data they provide.
5. **The Periodical Reports** present yearly the progress of UIC/CER in meeting their environmental targets set for 2020, 2030 and 2050.
6. **The Policy for External Communication of Data** regulates the response to requests of data from external entities, setting guidelines for data sharing with UIC/CER members and non-members.

Participation to the ESRS

UIC and CER encourage all their member railways to participate to the Environmental Strategy Reporting System. In order to participate to the ESRS, railways have to send their environmental data annually to UIC in order to allow monitoring towards the targets.

Two modes of participation to the ESRS are available:

- **Full Participation –** The member railway has to provide data from the baseline years (**1990** for energy and GHG-related targets, **2005** for PM and NOx-related targets). Only the Key Performance Indicators (KPIs) of full participants will be used to monitor the progress towards the collective targets, as those are relative to the data from baseline years.
- **Partial Participation** – Relevant data from 1990 or 2005 is not available. In this case the data from the member railway will be collected and used to monitor the progress of its environmental KPIs for future years.

Collection, Elaboration and Publication of Data

As a first step, member railways send their data to UIC through the “On-line Tool for Data Collection”.

The data is then collected in the “Environmental Performance Database”, carefully checked and reviewed by EPD Administrator, and finally confirmed and validated by the UIC member railways themselves.

When all data has been validated, the Annual Reports are published.

Following the Policy for External Communication, data can then be shared with UIC members (full version) and non-members (selected data), and with Ecopassenger and EcoTransIT World tools.

The process for collection, elaboration and sharing of data is shown in **Fig 2**.

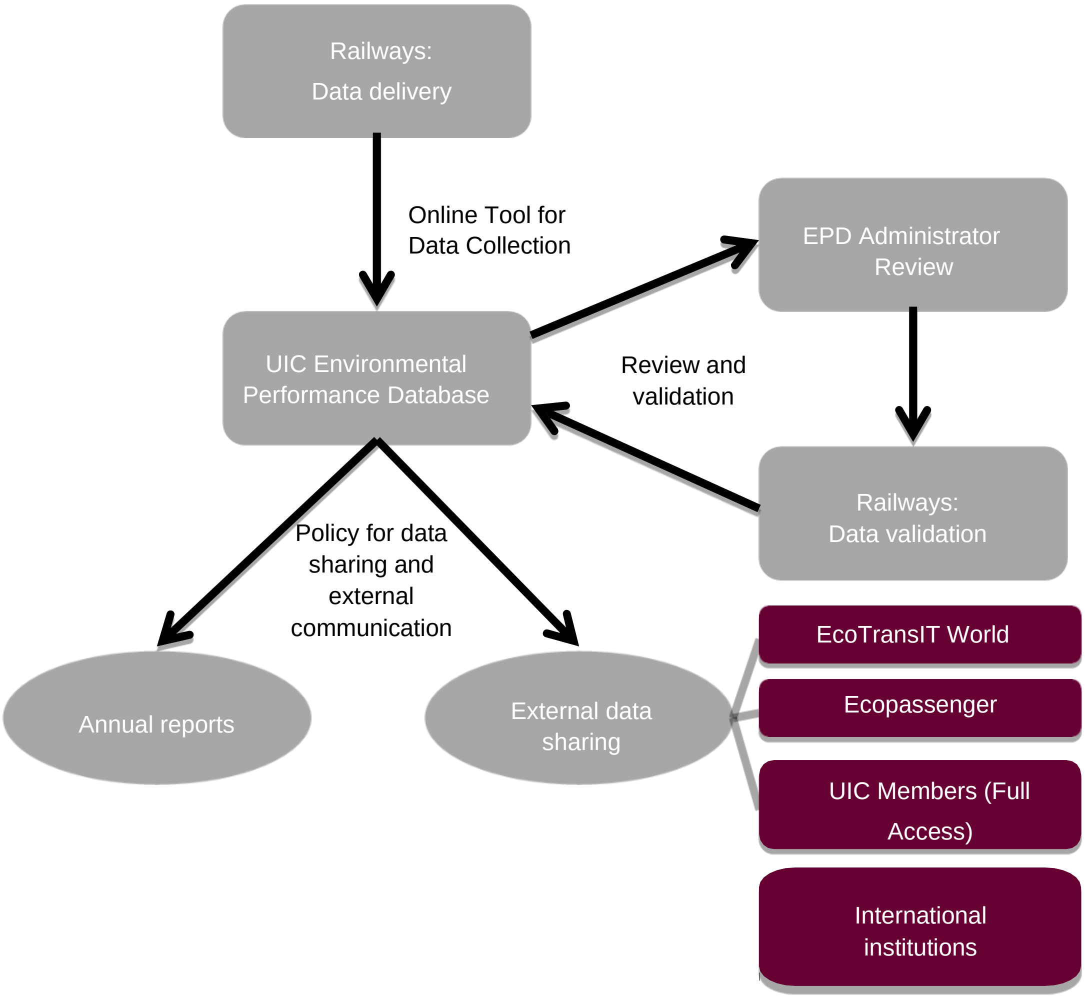


Fig. 2: Process for data collection, elaboration and publication

Section A **- The Methodology**

The present section has the aim of summarizing data collected and describing the methodological concepts on which the ESRS is based. A guideline for helping UIC members to submit good quality data is included in Annex I.

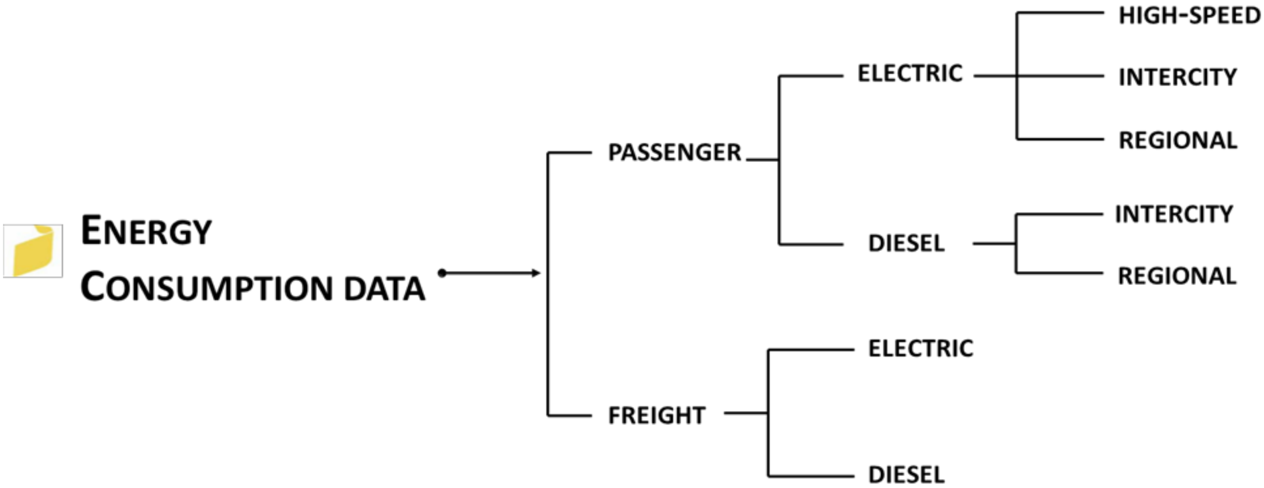
The data collected falls into five different categories, as shown in **Fig.3**.

Fig. 3: Data to be collected for ESRS

This section has been approved by the UIC Energy and CO_2 Expert Network in ***April 2013***.

1. Energy Consumption

The energy consumption data collected in the EPD database are electricity and diesel consumption for freight and passenger trains, split by passenger service types (local/regional, intercity, high-speed)[6]. The degree of detail of data collected is shown below:



The energy consumption data refer to the **final energy consumption** used for train traction.

The final energy consumption does not take into account:

- The electricity and diesel used by maintenance workshops, stations, railway offices and buildings (non-traction energy);
- The energy consumed in the "pre-chain" (exploration, extraction, transformation, transportation etc.), to get the electricity to the substation, or the fuel to the filling station (primary energy).

General observations on final energy consumption

- The energy consumption data correspond to the value of energy used to move the number of trains, people or goods declared in the production data section (i.e. train-km, passenger-km and tonnes-km). As an example, if the railway declares 100 million passenger-km, the energy consumption reported is the one used to move those 100 million pkm. This is essential to produce consistent values for specific energy consumption and specific GHG emissions.

- In order to avoid double-counting when putting the figures together on a larger scale (e.g. Europe), energy consumption data are referred to **single train operators** and not to national infrastructure managers.

- RUs that operate trains trans-nationally (e.g. Thalys, Eurostar) have the choice between having their consumption reported to UIC by national train operators or report it themselves

[6] According to the UIC Statistics' publication, data collected in the ESRS are separated by the following service type:
- Local and regional: train service covering local short distance travel;
- Intercity: train service covering longer distances than regional trains, but without the speed or infrastructure of high-speed trains;
- High-speed: train service running at more than 200 km/h on partly dedicated high- speed railway infrastructure.

as a single train operator. For example, the energy consumption of Thalys is reported separately by the three national railways (SNCF, SNCB and DB).

Electricity energy consumption

In the EPD, the electricity consumption is reported in Gigawatt-hours (GWh)[7] and it is calculated at the substation.

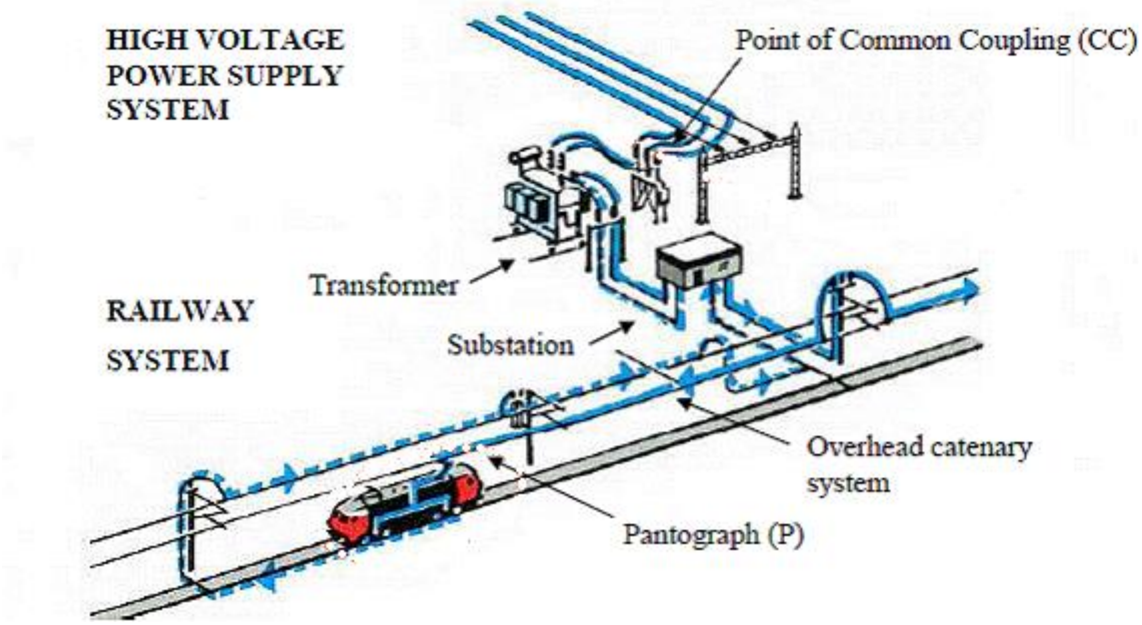


Fig. 4: Railway System and position of the Substation

If the RU reports the electricity consumption at pantograph rather than at substation, the average electricity losses in catenary are taken into account: the electricity losses in catenary are added to the consumption at pantograph in order to obtain the consumption at substation. For example, if a RU reports consumption at pantograph of 1,000 GWh and average electricity losses in catenary of 7%, the electricity consumption at substation will be calculated as follows:

$$1{,}000 \, * \, 100 \, / \, (100 - 7) \, = \, 1{,}075.27 \, GWh$$

If the RU is not able to provide a value for electricity losses, by default the average electricity losses in catenary are considered to be 5%.

