EUROFIMA
ROLLING STOCK FINANCING

ANNEX 1

# IMPACT ASSESSMENT METHODOLOGY

This annex covers the detailed methodology applied to quantify the impact indicators: the assumptions, the relevant data sources and the computational steps followed.

## GREEN BOND IMPACT REPORTING

## MARCH 2020

## METHODOLOGY OVERVIEW

The approach followed in order to derive the impact indicators is based on the comparison between:

a) the emissions and energy consumption of the green assets, and

b) the emissions and energy consumption of the alternative means of transportation (i.e., those that would be used, in case the rolling stock were not financed).

Therefore, the "baseline" for the impact assessment is the assumed "alternative means of transportation".

As the impact indicators represent in fact "estimated" impacts (ex-ante) and not on actual impact (ex-post), a number of assumptions are made in the framework.

The following paragraphs explain the assumptions made and define and quantify the baseline.

## MAIN ASSUMPTIONS

The estimate of the emission savings generated by EUROFIMA green projects relies on the following assumptions:

1. The reported impact is the expected environmental impact, based on ex-ante estimates[1], as opposed to the actual[2] ex-post data.
2. The reported impact is defined as "Avoided" or "Reduced". In the former case, the green assets financed do not generate any direct savings versus the historical data, but, if the project had not been financed, the related emissions or the energy consumption would be higher[3]. In the latter case, the green assets financed reduce emissions or energy consumption compared to the historical and actual data.

   These cases are described in table 1.

### Table 1 - Examples of projects and impact on GHG emission or energy consumption

| Projects type | GHG emissions | Energy consumption | Description |
|---|---|---|---|
| Additional electric rolling stock | Reduced/Avoided | Reduced/Avoided | The project provides additional rolling stock on a new or already existing line, thus increasing the ridership; partly because more people will move to train and partly to meet the increasing transport demands. |
| Renewal of electric with electric rolling stock | Avoided | Avoided/Reduced | The project replaces old trains with new and more efficient ones; the ridership is assumed to continue along the trend of the old trains. |
| Renewal of diesel with electric rolling stock | Reduced | Reduced | The project replaces diesel trains with electrical ones, thus delivering real emissions reduction compared to the past. |
| Retrofitting or modernization of electric rolling stock | Avoided | Avoided | The project upgrades old trains, making them more efficient or comfortable; the ridership is assumed to continue along the trend of the old trains. |

1. The benefits are estimated as savings to be generated on an annual basis and not as total cumulative benefits over the entire project lifetime and they rely on the following assumptions:

   a) the operations are steady and stable and all the financed rolling stock runs at the normal and planned operating schedule; and

   b) all passengers would move to a different means of transportation, in the case such rolling stock had not been financed[4].
2. The emissions considered for the financed rolling stock are assessed based on the standards of the Greenhouse Gas Protocol Scope 1, which considers only the "Tank-to-Wheel" (TtW) values (i.e., emissions generated only by the train) and excludes the "Well-to-Tank", (WtT) values (i.e., emissions generated in the electricity grid and power stations). This is also in line with the EU Taxonomy that considers electric rail transport as a zero-direct emission means of transport.

[1] Therefore, the actual environmental impact of the projects may diverge from initial estimates. In addition, when comparing different projects, caution should be taken because baselines, base years, and calculation methods may vary (infrastructure and cost structure may vary across countries). Finally, projects might have impact across a wider range of indicators than those captured in this report.

[2] The assessment of the impact indicators is based on assumptions, therefore the actual (ex-post) environmental impact of the projects may diverge from initial assessment and across projects. In addition, financed projects might also have other impacts than those captured in the impact assessment table.

[3] It is acknowledged that in case the trains are newly manufactured, savings in the ramp-up phase may well be overestimated, as the trains are not yet operated or are operated with limited utilization in order to finalize the commissioning phase.

However, in a long-term perspective, the assumption made is deemed to be the most appropriate to show the environmental impact of the train or project.

[4] It is acknowledged that in case of a substitution of existing rolling stock, the real flow of passengers who will stop using the old trains is very limited in the first months: it will increase as the rolling stock becomes less and less reliable or comfortable and only in the long-term all passengers will move to an alternative means of transportation. However, in a long-term perspective, the assumption made is deemed to be the most appropriate to show the environmental impact of the train or project.

