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Methodologies applied to the CEIP GNFR gap-filling 2022

Part II:
Heavy Metals (Cd, Hg, Pb)
and Persistant Organic Pollutants
(Benzo(a)pyrene, Benzo(b)fluoranthene,
Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene,
Total polycyclic aromatic hydrocarbons, Dioxin
and Furan, Hexachlorobenzene,
Polychlorinated biphenyls)
of the year 2020

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Contents

1. Overview

This is a technical report providing a brief overview of the gap-filling methods that have been used for the GNFR inventory year 2020 (as reported in 2022) for the mandatory heavy metals (lead, cadmium and mercury) and the Persistent organic pollutants (Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total polycyclic aromatic hydrocarbons, Dioxin and Furan, Hexachlorobenzene and Polychlorinated biphenyls).

2. Introduction

The EMEP Centre on Emission Inventories and Projections (CEIP) operates the UNECE/EMEP emission database (WebDab) which contains information on air pollutant emissions and projections from the Parties to the LRTAP Convention (UNECE 1979). Among these data sets, also emissions used in EMEP models (gap-filled emissions) and gridded emissions are available from the CEIP website (www.ceip.at, CEIP 2022).

Data used by CEIP were reported by the Parties to the LRTAP Convention as sectoral emissions in the NFR19 format and National Total emissions according to the UNECE guidelines for reporting emissions and projections data under the Convention on long-range transboundary air pollution, Annex I (UNECE 2014). For the use by CEIP, the 127 NFR categories are aggregated to 13 GNFR sectors. In several cases, no data were submitted by the countries, or the reporting is not complete or contains errors. Before these emission data can be used by modelers, missing or erroneous information have to be filled in. To gap-fill those missing data, CEIP typically applies different gap-filling methods. After the gap-filling, sectoral emissions are used for spatial emission mapping, i.e. the EMEP grid.

3. Gap-Filling

Gap filling for the year 2020 has been performed for countries and components in case that:

- The country did not report under CLRTAP
- The country did not report data for any of the GNFR sectors A_PublicPower, B_Industry and C_OtherStationaryComb, E_Solvents,
- The country reported data for the first time without providing relevant information (in the Informative Inventory Report)
- The country reports comparably high/low values for specific components and GNFR sectors
- The sum of the four PAH components is not equal to PAHs at sectoral or national total level

Furthermore, gap filling has been performed for mandatory heavy metals (Cd, Hg, Pb) and EMEP areas not covered by the LRTAP protocol:

- Asian Areas
- North Africa
- Russian Federation in the extended EMEP domain

The following gap filling methods have been applied:

- Use previous year LRTAP reported data
- Extrapolate previous year LRTAP by means of GDP, population or energy consumption (e.g. from the Common Reporting Format)
- The national total has been taken from an expert estimate (study) and divided to GNFR sectors by means of a comparable country sector distribution or the mean sector distribution (for heavy metals).
- Use the GNFR sector distribution of a comparable country.
- In case that the sum of reported components is smaller than total PAHs, estimate the missing component(s) under consideration of the default component share.

The mean GNFR sector distribution of mandatory heavy metals for the year 2020 has been calculated by means of reported data from 30 countries and year 2020 and is presented in Table 1.

Table 1: Default share on GNFR sectors for mandatory heavy metals 2020.

Share on national total	Cd	Hg	Pb
A_PublicPower	7.67%	31.06%	5.72%
B_Industry	51.22%	44.86%	56.59%
C_OtherStationaryComb	22.59%	8.07%	11.88%
D_Fugitive	1.49%	3.05%	0.72%
E_Solvents	8.52%	1.29%	2.31%
F_RoadTransport	2.76%	3.79%	18.79%
G_Shipping	0.15%	0.32%	0.08%
H_Aviation	0.01%	0.01%	0.90%
I_Offroad	0.48%	0.35%	0.80%
J_Waste	2.92%	6.61%	1.63%
K_AgriLivestock	0.00%	0.00%	0.00%
L_AgriOther	1.95%	0.43%	0.04%
M_Other	0.24%	0.15%	0.56%

The PAH component default split for national totals as presented in Table 2 has been calculated by means of data from 16 countries which report PAHs and its components in a consistent way.

Table 2: Default component share on total PAHs 2020.

Component	benzo(a)	benzo(b)	benzo(k)	Indeno
Share	29.6%	36.2%	16.4%	17.9%

Gap-filling methods by countries/areas and component are presented in Table 3: Gap-filling methods applied to countries and areas – heavy metals and Table 4: Gap-filling methods applied to countries – POPs.