Examples of calculation and estimation methodologies

There are different ways to measure electric consumption from traction, depending on the technological facilities available for the specific RU operator. The most common methodologies used in the EPD database are provided here below:

- Measurements at each vehicle based on on-board metering: if energy meters are

[7] The Gigawatt-hour (GWh) is a unit of energy equivalent to one Gigawatt (1GW) of power used for one hour (1h).

available on each vehicle, the measurement of data is very precise. The portion of energy utilized for each different service type can be easily obtained.

- Estimates based on energy consumption for each class of vehicles multiplied by the company's production figures. As an example, a passenger company with the fleet shown in the following table will have a total consumption of 650 GWh per year.

Class of vehicle	Number of vehicles	Energy consumption per vehicle (kWh/km)	Average annual mileage for each vehicle (million km)	Annual consumption (GWh)
A	100	0.05	50	100*0.05*50=250
B	200	0.1	20	200*0.1*20=400
			Total	650

- Estimates based on the recording of total consumption of electricity at substation, using appropriate factors to differentiate between Passenger and Freight traffic and between different service types, for instance by using the share of production in gross tkm. As an example, with a total annual electricity consumption of 1,000 GWh per year and the production data in the following table, it is possible to estimate the electricity consumption for the different service types.

The choice of the methodology is up to RUs and it is linked to the technology availability in the country where they operate. The EPD database contains the information about the final energy consumption of electricity.

Diesel energy consumption

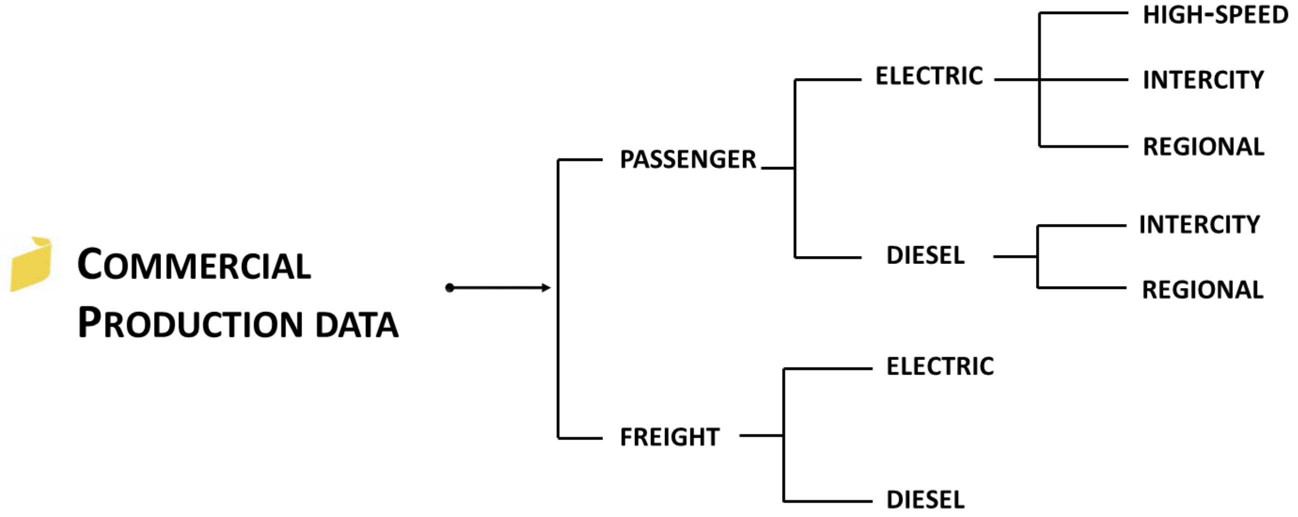
In the EPD database, the diesel consumption is reported in tonnes and it can be measured using fuel tank logs.

For some examples of calculation and estimation methodologies, it is possible to refer to the corresponding section in the paragraph "Electricity energy consumption".

2. Commercial Production (Operational Performance)

The ESRS collects the main commercial production data for the participating RUs. The collection of production data is functional to the generation of certain indicators, such as specific energy consumption and GHG emissions, which are measured by units of transport (passenger-km and tonnes-km).

The degree of detail collected is shown in the figure below:



The production data collected are:

- Train-km[8] for passenger and freight trains, both electric and diesel traction;
- Gross tonne-kilometres[9] for passenger and freight trains, both electric and diesel traction;
- Passenger-kilometres[10] (electric and diesel traction) for total passenger transport services, and for the different service types (local and regional, intercity and high- speed);
- Load factor of passenger transport services (total, local/regional, intercity, high-

[8] One train-km is one train travelling for one km. Total train-kms are calculated by multiplying the number of trains by the number of km they travel. This measure is not consistent throughout railways, as the size and weight of trains vary. It is however an indication of the magnitude of traffic.

[9] One gross tkm (tonne-kilometre) is one tonne (including weight of wagons, locomotives and cargo) travelling for one km. The gross tkm of one train is calculated by multiplying the total weight of the train by the distance it travels. This is different from the gross hauled tonne-km, which does not include the weight of locomotives.

[10] One passenger-km (pkm) is one passenger travelling for one km. The number of pkm is the number of passengers multiplied by the distance travelled per passenger.

speed); it can be calculated by dividing the passenger-km by the seat-km[11].

- Net tonne-kilometres[12] for freight transport services, both electric and diesel traction.

General observations:

- All the production data refer to **single train operators** and not national infrastructure managers. The production data should be consistent with the corresponding energy consumption data provided. This is especially relevant if a train operator runs on different national or international networks.

- *Shunting activities* (i.e. moving vehicles from one railway track to another) are included.

- *Empty trips* are taken into account, as they are an integral part of the system for the transportation of goods and passengers.

[11] One seat-km is one seat travelling for one km, calculated by multiplying the number of seats in a train by the distance travelled.

[12] One net tonne-km (net tkm) is one tonne of goods travelling for one km. The net tkm is the quantity of goods multiplied by the distance it travels.

3. GHG Emissions

The aim of the GHG emissions data collection is to obtain total and specific GHG emissions linked to the corresponding energy consumption. The GHG emissions calculated are well-to-wheel (WTW), corresponding to the primary energy consumption defined in UIC (2008a), with the boundaries shown in **Fig. 5**.

In the EPD, the unit of measure for emissions was CO2 until the 2016 data collection. Starting from the 2017 data collection, the main unity of measure for emissions is CO2-eq (for the calculation methodology, refer to Annex VI)[13].

This chapter and any reference to emissions in the present document have been updated to CO_2-eq.

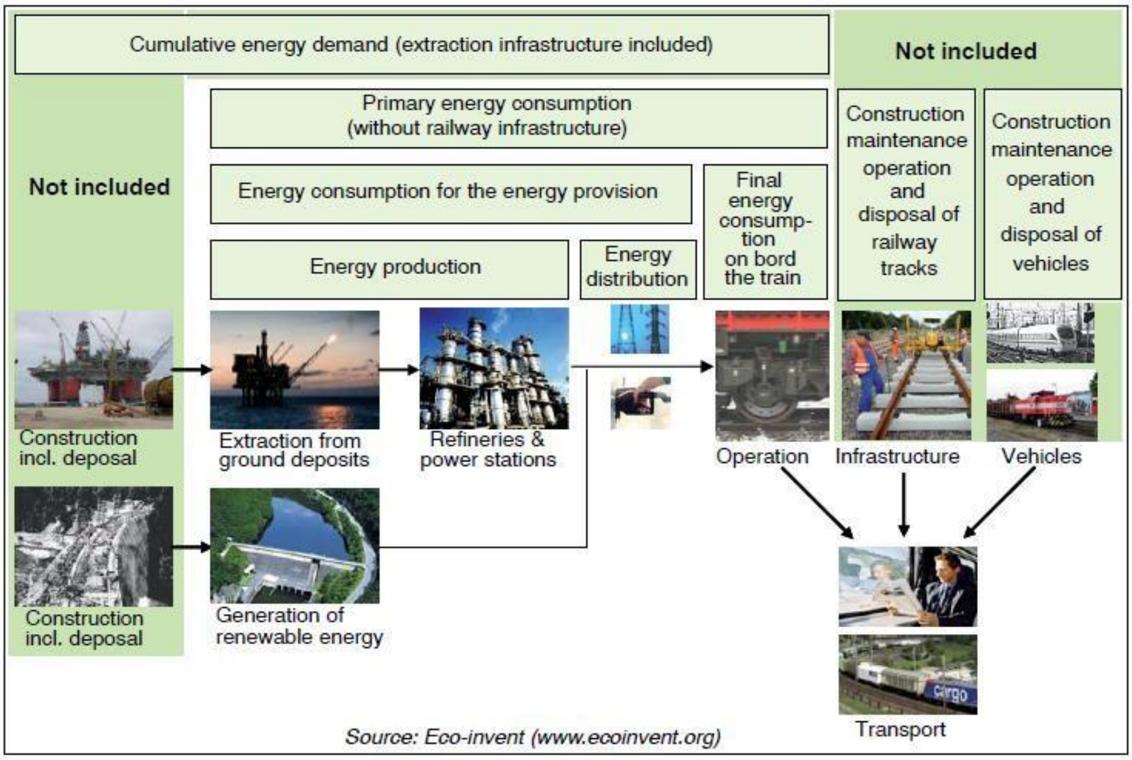


Fig. 5: Boundaries for primary energy consumption

Total GHG emissions from rail traction are the sum of emissions from diesel traction and emissions from electric traction.

GHG emissions, both electric and diesel, are the product of two factors multiplied: fuel consumption and emission factor. The emission factor represents the quantity of CO_2-eq expressed in grams released per kWh of electricity or kg of diesel used for traction.

For diesel traction, the emission factor used is given by the blend of diesel and biodiesel used by the railway (see Annex II).

For electric traction, following the UIC Zero-Carbon Project undertaken in 2013-2014, this methodology uses a dual approach (market-based and location-based) as recommended by the

[13] The need of this conversion comes from the opportunity to be aligned with the international reporting standards expressed by the UIC CO_2 Energy Network Members. In order to facilitate the transition from CO_2 to CO_2-eq indicators, both indicators will be collected and reported for a window of time, depending also on the availability of data for RUs.

GHG Protocol Scope 2 Guidance[14.]

This means that for each company, there are two values for each indicator related to emissions from electric traction:

- The **marked-based** value is reported by the RU according to its own methodology which should be consistent, transparent and - in line with the marked-based method of the GHG Protocol Scope 2 Guidance – may include green certificates such as Guarantees of Origin or Renewable Energy Certificates
- The **location-based** value is directly calculated by UIC using the national electricity production mix[15] and the energy consumption data reported by the company.

Marked-based and location-based values will be stored and used for the final reporting of the performance of railways towards UIC and CER 2020-2030 emission targets.

Thus, the database will contain a dual value (marked and location-based) for the following indicators[16]:

- CO_2-eq emission factor of traction electricity;
- Total CO_2-eq emissions;
- Specific CO_2-eq emissions.

If a RU cannot provide values for the previous indicators following the market-based method, the UIC will estimate those as well using the location-based approach. In that case, market-based and location-based values will be the same.

Electricity Mix

In the EPD, the electricity mix provided corresponds to the electricity purchased by the RU operator or distributed by the infrastructure manager to the operator.

