

# Adjustment DE-A regarding NO<sub>x</sub> from Road Vehicles

## PREFACE

When deriving proposals for national emission ceilings for negotiations of the 1999 Gothenburg Protocol, sector-specific emission estimates for the year 2010 were calculated at IIASA using a set of scenarios which assumed various technological abatement measures, policy incentives, and legislation available / in place or planned at that time. As a result, the 2010 emission by road transport in Germany was estimated at NO<sub>x</sub> (IIASA, 1999) <sup>1)</sup>. The over-all 2010 national emission ceiling (NEC) for NO<sub>x</sub> was set to 1,081 kt. When negotiating the EU NEC Directive two years later, Germany agreed to reduce its NO<sub>x</sub> emissions further, resulting in a NEC of 1,051 kt.

In its 2016 NEC emissions reporting, Germany provided a national total for NO<sub>x</sub> emissions of 1,337 kt for 2010. However, this total includes emissions from agricultural soils and other source categories not accounted for when setting the NEC. In addition, some assumptions made in 1999, including on emission factors from road traffic, turned out to be wrong in reality. Like in many other European countries, non-compliance with the 2010 NEC as set in 1999 was partly not caused by failed national mitigation policies, but by changes beyond the control of, and unforeseen by, the individual Party or Member State.

In order to differentiate such changes from policy failures in the responsibility of the individual Parties to the Gothenburg Protocol, a procedure (Inventory Adjustment) allowing the adjustment of emissions resulting from new emission categories, changes in estimation methodologies, emission factors etc. provided within the EMEP/EEA Guidebook, or other effects beyond national control with respect to complying to emission reduction obligations (EB, 2012a & c) <sup>2), 3)</sup> was agreed. This procedure is applicable also for existing NECs (EB, 2012b) <sup>4)</sup>.

With respect to road transport, such an unforeseeable effect was the partial failure of several so-called “Euro norms” set on the EU level to reduce emissions from road vehicles. In this report, Germany presents an estimate of the NO<sub>x</sub> emissions resulting from the partial failure of the mitigation policy reflected by the Euro norms, and lays out the calculations leading to these estimates.

## REASONS FOR MISSING THE GOTHENBURG CEILINGS

The TREMOD methodology applied for estimating emissions from road transportation in Germany has changed over time. These changes include updates of emission factors (EF) for various pollutants and other changes such as an extension of vehicle classification (and thus inclusion of emission factors associated with these new vehicle sub-categories) to improve the estimation's accuracy.

The main changes occurred for the emission factors and for the Heavy Duty Vehicles (HDV) fleet structure. This last point led to changes in emissions because of the reallocation of activities (consumption/traffic) between the sub-categories of vehicles.

For the formalism of the adjustments, it is difficult to flag whether the modifications for road transport are due to “methodological changes” or due to “changes of emission factor”. Therefore, only the term “change of methodology” will be used (even if at the NFR reporting level this may seem like a simple change in EFs).

So far as road transport is concerned, the inability to attain the emission ceiling is most likely to have been affected by a combination of technological changes within the fleet (which of course made their way into the several versions of TREMOD) combined with greater than originally expected dieselisation of the fleet.

## ANALYSING THE PROBLEM: THE EUROPEAN PERSPECTIVE BASED ON COPERT

Already in 2011, these effects were demonstrated by Ntziachristos and Papageorgiou (2011) <sup>5)</sup>. Here, the impacts of changing model versions and activity data in the context of meeting the EU NEC Directive ceiling commitments were examined for four European countries including Germany. Unfortunately, this comparison study was carried out within a COPERT environment. Therefore, the results gained cannot be transferred to the German TREMOD environment on a one-to-one level but nonetheless allow a highly illustrative insight in the reasons for not meeting the set ceiling. The study modeled fuel consumption and NO<sub>x</sub> emissions for four selected countries (Germany, France, Netherlands and Belgium) and found higher NO<sub>x</sub> emissions were estimated for the road transport sector than originally modelled by the RAINS model of IIASA (which underpinned the setting of 2010 ceilings). For Germany, this study shows that with the same activity data set (LIFE+

EC4MACS data from Amann et al. (2010)), NO<sub>x</sub> emissions estimated with COPERT II vs. COPERT 4 (v8.0) increase from 410 kt to 518 kt due to methodological changes, a difference of 282 kt. An additional consideration of changes in AD would lead to 620 kt of NO<sub>x</sub>. However, as changes in AD are no valid adjustment reason, the latter value is for information only.

This was mainly due to: \* NO<sub>x</sub> "artificial" current emissions = virtual current emissions assuming no changes in emission factors emission factors updated in COPERT 4 that did not follow the reductions as set by the emission standards for diesel passenger cars; \* important part of diesel fuel consumption in the total fuel consumption of the road traffic.

The results of this study showed that it is the combination of different parameters which might affect the ability (to different extents) of a Party to attain the emission ceilings. In other words, the exceeding of NO<sub>x</sub> ceilings for road transport is due to:

### Changes in methodology and emission factors

As these technologically driven changes (as reflected in the evolution of the different so-called Euro norms) lie outside the country's responsibility, current methodology and EFs have to be adjusted in a way to allow the comparison of the actual inventory and the Gothenburg ceilings.

### Changes in the activity data

As the development of mileage driven and fuels used within a country (Germany: stronger dieselisation then originally expected) is of the country's responsibility, this effect has to be excluded from any adjustment estimation.

## IN-COUNTRY ANALYSIS: THE TREMOD PERSPECTIVE

### INITIAL ASSUMPTION

In order to estimate the effect of NO<sub>x</sub> emissions resulting from the failure of the so-called Euro norms, the following procedure has been agreed by expert review teams in the last two years:



**proposed amount of adjustable emissions = current AD x current EF - current AD x original EF = current AD x (current EF - original EF)**  
**= current EM - "artificial" current EM<sup>1</sup>**

<sup>1</sup> "artificial" current emissions = virtual current emissions assuming no changes in emission factors



$$\begin{aligned} EM_{\text{adjustment}} &= AD_{\text{current}} * EF_{\text{current}} - AD_{\text{current}} * EF_{\text{original}} \\ &= AD_{\text{current}} * (EF_{\text{current}} - EF_{\text{original}}) \\ &= EM_{\text{current}} - EM_{\text{current "artificial"}} \end{aligned}$$

with

- **EM „adjustment,,** = amount of emissions to be subtracted from National Totals
- **AD „current,,** = AD from latest TREMOD version as used for current submission
- **EF „current,,** = EF from latest TREMOD version as used for current submission
- **EF „original,,** = EF from TREMOD version used at the time NEC ceilings were set (here: TREMOD 3.1)
- **EM „current,,** = EM estimated from AD and EF from latest TREMOD version = EM reported for NFR 1.A.3.b with latest submission
- **EM „current-“artificial”,,** = EM estimated from AD from latest TREMOD version and EF from TREMOD version used at the time NEC ceilings were set (here: TREMOD 3.1)

### APPLYING THE ORIGINAL METHODOLOGY

## FRAMEWORK INFORMATION

The methodology used for estimating Germany's exhaust emissions from road transport when determining emissions ceilings of the Gothenburg Protocol (1999), was the second version of the EMEP/CORINAIR guidebook corresponding to COPERT II software. This method proposed NO<sub>x</sub> emission factors for

- passenger cars (PC): up to Euro 1
- light commercial vehicles (LCV2): up to Euro 1
- heavy duty vehicles (HDV): pre-EURO I only (conventional)

Back then, without better knowledge, the emission factors for the most recent standards were derived by directly applying the expected reductions in emission standards.

However, as Germany does not use COPERT for compiling its road transport emissions inventory but a national model called TREMOD, the following comparison has to be carried out between the oldest version of TREMOD still available and the version as applied for the current inventory submission (2021).

Unfortunately, the oldest TREMOD version available for such comparison is TREMOD 3.1 from 2002 <sup>6)</sup>, including the following set of NO<sub>x</sub> emission factors:

- passenger cars (PC): up to Euro 4
- light commercial vehicles (LCV): up to Euro 4
- heavy duty vehicles (HDV) only up to EURO V

However, as this version includes the technological development since 1999 (when the ceilings were set based on COPERT II), the results from this analysis and the adjustment proposal based upon these results are likely to slightly underestimate the effect of technological changes since 1999 and must therefore be considered conservative.

## THE COMPARISON

### Application of the original NO<sub>x</sub> methodology to the current road transport background activity data

The *basic activity data* (such as over-all fuel sold and traffic mileages by vehicle type, by fuel or by Euro regulation) implemented in TREMOD 3.1 differ significantly from those of the current TREMOD version especially for the more recent years as of 2005. In addition, *specific activity data* (such as fuel consumptions per vehicle type, per fuel or per Euro regulation) strongly depend on the TREMOD version.

Within this report, Germany re-estimates the NO<sub>x</sub> emission within the TREMOD 3.1 model. To isolate the requested information, the original TREMOD 3.1 activity data was combined with emission factors from both TREMOD 3.1 and the currently used TREMOD 6.12 (Knörr et al., 2021a) <sup>7)</sup>.

### Description of the updated methodology used

The updated methodology, used in 2019 (for NFR submission 2021) and implemented in version 6.12 of the TREMOD software, considers emission factors of

- passenger cars (PC) up to Euro 6d
- light commercial vehicles (LCV) up to Euro 6d
- heavy duty vehicles (HDV) up to EURO VI

and

- motorized two-wheelers (M2W) up to Euro 4

### Comparison of emission estimates made using the original and updated methodologies

The values of NO<sub>x</sub> emissions presented in the table below are estimated with:

- TREMOD 3.1 model equations as initial methodology

and ,

- TREMOD 6.12 equations as methodology applied for NEC submission 2021.

The activity data applied to initial (here: oldest available) and most recent methodology, are those of the latest inventory provided with NEC submission 2021.

Table 1: Resulting adjustment proposal 2020

for year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
<b>proposed adjustment</b>	<b>-296.1</b>	<b>-300.7</b>	<b>-300.4</b>	<b>-305.2</b>	<b>-294.9</b>	<b>-274.9</b>	<b>-250.9</b>	<b>-221.1</b>	<b>-179.6</b>	<b>-144.8</b>

The following screenshots show the TREMOD 3.1 / TREMOD 6.12 implementation comparisons per vehicle type/fuel/Euro regulation.

#### **Activity Data**

- **current:** from TREMOD 6.12, as reported with the latest inventory submission
- **adjusted:** has to be similar to **current** AD!
- **difference:** as only recent AD are to be used for adjustment estimations, this value must be zero!

#### **Implied Emission Factor**

- **current:** representing the ratio of current emissions and current AD
- **adjusted:** representing the ratio of adjusted emissions and current AD
- **difference:** shows percentual difference

#### **NO<sub>x</sub> Emissions**

- **current:** from TREMOD 6.12, as reported with the latest inventory submission
- **adjusted:** estimated based on TREMOD 3.1 methodology and TREMOD 6.12 AD
- **adjustment:** adjusted emissions minus current emissions
- **difference:** percentual difference between current and adjusted emissions

