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This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO3', in the Global geography.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO3 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO3 \_ RoW :: ['average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 ton'] 7.5

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This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO2', in the geography of South Africa.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO2 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 7.2 tonnes, with a gross vehicle weight (GVW) of 13.1 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO2 \_ ZA :: ['average freight load factor of a 7.5-16 metric ton lorry is 7.2 tonnes, with a gross vehicle weight (GVW) of 13.1 ton'] 7.5

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None

Lorry size class Average load factor GVW

3.5-7.5t 0.98t 4.98t

7.5-16t 3.29t 9.29t

16-32t 5.79t 15.79t

>32t 15.96t 29.96t

The lorry size and load factor determines the GVW and therefore also the fuel consumption and amount of both exhaust and non-exhaust emissions. Non-exhaust emissions are those resulting from tyre, brake and road wear.

Fuel consumption and exhaust emissions are taken from v3.1 of the HBEFA model, using the data for Germany and without applying model weighting. There are a higher number of size categories used in HBEFA than in ecoinvent and so the data are grouped in order to fit the lorry size classes used in ecoinvent. The selective catalytic reduction (SCR) technology is around 3 times more common than that of exhaust gas recovery (EGR) as an emissions reduction measure and so the emission factors given in the dataset are weighted to reflect this. The data for the HBEFA categories SCR\* and VI\* were disregarded. The exhaust emissions caused by the burning of fuel are either fuel dependent (fuel type and quantity) or Euro class dependent. The latter reflect the emission regulations to which the vehicle complies. Regulated emissions are CO, NOx, particulate matter (PM) and total hydrocarbons (HC). Data from the Emissions Inventory Guidebook (EMEP/EEA, 2013) were used for specific exhaust emissions not covered by the HBEFA model.

Non-exhaust emissions are accounted for as weight dependent by-products and exist as seperate datasets.

For road infrastructure the expenditures and environmental interventions due to construction of roads have been allocated based on the gross tonne kilometer performance. Expenditures due to operation of the road infrastructure, as well as land use have been allocated based on the yearly vehicle kilometer performance. The same assumption on vehicle lifetime performance has been transferred from the ecoinvent v2 datasets of 540 000 km/vehicle. The production, maintenance and disposal of the vehicle are as reported in the ecoinvent (2007) report on transport services.

Main data sources:

De Ceuster, G., et al. (2009) TREMOVE: Final Report. Model code v2.7b, 2009. European Commission, Brussels.

Keller, M. et al. (2010) Handbook emission factors for road transport v3.1, HBEFA. INFRAS, Berne, CH.

Knörr, W. et al. (2011) Ecological Transport Information Tool for Worldwide Transports (EcoTransIT): Methodology and data update. Berlin, Hannover, Heidelberg, DE.

Ntziachristos, L., et al. (2013) EMEP/EEA air pollutant emissions inventory guidebook 2009: Exhaust emissions from road transport. European Environment Agency, Copenhagen, DK.

Spielmann, M., et al. (2007) Transport Services. ecoinvent report No. 14., Swiss Centre for Life Cycle Inventories, Dübendorf, CH.

Geography: None

None

None

Technology: None

None

transport, freight, lorry 7.5-16 metric ton, EURO3 \_ RoW :: [] TBD

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This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO5', in the geography of Brazil.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO5 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO5 \_ BR :: ['average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 ton'] 7.5

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This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO3', in the geography of Brazil.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO3 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO3 \_ BR :: ['average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 ton'] 7.5

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This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO2', in the geography of Brazil.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO2 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 7.2 tonnes, with a gross vehicle weight (GVW) of 13.1 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO2 \_ BR :: ['average freight load factor of a 7.5-16 metric ton lorry is 7.2 tonnes, with a gross vehicle weight (GVW) of 13.1 ton'] 7.5

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This dataset is an adaptation of “transport, freight, lorry 7.5-16 metric ton, EURO1” in South Africa, as available in version 3.6 of the ecoinvent database to reflect the situation in Brazil. It represents the service of 1tkm freight transport in a lorry of the size class 7.5-16 metric tons gross vehicle weight (GVW) and Euro 1 emissions class.

The Brazilian lorry fleet is regulated under the Vehicles Air Pollution Control Program – Proconve, which phases are equivalent to the European control program – EURO. Since 2012, the Proconve P7 (EURO 5) phase is in practice, while the P8 phase (EURO 6) will start in 2023. Before that, the Proconve P6 phase (EURO 4) was not implemented because of the unavailability of low-sulphur diesel, therefore recontextualized datasets do not consider this phase. The P5 (EURO 3), P4 (EURO 2) and P3 (EURO 1) phases started in 2005, 2000 and 1996, respectively. Prior technologies are classified as unregulated.

For the dataset recontextualization to the Brazilian reality, an updated average freight load and the diesel with 500 ppm of sulfur and 12% biodiesel blend are considered. Moreover, data from emission tests of the national vehicle production and import (CETESB, 2019) is used to update regulated emissions (carbon monoxide, particulate matter and nitrogen oxides). Furthermore, correction factors are used to consider the impact of biodiesel blend on exhaust emissions (USEPA 2002), and the fuel composition is considered to account for carbon dioxide and sulphur dioxide emission.

The vehicle mass category classification considered in Brazilian national statistics is approximated to the one adopted in ecoinvent datasets. The 7.5-16 metric ton lorry is representing the Brazilian heavy-duty lorry with gross vehicle weight (GVW) with 10 to 15 metric tons category classification. The average capacity utilization factor (including empty trips) for this category is 59.7 % according to the Road Freight Transport Model from the Brazilian Energy Research Enterprise – EPE (Stukart, 2018). Whereas, the average payload capacity for this category is 9.8 ton (Novo, 2016), resulting in an average freight load of 5.85 ton. GWV is estimated by assuming the same empty vehicle weight as for the RER region for the respective matching categories and accounting for the updated freight load. This resulted in a GWV of 11.9 ton. Vehicle mass dependent non-exhaust emissions (i.e. tyre, brake and road wear) are adjusted accordingly.

The emissions of carbon monoxide (CO), nitrogen oxides (NOx) and Particulate Matter (PM) were updated with data from (CETESB, 2019), which uses data from emission testing of the national vehicle fleet production and imports, weighted by sales amounts. Those tests are run with a reference fuel, which is not blended with biodiesel (ANP, 2018), therefore, those emission factors are adjusted for emissions from burning biodiesel.

The impact of the 12% biodiesel blend in exhaust emissions is accounted for by correction factors derived from USEPA (2002). Correction factors were calculated for the emissions of nitrogen oxides, particulate matter, hydrocarbons, carbon monoxide, acetaldehyde, ethylbenzene, formaldehyde, naphthalene and xylene. Moreover, fuel consumption was corrected with energy content values. For conventional diesel, it was considered energy content of 129.500 Btu/gal, animal-based biodiesel 115.720 Btu/gal and plant-based biodiesel 119.216 Btu/gal (USEPA 2002).

Fuel dependent emissions were updated as well. In Brazil, diesel containing 10 ppm (S10) of sulphur was introduced to attend to the demand of EURO V lorries, as its post-treatment technologies require the use of ultra-low sulphur diesel. Diesel containing 500 ppm (S500) of sulphur is also commercialized for the remaining lorry emission categories. For these cases, the use of S500 is assumed as no information on the share of S500 and S10 diesel used by these categories was available and because the price of S500 is lower than for the S10 (CNT, 2021). Therefore, sulphur dioxide emissions derived from S500 combustion were corrected assuming that all sulphur is emitted as SO2 (0.001 kg SO2/kg fossil diesel) and to account for the blend of biodiesel (12 %), which does not contain sulphur. Carbon dioxide emission is dependent on the fuel carbon content, which was considered as 77.8% for plant-based biodiesel and 76.1 % for animal-based biodiesel, resulting in a Brazilian average of 77.5%, while conventional diesel has 86.7% of carbon (USEPA, 2002). This results in emissions of 3.18 kg of fossil CO2/kg diesel and 2.84 biogenic CO2/kg biodiesel.

This dataset was developed under the Cornerstone project, an initiative from the Brazilian Business Network on Life cycle Assessment (Rede ACV) in collaboration with ecoinvent to increase the quantity and quality of inventories that represent Brazil, through a thorough adaptation of the datasets. More information about this project is available in redeacv.org.br/en/wg-database/. Technical background is provided in Valebona F.; Rocha T.B.; Motta F. L. Cornerstone Project. Recontextualization of Datasets: Methodology. ACV Brasil, Brazil.

Main data sources for the recontextualization:

ANP, 2018. Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (2018). RANP 764. RESOLUÇÃO ANP Nº 764, DE 20.12.2018 - DOU 21.12.2018.

EPE, 2020. Energy Research Enterprise (2020). Integrated Transport Model. Consultation through Information to Citizen System. Federal Government of Brazil.

Stukart, B., Lima, C., Pacheco, C., Silva, F., Antoniasse, G., Cavalcanti, M., Souza, M., Stelling, P. (2018). Transporte Rodoviário Brasileiro, Transição para Óleo Diesel S10 e Desafios para o Refino Nacional. Rio Oil&Gas. Available at:<https://stt.ibp.org.br/eventos/2018/riooil2018/pdfs/Riooil2018_1654_201806222325ibp1654_1> 8\_transic.pdf. Acessed in: 06/06/2020.

CETESB (2019). Companhia Ambiental do Estado de São Paulo (2019). Emissões Veiculares no Estado de São Paulo. Governo do Estado de São Paulo. Available at: [https://cetesb.sp.gov.br/veicular/relatoriose-publicacoes/.](https://cetesb.sp.gov.br/veicular/relatoriose-publicacoes/) Accessed in 15/06/2020.

USEPA, 2002. United States Environmental Protection Agency (2002). A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions. Draft Technical Report.

Novo, A. L. (2016). PERSPECTIVAS PARA O CONSUMO DE COMBUSTÍVEL NO TRANSPORTE DE CARGA NO BRASIL: UMA COMPARAÇÃO ENTRE OS EFEITOS ESTRUTURA E INTENSIDADE NO USO FINAL DE ENERGIA DO SETOR. Available at:<http://www.ppe.ufrj.br/images/publica%C3%A7%C3%B5es/mestrado/Ana_Luiza_Andrade_Novo.pdf>

CNT (2021). CNT acompanha, com atenção, a alta histórica do diesel. Available at: cnt.org.br/agencia-cnt/cnt-acompanha-alta-historica-do-diesel

Geography: Recontextualization from 'transport, freight, lorry 7.5-16 metric ton, EURO1, ZA'. Fuel type, freight load factor, regulated and fuel-dependent emissions were updated for the Brazilian situation. The environmental interventions due to vehicle transport are modelled by linking the environmental interventions due to vehicle operation with impacts due to vehicle manufacturing, vehicle maintenance, vehicle disposal, road construction, operation and maintenance of roads and road disposal.