## THE BASELINE

The baseline considered to derive the environmental impact is different according to the specific project type and case:

a) For the replacement of an existing electrical train, an upgrade, or introduction of additional trains, it is assumed that all passengers would continue using a car as the alternative means of transportation, in the case that project had not been financed. The baseline is assumed to be the "average car in the current European vehicle stock" in line with the EU Taxonomy[5]. This assumption is considered to be appropriate for the impact reporting purposes: despite the fact that there are differences across countries and projects, in terms of mix of cars used, local habits and different mix of transportation means (bus, plane, boat), the impact on the final estimated values is negligible.

b) For the replacement of diesel rolling stock with electrical rolling stock, it is assumed that all passengers would continue using the existing diesel train, in the case that the project had not been financed. Therefore, the alternative means of transportation taken as baseline is the replaced diesel equipment itself.

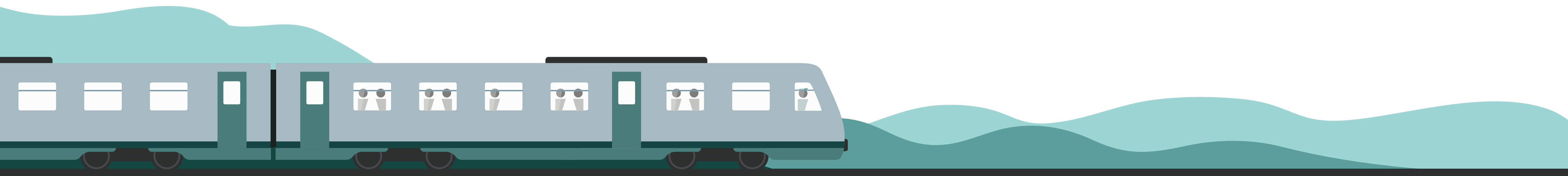
### BASELINE VALUES FOR GHG EMISSIONS

The baseline values reflect the guidelines of EU Taxonomy[5]. The values are either passenger-kilometres (pkm) in case the alternative means of transportation is a diesel train, or vehicle- kilometres (vkm) in case of a car.

Table 2 - GHG emissions baseline in the EU

| Projects type | HGH emissions | Alternative means of transportation | Baseline GHG emissions |
|---|---|---|---|
| Additional electric rolling stock | Reduced/Avoided | Car | 290 $gCO_2$/vkm |
| Renewal of electric with electric rolling stock | Avoided | Car | 290 $gCO_2$/vkm |
| Renewal of diesel with electric rolling stock | Reduced | Diesel train | 70/90 $gCO_2$/pkm |
| Retrofitting or modernization of electric rolling stock | Avoided | Car | 290 $gCO_2$/vkm |

5 Page 329 of the EU Taxonomy Technical Report by TEG (Link)



## BASELINE VALUES FOR ENERGY CONSUMPTION

The baseline values for energy consumptions are calculated based on: data from several public sources, assumptions on the mode of use (motorway, rural) of the alternative means of transportation, the mix of petrol versus diesel in the European car fleet, the weight of the average car, the car occupancy rate, and using an online calculator developed by a Swiss partnership led by the Swiss government[6].

The baseline values for a diesel rolling stock equipment are taken from the values assumed by UIC (the international association of railway companies)[7].

More specifically, the assumptions and data considered are as follows:

1. The average car consumption is sourced from the Ecopassenger Methodology report[8], developed by UIC by type of fuel, mode of utilization and size of the car.

### Table 3 - Car energy consumption as a function of usage in the EU

| Mode of use | Average auto consumption | | | | | |
|---|---|---|---|---|---|---|
| | Diesel (l/100 km) | | | Petrol (l/100 km) | | |
| | Small | Medium | Large | Small | Medium | Large |
| Motorway | 4.5 | 5.3 | 6.7 | 6.3 | 7.5 | 9.2 |
| Rural | 3.8 | 4.5 | 5.8 | 4.9 | 5.8 | 7.2 |
| Urban | 5.7 | 6.7 | 8.4 | 7.3 | 8.7 | 10.5 |

2. It is assumed that all passengers would use the alternative means travelling 50% of their time along a motorway and the other 50% along rural roads and driving a medium-size car. Urban traffic is excluded, even if part of the alternative journey would happen inside a city, as the project financed do not include trams or metro. Even if the actual modal mix may be a much more complex mix of the three above modal utilization, it is deemed that a more detailed estimation at project level would not yield a material and significant increase of reliability of the final estimates. The data is summarized in table 4.