Adjustment overview for years 2010 to 2019

NFR Code	Fuel	Year	Activity Data			Implied Emission Factor			NO <sub>x</sub> Emissions			
			current	adjusted	difference	current	adjusted	difference	current	adjusted	adjustment	difference
			in [TJ]	in [TJ]	in [%]	in [kg/TJ]	in [%]	in [%]	in [kg]	in [kg]	in [%]	in [%]
1.A.3.b.i	gasoline		795.957	795.957	0%	97.55	84.99	-13%	77.64.842	67.69.906	9.993.935	-13%
1.A.3.b.i	diesel oil		629.380	629.380	0%	429.45	160.51	-63%	227.341.096	84.970.461	142.376.635	-63%
1.A.3.b.ii	gasoline		6.325	6.325	0%	255.87	214.75	-16%	1.618.432	1.358.328	260.104	-16%
1.A.3.b.ii	diesel oil		113.450	113.450	0%	476.34	134.96	-72%	54.040.533	15.311.584	38.728.949	-72%
1.A.3.b.iii	diesel oil		48.844	48.844	0%	823.00	482.55	-23%	29.931.266	23.183.732	6.747.534	-23%
1.A.3.b.iii	diesel oil		566.741	566.741	0%	446.67	271.83	-39%	253.148.243	154.056.160	99.092.083	-39%
1.A.3.b.iv	gasoline		19.712	19.712	0%	113.68	168.43	48%	2.240.749	3.320.034	-1.079.285	48%
1.A.3.b TOTAL	2010		2.079.608	2.079.608	0%			0%	645.965.162	349.851.206	296.113.956	-46%
1.A.3.b.i	gasoline		794.688	794.688	0%	92.09	81.61	-11%	73.185.851	64.851.951	8.333.900	-11%
1.A.3.b.i	diesel oil		553.564	553.564	0%	434.12	159.22	-63%	240.313.791	88.138.959	152.174.832	-63%
1.A.3.b.ii	gasoline		6.118	6.118	0%	229.35	198.57	-13%	1.403.081	1.214.776	188.305	-13%
1.A.3.b.ii	diesel oil		115.967	115.967	0%	481.55	126.92	-74%	55.844.518	14.718.142	41.126.376	-74%
1.A.3.b.iii	diesel oil		47.355	47.355	0%	592.65	448.99	-24%	28.071.221	21.268.323	6.804.898	-24%
1.A.3.b.iii	diesel oil		563.891	563.891	0%	410.38	244.97	-40%	231.410.271	138.135.342	93.273.929	-40%
1.A.3.b.iv	gasoline		19.289	19.289	0%	110.79	171.60	54%	2.137.002	3.299.162	-1.162.160	54%
1.A.3.b TOTAL	2011		2.100.883	2.100.883	0%			0%	632.365.736	331.625.655	300.740.081	-48%
1.A.3.b.i	gasoline		750.957	750.957	0%	85.73	78.00	-8%	64.379.994	58.677.229	5.802.765	-9%
1.A.3.b.i	diesel oil		555.245	555.245	0%	435.96	158.66	-64%	242.062.902	88.096.699	153.966.203	-64%
1.A.3.b.ii	gasoline		5.657	5.657	0%	218.93	193.15	-12%	1.238.520	1.092.662	145.859	-12%
1.A.3.b.ii	diesel oil		114.350	114.350	0%	481.91	128.17	-75%	55.106.362	13.741.354	41.365.008	-75%
1.A.3.b.iii	diesel oil		50.902	50.902	0%	533.22	384.33	-28%	27.141.913	19.563.200	7.578.704	-28%
1.A.3.b.iii	diesel oil		589.585	589.585	0%	381.33	224.00	-41%	234.829.180	132.064.753	92.764.428	-41%
1.A.3.b.iv	gasoline		18.268	18.268	0%	107.43	173.28	61%	1.962.546	3.165.439	-1.202.893	61%
1.A.3.b TOTAL	2012		2.084.964	2.084.964	0%			0%	616.721.438	316.391.343	300.420.094	-49%
1.A.3.b.i	gasoline		749.114	749.114	0%	89.35	74.85	-7%	60.190.007	56.071.797	4.118.211	-7%
1.A.3.b.i	diesel oil		589.131	589.131	0%	437.14	158.71	-64%	257.633.728	93.499.010	164.134.718	-64%
1.A.3.b.ii	gasoline		5.578	5.578	0%	202.80	184.07	-9%	1.131.209	1.026.727	104.482	-9%
1.A.3.b.ii	diesel oil		118.777	118.777	0%	480.60	114.93	-76%	57.083.533	13.690.488	43.433.045	-76%
1.A.3.b.iii	diesel oil		51.716	51.716	0%	509.64	260.06	-29%	26.350.969	18.620.843	7.730.126	-29%
1.A.3.b.iii	diesel oil		600.139	600.139	0%	353.06	287.93	-41%	211.887.531	124.788.469	87.099.062	-41%
1.A.3.b.iv	gasoline		18.229	18.229	0%	104.34	175.30	68%	1.902.068	3.197.038	-1.294.951	68%
1.A.3.b TOTAL	2013		2.132.683	2.132.683	0%			0%	616.079.063	316.854.371	300.224.692	-50%
1.A.3.b.i	gasoline		752.526	752.526	0%	76.03	73.09	-4%	57.215.533	54.988.921	2.216.612	-4%
1.A.3.b.i	diesel oil		626.845	626.845	0%	435.87	159.12	-63%	272.876.061	95.613.892	173.262.169	-63%
1.A.3.b.ii	gasoline		5.845	5.845	0%	190.34	176.49	-7%	1.112.584	1.031.612	80.972	-7%
1.A.3.b.ii	diesel oil		128.578	128.578	0%	475.56	110.96	-77%	61.146.575	14.267.237	46.879.338	-77%
1.A.3.b.iii	diesel oil		49.143	49.143	0%	468.37	339.99	-27%	23.017.115	16.708.234	6.308.881	-27%
1.A.3.b.iii	diesel oil		572.754	572.754	0%	314.05	196.05	-38%	179.874.133	112.285.582	67.588.551	-38%
1.A.3.b.iv	gasoline		18.673	18.673	0%	100.59	179.24	78%	1.878.294	3.346.794	-1.468.499	78%
1.A.3.b TOTAL	2014		2.153.563	2.153.563	0%			0%	597.120.297	302.252.271	294.868.025	-49%
1.A.3.b.i	gasoline		715.156	715.156	0%	74.30	71.73	-4%	53.190.787	51.300.983	1.889.805	-4%
1.A.3.b.i	diesel oil		645.555	645.555	0%	426.19	159.80	-63%	275.130.233	103.163.501	171.966.732	-63%
1.A.3.b.ii	gasoline		5.793	5.793	0%	187.12	172.80	-8%	1.083.927	1.000.999	82.928	-8%
1.A.3.b.ii	diesel oil		135.386	135.386	0%	489.35	187.96	-77%	63.605.443	14.607.490	48.997.953	-77%
1.A.3.b.iii	diesel oil		52.287	52.287	0%	458.96	327.99	-29%	23.997.817	17.149.448	6.848.370	-29%
1.A.3.b.iii	diesel oil		589.411	589.411	0%	266.69	187.51	-30%	157.189.675	110.620.703	46.568.973	-30%
1.A.3.b.iv	gasoline		18.459	18.459	0%	99.32	180.65	82%	1.833.362	3.334.472	-1.501.090	82%
1.A.3.b TOTAL	2015		2.161.976	2.161.976	0%			0%	575.931.265	301.877.596	274.053.670	-48%
1.A.3.b.i	gasoline		715.272	715.272	0%	79.93	76.65	-4%	50.736.367	50.535.049	201.318	0%
1.A.3.b.i	diesel oil		675.119	675.119	0%	410.36	160.76	-61%	277.041.660	108.535.230	168.506.430	-61%
1.A.3.b.ii	gasoline		5.926	5.926	0%	180.27	171.05	-5%	1.068.292	1.013.678	54.614	-5%
1.A.3.b.ii	diesel oil		144.068	144.068	0%	456.12	185.62	-77%	65.712.732	15.216.007	50.496.725	-77%
1.A.3.b.iii	diesel oil		54.157	54.157	0%	424.73	388.24	-27%	23.002.109	16.683.117	6.308.992	-27%
1.A.3.b.iii	diesel oil		594.013	594.013	0%	226.31	180.97	-20%	134.431.699	107.496.262	26.935.437	-20%
1.A.3.b.iv	gasoline		18.785	18.785	0%	95.14	181.66	89%	1.805.897	3.412.476	-1.606.579	89%
1.A.3.b TOTAL	2016		2.207.339	2.207.339	0%			0%	553.790.558	302.901.820	250.897.738	-45%
1.A.3.b.i	gasoline		724.571	724.571	0%	67.66	69.88	3%	49.026.074	50.634.714	-1.607.640	3%
1.A.3.b.i	diesel oil		696.592	696.592	0%	390.65	161.95	-59%	272.126.091	112.810.721	159.315.370	-59%
1.A.3.b.ii	gasoline		6.186	6.186	0%	171.15	167.18	-2%	1.058.799	1.034.211	24.588	-2%
1.A.3.b.ii	diesel oil		153.284	153.284	0%	424.66	183.89	-76%	65.093.930	15.925.216	49.168.714	-76%
1.A.3.b.iii	diesel oil		53.382	53.382	0%	370.80	286.71	-23%	19.793.901	15.304.828	4.489.073	-23%
1.A.3.b.iii	diesel oil		596.263	596.263	0%	195.02	175.92	-10%	116.671.141	106.246.508	11.424.633	-10%
1.A.3.b.iv	gasoline		19.160	19.160	0%	92.83	183.39	98%	1.778.674	3.513.787	-1.735.114	98%
1.A.3.b TOTAL	2017		2.251.437	2.251.437	0%			0%	525.549.410	304.469.986	221.079.424	-42%
1.A.3.b.i	gasoline		699.027	699.027	0%	64.42	68.36	6%	45.032.996	47.786.817	-2.753.820	6%
1.A.3.b.i	diesel oil		666.074	666.074	0%	371.66	163.30	-56%	247.556.063	108.768.604	138.787.459	-56%
1.A.3.b.ii	gasoline		6.315	6.315	0%	158.22	160.11	1%	999.199	1.011.138	-11.939	1%
1.A.3.b.ii	diesel oil		154.259	154.259	0%	384.71	182.69	-73%	59.344.525	15.840.310	43.504.215	-73%
1.A.3.b.iii	diesel oil		51.634	51.634	0%	309.75	263.53	-15%	15.993.526	13.607.106	2.386.420	-15%
1.A.3.b.iii	diesel oil		585.186	585.186	0%	171.18	172.10	1%	180.173.337	180.710.869	-537.532	1%
1.A.3.b.iv	gasoline		18.497	18.497	0%	89.66	184.61	106%	1.658.568	3.414.767	-1.756.209	106%
1.A.3.b TOTAL	2018		2.180.993	2.180.993	0%			0%	478.758.206	291.139.612	179.618.593	-38%
1.A.3.b.i	gasoline		704.691	704.691	0%	62.30	68.45	10%	43.901.941	48.238.025	-4.336.084	10%
1.A.3.b.i	diesel oil		663.841	663.841	0%	345.81	165.07	-52%	229.566.088	109.582.982	119.983.106	-52%
1.A.3.b.ii	gasoline		6.683	6.683	0%	146.08	153.25	5%	976.219	1.034.150	-57.931	5%
1.A.3.b.ii	diesel oil		159.183	159.183	0%	347.42	181.90	-71%	55.303.535	16.221.445	39.082.090	-71%
1.A.3.b.iii	diesel oil		52.939	52.939	0%	274.41	247.81	-10%	14.527.012	13.118.578	1.408.434	-10%
1.A.3.b.iii	diesel oil		595.913	595.913	0%	153.35	169.17	10%	91.380.760	106.809.376	-15.428.616	10%
1.A.3.b.iv	gasoline		18.750	18.750	0%	86.05	186.83	117%	1.613.450	3.502.941	-1.889.491	117%
1.A.3.b TOTAL	2019		2.202.890	2.202.890	0%			0%	437.268.744	292.497.697	144.771.048	-33%