The electricity mix indicates, in percentage, the sources from which electricity is produced. The sources to be indicated are:

- Coal (any type)
- Oil

[14] The GHG Protocol Scope 2 Guidance is used to account and report emissions from – among others – consumed electricity. http://www.ghgprotocol.org/scope_2_guidance

[15] In order to calculate the location-based emissions indicators for each railway company, UIC uses the National Electricity Production Mix provided in the Official EUROSTAT database.

[16] During the data delivery process, RUs will have to provide the Electricity mix and at least one from the Marked-based indicator cited above. RUs can choose to fill only one indicator between emission factor, total emissions and specific emissions. After the data input, the other indicators will be automatically calculated using production and consumption data previously entered. The consistency within values is therefore guaranteed.

- Gas
- Nuclear
- Other non-renewable
- Renewable, of which:
    - Wind
    - Hydroelectric (excluding hydroelectric from pumped storage units, as specified by EC 2009a)
    - Solar
    - Biomass
    - Other renewable (e.g. geothermal)

The electricity mix includes, if existing, the green electricity produced by power plants owned by the railway company and consumed directly for traction.

REC and Green Certificates

Following the UIC Zero-Carbon Project, the use of "Renewable Energy Certificates", as well as other "CO_2-free procurement" in general is regulated as follows:

- <u>No "carbon offsetting" should be taken into account;</u>
- <u>Green certificates such as Renewable Energy Certificates (RECs) or Guarantees of Origin (GOs) can be included in the electricity mix.</u>

CO_2-eq emission factor of traction electricity

The RU that provides the well-to-wheel emission factor from traction electricity, should also provide the methodology used for the calculation. The emission factor for electricity has to be derived from the electricity mix declared by the RU.

If the RU does not provide an emission factor for electricity, it will be calculated by UIC from the National Electricity Production Mix provided by Eurostat (for more information about the methodology please see the Annex III).

CO_2-eq emission factor of diesel and % of blended biodiesel

The CO_2-eq emission factor of diesel can be reported in two different ways.

1. The RU declares which is the percentage of biodiesel contained in the diesel fuel used. Filling in the percentage of blended biodiesel, the CO_2-eq emission factor of diesel will be automatically calculated according to the WTW emission factors for diesel and biodiesel reported in **Table 3**.
2. The RU can choose to report their own WTW diesel emission factor **already discounted by the percentage of biodiesel blended.** In this case, the RU has to provide the methodology of calculation, specifying the WTW CO_2-eq biodiesel emission factor and the percentage of blend (the calculation methodology is detailed in Annex II).

Diesel type	WTW emission factor for diesel (gCO_2-eq/kgDiesel)
Standard Diesel	3900 *(Source: CEN, EN 16258)*
Biodiesel	2160 *(Source: CEN, EN 16258)*

Table 3: WTW emission factors for diesel and biodiesel

Total CO_2-eq emissions

Total CO_2-eq emissions is calculated as the sum of total diesel emissions and total electric emissions. This figure will be reported in two ways:

- *Total CO2-eq marked-based emissions* in which the total electric emissions are calculated with the marked-based method (for more information, see p.18)
- *Total CO2-eq location-based emissions* in which the total electric emissions are calculated with the location-based method. This figure will be calculated and reported by UIC (for more information about the methodology see the Annex III).

Specific CO_2-eq emissions

Specific CO_2-eq emissions refer to total CO_2-eq emissions and production, both electric and diesel.

They are calculated as total CO_2-eq emissions divided by production (pkm for passenger and net-tkm for freight). Thus, specific passenger CO_2-eq emissions are reported in gCO_2-eq/pkm and specific freight CO_2-eq emissions are reported in gCO_2-eq/net-tkm.

Also the specific CO_2-eq emissions are reported in a dual way (market-based and location-based method), as explained in the Annex III.

4. PM and NO_X

In the EPD, the PM and NOx emissions are calculated with three different methodologies (called "levels"), according to the data that can be provided by the railways:

- **Level 1 (expert):** the RU can provide directly its **total annual PM and NOx emissions**. It should also specify the methodology used for calculating those emissions.
- **Level 2 (intermediate):** if the RU is not able to provide its total annual PM and NOx emissions, but it is able to provide data concerning the **composition and the detailed consumption of its diesel traction fleet** (specified by series), then PM and NOx emissions will be automatically calculated from that data by using standard PM and NOx emissions factors for traction diesel engines in railway tractive stock (locomotives and MUs).
- **Level 3 (basic):** if the RU cannot provide its total annual PM and NOx emissions, nor is it able to provide composition and detailed consumption data for its diesel traction fleet (specified by series), then a **proxy method** will be used to calculate PM and NOx emissions based on *total diesel consumption* and an *average composition of the diesel fleet*. The proxy method is described later in this section; it also makes use of some results of the EU co-funded "CleanER-D" project, sub-project 5 Sustainability & Integration[17].

Diesel fleet data

In order to support the calculation of PM and NOx exhaust emissions from diesel traction for each railway, the following data have been collected by UIC in 2012 about the diesel fleet of railways:

- diesel fleet composition by series, for DMUs/railcars and different types of locomotives, in particular:
  - emission performance of engines
  - number of units and engines for each type of DMU/railcar or locomotive
  - power of traction engine
  - average annual mileage per vehicle (in train-km and gross tonne-km)

The diesel fleet composition by series will be updated by UIC every three years by sending to all UIC members a questionnaire on diesel fleet composition. The diesel fleet composition request table is in Annex IV.

The data entry in this section is optional: if none of the indicators is filled, the PM and NOx will be calculated with the Level 3 (basic) methodology.

For an overview of the methodology used to calculate PM and NOx emissions in the different levels,

[17] http://www.cleaner-d.eu/

please see **Annex V**.

General information

RUs will contribute according to the availability of data.

- RUs that can provide total annual PM and NOx emissions (Level 1) should enter them directly.
- RUs that cannot provide total annual PM and NOx emissions, but are able to provide data concerning the composition and the detailed consumption of their diesel traction fleet (Level 2) will not fill indicators about PM and NOx emissions, but will provide details about the diesel fleet.
- RUs that cannot provide the above data can leave these indicators blank. A proxy method (Level 3) will be used to estimate their PM and NOx emissions.

PM and NOx emissions

The emissions are indicated in tonnes. The methodology used by the RU to calculate the emissions has to be specified. RUs can insert references to documents where the methodology is described in more detail.

Diesel consumption per series

The diesel consumption (in tonnes) has to be specified for all the categories listed in Annex II:

- DMUs/railcars with power greater than 130kW (Pre-UIC, UIC I, UIC II, IIIA and IIIB);
- Locomotives with power between 130 and 560 kW (Pre-UIC, UIC I, UIC II, IIIA and IIIB);
- Locomotives with power between 560 and 2,000 kW (Pre-UIC, UIC I, UIC II, IIIA and IIIB);
- Locomotives with power greater than 2,000 kW (Pre-UIC, UIC I, UIC II, IIIA and IIIB).

The categories Pre-UIC, UIC I, UIC II, IIIA and IIIB are the exhaust emission regulation stages of diesel engines, defined in UIC (2012) for UIC I and UIC II, in EC (1997) (and its amendments) for stages IIIA and IIIB. Pre-UIC is a term used for all railway diesel engines not complying to emission limit stages as defined in UIC (2012) or EC (1997) and its amendments and brought into operation before the coming into force of UIC I emission stage[18]. The power class classification has been made according to EC (1997) as the currently valid legislation.

[18] For an overview on exhaust emission performance of so-called pre-UIC railway diesel engines, see UIC (2006), p. 22f and ARCADIS (2009), p. 310. Additionally, ORE (n.y.) specified exhaust limit recommendations for locomotive diesel engines, starting from 1978 and regularly revised until UIC I (ORE: Office of Research and Experiments of the International Union of Railways, expired).

5. Drivers for Energy Efficiency Improvement

As quoted in the Emission Reduction Guidelines (UIC 2007), “Increasing the energy efficiency in traction is […] the major factor in reducing CO_2 emissions by railways”. It is therefore extremely useful to understand what the drivers of energy efficiency improvement of all railways are, so that they can be used as “lessons learned” to foster the same type of improvement for other railways.

RUs indicate the effectiveness of the methods they use to improve energy efficiency.

Energy consumption measurement

RUs indicate how they measure energy consumption. The possibilities are:

- On-board metering;
- Alternative technical solution;
- Estimates from infrastructure data;
- Other.

Extent of the impact on energy efficiency from the following measures

RUs indicate, for all categories, to what extent (in percentage) the following measures have contributed to improve energy efficiency in the last 3 years.

- *Eco-driving:* train drivers trained to understand how energy is consumed and how to drive more efficiently;
- *Increase of load factor:* an increased load factor measured and improved with efficient management measures such as the reduction of empty trips and a more productive daily offer;
- *More efficient rolling stock:* use of (new or refurbished) locomotives, EMUs and DMUs designed to be more energy efficient, both in traction and in “hotel loads”;
- *Regenerative braking:* re-using the amount of electricity sent back to the grid, e.g. via the reversible substations;
- *Infrastructure energy efficiency management:* measures include lowering energy losses from internal grid and catenary, energy efficient timetabling, train control etc.;
- *Other:* if other measures are applied by RUs, it is possible to specify what they are and the impact they have had on energy efficiency.

For a detailed description of measures that can improve energy efficiency in railways, see the UIC publication “Process, Power, People. Energy Efficiency for Railway Managers” (UIC, 2008b), available at the following URL: www.uic.org/download.php/publication/522E.pdf

Green electricity production by railway

The RU may say whether it is actually producing green electricity, for example through own hydroelectric power plants, windmills or photovoltaic panel installations. If that is the case, the following information are going to be specified:

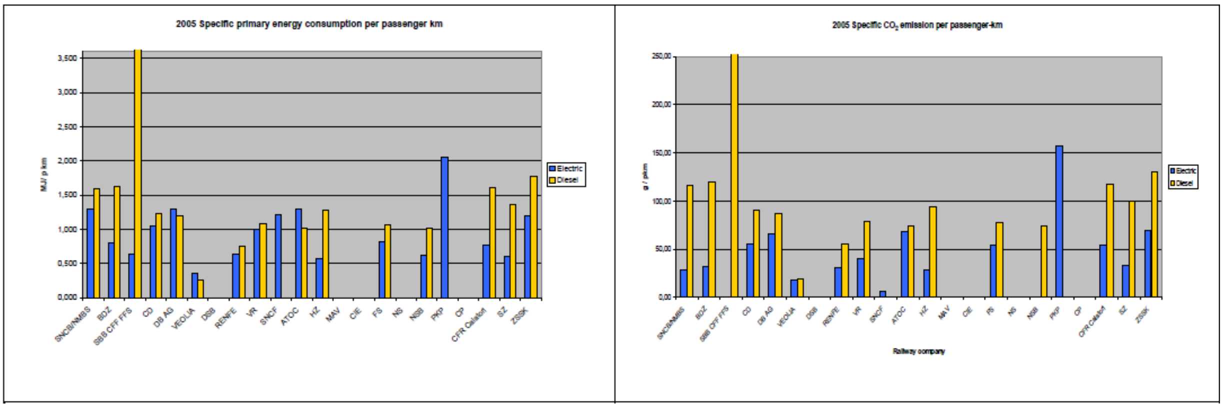
- Total power installed (in MW);
- Green electricity produced by railway and used in traction (in GWh). This entry should exclude the green electricity produced by the railway and sold, or used for non-traction purposes (such as powering buildings or workshops).

Section B – The policy for external communication of data

Introduction

Over the last 6 years, the UIC has performed a strong effort to collect, among its Members, a detailed railway energy database, containing very specific information about the energy consumption (and the consequential GHG emissions) of most of European railway companies. The pool of data starts with year 2005.