Applied methods for heavy metals

Table 3: Gap-filling methods applied to countries and areas – heavy metals

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
Albania	Cd	Yes	Yes	sectoral incomplete	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2020	t	0.046	0.193
	Hg	Yes	Yes	sectoral incomplete	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2020	t	0.080	0.189
	Pb	Yes	Yes	sectoral incomplete	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2020	t	1.319	6.127
Asian Areas	Cd	No	Yes	no reporting obligation	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2020	t	0.000	27.596
	Hg	No	Yes	no reporting obligation	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2020	t	0.000	30.325
	Pb	No	Yes	no reporting obligation	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2020	t	0.000	1214.050
Azerbaijan	Cd	No	Yes	not reported	sum of sectors	trend/average (2013-2017), reported 2017.	t	0.000	0.104
	Hg	No	Yes	not reported	sum of sectors	trend/average (2013-2017), reported 2017.	t	0.000	0.272
	Pb	No	Yes	not reported	sum of sectors	trend/average (2013-2017), reported 2017.	t	0.000	2.100
Bosnia and Herzegovina	Cd	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2020	t	0.000	1.490
	Hg	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2020	t	0.000	1.728
	Pb	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2020	t	0.000	35.530
Kyrgyzstan	Cd	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2020	t	0.000	0.501
	Hg	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2020	t	0.000	0.849
	Pb	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2020	t	0.000	12.216
Kazakhstan	Cd	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Sector distribution like PL	t	0.000	11.056
	Hg	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Sector distribution like PL	t	0.000	24.554
	Pb	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Sector distribution like PL	t	0.000	696.025
Republic of Moldova	Cd	No	Yes	not reported	2019 data from submission 2021	2019 data from submission 2021	t	0.000	0.396
	Hg	No	Yes	not reported	2019 data from submission 2021	2019 data from submission 2021	t	0.000	0.091
	Pb	No	Yes	not reported	2019 data from submission 2021	2019 data from submission 2021	t	0.000	1.673
North Africa	Cd	No	Yes	no reporting obligation	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2020	t	0.000	8.493

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
	Hg	No	Yes	no reporting obligation	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2020	t	0.000	9.333
	Pb	No	Yes	no reporting obligation	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2021	t	0.000	791.098
Serbia	Cd	Yes	Yes	Difference due to late resubmission 27.4.2022	-	-	t	2.765	3.853
	Hg	Yes	Yes	Difference due to late resubmission 27.4.2022	-	-	t	1.627	1.828
	Pb	Yes	Yes	Difference due to late resubmission 27.4.2022	-	-	t	33.013	34.980
Russian Federation	Cd	No	Yes	not reported	sum of sectors	Copy of 2009 reported data; A_PublicPower: Extrapolation of reported data 2006 with 1A1a solid fuels consumption (+0.8%) from CRF submission 2022	t	0.000	24.497
	Hg	No	Yes	not reported	sum of sectors	Copy of 2009 reported data; A_PublicPower: Extrapolation of reported data 2006 with 1A1a solid fuels consumption (+0.8%) from CRF submission 2022	t	0.000	8.508
	Pb	No	Yes	not reported	sum of sectors	Copy of 2009 reported data; A_PublicPower: Extrapolation of reported data 2006 with 1A1a solid fuels consumption (+0.8%) from CRF submission 2022	t	0.000	146.842
Russian Federation in the extended EMEP domain	Cd	No	Yes	no reporting obligation	calculated from RU emissions RU:RUE factor 0.66 : 0.34	Sector distribution like RU	t	0.000	12.620
	Hg	No	Yes	no reporting obligation	calculated from RU emissions RU:RUE factor 0.66 : 0.34	Sector distribution like RU	t	0.000	4.383
	Pb	No	Yes	no reporting obligation	calculated from RU emissions RU:RUE factor 0.66 : 0.34	Sector distribution like RU	t	0.000	75.646
Tajikistan	Cd	No	Yes	not reported	Factor 0.56 from the Hg emissions calculated by extrapolation of unpublished expert estimates using population data	Mean sector distribution for 2020	t	0.000	0.313
	Hg	No	Yes	not reported	copy of unpublished expert estimates	Mean sector distribution for 2020	t	0.000	0.560
	Pb	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2020	t	0.000	63.719
Turkmenistan	Cd	No	Yes	not reported	Factor 0.56 from the Hg emissions calculated by extrapolation of unpublished expert estimates using population data	Mean sector distribution for 2020	t	0.000	0.268
	Hg	No	Yes	not reported	copy of unpublished expert estimates	Mean sector distribution for 2020	t	0.000	0.479
	Pb	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2020	t	0.000	38.996
Turkey	Cd	Yes	Yes	sectoral incomplete and inconsistent (high values) reporting for J_WASTE	sum of sectors	A_PublicPower: copy of Poland, J_WASTE: IIR 2022, C_OtherStationaryComb: copy of 2021 gap filling (2019 data)	t	60.755	3.976