Technology: Diesel and diesel engine. Lorry transport is further differentiated with respect to vehicle weight and emission technology standard (EURO-standard).

Technology classifications are based on those used widely within the works of the European Environment Agency, particularly in the Emissions Inventory Guidebook.

Time period: Validity period of the 12% biodiesel blend regulation. The regulation foresees incremental increases in the biodiesel content in the Brazilian market fuel (it started with a 2% blend in 2008, reached 12% in 2020 and will increase 1% a year, until it reaches 15% in 2023).

transport, freight, lorry 7.5-16 metric ton, EURO1 \_ BR :: ['average freight load of 5.85 ton. GWV is estimated by assuming the same empty vehicle weight as for the RER region for the respective matching categories and accounting for the updated freight load. This resulted in a GWV of 11.9 ton'] 5.85

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This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO1', in the geography of Brazil.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO1 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 7.2 tonnes, with a gross vehicle weight (GVW) of 13.1 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO1 \_ BR :: ['average freight load factor of a 7.5-16 metric ton lorry is 7.2 tonnes, with a gross vehicle weight (GVW) of 13.1 ton'] 7.5

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This dataset represents the service of 1tkm freight transport in a lorry of the size class 7.5-16 metric tons gross vehicle weight (GVW) and Euro VI emissions class. The transport datasets refer to the entire transport life cycle i.e. to the construction, operation, maintenance and end of life of vehicle and road infrastructures. Fuel consumption and emissions are for average European journeys and load factors and not representative of a specific transport scenario. The average load factors are taken from the Tremove model v2.7b (2009) and EcoTransIT (2011) report. These are as follows:

Lorry size class Average load factor GVW

3.5-7.5t 0.98t 4.98t

7.5-16t 3.29t 9.29t

16-32t 5.79t 15.79t

>32t 15.96t 29.96t

The lorry size and load factor determines the GVW and therefore also the fuel consumption and amount of both exhaust and non-exhaust emissions. Non-exhaust emissions are those resulting from tyre, brake and road wear.

Fuel consumption and exhaust emissions are taken from v3.1 of the HBEFA model, using the data for Germany and without applying model weighting. There are a higher number of size categories used in HBEFA than in ecoinvent and so the data are grouped in order to fit the lorry size classes used in ecoinvent. The selective catalytic reduction (SCR) technology is around 3 times more common than that of exhaust gas recovery (EGR) as an emissions reduction measure and so the emission factors given in the dataset are weighted to reflect this. The data for the HBEFA categories SCR\* and VI\* were disregarded. The exhaust emissions caused by the burning of fuel are either fuel dependent (fuel type and quantity) or Euro class dependent. The latter reflect the emission regulations to which the vehicle complies. Regulated emissions are CO, NOx, particulate matter (PM) and total hydrocarbons (HC). Data from the Emissions Inventory Guidebook (EMEP/EEA, 2013) were used for specific exhaust emissions not covered by the HBEFA model.

Non-exhaust emissions are accounted for as weight dependent by-products and exist as seperate datasets.

For road infrastructure the expenditures and environmental interventions due to construction of roads have been allocated based on the gross tonne kilometer performance. Expenditures due to operation of the road infrastructure, as well as land use have been allocated based on the yearly vehicle kilometer performance. The same assumption on vehicle lifetime performance has been transferred from the ecoinvent v2 datasets of 540 000 km/vehicle. The production, maintenance and disposal of the vehicle are as reported in the ecoinvent (2007) report on transport services.

Main data sources:

De Ceuster, G., et al. (2009) TREMOVE: Final Report. Model code v2.7b, 2009. European Commission, Brussels.

Keller, M. et al. (2010) Handbook emission factors for road transport v3.1, HBEFA. INFRAS, Berne, CH.

Knörr, W. et al. (2011) Ecological Transport Information Tool for Worldwide Transports (EcoTransIT): Methodology and data update. Berlin, Hannover, Heidelberg, DE.

Ntziachristos, L., et al. (2013) EMEP/EEA air pollutant emissions inventory guidebook 2009: Exhaust emissions from road transport. European Environment Agency, Copenhagen, DK.

Spielmann, M., et al. (2007) Transport Services. ecoinvent report No. 14., Swiss Centre for Life Cycle Inventories, Dübendorf, CH.

Geography: None

None

None

Technology: None

None

transport, freight, lorry 7.5-16 metric ton, EURO6 \_ RoW :: [] TBD

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This dataset is an adaptation of “transport, freight, lorry 7.5-16 metric ton, EURO2” in South Africa, as available in version 3.6 of the ecoinvent database to reflect the situation in Brazil. It represents the service of 1tkm freight transport in a lorry of the size class 7.5-16 metric tons gross vehicle weight (GVW) and Euro 2 emissions class.

The Brazilian lorry fleet is regulated under the Vehicles Air Pollution Control Program – Proconve, which phases are equivalent to the European control program – EURO. Since 2012, the Proconve P7 (EURO 5) phase is in practice, while the P8 phase (EURO 6) will start in 2023. Before that, the Proconve P6 phase (EURO 4) was not implemented because of the unavailability of low-sulphur diesel, therefore recontextualized datasets do not consider this phase. The P5 (EURO 3), P4 (EURO 2) and P3 (EURO 1) phases started in 2005, 2000 and 1996, respectively. Prior technologies are classified as unregulated.

For the dataset recontextualization to the Brazilian reality, an updated average freight load and the diesel with 500 ppm of sulfur and 12% biodiesel blend are considered. Moreover, data from emission tests of the national vehicle production and import (CETESB, 2019) is used to update regulated emissions (carbon monoxide, particulate matter and nitrogen oxides). Furthermore, correction factors are used to consider the impact of biodiesel blend on exhaust emissions (USEPA 2002), and the fuel composition is considered to account for carbon dioxide and sulphur dioxide emission.

The vehicle mass category classification considered in Brazilian national statistics is approximated to the one adopted in ecoinvent datasets. The 7.5-16 metric ton lorry is representing the Brazilian heavy-duty lorry with gross vehicle weight (GVW) with 10 to 15 metric tons category classification. The average capacity utilization factor (including empty trips) for this category is 59.7 % according to the Road Freight Transport Model from the Brazilian Energy Research Enterprise – EPE (Stukart, 2018). Whereas, the average payload capacity for this category is 9.8 ton (Novo, 2016), resulting in an average freight load of 5.85 ton. GWV is estimated by assuming the same empty vehicle weight as for the RER region for the respective matching categories and accounting for the updated freight load. This resulted in a GWV of 11.9 ton. Vehicle mass dependent non-exhaust emissions (i.e. tyre, brake and road wear) are adjusted accordingly.

The emissions of carbon monoxide (CO), nitrogen oxides (NOx) and Particulate Matter (PM) were updated with data from (CETESB, 2019), which uses data from emission testing of the national vehicle fleet production and imports, weighted by sales amounts. Those tests are run with a reference fuel, which is not blended with biodiesel (ANP, 2018), therefore, those emission factors are adjusted for emissions from burning biodiesel.

The impact of the 12% biodiesel blend in exhaust emissions is accounted for by correction factors derived from USEPA (2002). Correction factors were calculated for the emissions of nitrogen oxides, particulate matter, hydrocarbons, carbon monoxide, acetaldehyde, ethylbenzene, formaldehyde, naphthalene and xylene. Moreover, fuel consumption was corrected with energy content values. For conventional diesel, it was considered energy content of 129.500 Btu/gal, animal-based biodiesel 115.720 Btu/gal and plant-based biodiesel 119.216 Btu/gal (USEPA 2002).

Fuel dependent emissions were updated as well. In Brazil, diesel containing 10 ppm (S10) of sulphur was introduced to attend to the demand of EURO V lorries, as its post-treatment technologies require the use of ultra-low sulphur diesel. Diesel containing 500 ppm (S500) of sulphur is also commercialized for the remaining lorry emission categories. For these cases, the use of S500 is assumed as no information on the share of S500 and S10 diesel used by these categories was available and because the price of S500 is lower than for the S10 (CNT, 2021). Therefore, sulphur dioxide emissions derived from S500 combustion were corrected assuming that all sulphur is emitted as SO2 (0.001 kg SO2/kg fossil diesel) and to account for the blend of biodiesel (12 %), which does not contain sulphur. Carbon dioxide emission is dependent on the fuel carbon content, which was considered as 77.8% for plant-based biodiesel and 76.1 % for animal-based biodiesel, resulting in a Brazilian average of 77.5%, while conventional diesel has 86.7% of carbon (USEPA, 2002). This results in emissions of 3.18 kg of fossil CO2/kg diesel and 2.84 biogenic CO2/kg biodiesel.

This dataset was developed under the Cornerstone project, an initiative from the Brazilian Business Network on Life cycle Assessment (Rede ACV) in collaboration with ecoinvent to increase the quantity and quality of inventories that represent Brazil, through a thorough adaptation of the datasets. More information about this project is available in redeacv.org.br/en/wg-database/. Technical background is provided in Valebona F.; Rocha T.B.; Motta F. L. Cornerstone Project. Recontextualization of Datasets: Methodology. ACV Brasil, Brazil.

Main data sources for the recontextualization:

ANP, 2018. Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (2018). RANP 764. RESOLUÇÃO ANP Nº 764, DE 20.12.2018 - DOU 21.12.2018.

EPE, 2020. Energy Research Enterprise (2020). Integrated Transport Model. Consultation through Information to Citizen System. Federal Government of Brazil.

Stukart, B., Lima, C., Pacheco, C., Silva, F., Antoniasse, G., Cavalcanti, M., Souza, M., Stelling, P. (2018). Transporte Rodoviário Brasileiro, Transição para Óleo Diesel S10 e Desafios para o Refino Nacional. Rio Oil&Gas. Available at:<https://stt.ibp.org.br/eventos/2018/riooil2018/pdfs/Riooil2018_1654_201806222325ibp1654_1> 8\_transic.pdf. Acessed in: 06/06/2020.

CETESB (2019). Companhia Ambiental do Estado de São Paulo (2019). Emissões Veiculares no Estado de São Paulo. Governo do Estado de São Paulo. Available at: [https://cetesb.sp.gov.br/veicular/relatoriose-publicacoes/.](https://cetesb.sp.gov.br/veicular/relatoriose-publicacoes/) Accessed in 15/06/2020.

USEPA, 2002. United States Environmental Protection Agency (2002). A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions. Draft Technical Report.