Adjustment details for 2020												
NFR Code	Fuel	Activity Data			Implied Emission Factor			NO <sub>x</sub> Emissions				
		current	adjusted	difference	current	adjusted	difference	current	adjusted	adjustment	difference	
		in [t]	in [t]	in [%]	in [g/t]	in [g/t]	in [%]	in [t]	in [t]	in [t]	in [t]	
1.A.3.a.i. Passenger Cars	Gasoline	pre-Cars	13.685	13.685	0%	584.75	514.25	-12%	7.955.060	6.986.917	-658.143	-8%
		Car 1	36.541	36.541	0%	338.50	297.71	-10%	25.915.925	10.189.262	-7.716.663	-30%
		Car 2	96.425	96.425	0%	172.95	135.63	-22%	16.580.020	13.020.026	-3.589.995	-22%
		Car 3	133.139	133.139	0%	58.51	70.19	20%	7.790.384	9.343.433	1.553.129	20%
		Car 4	444.991	444.991	0%	42.27	42.19	0%	18.911.389	18.773.529	-37.859	0%
		Car 5	31.234	31.234	0%	18.61	42.19	127%	581.142	1.317.737	736.595	127%
		Car 6	0	0	0%	25.08	42.19	67%	2	2	0	0%
		Gasoline total	795.057	795.057	0%	592.25	514.25	-13%	37.644.642	47.650.586	8.993.935	13%
	Diesel Oil	pre-Cars	10.339	10.339	0%	318.13	264.95	-15%	583.760	527.256	-56.504	-10%
		Car 1	10.339	10.339	0%	294.42	245.17	-17%	3.044.428	2.741.387	-302.521	-10%
		Car 2	50.088	50.088	0%	406.90	279.19	-40%	29.372.795	10.974.210	-9.398.584	-40%
		Car 3	134.025	134.025	0%	542.54	170.54	-69%	72.645.173	23.929.276	-48.716.957	-67%
		Car 4	279.154	279.154	0%	304.37	140.58	-53%	187.299.180	39.243.811	-88.655.349	-47%
		Car 5	53.547	53.547	0%	434.70	140.58	-68%	23.276.735	7.527.796	-15.749.829	-68%
		Car 6	334	334	0%	257.62	140.58	-45%	85.044	46.553	-38.491	-45%
		Diesel oil total	529.380	529.380	0%	429.45	140.55	-67%	227.347.096	84.970.461	-142.376.635	-63%
		Pkx Total	1.325.337	1.325.337	0%	238.12	155.14	-36%	364.985.938	152.621.367	-152.364.570	-42%
1.A.3.b.i. Light Duty Vehicles (LDVs)	Gasoline	pre-Cars	1.249	1.249	0%	627.99	545.95	-13%	783.320	698.871	-23.511	-3%
		Car 1	367	367	0%	361.95	297.39	-19%	368.969	186.620	-208.358	-56%
		Car 2	1.393	1.393	0%	264.75	184.41	-30%	368.840	256.917	-111.931	-30%
		Car 3	856	856	0%	82.47	30.83	-63%	70.631	77.625	6.994	10%
		Car 4	2.420	2.420	0%	36.32	44.90	24%	87.987	188.679	28.772	34%
		Car 5	49	49	0%	15.34	44.90	193%	750	2.218	1.468	193%
		Car 6	0	0	0%	0	0	0%	0	0	0	0%
		Gasoline total	6.345	6.345	0%	255.87	254.75	-1%	1.478.832	1.358.128	-248.934	-16%
	Diesel Oil	pre-Cars	4.876	4.876	0%	425.99	386.79	-9%	2.077.142	1.436.983	-691.239	-33%
		Car 1	9.989	9.989	0%	399.18	276.24	-30%	2.389.080	1.289.636	-1.099.409	-46%
		Car 2	13.126	13.126	0%	336.76	153.18	-54%	4.420.280	2.534.731	-1.885.629	-43%
		Car 3	33.249	33.249	0%	531.91	150.58	-72%	17.655.883	5.085.760	-12.649.123	-72%
		Car 4	54.581	54.581	0%	491.42	80.69	-84%	26.021.036	4.040.722	-21.981.114	-84%
		Car 5	1.629	1.629	0%	427.50	80.69	-81%	696.296	144.434	-551.772	-79%
		Car 6	0	0	0%	10.73	80.69	-87%	7	4	-3	-43%
		Diesel oil total	113.450	113.450	0%	476.34	134.94	-72%	54.043.533	15.351.584	-38.728.949	-72%
		LDVs Total	179.775	179.775	0%	464.70	139.18	-70%	55.658.966	16.689.913	-38.989.853	-70%
1.A.3.b.ii. Heavy Duty Vehicles (HDVs)	Gasoline	pre-Cars	3.382	3.382	0%	1096.25	1028.78	-6%	3.674.087	3.432.644	-221.423	-6%
		Car 1	2.826	2.826	0%	749.41	732.14	-2%	2.117.871	2.125.595	7.723	0%
		Car 2	10.152	10.152	0%	801.96	643.47	-20%	8.140.119	6.532.213	-1.607.906	-20%
		Car 3	15.890	15.890	0%	633.22	437.25	-30%	10.865.776	7.289.299	-2.797.567	-26%
		Car 4	5.461	5.461	0%	448.63	351.65	-21%	2.650.016	1.921.527	-628.499	-24%
		Car 5	10.326	10.326	0%	337.28	182.33	-46%	3.882.417	1.882.644	-1.999.873	-51%
		Car 6	0	0	0%	0	0	0%	0	0	0	0%
		Buses Total	48.044	48.044	0%	623.80	482.35	-23%	29.931.286	23.183.732	-6.747.534	-23%
	Diesel Oil	pre-Cars	10.185	10.185	0%	1040.16	787.37	-25%	10.510.623	7.754.138	-2.756.485	-26%
		Car 1	5.677	5.677	0%	758.59	575.55	-24%	4.261.383	3.287.681	-993.702	-23%
		Car 2	38.558	38.558	0%	817.62	524.79	-35%	31.525.526	20.234.619	-11.290.907	-36%
		Car 3	169.023	169.023	0%	636.28	374.48	-41%	161.136.182	99.617.271	-61.508.921	-41%
		Car 4	69.636	69.636	0%	368.34	280.62	-24%	27.183.867	20.146.636	-7.037.233	-26%
		Car 5	283.934	283.934	0%	276.42	151.65	-45%	78.643.643	43.115.897	-35.524.746	-45%
		Car 6	0	0	0%	0	0	0%	0	0	0	0%
		Trucks Total	566.741	566.741	0%	446.67	271.83	-39%	293.148.243	154.696.160	-99.892.883	-39%
		HDVs Total	7.973	7.973	0%	122.80	149.18	22%	372.721	1.189.383	216.952	23%
1.A.3.b.iii. Motorised Two-Wheelers (MTWs)	Gasoline	pre-Cars	5.231	5.231	0%	123.77	105.74	-14%	647.479	887.039	219.568	34%
		Car 1	3.587	3.587	0%	141.16	184.21	30%	585.362	686.681	101.309	18%
		Car 2	2.500	2.500	0%	38.11	184.21	387%	116.188	687.032	452.834	387%
		Car 3	0	0	0%	0	0	0%	0	0	0	0%
		Car 4	0	0	0%	0	0	0%	0	0	0	0%
		Car 5	0	0	0%	0	0	0%	0	0	0	0%
		MTWs Total	19.712	19.712	0%	113.68	148.43	30%	2.243.149	3.320.634	1.079.285	48%
		1.A.3.b. Road Transport	2.879.688	2.879.688	0%	218.62	148.23	-32%	645.965.162	349.851.296	-296.113.956	-46%

Adjustment details for 2021												
NFR Code	Fuel	Activity Data			Implied Emission Factor			NO <sub>x</sub> Emissions				
		current	adjusted	difference	current	adjusted	difference	current	adjusted	adjustment	difference	
		in [t]	in [t]	in [%]	in [g/t]	in [g/t]	in [%]	in [t]	in [t]	in [t]	in [t]	
1.A.3.a.i. Passenger Cars	Gasoline	pre-Cars	13.063	13.063	0%	592.96	534.68	-10%	7.728.235	6.979.435	-748.801	-10%
		Car 1	61.979	61.979	0%	347.86	240.14	-31%	21.540.430	14.884.961	-6.655.479	-31%
		Car 2	87.083	87.083	0%	178.38	136.58	-24%	15.620.983	11.883.782	-3.727.191	-24%
		Car 3	124.330	124.330	0%	61.94	71.52	16%	7.683.891	8.891.671	1.227.780	16%
		Car 4	442.185	442.185	0%	43.94	43.68	0%	19.384.914	19.736.439	351.525	0%
		Car 5	66.057	66.057	0%	18.58	43.68	135%	1.227.381	2.085.636	1.658.255	135%
		Car 6	1	1	0%	25.00	43.68	60%	17	20	3	15%
		Gasoline total	794.688	794.688	0%	52.69	51.65	-2%	73.185.851	64.851.551	-8.333.900	-11%
	Diesel Oil	pre-Cars	1.711	1.711	0%	519.80	264.56	-50%	1.882.214	453.187	-1.429.027	-76%
		Car 1	8.426	8.426	0%	297.32	266.65	-11%	2.585.115	2.239.987	-345.119	-13%
		Car 2	42.514	42.514	0%	407.93	285.27	-30%	17.384.549	9.321.916	-7.962.634	-46%
		Car 3	121.429	121.429	0%	555.36	170.55	-69%	67.437.053	21.681.386	-45.755.667	-69%
		Car 4	264.943	264.943	0%	388.88	143.48	-63%	182.817.881	30.089.755	-64.808.848	-35%
		Car 5	113.047	113.047	0%	435.12	143.48	-67%	49.536.960	16.332.974	-33.203.984	-67%
		Car 6	695	695	0%	259.59	143.48	-45%	180.582	99.754	-80.748	-45%
		Diesel oil total	553.564	553.564	0%	434.12	159.92	-63%	249.713.791	88.138.959	-152.174.832	-63%
		Pkx Total	1.348.252	1.348.252	0%	232.52	153.47	-35%	313.899.642	152.990.510	-160.508.732	-51%
1.A.3.b.i. Light Duty Vehicles (LDVs)	Gasoline	pre-Cars	1.084	1.084	0%	626.75	545.95	-13%	1.082.014	780.373	-38.699	-4%
		Car 1	283	283	0%	818.74	584.47	-29%	243.289	86.158	-157.132	-65%
		Car 2	1.184	1.184	0%	268.66	191.68	-29%	310.529	223.189	-87.340	-28%
		Car 3	783	783	0%	85.97	35.39	-59%	67.320	74.782	7.381	11%
		Car 4	2.562	2.562	0%	37.38	46.51	24%	95.786	119.162	23.376	24%
		Car 5	241	241	0%	16.13	46.51	189%	3.882	11.190	7.308	189%
		Car 6	0	0	0%	15.33	46.51	203%	1	2	2	203%
		Gasoline total	6.118	6.118	0%	229.35	186.57	-23%	1.483.081	1.254.776	-228.305	-15%
	Diesel Oil	pre-Cars	3.995	3.995	0%	425.99	386.79	-9%	1.988.280	1.225.682	-472.598	-24%
		Car 1	4.787	4.787	0%	399.71	276.24	-30%	1.984.260	1.030.426	-953.825	-48%
		Car 2	10.816	10.816	0%	336.90	153.29	-54%	3.644.582	2.091.063	-1.553.519	-43%
	1.A.3.b.ii. Heavy Duty Vehicles (HDVs)	Gasoline	pre-Cars	3.995	3.995	0%	425.99	386.79	-9%	1.988.280	1.225.682	-472.598
Car 1			4.787	4.787	0%	399.71	276.24	-30%	1.984.260	1.030.426	-953.825	-48%
Car 2			10.816	10.816	0%	336.90	153.29	-54%	3.644.582	2.091.063	-1.553.519	-43%
Car 3			321.429	321.429	0%	544.12	190.54	-65%	183.627.249	4.348.078	-179.279.171	-98%
Car 4			60.032	60.032	0%	402.82	89.26	-78%	30.079.914	5.420.811	-24.619.104	-82%
Car 5			6.609	6.609	0%	448.05	89.26	-80%	2.930.190	584.364	-2.335.826	-80%
Car 6			0	0	0%	161.21	89.26	-43%	14	6	-6	-43%
Diesel oil total			115.961	115.961	0%	485.55	126.92	-74%	55.844.588	15.718.142	-40.126.376	-74%
Diesel Oil		LDVs total	122.085	122.085	0%	488.92	130.95	-73%	57.247.599	15.932.898	-41.314.681	-73%
		pre-Cars	2.620	2.620	0%	100.63	101.18	6%	2.636.189	2.671.331	35.147	6%
		Car 1	2.258	2.258	0%	752.91	711.45	-5%	1.699.781	1.696.297	-3.484	0%
		Car 2	3.024	3.024	0%	804.17	653.36	-19%	2.281.125	5.837.559	3.556.434	156%
		Car 3	16.887	16.887	0%	633.16	457.38	-28%	9.425.880	6.889.054	-2.516.827	-27%
		Car 4	5.131	5.131	0%	448.88	351.81	-21%	2.333.330	1.881.274	-448.056	-20%
		Car 5	13.396	13.396	0%	336.60	182.62	-46%	4.589.052	2.486.399	-2.092.653	-46%
		Car 6	0	0	0%	0	0	0%	0	0	0	0%
		Diesel total	47.365	47.365	0%	592.65	448.99	-24%	28.071.221	21.286.323	-6.884.898	-24%
1.A.3.b.iii. Heavy Duty Vehicle: Trucks & Lorries	Diesel Oil	pre-Cars	8.044	8.044	0%	1030.67	753.88	-26%	8.365.423	6.144.933	-2.210.491	-26%
		Car 1	4.384	4.384	0%	758.16	574.04	-24%	3.288.422	2.535.327	-772.844	-24%
		Car 2	29.277	29.277	0%	817.37	550.61	-32%	23.947.723	12.926.277	-11.021.499	-50%
		Car 3	121.581	121.581	0%	636.16	436.56	-31%	77.271.520	45.310.423	-31.961.097	-41%
		Car 4	68.430	68.430	0%	290.35	289.43	-0%	32.177.784	15.969.685	-6.468.019	-20%
		Car 5	342.175	342.175	0%	276.29	152.63	-45%	96.589.479	52.019.687	-44.570.792	-54%
		Car 6	0	0	0%	0	0	0%	0	0	0	0%
		Diesel total	563.891	563.891	0%	418.38	244.97	-40%	215.470.271	138.136.342	-77.333.929	-36%
	MGNs total	pre-Cars	7.389	7.389	0%	322.96	150.24	-53%	969.580	1.110.170	21.588	22%
		Car 1	4.885	4.885	0%	134.72	108.26	-19%	599.299	888.547	289.248	35%
		Car 2	3.544	3.544	0%	137.85	194.58	41%	488.552	688.693	201.851	41%
		Car 3	3.560	3.560	0%	39.59	194.58	382%	160.553	680.634	519.280	382%
Car 4		0	0	0%	0	0	0%	0	0	0	0%	
MGNs total	pre-Cars	19.289	19.289	0%	119.79	177.04	54%	2.137.082	3.299.162	1.162.180	54%	
	Total	2.180.883	2.180.883	0%	305.90	157.85	-49%	632.363.736	321.625.655	-308.748.081	-49%	