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
	Hg	Yes	Yes	sectoral incomplete and inconsistent (high values) reporting for J_WASTE	sum of sectors	A_PublicPower: copy of Poland, J_WASTE: IIR 2022, C_OtherStationaryComb: copy of 2021 gap filling (2019 data)	t	31.512	10.731
	Pb	Yes	Yes	sectoral incomplete and inconsistent (high values) reporting for J_WASTE	sum of sectors	A_PublicPower: copy of Poland, J_WASTE: IIR 2022, C_OtherStationaryComb: copy of 2021 gap filling (2019 data)	t	65.671	94.936
Uzbekistan	Cd	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution 2020 w/o shipping	t	0.000	3.277
	Hg	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution 2020 w/o shipping	t	0.000	5.852
	Pb	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution 2020 w/o shipping	t	0.000	184.821

Applied methods for POPs

Table 4: Gap-filling methods applied to countries – POPs

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
Albania	benzo(a)	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors		t	0.021	0.642
	benzo(b)	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors		t	0.033	0.603
	benzo(k)	No	Yes	not reported	sum of sectors		t	0.000	0.226
	DIOX	Yes	Yes	inplausible low value	TNO expert data	Sector distribution like LV	g	0.002	45.468
	HCB	Yes	No	-			kg	0.016	0.016
	Indeno	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors		t	0.197	0.566
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors		t	0.261	2.038
	PCB	Yes	No	-			kg	1.590	1.590
Armenia	benzo(a)	Yes	No	-			t	0.377	0.377
	benzo(b)	Yes	No	-			t	0.349	0.349
	benzo(k)	Yes	No	-			t	0.132	0.132
	DIOX	Yes	No	-			g	2.507	2.507
	HCB	Yes	No	-			kg	0.015	0.015
	Indeno	Yes	No	-			t	0.220	0.220

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors	sum of components	t	1.078	1.079
	PCB	Yes	No	-			kg	0.006	0.006
Azerbaijan	benzo(a)	No	Yes	not reported	sum of sectors	Reported value for 2017	t	0.000	0.396
	benzo(b)	No	Yes	not reported	sum of sectors	Reported value for 2017	t	0.000	0.420
	benzo(k)	No	Yes	not reported	sum of sectors	Reported value for 2017	t	0.000	0.353
	DIOX	No	Yes	not reported	sum of sectors	Reported value for 2017	g	0.000	5.176
	HCB	No	Yes	not reported	sum of sectors	Reported value for 2017	kg	0.000	0.043
	Indeno	No	Yes	not reported	sum of sectors	Reported value for 2017	t	0.000	0.080
	PAH	No	Yes	not reported	sum of sectors	sum of components	t	0.000	1.250
	PCB	No	Yes	not reported	sum of sectors	Reported value for 2017	kg	0.000	0.968
Bosnia and Herzegovina	benzo(a)	No	Yes	not reported	TNO expert data	Sector distribution like SK gapfilled 2020	t	0.000	3.061
	benzo(b)	No	Yes	not reported	TNO expert data	Sector distribution like SK gapfilled 2020	t	0.000	4.073
	benzo(k)	No	Yes	not reported	TNO expert data	Sector distribution like SK gapfilled 2020	t	0.000	1.626
	DIOX	No	Yes	not reported	TNO expert data	Sector distribution like SK gapfilled 2020	g	0.000	48.004
	HCB	No	Yes	not reported	Extrapolation of expert data (Pacyna et al. 1999) using population data	Sector distribution like SK gapfilled 2020	kg	0.000	50.000
	Indeno	No	Yes	not reported	TNO expert data	Sector distribution like SK gapfilled 2020	t	0.000	2.786
	PAH	No	Yes	not reported	sum of sectors	Sector distribution like SK gapfilled 2020	t	0.000	11.546
	PCB	No	No	not reported	No data available	not applicable	kg	0.000	0.000
Czech Republic	benzo(a)	Yes	No	-			t	13.672	13.672
	benzo(b)	Yes	No	-			t	10.182	10.182
	benzo(k)	Yes	No	-			t	7.060	7.060
	DIOX	Yes	No	-			g	25.968	25.968
	HCB	Yes	No	-			kg	15.053	15.053
	Indeno	Yes	No	-			t	9.480	9.480
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	38.618	40.393
	PCB	Yes	No	-			kg	1.515	1.515

