Convention on Long-range Transboundary Air Pollution

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Co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe

TECHNICAL REPORT CEIP
02/2025

Methodologies applied to the CEIP GNFR gap-filling 2025

Part II:
Heavy Metals and POPs (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 years 2023

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Technical report CEIP 02/2025

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1. Overview

This is a technical report providing a brief overview of the gap-filling methods used for the GNFR inventory year 2023 (as reported in 2025) 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).

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 (ECE/EB.AIR/156/Add.3)[1]. 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 the emission data is used by the 'modellers', missing or erroneous information is supplemented or replaced with specific methods and expert data. The supplemented emission data is used for e.g. spatial emission mapping to the EMEP grid.

[1] ECE/EB.AIR/156/Add.3: *Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution*.. https://unece.org/sites/default/files/2025-05/ECE_EB.AIR_156_Add.3%20%28E%29.pdf

3. Gap-Filling

Gap filling for the year 2023 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 or C_OtherStationaryComb.
- The country reports comparably high/low values for specific components and GNFR sectors
- The trends in emissions show implausibly high fluctuations.
- 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 of GAINS baseline 2015-2025 data for mercury provided by IIASA.
- 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. This approach was mainly applied for the GNFR sector B_Industry for which the EMEP Guidebook 2023 does not provide methods for individual PAH compounds but only for the total amount of PAHs (e.g. for NFR 2C1 iron and steel).

The mean GNFR sector distribution of mandatory heavy metals for the year 2023 is calculated by means of reported data from 47 countries and year 2023 and is presented in

Table 1.

Table 1: Default share on GNFR sectors for mandatory heavy metals 2023.

Share on national total	Cd	Hg	Pb
A_PublicPower	7.57%	28.83%	4.32%
B_Industry	46.39%	44.51%	46.94%
C_OtherStationaryComb	25.10%	8.30%	10.20%
D_Fugitive	0.91%	2.32%	0.56%
E_Solvents	9.43%	1.04%	3.46%
F_RoadTransport	4.45%	4.82%	30.40%
G_Shipping	0.14%	0.37%	0.06%
H_Aviation	0.03%	0.03%	2.12%
I_Offroad	0.55%	0.44%	0.36%
J_Waste	4.53%	9.11%	1.40%
K_AgriLivestock	0.00%	0.00%	0.00%
L_AgriOther	0.89%	0.22%	0.02%
M_Other	0.00%	0.00%	0.15%

The PAH component default split for national totals as presented in Table 2 has been calculated by means of data from 13 countries which report PAHs and its components in a consistent way.

Table 2: Default component share on total PAHs 2023.

Component	benzo(a)	benzo(b)	benzo(k)	Indeno
Share	29.9%	32.2%	17.7%	20.2%

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	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
Asian Areas	Cd	No	Yes	no reporting obligation	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2023	t	-	27.60
	Hg	No	Yes	no reporting obligation	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2023	t	-	30.33
	Pb	No	Yes	no reporting obligation	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2023	t	-	1 214.05
Azerbaijan	Cd	No	Yes	not reported	2022 data from submission 2024	2022 data from submission 2024	t	-	0.18
	Hg	No	Yes	not reported	2022 data from submission 2024	2022 data from submission 2024	t	-	0.20
	Pb	No	Yes	not reported	2022 data from submission 2024	2022 data from submission 2024	t	-	0.59
Bosnia and Herzegovina	Cd	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2023	t	-	1.49
	Hg	No	Yes	not reported	sum of sectors	GAINS Baseline interpolated data 2023	t	-	0.49
	Pb	No	Yes	not reported	TNO data (intra-/extrapolated or copy of data)	Mean sector distribution for 2023	t	-	35.53
Kyrgyzstan	Cd	No	Yes	not reported	2022 data from submission 2024	2022 data from submission 2024	t	-	0.25
	Hg	No	Yes	not reported	2022 data from submission 2024	2022 data from submission 2024	t	-	0.29
	Pb	No	Yes	not reported	2022 data from submission 2024	2022 data from submission 2024	t	-	5.07
North Africa	Cd	No	Yes	no reporting obligation	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2023	t	-	8.49
	Hg	No	Yes	no reporting obligation	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2023	t	-	9.33
	Pb	No	Yes	no reporting obligation	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2023	t	-	791.10
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 2021 (-5%) from CRF submission 2023	t	-	26.55
	Hg	No	Yes	not reported	sum of sectors	GAINS Baseline interpolated data 2023	t	-	20.70