This work, unique in terms of quality and wideness of the data, has become more and more appealing to Institutions, Universities, Research Institutes or business companies that might have an interest (commercial or not) in using it.



Examples of outputs of the UIC database

As a matter of fact, the UIC has already received a number of requests from different bodies (EU, UN, research bodies, on-line calculators etc.) that are applying for the use of the energy database.

This document contains the guidelines for the external handling of the UIC energy and GHG database and aims to define a structured policy for its dissemination and use.

The cession of the database has to follow certain rules and principles here defined, while possible links and references to the UIC Ecotools (based on the UIC energy database) are generally welcome (see also “EcoTransIT communication strategy” document) with no particular restrictions.

Database Use Strategy

Targets

There are three main beneficiaries groups, which it is possible to focus on:

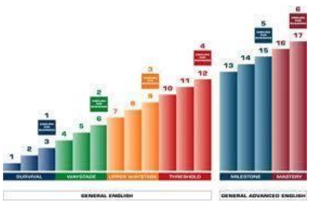
1. **UIC members**
2. **Non UIC Members (Institutions, NGOs and Private Companies)**
3. **General public**

Legal agreement on the database use

Every time the database is given or sold to a non UIC member, it should be signed a "Legal agreement on the UIC energy and GHG database use" between UIC and the receiver of the database (single person, person representing an Institution etc.). This agreement is necessary to give UIC, from a legal point of view, a further guarantee of correct and responsible use of its energy data.

The agreement paper has to be registered in the UIC files and one copy has always to be available at the UIC Sustainability Department.

Templates



For each of the possible beneficiaries it's hereafter proposed an authorization criteria and possible data quality levels, indicating the procedures to decide whether to give or not the database to the requester and possible aggregation of the provided data, to be chosen between 3 different levels:

- **Level 1 – Detailed data per Company**: includes the complete UIC energy and GHG database (Table 84-UIC statistics), detailed at single Company level.

- **Level 2 – Main data per Company**: includes main information about specific energy consumption and the related CO_2-eq emissions at single Company level.

- **Level 3 – Main data at EU average**: includes main information about specific energy consumption and the related CO_2-eq emissions of the railway sector in Europe.

<u>Fee</u>

Under certain conditions, a price for the **database could be charged. The money gained by selling the** database would be re-invested in the development and improvement of the UIC data collection activity.

As general guideline, the database could be:

1. **free of charge** for UIC Members and Institutions;

2. **with or without charge** for NGOs, according to the UIC evaluation to be made case by case;

3. **with a charge** for all Private Companies and profit-making Bodies.

1. UIC Members

UIC active and associate Members will have free and direct access to the maximum level of data quality (**Level 1** - Detailed data per Company), by downloading the entire database in the restricted area of the UIC website (accessible only with user-id and password).

2. Non UIC Members (Institutions, NGOs and Private Companies)

Non UIC Members (Institutions, NGOs or Private Companies), **will have access to Level 2 -** Main data per Company**.**

The UIC and CER will follow these steps:

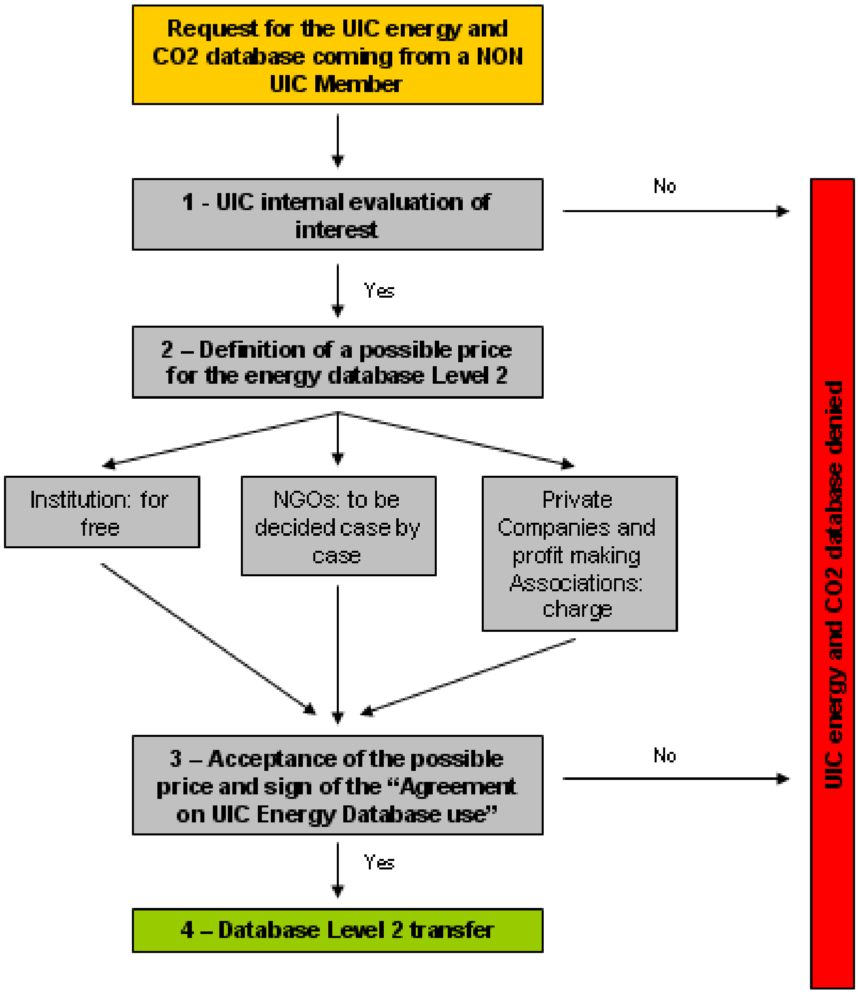
a. Decision whether a reasonable interest (in terms of visibility, prestige, possible strategic advantages/agreements, monetary etc.) in giving the database is present;

b. Decision whether to charge a price for it or not, according to the mentioned scheme (free for Institutions, with or without charge for NGOs according to UIC evaluation, always with a charge for Private Companies and profit-making Bodies);

c. Signature of the “Legal agreement on UIC Energy and GHG Database use”;

d. Transfer of the database Level 2.

This process can be summarised with the following flow chart:



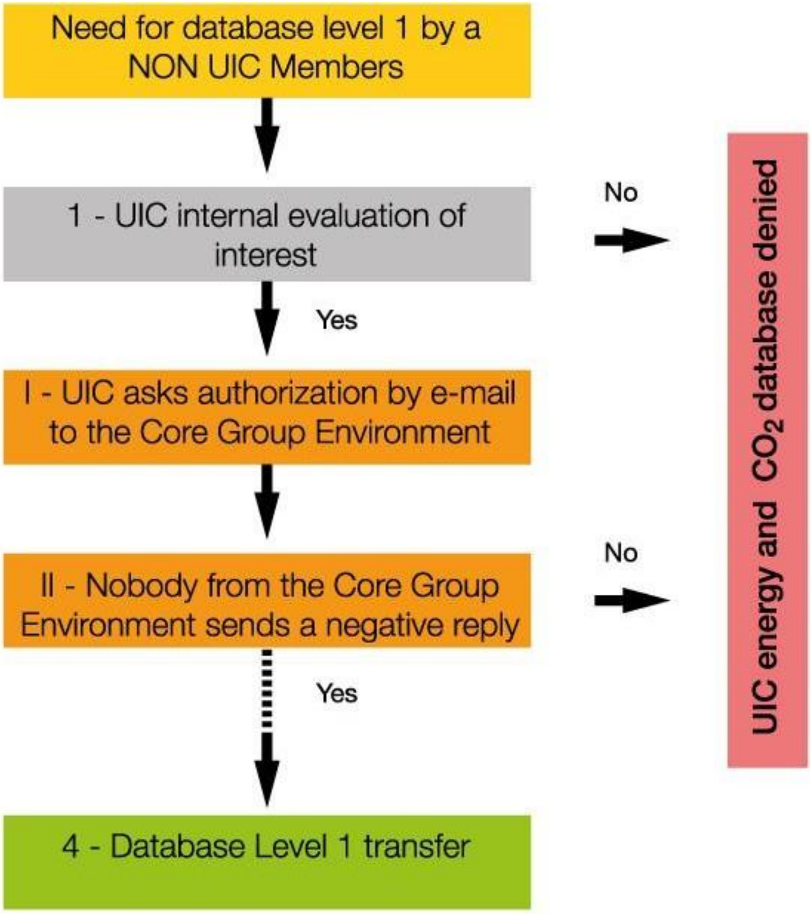
Exemption to the rule:

In particular cases, if it is evaluated that a Non-UIC member should receive the maximum level of data quality (Level 1 - Detailed data per Company), UIC Env. Department will send the UIC/CER Core Group Environment an e-mail for:

I. Asking the authorization to give the UIC energy and CO_2 database at **Level 1**, specifying what kind of use the possible beneficiary would make out of it, explaining the reasons why it would be convenient for UIC and/or its Members to do it.

If nobody from the Core Group Environment sends a negative reply, UIC will proceed as described in points 3 and 4.

This process can be summarized by integrating the previous flow chart as follows:

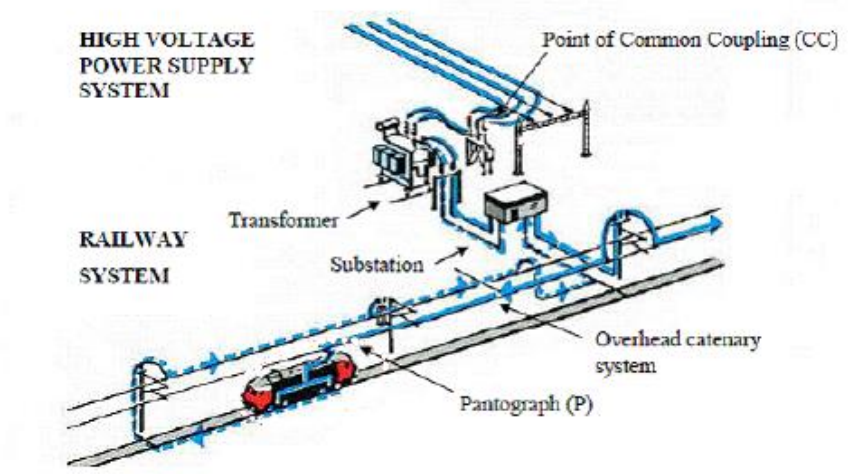


3. General public

It is important that UIC preserves the data quality level in the external communication to the general public (meaning UIC leaflets, publication, internet pages, press release etc.).

Towards the General Public, a use of the **Level 3 - Main data at EU level** will be made. Any other data quality level use has to be agreed in compliance with the previous chapter.