Adjustment details for 2023															
NFR Code	Fuel	Activity Data			Implied Emission Factor			NO <sub>x</sub> Emissions							
		current	adjusted	difference	current	adjusted	difference	current	adjusted	adjustment	difference				
		in [t]			in [g/t]			in [kg]							
1.A.3.a.i. Passenger Cars	Gasoline	pre-Cars	11,581	11,581	0%	607.72	635.39	-12%	7,026,041	6,189,785	-836,256	-12%			
		Car 1	47,487	47,487	0%	348.56	341.62	-31%	16,571,746	11,426,129	-5,145,617	-31%			
		Car 2	72,781	72,781	0%	194.27	172.82	-10%	13,487,749	10,039,380	-3,372,369	-25%			
		Car 3	189,443	189,443	0%	63.89	72.62	14%	6,927,963	7,875,172	947,209	14%			
		Car 4	489,541	489,541	0%	45.39	45.13	-1%	18,541,881	18,436,736	-105,145	-1%			
		Car 5	181,961	181,961	0%	18.61	45.13	142%	1,887,355	4,681,311	2,793,956	142%			
	Car 6	282	282	0%	25.06	45.13	74%	7,339	12,736	5,399	74%				
	Gasoline total	790,957	790,957	0%	85.73	78.89	-8%	64,379,964	58,577,229	-5,802,735	-9%				
	Diesel Oil	pre-Cars	1,487	1,487	0%	311.98	284.56	-15%	463,963	383,872	-80,091	-15%			
		Car 1	6,660	6,660	0%	297.79	266.44	-11%	1,980,364	1,771,787	-208,577	-11%			
Car 2		33,967	33,967	0%	406.82	279.27	-40%	13,987,432	7,445,646	-6,541,787	-40%				
Car 3		183,539	183,539	0%	564.82	176.63	-69%	58,399,037	18,434,837	-39,964,200	-69%				
1.A.3.b.i. Light Duty Vehicles (LDVs)	Gasoline	pre-Cars	624,962	624,962	0%	89.28	98.33	10%	14,623	82,082	7,459	10%			
		Car 1	2,030	2,030	0%	38.49	47.58	24%	78,155	96,691	18,536	24%			
		Car 2	610	610	0%	16.36	47.58	182%	9,941	29,011	19,069	182%			
		Car 3	0	0	0%	15.37	47.58	210%	2	6	4	210%			
		Gasoline total	5,657	5,657	0%	218.93	193.15	-12%	1,238,520	1,094,662	-143,858	-12%			
		pre-Cars	3,281	3,281	0%	424.46	386.79	-9%	1,368,754	1,362,093	-6,661	-0%			
	Diesel Oil	pre-Cars	3,666	3,666	0%	398.34	276.24	-30%	1,445,980	1,187,634	-258,346	-18%			
		Car 1	8,479	8,479	0%	336.40	193.39	-42%	2,852,325	1,639,772	-1,212,553	-43%			
		Car 2	23,785	23,785	0%	558.53	150.44	-73%	13,050,281	3,566,082	-9,484,199	-73%			
		Car 3	59,485	59,485	0%	494.22	89.85	-82%	29,369,870	5,337,395	-24,032,475	-82%			
1.A.3.b.ii. Heavy Duty Vehicles (HDVs)	Gasoline	pre-Cars	15,964	15,964	0%	442.70	89.85	-80%	7,040,451	1,420,906	-5,619,545	-80%			
		Car 1	1	1	0%	15.14	89.85	-81%	122	72	-50	-41%			
		Diesel oil total	114,350	114,350	0%	485.91	120.17	-75%	55,186,382	13,741,354	-41,445,028	-75%			
		LDVs Total	128,008	128,008	0%	485.91	120.17	-75%	55,186,382	13,741,354	-41,445,028	-75%			
		pre-Cars	1,205	1,205	0%	1093.46	1119.45	4%	1,410,640	1,352,283	-58,357	-4%			
		Car 1	1,245	1,245	0%	727.34	731.15	1%	1,817,476	1,817,184	-292	-0%			
	Diesel Oil	Car 2	7,788	7,788	0%	703.46	643.34	-9%	5,085,091	4,597,478	-487,613	-9%			
		Car 3	14,483	14,483	0%	629.94	457.61	-27%	9,073,137	6,689,744	-2,383,393	-27%			
		Car 4	5,331	5,331	0%	468.10	361.85	-23%	2,642,179	1,677,766	-964,413	-37%			
		Car 5	20,752	20,752	0%	347.84	182.99	-47%	7,219,563	3,787,467	-3,432,096	-47%			
Car 6	73	73	0%	64.52	182.99	286%	3,961	13,296	9,334	236%					
Diesel Total	50,962	50,962	0%	533.22	384.33	-28%	27,141,913	19,945,288	-7,196,625	-27%					
1.A.3.b.iii. Heavy Duty Vehicle: Trucks & Lorries	Gasoline	pre-Cars	6,922	6,922	0%	1036.95	758.82	-27%	7,107,543	5,252,345	-1,855,198	-27%			
		Car 1	3,630	3,630	0%	743.70	570.57	-24%	2,721,305	2,071,111	-650,194	-24%			
		Car 2	23,577	23,577	0%	818.27	516.43	-37%	19,262,253	12,175,855	-7,086,398	-37%			
		Car 3	96,743	96,743	0%	634.65	370.21	-42%	61,387,137	35,848,665	-25,538,472	-42%			
		Car 4	60,550	60,550	0%	366.50	288.44	-21%	19,962,680	14,680,877	-5,281,723	-27%			
		Car 5	485,981	485,981	0%	261.24	152.32	-42%	116,149,955	61,626,577	-54,523,378	-47%			
	Car 6	2,380	2,380	0%	188.487	360.323	191%	188,487	360,323	171,836	223%				
	Trucks Total	589,585	589,585	0%	385.33	224.69	-41%	224,829,180	132,064,153	-92,765,027	-41%				
	1.A.3.b.iv. Motorised Two-Wheelers (MOWs)	Gasoline	pre-Cars	6,780	6,780	0%	122.76	151.03	23%	822,530	1,011,520	188,991	23%		
			Car 1	4,386	4,386	0%	134.61	171.39	28%	536,615	738,050	201,435	38%		
Car 2			3,287	3,287	0%	136.22	184.56	35%	445,087	636,853	191,766	43%			
Car 3			3,984	3,984	0%	38.66	184.56	382%	18,386	778,616	760,230	382%			
Car 4			0	0	0%	0	0	0%	0	0	0	0%			
Car 5			0	0	0%	0	0	0%	0	0	0	0%			
MOWs Total	18,268	18,268	0%	107.43	175.28	61%	1,982,546	3,165,439	1,182,893	61%					
1.A.3.b. Road Transport Total	2,084,964		2,084,964		0%		295.79	151.71		-49%		616,721,438	396,381,343	-220,340,094	-49%

Adjustment details for 2023												
NFR Code	Fuel	Activity Data			Implied Emission Factor			NO <sub>x</sub> Emissions				
		current	adjusted	difference	current	adjusted	difference	current	adjusted	adjustment	difference	
		in [t]			in [g/t]			in [t]				
1.A.3.a.i. Passenger Cars	Gasoline	pre-Cars	11,680	11,680	0%	618.27	649.35	-5%	7,011,541	6,967,452	-1,044,089	-15%
		Car 1	37,743	37,743	0%	353.78	341.68	-3%	13,362,986	9,129,495	-4,233,491	-32%
		Car 2	62,680	62,680	0%	188.93	139.33	-27%	11,889,922	8,722,244	-3,167,678	-27%
		Car 3	97,782	97,782	0%	66.38	73.19	10%	6,481,618	7,156,920	675,303	10%
		Car 4	397,911	397,911	0%	47.22	46.52	-1%	18,790,345	18,589,937	-200,407	-1%
		Car 5	138,063	138,063	0%	18.60	46.52	150%	2,583,150	6,439,691	3,856,541	150%
	Car 6	2,714	2,714	0%	25.99	46.52	79%	70,526	126,237	55,711	79%	
	Gasoline total	748,114	748,114	0%	88.35	74.85	-16%	68,090,887	56,671,737	-11,419,150	-17%	
	pre-Cars	1,389	1,389	0%	112.74	244.56	-54%	1,643,081	248,136	-1,394,945	-85%	
	Car 1	5,426	5,426	0%	298.42	246.79	-17%	1,678,472	1,640,688	-37,784	-2%	
	Car 2	28,437	28,437	0%	406.84	279.91	-40%	11,563,522	6,253,531	-5,309,991	-46%	
	Car 3	92,795	92,795	0%	574.33	176.67	-69%	53,284,956	16,579,373	-36,705,583	-69%	
	Car 4	222,583	222,583	0%	393.55	149.27	-62%	87,588,471	33,225,566	-54,362,905	-62%	
	Car 5	233,786	233,786	0%	435.42	149.27	-66%	101,787,275	34,894,768	-66,892,507	-66%	
Car 6	4,536	4,536	0%	259.53	149.27	-42%	1,177,151	677,045	-500,106	-42%		
Diesel oil total	589,131	589,131	0%	437.14	158.71	-64%	257,533,128	83,899,619	-173,633,509	-64%		
FCs Total	1,338,245	1,338,245	0%	237.40	111.77	-53%	317,723,135	146,571,356	-171,151,779	-53%		
1.A.3.a.ii. Heavy Duty Vehicles (HDV)	Gasoline	pre-Cars	981	981	0%	633.81	645.95	2%	568,320	575,293	6,973	1%
		Car 1	184	184	0%	803.50	389.27	-45%	187,281	59,328	-127,953	-68%
		Car 2	836	836	0%	274.42	291.18	7%	229,520	188,285	-41,235	-18%
		Car 3	784	784	0%	52.66	181.79	10%	72,691	79,780	7,089	10%
		Car 4	1,089	1,089	0%	43.70	48.89	12%	77,284	82,833	5,549	7%
		Car 5	966	966	0%	16.37	48.89	183%	15,187	47,268	32,081	183%
	Car 6	1	1	0%	17.66	48.89	176%	26	72	46	176%	
	Gasoline total	5,578	5,578	0%	262.86	184.67	-30%	1,137,299	1,696,727	559,428	49%	
	pre-Cars	2,744	2,744	0%	424.37	386.79	-9%	1,168,757	944,928	-223,829	-19%	
	Car 1	2,945	2,945	0%	398.34	276.25	-30%	1,166,782	934,596	-232,186	-20%	
	Car 2	6,982	6,982	0%	338.92	135.35	-42%	2,340,147	1,350,014	-990,133	-42%	
	Car 3	20,421	20,421	0%	558.32	130.37	-77%	11,437,988	8,025,843	-3,412,145	-73%	
	Car 4	55,087	55,087	0%	67.72	90.45	40%	27,776,440	5,040,145	-22,736,295	-40%	
	Car 5	29,024	29,024	0%	441.97	90.45	-80%	13,181,325	2,687,954	-10,493,371	-80%	
Car 6	41	41	0%	161.28	90.45	-44%	6,168	3,688	-2,479	-40%		
Diesel oil total	118,777	118,777	0%	488.86	154.83	-76%	57,083,533	13,656,488	-43,427,045	-76%		
LDVs Total	124,834	124,834	0%	488.84	158.63	-69%	58,214,142	14,677,215	-43,537,927	-76%		
1.A.3.a.iii. Heavy Duty Vehicles (HDV)	Diesel Oil	pre-Cars	1,172	1,172	0%	1098.69	1119.23	-4%	1,249,028	1,134,143	-114,885	-9%
		Car 1	1,054	1,054	0%	727.68	750.39	3%	780,620	791,181	10,561	1%
		Car 2	6,884	6,884	0%	764.87	643.48	-16%	3,324,968	4,379,371	1,054,403	32%
		Car 3	11,187	11,187	0%	638.43	473.65	-25%	8,262,880	5,998,226	-2,264,654	-27%
		Car 4	4,946	4,946	0%	468.55	351.71	-24%	2,278,051	1,739,736	-538,314	-24%
		Car 5	26,096	26,096	0%	368.98	183.48	-40%	8,435,583	4,240,743	-4,194,761	-40%
	Car 6	537	537	0%	44.76	183.48	310%	24,047	86,672	62,625	260%	
	Buses Total	11,716	11,716	0%	508.54	340.06	-29%	26,390,969	16,620,843	-9,770,126	-29%	
	pre-Cars	5,983	5,983	0%	1039.72	737.35	-29%	6,072,170	4,322,888	-1,749,283	-29%	
	Car 1	2,945	2,945	0%	748.27	583.27	-24%	2,176,946	1,650,960	-525,987	-24%	
	Car 2	11,444	11,444	0%	818.17	510.45	-37%	10,080,881	6,949,975	-3,130,906	-37%	
	Car 3	15,132	15,132	0%	633.52	487.73	-24%	47,587,448	27,081,187	-20,506,261	-43%	
	Car 4	42,781	42,781	0%	356.96	287.27	-27%	16,936,867	12,289,770	-4,647,097	-27%	
	Car 5	436,980	436,980	0%	261.70	152.65	-40%	123,181,324	66,796,436	-56,384,887	-46%	
Car 6	18,020	18,020	0%	91.87	152.65	261%	913,082	2,750,630	1,837,548	201%		
Trucks Total	680,139	680,139	0%	353.96	287.33	-21%	218,587,531	124,188,469	-94,399,062	-43%		
1.A.3.b.iii. Motorized Two-Wheelers (M2W)	Gasoline	pre-Cars	6,352	6,352	0%	123.97	151.79	23%	781,736	964,170	182,433	23%
		Car 1	4,013	4,013	0%	125.91	173.15	39%	582,073	634,880	52,807	30%
		Car 2	3,362	3,362	0%	132.24	158.58	40%	436,688	648,894	212,196	49%
		Car 3	4,562	4,562	0%	39.81	158.58	291%	181,610	882,175	716,565	291%
		Car 4	0	0	0%	0	0	0%	0	0	0	0%
		Car 5	0	0	0%	0	0	0%	0	0	0	0%
	M2Ws Total	18,229	18,229	0%	104.34	175.38	68%	1,962,088	3,197,038	1,234,951	68%	
	1.A.3.b. Road Transport Total	2,132,083	2,132,083	0%	268.88	186.27	-56%	616,078,963	310,854,371	-305,224,592	-56%	