Novo, A. L. (2016). PERSPECTIVAS PARA O CONSUMO DE COMBUSTÍVEL NO TRANSPORTE DE CARGA NO BRASIL: UMA COMPARAÇÃO ENTRE OS EFEITOS ESTRUTURA E INTENSIDADE NO USO FINAL DE ENERGIA DO SETOR. Available at:<http://www.ppe.ufrj.br/images/publica%C3%A7%C3%B5es/mestrado/Ana_Luiza_Andrade_Novo.pdf>

CNT (2021). CNT acompanha, com atenção, a alta histórica do diesel. Available at: cnt.org.br/agencia-cnt/cnt-acompanha-alta-historica-do-diesel

Geography: Recontextualization from 'transport, freight, lorry 7.5-16 metric ton, EURO2, ZA'. Fuel type, freight load factor, regulated and fuel-dependent emissions were updated for the Brazilian situation. The environmental interventions due to vehicle transport are modelled by linking the environmental interventions due to vehicle operation with impacts due to vehicle manufacturing, vehicle maintenance, vehicle disposal, road construction, operation and maintenance of roads and road disposal.

Technology: Diesel and diesel engine. Lorry transport is further differentiated with respect to vehicle weight and emission technology standard (EURO-standard).

Technology classifications are based on those used widely within the works of the European Environment Agency, particularly in the Emissions Inventory Guidebook.

Time period: Validity period of the 12% biodiesel blend regulation. The regulation foresees incremental increases in the biodiesel content in the Brazilian market fuel (it started with a 2% blend in 2008, reached 12% in 2020 and will increase 1% a year, until it reaches 15% in 2023).

transport, freight, lorry 7.5-16 metric ton, EURO2 \_ BR :: ['average freight load of 5.85 ton. GWV is estimated by assuming the same empty vehicle weight as for the RER region for the respective matching categories and accounting for the updated freight load. This resulted in a GWV of 11.9 ton'] 5.85

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This dataset represents the service of 1tkm freight transport in a lorry of the size class 7.5-16 metric tons gross vehicle weight (GVW) and Euro IV emissions class. The transport datasets refer to the entire transport life cycle i.e. to the construction, operation, maintenance and end of life of vehicle and road infrastructures. Fuel consumption and emissions are for average European journeys and load factors and not representative of a specific transport scenario. The average load factors are taken from the Tremove model v2.7b (2009) and EcoTransIT (2011) report. These are as follows:

Lorry size class Average load factor GVW

3.5-7.5t 0.98t 4.98t

7.5-16t 3.29t 9.29t

16-32t 5.79t 15.79t

>32t 15.96t 29.96t

The lorry size and load factor determines the GVW and therefore also the fuel consumption and amount of both exhaust and non-exhaust emissions. Non-exhaust emissions are those resulting from tyre, brake and road wear.

Fuel consumption and exhaust emissions are taken from v3.1 of the HBEFA model, using the data for Germany and without applying model weighting. There are a higher number of size categories used in HBEFA than in ecoinvent and so the data are grouped in order to fit the lorry size classes used in ecoinvent. The selective catalytic reduction (SCR) technology is around 3 times more common than that of exhaust gas recovery (EGR) as an emissions reduction measure and so the emission factors given in the dataset are weighted to reflect this. The data for the HBEFA categories SCR\* and VI\* were disregarded. The exhaust emissions caused by the burning of fuel are either fuel dependent (fuel type and quantity) or Euro class dependent. The latter reflect the emission regulations to which the vehicle complies. Regulated emissions are CO, NOx, particulate matter (PM) and total hydrocarbons (HC). Data from the Emissions Inventory Guidebook (EMEP/EEA, 2013) were used for specific exhaust emissions not covered by the HBEFA model.

Non-exhaust emissions are accounted for as weight dependent by-products and exist as seperate datasets.

For road infrastructure the expenditures and environmental interventions due to construction of roads have been allocated based on the gross tonne kilometer performance. Expenditures due to operation of the road infrastructure, as well as land use have been allocated based on the yearly vehicle kilometer performance. The same assumption on vehicle lifetime performance has been transferred from the ecoinvent v2 datasets of 540 000 km/vehicle. The production, maintenance and disposal of the vehicle are as reported in the ecoinvent (2007) report on transport services.

Main data sources:

De Ceuster, G., et al. (2009) TREMOVE: Final Report. Model code v2.7b, 2009. European Commission, Brussels.

Keller, M. et al. (2010) Handbook emission factors for road transport v3.1, HBEFA. INFRAS, Berne, CH.

Knörr, W. et al. (2011) Ecological Transport Information Tool for Worldwide Transports (EcoTransIT): Methodology and data update. Berlin, Hannover, Heidelberg, DE.

Ntziachristos, L., et al. (2013) EMEP/EEA air pollutant emissions inventory guidebook 2009: Exhaust emissions from road transport. European Environment Agency, Copenhagen, DK.

Spielmann, M., et al. (2007) Transport Services. ecoinvent report No. 14., Swiss Centre for Life Cycle Inventories, Dübendorf, CH.

Geography: The data for road infrastructure reflect Swiss conditions. Data for vehicle operation, manufacturing and maintenance represents generic European data. Data for the vehicle disposal reflect the Swiss situation. The environmental interventions due to vehicle transport are modelled by linking the environmental interventions due to vehicle operation with impacts due to vehicle manufacturing, vehicle maintenance, vehicle disposal, road construction, operation and maintenance of roads and road disposal. So-called demand factors are used to link the transport service components to the functional unit of one tonne kilometre [tkm] (Spielmann & Scholz 2005).

References:

Spielmann M. and Scholz R. W. (2005) Life Cycle Inventories for Transport Services - Background Data for Freight Transport. In: Int J LCA, 10(1), pp.

Technology: Diesel and diesel engine. Lorry transport is further differentiated with respect to vehicle weight and emission technology standard (EURO-standard).

Technology classifications are based on those used widely within the works of the European Environment Agency, particularly in the Emissions Inventory Guidebook.

transport, freight, lorry 7.5-16 metric ton, EURO4 \_ RER :: [] TBD

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This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, unregulated', in the geography of Brazil.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel and it does not meet any emission standard. The average freight load factor of a 7.5-16 metric ton lorry is 7.2 tonnes, with a gross vehicle weight (GVW) of 13.1 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, unregulated \_ BR :: ['average freight load factor of a 7.5-16 metric ton lorry is 7.2 tonnes, with a gross vehicle weight (GVW) of 13.1 ton'] 7.5

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This dataset represents the transport of one metric ton.km of freight in South Africa by a 7.5-16 metric ton lorry of Euro 1 emission standard. The dataset represents the entire transport life cycle, including the production and maintenance of the vehicle, the transportation of goods and the construction, operation, maintenance and disposal of the road pavement. The scope of the dataset is the operation of the vehicle, which has inputs of vehicle production, vehicle maintenance, and road pavement construction, maintenance and operation, via linking to global datasets (i.e. the equipment and infrastructure datasets are not South African-specific).

The average freight load of a 7.5-16 metric ton lorry is 7.2 tonnes, with an average freight load factor of 60% (both values calculated from SATIM model (ERC, 2015), which used factors from the Road Freight Association's vehicle cost schedule and calibrated these values to the 2014 tonne.kms reported by the Department of Logistics at the University of Stellenbosch. The load factor accounts for all transport trips). The average gross vehicle mass (GVW) is 13.1 tonnes (calculated from freight loading and that freight accounts for 55% of GVW in a heavy commercial vehicle (DoT,2009).

The dataset is not parameterised and factors cannot be changed by users.

Fuel consumption and the primary emissions (nitrogen oxides, nitrous oxide, methane, non-methane hydrocarbons, ammonia, benzene and lead) are modelled based on information and assumptions on fleet mixes and usage of vehicles in different road and traffic situations. Basic emission data is taken from HBEFA 3.4. (INFRAS, 2017), with extensive weighted averaging of vehicles in different traffic situations performed (see report for parameters applied and data sources for road and traffic conditions in South Africa). Emission factors for sulphur dioxide and for carbon dioxide are not taken directly from HBEFA but are calculated using the carbon content and the sulphur content of diesel in South Africa (and the fuel consumption). Heavy metal emissions to air (other than lead) are extrapolated from "transport, freight, lorry 3.5-7.5 metric ton, EURO3" on the basis of fuel consumption. Emissions arising from wear of tyres, brakes and road are calculated from the applicable global datasets ("treatment of tyre/brake/road wear emissions, lorry, GLO, 2013") on the basis of GVW and freight loading.

Vehicle production and maintenance is described in the individual global datasets. Vehicle demand per tonne.km is calculated based on the lifetime kilometric performance, taken from Spielmann et al., (2007) (540,000 km for a heavy commercial vehicle), and the average freight load. The average freight load is calculated from the SATIM model (ERC, 2015), weighted to account for the current commercial vehicle fleet in South Africa (eNaTIS, 2017). Road construction, maintenance and disposal, and road operation are described in the individual global datasets. Road demand per tonne.km is calculated based on weighted road usage of each vehicle type of the road network in South Africa (see report for calculations and data sources).

References:

INFRAS (2017) Handbook Emission Factors for Road Transport (HBEFA) 3.4. INFRAS, Bern, Switzerland;

eNaTIS (2018) Vehicle population statistics for December 2017/January 2018, Electronic National Administration Traffic Information System (eNaTIS): Pretoria, SA.;

ERC (2015) South African TIMES Model (SATIM) Energy Research Centre - University of Cape Town: Cape Town, SA.;

Spielmann, M., Bauer, C., Dones, R. & Tuchschmid, M. (2007) Transport Services Data v2.0, ecoinvent association, Zurich, Switzerland.; DoT (2009) National Transport Master Plan: The Implications of Global Oil Depletion for Transport Systems in South Africa. Department of Transport. Pretoria, SA.

Geography: Fuel consumption and primary emissions (nitrogen oxides, nitrous oxide, methane, non-methane hydrocarbons, ammonia, benzene and lead) are based on fleet composition and usage of vehicles in different road and traffic situations in South Africa (see report for parameters applied and data sources for road and traffic conditions in South Africa). Basic emission data is taken from HBEFA 3.4. (INFRAS, 2017) for the emission standard relevant to South Africa, and with weighted averaging of vehicles reflecting the different traffic situations in South Africa. Sulphur dioxide and carbon dioxide emissions reflect the sulphur and carbon content of fuels in South Africa. Heavy metal emissions to air (other than lead) and wear emissions (tyre, break and road) are not South African specific or emission-standard relevant (i.e. are extrapolated from a Euro 3 global transport dataset of the same vehicle. Equipment and infrastructure datasets are not South African specific.

Technology: The dataset reflects current technology in that the calculations apply current/recent road infrastructure, commercial vehicle fleet and road freight data for South Africa. The calculations also reflect current fuel quality and emission standards in South Africa.