Annex I – RUs manual

A	ELECTRICITY	
1_01	ENERGY MEASUREMENT	
1_01_01	Energy measured at pantograph or substation	It reports if final energy consumption is measured at pantograph or at substation. If the answer is pantograph the average loss in catenary indicated in 1_01_02 will be added to the energy consumption at pantograph in order to obtain the final energy consumption (see indicators from 1_02_07 to 1_02_12) 
1_01_02	Average loss in catenary	The average electricity loss between substation and catenary. The default value is 5%.
1_02	Final energy consumption of electric trains	

Final electricity consumption directly by motive power units. This consumption includes auxiliary consumption for heating, air-conditioning, lighting, on-board catering, etc. **The final energy consumption does not take into account:** - **The electricity used by: maintenance workshops, stations, railway offices and buildings (non-traction energy);** - **The energy consumed in the "pre-chain" (exploration, extraction, transformation, transportation, etc.), to get the electricity to the substation.**		
1_02_01	Energy consumption of passenger trains	Final energy consumption of passenger trains
1_02_02	Local/Regional	Final energy consumption of local/regional passenger trains
1_02_03	Intercity	Final energy consumption of intercity passenger trains
1_02_04	High-speed	Final energy consumption of high-speed passenger trains
1_02_05	Energy consumption of freight trains	Final energy consumption of passenger trains
1_02_06	Total energy consumption	Automatic calculation; the cell cannot be modified. Sum of final energy consumption of passenger trains and of final energy consumption of freight trains
Final electricity consumption taken into account is meant <u>at the substation</u> (indicators 1_02_07 to 1_02_12). Hence, **- If you measure energy <u>at substation</u>, values entered within 1_02_01 and 1_02_06 will be considered without changes.** **- If you measure energy <u>at pantograph</u>, the percentage of energy lost in catenary (1_01_02) will be added to the values entered.**		
1_02_07	At the substation - Energy consumption of passenger trains	Final energy consumption of passenger trains at the substation
1_02_08	At the substation - Local/Regional	Final energy consumption of local/regional passenger trains at the substation
1_02_09	At the substation - Intercity	Final energy consumption of intercity passenger trains at the substation
1_02_10	At the substation - High-speed	Final energy consumption of high-speed passenger trains at the substation

1_02_11	At the substation - Energy consumption of freight trains	Final energy consumption of passenger trains at the substation
1_02_12	At the substation - Total energy consumption	Automatic calculation; the cell cannot be modified. Sum of final energy consumption of passenger trains at the substation and of final energy consumption of freight trains at the substation
1_03	**Gross tkm**	
One gross tkm (tonne-kilometre) is one tonne (including weight of wagons, locomotives and cargo) travelling for one km. You can calculate the gross tkm of one train by multiplying the total weight of the train by the distance it travels. **This is different from the gross hauled tonne-km, which does not include the weight of locomotives.**		
1_03_01	Corresponding gross tkm of passenger trains	Gross tkm of passenger trains corresponding to the final electricity consumption declared in 1_02_01
1_03_02	Local/Regional	Gross tkm of local/regional passenger trains corresponding to the final electricity consumption declared in 1_02_02
1_03_03	Intercity	Gross tkm of intercity passenger trains corresponding to the final electricity consumption declared in 1_02_03
1_03_04	High-speed	Gross tkm of high-speed passenger trains corresponding to the final electricity consumption declared in 1_02_04
1_03_05	Corresponding gross tkm of freight trains	Gross tkm of freight trains corresponding to the final electricity consumption declared in 1_02_05
1_04	**Train km**	
One train-km is one train travelling for one km. You can calculate train-km by multiplying the number of trains by the number of km they travel.		
1_04_01	Corresponding train km of passenger trains	Train-km of passenger trains corresponding to the final electricity consumption declared in 1_02_01

1_04_02	Local/Regional	Train-km of local/regional passenger trains corresponding to the final electricity consumption declared in 1_02_02
1_04_03	Intercity	Train-km of local/regional passenger trains corresponding to the final electricity consumption declared in 1_02_03
1_04_04	High-speed	Train-km of high-speed passenger trains corresponding to the final electricity consumption declared in 1_02_04
1_04_05	Corresponding train km of freight trains	Train-km of freight trains corresponding to the final electricity consumption declared in 1_02_05
1_05	**Production**	
One passenger-km (pkm) is one tonne of goods travelling for one km. The net tkm is the quantity of good multiplied by the distance it travels.		
1_05_01	Corresponding train km of passenger trains	Production of passenger trains corresponding to the final electricity consumption declared in 1_02_01
1_05_02	Local/Regional	Production of local/regional passenger trains corresponding to the final electricity consumption declared in 1_02_02
1_05_03	Intercity	Production of intercity passenger trains corresponding to the final electricity consumption declared in 1_02_03
1_05_04	High-speed	Production of high-speed passenger trains corresponding to the final electricity consumption declared in 1_02_04
One net tonne-km (net tkm) is one tonne of goods travelling for one km. The net tkm is the quantity of goods multiplied by the distance it travels.		
1_05_05	Corresponding train km of freight trains	Production of freight trains corresponding to the final electricity consumption declared in 1_02_05
B	DIESEL	

<table>
<tr><td>2_01</td><td colspan="2">Final energy consumption of diesel trains</td></tr>
<tr><td colspan="3">Final diesel consumption directly by motive power units. This consumption includes auxiliary consumption for heating, air-conditioning, lighting, on-board catering, etc. The final energy consumed shall be defined in terms of the fuel (volume of diesel) measured at the tank.
The final energy consumption does not take into account:
• The diesel used by: maintenance workshops, stations, railway offices and buildings (non-traction energy);
• The energy consumed in the “pre-chain” (exploration, extraction, transformation, transportation, etc.), to get the fuel to the filling station (primary energy).</td></tr>
<tr><td>2_01_01</td><td>Energy consumption of passenger trains</td><td>Final energy consumption of passenger trains</td></tr>
<tr><td>2_01_02</td><td>Local/Regional</td><td>Final energy consumption of local/regional passenger trains</td></tr>
<tr><td>2_01_03</td><td>Intercity</td><td>Final energy consumption of intercity passenger trains</td></tr>
<tr><td>2_01_04</td><td>High-speed</td><td>Final energy consumption of high-speed passenger trains</td></tr>
<tr><td>2_01_05</td><td>Energy consumption of freight trains</td><td>Final energy consumption of passenger trains</td></tr>
<tr><td>2_01_06</td><td>Total energy consumption</td><td>Automatic calculation; the cell cannot be modified. Sum of final energy consumption of passenger trains and of final energy consumption of freight trains</td></tr>
<tr><td>2_02</td><td colspan="2">Gross tkm</td></tr>
<tr><td colspan="3">One gross tkm (tonne-kilometre) is one tonne (including weight of wagons, locomotives and cargo) travelling for one km. You can calculate the gross tkm of one train by multiplying the total weight of the train by the distance it travels.
This is different from the gross hauled tonne-km, which does not include the weight of locomotives.</td></tr>
<tr><td>2_02_01</td><td>Corresponding gross tkm of passenger trains</td><td>Gross tkm of passenger trains corresponding to the final diesel consumption declared in 2_01_01</td></tr>
<tr><td>2_02_02</td><td>Local/Regional</td><td>Gross tkm of local/regional passenger trains corresponding to the final diesel consumption declared in 2_01_02</td></tr>
</table>

2_02_03	Intercity	Gross tkm of intercity passenger trains corresponding to the final diesel consumption declared in 2_01_03
2_02_04	High-speed	Gross tkm of high-speed passenger trains corresponding to the final diesel consumption declared in 2_01_04
2_02_05	Corresponding gross tkm of freight trains	Gross tkm of freight trains corresponding to the final diesel consumption declared in 2_01_05
2_03	**Train km**	
One train-km is one train travelling for one km. You can calculate train-km by calculating the number of trains by the number of km they travel.		
2_03_01	Corresponding train km of passenger trains	Train-km of passenger trains corresponding to the final electricity consumption declared in 2_01_01
2_03_02	Local/Regional	Train-km of local/regional passenger trains corresponding to the final electricity consumption declared in 2_01_02
2_03_03	Intercity	Train-km of local/regional passenger trains corresponding to the final electricity consumption declared in 2_01_03
2_03_04	High-speed	Train-km of high-speed passenger trains corresponding to the final electricity consumption declared in 2_01_04
2_03_05	Corresponding train km of freight trains	Train-km of freight trains corresponding to the final electricity consumption declared in 2_01_05
2_04	**Production**	
One passenger-km (pkm) is one tonne of goods travelling for one km. The net tkm is the quantity of good multiplied by the distance it travels.		
2_04_01	Corresponding production of passenger trains	Production of passenger trains corresponding to the final electricity consumption declared in 2_01_01

2_04_02	Local/Regional	Production of local/regional passenger trains corresponding to the final electricity consumption declared in 2_01_02
2_04_03	Intercity	Production of intercity passenger trains corresponding to the final electricity consumption declared in 2_01_03
2_04_04	High-speed	Production of high-speed passenger trains corresponding to the final electricity consumption declared in 2_01_04
One net tonne-km (net tkm) is one tonne of goods travelling for one km. The net tkm is the quantity of goods multiplied by the distance it travels.		
2_04_05	Corresponding production of freight trains	Production of freight trains corresponding to the final electricity consumption declared in 2_01_05
C	ENERGY AND GHG EMISSIONS	
3_01	**Electricity mix**	
The mix of energy sources used to generate the electricity used by the railway. This indicator should be calculated with the marked-based method, i.e. take into account green certificates (GOs and RECs) where present. **The electricity mix provided should be the one corresponding to the electricity purchased by the railway operator or distributed by the infrastructure manager to the operator.**		
3_01_01	Electricity mix: Coal	Percentage of coal in the Electricity mix
3_01_02	Electricity mix: Oil	Percentage of oil in the Electricity mix
3_01_03	Electricity mix: Gas	Percentage of gas in the Electricity mix
3_01_04	Electricity mix: Nuclear	Percentage of nuclear energy in the Electricity mix
3_01_05	Electricity mix: Other Non Renewable	Percentage of other non-renewable energy in the Electricity mix
3_01_06	Electricity mix: Renewable	Percentage of renewable energy in the Electricity mix

3_01_07	Electricity mix: of which wind	Percentage of wind energy in the Electricity mix
3_01_08	Electricity mix: of which hydroelectric	Percentage of hydroelectric energy in the Electricity mix
3_01_09	Electricity mix: of which solar	Percentage of solar energy in the Electricity mix
3_01_10	Electricity mix: of which biomass	Percentage of biomass in the Electricity mix
3_01_11	Electricity mix: of which other	Percentage of biomass in the Electricity mix
3_02	**CO2-eq electricity emission**	
3_02_01	CO2-eq emission factor for electric traction	Well-to-wheel CO_2-equivalent emission factor of electricity used by railway corresponding to the electricity mix provided in 3_01. The CO_2-eq emission factor for electric traction must be coherent with figures declared in 3_03 and 3_04. If the CO_2-eq emission factor is not provided, it will be replaced with the location-based emission factor.
3_03	**Electric traction: total CO2-eq emissions**	
The emissions for electric traction should be calculated by taking into account green certificates such as REC and GOs. **Total CO_2-eq emissions for electric traction must be coherent with figures declared in 3_02 and 3_04.**		
3_03_01	Electric traction: Total CO2-eq emissions of passenger trains	Total CO_2-eq emissions of electric passenger trains
3_03_02	Local/Regional	Total CO_2-eq emissions of electric local/regional passenger trains
3_03_03	Intercity	Total CO_2-eq emissions of electric intercity passenger trains
3_03_04	High-speed	Total CO_2-eq emissions of electric high-speed passenger trains
3_03_05	Electric traction: Total CO2-eq emissions of freight trains	Total CO_2-eq emissions of electric freight trains