Adjustment details for 2024													
NFR Code	Fuel	Activity Data			Implied Emission Factor			NO <sub>x</sub> Emissions					
		current	adjusted	difference	current	adjusted	difference	current	adjusted	adjustment	difference		
		in [t]	in [t]	in [%]	in [g/t]	in [g/t]	in [%]	in [g]	in [g]	in [g]	in [g]		
1.A.3.a.i. - Passenger Cars	Gasoline	pre-Cars	11.647	11.647	0%	812.37	844.11	-11%	7.132.688	6.337.484	-796.844	-11%	
		Car 1	30.667	30.667	0%	368.77	343.93	-32%	11.082.246	7.480.641	-3.621.706	-32%	
		Car 2	53.486	53.486	0%	198.58	140.31	-29%	10.514.477	7.584.432	-3.018.844	-29%	
		Car 3	87.374	87.374	0%	65.31	73.93	7%	6.955.589	6.459.797	-494.218	-7%	
		Car 4	387.759	387.759	0%	45.16	47.80	-3%	19.093.585	19.536.099	-523.557	-3%	
		Car 5	171.270	171.270	0%	18.59	47.80	151%	3.183.282	0.187.581	5.004.209	151%	
		Car 6	10.315	10.315	0%	25.97	47.80	84%	267.855	433.096	-225.245	-84%	
		Gasoline total	752.506	752.506	0%	76.03	73.89	4%	57.215.533	54.988.501	2,216.412	-4%	
	Diesel Oil	pre-Cars	1.341	1.341	0%	311.73	284.66	-56%	417.967	366.246	-42.722	-10%	
		Car 1	4.892	4.892	0%	298.92	267.28	-11%	1.482.284	1.387.643	-156.951	-11%	
		Car 2	23.934	23.934	0%	408.71	320.45	-40%	9.734.484	5.276.480	4.458.004	-40%	
		Car 3	82.749	82.749	0%	585.53	176.81	-49%	48.451.830	14.796.245	-33.655.585	-49%	
		Car 4	211.237	211.237	0%	297.27	151.77	-62%	83.917.680	32.059.973	-51.857.706	-62%	
		Car 5	285.011	285.011	0%	436.38	151.77	-65%	124.721.396	43.370.300	-81.343.896	-65%	
		Car 6	16.081	16.081	0%	259.34	151.77	-41%	4.170.580	2.440.686	-1.729.814	-41%	
		Diesel oil total	626.045	626.045	0%	415.87	159.12	-63%	272.876.061	99.613.892	-173.262.169	-63%	
		Flx Total	1,338,571	1,338,571	0%	238.44	152.15	-53%	138,091,584	154,652,853	-175,478,269	-53%	
	Gasoline	pre-Cars	986	986	0%	632.44	645.95	-2%	193.683	176.124	-18.444	-10%	
		Car 1	173	173	0%	968.27	989.98	-64%	150.074	53.575	-96.499	-64%	
		Car 2	748	748	0%	204.73	287.11	-27%	212.888	154.839	-58.029	-27%	
		Car 3	771	771	0%	98.62	185.21	7%	75.982	81.070	-5.078	7%	
		Car 4	1.087	1.087	0%	43.47	50.15	15%	81.139	83.618	-2.479	15%	
		Car 5	1.374	1.374	0%	17.11	50.15	183%	23.517	68.918	-45.401	183%	
		Car 6	17	17	0%	18.06	50.15	179%	212	670	-657	179%	
		Gasoline total	5.845	5.845	0%	598.34	176.49	-7%	1,112,584	1,031,852	-88,732	-7%	
1.A.3.b.i. - Light Duty Vehicles (LDVs)	Gasoline	pre-Cars	2.537	2.537	0%	428.16	386.79	-21%	1.985.879	1.76.259	-257.559	-21%	
		Car 1	2.588	2.588	0%	393.82	276.25	-40%	987.136	539.898	-447.328	-40%	
		Car 2	6.087	6.087	0%	338.91	193.25	-42%	1.385.995	1.180.889	-428.128	-42%	
		Car 3	18.220	18.220	0%	571.75	150.58	-74%	10.417.076	2.742.056	-7.675.028	-74%	
		Car 4	52.361	52.361	0%	498.70	91.69	-82%	26.164.486	4.703.746	-21.394.748	-82%	
		Car 5	46.749	46.749	0%	438.44	91.69	-79%	20.696.234	4.258.626	-16.237.709	-79%	
	Diesel Oil	pre-Cars	187	187	0%	151.18	91.69	-60%	29.829	17.974	-11.855	-60%	
		Diesel oil total	128.528	128.528	0%	415.56	170.96	-77%	61.146.575	14,267,237	-46,879,338	-77%	
		LDVs Total	134,423	134,423	0%	463.56	153.81	-75%	62,295,160	15,298,849	-46,996,311	-75%	
	Diesel Oil	pre-Cars	984	984	0%	1099.48	1919.23	-5%	1.062.384	1.062.921	-48.443	-5%	
		Car 1	837	837	0%	728.12	130.98	-3%	689.232	628.359	18.127	-3%	
		Car 2	5.586	5.586	0%	704.95	643.67	-10%	4.284.320	3.683.441	-798.887	-18%	
		Car 3	11.221	11.221	0%	621.20	458.38	-27%	7.082.740	5.143.628	-1.939.228	-27%	
		Car 4	4.278	4.278	0%	461.10	361.79	-24%	1.972.610	1.584.978	-467.632	-24%	
		Car 5	22.042	22.042	0%	368.55	183.99	-49%	7.726.921	4.065.632	-3.671.389	-49%	
		Car 6	4.182	4.182	0%	42.78	183.99	330%	178.913	789.476	-610.563	330%	
		Diesel Total	49,143	49,143	0%	468.37	339.99	-27%	23,017,115	16,788,234	-6,228,881	-27%	
		Trucks Total	572,754	572,754	0%	314.85	196.65	-38%	179,874,133	112,285,562	-67,588,571	-38%	
1.A.3.b.ii. - Heavy Duty Vehicles (HDVs)	Gasoline	pre-Cars	6.185	6.185	0%	122.85	158.64	29%	795.185	974.388	-218.192	29%	
		Car 1	3.037	3.037	0%	134.71	174.84	40%	478.514	670.859	-192.346	40%	
		Car 2	3.365	3.365	0%	128.94	186.25	52%	433.874	680.378	-246.504	52%	
		Car 3	5.385	5.385	0%	38.53	186.25	386%	29.722	1.041.189	-831.467	386%	
		Car 4	0	0	0%	0	0	0%	0	0	0	0%	
		Car 5	0	0	0%	0	0	0%	0	0	0	0%	
		HDVs Total	18,673	18,673	0%	108.59	179.24	78%	1,878,294	3,381,794	-1,488,499	78%	
	Diesel Oil	pre-Cars	1.182	1.182	0%	1034.34	737.35	-29%	4.945.942	3.525.898	-1.420.134	-29%	
		Car 1	2.285	2.285	0%	748.66	561.41	-25%	1.600.089	1.237.759	-362.338	-25%	
		Car 2	13.623	13.623	0%	817.90	510.38	-38%	11.446.862	6.565.738	-4.891.123	-38%	
		Car 3	54.685	54.685	0%	632.52	384.41	-42%	36.589.677	19.937.835	-16.651.841	-42%	
		Car 4	34.037	34.037	0%	396.37	285.34	-30%	13.481.158	9.711.896	-3.779.262	-30%	
		Car 5	389.263	389.263	0%	282.92	153.66	-46%	110.112.782	59.688.643	-50.424.148	-46%	
		Car 6	34.214	34.214	0%	63.96	153.66	189%	3.937.089	11.368.682	-7.421.413	189%	
		Trucks Total	572,754	572,754	0%	314.85	196.65	-38%	179,874,133	112,285,562	-67,588,571	-38%	
		Trucks Total	572,754	572,754	0%	314.85	196.65	-38%	179,874,133	112,285,562	-67,588,571	-38%	
1.A.3.b.iii. - Motorised Two-Wheelers (MOWs)	Gasoline	pre-Cars	6.185	6.185	0%	122.85	158.64	29%	795.185	974.388	-218.192	29%	
		Car 1	3.037	3.037	0%	134.71	174.84	40%	478.514	670.859	-192.346	40%	
		Car 2	3.365	3.365	0%	128.94	186.25	52%	433.874	680.378	-246.504	52%	
		Car 3	5.385	5.385	0%	38.53	186.25	386%	29.722	1.041.189	-831.467	386%	
		Car 4	0	0	0%	0	0	0%	0	0	0	0%	
		Car 5	0	0	0%	0	0	0%	0	0	0	0%	
		MOWs Total	18,673	18,673	0%	108.59	179.24	78%	1,878,294	3,381,794	-1,488,499	78%	
		1.A.3.b. Road Transport	Total	2,153,563	2,153,563	0%	277.27	140.35	-49%	587,120,297	382,252,271	-204,868,625	-49%