Time period: Data are representative of vehicle fleet and road freight data for 2017.

transport, freight, lorry 7.5-16 metric ton, EURO1 \_ ZA :: ["average freight load of a 7.5-16 metric ton lorry is 7.2 tonnes, with an average freight load factor of 60% (both values calculated from SATIM model (ERC, 2015), which used factors from the Road Freight Association's vehicle cost schedule and calibrated these values to the 2014 tonne.kms reported by the Department of Logistics at the University of Stellenbosch. The load factor accounts for all transport trips). The average gross vehicle mass (GVW) is 13.1 ton", 'average freight load is calculated from the SATIM model (ERC, 2015), weighted to account for the current commercial vehicle fleet in South Africa (eNaTIS, 2017). Road construction, maintenance and disposal, and road operation are described in the individual global datasets. Road demand per ton'] 7.5

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This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO6', in the Global geography.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO6 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO6 \_ RoW :: ['average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 ton'] 7.5

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This dataset represents the transport of one metric ton.km of freight in South Africa by a 7.5-16 metric ton lorry not meeting any emission standard. The dataset represents the entire transport life cycle, including the production and maintenance of the vehicle, the transportation of goods and the construction, operation, maintenance and disposal of the road pavement. The scope of the dataset is the operation of the vehicle, which has inputs of vehicle production, vehicle maintenance, and road pavement construction, maintenance and operation, via linking to global datasets (i.e. the equipment and infrastructure datasets are not South African-specific).

The average freight load of a 7.5-16 metric ton lorry is 7.2 tonnes, with an average freight load factor of 60% (both values calculated from SATIM model (ERC, 2015), which used factors from the Road Freight Association's vehicle cost schedule and calibrated these values to the 2014 tonne.kms reported by the Department of Logistics at the University of Stellenbosch. The load factor accounts for all transport trips). The average gross vehicle mass (GVW) is 13.1 tonnes (calculated from freight loading and that freight accounts for 55% of GVW in a heavy commercial vehicle (DoT,2009).

The dataset is not parameterised and factors cannot be changed by users.

Fuel consumption and the primary emissions (nitrogen oxides, nitrous oxide, methane, non-methane hydrocarbons, ammonia, benzene and lead) are modelled based on information and assumptions on fleet mixes and usage of vehicles in different road and traffic situations. Basic emission data is taken from HBEFA 3.4. (INFRAS, 2017), with extensive weighted averaging of vehicles in different traffic situations performed (see report for parameters applied and data sources for road and traffic conditions in South Africa). Emission factors for sulphur dioxide and for carbon dioxide are not taken directly from HBEFA but are calculated using the carbon content and the sulphur content of diesel in South Africa (and the fuel consumption). Heavy metal emissions to air (other than lead) are extrapolated from "transport, freight, lorry 3.5-7.5 metric ton, EURO3" on the basis of fuel consumption. Emissions arising from wear of tyres, brakes and road are calculated from the applicable global datasets ("treatment of tyre/brake/road wear emissions, lorry, GLO, 2013") on the basis of GVW and freight loading.

Vehicle production and maintenance is described in the individual global datasets. Vehicle demand per tonne.km is calculated based on the lifetime kilometric performance, taken from Spielmann et al., (2007) (540,000 km for a heavy commercial vehicle), and the average freight load. The average freight load is calculated from the SATIM model (ERC, 2015), weighted to account for the current commercial vehicle fleet in South Africa (eNaTIS, 2017). Road construction, maintenance and disposal, and road operation are described in the individual global datasets. Road demand per tonne.km is calculated based on weighted road usage of each vehicle type of the road network in South Africa (see report for calculations and data sources).

References:

INFRAS (2017) Handbook Emission Factors for Road Transport (HBEFA) 3.4. INFRAS, Bern, Switzerland;

eNaTIS (2018) Vehicle population statistics for December 2017/January 2018, Electronic National Administration Traffic Information System (eNaTIS): Pretoria, SA.;

ERC (2015) South African TIMES Model (SATIM) Energy Research Centre - University of Cape Town: Cape Town, SA.;

Spielmann, M., Bauer, C., Dones, R. & Tuchschmid, M. (2007) Transport Services Data v2.0, ecoinvent association, Zurich, Switzerland.; DoT (2009) National Transport Master Plan: The Implications of Global Oil Depletion for Transport Systems in South Africa. Department of Transport. Pretoria, SA.

Geography: Fuel consumption and primary emissions (nitrogen oxides, nitrous oxide, methane, non-methane hydrocarbons, ammonia, benzene and lead) are based on fleet composition and usage of vehicles in different road and traffic situations in South Africa (see report for parameters applied and data sources for road and traffic conditions in South Africa). Basic emission data is taken from HBEFA 3.4. (INFRAS, 2017) for the emission standard relevant to South Africa, and with weighted averaging of vehicles reflecting the different traffic situations in South Africa. Sulphur dioxide and carbon dioxide emissions reflect the sulphur and carbon content of fuels in South Africa. Heavy metal emissions to air (other than lead) and wear emissions (tyre, break and road) are not South African specific or emission-standard relevant (i.e. are extrapolated from a Euro 3 global transport dataset of the same vehicle. Equipment and infrastructure datasets are not South African specific.

Technology: The dataset reflects current technology in that the calculations apply current/recent road infrastructure, commercial vehicle fleet and road freight data for South Africa. The calculations also reflect current fuel quality and emission standards in South Africa.

Time period: Data are representative of vehicle fleet and road freight data for 2017.

transport, freight, lorry 7.5-16 metric ton, unregulated \_ ZA :: ["average freight load of a 7.5-16 metric ton lorry is 7.2 tonnes, with an average freight load factor of 60% (both values calculated from SATIM model (ERC, 2015), which used factors from the Road Freight Association's vehicle cost schedule and calibrated these values to the 2014 tonne.kms reported by the Department of Logistics at the University of Stellenbosch. The load factor accounts for all transport trips). The average gross vehicle mass (GVW) is 13.1 ton", 'average freight load is calculated from the SATIM model (ERC, 2015), weighted to account for the current commercial vehicle fleet in South Africa (eNaTIS, 2017). Road construction, maintenance and disposal, and road operation are described in the individual global datasets. Road demand per ton'] 7.5

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This dataset is an adaptation of “transport, freight, lorry 7.5-16 metric ton, EURO5” in Europe, as available in version 3.6 of the ecoinvent database to reflect the situation in Brazil. It represents the service of 1tkm freight transport in a lorry of the size class 7.5-16 metric tons gross vehicle weight (GVW) and Euro 5 emissions class.

The Brazilian lorry fleet is regulated under the Vehicles Air Pollution Control Program – Proconve, which phases are equivalent to the European control program – EURO. Since 2012, the Proconve P7 (EURO 5) phase is in practice, while the P8 phase (EURO 6) will start in 2023. Before that, the Proconve P6 phase (EURO 4) was not implemented because of the unavailability of low-sulphur diesel, therefore recontextualized datasets do not consider this phase. The P5 (EURO 3), P4 (EURO 2) and P3 (EURO 1) phases started in 2005, 2000 and 1996, respectively. Prior technologies are classified as unregulated.

None

For the dataset recontextualization to the Brazilian reality, an updated average freight load and the diesel with 10 ppm of sulfur and 12% biodiesel blend are considered. Moreover, data from emission tests of the national vehicle production and import (CETESB, 2019) is used to update regulated emissions (carbon monoxide, particulate matter and nitrogen oxides). Furthermore, correction factors are used to consider the impact of biodiesel blend on exhaust emissions (USEPA 2002), and the fuel composition is considered to account for carbon dioxide and sulphur dioxide emission.

The vehicle mass category classification considered in Brazilian national statistics is approximated to the one adopted in ecoinvent datasets. The 7.5-16 metric ton lorry is representing the Brazilian heavy-duty lorry with gross vehicle weight (GVW) with 10 to 15 metric tons category classification. The average capacity utilization factor (including empty trips) for this category is 59.7 % according to the Road Freight Transport Model from the Brazilian Energy Research Enterprise – EPE (Stukart, 2018). Whereas, the average payload capacity for this category is 9.8 ton (Novo, 2016), resulting in an average freight load of 5.85 ton. GWV is estimated by assuming the same empty vehicle weight as for the RER region for the respective matching categories and accounting for the updated freight load. This resulted in a GWV of 11.9 ton. Vehicle mass dependent non-exhaust emissions (i.e. tyre, brake and road wear) are adjusted accordingly.

The emissions of carbon monoxide (CO), nitrogen oxides (NOx) and Particulate Matter (PM) were updated with data from (CETESB, 2019), which uses data from emission testing of the national vehicle fleet production and imports, weighted by sales amounts. Those tests are run with a reference fuel, which is not blended with biodiesel (ANP, 2018), therefore, those emission factors are adjusted for emissions from burning biodiesel.

The impact of the 12% biodiesel blend in exhaust emissions is accounted for by correction factors derived from USEPA (2002). Correction factors were calculated for the emissions of nitrogen oxides, particulate matter, hydrocarbons, carbon monoxide, acetaldehyde, ethylbenzene, formaldehyde, naphthalene and xylene. Moreover, fuel consumption was corrected with energy content values. For conventional diesel, it was considered energy content of 129.500 Btu/gal, animal-based biodiesel 115.720 Btu/gal and plant-based biodiesel 119.216 Btu/gal (USEPA 2002).

Fuel dependent emissions were updated as well. EURO V lorries are fuelled with 10 ppm sulfur content diesel (blended with 12% biodiesel). Therefore, sulphur dioxide emissions were corrected assuming that all sulphur is emitted as SO2 (0.00002 kg SO2/kg fossil diesel) and to account for the blend of biodiesel, which does not contain sulphur. Carbon dioxide emission is dependent on the fuel carbon content, which was considered as 77.8% for plant-based biodiesel and 76.1 % for animal-based biodiesel, resulting in a Brazilian average of 77.5%, while conventional diesel has 86.7% of carbon (USEPA, 2002). This results in emissions of 3.18 kg of fossil CO2/kg diesel and 2.84 biogenic CO2/kg biodiesel.

This dataset was developed under the Cornerstone project, an initiative from the Brazilian Business Network on Life cycle Assessment (Rede ACV) in collaboration with ecoinvent to increase the quantity and quality of inventories that represent Brazil, through a thorough adaptation of the datasets. More information about this project is available in redeacv.org.br/en/wg-database/. Technical background is provided in Valebona F.; Rocha T.B.; Motta F. L. Cornerstone Project. Recontextualization of Datasets: Methodology. ACV Brasil, Brazil.

