

Methodologies applied to the CEIP GNFR gap-filling 2021

Part II:

Heavy Metals (Cd, Hg, Pb)

and 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,
Polychlorinated biphenyls)
of the year 2019

Stephan Poupa

CEIP

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Technical report CEIP 06/2021

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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 2019 (as reported in 2021) 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 in Google maps are available from the CEIP website (www.ceip.at, CEIP 2021).

Data used by CEIP were reported by the Parties to the LRTAP Convention as sectoral emissions in the NFR14/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, sector emissions are used for spatial emission mapping, i.e. the EMEP grid.

3. Gap-Filling

Gap filling for the year 2019 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
- 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 guess (study) and divided to GNFR sectors by means of a comparable country sector distribution or the mean sector distribution (for heavy metals).
- Use a copy of GNFR sector data from 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 2019 has been calculated by means of reported data from 20 countries and year 2019 and is presented in Table 1.

Table 1: Default share on GNFR sectors for mandatory heavy metals 2019.

Share on national total	Cd	Hg	Pb
A_PublicPower	7.83%	32.34%	5.50%
B_Industry	50.95%	45.67%	59.80%
C_OtherStationaryComb	20.92%	7.59%	10.84%
D_Fugitive	1.31%	2.91%	0.63%
E_Solvents	8.80%	0.91%	2.99%
F_RoadTransport	2.94%	3.74%	17.17%
G_Shipping	0.15%	0.32%	0.07%
H_Aviation	0.02%	0.02%	0.85%
I_Offroad	0.47%	0.31%	0.23%
J_Waste	4.39%	5.60%	1.38%
K_AgriLivestock	0.00%	0.00%	0.00%
L_AgriOther	1.97%	0.43%	0.03%
M_Other	0.25%	0.15%	0.51%

The PAH component default split for national totals as presented in Table 2 has been calculated by means of data from 15 countries which report PAHs and its components in a consistent way.

Table 2: Default component share on total PAHs 2019.

Component	benzo(a)	benzo(b)	benzo(k)	Indeno
Share	30.5%	34.7%	16.1%	18.7%

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	Component	Reported	Gap-filling/ replacement required	Rationale for Gap- filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
Albania	Cd	Yes	Yes	sectoral incomplete	TNO data (copy of 2018 data)	Mean sector distribution for 2019	t	0.113	0.193
	Hg	Yes	Yes	sectoral incomplete	TNO data (copy of 2018 data)	Mean sector distribution for 2019	t	0.086	0.189
	Pb	Yes	Yes	sectoral incomplete	TNO data (copy of 2018 data)	Mean sector distribution for 2019	t	1.458	6.127
Asian Areas	Cd	No	Yes	no reporting obligation	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2019	t	0.000	27.596
	Hg	No	Yes	no reporting obligation	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2019	t	0.000	30.325
	Pb	No	Yes	no reporting obligation	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2019	t	0.000	1214.050
Azerbaijan	Cd	No	Yes	not reported	sum of sectors	Linear Interpolation of 2019 reported data	t	0.000	0.105
	Hg	No	Yes	not reported	sum of sectors	Linear Interpolation of 2019 reported data	t	0.000	0.270
	Pb	No	Yes	not reported	sum of sectors	Linear Interpolation of 2019 reported data	t	0.000	2.097
Bosnia and Herzegovina	Cd	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2019	t	0.000	1.490
	Hg	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2019	t	0.000	1.728
	Pb	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2019	t	0.000	35.530
Kyrgyzstan	Cd	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2019	t	0.000	0.501
	Hg	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2019	t	0.000	0.849
	Pb	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2019	t	0.000	12.216
Kazakhstan	Cd	Yes	Yes	Keep gap-filling. Although 2021 submission is more complete than 2020 submission. IIR has lack on methodology information.	Copy of 2011 MSC-E estimate	Sector distribution like PL	t	7.599	11.056
	Hg	Yes	Yes	Keep gap-filling. Although 2021 submission is more complete than 2020 submission. IIR has lack on methodology information.	Copy of 2010 GMA data	Sector distribution like PL	t	20.651	24.554
	Pb	Yes	Yes	Keep gap-filling. Although 2021 submission is more complete than 2020 submission. IIR has	Copy of 2011 MSC-E estimate	Sector distribution like PL	t	511.944	696.025