3_03_06	Electric traction: Total CO2-eq emissions of freight trains	Automatic calculation; the cell cannot be modified. Sum of total CO_2-eq emissions of electric passenger trains and of total CO_2-eq emissions of electric freight trains.
3_04	**Electric traction: specific CO2-eq emissions**	
Specific CO_2-eq emissions for electric traction must be coherent with figures declared in 3_02 and 3_03.		
3_04_01	Electric traction: Specific CO2-eq emissions of passenger trains	Specific CO_2-eq emissions of electric passenger trains
3_04_02	Local/Regional	Specific CO_2-eq emissions of electric local/regional passenger trains
3_04_03	Intercity	Specific CO_2-eq emissions of electric intercity passenger trains
3_04_04	High-speed	Specific CO_2-eq emissions of electric high-speed passenger trains
3_04_05	Electric traction: Specific CO2-eq emissions of freight trains	Specific CO_2-eq emissions of electric freight trains
3_05	**CO2 electricity emission factor**	
3_05_01	CO2 emission factor for electric traction	Well-to-wheel CO_{2}-equivalent emission factor of electricity used by railway corresponding to the electricity mix provided in 3_01. The CO_2 emission factor for electric traction must be coherent with figures declared in 3_06 and 3_07. If the CO_2 emission factor is not provided, it will be replaced with the location-based emission factor.
3_06	**Electric traction: total CO2 emissions**	
The emissions for electric traction should be calculated by taking into account green certificates such as REC and GOs. **Total CO_2 emissions for electric traction must be coherent with figures declared in 3_05 and 3_07.**		
3_06_01	Electric traction: Total CO2 emissions of passenger trains	Total CO_2 emissions of electric passenger trains
3_06_02	Local/Regional	Total CO_2 emissions of electric local/regional passenger trains

3_06_03	Intercity	Total CO_2 emissions of electric intercity passenger trains
3_06_04	High-speed	Total CO_2 emissions of electric high-speed passenger trains
3_06_05	Electric traction: Total CO2 emissions of freight trains	Total CO_2 emissions of electric freight trains
3_06_06	Electric traction: Total CO2 emissions of freight trains	Automatic calculation; the cell cannot be modified. Sum of total CO_2 emissions of electric passenger trains and of total CO_2 emissions of electric freight trains.
3_07	**Electric traction: specific CO2 emissions**	
Specific CO_2 emissions for electric traction must be coherent with figures declared in 3_05 and 3_06.		
3_07_01	Electric traction: Specific CO2 emissions of passenger trains	Specific CO_2 emissions of electric passenger trains
3_07_02	Local/Regional	Specific CO_2 emissions of electric local/regional passenger trains
3_07_03	Intercity	Specific CO_2 emissions of electric intercity passenger trains
3_07_04	High-speed	Specific CO_2 emissions of electric high-speed passenger trains
3_07_05	Electric traction: Specific CO2 emissions of freight trains	Specific CO_2 emissions of electric freight trains
3_08	**CO2-eq diesel emission factor**	
The CO_2-eq emission factor for diesel traction must be coherent with figures declared in 3_09 and 3_10.		
3_08_01	% of blended diesel	Amount of biodiesel that is blended in the diesel used by the railway. The default value is 5%.
3_08_02	CO2-eq emission factor of diesel traction	If the percentage of biodiesel (3_08_01) has been entered, diesel emission factor is automatically calculated. The calculation methodology is described below:

Type of diesel	WTW Emission factor for diesel gCO_2-eq/kgDiesel
Standard Diesel	3900
Biodiesel	2160

If for example, the percentage of blended biodiesel declared (3_08_01) is 10%, the CO_2-eq diesel emission factor used by the railway will be:

*3900 * 90% + 2160 * 10% = 3726 gCO2-eq/kgDiesel*

Remark: The railway can specify its own well-to-wheel CO_2-eq emission factor if preferred. The CO_2-eq emission factor declared by the railway must be already discounted of the percentage of biodiesel.

3_09	**Diesel traction: total CO2 emissions**	
Total CO_2-eq emissions for diesel traction must be coherent with figures declared in 3_08 and 3_10.		
3_09_01	Diesel traction: Total CO2-eq emissions of passenger trains	Total CO_2-eq emissions of diesel passenger trains
3_09_02	Local/Regional	Total CO_2-eq emissions of diesel local/regional passenger trains
3_09_03	Intercity	Total CO_2-eq emissions of diesel intercity passenger trains
3_09_04	High-speed	Total CO_2-eq emissions of diesel high-speed passenger trains
3_09_05	Diesel traction: Total CO2-eq emissions of freight trains	Total CO_2-eq emissions of diesel freight trains
3_09_06	Diesel traction: Total CO2-eq emissions of freight trains	Automatic calculation; the cell cannot be modified. Sum of total CO_2-eq emissions of diesel passenger trains and of total CO_2-eq emissions of diesel freight trains.
3_10	**Diesel traction: specific CO2-eq emissions**	

<table>
<tr><td colspan="3">Specific CO_2-eq emissions for diesel traction must be coherent with figures declared in 3_08 and 3_09.</td></tr>
<tr><td>3_10_01</td><td>Diesel traction: Specific CO2-eq emissions of passenger trains</td><td>Specific CO_2-eq emissions of diesel passenger trains</td></tr>
<tr><td>3_10_02</td><td>Local/Regional</td><td>Specific CO_2-eq emissions of diesel local/regional passenger trains</td></tr>
<tr><td>3_10_03</td><td>Intercity</td><td>Specific CO_2-eq emissions of diesel intercity passenger trains</td></tr>
<tr><td>3_10_04</td><td>High-speed</td><td>Specific CO_2-eq emissions of diesel high-speed passenger trains</td></tr>
<tr><td>3_10_05</td><td>Diesel traction: Specific CO2-eq emissions of freight trains</td><td>Specific CO_2-eq emissions of diesel freight trains</td></tr>
<tr><td>3_11</td><td colspan="2">CO2 diesel emission factor</td></tr>
<tr><td colspan="3">The CO_2 emission factor for diesel traction must be coherent with figures declared in 3_12 and 3_13.</td></tr>
<tr><td>3_11_01</td><td>% of blended diesel</td><td>Amount of biodiesel that is blended in the diesel used by the railway. The default value is 5%.</td></tr>
<tr><td>3_11_02</td><td>CO2 emission factor of diesel traction</td><td>If the percentage of biodiesel (3_11_01) has been entered, diesel emission factor is automatically calculated. The calculation methodology is described below:<table>
<tr><th>Type of diesel</th><th>WTW Emission factor for diesel
$gCO_2/kgDiesel$</th></tr>
<tr><td>Standard Diesel</td><td>3582</td></tr>
<tr><td>Biodiesel</td><td>2130</td></tr>
</table>If for example, the percentage of blended biodiesel declared (3_11_01) is 10%, the CO_2 diesel emission factor used by the railway will be:</td></tr>
</table>

		*3582 * 90% + 2130 * 10% = 3436.8 gCO2/kgDiesel* Remark: The railway can specify its own well-to-wheel CO_2 emission factor if preferred. The CO_2 emission factor declared by the railway must be already discounted of the percentage of biodiesel.
3_12	**Diesel traction: total CO2 emissions**	
Total CO_2 emissions for diesel traction must be coherent with figures declared in 3_11 and 3_13.		
3_12_01	Diesel traction: Total CO2 emissions of passenger trains	Total CO_2 emissions of diesel passenger trains
3_12_02	Local/Regional	Total CO_2 emissions of diesel local/regional passenger trains
3_12_03	Intercity	Total CO_2 emissions of diesel intercity passenger trains
3_12_04	High-speed	Total CO_2 emissions of diesel high-speed passenger trains
3_12_05	Diesel traction: Total CO2 emissions of freight trains	Total CO_2 emissions of diesel freight trains
3_12_06	Diesel traction: Total CO2 emissions of freight trains	Automatic calculation; the cell cannot be modified. Sum of total CO_2 emissions of diesel passenger trains and of total CO_2 emissions of diesel freight trains.
3_13	**Diesel traction: specific CO2 emissions**	
Specific CO_2 emissions for diesel traction must be coherent with figures declared in 3_11 and 3_12.		
3_13_01	Diesel traction: Specific CO2 emissions of passenger trains	Specific CO_2 emissions of diesel passenger trains
3_13_02	Local/Regional	Specific CO_2 emissions of diesel local/regional passenger trains
3_13_03	Intercity	Specific CO_2 emissions of diesel intercity passenger trains

3_13_04	High-speed	Specific CO_2 emissions of diesel high-speed passenger trains
3_13_05	Diesel traction: Specific CO2 emissions of freight trains	Specific CO_2 emissions of diesel freight trains
D	PM AND NOX EMISSIONS	
4_01	**PM emissions**	
4_01_01	Total PM emissions	Total PM emissions by railway
4_01_02	Total PM emissions: methodology	Methodology used to calculate PM emissions
4_02	**NOX emissions**	
4_02_01	Total NOX emissions	Total NO_X emissions by railway
4_02_02	Total NOX emissions: methodology	Methodology used to calculate NO_X emissions
4_03	**Diesel consumption per series**	
4_03_01	Diesel consumption: Railcar > 130 kW - Pre-UIC	Diesel consumption of Pre-UIC Railcar > 130 kW
4_03_02	Diesel consumption: Railcar > 130 kW - UIC 1	Diesel consumption of UIC 1 Railcar > 130 kW
4_03_03	Diesel consumption: Railcar > 130 kW - UIC 2	Diesel consumption of UIC 2 Railcar > 130 kW
4_03_04	Diesel consumption: Railcar > 130 kW - IIIA	Diesel consumption of IIIA Railcar > 130 kW
4_03_05	Diesel consumption: Railcar > 130 kW - IIIB	Diesel consumption of IIIB Railcar > 130 kW
4_03_06	Diesel consumption: Locomotive 130-560 kW - Pre-UIC	Diesel consumption of Pre-UIC Locomotive 130-560 kW
4_03_07	Diesel consumption: Locomotive 130-560 kW - UIC 1	Diesel consumption of UIC 1 Locomotive 130-560 kW
4_03_08	Diesel consumption: Locomotive 130-560 kW - UIC 2	Diesel consumption of UIC 2 Locomotive 130-560 kW

4_03_09	Diesel consumption: Locomotive 130-560 kW – IIIA	Diesel consumption of IIIA Locomotive 130-560 kW
4_03_10	Diesel consumption: Locomotive 130-560 kW - IIIB	Diesel consumption of IIIB Locomotive 130-560 kW
4_03_11	Diesel consumption: Locomotive 560-2000 kW - Pre-UIC	Diesel consumption of Pre-UIC Locomotive 560-2000 kW
4_03_12	Diesel consumption: Locomotive 560-2000 kW - UIC 1	Diesel consumption of UIC 1 Locomotive 560-2000 kW
4_03_13	Diesel consumption: Locomotive 560-2000 kW - UIC 2	Diesel consumption of UIC 2 Locomotive 560-2000 kW
4_03_14	Diesel consumption: Locomotive 560-2000 kW – IIIA	Diesel consumption of IIIA Locomotive 560-2000 kW
4_03_15	Diesel consumption: Locomotive 560-2000 kW - IIIB	Diesel consumption of IIIB Locomotive 560-2000 kW
4_03_16	Diesel consumption: Locomotive >2000 kW - Pre-UIC	Diesel consumption of Pre-UIC Locomotive >2000 kW
4_03_17	Diesel consumption: Locomotive >2000 kW - UIC 1	Diesel consumption of UIC 1 Locomotive >2000 kW
4_03_18	Diesel consumption: Locomotive >2000 kW - UIC 2	Diesel consumption of UIC 2 Locomotive >2000 kW
4_03_19	Diesel consumption: Locomotive >2000 kW – IIIA	Diesel consumption of IIIA Locomotive >2000 kW
4_03_20	Diesel consumption: Locomotive >2000 kW - IIIB	Diesel consumption of IIIB Locomotive >2000 kW
E	ELECTRICITY AND ENERGY EFFICIENCY	
5_01	**Load factor**	
5_01_01	Total Load factor	Load factor for passenger trains
5_01_02	Local/Regional	Load factor for local/regional passenger trains
5_01_03	Intercity	Load factor for intercity passenger trains

5_01_04	High-speed	Load factor for high-speed passenger trains
5_02	**Energy consumption measurement method**	
5_02_01	Method used to measure energy consumption	Methodology used to measure energy consumption
5_02_02	Details	If the answer to 5_02_01 is “On-board metering”, here it should be indicated the number of meters already installed. If the answer to 5_02_01 is not “On-board metering”, here you can add more details.
5_02_03	Details	If the answer to 5_02_03 is “On-board metering”, here it should be indicated the number of meters forecasted to be installed in the next 5 years.
5_03	**Impact on energy efficiency**	
It should be inserted here to which extent different measures indicated influence the energy efficiency. The impacts have to be measured in percentage: of the total energy efficient improvement, what is the impact in percentage of eco-driving initiatives? Of regenerative braking? The total has to be 100%.		
5_03_01	Impact on energy efficiency from Eco-driving	Impact on energy efficiency from Eco-driving
5_03_02	Impact on energy efficiency from Increase of load factor	Impact on energy efficiency from Increase of load factor
5_03_03	Impact on energy efficiency from More efficient rolling stock	Impact on energy efficiency from More efficient rolling stock
5_03_04	Impact on energy efficiency from Regenerative braking	Impact on energy efficiency from Regenerative braking
5_03_05	Impact on energy efficiency from Infrastructure energy efficiency management	Impact on energy efficiency from Infrastructure energy efficiency management
5_03_06	Impact on energy efficiency from Other (1)	Impact on energy efficiency from other measures. Please specify which measure.
5_03_07	Impact on energy efficiency from Other (2)	Impact on energy efficiency from other measures. Please specify which measure.