Main data sources for the recontextualization:

ANP, 2018. Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (2018). RANP 764. RESOLUÇÃO ANP Nº 764, DE 20.12.2018 - DOU 21.12.2018.

EPE, 2020. Energy Research Enterprise (2020). Integrated Transport Model. Consultation through Information to Citizen System. Federal Government of Brazil.

Stukart, B., Lima, C., Pacheco, C., Silva, F., Antoniasse, G., Cavalcanti, M., Souza, M., Stelling, P. (2018). Transporte Rodoviário Brasileiro, Transição para Óleo Diesel S10 e Desafios para o Refino Nacional. Rio Oil&Gas. Available at:<https://stt.ibp.org.br/eventos/2018/riooil2018/pdfs/Riooil2018_1654_201806222325ibp1654_1> 8\_transic.pdf. Acessed in: 06/06/2020.

CETESB (2019). Companhia Ambiental do Estado de São Paulo (2019). Emissões Veiculares no Estado de São Paulo. Governo do Estado de São Paulo. Available at: [https://cetesb.sp.gov.br/veicular/relatoriose-publicacoes/.](https://cetesb.sp.gov.br/veicular/relatoriose-publicacoes/) Accessed in 15/06/2020.

USEPA, 2002. United States Environmental Protection Agency (2002). A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions. Draft Technical Report.

Novo, A. L. (2016). PERSPECTIVAS PARA O CONSUMO DE COMBUSTÍVEL NO TRANSPORTE DE CARGA NO BRASIL: UMA COMPARAÇÃO ENTRE OS EFEITOS ESTRUTURA E INTENSIDADE NO USO FINAL DE ENERGIA DO SETOR. Available at:<http://www.ppe.ufrj.br/images/publica%C3%A7%C3%B5es/mestrado/Ana_Luiza_Andrade_Novo.pdf>

Geography: Recontextualization from 'transport, freight, lorry 7.5-16 metric ton, EURO5, RER'. Fuel type, freight load factor, regulated and fuel-dependent emissions were updated for the Brazilian situation. The environmental interventions due to vehicle transport are modelled by linking the environmental interventions due to vehicle operation with impacts due to vehicle manufacturing, vehicle maintenance, vehicle disposal, road construction, operation and maintenance of roads and road disposal.

Technology: Diesel and diesel engine. Lorry transport is further differentiated with respect to vehicle weight and emission technology standard (EURO-standard).

Technology classifications are based on those used widely within the works of the European Environment Agency, particularly in the Emissions Inventory Guidebook.

Time period: Validity period of the 12% biodiesel blend regulation. The regulation foresees incremental increases in the biodiesel content in the Brazilian market fuel (it started with a 2% blend in 2008, reached 12% in 2020 and will increase 1% a year, until it reaches 15% in 2023).

transport, freight, lorry 7.5-16 metric ton, EURO5 \_ BR :: ['average freight load of 5.85 ton. GWV is estimated by assuming the same empty vehicle weight as for the RER region for the respective matching categories and accounting for the updated freight load. This resulted in a GWV of 11.9 ton'] 5.85

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None

Lorry size class Average load factor GVW

3.5-7.5t 0.98t 4.98t

7.5-16t 3.29t 9.29t

16-32t 5.79t 15.79t

>32t 15.96t 29.96t

The lorry size and load factor determines the GVW and therefore also the fuel consumption and amount of both exhaust and non-exhaust emissions. Non-exhaust emissions are those resulting from tyre, brake and road wear.

Fuel consumption and exhaust emissions are taken from v3.1 of the HBEFA model, using the data for Germany and without applying model weighting. There are a higher number of size categories used in HBEFA than in ecoinvent and so the data are grouped in order to fit the lorry size classes used in ecoinvent. The selective catalytic reduction (SCR) technology is around 3 times more common than that of exhaust gas recovery (EGR) as an emissions reduction measure and so the emission factors given in the dataset are weighted to reflect this. The data for the HBEFA categories SCR\* and VI\* were disregarded. The exhaust emissions caused by the burning of fuel are either fuel dependent (fuel type and quantity) or Euro class dependent. The latter reflect the emission regulations to which the vehicle complies. Regulated emissions are CO, NOx, particulate matter (PM) and total hydrocarbons (HC). Data from the Emissions Inventory Guidebook (EMEP/EEA, 2013) were used for specific exhaust emissions not covered by the HBEFA model.

Non-exhaust emissions are accounted for as weight dependent by-products and exist as seperate datasets.

For road infrastructure the expenditures and environmental interventions due to construction of roads have been allocated based on the gross tonne kilometer performance. Expenditures due to operation of the road infrastructure, as well as land use have been allocated based on the yearly vehicle kilometer performance. The same assumption on vehicle lifetime performance has been transferred from the ecoinvent v2 datasets of 540 000 km/vehicle. The production, maintenance and disposal of the vehicle are as reported in the ecoinvent (2007) report on transport services.

Main data sources:

De Ceuster, G., et al. (2009) TREMOVE: Final Report. Model code v2.7b, 2009. European Commission, Brussels.

Keller, M. et al. (2010) Handbook emission factors for road transport v3.1, HBEFA. INFRAS, Berne, CH.

Knörr, W. et al. (2011) Ecological Transport Information Tool for Worldwide Transports (EcoTransIT): Methodology and data update. Berlin, Hannover, Heidelberg, DE.

Ntziachristos, L., et al. (2013) EMEP/EEA air pollutant emissions inventory guidebook 2009: Exhaust emissions from road transport. European Environment Agency, Copenhagen, DK.

Spielmann, M., et al. (2007) Transport Services. ecoinvent report No. 14., Swiss Centre for Life Cycle Inventories, Dübendorf, CH.

Geography: None

None

None

Technology: None

None

transport, freight, lorry 7.5-16 metric ton, EURO5 \_ RoW :: [] TBD

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This dataset is an adaptation of “transport, freight, lorry 7.5-16 metric ton, unregulated” in South Africa, as available in version 3.6 of the ecoinvent database to reflect the situation in Brazil. It represents the service of 1tkm freight transport in a lorry of the size class 7.5-16 metric tons gross vehicle weight (GVW) and unregulated emissions class.

The Brazilian lorry fleet is regulated under the Vehicles Air Pollution Control Program – Proconve, which phases are equivalent to the European control program – EURO. Since 2012, the Proconve P7 (EURO 5) phase is in practice, while the P8 phase (EURO 6) will start in 2023. Before that, the Proconve P6 phase (EURO 4) was not implemented because of the unavailability of low-sulphur diesel, therefore recontextualized datasets do not consider this phase. The P5 (EURO 3), P4 (EURO 2) and P3 (EURO 1) phases started in 2005, 2000 and 1996, respectively. Prior technologies are classified as unregulated.

For the dataset recontextualization to the Brazilian reality, an updated average freight load and the diesel with 500 ppm of sulfur and 12% biodiesel blend are considered. Moreover, data from emission tests of the national vehicle production and import (CETESB, 2019) is used to update regulated emissions (carbon monoxide, particulate matter and nitrogen oxides). Furthermore, correction factors are used to consider the impact of biodiesel blend on exhaust emissions (USEPA 2002), and the fuel composition is considered to account for carbon dioxide and sulphur dioxide emission.

The vehicle mass category classification considered in Brazilian national statistics is approximated to the one adopted in ecoinvent datasets. The 7.5-16 metric ton lorry is representing the Brazilian heavy-duty lorry with gross vehicle weight (GVW) with 10 to 15 metric tons category classification. The average capacity utilization factor (including empty trips) for this category is 59.7 % according to the Road Freight Transport Model from the Brazilian Energy Research Enterprise – EPE (Stukart, 2018). Whereas, the average payload capacity for this category is 9.8 ton (Novo, 2016), resulting in an average freight load of 5.85 ton. GWV is estimated by assuming the same empty vehicle weight as for the RER region for the respective matching categories and accounting for the updated freight load. This resulted in a GWV of 11.9 ton. Vehicle mass dependent non-exhaust emissions (i.e. tyre, brake and road wear) are adjusted accordingly.

The emissions of carbon monoxide (CO), nitrogen oxides (NOx) and Particulate Matter (PM) were updated with data from (CETESB, 2019), which uses data from emission testing of the national vehicle fleet production and imports, weighted by sales amounts. Those tests are run with a reference fuel, which is not blended with biodiesel (ANP, 2018), therefore, those emission factors are adjusted for emissions from burning biodiesel.

The impact of the 12% biodiesel blend in exhaust emissions is accounted for by correction factors derived from USEPA (2002). Correction factors were calculated for the emissions of nitrogen oxides, particulate matter, hydrocarbons, carbon monoxide, acetaldehyde, ethylbenzene, formaldehyde, naphthalene and xylene. Moreover, fuel consumption was corrected with energy content values. For conventional diesel, it was considered energy content of 129.500 Btu/gal, animal-based biodiesel 115.720 Btu/gal and plant-based biodiesel 119.216 Btu/gal (USEPA 2002).

Fuel dependent emissions were updated as well. In Brazil, diesel containing 10 ppm (S10) of sulphur was introduced to attend to the demand of EURO V lorries, as its post-treatment technologies require the use of ultra-low sulphur diesel. Diesel containing 500 ppm (S500) of sulphur is also commercialized for the remaining lorry emission categories. For these cases, the use of S500 is assumed as no information on the share of S500 and S10 diesel used by these categories was available and because the price of S500 is lower than for the S10 (CNT, 2021). Therefore, sulphur dioxide emissions derived from S500 combustion were corrected assuming that all sulphur is emitted as SO2 (0.001 kg SO2/kg fossil diesel) and to account for the blend of biodiesel (12 %), which does not contain sulphur. Carbon dioxide emission is dependent on the fuel carbon content, which was considered as 77.8% for plant-based biodiesel and 76.1 % for animal-based biodiesel, resulting in a Brazilian average of 77.5%, while conventional diesel has 86.7% of carbon (USEPA, 2002). This results in emissions of 3.18 kg of fossil CO2/kg diesel and 2.84 biogenic CO2/kg biodiesel.

This dataset was developed under the Cornerstone project, an initiative from the Brazilian Business Network on Life cycle Assessment (Rede ACV) in collaboration with ecoinvent to increase the quantity and quality of inventories that represent Brazil, through a thorough adaptation of the datasets. More information about this project is available in redeacv.org.br/en/wg-database/. Technical background is provided in Valebona F.; Rocha T.B.; Motta F. L. Cornerstone Project. Recontextualization of Datasets: Methodology. ACV Brasil, Brazil.

Main data sources for the recontextualization:

ANP, 2018. Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (2018). RANP 764. RESOLUÇÃO ANP Nº 764, DE 20.12.2018 - DOU 21.12.2018.