Country	Component	Reported	Gap-filling/ replacement required	Rationale for Gap- filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
				lack on methodology information.					
North Africa	Cd	No	Yes	no reporting obligation	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2019	t	0.000	8.493
	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
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 (-17%) from CRF submission 2020	t	0.000	24.721
	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 (-17%) from CRF submission 2020	t	0.000	8.452
	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 (-17%) from CRF submission 2020	t	0.000	145.981
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	12.735
	Hg	No	Yes	no reporting obligation	calculated from RU emissions RU:RUE factor 0.66 : 0.34	Sector distribution like RU	t	0.000	4.354
	Pb	No	Yes	no reporting obligation	calculated from RU emissions RU:RUE factor 0.66 : 0.34	Sector distribution like RU	t	0.000	75.202
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 2019	t	0.000	0.313
	Hg	No	Yes	not reported	copy of unpublished expert estimates	Mean sector distribution for 2019	t	0.000	0.560
	Pb	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2019	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 2019	t	0.000	0.268
	Hg	No	Yes	not reported	copy of unpublished expert estimates	Mean sector distribution for 2019	t	0.000	0.479
	Pb	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2019	t	0.000	38.996
Turkey	Cd	Yes	Yes	sectoral incomplete	sum of sectors	A_PublicPower: copy of Poland	t	0.653	3.211
	Hg	Yes	Yes	sectoral incomplete	sum of sectors	A_PublicPower: copy of Poland	t	1.186	6.922
	Pb	Yes	Yes	sectoral incomplete	sum of sectors	A_PublicPower: copy of Poland	t	4.640	89.381
Uzbekistan	Cd	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2019	t	0.000	3.277

Country	Component	Reported	Gap-filling/ replacement required	Rationale for Gap- filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
	Hg	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2019	t	0.000	5.852
	Pb	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2019	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	No	-			t	0.021	0.021
	benzo(b)	Yes	No	-			t	0.033	0.033
	benzo(k)	No	Yes	not reported	Rest of PAHs	sum of sectors	t	0.000	0.010
	DIOX	Yes	Yes	inplausible low value (mg)	Extrapolation of TNO data	Sector distribution like LV	g	0.002	45.364
	HCB	Yes	No	-			kg	0.016	0.016
	Indeno	Yes	No	-			t	0.197	0.197
	PAH	Yes	No	-			t	0.261	0.261
	PCB	Yes	No	-			kg	1.590	1.590
Armenia	benzo(a)	Yes	No	-			t	0.423	0.423
	benzo(b)	Yes	No	-			t	0.390	0.390
	benzo(k)	Yes	No	-			t	0.148	0.148
	DIOX	Yes	No	-			g	2.799	2.799
	HCB	Yes	No	-			kg	0.017	0.017
	Indeno	Yes	No	-			t	0.246	0.246
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors	sum of components	t	1.206	1.208
	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	Extrapolation of TNO data	Sector distribution like FI 2019	t	0.000	1.497
	benzo(b)	No	Yes	not reported	Extrapolation of TNO data	Sector distribution like FI 2019	t	0.000	1.943

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	not reported	Extrapolation of TNO data	Sector distribution like FI 2019	t	0.000	0.653
	DIOX	No	Yes	not reported	Extrapolation of TNO data	Sector distribution like FI 2019	g	0.000	31.121
	HCB	No	Yes	not reported	Extrapolation of expert data (Pacyna et al. 1999) using population data	Sector distribution like FI 2019	kg	0.000	50.000
	Indeno	No	Yes	not reported	Extrapolation of TNO data	Sector distribution like FI 2019	t	0.000	0.728
	PAH	No	Yes	not reported	Sum of individual PAHs	Sector distribution like FI 2019	t	0.000	4.820
	PCB	No	No	not reported	No data available	not applicable	kg	0.000	0.000
Czech Republic	benzo(a)	Yes	No	-			t	14.702	14.702
	benzo(b)	Yes	No	-			t	10.900	10.900
	benzo(k)	Yes	No	-			t	7.488	7.488
	DIOX	Yes	No	-			g	27.594	27.594
	HCB	Yes	No	-			kg	18.472	18.472
	Indeno	Yes	No	-			t	10.325	10.325
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	41.631	43.415
	PCB	Yes	No	-			kg	1.644	1.644
Germany	benzo(a)	Yes	No	-			t	16.088	16.088
	benzo(b)	Yes	No	-			t	23.346	23.346
	benzo(k)	Yes	No	-			t	10.690	10.690
	DIOX	Yes	No	-			g	118.720	118.720
	HCB	Yes	No	-			kg	12.663	12.663
	Indeno	Yes	No	-			t	15.474	15.474
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	76.791	65.599
	PCB	Yes	No	-			kg	215.782	215.782
Spain	benzo(a)	Yes	No	-			t	15.953	15.953
	benzo(b)	Yes	No	-			t	15.769	15.769
	benzo(k)	Yes	No	-			t	6.541	6.541
	DIOX	Yes	No	-			g	172.227	172.227
	HCB	Yes	No	-			kg	12.889	12.889
	Indeno	Yes	No	-			t	8.650	8.650
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	63.810	46.912
	PCB	Yes	No	-			kg	25.694	25.694
Georgia	benzo(a)	Yes	No	-			t	1.449	1.449
	benzo(b)	Yes	No	-			t	1.427	1.427
	benzo(k)	Yes	No	-			t	0.554	0.554
	DIOX	Yes	No	-			g	9.943	9.943
	HCB	Yes	No	-			kg	5.288	5.288
	Indeno	Yes	No	-			t	0.817	0.817