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
Germany	benzo(a)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	15.220	16.045
	benzo(b)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	22.193	23.233
	benzo(k)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	10.198	10.724
	DIOX	Yes	No	-			g	111.909	111.909
	HCB	Yes	No	-			kg	4.766	4.766
	Indeno	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	14.850	15.229
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	66.599	65.232
	PCB	Yes	No	-			kg	214.125	214.125
Spain	benzo(a)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	10.968	12.950
	benzo(b)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	11.062	13.560
	benzo(k)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	4.691	5.954
	DIOX	Yes	No	-			g	229.682	229.682
	HCB	Yes	No	-			kg	13.363	13.363
	Indeno	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	6.094	7.004
	PAH	Yes	No	Sum of components not consistent with PAHs	sum of components	sum of components	t	39.468	39.468
	PCB	Yes	No	-			kg	23.816	23.816
Georgia	benzo(a)	Yes	No	-			t	1.332	1.332
	benzo(b)	Yes	No	-			t	1.302	1.302
	benzo(k)	Yes	No	-			t	0.507	0.507
	DIOX	Yes	No	-			g	9.545	9.545

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
	HCB	Yes	No	-			kg	22.066	22.066
	Indeno	Yes	No	-			t	0.756	0.756
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	4.044	3.897
	PCB	Yes	No	-			kg	373.266	373.266
Greece	benzo(a)	Yes	No	-			t	5.126	5.126
	benzo(b)	Yes	No	-			t	5.633	5.633
	benzo(k)	Yes	No	-			t	3.148	3.148
	DIOX	Yes	No	-			g	22.903	22.903
	HCB	Yes	No	-			kg	1.280	1.280
	Indeno	Yes	No	-			t	2.192	2.192
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	16.688	16.100
	PCB	Yes	No	-			kg	43.920	43.920
Croatia	benzo(a)	Yes	No	-			t	4.672	4.672
	benzo(b)	Yes	No	-			t	4.324	4.324
	benzo(k)	Yes	No	-			t	1.669	1.669
	DIOX	Yes	No	-			g	25.534	25.534
	HCB	Yes	No	-			kg	0.359	0.359
	Indeno	Yes	No	-			t	2.646	2.646
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	13.333	13.311
	PCB	Yes	No	-			kg	407.142	407.142
Hungary	benzo(a)	Yes	No	-			t	7.283	7.283
	benzo(b)	Yes	No	-			t	7.136	7.136
	benzo(k)	Yes	No	-			t	2.749	2.749
	DIOX	Yes	No	-			g	60.530	60.530
	HCB	Yes	No	-			kg	2.058	2.058
	Indeno	Yes	No	-			t	4.108	4.108
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	21.372	21.277

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
	PCB	Yes	No	-			kg	5.020	5.020
Iceland	benzo(a)	Yes	No	-			t	0.008	0.008
	benzo(b)	Yes	No	-			t	0.031	0.031
	benzo(k)	Yes	No	-			t	0.014	0.014
	DIOX	Yes	No	-			g	0.737	0.737
	HCB	Yes	No	-			kg	0.068	0.068
	Indeno	Yes	No	-			t	0.008	0.008
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	0.061	0.061
	PCB	Yes	No	-			kg	0.015	0.015
Italy	benzo(a)	Yes	Yes	Incomplete	sum of sectors	Component split	t	15.519	17.910
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	Component split	t	18.192	21.116
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	Component split	t	8.331	9.660
	DIOX	Yes	No	-			g	280.170	280.170
	HCB	Yes	No	-			kg	12.982	12.982
	Indeno	Yes	Yes	Incomplete	sum of sectors	Component split	t	10.224	11.669
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors	sum of components	t	60.361	60.355
	PCB	Yes	No	-			kg	102.971	102.971
Kyrgyzstan	benzo(a)	No	Yes	not reported	sum of sectors	Reported value 2017	t	0.000	4.112
	benzo(b)	No	Yes	not reported	sum of sectors	Reported value 2017	t	0.000	5.860
	benzo(k)	No	Yes	not reported	sum of sectors	Reported value 2017	t	0.000	2.310
	DIOX	No	Yes	not reported	sum of sectors	Reported value 2017	g	0.000	14.595
	HCB	No	Yes	not reported	TNO expert data	Sector distribution like ME 2020	kg	0.000	0.665
	Indeno	No	Yes	not reported	sum of sectors	Reported value 2017	t	0.000	1.944
	PAH	No	Yes	not reported	sum of sectors	sum of components	t	0.000	14.226
	PCB	No	Yes	not reported	sum of sectors	Reported value 2017	kg	0.000	3.912
Kazakhstan	benzo(a)	Yes	No	-			t	65.835	65.835
	benzo(b)	Yes	No	-			t	137.247	137.247
	benzo(k)	Yes	No	-			t	99.538	99.538