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Geography: Recontextualization from 'transport, freight, lorry 7.5-16 metric ton, unregulated, ZA'. Fuel type, freight load factor, regulated and fuel-dependent emissions were updated for the Brazilian situation. The environmental interventions due to vehicle transport are modelled by linking the environmental interventions due to vehicle operation with impacts due to vehicle manufacturing, vehicle maintenance, vehicle disposal, road construction, operation and maintenance of roads and road disposal.

Technology: Diesel and diesel engine. Lorry transport is further differentiated with respect to vehicle weight and emission technology standard (EURO-standard).

Technology classifications are based on those used widely within the works of the European Environment Agency, particularly in the Emissions Inventory Guidebook.

Time period: Validity period of the 12% biodiesel blend regulation. The regulation foresees incremental increases in the biodiesel content in the Brazilian market fuel (it started with a 2% blend in 2008, reached 12% in 2020 and will increase 1% a year, until it reaches 15% in 2023).

transport, freight, lorry 7.5-16 metric ton, unregulated \_ BR :: ['average freight load of 5.85 ton. GWV is estimated by assuming the same empty vehicle weight as for the RER region for the respective matching categories and accounting for the updated freight load. This resulted in a GWV of 11.9 ton'] 5.85

##########################################################################################

This dataset represents the service of 1tkm freight transport in a lorry of the size class 7.5-16 metric tons gross vehicle weight (GVW) and Euro V emissions class. The transport datasets refer to the entire transport life cycle i.e. to the construction, operation, maintenance and end of life of vehicle and road infrastructures. Fuel consumption and emissions are for average European journeys and load factors and not representative of a specific transport scenario. The average load factors are taken from the Tremove model v2.7b (2009) and EcoTransIT (2011) report. These are as follows:

Lorry size class Average load factor GVW

3.5-7.5t 0.98t 4.98t

7.5-16t 3.29t 9.29t

16-32t 5.79t 15.79t

>32t 15.96t 29.96t

The lorry size and load factor determines the GVW and therefore also the fuel consumption and amount of both exhaust and non-exhaust emissions. Non-exhaust emissions are those resulting from tyre, brake and road wear.

Fuel consumption and exhaust emissions are taken from v3.1 of the HBEFA model, using the data for Germany and without applying model weighting. There are a higher number of size categories used in HBEFA than in ecoinvent and so the data are grouped in order to fit the lorry size classes used in ecoinvent. The selective catalytic reduction (SCR) technology is around 3 times more common than that of exhaust gas recovery (EGR) as an emissions reduction measure and so the emission factors given in the dataset are weighted to reflect this. The data for the HBEFA categories SCR\* and VI\* were disregarded. The exhaust emissions caused by the burning of fuel are either fuel dependent (fuel type and quantity) or Euro class dependent. The latter reflect the emission regulations to which the vehicle complies. Regulated emissions are CO, NOx, particulate matter (PM) and total hydrocarbons (HC). Data from the Emissions Inventory Guidebook (EMEP/EEA, 2013) were used for specific exhaust emissions not covered by the HBEFA model.

Non-exhaust emissions are accounted for as weight dependent by-products and exist as seperate datasets.

For road infrastructure the expenditures and environmental interventions due to construction of roads have been allocated based on the gross tonne kilometer performance. Expenditures due to operation of the road infrastructure, as well as land use have been allocated based on the yearly vehicle kilometer performance. The same assumption on vehicle lifetime performance has been transferred from the ecoinvent v2 datasets of 540 000 km/vehicle. The production, maintenance and disposal of the vehicle are as reported in the ecoinvent (2007) report on transport services.

Main data sources:

De Ceuster, G., et al. (2009) TREMOVE: Final Report. Model code v2.7b, 2009. European Commission, Brussels.

Keller, M. et al. (2010) Handbook emission factors for road transport v3.1, HBEFA. INFRAS, Berne, CH.

Knörr, W. et al. (2011) Ecological Transport Information Tool for Worldwide Transports (EcoTransIT): Methodology and data update. Berlin, Hannover, Heidelberg, DE.

Ntziachristos, L., et al. (2013) EMEP/EEA air pollutant emissions inventory guidebook 2009: Exhaust emissions from road transport. European Environment Agency, Copenhagen, DK.

Spielmann, M., et al. (2007) Transport Services. ecoinvent report No. 14., Swiss Centre for Life Cycle Inventories, Dübendorf, CH.

Geography: The data for road infrastructure reflect Swiss conditions. Data for vehicle operation, manufacturing and maintenance represents generic European data. Data for the vehicle disposal reflect the Swiss situation. The environmental interventions due to vehicle transport are modelled by linking the environmental interventions due to vehicle operation with impacts due to vehicle manufacturing, vehicle maintenance, vehicle disposal, road construction, operation and maintenance of roads and road disposal. So-called demand factors are used to link the transport service components to the functional unit of one tonne kilometre [tkm] (Spielmann & Scholz 2005).

References:

Spielmann M. and Scholz R. W. (2005) Life Cycle Inventories for Transport Services - Background Data for Freight Transport. In: Int J LCA, 10(1), pp.

Technology: Diesel and diesel engine. Lorry transport is further differentiated with respect to vehicle weight and emission technology standard (EURO-standard).

Technology classifications are based on those used widely within the works of the European Environment Agency, particularly in the Emissions Inventory Guidebook.

transport, freight, lorry 7.5-16 metric ton, EURO5 \_ RER :: [] TBD

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This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO1', in the geography of South Africa.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO1 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 7.2 tonnes, with a gross vehicle weight (GVW) of 13.1 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO1 \_ ZA :: ['average freight load factor of a 7.5-16 metric ton lorry is 7.2 tonnes, with a gross vehicle weight (GVW) of 13.1 ton'] 7.5

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This dataset represents the service of 1tkm freight transport in a lorry of the size class 7.5-16 metric tons gross vehicle weight (GVW) and Euro III emissions class. The transport datasets refer to the entire transport life cycle i.e. to the construction, operation, maintenance and end of life of vehicle and road infrastructures. Fuel consumption and emissions are for average European journeys and load factors and not representative of a specific transport scenario. The average load factors are taken from the Tremove model v2.7b (2009) and EcoTransIT (2011) report. These are as follows:

Lorry size class Average load factor GVW

3.5-7.5t 0.98t 4.98t

7.5-16t 3.29t 9.29t

16-32t 5.79t 15.79t

>32t 15.96t 29.96t

The lorry size and load factor determines the GVW and therefore also the fuel consumption and amount of both exhaust and non-exhaust emissions. Non-exhaust emissions are those resulting from tyre, brake and road wear.

Fuel consumption and exhaust emissions are taken from v3.1 of the HBEFA model, using the data for Germany and without applying model weighting. There are a higher number of size categories used in HBEFA than in ecoinvent and so the data are grouped in order to fit the lorry size classes used in ecoinvent. The selective catalytic reduction (SCR) technology is around 3 times more common than that of exhaust gas recovery (EGR) as an emissions reduction measure and so the emission factors given in the dataset are weighted to reflect this. The data for the HBEFA categories SCR\* and VI\* were disregarded. The exhaust emissions caused by the burning of fuel are either fuel dependent (fuel type and quantity) or Euro class dependent. The latter reflect the emission regulations to which the vehicle complies. Regulated emissions are CO, NOx, particulate matter (PM) and total hydrocarbons (HC). Data from the Emissions Inventory Guidebook (EMEP/EEA, 2013) were used for specific exhaust emissions not covered by the HBEFA model.

Non-exhaust emissions are accounted for as weight dependent by-products and exist as seperate datasets.

For road infrastructure the expenditures and environmental interventions due to construction of roads have been allocated based on the gross tonne kilometer performance. Expenditures due to operation of the road infrastructure, as well as land use have been allocated based on the yearly vehicle kilometer performance. The same assumption on vehicle lifetime performance has been transferred from the ecoinvent v2 datasets of 540 000 km/vehicle. The production, maintenance and disposal of the vehicle are as reported in the ecoinvent (2007) report on transport services.

Main data sources:

De Ceuster, G., et al. (2009) TREMOVE: Final Report. Model code v2.7b, 2009. European Commission, Brussels.

Keller, M. et al. (2010) Handbook emission factors for road transport v3.1, HBEFA. INFRAS, Berne, CH.

Knörr, W. et al. (2011) Ecological Transport Information Tool for Worldwide Transports (EcoTransIT): Methodology and data update. Berlin, Hannover, Heidelberg, DE.

Ntziachristos, L., et al. (2013) EMEP/EEA air pollutant emissions inventory guidebook 2009: Exhaust emissions from road transport. European Environment Agency, Copenhagen, DK.

Spielmann, M., et al. (2007) Transport Services. ecoinvent report No. 14., Swiss Centre for Life Cycle Inventories, Dübendorf, CH.

Geography: The data for road infrastructure reflect Swiss conditions. Data for vehicle operation, manufacturing and maintenance represents generic European data. Data for the vehicle disposal reflect the Swiss situation. The environmental interventions due to vehicle transport are modelled by linking the environmental interventions due to vehicle operation with impacts due to vehicle manufacturing, vehicle maintenance, vehicle disposal, road construction, operation and maintenance of roads and road disposal. So-called demand factors are used to link the transport service components to the functional unit of one tonne kilometre [tkm] (Spielmann & Scholz 2005).

References:

Spielmann M. and Scholz R. W. (2005) Life Cycle Inventories for Transport Services - Background Data for Freight Transport. In: Int J LCA, 10(1), pp.

Technology: Diesel and diesel engine. Lorry transport is further differentiated with respect to vehicle weight and emission technology standard (EURO-standard).

Technology classifications are based on those used widely within the works of the European Environment Agency, particularly in the Emissions Inventory Guidebook.

transport, freight, lorry 7.5-16 metric ton, EURO3 \_ RER :: [] TBD

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This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO4', in the Global geography.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO4 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO4 \_ RoW :: ['average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 ton'] 7.5

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This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO6', in the geography of Europe.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO6 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO6 \_ RER :: ['average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 ton'] 7.5

##########################################################################################

This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO5', in the geography of Europe.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO5 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO5 \_ RER :: ['average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 ton'] 7.5

##########################################################################################

This dataset represents the service of 1tkm freight transport in a lorry of the size class 7.5-16 metric tons gross vehicle weight (GVW) and Euro IV emissions class. The transport datasets refer to the entire transport life cycle i.e. to the construction, operation, maintenance and end of life of vehicle and road infrastructures. Fuel consumption and emissions are for average European journeys and load factors and not representative of a specific transport scenario. The average load factors are taken from the Tremove model v2.7b (2009) and EcoTransIT (2011) report. These are as follows:

Lorry size class Average load factor GVW

3.5-7.5t 0.98t 4.98t

7.5-16t 3.29t 9.29t

16-32t 5.79t 15.79t

>32t 15.96t 29.96t

The lorry size and load factor determines the GVW and therefore also the fuel consumption and amount of both exhaust and non-exhaust emissions. Non-exhaust emissions are those resulting from tyre, brake and road wear.