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 components	sum of components	t	4.370	4.247
	PCB	Yes	No	-			kg	373.897	373.897
Greece	benzo(a)	Yes	No	-			t	5.271	5.271
	benzo(b)	Yes	No	-			t	5.861	5.861
	benzo(k)	Yes	No	-			t	3.188	3.188
	DIOX	Yes	No	-			g	24.176	24.176
	HCB	Yes	No	-			kg	1.707	1.707
	Indeno	Yes	No	-			t	2.325	2.325
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	17.292	16.644
	PCB	Yes	No	-			kg	35.496	35.496
Croatia	benzo(a)	Yes	No	-			t	4.689	4.689
	benzo(b)	Yes	No	-			t	4.353	4.353
	benzo(k)	Yes	No	-			t	1.682	1.682
	DIOX	Yes	No	-			g	27.010	27.010
	HCB	Yes	No	-			kg	0.603	0.603
	Indeno	Yes	No	-			t	2.647	2.647
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	13.404	13.371
	PCB	Yes	No	-			kg	409.749	409.749
Iceland	benzo(a)	Yes	No	-			t	0.012	0.012
	benzo(b)	Yes	No	-			t	0.039	0.039
	benzo(k)	Yes	No	-			t	0.024	0.024
	DIOX	Yes	No	-			g	0.460	0.460
	HCB	Yes	No	-			kg	0.072	0.072
	Indeno	Yes	No	-			t	0.011	0.011
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	0.087	0.087
	PCB	Yes	No	-			kg	0.032	0.032
Italy	benzo(a)	Yes	Yes	Incomplete	sum of sectors	Component split	t	16.723	19.783
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	Component split	t	19.582	23.065
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	Component split	t	9.049	10.666
	DIOX	Yes	No	-			g	270.572	270.572
	HCB	Yes	No	-			kg	10.435	10.435
	Indeno	Yes	Yes	Incomplete	sum of sectors	Component split	t	11.050	12.933
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors	sum of components	t	65.488	66.448
	PCB	Yes	No	-			kg	111.705	111.705
Kyrgyzstan	benzo(a)	No	Yes	not reported	sum of sectors	Reported value 2017	t	0.000	4.112

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
	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	Extrapolation of TNO data	Sector distribution like ME 2019	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	Yes	Sum of components not consistent with PAHs	sum of sectors	PAH split	t	36.754	36.754
	benzo(b)	Yes	No	-			t	52.573	52.573
	benzo(k)	Yes	No	-			t	20.853	20.853
	DIOX	Yes	Yes	inplausible low value (mg)	Extrapolation of TNO data	Sector distribution like RO 2019	g	0.332	325.930
	HCB	Yes	No	-			kg	7.934	7.934
	Indeno	Yes	No	-			t	17.654	17.654
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	127.742	127.834
Poland	PCB	Yes	No	-			kg	123.935	123.935
	benzo(a)	Yes	No	-			t	62.160	62.160
	benzo(b)	Yes	No	-			t	69.933	69.933
	benzo(k)	Yes	No	-			t	32.046	32.046
	DIOX	Yes	No	-			g	274.096	274.096
	HCB	Yes	No	-			kg	14.917	14.917
	Indeno	Yes	No	-			t	26.399	26.399
Portugal	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	197.338	190.537
	PCB	Yes	No	-			kg	156.399	156.399
	benzo(a)	Yes	No	-			t	4.962	4.962
	benzo(b)	Yes	No	-			t	4.187	4.187
	benzo(k)	Yes	No	-			t	2.161	2.161
	DIOX	Yes	No	-			g	55.799	55.799
	HCB	Yes	No	-			kg	2.383	2.383
Romania	Indeno	Yes	No	-			t	2.799	2.799
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	16.669	14.109
	PCB	Yes	No	-			kg	89.439	89.439
	benzo(a)	Yes	No	-			t	17.748	17.748
	benzo(b)	Yes	No	-			t	17.210	17.210
	benzo(k)	Yes	No	-			t	6.615	6.615
	DIOX	Yes	No	-			g	186.088	186.088
	HCB	Yes	No	-			kg	3.102	3.102