Country	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
	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 2021 (-5%) from CRF submission 2023	t	-	157.49
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	-	13.68
	Hg	No	Yes	not reported	sum of sectors	GAINS Baseline interpolated data 2023	t	-	26.67
	Pb	No	Yes	no reporting obligation	calculated from RU emissions RU:RUE factor 0.66 : 0.34	Sector distribution like RU	t	-	81.13
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 2023	t	-	4.66
	Hg	No	Yes	not reported	sum of sectors	GAINS Baseline interpolated data 2023	t	-	8.32
	Pb	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2023	t	-	63.72
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 2023	t	-	0.14
	Hg	No	Yes	not reported	copy of unpublished expert estimates	Mean sector distribution for 2023	t	-	0.25
	Pb	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution for 2023	t	-	39.00
Türkiye	Cd	Yes	Yes	sectoral incomplete	sum of sectors	A_PublicPower, C_OtherStationaryComb: copy of Poland 2019	t	0.09	7.31
	Hg	Yes	Yes	not reported	sum of sectors	GAINS Baseline interpolated data 2023	t	0.01	12.50
	Pb	Yes	Yes	sectoral incomplete	sum of sectors	A_PublicPower, C_OtherStationaryComb: copy of Poland 2019	t	3.62	80.42
Uzbekistan	Cd	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution 2023 w/o shipping	t	-	3.28
	Hg	No	Yes	not reported	sum of sectors	GAINS Baseline interpolated data 2023	t	-	5.41
	Pb	No	Yes	not reported	copy of expert estimates (MSC-E, 2011)	Mean sector distribution 2023 w/o shipping	t	-	184.82

Applied methods for POPs

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

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
Albania	benzo(a)	Yes	No				t	0.071	0.071
	benzo(b)	Yes	No				t	0.185	0.185
	benzo(k)	Yes	No				t	0.040	0.040
	DIOX	Yes	No				g	1.292	1.292
	HCB	Yes	No				kg	0.033	0.033
	Indeno	Yes	No				t	0.032	0.032
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors	sum of components	t	0.329	0.329
	PCB	Yes	No				kg	0.001	0.001
Armenia	benzo(a)	Yes	No	-			t	0.662	0.662
	benzo(b)	Yes	No	-			t	0.669	0.669
	benzo(k)	Yes	No	-			t	0.256	0.256
	DIOX	Yes	No	-			g	4.054	4.054
	HCB	Yes	No	-			kg	0.023	0.023
	Indeno	Yes	No	-			t	0.376	0.376
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors	sum of components	t	1.962	1.962
	PCB	Yes	No	-			kg	0.088	0.088
Austria	benzo(a)	Yes	No	-			t	1.693	1.693
	benzo(b)	Yes	No	-			t	1.902	1.902
	benzo(k)	Yes	No	-			t	0.782	0.782
	DIOX	Yes	No	-			g	30.240	30.240
	HCB	Yes	No	-			kg	10.120	10.120
	Indeno	Yes	No	-			t	0.983	0.983
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors	sum of components	t	5.361	5.361
	PCB	Yes	No	-			kg	2.425	2.425
Azerbaijan	benzo(a)	No	Yes	-			t	-	0.474
	benzo(b)	No	Yes	-			t	-	0.493
	benzo(k)	No	Yes	-			t	-	0.427
	DIOX	No	Yes	-			g	-	3.406
	HCB	No	Yes	-			kg	-	0.160
	Indeno	No	Yes	-			t	-	0.106
	PAH	No	Yes	Sum of components not consistent with PAHs	sum of sectors	sum of components	t	-	1.499