Fuel consumption and exhaust emissions are taken from v3.1 of the HBEFA model, using the data for Germany and without applying model weighting. There are a higher number of size categories used in HBEFA than in ecoinvent and so the data are grouped in order to fit the lorry size classes used in ecoinvent. The selective catalytic reduction (SCR) technology is around 3 times more common than that of exhaust gas recovery (EGR) as an emissions reduction measure and so the emission factors given in the dataset are weighted to reflect this. The data for the HBEFA categories SCR\* and VI\* were disregarded. The exhaust emissions caused by the burning of fuel are either fuel dependent (fuel type and quantity) or Euro class dependent. The latter reflect the emission regulations to which the vehicle complies. Regulated emissions are CO, NOx, particulate matter (PM) and total hydrocarbons (HC). Data from the Emissions Inventory Guidebook (EMEP/EEA, 2013) were used for specific exhaust emissions not covered by the HBEFA model.

Non-exhaust emissions are accounted for as weight dependent by-products and exist as seperate datasets.

For road infrastructure the expenditures and environmental interventions due to construction of roads have been allocated based on the gross tonne kilometer performance. Expenditures due to operation of the road infrastructure, as well as land use have been allocated based on the yearly vehicle kilometer performance. The same assumption on vehicle lifetime performance has been transferred from the ecoinvent v2 datasets of 540 000 km/vehicle. The production, maintenance and disposal of the vehicle are as reported in the ecoinvent (2007) report on transport services.

Main data sources:

De Ceuster, G., et al. (2009) TREMOVE: Final Report. Model code v2.7b, 2009. European Commission, Brussels.

Keller, M. et al. (2010) Handbook emission factors for road transport v3.1, HBEFA. INFRAS, Berne, CH.

Knörr, W. et al. (2011) Ecological Transport Information Tool for Worldwide Transports (EcoTransIT): Methodology and data update. Berlin, Hannover, Heidelberg, DE.

Ntziachristos, L., et al. (2013) EMEP/EEA air pollutant emissions inventory guidebook 2009: Exhaust emissions from road transport. European Environment Agency, Copenhagen, DK.

Spielmann, M., et al. (2007) Transport Services. ecoinvent report No. 14., Swiss Centre for Life Cycle Inventories, Dübendorf, CH.

Geography: None

None

None

Technology: None

None

transport, freight, lorry 7.5-16 metric ton, EURO4 \_ RoW :: [] TBD

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This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO4', in the geography of Europe.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO4 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO4 \_ RER :: ['average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 ton'] 7.5

##########################################################################################

This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO3', in the geography of Europe.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO3 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO3 \_ RER :: ['average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 ton'] 7.5

##########################################################################################

This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, unregulated', in the geography of South Africa.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel and it does not meet any emission standard. The average freight load factor of a 7.5-16 metric ton lorry is 7.2 tonnes, with a gross vehicle weight (GVW) of 13.1 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, unregulated \_ ZA :: ['average freight load factor of a 7.5-16 metric ton lorry is 7.2 tonnes, with a gross vehicle weight (GVW) of 13.1 ton'] 7.5

##########################################################################################

This dataset represents the service of 1tkm freight transport in a lorry of the size class 7.5-16 metric tons gross vehicle weight (GVW) and Euro VI emissions class. The transport datasets refer to the entire transport life cycle i.e. to the construction, operation, maintenance and end of life of vehicle and road infrastructures. Fuel consumption and emissions are for average European journeys and load factors and not representative of a specific transport scenario. The average load factors are taken from the Tremove model v2.7b (2009) and EcoTransIT (2011) report. These are as follows:

Lorry size class Average load factor GVW

3.5-7.5t 0.98t 4.98t

7.5-16t 3.29t 9.29t

16-32t 5.79t 15.79t

>32t 15.96t 29.96t

The lorry size and load factor determines the GVW and therefore also the fuel consumption and amount of both exhaust and non-exhaust emissions. Non-exhaust emissions are those resulting from tyre, brake and road wear.

Fuel consumption and exhaust emissions are taken from v3.1 of the HBEFA model, using the data for Germany and without applying model weighting. There are a higher number of size categories used in HBEFA than in ecoinvent and so the data are grouped in order to fit the lorry size classes used in ecoinvent. The selective catalytic reduction (SCR) technology is around 3 times more common than that of exhaust gas recovery (EGR) as an emissions reduction measure and so the emission factors given in the dataset are weighted to reflect this. The data for the HBEFA categories SCR\* and VI\* were disregarded. The exhaust emissions caused by the burning of fuel are either fuel dependent (fuel type and quantity) or Euro class dependent. The latter reflect the emission regulations to which the vehicle complies. Regulated emissions are CO, NOx, particulate matter (PM) and total hydrocarbons (HC). Data from the Emissions Inventory Guidebook (EMEP/EEA, 2013) were used for specific exhaust emissions not covered by the HBEFA model.

Non-exhaust emissions are accounted for as weight dependent by-products and exist as seperate datasets.

For road infrastructure the expenditures and environmental interventions due to construction of roads have been allocated based on the gross tonne kilometer performance. Expenditures due to operation of the road infrastructure, as well as land use have been allocated based on the yearly vehicle kilometer performance. The same assumption on vehicle lifetime performance has been transferred from the ecoinvent v2 datasets of 540 000 km/vehicle. The production, maintenance and disposal of the vehicle are as reported in the ecoinvent (2007) report on transport services.

Main data sources:

De Ceuster, G., et al. (2009) TREMOVE: Final Report. Model code v2.7b, 2009. European Commission, Brussels.

Keller, M. et al. (2010) Handbook emission factors for road transport v3.1, HBEFA. INFRAS, Berne, CH.

Knörr, W. et al. (2011) Ecological Transport Information Tool for Worldwide Transports (EcoTransIT): Methodology and data update. Berlin, Hannover, Heidelberg, DE.

Ntziachristos, L., et al. (2013) EMEP/EEA air pollutant emissions inventory guidebook 2009: Exhaust emissions from road transport. European Environment Agency, Copenhagen, DK.

Spielmann, M., et al. (2007) Transport Services. ecoinvent report No. 14., Swiss Centre for Life Cycle Inventories, Dübendorf, CH.

Geography: The data for road infrastructure reflect Swiss conditions. Data for vehicle operation, manufacturing and maintenance represents generic European data. Data for the vehicle disposal reflect the Swiss situation. The environmental interventions due to vehicle transport are modelled by linking the environmental interventions due to vehicle operation with impacts due to vehicle manufacturing, vehicle maintenance, vehicle disposal, road construction, operation and maintenance of roads and road disposal. So-called demand factors are used to link the transport service components to the functional unit of one tonne kilometre [tkm] (Spielmann & Scholz 2005).

References:

Spielmann M. and Scholz R. W. (2005) Life Cycle Inventories for Transport Services - Background Data for Freight Transport. In: Int J LCA, 10(1), pp.

Technology: Diesel and diesel engine. Lorry transport is further differentiated with respect to vehicle weight and emission technology standard (EURO-standard).

Technology classifications are based on those used widely within the works of the European Environment Agency, particularly in the Emissions Inventory Guidebook.

transport, freight, lorry 7.5-16 metric ton, EURO6 \_ RER :: [] TBD

##########################################################################################

This is a market activity. Each market represents the consumption mix of a product in a given geography, connecting suppliers with consumers of the same product in the same geographical area. Markets group the producers and also the imports of the product (if relevant) within the same geographical area. They also account for transport to the consumer and for the losses during that process, when relevant.

This is the market for 'transport, freight, lorry 7.5-16 metric ton, EURO5', in the Global geography.

This market contains no transport or losses, as they are irrelevant for the delivered product.

This is delivering the service of transportation of 1 metric ton across the distance of 1 km. This service only considers the transportation of goods. The vehicle operates with diesel, its emission standard is classified as EURO5 and it falls under the lorry size class of 7.5-16 metric tons. The average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 tonnes. It has a lifetime capacity of 540,000 km. Data for transport is calculated for an average load factor, including empty return trips.

market for transport, freight, lorry 7.5-16 metric ton, EURO5 \_ RoW :: ['average freight load factor of a 7.5-16 metric ton lorry is 3.29 tonnes, with a gross vehicle weight (GVW) of 9.29 ton'] 7.5

##########################################################################################

This dataset represents the transport of one metric ton.km of freight in South Africa by a 7.5-16 metric ton lorry of Euro 2 emission standard. The dataset represents the entire transport life cycle, including the production and maintenance of the vehicle, the transportation of goods and the construction, operation, maintenance and disposal of the road pavement. The scope of the dataset is the operation of the vehicle, which has inputs of vehicle production, vehicle maintenance, and road pavement construction, maintenance and operation, via linking to global datasets (i.e. the equipment and infrastructure datasets are not South African-specific).

The average freight load of a 7.5-16 metric ton lorry is 7.2 tonnes, with an average freight load factor of 60% (both values calculated from SATIM model (ERC, 2015), which used factors from the Road Freight Association's vehicle cost schedule and calibrated these values to the 2014 tonne.kms reported by the Department of Logistics at the University of Stellenbosch. The load factor accounts for all transport trips). The average gross vehicle mass (GVW) is 13.1 tonnes (calculated from freight loading and that freight accounts for 55% of GVW in a heavy commercial vehicle (DoT,2009).

The dataset is not parameterised and factors cannot be changed by users.

Fuel consumption and the primary emissions (nitrogen oxides, nitrous oxide, methane, non-methane hydrocarbons, ammonia, benzene and lead) are modelled based on information and assumptions on fleet mixes and usage of vehicles in different road and traffic situations. Basic emission data is taken from HBEFA 3.4. (INFRAS, 2017), with extensive weighted averaging of vehicles in different traffic situations performed (see report for parameters applied and data sources for road and traffic conditions in South Africa). Emission factors for sulphur dioxide and for carbon dioxide are not taken directly from HBEFA but are calculated using the carbon content and the sulphur content of diesel in South Africa (and the fuel consumption). Heavy metal emissions to air (other than lead) are extrapolated from "transport, freight, lorry 3.5-7.5 metric ton, EURO3" on the basis of fuel consumption. Emissions arising from wear of tyres, brakes and road are calculated from the applicable global datasets ("treatment of tyre/brake/road wear emissions, lorry, GLO, 2013") on the basis of GVW and freight loading.