### Table 4 - Average car energy consumption for motorway and rural usage in the EU

| | Average auto consumption | | Travel % |
|---|---|---|---|
| | Diesel (l/100 km) | Petrol (l/100 km) | |
| Motorway | 5.3 | 7.5 | 50% |
| Rural | 4.5 | 5.8 | 50% |
| Average travel | 4.9 | 6.7 | |

The average energy consumption for the travel for both petrol and diesel is calculated as follows:

Average Auto Consumption - Motorway = ACM
Average Auto Consumption - Rural = ACR
% of time traveled in a Motorway = TM% = 50%
% of time traveled in Rural roads = TR% = 50%
Average Auto Consumption - Travel = ACT

ACT = (ACM * TM% + ACR * TR%)

3. The mix diesel versus petrol cars of the European fleet is sourced from the most up-to-date date of the European cars manufacturers (ACEA) statistics[9].

### Table 5 Car energy mix in the EU

| | Mix % of the European fleet |
|---|---|
| Petrol | 53.9% |
| Diesel | 42.0% |
| Other | 4.1% |

4. The average consumption is calculated with the following steps, with the diesel versus petrol mix and the average travel consumption as shown in Table 3, 4 and 5.

Average Diesel Auto Consumption – Travel = ACTD = 4.9 l/100km
Average Petrol Auto Consumption – Travel = ACTP = 6.7 l/100km
% of Diesel cars in the European Fleet = DC% = 42%
% of Petrol cars in the European Fleet = PC% = 53,9%
Average Auto Consumption = AC

AC = (ACTD * DC% + ACTP * PC%)/(PC% + DC%) = (4.9*42%+6.7*53.9%)/(53.9%+42%) = 5.9 l/100km

5. In order to calculate journey savings, the average European car utilization is assumed to be 1.5 passengers/car, as set by UIC[10], with an average car weight of 1395 Kg., as per the European Vehicle Market Statistics pocketbook[11] .

[6] https://www.mobitool.ch/fr/info/a-propos-de-mobitool-9.html
[7] https://uic.org/
[8] http://ecopassenger.hafas.de/bin/help.exe/en?L=vs_uic&tpl=methodology
[9] https://www.acea.be/statistics/tag/category/passenger-car-fleet-by-fuel-type
[10] http://ecopassenger.org/bin/query.exe/en?ld=uic-eco&L=vs_uic&OK#focus
[11] https://theicct.org/sites/default/files/publications/ICCT_Pocketbook_2018_Final_20181205.pdf

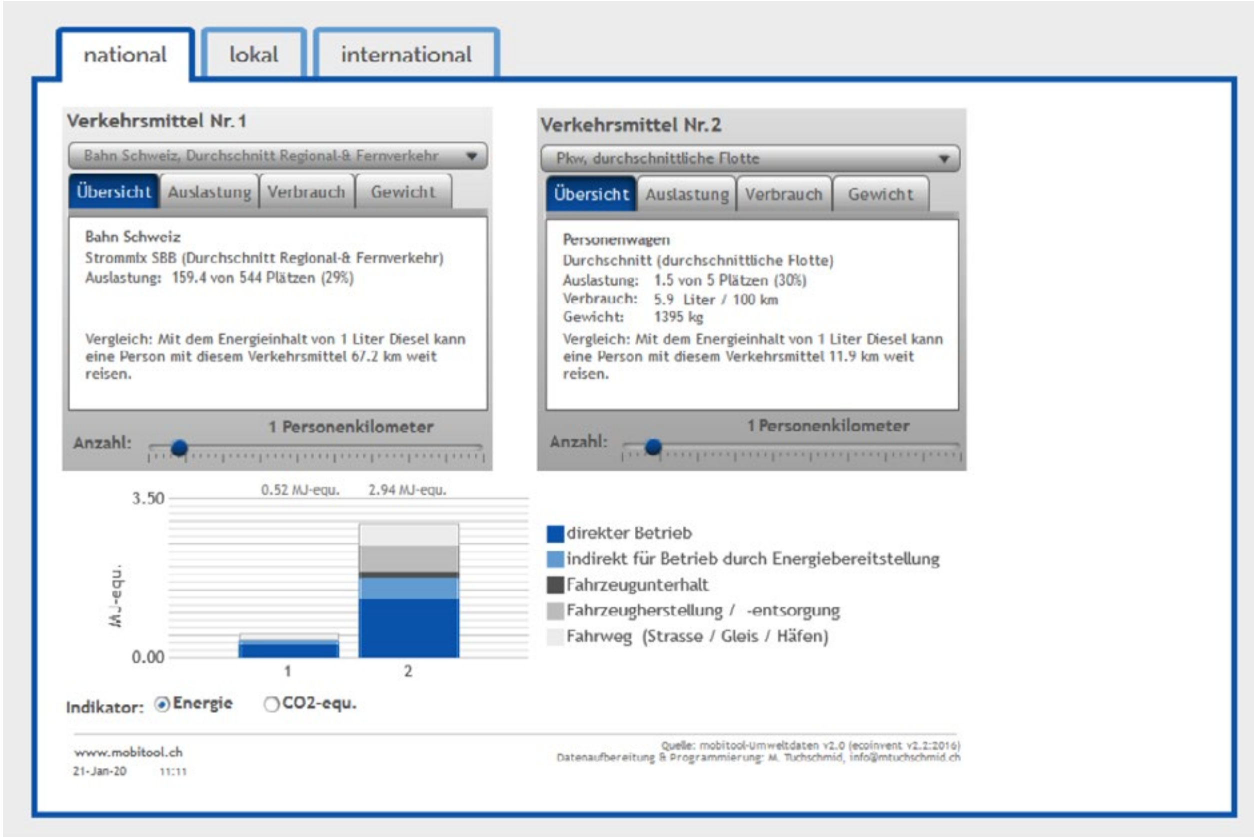
6. The online Mobitool[12], developed by the Swiss federal government and other public institutions, is used to set the baseline of the average car in the current stock, along with the above parameters in Table 6.