Adjustment details for 2026												
NFR Code	Fuel	Activity Data			Implied Emission Factor			NO <sub>x</sub> Emissions				
		current	adjusted	difference	current	adjusted	difference	current	adjusted	adjustment	difference	
		in [t]	in [t]	in [%]	in [g/t]	in [g/t]	in [%]	in [kg]	in [kg]	in [kg]	in [kg]	
1.A.3.a.i. - Passenger Cars	Gasoline	pre-Cars	15.782	15.782	0%	636.75	644.11	-4%	7.670.916	6.410.967	-1.667.867	-54%
		Car 1	20.270	20.270	0%	372.25	241.68	-35%	7.545.483	4.986.898	-2.646.596	-36%
		Car 2	36.062	36.062	0%	212.73	143.11	-33%	7.671.591	5.180.897	-2.516.693	-33%
		Car 3	83.039	83.039	0%	76.17	75.50	-1%	4.861.482	4.759.259	-42.233	-1%
		Car 4	334.413	334.413	0%	53.74	50.17	-7%	17.969.964	16.777.445	-1.192.489	-7%
		Car 5	183.374	183.374	0%	19.09	50.17	163%	3.580.746	9.199.834	5.639.898	163%
		Car 6	66.332	66.332	0%	26.67	50.17	88%	1.768.917	3.327.855	1.558.933	88%
		Gasoline total	715.272	715.272	0%	79.93	70.65	-9%	58.736.967	50.535.049	-8.201.918	-9%
	Diesel Oil	pre-Cars	1.280	1.280	0%	369.76	254.66	-31%	366.262	239.173	-126.898	-34%
		Car 1	3.749	3.749	0%	299.36	269.66	-10%	1.122.449	1.011.626	-111.425	-10%
		Car 2	16.584	16.584	0%	407.19	221.43	-46%	6.720.132	3.663.964	-3.056.168	-46%
		Car 3	61.398	61.398	0%	602.50	179.24	-70%	36.991.999	11.085.409	-25.906.958	-70%
		Car 4	175.940	175.940	0%	405.76	156.24	-61%	71.362.220	27.474.096	-43.878.214	-61%
		Car 5	299.054	299.054	0%	433.34	156.24	-64%	130.032.044	46.019.229	-83.212.815	-64%
		Car 6	116.034	116.034	0%	268.75	156.24	-42%	30.427.555	10.232.786	-19.194.778	-60%
		Diesel oil total	625.119	625.119	0%	416.36	160.76	-61%	277.947.660	188.535.230	-89.506.436	-61%
		Pkx Total	1.360.391	1.360.391	0%	235.75	154.41	-35%	327.778.627	199.070.289	-128.708.337	-39%
	Gasoline	pre-Cars	910	910	0%	602.79	645.95	11%	593.199	547.643	-45.556	-8%
		Car 1	136	136	0%	908.31	312.78	-66%	122.126	42.425	-79.708	-66%
		Car 2	540	540	0%	308.39	217.84	-29%	162.311	117.797	-44.514	-28%
		Car 3	650	650	0%	108.43	111.57	3%	70.432	72.731	2.299	3%
		Car 4	1.684	1.684	0%	43.06	52.36	21%	70.714	84.003	13.289	19%
		Car 5	1.724	1.724	0%	19.82	52.36	164%	34.157	80.258	46.106	164%
		Car 6	363	363	0%	19.85	52.36	181%	6.764	19.992	13.228	181%
		Gasoline total	5.506	5.506	0%	388.27	171.66	-56%	1.068.292	1.013.678	-54.614	-5%
	Diesel Oil	pre-Cars	2.189	2.189	0%	414.81	386.79	-7%	999.849	986.433	-13.416	-1%
		Car 1	1.790	1.790	0%	391.99	276.25	-30%	780.169	586.371	-194.798	-25%
		Car 2	4.223	4.223	0%	323.43	193.31	-40%	1.365.994	876.452	-489.542	-40%
		Car 3	13.582	13.582	0%	588.91	150.77	-74%	8.064.323	2.940.233	-5.124.090	-74%
		Car 4	43.141	43.141	0%	504.48	32.40	-93%	21.763.989	3.986.141	-17.777.788	-82%
		Car 5	74.231	74.231	0%	434.16	32.40	-93%	32.223.283	6.668.790	-25.554.493	-80%
		Car 6	4.921	4.921	0%	113.49	32.40	-72%	765.285	454.676	-310.609	-41%
		Diesel oil total	148.068	148.068	0%	456.12	185.62	-59%	65.712.732	15.296.007	-50.416.726	-77%
		LN% Total	149.994	149.994	0%	445.23	188.29	-58%	66.787.025	16.229.684	-50.557.348	-76%
1.A.3.b.ii. - Heavy Duty Vehicles - Buses	Diesel Oil	pre-Cars	891	891	0%	1076.81	1919.23	78%	964.197	988.234	24.037	2%
		Car I	583	583	0%	731.36	732.67	0%	433.675	446.236	12.568	3%
		Car II	4.375	4.375	0%	708.25	645.03	-9%	3.440.614	2.822.621	-617.993	-18%
		Car III	10.333	10.333	0%	632.87	458.91	-28%	6.530.364	4.741.827	-1.788.536	-27%
		Car IV	4.449	4.449	0%	475.90	382.29	-20%	2.117.219	1.666.881	-450.338	-21%
		Car V	34.360	34.360	0%	366.36	185.22	-49%	8.935.974	4.617.617	-4.318.357	-49%
		Car VI	9.126	9.126	0%	62.79	185.22	196%	573.066	1.680.431	1.107.365	196%
		Buses Total	54.157	54.157	0%	404.73	388.24	-4%	23.082.189	16.885.117	-6.197.072	-27%
	Trucks & Lorries	pre-Cars	3.933	3.933	0%	1034.81	737.35	-29%	4.087.249	2.980.379	-1.106.870	-28%
		Car I	1.555	1.555	0%	748.16	587.92	-22%	1.163.482	789.813	-373.669	-33%
		Car II	8.876	8.876	0%	817.75	585.42	-29%	7.258.047	4.486.626	-2.771.421	-38%
		Car III	34.167	34.167	0%	638.91	588.64	-9%	21.563.280	12.251.155	-9.312.123	-43%
		Car IV	34.287	34.287	0%	396.94	281.86	-29%	9.640.384	6.885.621	-2.754.803	-29%
		Car V	269.736	269.736	0%	267.22	153.60	-43%	74.680.233	39.676.610	-34.993.623	-47%
1.A.3.b.iv. - Motorised Two-Wheelers (MOWs)	Gasoline	pre-Cars	5.543	5.543	0%	125.59	155.78	24%	696.072	883.289	187.218	24%
		Car 1	3.360	3.360	0%	127.11	177.29	39%	427.113	585.796	158.682	39%
		Car 2	3.375	3.375	0%	125.94	187.68	50%	421.961	687.078	265.127	63%
		Car 3	6.443	6.443	0%	48.36	187.68	381%	209.627	1.273.671	1.064.043	508%
		Car 4	66	66	0%	17.47	187.68	1031%	1.134	12.632	11.498	1011%
		Car 5	0	0	0%	0	0	0%	0	0	0	0%
		MOWs Total	16.185	16.185	0%	96.14	181.68	89%	1.885.897	3.452.476	1.566.579	83%
	Road Transport	pre-Cars	2.267.339	2.267.339	0%	258.89	137.22	-47%	553.799.598	362.981.620	-190.817.978	-47%
		LN% Total	2.267.339	2.267.339	0%	258.89	137.22	-47%	553.799.598	362.981.620	-190.817.978	-47%

Adjustment details for 2027													
NFR Code	Fuel	Activity Data			Implied Emission Factor			NO <sub>x</sub> Emissions					
		current	adjusted	difference	current	adjusted	difference	current	adjusted	adjustment	difference		
		in [T]	in [T]	in [%]	in [g/t]	in [g/t]	in [%]	in [kg]	in [kg]	in [kg]	in [%]		
1.A.3.a.i. - Passenger Cars	Gasoline	pre-Cars	12.282	12.282	0%	636.75	644.11	-11%	7.616.267	6.680.187	-1.126.108	-14%	
		Car 1	17.449	17.449	0%	372.96	241.68	-35%	6.588.311	4.217.644	-2.391.267	-36%	
		Car 2	30.435	30.435	0%	217.43	141.75	-35%	6.617.570	4.374.140	-2.243.430	-34%	
		Car 3	54.271	54.271	0%	78.48	76.27	-3%	4.254.938	4.139.376	-115.562	-3%	
		Car 4	315.086	315.086	0%	54.96	51.26	-7%	17.316.320	16.151.881	-1.164.438	-7%	
		Car 5	180.240	180.240	0%	19.17	51.26	167%	3.485.382	9.239.815	5.754.433	167%	
	Gasoline total	724.571	724.571	0%	87.66	80.88	-8%	49.804.874	50.634.374	1.607.888	3%		
	Diesel Oil	pre-Cars	1.790	1.790	0%	369.76	264.66	-13%	483.963	347.620	-131.883	-13%	
		Car 1	3.760	3.760	0%	299.37	271.67	-9%	1.082.288	910.182	-172.106	-16%	
		Car 2	13.788	13.788	0%	407.17	222.43	-45%	5.914.130	3.066.393	-2.847.736	-48%	
Car 3		52.128	52.128	0%	608.95	179.65	-70%	31.696.478	9.364.788	-22.331.689	-70%		
1.A.3.a.ii. - Heavy Duty Vehicles (LDV)	Gasoline	Car 4	187.947	187.947	0%	418.16	158.34	-61%	64.733.485	24.983.323	-39.748.142	-61%	
		Car 5	283.480	283.480	0%	423.39	158.34	-63%	120.187.695	44.873.190	-75.314.405	-63%	
		Car 6	184.768	184.768	0%	262.61	158.34	-40%	48.521.163	29.255.985	-19.265.258	-40%	
		Diesel oil total	696.582	696.582	0%	398.65	161.95	-59%	272.126.091	112.870.717	-159.255.374	-59%	
		Pkx Total	1.621.162	1.621.162	0%	225.98	155.61	-31%	521.152.965	163.445.435	-357.707.538	-68%	
		Diesel Oil	pre-Cars	940	940	0%	611.41	645.95	11%	612.247	686.978	5.322	1%
	Car 1		124	124	0%	908.23	312.78	-66%	112.083	39.682	-72.401	-66%	
	Car 2		485	485	0%	302.12	221.62	-27%	140.344	182.950	42.606	30%	
	Car 3		596	596	0%	118.57	115.36	-3%	65.955	68.812	2.857	4%	
	1.A.3.a.iii. - Heavy Duty Vehicles (MDV)	Gasoline	Car 4	1.476	1.476	0%	50.72	53.38	5%	74.877	78.816	3.938	5%
Car 5			1.680	1.680	0%	21.73	53.38	146%	36.240	89.034	52.794	146%	
Car 6			910	910	0%	19.18	53.38	180%	17.052	49.080	31.928	187%	
Gasoline total			6.186	6.186	0%	171.55	167.18	-2%	1.058.799	1.034.211	-24.588	-2%	
Diesel Oil			pre-Cars	2.067	2.067	0%	413.41	386.79	-7%	999.849	986.433	-13.416	-1%
			Car 1	1.538	1.538	0%	399.47	276.25	-30%	660.795	511.158	-149.638	-23%
		Car 2	3.580	3.580	0%	321.26	193.04	-40%	1.143.793	887.293	-256.500	-23%	
		Car 3	11.684	11.684	0%	595.30	150.73	-75%	5.240.935	1.758.212	-3.482.723	-66%	
1.A.3.a.iv. - Heavy Duty Vehicles (LDV)		Gasoline	Car 4	39.050	39.050	0%	306.76	83.09	-73%	19.749.647	3.635.025	-16.114.612	-82%
			Car 5	75.789	75.789	0%	432.66	83.09	-79%	32.790.564	7.054.565	-25.735.911	-79%
	Car 6		19.625	19.625	0%	167.71	83.09	-39%	2.977.239	1.626.675	-1.156.564	-39%	
	Diesel oil total		153.284	153.284	0%	424.66	183.89	-57%	65.081.930	15.925.274	-49.156.714	-74%	
	LDVs Total		159.470	159.470	0%	414.83	186.35	-54%	66.152.129	16.959.427	-49.193.302	-74%	
	Diesel Oil		pre-Cars	736	736	0%	707.33	1011.23	43%	790.259	150.425	-639.834	-81%
		Car 1	411	411	0%	723.97	152.57	-79%	390.684	399.082	8.458	3%	
		Car 2	3.325	3.325	0%	731.97	646.79	-11%	2.523.087	2.147.480	-375.607	-15%	
		Car 3	8.678	8.678	0%	671.23	459.12	-31%	6.473.480	5.984.085	-489.395	-8%	
	1.A.3.a.v. - Heavy Duty Vehicles (MDV)	Diesel Oil	Car 4	3.923	3.923	0%	474.07	352.49	-26%	1.912.380	1.347.680	-564.700	-30%
Car 5			21.913	21.913	0%	363.92	186.64	-49%	7.937.975	4.053.686	-3.884.291	-49%	
Car 6			14.586	14.586	0%	68.52	186.64	270%	854.215	2.732.580	1.878.375	218%	
Buses Total			53.382	53.382	0%	318.80	286.75	-9%	19.193.961	19.384.620	4.489.873	23%	
pre-Cars			3.686	3.686	0%	1034.40	719.13	-29%	3.730.272	2.659.076	-1.071.256	-29%	
Car 1			1.711	1.711	0%	748.03	483.48	-35%	902.942	614.151	-288.696	-31%	
Diesel Oil		Car 2	7.387	7.387	0%	817.96	540.55	-34%	3.794.676	3.580.026	-2.226.851	-30%	
		Car 3	26.886	26.886	0%	626.17	345.12	-44%	12.642.041	7.953.565	-4.688.476	-37%	
		Car 4	39.082	39.082	0%	397.77	279.34	-30%	7.965.414	5.637.487	-2.368.948	-30%	
		Car 5	264.365	264.365	0%	268.16	154.36	-42%	49.280.789	31.085.347	-17.735.342	-42%	
Diesel Oil total	335.065	335.065	0%	65.82	154.36	135%	21.985.366	17.516.641	-29.733.725	-135%			
Trucks Total	598.263	598.263	0%	1095.142	719.92	-34%	116.671.141	105.248.960	-11.422.633	-10%			
1.A.3.b.i. - Motorized Two-Wheelers (MDV)	Gasoline	pre-Cars	5.336	5.336	0%	125.91	157.19	25%	671.080	830.180	169.851	25%	
		Car 1	3.257	3.257	0%	126.39	177.06	41%	411.617	579.244	167.627	41%	
		Car 2	3.396	3.396	0%	122.55	180.33	47%	476.293	673.548	257.348	47%	
		Car 3	6.711	6.711	0%	41.22	180.33	363%	271.187	1.336.565	1.065.848	393%	
		Car 4	0	0	0%	0.69	0	0%	0	82.278	77.498	96%	
		MDVs Total	15.160	15.160	0%	92.81	183.39	96%	7.782.484	3.551.787	-1.735.114	-96%	
	1.A.3.b. Road Transport	Total	2.291.427	2.291.427	0%	213.43	175.23	-42%	525.563.490	384.685.986	-221.875.424	-42%	