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
	PCB	No	Yes	-			kg	-	0.032
Bosnia and Herzegovina	benzo(a)	No	Yes	not reported	TNO expert data	Sector distribution like SK gapfilled 2023	t	-	3.061
	benzo(b)	No	Yes	not reported	TNO expert data	Sector distribution like SK gapfilled 2023	t	-	4.073
	benzo(k)	No	Yes	not reported	TNO expert data	Sector distribution like SK gapfilled 2023	t	-	1.626
	DIOX	No	Yes	not reported	TNO expert data	Sector distribution like SK gapfilled 2023	g	-	48.004
	HCB	No	Yes	not reported	Extrapolation of expert data (Pacyna et al. 1999) using population data	Sector distribution like SK gapfilled 2023	kg	-	50.000
	Indeno	No	Yes	not reported	TNO expert data	Sector distribution like SK gapfilled 2023	t	-	2.786
	PAH	No	Yes	not reported	sum of sectors	Sector distribution like SK gapfilled 2023	t	-	11.546
	PCB	No	No	not reported	No data available	not applicable	kg	-	-
Belgium	benzo(a)	Yes	No	-			t	1.849	1.849
	benzo(b)	Yes	No	-			t	2.063	2.063
	benzo(k)	Yes	No	-			t	0.890	0.890
	DIOX	Yes	No	-			g	28.317	28.317
	HCB	Yes	No	-			kg	5.409	5.409
	Indeno	Yes	No	-			t	1.039	1.039
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors	sum of components	t	5.841	5.841
	PCB	Yes	No	-			kg	3.752	3.752
Bulgaria	benzo(a)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	2.976	3.046
	benzo(b)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	2.881	2.969
	benzo(k)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	1.244	1.288
	DIOX	Yes	No	-			g	31.230	31.230
	HCB	Yes	No	-			kg	1.398	1.398
	Indeno	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	1.789	1.821

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors	sum of components	t	9.204	9.125
	PCB	Yes	No	-			kg	1.713	1.713
Czech Republic	benzo(a)	Yes	No	-			t	14.814	14.814
	benzo(b)	Yes	No	-			t	9.762	9.762
	benzo(k)	Yes	No	-			t	6.506	6.506
	DIOX	Yes	No	-			g	17.918	17.918
	HCB	Yes	No	-			kg	6.258	6.258
	Indeno	Yes	No	-			t	7.176	7.176
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	38.271	38.259
	PCB	Yes	No	-			kg	0.720	0.720
Germany	benzo(a)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	15.659	16.512
	benzo(b)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	22.722	23.797
	benzo(k)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	10.352	10.895
	DIOX	Yes	No	-			g	110.975	110.975
	HCB	Yes	No	-			kg	3.854	3.854
	Indeno	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	15.053	15.445
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	67.134	66.648
	PCB	Yes	No	-			kg	203.804	203.804
Estonia	benzo(a)	Yes	No	-			t	1.040	1.040
	benzo(b)	Yes	No	-			t	1.040	1.040
	benzo(k)	Yes	No	-			t	0.634	0.634
	DIOX	Yes	No	-			g	4.510	4.510
	HCB	Yes	No	-			kg	0.494	0.494
	Indeno	Yes	No	-			t	0.916	0.916
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	3.631	3.631
	PCB	Yes	No	-			kg	0.439	0.439

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
Spain	benzo(a)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	7.566	11.010
	benzo(b)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	8.126	12.465
	benzo(k)	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	3.513	5.706
	DIOX	Yes	No	-			g	419.053	419.053
	HCB	Yes	No	-			kg	1.796	1.796
	Indeno	Yes	Yes	Incomplete (2C1)	sum of components	reported value plus 2C1 PAH disaggregated by compound share of BE for 2004	t	4.334	5.916
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	35.096	35.096
	PCB	Yes	No	-			kg	308.043	308.043
Georgia	benzo(a)	Yes	No				t	1.234	1.234
	benzo(b)	Yes	No				t	1.211	1.211
	benzo(k)	Yes	No				t	0.472	0.472
	DIOX	Yes	No	-			g	8.893	8.893
	HCB	Yes	No	-			kg	23.326	23.326
	Indeno	Yes	No				t	0.698	0.698
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	3.759	3.614
	PCB	Yes	No	-			kg	375.189	375.189
Greece	benzo(a)	Yes	Yes	-			t	5.667	5.668
	benzo(b)	Yes	No	-			t	6.090	6.090
	benzo(k)	Yes	No	-			t	3.303	3.303
	DIOX	Yes	No	-			g	25.508	25.508
	HCB	Yes	No	-			kg	0.873	0.873
	Indeno	Yes	No	-			t	2.536	2.536
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	17.467	17.597
	PCB	Yes	No	-			kg	71.835	71.835
Croatia	benzo(a)	Yes	No	-			t	4.529	4.529
	benzo(b)	Yes	No	-			t	4.221	4.221
	benzo(k)	Yes	No	-			t	1.773	1.773
	DIOX	Yes	No	-			g	24.256	24.256