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
	DIOX	Yes	No	-			g	467.355	467.355
	HCB	Yes	No	-			kg	32.664	32.664
	Indeno	Yes	No	-			t	37.269	37.269
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	291.304	339.888
	PCB	Yes	No	-			kg	89.115	89.115
Lithuania	benzo(a)	Yes	No	-			t	2.780	2.780
	benzo(b)	Yes	No	-			t	3.117	3.117
	benzo(k)	Yes	No	-			t	1.390	1.390
	DIOX	Yes	No	-			g	16.628	16.628
	HCB	Yes	No	-			kg	0.472	0.472
	Indeno	Yes	No	-			t	1.452	1.452
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	8.089	8.739
	PCB	Yes	No	-			kg	0.934	0.934
Luxembourg	benzo(a)	Yes	Yes	Sum of sectors not consistent with National Total	sum of sectors		t	0.124	0.124
	benzo(b)	Yes	Yes	Sum of sectors not consistent with National Total	sum of sectors		t	0.221	0.220
	benzo(k)	Yes	Yes	Sum of sectors not consistent with National Total	sum of sectors		t	0.112	0.111
	DIOX	Yes	No	-			g	1.909	1.909
	HCB	Yes	No	-			kg	0.707	0.707
	Indeno	Yes	Yes	Sum of sectors not consistent with National Total	sum of sectors		t	0.077	0.077
	PAH	Yes	Yes	Sum of sectors not consistent with National Total	sum of sectors		t	0.533	0.532
	PCB	Yes	Yes	Sum of sectors not consistent with National Total	sum of sectors		kg	2.595	2.578
Latvia	benzo(a)	Yes	No	-			t	2.434	2.434
	benzo(b)	Yes	No	-			t	2.268	2.268
	benzo(k)	Yes	No	-			t	0.868	0.868
	DIOX	Yes	No	-			g	16.920	16.920
	HCB	Yes	No	-			kg	0.496	0.496

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
	Indeno	Yes	No	-			t	1.300	1.300
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	6.869	6.869
	PCB	Yes	No	-			kg	0.138	0.138
Republic of Moldova	benzo(a)	No	Yes	not reported	sum of sectors	reported data 2019	t	0.000	4.420
	benzo(b)	No	Yes	not reported	sum of sectors	reported data 2019	t	0.000	4.763
	benzo(k)	No	Yes	not reported	sum of sectors	reported data 2019	t	0.000	2.236
	DIOX	No	Yes	not reported	reported data 2019	reported data 2019	g	0.000	47.315
	HCB	No	Yes	not reported	reported data 2019	reported data 2019	kg	0.000	0.187
	Indeno	No	Yes	not reported	sum of sectors	reported data 2019	t	0.000	2.390
	PAH	No	Yes	not reported	sum of sectors	reported data 2019	t	0.000	13.809
	PCB	No	Yes	not reported	reported data 2019	reported data 2019	kg	0.000	1.763
The former Yugoslav Republic of Macedonia	benzo(a)	Yes	No	-			t	1.210	1.210
	benzo(b)	Yes	No	-			t	1.303	1.303
	benzo(k)	Yes	No	-			t	0.536	0.536
	DIOX	Yes	No	-			g	8.643	8.643
	HCB	Yes	No	-			kg	0.155	0.155
	Indeno	Yes	No	-			t	0.662	0.662
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	3.807	3.712
	PCB	Yes	No	-			kg	237.240	237.240
Malta	benzo(a)	Yes	No	-			t	0.015	0.015
	benzo(b)	Yes	No	-			t	0.036	0.036
	benzo(k)	Yes	No	-			t	0.022	0.022
	DIOX	Yes	No	-			g	0.224	0.224
	HCB	Yes	No	-			kg	0.080	0.080
	Indeno	Yes	No	-			t	0.010	0.010
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	0.083	0.083
	PCB	Yes	No	-			kg	0.001	0.001