Adjustment details for 2018												
NFR Code	Fuel	Activity Data			Implied Emission Factor			NO <sub>x</sub> Emissions				
		current	adjusted	difference	current	adjusted	difference	current	adjusted	adjustment	difference	
		in [t]	in [t]	in [%]	in [g/t]	in [g/t]	in [%]	in [kg]	in [kg]	in [kg]	in [%]	
1.A.3.a.i - Passenger Cars	Gasoline	pre-Cars	12,219	12,219	0%	637.58	644.11	-10%	7,780,965	6,648,721	-1,132,234	-15%
		Car 1	14,362	14,362	0%	374.24	341.68	-9%	5,371,161	3,448,643	-1,922,518	-36%
		Car 2	34,285	34,285	0%	221.97	111.66	-50%	5,360,977	2,688,161	-2,672,814	-50%
		Car 3	43,642	43,642	0%	88.16	76.96	-13%	3,487,781	3,358,617	-129,164	-4%
		Car 4	278,738	278,738	0%	55.98	52.30	-7%	15,683,488	14,576,755	-1,106,733	-7%
		Car 5	186,830	186,830	0%	19.35	52.30	-170%	3,228,282	8,725,688	5,497,406	170%
	Diesel Oil	pre-Cars	159,041	159,041	0%	6.00	52.30	-89%	4,190,422	8,716,250	4,525,828	89%
		Car 1	2,949	2,949	0%	64.42	66.36	6%	45,032,296	47,786,817	2,754,521	6%
		Car 2	1,363	1,363	0%	366.46	345.173	-6%	366,446	345.173	-21,273	-6%
		Car 3	2,949	2,949	0%	298.17	272.65	-9%	862,432	775,165	-87,267	-10%
		Car 4	10,784	10,784	0%	407.20	222.87	-45%	4,981,983	2,483,536	-2,498,447	-50%
		Car 5	40,786	40,786	0%	612.49	180.15	-71%	24,932,029	7,333,241	-17,598,788	-71%
	LNW Total	pre-Cars	278,738	278,738	0%	414.71	180.40	-56%	54,133,837	20,937,329	-33,196,508	-61%
		Car 1	251,212	251,212	0%	416.25	180.40	-56%	104,585,706	40,253,731	-64,331,975	-57%
		Car 2	228,075	228,075	0%	254.87	163.38	-36%	58,284,140	35,680,446	-22,603,694	-39%
		Car 3	666,076	666,076	0%	375.66	163.38	-56%	247,556,063	188,768,684	-158,787,459	-56%
		Car 4	1,365,181	1,365,181	0%	214.34	154.68	-26%	262,589,060	156,555,421	-106,033,639	-40%
		Car 5	917	917	0%	604.53	645.95	11%	196,851	182,652	-14,199	-7%
1.A.3.b.i - Light Duty Vehicles (LDV)	Gasoline	pre-Cars	189	189	0%	911.58	312.78	-66%	98,528	33,895	-64,633	-66%
		Car 1	377	377	0%	303.64	224.45	-26%	114,682	84,713	-29,969	-26%
		Car 2	511	511	0%	111.92	116.84	5%	57,282	60,739	3,457	6%
		Car 3	1,275	1,275	0%	52.02	54.36	4%	65,290	69,270	3,980	4%
		Car 4	1,483	1,483	0%	23.70	54.36	129%	35,160	80,626	45,466	129%
		Car 5	1,643	1,643	0%	19.18	54.36	182%	39,550	89,326	49,776	182%
	Diesel Oil	pre-Cars	6,315	6,315	0%	154.22	160.11	4%	999,199	1,011,136	11,937	1%
		Car 1	1,872	1,872	0%	411.51	386.79	-6%	771,337	574,432	-196,905	-26%
		Car 2	1,285	1,285	0%	389.94	276.25	-29%	483,129	272,286	-210,843	-44%
		Car 3	2,942	2,942	0%	318.56	153.88	-52%	965,389	550,789	-414,600	-43%
		Car 4	9,363	9,363	0%	559.10	150.74	-73%	5,689,152	1,411,299	-4,277,853	-75%
		Car 5	33,232	33,232	0%	508.42	93.81	-82%	15,929,185	3,117,457	-12,811,728	-80%
	LNW Total	pre-Cars	66,283	66,283	0%	432.92	93.81	-78%	28,684,080	6,217,860	-22,466,220	-78%
		Car 1	39,482	39,482	0%	158.79	93.81	-41%	5,941,615	3,686,228	-2,255,387	-38%
		Car 2	154,259	154,259	0%	384.71	182.69	-53%	59,344,525	35,880,316	-23,464,209	-39%
		Car 3	180,574	180,574	0%	375.86	184.94	-52%	69,343,125	36,851,449	-32,491,676	-52%
		Car 4	547	547	0%	1078.15	1919.23	-43%	589,267	557,147	-32,120	-5%
		Car 5	237	237	0%	732.77	132.57	-82%	173,676	168,348	-4,698	-3%
1.A.3.b.ii - Heavy Duty Vehicle Buses	Diesel Oil	pre-Cars	2,270	2,270	0%	787.83	646.33	-18%	1,780,686	1,487,437	-293,249	-16%
		Car 1	6,757	6,757	0%	638.89	459.32	-29%	4,262,734	3,183,482	-1,079,252	-25%
		Car 2	3,043	3,043	0%	473.16	382.73	-19%	1,439,790	1,073,333	-366,457	-26%
		Car 3	18,189	18,189	0%	362.42	186.37	-49%	6,463,266	3,376,016	-3,087,249	-48%
		Car 4	20,670	20,670	0%	64.89	186.37	228%	1,176,026	3,682,314	2,506,288	228%
		Car 5	91,634	91,634	0%	309.75	283.53	-9%	15,993,546	13,687,186	-2,306,360	-15%
	LNW Total	pre-Cars	3,262	3,262	0%	1034.82	737.35	-29%	3,375,359	2,485,071	-890,288	-26%
		Car 1	1,094	1,094	0%	747.82	488.39	-35%	918,052	512,378	-405,674	-44%
		Car 2	5,544	5,544	0%	817.44	581.68	-29%	4,532,190	2,781,516	-1,750,674	-39%
		Car 3	6,757	6,757	0%	629.54	459.32	-29%	4,262,734	3,183,482	-1,079,252	-25%
		Car 4	15,912	15,912	0%	358.89	276.23	-23%	6,334,421	4,386,424	-1,947,997	-31%
		Car 5	154,983	154,983	0%	250.40	154.68	-38%	45,964,153	24,283,389	-21,680,764	-47%
	LNW Total	pre-Cars	381,799	381,799	0%	68.78	154.68	125%	28,251,482	69,665,886	41,414,404	125%
		Car 1	585,186	585,186	0%	515.18	172.19	-66%	188,173,537	180,760,889	-7,412,648	-4%
		Car 2	4,940	4,940	0%	128.95	188.61	46%	622,656	783,451	160,795	26%
		Car 3	2,966	2,966	0%	128.14	177.79	41%	374,114	527,294	153,180	41%
		Car 4	3,221	3,221	0%	129.33	186.64	45%	387,596	639,833	252,237	65%
		Car 5	6,241	6,241	0%	48.24	186.64	284%	20,126	1,239,686	1,219,560	284%
1.A.3.b.iii - Motorised Two-Wheelers (M2W)	Gasoline	pre-Cars	1,130	1,130	0%	58.41	186.64	321%	23,966	224,682	200,716	873%
		Car 1	0	0	0%	0.00	0.00	0%	0	0	0	0%
		Car 2	0	0	0%	0.00	0.00	0%	0	0	0	0%
		Car 3	0	0	0%	0.00	0.00	0%	0	0	0	0%
		Car 4	0	0	0%	0.00	0.00	0%	0	0	0	0%
		Car 5	0	0	0%	0.00	0.00	0%	0	0	0	0%
	LNW Total	pre-Cars	18,497	18,497	0%	85.86	186.64	118%	1,658,558	3,454,767	1,796,209	108%
		Car 1	2,180,983	2,180,983	0%	215.85	133.49	-38%	478,758,286	291,129,652	-187,628,634	-38%
		Car 2	2,180,983	2,180,983	0%	215.85	133.49	-38%	478,758,286	291,129,652	-187,628,634	-38%
		Car 3	2,180,983	2,180,983	0%	215.85	133.49	-38%	478,758,286	291,129,652	-187,628,634	-38%
		Car 4	2,180,983	2,180,983	0%	215.85	133.49	-38%	478,758,286	291,129,652	-187,628,634	-38%
		Car 5	2,180,983	2,180,983	0%	215.85	133.49	-38%	478,758,286	291,129,652	-187,628,634	-38%
	LNW Total	pre-Cars	18,497	18,497	0%	85.86	186.64	118%	1,658,558	3,454,767	1,796,209	108%
		Car 1	2,180,983	2,180,983	0%	215.85	133.49	-38%	478,758,286	291,129,652	-187,628,634	-38%
		Car 2	2,180,983	2,180,983	0%	215.85	133.49	-38%	478,758,286	291,129,652	-187,628,634	-38%
		Car 3	2,180,983	2,180,983	0%	215.85	133.49	-38%	478,758,286	291,129,652	-187,628,634	-38%
		Car 4	2,180,983	2,180,983	0%	215.85	133.49	-38%	478,758,286	291,129,652	-187,628,634	-38%
		Car 5	2,180,983	2,180,983	0%	215.85	133.49	-38%	478,758,286	291,129,652	-187,628,634	-38%

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Adjustment 2014 (accepted)	-105.6	-101.3	-95.7	-91.7						
Adjustment 2015 (accepted)	-100.3	-95.5	-89.9	-85.1						
Adjustment 2016 (accepted)	-151.3	-146.9	-145.1	-142.5	-128.1					
Adjustment 2017 (accepted)	-151.3	-146.8	-145.0	-142.4	-127.2	-100.9				
Adjustment 2018 (accepted)	-172.3	-174.5	-177.4	-180.4	-171.5	-148.9	-123.2			
Adjustment 2019 (accepted)	-172.3	-174.5	-177.4	-180.3	-171.4	-148.8	-123.3	93.7		
Adjustment 2020 (accepted)	-297.8	-302.3	-301.3	-306.1	-294.5	-269.0	-244.3	-214.9	-174.6	
<b>Adjustment 2021 (proposal)</b>	<b>-296.1</b>	<b>-300.7</b>	<b>-300.4</b>	<b>-305.2</b>	<b>-294.9</b>	<b>-274.9</b>	<b>-250.9</b>	<b>-221.1</b>	<b>-179.6</b>	<b>-144.8</b>
Change against Adjustment 2020	1.7	1.6	0.9	0.9	-0.4	-5.9	-6.6	-6.2	-5.0	

The noticeable differences between the 2017 and 2018 adjustment proposals resulted from an ad-hoc revision of the *Handbook Emission Factors for Road Transport* (HBEFA, version 3.3) in the aftermath of the so-called "Diesel-gate". <sup>8)</sup>

The even bigger changes between adjustment 2019 and adjustment proposal 2020 result from an additional rather fundamental revision of the *Handbook Emission Factors for Road Transport* now available in version 4.1 <sup>9)</sup> strongly effecting the TREMOD model underlying Germany's emission reporting for road transport and hence any adjustments of NO<sub>x</sub> emissions.