Vehicle production and maintenance is described in the individual global datasets. Vehicle demand per tonne.km is calculated based on the lifetime kilometric performance, taken from Spielmann et al., (2007) (540,000 km for a heavy commercial vehicle), and the average freight load. The average freight load is calculated from the SATIM model (ERC, 2015), weighted to account for the current commercial vehicle fleet in South Africa (eNaTIS, 2017). Road construction, maintenance and disposal, and road operation are described in the individual global datasets. Road demand per tonne.km is calculated based on weighted road usage of each vehicle type of the road network in South Africa (see report for calculations and data sources).

References:

INFRAS (2017) Handbook Emission Factors for Road Transport (HBEFA) 3.4. INFRAS, Bern, Switzerland;

eNaTIS (2018) Vehicle population statistics for December 2017/January 2018, Electronic National Administration Traffic Information System (eNaTIS): Pretoria, SA.;

ERC (2015) South African TIMES Model (SATIM) Energy Research Centre - University of Cape Town: Cape Town, SA.;

Spielmann, M., Bauer, C., Dones, R. & Tuchschmid, M. (2007) Transport Services Data v2.0, ecoinvent association, Zurich, Switzerland.; DoT (2009) National Transport Master Plan: The Implications of Global Oil Depletion for Transport Systems in South Africa. Department of Transport. Pretoria, SA.

Geography: Fuel consumption and primary emissions (nitrogen oxides, nitrous oxide, methane, non-methane hydrocarbons, ammonia, benzene and lead) are based on fleet composition and usage of vehicles in different road and traffic situations in South Africa (see report for parameters applied and data sources for road and traffic conditions in South Africa). Basic emission data is taken from HBEFA 3.4. (INFRAS, 2017) for the emission standard relevant to South Africa, and with weighted averaging of vehicles reflecting the different traffic situations in South Africa. Sulphur dioxide and carbon dioxide emissions reflect the sulphur and carbon content of fuels in South Africa. Heavy metal emissions to air (other than lead) and wear emissions (tyre, break and road) are not South African specific or emission-standard relevant (i.e. are extrapolated from a Euro 3 global transport dataset of the same vehicle. Equipment and infrastructure datasets are not South African specific.

Technology: The dataset reflects current technology in that the calculations apply current/recent road infrastructure, commercial vehicle fleet and road freight data for South Africa. The calculations also reflect current fuel quality and emission standards in South Africa.

Time period: Data are representative of vehicle fleet and road freight data for 2017.

transport, freight, lorry 7.5-16 metric ton, EURO2 \_ ZA :: ["average freight load of a 7.5-16 metric ton lorry is 7.2 tonnes, with an average freight load factor of 60% (both values calculated from SATIM model (ERC, 2015), which used factors from the Road Freight Association's vehicle cost schedule and calibrated these values to the 2014 tonne.kms reported by the Department of Logistics at the University of Stellenbosch. The load factor accounts for all transport trips). The average gross vehicle mass (GVW) is 13.1 ton", 'average freight load is calculated from the SATIM model (ERC, 2015), weighted to account for the current commercial vehicle fleet in South Africa (eNaTIS, 2017). Road construction, maintenance and disposal, and road operation are described in the individual global datasets. Road demand per ton'] 7.5

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This dataset is an adaptation of “transport, freight, lorry 7.5-16 metric ton, EURO3” in Europe, as available in version 3.6 of the ecoinvent database to reflect the situation in Brazil. It represents the service of 1tkm freight transport in a lorry of the size class 7.5-16 metric tons gross vehicle weight (GVW) and Euro 3 emissions class.

The Brazilian lorry fleet is regulated under the Vehicles Air Pollution Control Program – Proconve, which phases are equivalent to the European control program – EURO. Since 2012, the Proconve P7 (EURO 5) phase is in practice, while the P8 phase (EURO 6) will start in 2023. Before that, the Proconve P6 phase (EURO 4) was not implemented because of the unavailability of low-sulphur diesel, therefore recontextualized datasets do not consider this phase. The P5 (EURO 3), P4 (EURO 2) and P3 (EURO 1) phases started in 2005, 2000 and 1996, respectively. Prior technologies are classified as unregulated.

For the dataset recontextualization to the Brazilian reality, an updated average freight load and the diesel with 500 ppm of sulfur and 12% biodiesel blend are considered. Moreover, data from emission tests of the national vehicle production and import (CETESB, 2019) is used to update regulated emissions (carbon monoxide, particulate matter and nitrogen oxides). Furthermore, correction factors are used to consider the impact of biodiesel blend on exhaust emissions (USEPA 2002), and the fuel composition is considered to account for carbon dioxide and sulphur dioxide emission.

The vehicle mass category classification considered in Brazilian national statistics is approximated to the one adopted in ecoinvent datasets. The 7.5-16 metric ton lorry is representing the Brazilian heavy-duty lorry with gross vehicle weight (GVW) with 10 to 15 metric tons category classification. The average capacity utilization factor (including empty trips) for this category is 59.7 % according to the Road Freight Transport Model from the Brazilian Energy Research Enterprise – EPE (Stukart, 2018). Whereas, the average payload capacity for this category is 9.8 ton (Novo, 2016), resulting in an average freight load of 5.85 ton. GWV is estimated by assuming the same empty vehicle weight as for the RER region for the respective matching categories and accounting for the updated freight load. This resulted in a GWV of 11.9 ton. Vehicle mass dependent non-exhaust emissions (i.e. tyre, brake and road wear) are adjusted accordingly.

The emissions of carbon monoxide (CO), nitrogen oxides (NOx) and Particulate Matter (PM) were updated with data from (CETESB, 2019), which uses data from emission testing of the national vehicle fleet production and imports, weighted by sales amounts. Those tests are run with a reference fuel, which is not blended with biodiesel (ANP, 2018), therefore, those emission factors are adjusted for emissions from burning biodiesel.

The impact of the 12% biodiesel blend in exhaust emissions is accounted for by correction factors derived from USEPA (2002). Correction factors were calculated for the emissions of nitrogen oxides, particulate matter, hydrocarbons, carbon monoxide, acetaldehyde, ethylbenzene, formaldehyde, naphthalene and xylene. Moreover, fuel consumption was corrected with energy content values. For conventional diesel, it was considered energy content of 129.500 Btu/gal, animal-based biodiesel 115.720 Btu/gal and plant-based biodiesel 119.216 Btu/gal (USEPA 2002).

Fuel dependent emissions were updated as well. In Brazil, diesel containing 10 ppm (S10) of sulphur was introduced to attend to the demand of EURO V lorries, as its post-treatment technologies require the use of ultra-low sulphur diesel. Diesel containing 500 ppm (S500) of sulphur is also commercialized for the remaining lorry emission categories. For these cases, the use of S500 is assumed as no information on the share of S500 and S10 diesel used by these categories was available and because the price of S500 is lower than for the S10 (CNT, 2021). Therefore, sulphur dioxide emissions derived from S500 combustion were corrected assuming that all sulphur is emitted as SO2 (0.001 kg SO2/kg fossil diesel) and to account for the blend of biodiesel (12 %), which does not contain sulphur. Carbon dioxide emission is dependent on the fuel carbon content, which was considered as 77.8% for plant-based biodiesel and 76.1 % for animal-based biodiesel, resulting in a Brazilian average of 77.5%, while conventional diesel has 86.7% of carbon (USEPA, 2002). This results in emissions of 3.18 kg of fossil CO2/kg diesel and 2.84 biogenic CO2/kg biodiesel.

This dataset was developed under the Cornerstone project, an initiative from the Brazilian Business Network on Life cycle Assessment (Rede ACV) in collaboration with ecoinvent to increase the quantity and quality of inventories that represent Brazil, through a thorough adaptation of the datasets. More information about this project is available in redeacv.org.br/en/wg-database/.

Main data sources for the recontextualization:

ANP, 2018. Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (2018). RANP 764. RESOLUÇÃO ANP Nº 764, DE 20.12.2018 - DOU 21.12.2018.

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Stukart, B., Lima, C., Pacheco, C., Silva, F., Antoniasse, G., Cavalcanti, M., Souza, M., Stelling, P. (2018). Transporte Rodoviário Brasileiro, Transição para Óleo Diesel S10 e Desafios para o Refino Nacional. Rio Oil&Gas. Available at:<https://stt.ibp.org.br/eventos/2018/riooil2018/pdfs/Riooil2018_1654_201806222325ibp1654_1> 8\_transic.pdf. Acessed in: 06/06/2020.

CETESB (2019). Companhia Ambiental do Estado de São Paulo (2019). Emissões Veiculares no Estado de São Paulo. Governo do Estado de São Paulo. Available at: [https://cetesb.sp.gov.br/veicular/relatoriose-publicacoes/.](https://cetesb.sp.gov.br/veicular/relatoriose-publicacoes/) Accessed in 15/06/2020.

USEPA, 2002. United States Environmental Protection Agency (2002). A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions. Draft Technical Report.

Novo, A. L. (2016). PERSPECTIVAS PARA O CONSUMO DE COMBUSTÍVEL NO TRANSPORTE DE CARGA NO BRASIL: UMA COMPARAÇÃO ENTRE OS EFEITOS ESTRUTURA E INTENSIDADE NO USO FINAL DE ENERGIA DO SETOR. Available at:<http://www.ppe.ufrj.br/images/publica%C3%A7%C3%B5es/mestrado/Ana_Luiza_Andrade_Novo.pdf>

CNT (2021). CNT acompanha, com atenção, a alta histórica do diesel. Available at: cnt.org.br/agencia-cnt/cnt-acompanha-alta-historica-do-diesel

Geography: Recontextualization from 'transport, freight, lorry 7.5-16 metric ton, EURO3, RER'. Fuel type, freight load factor, regulated and fuel-dependent emissions were updated for the Brazilian situation. The environmental interventions due to vehicle transport are modelled by linking the environmental interventions due to vehicle operation with impacts due to vehicle manufacturing, vehicle maintenance, vehicle disposal, road construction, operation and maintenance of roads and road disposal.

Technology: Diesel and diesel engine. Lorry transport is further differentiated with respect to vehicle weight and emission technology standard (EURO-standard).

Technology classifications are based on those used widely within the works of the European Environment Agency, particularly in the Emissions Inventory Guidebook.

Time period: Validity period of the 12% biodiesel blend regulation. The regulation foresees incremental increases in the biodiesel content in the Brazilian market fuel (it started with a 2% blend in 2008, reached 12% in 2020 and will increase 1% a year, until it reaches 15% in 2023).

transport, freight, lorry 7.5-16 metric ton, EURO3 \_ BR :: ['average freight load of 5.85 ton. GWV is estimated by assuming the same empty vehicle weight as for the RER region for the respective matching categories and accounting for the updated freight load. This resulted in a GWV of 11.9 ton'] 5.85