5_03_08	Impact on energy efficiency from Other (3)	Impact on energy efficiency from other measures. Please specify which measure.
5_04	**Factors influencing consumption**	
5_04_01	Factors influencing consumption	Open ended optional question. Describe which factors influence consumption.
5_05	**Green electricity production**	
5_05_01	Green electricity production by railway	If the railway produces directly green electricity through own power plants, please specify the installed power (in MW).
5_05_02	Green electricity production by railway used in traction	If the railway produces directly green electricity through own power plants, please specify how much of that electricity is used in traction (in Gwh).

Annex II – Methodology for the Calculation of the Emission Factor for Diesel

The default CO_2-equivalent emission factor for diesel is calculated with the following formula:

$$EFD_{Total} = EFD_{Standard} * [(1 - Sh]_B) + EFD_{Biodiesel} * Sh_B$$

Where:

- EFD_{Total} = CO_2-eq emission factor for the diesel blend used by the railway;
- $EFD_{Standard}$ = CO_2-eq emission factor for standard diesel;
- Sh_B = Share of biodiesel used by the railway;
- $EFD_{Biodiesel}$ = CO_2-eq emission factor for biodiesel;

The emission factors for standard diesel and biodiesel are shown in Table 3 and repeated below:

Diesel type	WTW emission factor for diesel (gCO_2-eq/kgDiesel)
Standard Diesel	3900 *(Source: CEN, EN 16258)*
Biodiesel	2160 *(Source: CEN, EN 16258)*

As an example, if the percentage of blended biodiesel declared by a railway is 10%, the CO2 emission factor of the blend used by the railway will be:

3900 * 90% + 2160 * 10% = 3726 gCO2-eq/kgDiesel

The railways can specify its own well-to-wheel CO_2-eq emission factor for diesel, but they have to add a remark explaining the methodology used to calculate the emission factor.

Note: The emission factor for biodiesel. The emission factor for biodiesel takes into account CO_2, CH_4 and N_2O emissions. The value considered for the emission factor for biodiesel is 2,160 gCO_2-eq/kgDiesel (source: CEN 2012, EN 16258; page 24, Table A.1)

Annex III – CO_2-eq emissions reporting and calculation with the location-based method

As explained in the document, following the UIC Zero-Carbon Project, it has been decided to use dual reporting for emissions from electric traction, in line with the GHG Protocol Scope 2 Guidance. Emissions calculated with the market-based approach (which may include green certificates) are reported directly by the RUs, while emissions calculated with the location-based approach are calculated by UIC using the following methodology.

Electric CO_2-eq emissions according to the location-based method of the GHG Protocol Scope 2 Guidance are calculated from energy consumption and location-based electric emission factor, as follows:

$$Em_{Electric\ (LOCATION)} = C_{Electric} * EF_{Electric\ (LOCATION)}$$

Where:

- $Em_{Electric\ (LOCATION)}$ = Location-based total CO_2-eq emissions of electric traction;
- $C_{Electric}$ = Electricity Consumption;
- $EF_{Electric\ (LOCATION)}$ = Location-based electric CO_2-eq emission factor.

The CO_2-eq emission factor from electricity is calculated by UIC based on national electricity production mix of the country of operation of the RU[19], national plants efficiency[20], CO_2-eq emission factors for stationary combustion in the energy industries[21] and the well-to-wheel overhead factor calculation[22].

The calculation takes into consideration all the energy operational processes and excludes the non-operational processes as per the definition of well-to-wheel in CEN (2012).

The calculation of the location-based CO2-eq emission factor is made as follows:

$$EF_{E\ (LOC)} = \left(\sum_{i=1}^{4} (\%_i \times M_i) \right) \times (1 + F_{Well-to-wheel})$$

Where

- i= primary sources index where
  - 1= Coal products (Anthracite);
  - 2= Oil products (Crude oil);
  - 3= Natural gas;
  - 4= Other non-renewable;
- $F_{Well\text{-}to\text{-}Wheel}$ is the well-to-wheel overhead factor
- $\%_i$ is the percentage of the i-th primary source in the national electricity production mix;

[19] Source: Eurostat

[20] Source: IEA

[21] Source: IPCC 2006 Tier 1

[22] Source: JRC EU Well-to-wheels analysis 2014

- M_i is the multiplier of the i-th primary source obtained as follows:

$$M_i = \frac{StechEF_i}{EFF_i}$$

Where

  - $StechEF_i$ is the CO_2-eq stoichiometric emission factor of the i-th primary source;
  - EFF_i is the efficiency of plants that use the i-th primary source, expressed as a percentage.

The value for location-based electric CO_2-eq is then added to the value for diesel CO_2-eq emissions to give rise to the value of total location-based CO_2-eq emissions:

$$Em_{Total\,(LOCATION)} = Em_{Diesel} + Em_{Electric\,(LOCATION)}$$

Specific CO_2-eq emissions are calculated by dividing total CO_2-eq emissions for a type of service by the production for that service. For example, specific CO_2-eq emissions for freight are calculated as follows:

$$Spec\ Em_{Freight} = \frac{Em_{Freight}}{Net - tonnekm}$$

The calculation of the location-based CO_2 electricity emission factor follows exactly the same method described above but using the CO_2 stoichiometric emission factors instead of the CO_2-eq stoichiometric emission factor.

Annex IV – Diesel Fleet Request Table

Categories according to amendment of directive 97/68	Emission performance of engines (e.g. pre-UIC, UIC1, UIC2, IIIA, IIIB limit values)	Emission performance of engines (please enter here your own engine specific emission values from measurement campaigns if you have these)	Number of traction engines per vehicle	Power of traction engine [kW]	Number of traction units (vehicles)	Average annual mileage per vehicle (train-km)	Average annual mileage per vehicle (gross tonne km)
Railcar> 130 kW	Pre-UIC						
	UIC I						
	UIC II						
	IIIA						
	IIIB						
Locomotive 130 - 560 kW	Pre-UIC						
	UIC I						
	UIC II						
	IIIA						
	IIIB						
Locomotive 560 - 2000 kW	Pre-UIC						
	UIC I						
	UIC II						
	IIIA						
	IIIB						
Locomotive > 2000 kW	Pre-UIC						
	UIC I						
	UIC II						
	IIIA						
	IIIB						

Annex V – Methodologies for the Calculation of PM and NOx Emissions

This annex reviews the different methodologies used to calculate PM and NOx emissions according to the data that can be provided by the railways. As a reminder, the different "levels" of available data are:

- **Level 1 (expert):** the railway can provide directly its total annual PM and NOx emissions.
- **Level 2 (intermediate):** the railway is not able to provide its total annual PM and NOx emissions, but it is able to provide data concerning the composition and the detailed consumption of its diesel traction fleet (specified by series).
- **Level 3 (basic):** the railway cannot provide its total annual PM and NOx emissions, nor is it able to provide composition and detailed consumption data for its diesel traction fleet (specified by series).

Level 1 (expert)

For level 1, the emissions and the methodology used to calculate them are directly provided by the railway.

Level 2 (intermediate)

The level 2 proxy method is based on the diesel fuel consumed per vehicle type/category and emission class. The total emissions per vehicle type and emission class are summed up to give total emissions per pollutant (NOx or PM):

$$Em_{Total} = \sum_{class} Em_{class}$$

Where:

- Em_{Total} = total emissions per pollutant (NOx, PM);
- Em_{class} = total emissions per pollutant (NOx, PM) for an emission class of vehicles.

The calculation of total emissions per emission class is as follows, for each emission type (NOx or PM):

$$Em_{Class} = C_{D\ EC} * EF_{D\ EC}$$

Where:

- Em_{class} = total emissions per pollutant (NOx, PM) for an emission class of vehicles;
- $C_{D\ EC}$ = total diesel consumption in tonnes per emission class and vehicle type;
- $EF_{D\ EC}$ = emission factor in g/tonne diesel fuel burned for the emission class and vehicle type.

The emission factor in g/tonne is being derived from the emission factors (limit values) which are given in g/kWh. Emission factors (or limit values) are being converted from g/kWh to g/tonne diesel fuel taking into account the proximate efficiency of the transmission chain from tank to wheel/track (e.g. efficiency of diesel engine, transmission, power demand of auxiliaries, axle gear efficiency). The calculation is as follows:

$$EF_D = EF_{kWh} * EC_D * CF_{ME}$$

Where:

- EF_D = emission factor in g/tonne;
- EF_{kWh} = emission factor in g/kWh;
- EC_D= energy conversion factor - kg diesel in kWh (1 kg diesel fuel = 11.93 kWh);
- CF_{ME} = conversion factor of efficiency of engine-to-wheel transmission (efficiency of diesel engine, transmission, auxiliaries power demand, axle gear)estimated to be0.36 (source: CleanER-D project, sub-project 5, experts estimation, range estimated from 0.34 to 0.38).

The emission factors for the different vehicle types and emission classes are contained in **Table 4**.

Exhaust emission values	**g/kWh**		**g/t diesel**	
	NOx	PM	NOx	PM
Railcars				
Pre-UIC	13.7	0.53	58,855.2	2,276.88
UIC I	12	0.25	51,552	1,074
UIC II	6	0.25	25,776	1,074
IIIA	3.7	0.2	15,895.2	859.2
IIIB	2	0.025	8,592	107.4
Locomotives				
Pre-UIC	15.4	0.34	66,158.4	1,460.64
UIC I	12	0.25	51,552	1,074
UIC II	9.9	0.25	42,530.4	1,074
IIIA	3.7	0.2	15,895.2	859.2
IIIB	3.7	0.025	15,895.2	107.4

Table 4: Emission Factors for diesel traction

Vehicle Type	Emission Class	Diesel consumption (t)

Railcar > 130 kW	Pre-UIC	100
	UIC I	200
	UIC II	300
	IIIA	400
	IIIB	500
Locomotive 130 - 560 kW	Pre-UIC	120
	UIC I	220
	UIC II	320
	IIIA	420
	IIIB	520
Locomotive 560 - 2000 kW	Pre-UIC	140
	UIC I	240
	UIC II	340
	IIIA	440
	IIIB	540
Locomotive > 2000 kW	Pre-UIC	160
	UIC I	260
	UIC II	360
	IIIA	460
	IIIB	560

Example: If a railway has the following data table for the different vehicle types and emission classes:

Then the NOx emissions for the UIC II locomotives between 560 and 2000 kW will be: 340 * 42,530.4 = 14,460,336gNOx = 14.46tNOx

Similarly, the NOx emissions will be calculated for all vehicle types and emission classes. The sum of emissions for all classes will give total NOx emissions. The same procedure can be applied to PM emissions.