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
Poland	benzo(a)	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	80.908	82.685
	benzo(b)	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	79.926	81.906
	benzo(k)	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	36.786	37.570
	DIOX	Yes	No	-			g	283.659	283.659
	HCB	Yes	No	-			kg	3.137	3.137
	Indeno	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	29.730	30.725
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	232.892	232.886
	PCB	Yes	No	-			kg	143.272	143.272
Portugal	benzo(a)	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	7.547	8.119
	benzo(b)	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	5.500	6.172
	benzo(k)	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	3.453	3.768
	DIOX	Yes	No	-			g	70.660	70.660
	HCB	Yes	No	-			kg	1.283	1.283
	Indeno	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	4.101	4.445
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	22.987	22.503
	PCB	Yes	No	-			kg	90.019	90.019
Romania	benzo(a)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	18.045	19.739
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	17.543	19.314
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	6.770	7.767
	DIOX	Yes	No	-			g	187.588	187.588
	HCB	Yes	No	-			kg	2.968	2.968
	Indeno	Yes	Yes	Incomplete	sum of sectors	PAH split	t	10.087	11.445
	PAH	Yes	Yes	Incomplete	sum of sectors	sum of components	t	58.266	58.265
	PCB	Yes	No	-			kg	18.627	18.627
Serbia	benzo(a)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	9.894	10.812

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	10.786	11.849
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	4.242	4.756
	DIOX	Yes	No	-			g	74.221	74.221
	HCB	Yes	No	-			kg	2.315	2.315
	Indeno	Yes	Yes	Incomplete	sum of sectors	PAH split	t	5.544	6.134
	PAH	Yes	No	-			t	33.552	33.552
	PCB	Yes	No	-			kg	733.397	733.397
Russian Federation	benzo(a)	No	Yes	not reported	79% of expert data (Shen et al 2013) from 2007	Sector distribution like IT 2020 (gapfilled)	t	0.000	86.900
	benzo(b)	No	Yes	not reported	79% of PAH Split using Benzo(a)	Sector distribution like IT 2020 (gapfilled)	t	0.000	106.314
	benzo(k)	No	Yes	not reported	79% of PAH Split using Benzo(a)	Sector distribution like IT 2020 (gapfilled)	t	0.000	48.300
	DIOX	No	Yes	not reported	79% of of expert data (Treger) from 2007	Sector distribution like IT 2020 (gapfilled)	g	0.000	1409.676
	HCB	No	Yes	not reported	75% of Extrapolation of TNO data 2010 using GDP	Sector distribution like IT 2020 (gapfilled)	kg	0.000	5.144
	Indeno	No	Yes	not reported	79% of PAH Split using Benzo(a)	Sector distribution like IT 2020 (gapfilled)	t	0.000	52.518
	PAH	No	Yes	not reported	79% of sum of individual PAHs	Sector distribution like IT 2020 (gapfilled)	t	0.000	294.033
	PCB	No	No	not reported	No data available	not applicable	kg	0.000	0.000
Russian Federation in the extended EMEP domain	benzo(a)	No	Yes	no reporting obligation	21% of expert data (Shen et al 2013) from 2007	Sector distribution like IT 2020 (gapfilled)	t	0.000	23.100
	benzo(b)	No	Yes	no reporting obligation	21% of PAH Split using Benzo(a)	Sector distribution like IT 2020 (gapfilled)	t	0.000	28.261
	benzo(k)	No	Yes	no reporting obligation	21% of PAH Split using Benzo(a)	Sector distribution like IT 2020 (gapfilled)	t	0.000	12.839
	DIOX	No	Yes	no reporting obligation	21% of of expert data (Treger) from 2007	Sector distribution like IT 2020 (gapfilled)	g	0.000	374.724
	HCB	No	Yes	no reporting obligation	25% of Extrapolation of TNO data 2010 using GDP	Sector distribution like IT 2020 (gapfilled)	kg	0.000	0.456
	Indeno	No	Yes	no reporting obligation	21% of PAH Split using Benzo(a)	Sector distribution like IT 2020 (gapfilled)	t	0.000	13.961
	PAH	No	Yes	no reporting obligation	21% of sum of individual PAHs	Sector distribution like IT 2020 (gapfilled)	t	0.000	78.161
	PCB	No	No	no reporting obligation	No data available	not applicable	kg	0.000	0.000
Sweden	benzo(a)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	2.141	2.390