### Table 6 - Inputs into Mobitool

| Inputs to Mobitool | Values |
|---|---|
| Car occupancy | 1.5 person per car |
| Consumption | 5.9 l/100km |
| Weight | 1395 Kg |

If the baseline for a specific project is the transportation by car, in order to be consistent with the Scope 1 definition, only the consumption for the car itself and not any other side-costs (e.g., road construction, etc.) is considered in Mobitool (referred as “Direkter Betrieb”), with is 1.30 MJ/pkm.

### Figure 1 - Mobitool Energy consumption of a car in the EU




7. If the baseline for a specific project is the another diesel train, the corresponding value (25.2 g/pkm) assumed by UIC from the Ecopassenger Methodology[8] is translated in MJ/pkm, assuming a diesel heating value 45.5 MJ/Kg.[13]

(25.2 g/pkm)*(45.5 MJ/1000g) = 1.15 MJ/pkm

8. The energy consumption baseline values are summarized in Table 7.

### Table 7 - Energy consumption baselines

| Projects denomination | Energy consumption | Alternative means of transportation | Baseline energy consumption |
|---|---|---|---|
| Additional electric rolling stock | Reduced/Avoided | Car | 1.30 MJ/pkm |
| Renewal of electric with electric rolling stock | Avoided | Car | 1.30 MJ/pkm |
| Renewal of diesel with electric rolling stock | Reduced | Diesel train | 1.15 MJ/pkm |
| Retrofitting/modernization of electric rolling stock | Avoided | Car | 1.30 MJ/pkm |

[12] https://www.mobitool.ch/de/tools/vergleichsrechner-15.html

[13] https://www.acea.be/news/article/differences-between-diesel-and-petrol

## ESTIMATION MODEL

Based on the assumptions above, the following model estimates the GHG emissions and energy savings.

### a) GHG emissions savings

For an estimate of GHG savings, it is considered that the emissions of the financed rolling stock (electric trains) are assumed to be zero and they need to be compared to an estimate of the annual pollutant emissions of the baseline, for which the corresponding standard value per passenger-kilometre is publicly available.

The annual passenger-kilometre relevant to a specific item of equipment, either a train or a coach or a locomotive, is not a publicly available data, therefore requiring a separate estimate.

The individual factors and assumptions for the above estimate are as follows:

1. The latest estimate of the passenger-kilometre by country from the European pocketbook on transportation[14]
2. Available seats by country from SCI Verkehr GmbH[15]
3. The value [(Passengers*km)/(Available Seats)] by country;
4. This value is assumed the same for all trains and lines in the relevant countries;
5. The available seats of the single item of equipment is sourced from the rolling stock manufacturer or the corresponding railway operator;
6. The [Passengers*km] by item of equipment, and then the corresponding savings is derived as follows:

Passengers per kilometer by item = pkmT
Passengers per kilometer by country = pkmC
Available seats by country = AvSC
Available seats by specific item = AvST

$$pkmT = [pkmC / AvSC] * AvST$$

The "Avoided" emissions can be calculated as a difference between the emissions of the alternative means of transportation taken as baseline and the emissions of the green asset (which are zero, by definition, as defined in Scope 1):