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
	HCB	Yes	No	-			kg	0.323	0.323
	Indeno	Yes	No	-			t	2.483	2.483
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	13.107	13.005
	PCB	Yes	No	-			kg	3.006	3.006
Hungary	benzo(a)	Yes	No	-			t	6.732	6.732
	benzo(b)	Yes	No	-			t	6.945	6.945
	benzo(k)	Yes	No	-			t	3.272	3.272
	DIOX	Yes	No	-			g	35.393	35.393
	HCB	Yes	No	-			kg	1.249	1.249
	Indeno	Yes	No	-			t	3.560	3.560
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	20.549	20.508
	PCB	Yes	No	-			kg	4.800	4.800
Iceland	benzo(a)	Yes	No	-			t	0.014	0.014
	benzo(b)	Yes	No	-			t	0.042	0.042
	benzo(k)	Yes	No	-			t	0.026	0.026
	DIOX	Yes	No	-			g	0.801	0.801
	HCB	Yes	No	-			kg	0.115	0.115
	Indeno	Yes	No	-			t	0.012	0.012
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	0.093	0.093
	PCB	Yes	No	-			kg	0.018	0.018
Italy	benzo(a)	Yes	Yes	Incomplete	sum of sectors	Component split	t	15.749	18.101
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	Component split	t	18.589	21.115
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	Component split	t	8.529	9.923
	DIOX	Yes	No	-			g	297.180	297.180
	HCB	Yes	No	-			kg	11.997	11.997
	Indeno	Yes	Yes	Incomplete	sum of sectors	Component split	t	10.418	12.000
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors	sum of components	t	61.144	61.139
	PCB	Yes	No	-			kg	105.740	105.740
Kazakhstan	benzo(a)	Yes	No				t	60.049	60.049
	benzo(b)	Yes	No				t	112.626	112.626
	benzo(k)	Yes	No				t	82.715	82.715
	DIOX	Yes	No				g	353.824	353.824
	HCB	Yes	No				kg	33.899	33.899
	Indeno	Yes	No				t	26.108	26.108

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of sectors	sum of components	t	243.464	281.498
	PCB	Yes	No				kg	78.888	78.888
Lithuania	benzo(a)	Yes	No	-			t	2.143	2.143
	benzo(b)	Yes	No	-			t	2.532	2.532
	benzo(k)	Yes	No	-			t	1.238	1.238
	DIOX	Yes	No	-			g	14.326	14.326
	HCB	Yes	No	-			kg	0.370	0.370
	Indeno	Yes	No	-			t	1.131	1.131
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	6.341	7.044
	PCB	Yes	No				kg	0.433	0.433
Latvia	benzo(a)	Yes	No	-			t	2.024	2.024
	benzo(b)	Yes	No	-			t	2.034	2.034
	benzo(k)	Yes	No	-			t	0.752	0.752
	DIOX	Yes	No	-			g	17.998	17.998
	HCB	Yes	No	-			kg	0.518	0.518
	Indeno	Yes	No	-			t	1.129	1.129
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	5.938	5.938
	PCB	Yes	No	-			kg	0.104	0.104
Republic of Moldova	benzo(a)	Yes	No				t	3.001	3.001
	benzo(b)	Yes	No				t	3.160	3.160
	benzo(k)	Yes	No				t	1.468	1.468
	DIOX	Yes	No				g	20.775	20.775
	HCB	Yes	No				kg	0.151	0.151
	Indeno	Yes	No				t	1.617	1.617
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	11.201	9.247
	PCB	Yes	No				kg	1.198	1.198
The former Yugoslav Republic of Macedonia	benzo(a)	Yes	Yes	-			t	0.986	0.984
	benzo(b)	Yes	Yes	-			t	1.119	1.113
	benzo(k)	Yes	Yes	-			t	0.443	0.438
	DIOX	Yes	Yes	-			g	7.809	7.730
	HCB	Yes	Yes	-			kg	0.096	0.096
	Indeno	Yes	Yes	-			t	0.546	0.544
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	3.245	3.079
	PCB	Yes	Yes	-			kg	358.565	358.565