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	2.262	2.565
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	0.785	0.938
	DIOX	Yes	No	-			g	23.271	23.271
	HCB	Yes	No	-			kg	2.583	2.583
	Indeno	Yes	Yes	Incomplete	sum of sectors	PAH split	t	1.160	1.337
	PAH	Yes	Yes	Incomplete	sum of sectors	sum of components	t	7.132	7.230
	PCB	Yes	No	-			kg	8.785	8.785
Slovenia	benzo(a)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	1.808	1.914
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	1.056	1.122
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	0.999	1.048
	DIOX	Yes	No	-			g	13.168	13.168
	HCB	Yes	No	-			kg	0.456	0.456
	Indeno	Yes	Yes	Incomplete	sum of sectors	PAH split	t	0.354	0.426
	PAH	Yes	Yes	Incomplete	sum of sectors	sum of components	t	4.510	4.510
	PCB	Yes	No	-			kg	35.379	35.379
Slovakia	benzo(a)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	5.069	7.553
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	4.637	7.513
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	2.230	3.621
	DIOX	Yes	No	-			g	68.799	68.799
	HCB	Yes	No	-			kg	3.319	3.319
	Indeno	Yes	Yes	Incomplete	sum of sectors	PAH split	t	2.751	4.364
	PAH	Yes	Yes	Incomplete	sum of sectors	sum of components	t	23.052	23.052
	PCB	Yes	No	-			kg	19.514	19.514
Tajikistan	benzo(a)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using population data	Sector distribution like LV 2020	t	0.000	4.008
	benzo(b)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using population data	Sector distribution like LV 2020	t	0.000	3.293
	benzo(k)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using population data	Sector distribution like LV 2020	t	0.000	2.291
	DIOX	No	Yes	not reported	Extrapolation of Hodjamberdiev data (2006) using population data	Sector distribution like LV 2020	g	0.000	68.888

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
	HCB	No	Yes	not reported	Copy from 2015 gap-filling	Copy from 2015 gap-filling	kg	0.000	0.844
	Indeno	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using population data	Sector distribution like LV 2020	t	0.000	1.102
	PAH	No	Yes	not reported	Sum of individual PAHs	Sum of individual PAHs	t	0.000	10.694
	PCB	No	No	not reported	No data available	not applicable	kg	0.000	0.000
Turkmenistan	benzo(a)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like HR 2020	t	0.000	1.139
	benzo(b)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like HR 2020	t	0.000	2.522
	benzo(k)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like HR 2020	t	0.000	1.749
	DIOX	No	Yes	not reported	Extrapolation of Hodjamberdiev data (2006) using population data	Sector distribution like HR 2020	g	0.000	43.885
	HCB	No	Yes	not reported	Copy from 2015 gap-filling	Copy from 2015 gap-filling	kg	0.000	1.057
	Indeno	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like HR 2020	t	0.000	0.378
	PAH	No	Yes	not reported	Sum of individual PAHs	Sum of individual PAHs	t	0.000	5.789
	PCB	No	No	not reported	No data available	not applicable	kg	0.000	0.000
Turkey	benzo(a)	No	Yes	not reported	Extrapolation of TNO data 2010 using population data	Sector distribution like IT 2020 (gapfilled)	t	0.000	42.906
	benzo(b)	No	Yes	not reported	Extrapolation of TNO data 2010 using population data	Sector distribution like IT 2020 (gapfilled)	t	0.000	53.920
	benzo(k)	No	Yes	not reported	Extrapolation of TNO data 2010 using population data	Sector distribution like IT 2020 (gapfilled)	t	0.000	20.511
	DIOX	No	Yes	not reported	Extrapolation of expert data 2010 (Pulles et al. 2006) using population data	Sector distribution like IT 2020 (gapfilled)	g	0.000	1280.285
	HCB	No	Yes	not reported	Extrapolation of TNO data 2010 using GDP data	Sector distribution like IT 2020 (gapfilled)	kg	0.000	3.812
	Indeno	No	Yes	not reported	Extrapolation of TNO data 2010 using population data	Sector distribution like IT 2020 (gapfilled)	t	0.000	34.560
	PAH	No	Yes	not reported	Sum of individual PAHs	Sum of individual PAHs	t	0.000	151.897
	PCB	No	No	not reported	No data available	not applicable	kg	0.000	0.000
Ukraine	benzo(a)	No	Yes	implausible low values	Copy of expert data (National Implementation Plan for the Stockholm Convention on POPs) from 2002	Sector distribution like PL 2020 (gapfilled)	t	0.409	51.950
	benzo(b)	No	Yes	implausible low values	Copy of expert data (National Implementation Plan for the Stockholm Convention on POPs) from 2002	Sector distribution like PL 2020 (gapfilled)	t	0.200	83.562