Number of specific green items = #ST
Baseline GhG emissions per pkm, avoided = EBA = 290 gCO2/vkm
Baseline GhG emissions per pkm, reduced = EBR = 90 gCO2/pkm
Passenger per vehicle = PV = 1.5
Project savings as reduced emissions = PSR
Project savings as avoided emission = PSA

$$PSA = \Sigma\,[pkmT * (EBA/PV)]_{\#ST} - 0$$

In case of "Reduced" emissions, they are quantified as follows:

$$PSR = \Sigma\,[pkmT * EBR]_{\#ST} - 0$$

To provide more clarity, we add an example calculation, taking the savings generated by the 22 trains for the Zürich S-Bahn (14 Rabe 514 and 8 Rabe 511-6 cars, operated by SBB); we allocated to this project 183,4 ML€ for a 4.9 years project duration (see first line on the table page 12)

pkmC (CH) = 20'865 Mpkm
AvSC (CH) = 446'260
AvST (Rabe 514) = 384
AvST (Rabe 511) = 526

PkmT (Rabe 514) = (20'865/446'260)*384 = 17.96 Mpkm
PkmT (Rabe 511) = (20'865/446'260)*526 = 24.59 Mpkm

#ST (Rabe 514) = 14
#ST (Rabe 511) = 8

EBA = 290 gCO2/vkm
PV = 1.5

PSA = $\{17.96*10^6*[(290/1.5)/10^6]*14\}+\{24.59*10^6*[(290/1.5)/10^6]*8\}- 0=86'633\ tCO_2$

[14] https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2019_en

[15] This is a rail consulting company and specific values cannot be disclosed due to confidentiality.

### b) Energy consumption savings

In this case the energy consumed by the green asset is not zero and must be estimated as well through publicly available data: in the case the green asset is a passenger coach, we assume the consumption of the locomotive(s) that pull/push them. The energy consumption of the alternative means of transportation is calculated based on other available data (i.e., pkm by item of equipment and energy consumed by pkm).

The methodology to estimate the energy saved by the train or project is as follows:

1. When specific rail rolling stock data is not available, the average values by country or the European average are taken, even if there may be differences across specific rolling stock items[16].

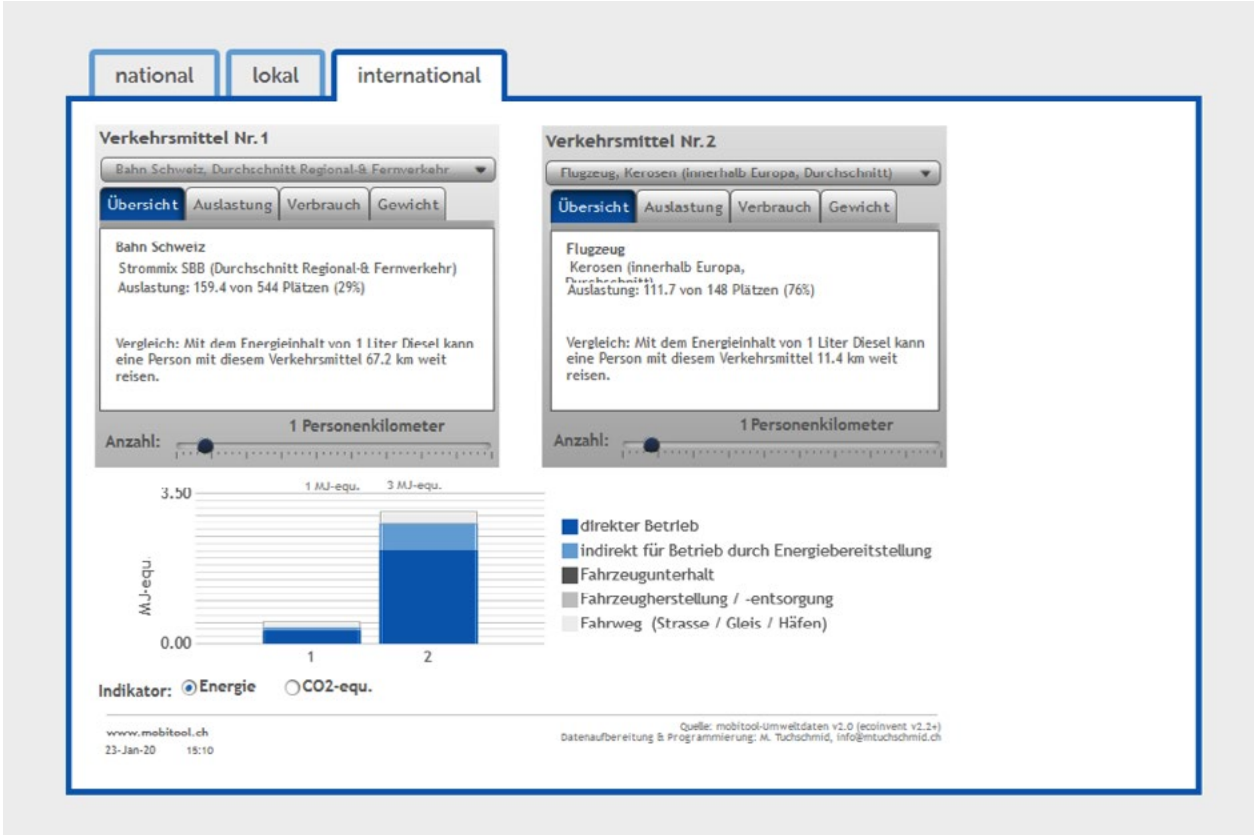
2. The energy consumption data for Austria, Switzerland, Germany, France and Italy is available in Mobitool as well as the average load factors (actual passengers per available seat) per country. The consumption considered is that of the train ("direkter Betrieb") only (Figure page 2).