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
Netherlands	benzo(a)	Yes	No	-			t	1.535	1.535
	benzo(b)	Yes	No	-			t	1.482	1.482
	benzo(k)	Yes	No	-			t	0.786	0.786
	DIOX	Yes	No	-			g	42.925	42.925
	HCB	Yes	No	-			kg	3.166	3.166
	Indeno	Yes	No	-			t	0.749	0.749
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	5.078	4.553
	PCB	Yes	No	-			kg	0.126	0.126
Norway	benzo(a)	Yes	No	-			t	0.792	0.792
	benzo(b)	Yes	No	-			t	1.838	1.838
	benzo(k)	Yes	No	-			t	0.685	0.685
	DIOX	Yes	No	-			g	20.115	20.115
	HCB	Yes	No	-			kg	1.210	1.210
	Indeno	Yes	No	-			t	0.648	0.648
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	sum of components	t	3.963	3.963
	PCB	Yes	No	-			kg	24.687	24.687
Poland	benzo(a)	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	67.985	69.266
	benzo(b)	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	70.457	71.676
	benzo(k)	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	34.038	34.634
	DIOX	Yes	No	-			g	260.640	260.640
	HCB	Yes	No	-			kg	3.548	3.548
	Indeno	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	27.047	27.845
	PAH	Yes	Yes	Sum of components not consistent with PAHs	sum of components	PAH split	t	203.422	203.422
	PCB	Yes	No	-			kg	127.008	127.008
Portugal	benzo(a)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	3.393	3.842
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	3.434	3.882
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	1.367	1.630
	DIOX	Yes	No	-			g	52.797	52.797
	HCB	Yes	No	-			kg	0.755	0.755
	Indeno	Yes	Yes	Incomplete	sum of sectors	PAH split	t	2.008	2.308
	PAH	Yes	Yes	Incomplete	sum of sectors	sum of components	t	11.663	11.662
	PCB	Yes	No	-			kg	76.604	76.604

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
Romania	benzo(a)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	15.980	16.616
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	15.317	15.887
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	6.393	6.803
	DIOX	Yes	No	-			g	180.781	180.781
	HCB	Yes	No	-			kg	2.896	2.896
	Indeno	Yes	Yes	Incomplete	sum of sectors	PAH split	t	8.911	9.459
	PAH	Yes	Yes	Incomplete	sum of sectors	sum of components	t	48.766	48.766
	PCB	Yes	No	-			kg	8.627	8.627
Serbia	benzo(a)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	9.912	10.795
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	10.459	11.323
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	4.056	4.597
	DIOX	Yes	No	-			g	74.943	74.943
	HCB	Yes	No	-			kg	2.152	2.152
	Indeno	Yes	Yes	Incomplete	sum of sectors	PAH split	t	5.522	6.177
	PAH	Yes	No	-			t	32.892	32.892
	PCB	Yes	No	-			kg	752.708	752.708
Russian Federation	benzo(a)	No	Yes	not reported	79% of expert data (Shen et al 2013) from 2007	Sector distribution like IT 2023 (gapfilled)	t	-	86.900
	benzo(b)	No	Yes	not reported	79% of PAH Split using Benzo(a)	Sector distribution like IT 2023 (gapfilled)	t	-	93.345
	benzo(k)	No	Yes	not reported	79% of PAH Split using Benzo(a)	Sector distribution like IT 2023 (gapfilled)	t	-	51.498
	DIOX	No	Yes	not reported	79% of of expert data (Treger) from 2007	Sector distribution like IT 2023 (gapfilled)	g	-	1 409.676
	HCB	No	Yes	not reported	75% of Extrapolation of TNO data 2010 using GDP	Sector distribution like IT 2023 (gapfilled)	kg	-	5.537
	Indeno	No	Yes	not reported	79% of PAH Split using Benzo(a)	Sector distribution like IT 2023 (gapfilled)	t	-	58.482
	PAH	No	Yes	not reported	79% of sum of individual PAHs	Sector distribution like IT 2023 (gapfilled)	t	-	290.226
	PCB	No	No	not reported	No data available	Sector distribution like IT 2023 (gapfilled)	kg	-	-
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 2023 (gapfilled)	t	-	23.100
	benzo(b)	No	Yes	no reporting obligation	21% of PAH Split using Benzo(a)	Sector distribution like IT 2023 (gapfilled)	t	-	24.813
	benzo(k)	No	Yes	no reporting obligation	21% of PAH Split using Benzo(a)	Sector distribution like IT 2023 (gapfilled)	t	-	13.689
	DIOX	No	Yes	no reporting obligation	21% of of expert data (Treger) from 2007	Sector distribution like IT 2023 (gapfilled)	g	-	374.724