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
	benzo(k)	No	Yes	implausible low values	Copy of expert data (National Implementation Plan for the Stockholm Convention on POPs) from 2002	Sector distribution like PL 2020 (gapfilled)	t	0.142	30.610
	DIOX	No	Yes	Incomplete	30% of: National Implementation Plan of UA for the Stockholm Convention on POPs, extrapolated using population data	Sector distribution like PL 2020 (gapfilled)	g	189.074	235.833
	HCB	No	Yes	implausible low values	30% of: National Implementation Plan of UA for the Stockholm Convention on POPs, extrapolated using population data	Sector distribution like PL 2020 (gapfilled)	kg	2.478	165.951
	Indeno	No	Yes	implausible low values	Copy of expert data (National Implementation Plan for the Stockholm Convention on POPs) from 2002	Sector distribution like PL 2020 (gapfilled)	t	0.135	30.160
	PAH	No	Yes	-	Sum of individual PAHs	Sector distribution like PL 2020 (gapfilled)	t	32.541	196.282
	PCB	No	No	-		not applicable	kg	187.765	187.765
Uzbekistan	benzo(a)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like SK 2020	t	0.000	2.600
	benzo(b)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like SK 2020	t	0.000	5.087
	benzo(k)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like SK 2020	t	0.000	3.956
	DIOX	No	Yes	not reported	Extrapolation of Hodjamberdiev data (2006) using population data	Sector distribution like SK 2020	g	0.000	170.590
	HCB	No	Yes	not reported	Copy from 2015 gap-filling	Copy from 2015 gap-filling	kg	0.000	1.030
	Indeno	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like SK 2020	t	0.000	1.159
	PAH	No	Yes	not reported	Sum of individual PAHs	Sum of individual PAHs	t	0.000	12.802
	PCB	No	No	not reported	No data available	not applicable	kg	0.000	0.000

Annex I:

EMEP Country Codes

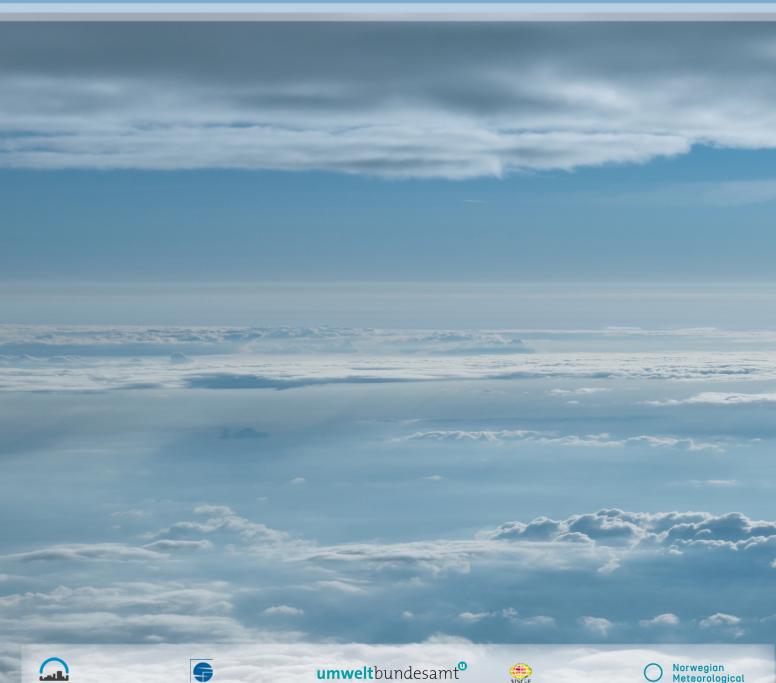|	
AL	Albania
AM	Armenia
AST	Asian areas in the extended EMEP domain
AT	Austria
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BE	Belgium
BG	Bulgaria
BY	Belarus
CA	Canada
CH	Switzerland
CY	Cyprus
CZ	Czechia
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
EU	European Union
FI	Finland
FR	France
GB	United Kingdom
GE	Georgia
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IS	Iceland
IT	Italy
KG	Kyrgyzstan
KZ	Kazakhstan
LI	Liechtenstein
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
ME	Montenegro
MK	North Macedonia
MT	Malta
NL	Netherlands
NO	Norway
NOA	North Africa
PL	Poland
PT	Portugal
RO	Romania
RS	Serbia
RU	Russian Federation in the former official EMEP domain
RUE	Russian Federation in the extended EMEP domain
SE	Sweden
SI	Slovenia
SK	Slovakia
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
UA	Ukraine
US	United States
UZ	Uzbekistan

Table A.1: Countries of the EMEP West and EMEP East region

EMEP West countries	AL, AT, BA, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LI, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK
EMEP East countries (9 EECCA countries + TR)	AM, AZ, BY, GE, KG, KZ, MD, RU, TR, UA
Non-EMEP EECCA countries (CLRTAP not ratified)	TJ, TM, UZ
EMEP countries outside the EMEP domain	CA, US

Note: EECCA = Eastern Europe, Caucasus and Central Asia

emep

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