**With such major model revision between submissions 2019 and 2020, the current adjustment proposal differs significantly from the adjustment applied for and accepted in 2019.**

In comparison to 2020, the TREMOD model applied for the 2021 submission has been revised only slightly in terms of NO<sub>x</sub> emission factors. Hence, the current adjustment proposal differs only slightly from the (accepted) proposal provided with submission 2020.

#### **Adjustment description as provided in IIRs 2014 and 2015:**

[image Description%20Adjustment%20DE-A%20-%20NOx%20from%201.A.3.b%20Road%20transport%20-%20IIRs%202014%20%26%202015.pdf](#)

**bibliography** : 1 : EB, 2012a: CLRTAP EB Decision 2012/3, ECE/EB.AIR/111/Add.1: Adjustments under the Gothenburg Protocol to emission reduction commitments or to inventories for the purposes of comparing total national emissions with them URL: [http://www.unece.org/fileadmin/DAM/env/documents/2013/air/ECE\\_EB.AIR\\_111\\_Add.1\\_ENG\\_DECISION\\_3.pdf](http://www.unece.org/fileadmin/DAM/env/documents/2013/air/ECE_EB.AIR_111_Add.1_ENG_DECISION_3.pdf) : 2 : EB, 2012b: CLRTAP EB Decision 2012/4: Provisional Application of Amendment to the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone URL: [http://www.unece.org/fileadmin/DAM/env/documents/2013/air/ECE\\_EB.AIR\\_111\\_Add.1\\_ENG\\_DECISION\\_4.pdf](http://www.unece.org/fileadmin/DAM/env/documents/2013/air/ECE_EB.AIR_111_Add.1_ENG_DECISION_4.pdf) : 3 : EB, 2012c: CLRTAP EB Decision 2012/12: Guidance for adjustments under the 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone to emission reduction commitments or to inventories for the purposes of comparing total national emissions with them URL: [http://www.unece.org/fileadmin/DAM/env/documents/2012/EB/Decision\\_2012\\_12.pdf](http://www.unece.org/fileadmin/DAM/env/documents/2012/EB/Decision_2012_12.pdf) : 4 : IIASA, 1999: Amann, M.; Bertok, I.; Cofala, J.; Gyarfas, F.; Heyes, Chr.; Klimont, Zb.; Syri, S.; Schöpp, W.: Further analysis of scenario results obtained with the RAINS model - Interim Report to the Ministère de L'Aménagement du Territoire et de l'Environnement Direction de la Prévention des Pollutions et des Risques 20, avenue de Ségur 75302 Paris 07 SP, April 1999 - URL: <https://iiasa.ac.at/web/home/research/researchPrograms/air/policy/france3b.pdf> : 5 : ifeu, 2002: Final report to UFOPLAN study FKZ 201 45 112 (German version only): Aktualisierung des Daten- und Rechenmodells: Energieverbrauch und Schadstoffemissionen des motorisierten Verkehrs in Deutschland 1980-2020; Im Auftrag des Umweltbundesamtes; ifeu Institut für Energie- und Umweltforschung Heidelberg GmbH (Institute for Energy and Environmental Research), Wilckensstraße 3, D-69120 Heidelberg, Germany, phone: +49 (0) 6221 / 47 67 -0, fax: +49 (0) 6221 / 47 67 -19, Heidelberg, 31. Oktober 2002 : 6 : Knörr et al. (2019a): Knörr, W., Heidt, C., Gores, S., & Bergk, F.: ifeu Institute for Energy and Environmental Research (Institut für Energie- und Umweltforschung Heidelberg gGmbH, ifeu): Fortschreibung des Daten- und Rechenmodells: Energieverbrauch und Schadstoffemissionen des motorisierten Verkehrs in Deutschland 1960-2035, sowie TREMOD, im Auftrag des Umweltbundesamtes, Heidelberg & Berlin, 2019. : 7 : UBA, 2018: CLRTAP submission 2018, Dessau, 2018 : 8 : ECE/EB.AIR/113/Add.1, 2012: Report of the Executive Body on its thirty-first session, Decision 2012/12 on Guidance for adjustments under the 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone to emission reduction commitments or to inventories for the purposes of comparing total national emissions with them; URL: [http://www.unece.org/fileadmin/DAM/env/documents/2012/EB/ECE\\_EB.AIR\\_113\\_Add.1\\_ENG\\_1.pdf](http://www.unece.org/fileadmin/DAM/env/documents/2012/EB/ECE_EB.AIR_113_Add.1_ENG_1.pdf) : 9 : CEIP, 2014a: Centre on Emission Inventories and Projections (CEIP): CEIP/Adjustment RR/2014/GERMANY: Review of the 2014 Adjustment Application by Germany, URL: [https://webdab01.umweltbundesamt.at/download/adjustments2014/Adjustment\\_Review\\_Report\\_GERMANY\\_2014.pdf?cgiprox\\_y\\_skip=1](https://webdab01.umweltbundesamt.at/download/adjustments2014/Adjustment_Review_Report_GERMANY_2014.pdf?cgiprox_y_skip=1), 5 August 2014 : 10 : CEIP, 2014b: Centre on Emission Inventories and Projections (CEIP):

ECE/EB.AIR/GE.1/2014/10: Review of adjustment applications 2014; URL: [http://www.ceip.at/fileadmin/inhalte/emep/pdf/2015/ece.eb.air.ge.1.2014.10.edited.ae\\_formatting\\_accepted.ko.pdf](http://www.ceip.at/fileadmin/inhalte/emep/pdf/2015/ece.eb.air.ge.1.2014.10.edited.ae_formatting_accepted.ko.pdf), 5 August 2014 : 11 : CEIP, 2015a: Centre on Emission Inventories and Projections (CEIP): CEIP/Adjustment RR/2015/Germany: Review of the 2015 Adjustment Application by Germany, URL: [https://webdab01.umweltbundesamt.at/download/adjustments2015/Germany2015-adj.pdf?cgiproxy\\_skip=1](https://webdab01.umweltbundesamt.at/download/adjustments2015/Germany2015-adj.pdf?cgiproxy_skip=1), September 2015 : 12 : CEIP, 2015b: Centre on Emission Inventories and Projections (CEIP): CE/EB.AIR/GE.1/2015/10–ECE/EB.AIR/WG.1/2015/13: Review of adjustment applications 2015; URL: [http://www.ceip.at/fileadmin/inhalte/emep/Adjustments/ece.eb.air.ge.1.2015.10\\_ece.eb.air.wg.1.2015.13.AV.pdf](http://www.ceip.at/fileadmin/inhalte/emep/Adjustments/ece.eb.air.ge.1.2015.10_ece.eb.air.wg.1.2015.13.AV.pdf), 6 July 2015 : 13 : CEIP, 2016a: Centre on Emission Inventories and Projections (CEIP): Review of the 2016 Adjustment Application by Germany, URL: [https://webdab01.umweltbundesamt.at/download/adjustments2016/Germany2016-adj.pdf?cgiproxy\\_skip=1](https://webdab01.umweltbundesamt.at/download/adjustments2016/Germany2016-adj.pdf?cgiproxy_skip=1), 2016 : 14 : CEIP, 2016b: Centre on Emission Inventories and Projections (CEIP): ECE/EB.AIR/GE.1/2016/10–ECE/EB.AIR/WG.1/2016/18: Review of adjustment applications 2016; URL: [http://www.ceip.at/fileadmin/inhalte/emep/pdf/2016/ECE\\_EB.AIR\\_GE.1\\_2016\\_10\\_E.pdf](http://www.ceip.at/fileadmin/inhalte/emep/pdf/2016/ECE_EB.AIR_GE.1_2016_10_E.pdf), 2016 : 15 : CEIP, 2017a: Centre on Emission Inventories and Projections (CEIP): ECE/EB.AIR/GE.1/2017/10–ECE/EB.AIR/WG.1/2017/20: Review of adjustment applications 2017; URL: [http://www.ceip.at/fileadmin/inhalte/emep/pdf/2017/Advance\\_ece\\_eb\\_air\\_ge\\_1\\_2017\\_10\\_ece\\_eb\\_air\\_wg\\_1\\_2017.pdf](http://www.ceip.at/fileadmin/inhalte/emep/pdf/2017/Advance_ece_eb_air_ge_1_2017_10_ece_eb_air_wg_1_2017.pdf), 2017 : 16 : CEIP, 2018a: Centre on Emission Inventories and Projections (CEIP): ECE/EB.AIR/GE.1/2018/10–ECE/EB.AIR/WG.1/2018/21: Review of adjustment applications 2018; URL: [https://www.ceip.at/fileadmin/inhalte/emep/pdf/2018/ADJ\\_ece.eb.air.ge.1.2018.10-ece.eb.air.wg.1.2018.21\\_advance.pdf](https://www.ceip.at/fileadmin/inhalte/emep/pdf/2018/ADJ_ece.eb.air.ge.1.2018.10-ece.eb.air.wg.1.2018.21_advance.pdf), 2018 : 17 : CEIP, 2019a: Centre on Emission Inventories and Projections (CEIP): ECE/EB.AIR/GE.1/2019/10–ECE/EB.AIR/WG.1/2019/22: Review of adjustment applications 2019; URL: [https://www.ceip.at/fileadmin/inhalte/emep/pdf/2019/ECE\\_EB.AIR\\_GE.1\\_2019\\_10-1909789E.pdf](https://www.ceip.at/fileadmin/inhalte/emep/pdf/2019/ECE_EB.AIR_GE.1_2019_10-1909789E.pdf), 2019 : 18 : Keller et al. (2017): Keller, M., Hausberger, S., Matzer, C., Wüthrich, P., & Notter, B.: Handbook Emission Factors for Road Transport, version 3.3 (Handbuch Emissionsfaktoren des Straßenverkehrs 3.3) URL: [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=2ahUKewj0y67pi5foAhWB16QKHfpYDIgQFjAAegQIAhAB&url=https%3A%2F%2Fwww.hbefa.net%2Fd%2Fdocuments%2FHBEFA33\\_Hintergrundbericht.pdf&usq=AOvVaw2sOF884KtccVyWLItdt1CIZ](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=2ahUKewj0y67pi5foAhWB16QKHfpYDIgQFjAAegQIAhAB&url=https%3A%2F%2Fwww.hbefa.net%2Fd%2Fdocuments%2FHBEFA33_Hintergrundbericht.pdf&usq=AOvVaw2sOF884KtccVyWLItdt1CIZ) - Dokumentation, Bern, 2017. : 19 : Notter et al. (2019): Keller, M., Althaus, H.-J., Cox, B., Knörr, W., Heide, Ch., Biemann, K., Räder, D.: Handbook Emission Factors for Road Transport, version 4.1 (Handbuch Emissionsfaktoren des Straßenverkehrs 4.1), HBEFA 4.1 Development Report; URL: [https://www.hbefa.net/e/documents/HBEFA41\\_Development\\_Report.pdf](https://www.hbefa.net/e/documents/HBEFA41_Development_Report.pdf), Bern, Heidelberg, 21. August 2019. [bibliography](#)

---

<sup>1)</sup> (bibcite 4)

<sup>2)</sup> (bibcite 1)

<sup>3)</sup> (bibcite 3)

<sup>4)</sup> (bibcite 2)

<sup>5)</sup> (bibcite 4)

<sup>6)</sup> (bibcite 5)

<sup>7)</sup> (bibcite 6)

<sup>8)</sup> (bibcite 18)

<sup>9)</sup> (bibcite 19)