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	9.934	9.934
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	58.126	51.508
	PCB	Yes	No	-			kg	20.021	20.021
Serbia	benzo(a)	Yes	Yes	inplausible high values (factor 1000) for GNFR L_AgriOther	sum of sectors	GNFR L_AgriOther omitted	t	80.832	6.822
	benzo(b)	Yes	Yes	inplausible high values (factor 1000) for GNFR L_AgriOther	sum of sectors	GNFR L_AgriOther omitted	t	214.243	7.518
	benzo(k)	Yes	Yes	inplausible high values (factor 1000) for GNFR L_AgriOther	sum of sectors	GNFR L_AgriOther omitted	t	99.901	2.933
	DIOX	Yes	Yes	inplausible high values (factor 1000) for GNFR L_AgriOther	sum of sectors	GNFR L_AgriOther omitted	g	602.384	55.780
	HCB	Yes	Yes	-			kg	2.140	2.140
	Indeno	Yes	Yes	inplausible high values (factor 1000) for GNFR L_AgriOther	sum of sectors	GNFR L_AgriOther omitted	t	67.041	3.745
	PAH	Yes	Yes	inplausible high values (factor 1000) for GNFR L_AgriOther	sum of sectors	GNFR L_AgriOther omitted	t	466.606	21.017
	PCB	Yes	No	-			kg	723.136	723.136
Russian Federation	benzo(a)	No	Yes	not reported	79% of expert data (Shen et al 2013) from 2007	Sector distribution like IT 2019	t	0.000	86.900
	benzo(b)	No	Yes	not reported	79% of PAH Split using Benzo(a)	Sector distribution like IT 2019	t	0.000	98.915
	benzo(k)	No	Yes	not reported	79% of PAH Split using Benzo(a)	Sector distribution like IT 2019	t	0.000	45.910
	DIOX	No	Yes	not reported	79% of expert data (Treger) from 2007	Sector distribution like IT 2019	g	0.000	1409.676
	HCB	No	Yes	not reported	75% of Extrapolation of TNO data 2010 using GDP	Sector distribution like IT 2019	kg	0.000	5.178
	Indeno	No	Yes	not reported	79% of PAH Split using Benzo(a)	Sector distribution like IT 2019	t	0.000	53.467
	PAH	No	Yes	not reported	79% of sum of individual PAHs	Sector distribution like IT 2019	t	0.000	285.193
	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 2019	t	0.000	23.100
	benzo(b)	No	Yes	no reporting obligation	21% of PAH Split using Benzo(a)	Sector distribution like IT 2019	t	0.000	26.294
	benzo(k)	No	Yes	no reporting obligation	21% of PAH Split using Benzo(a)	Sector distribution like IT 2019	t	0.000	12.204
	DIOX	No	Yes	no reporting obligation	21% of expert data (Treger) from 2007	Sector distribution like IT 2019	g	0.000	374.724
	HCB	No	Yes	no reporting obligation	25% of Extrapolation of TNO data 2010 using GDP	Sector distribution like IT 2019	kg	0.000	0.459
	Indeno	No	Yes	no reporting obligation	21% of PAH Split using Benzo(a)	Sector distribution like IT 2019	t	0.000	14.213
	PAH	No	Yes	no reporting obligation	21% of sum of individual PAHs	Sector distribution like IT 2019	t	0.000	75.811
	PCB	No	No	no reporting obligation	No data available	not applicable	kg	0.000	0.000
Sweden	benzo(a)	Yes	No	-			t	2.178	2.178
	benzo(b)	Yes	No	-			t	2.279	2.279
	benzo(k)	Yes	No	-			t	0.792	0.792
	DIOX	Yes	No	-			g	24.263	24.263
	HCB	Yes	No	-			kg	2.737	2.737