**Table 8 - Average Load factor defined in Mobitool as default parameters**

| Country | Mode | Load factor |
|---|---|---|
| Germany | Average Regional/Intercity | 43% |
| France | Average Regional/Intercity | 38% |
| Italy | Average Regional/Intercity | 31% |
| Austria | Average Regional/Intercity | 37% |
| Switzerland | Average Regional/Intercity | 29% |

[16] This simplification is deemed to have no significant or material impact on the final impact estimation at a portfolio level.

**Figure 2 - Mobitool example for Switzerland**



3. The average energy consumption of rail rolling stock in other countries is based on the average value of 88.2 Wh/pkm, as in the Ecopassenger Methodology[8].

(88.2 Wh/pkm) * 3.6/1000 = 0.32 MJ/pkm

4. The energy consumed by the green asset is summarized in Table 9.

**Table 9 - Energy consumed by the green asset by country**

| Country | Green Asset average energy consumption (MJ/pkm) | Source |
|---|---|---|
| Germany | 0.42 | Mobitool.ch |
| France | 0.32 | Mobitool.ch |
| Italy | 0.39 | Mobitool.ch |
| Austria | 0.42 | Mobitool.ch |
| Switzerland | 0.29 | Mobitool.ch |
| Others | 0.32 | UIC Ecopassengers |

5. The energy saved in a year is derived, both as "Reduced" and as "Avoided", as a difference between the energy consumed by the alternative means of transportation taken as baseline and the energy consumed by the green asset.

Numbers of specific green items = #ST
Energy consumption baseline per pkm, car = JBC = 1.30 MJ/pkm
Energy consumption baseline per pkm, diesel equipment = JBD = 1.15 MJ/pkm
Average Energy Consumption of the Green Asset per pkm = JGA
Passengers per kilometer by item = pkmT
Project savings as avoided energy consumption = PSJA
Project savings as reduced energy consumption = PSJR

$$PSJA = \Sigma\,[(JBC - JGA) * pkmT]_{\#ST}$$
$$PSJR = \Sigma\,[(JBD - JGA) * pkmT]_{\#ST}$$

To provide more clarity, we add also here an example calculation, taking the energy savings generated by the same 22 trains for the Zürich S-Bahn (14 Rabe 514 and 8 Rabe 511-6 cars, operated by SBB); see first line on the table page 12.

JBC = 1.30 MJ/pkm
JGA = 0.29 MJ/pkm

pkmC (CH) = 20'865 Mpkm
AvSC (CH) = 446'260
AvST (Rabe 514) = 384
AvST (Rabe 511) = 526

PkmT (Rabe 514) =(20'865/446'260)*384=17.96 Mpkm
PkmT (Rabe 511) =(20'865/446'260)*526=24.59 Mpkm

#ST (Rabe 514) = 14
#ST (Rabe 511) = 8

$PSJA=\{[[(1.3-0.29)/(3600*10^3)]*17.96*10^6\}*14+\{[[(1.3-0.29)/(3600*10^3)]*24.59*10^6\}*8$ = **125.7 GWh**