Level 3 (basic)

The proxy method for calculating PM and NOx emissions in Level 3 is based on the diesel fleet composition of railways as well as annual mileage per vehicle type and emission class. As mentioned earlier, the fleet composition and annual mileages have been separately asked to the members in 2012 and will be updated every three years (see the request table included in Annex IV).

The shares of performed mileages (or number of vehicles per emissions class) are being used to calculate the diesel fuel consumed by all vehicles of a given emission class and vehicle type. E.g. if one fourth of the railways' total freight mileage is being performed by its UIC-I-conform locomotives, one fourth of the diesel fuel for freight transport will be assigned to the calculation of the exhaust emissions from UIC I locomotives (in freight service)[23].

The following input data and assumptions are needed for the calculations in level 3:

- Total diesel fuel consumption per railway for passenger and freight transport (indicator 1.3);
- Average annual mileage per vehicle type and emission class (train-km and/or gross tonne-km) from the request table in Annex II;
  - For railways which do not provide data on average annual mileage per vehicle type and emission class, total mileages from UIC Railisa statistics per vehicle category, passenger and freight transport, table 41 (train-km) or table 42 (gross tonne-km) are being used (UIC 2010)[24]. From the data on average annual mileages from all responding railways, average European annual mileages per vehicle type and emission class are being derived. The total annual mileage (passenger and freight, respectively, from table 41) of a non- reporting railway is split to the different emission classes according to the average shares of all reporting railways, i.e. the average of the reported European fleet is being assumed to be valid for any given non-reporting railway.
- Regarding passenger transport, it is assumed that all DMUs are used for passenger transport; the portion of diesel locomotives used for passenger transport can be deduced from table 41 of UIC Railisa statistics.

The calculation of total emissions per emission class and emission type (NOx or PM) is as follows:

Where:

$$Em_{Total} = Em_{pass} + Em_{Freight}$$

- Em_{Total} = total emissions per pollutant (NOx, PM);
- Em_{Pass} = emissions per pollutant (NOx, PM) for passenger traction;
- $Em_{Freight}$ = emissions per pollutant (NOx, PM) for freight traction.

In order to calculate the PM or NOx emissions for passenger traction, the following formula is used, which multiplies the diesel consumption of passenger traction by a PM/NOx emission factor weighted by the share of mileage per emission class (and the share of locomotives used for passenger transport):

$$Em_{Pass} = C_{D\ Pass} * \left(\sum_{EC\ DMU} Sh_{m\ EC} * EF_{D\ EC} + Sh_{Loc\ Pass} * \sum_{EC\ Loc} Sh_{m\ EC} * EF_{D\ EC} \right)$$

Where:

---

[23] This approximation method is therefore also based on the assumption that there are no significant differences in fuel consumption between diesel rail vehicles of different emission classes.

[24] Data from table 41 “Train-km” is preferred as train-km have been reported by the operators in the past more completely than data on gross tonne-km from table 42.

- Em_{Pass} = emissions per pollutant (NOx, PM) for passenger traction;
- $C_{D\ Pass}$ = total diesel consumption for passenger traction (indicator 1.3);
- $Sh_{m\ EC}$= share of total mileage per emission class (from request table);
- $EF_{D\ EC}$ = emission factor in g/tonne diesel fuel burned per emission class;
- $Sh_{Loc\ Pass}$= share of diesel locomotives used for passenger transport.

Similarly, the emission for freight traction is calculated as following: the diesel consumption of freight traction is multiplied by an emission factor weighted by the share of mileage per emission class (and the share of locomotives used for diesel transport).

$$Em_{Freight} = C_{D\ Freight} * Sh_{Loc\ Freight} * \sum_{EC\ Loc} Sh_{m\ EC} * EF_{D\ EC}$$

Where:

- $Em_{Freight}$ = emissions per pollutant (NOx, PM) for freight traction;
- $C_{D\ Freight}$ = total diesel consumption for freight traction (indicator 1.3);
- $Sh_{Loc\ Freight}$= share of diesel locomotives used for freight transport;
- $Sh_{m\ EC}$= share of total mileage per emission class (from request table);
- $EF_{D\ EC}$ = emission factor in g/ tonne diesel fuel burned per emission class.

The emission factors in g/tonne are derived from the emission factors (limit values) which are given in g/kWh. Emission factors (or limit values) are being converted from g/kWh to g/tonne diesel fuel taking into account the proximate efficiency of the transmission chain from tank to wheel/track (e.g. efficiency of diesel engine, transmission, power demand of auxiliaries, axle gear efficiency). The calculation is as follows:

$$EF_D = EF_{kWh} * EC_D * CF_{ME}$$

Where:

- EF_D = emission factor in g/tonne;
- EF_{kWh} = emission factor in g/kWh;
- EC_D = energy conversion factor - kg diesel in kWh (1 kg diesel fuel = 11.93 kWh);
- CF_{ME} = conversion factor of efficiency of engine-to-wheel transmission (efficiency of diesel engine, transmission, auxiliaries power demand, axle gear) estimated to be 0.36 (source: CleanER-D project, sub-project 5, experts' estimation, range estimated from 0.34 to 0.38).

The emission factors for the different vehicle types and emission classes are shown in Table.

Example: Let's consider a railway with the following data table for the different vehicle types and emission classes (calculated from number of vehicles and mileage per class):

Vehicle Type	Emission Class	Share of mileage
Railcars	Pre-UIC	4%
	UIC I	8%
	UIC II	16%
	IIIA	32%
	IIIB	40%
Locomotives	Pre-UIC	10%
	UIC I	15%
	UIC II	20%
	IIIA	25%
	IIIB	30%

Let's also consider that the railway has:

- a total diesel consumption of 1,500 tonnes of diesel for passenger and 2,500 tonnes of diesel for freight transport;
- a proportion of 25% locomotives used for passenger and 75% used for freight.

  The NOx emissions from passenger transport will be:

1,500 * ((4% * 58,855.2 + 8% * 51,552 + 16% * 25,776 + 32% * 15,895.2 + 40% * 8,592) + 25% * (10% * 66,158.4 + 15% * 51,552 + 20% * 42,530.4 + 25% * 15,895.2 + 30% * 15,895.2)) / 1,000,000 = 40,537.59 tNOx

The NOx emissions from freight transport will be:

2,500 * 75% * (10% * 66,158.4 + 15% * 51,552 + 20% * 42,530.4 + 25% * 15,895.2 +30% * 15,895.2)) / 1,000,000 = 59,244.52 tNOx

So, the total NOx emissions will be:

40,537.59 + 59,244.52 = 99,782.11 tNOx

Annex VI – CO_2-equivalent

For the first time in the 2017 data collection, data monitored and climate protection targets adopted by UIC and CER will be expressed in CO_2-equivalent instead of CO_2. The conversion of the UIC-CER reporting system will concern both the new data entry and historic figures.

The idea of CO_2-equivalent is to express the impact of GHG in terms of CO_2 in order to obtain only one figure that includes all emissions from greenhouse gasses.

The global warming potential (GWP) of each GHG considered in the EPD is in the table below:

		Global Warming Potential (GWP) – 100 years (UNFCCC)
CO_2	→	1
CH_4	→	21
N_2O	→	310
F-Gases	→	Min 140/Max 23,900*
		*Different for each gas

Re-calculation of historic values and baseline (1990)

Diesel

$$CO_2eq\ Emissions_{DIESEL} = Consumption_{DIESEL} * CO_2eq\ E.F._{DIESEL}$$

Where

- Diesel consumption provided by the RU
- The CO_2-eq emission factor for diesel is calculated as explained in the Annex II. The CO_2-eq emission factor for diesel and the CO_2-eq emission factor for biodiesel are based on CEN, EN 16258:2012

Electricity

The re-calculation of historic values (1990; 2005-2016) for electric emissions is carried out with the location-based method.

$$CO_2eq\ Emissions_{ELECTRICITY} = Consumption_{ELECTRICITY} * CO_2eq\ E.F._{ELECTRICITY}$$

Where

- Electricity consumption provided by the RU
- The CO_2-eq emission factor for electricity is the location-based emission factor that is calculated as explained in the Annex III.

Fluorinated gases

The current calculation of CO_2-eq includes only CO_2, CH_4 and N_2O. In fact, after careful consideration, it has been decided to exclude F-Gases. The main reasons are the following:

- ESRS takes into account only emissions and energy consumption derived from the traction, while the Fluorinated gases depend of A/C systems and refrigerators on board.

- EN 16258 excludes emissions relating to this kind of processes[25].
- According to the Official National Inventory Report for UNFCCC, transport sector and energy industries are not responsible for Fluorinated gases emissions. The Industrial sector is the only one that accounts for Fluorinated gases emissions.

[25] "4.3 *Processes not included. The results calculated in accordance with this standard shall not include, in particular: Direct emissions of GHG at the vehicle level, resulting from leakages (of refrigerant gas or natural gas for example) and not from combustion*." (CEN 2012, EN 16258 par. 4.3)

References

ARCADIS 2009*, Impact Assessment Study – Reviewing Directive 97/68/EC, Emissions from non-road mobile machinery, Final Report.* Brussels, 2009.

CEN 2012*, EN 16258:2012. Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)*. Brussels, 2012.

CER 2008, *CER CO_2 commitments*.

EC 1997, *Directive 97/68/EC DIRECTIVE 97/68/EC of the European Parliament and of the Council of 16 December 1997 on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery. Official Journal of the European Union.* Brussels, 1997.

EC 2003*, Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport. Official Journal of the European Union*. Brussels, 2003.

EC 2009a, *Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. Official Journal of the European Union.* Brussels, 2009.

EC 2009b*, Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas- oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC. Official Journal of the European Union.* Brussels, 2009.

IEA 2008*, Energy Efficiency Indicators for Public Electricity Production from Fossil Fuels. International Energy Agency (IEA).* Paris, 2008.

JEC 2011, *Well-to-Wheels Analysis of Future Automotive Fuels and Powertrains in the European Context Version 3c (Report EUR 24952 EN - 2011). JEC - Joint Research Centre-EUCAR-CONCAWE collaboration*. Luxembourg, 2011.

Sotos 2011, *GHG Protocol Scope 2 Guidance. Mary Sotos. World Resources Institute.* Washington, D.C. 2014.

ORE, *n.y., ORE B13/21 European Locomotive Test Procedures.* Paris, n.y.

UIC 2006, *Rail Diesel Study, WP1 Final Report Status and future development of the diesel fleet.* Paris, 2006.

UIC 2007, *Emissions Reduction Guidelines. International Union of Railways (UIC).* Paris, 2007.

UIC 2008a, *UIC Leaflet 330 -Railway specific environmental performance indicators. International Union of Railways (UIC).* Paris, 2008.

UIC 2008b, *Process, Power, People. Energy Efficiency for Railway Managers. International Union of Railways (UIC).* Paris, 2008. URL: www.uic.org/download.php/publication/522E.pdf

UIC-CER 2010*, Moving towards Sustainable Mobility: European Rail Sector Strategy 2030 and beyond. International Union of Railways (UIC), Community of European Railway and Infrastructure Managers (CER)*. Brussels, Paris, 2010. URL: www.cer.be/fileadmin/user_upload/members_area/policy_areas/Environment/FULLREPORTMovingTowardsSustainableMobilityEuropeanRailSectorStrategy20301.pdf

UIC 2010, *International Railway Statistics 2010. International Union of Railways (UIC).* Paris, 2010.

UIC 2012*, Exhaust Emissions Tests for Diesel Traction, Leaflet UIC624-4ed*. Paris, 2012.

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