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	1.188	1.188
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	6.808	6.437
	PCB	Yes	No	-			kg	9.167	9.167
Slovenia	benzo(a)	Yes	No	-			t	1.905	1.905
	benzo(b)	Yes	No	-			t	1.155	1.155
	benzo(k)	Yes	No	-			t	1.062	1.062
	DIOX	Yes	No	-			g	13.904	13.904
	HCB	Yes	No	-			kg	0.543	0.543
	Indeno	Yes	No	-			t	0.370	0.370
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	4.800	4.492
	PCB	Yes	No	-			kg	35.455	35.455
Slovakia	benzo(a)	Yes	No	-			t	6.117	6.117
	benzo(b)	Yes	No	-			t	6.400	6.400
	benzo(k)	Yes	No	-			t	2.257	2.257
	DIOX	Yes	No	-			g	64.676	64.676
	HCB	Yes	No	-			kg	3.369	3.369
	Indeno	Yes	No	-			t	2.748	2.748
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	30.952	17.521
	PCB	Yes	No	-			kg	17.723	17.723
Tajikistan	benzo(a)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using population data	Sector distribution like LV	t	0.000	3.893
	benzo(b)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using population data	Sector distribution like LV	t	0.000	3.198
	benzo(k)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using population data	Sector distribution like LV	t	0.000	2.225
	DIOX	No	Yes	not reported	Extrapolation of Hodjamberdiev data (2006) using population data	Sector distribution like LV	g	0.000	66.908
	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	t	0.000	1.071
	PAH	No	Yes	not reported	Sum of individual PAHs	Sum of individual PAHs	t	0.000	10.386
	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	t	0.000	1.099
	benzo(b)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like HR	t	0.000	2.434
	benzo(k)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like HR	t	0.000	1.688

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
	DIOX	No	Yes	not reported	Extrapolation of Hodjamberdiev data (2006) using population data	Sector distribution like HR	g	0.000	43.289
	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	t	0.000	3.023
	PAH	No	Yes	not reported	Sum of individual PAHs	Sum of individual PAHs	t	0.000	8.244
	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	t	0.000	42.443
	benzo(b)	No	Yes	not reported	Extrapolation of TNO data 2010 using population data	Sector distribution like IT	t	0.000	53.338
	benzo(k)	No	Yes	not reported	Extrapolation of TNO data 2010 using population data	Sector distribution like IT	t	0.000	20.290
	DIOX	No	Yes	not reported	Extrapolation of expert data 2010 (Pulles et al. 2006) using population data	Sector distribution like IT	g	0.000	1266.480
	HCB	No	Yes	not reported	Extrapolation of TNO data 2010 using GDP data	Sector distribution like IT	kg	0.000	3.739
	Indeno	No	Yes	not reported	Extrapolation of TNO data 2010 using population data	Sector distribution like IT	t	0.000	34.187
	PAH	No	Yes	not reported	Sum of individual PAHs	Sum of individual PAHs	t	0.000	150.259
	PCB	No	No	not reported	No data available	not applicable	kg	0.000	0.000
Ukraine	benzo(a)	Yes	Yes	sectoral incomplete	Copy of expert data (National Implementation Plan for the Stockholm Convention on POPs) from 2002	Sector distribution like PL	t	12.717	51.950
	benzo(b)	Yes	Yes	sectoral incomplete	Copy of expert data (National Implementation Plan for the Stockholm Convention on POPs) from 2002	Sector distribution like PL	t	13.388	83.562
	benzo(k)	Yes	Yes	sectoral incomplete	Copy of expert data (National Implementation Plan for the Stockholm Convention on POPs) from 2002	Sector distribution like PL	t	14.361	30.610
	DIOX	Yes	Yes	sectoral incomplete	National Implementation Plan of UA for the Stockholm Convention on POPs, extrapolated using population data	Sector distribution like PL	g	635.895	806.569
	HCB	Yes	No	-			kg	118.083	118.083
	Indeno	Yes	Yes	sectoral incomplete	Copy of expert data (National Implementation Plan for the Stockholm Convention on POPs) from 2002	Sector distribution like PL	t	15.062	30.160
	PAH	Yes	Yes	sectoral incomplete	Sum of individual PAHs	Sector distribution like PL	t	56.653	196.282
	PCB	Yes	No	-			kg	174.411	174.411
Uzbekistan	benzo(a)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like SK	t	0.000	2.587
	benzo(b)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like SK	t	0.000	5.062
	benzo(k)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like SK	t	0.000	3.937

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gap-filling/replacement	National total method	Sector method	Unit	Reported Value	Gap-Filled Value
	DIOX	No	Yes	not reported	Extrapolation of Hodjamberdiev data (2006) using population data	Sector distribution like SK	g	0.000	167.344
	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	t	0.000	1.153
	PAH	No	Yes	not reported	Sum of individual PAHs	Sum of individual PAHs	t	0.000	12.739
	PCB	No	No	not reported	No data available	not applicable	kg	0.000	0.000

Annex I: EMEP Country Codes

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

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, KZT, 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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