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
	HCB	No	Yes	no reporting obligation	25% of Extrapolation of TNO data 2010 using GDP	Sector distribution like IT 2023 (gapfilled)	kg	-	0.491
	Indeno	No	Yes	no reporting obligation	21% of PAH Split using Benzo(a)	Sector distribution like IT 2023 (gapfilled)	t	-	15.546
	PAH	No	Yes	no reporting obligation	21% of sum of individual PAHs	Sector distribution like IT 2023 (gapfilled)	t	-	77.149
	PCB	No	No	no reporting obligation	No data available	not applicable	kg	-	-
Sweden	benzo(a)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	1.879	2.127
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	2.002	2.260
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	0.692	0.853
	DIOX	Yes	No	-			g	16.360	16.360
	HCB	Yes	Yes	-			kg	3.439	2.620
	Indeno	Yes	Yes	Incomplete	sum of sectors	PAH split	t	1.015	1.206
	PAH	Yes	Yes	Incomplete	sum of sectors	sum of components	t	6.359	6.446
	PCB	Yes	No	-			kg	8.439	8.439
Slovenia	benzo(a)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	1.532	1.614
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	1.497	1.549
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	0.576	0.631
	DIOX	Yes	No	-			g	12.223	12.223
	HCB	Yes	No	-			kg	0.374	0.374
	Indeno	Yes	Yes	Incomplete	sum of sectors	PAH split	t	0.886	0.962
	PAH	Yes	Yes	Incomplete	sum of sectors	sum of components	t	4.756	4.756
	PCB	Yes	No	-			kg	34.316	34.316
Slovakia	benzo(a)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	3.659	6.801
	benzo(b)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	3.464	6.835
	benzo(k)	Yes	Yes	Incomplete	sum of sectors	PAH split	t	2.497	4.363
	DIOX	Yes	No	-			g	23.180	23.180
	HCB	Yes	No	-			kg	11.353	11.353
	Indeno	Yes	Yes	Incomplete	sum of sectors	PAH split	t	1.736	3.858
	PAH	Yes	Yes	Incomplete	sum of sectors	sum of components	t	21.857	21.857
	PCB	Yes	No	-			kg	33.722	33.722
Tajikistan	benzo(a)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using population data	Sector distribution like LV 2023	t	-	4.277
	benzo(b)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using population data	Sector distribution like LV 2023	t	-	3.514
	benzo(k)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using population data	Sector distribution like LV 2023	t	-	2.444

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
	DIOX	No	Yes	not reported	Extrapolation of Hodjamberdiev data (2006) using population data	Sector distribution like LV 2023	g	-	73.609
	HCB	No	Yes	not reported	Copy from 2015 gap-filling	Copy from 2015 gap-filling	kg	-	0.844
	Indeno	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using population data	Sector distribution like LV 2023	t	-	1.176
	PAH	No	Yes	not reported	Sum of individual PAHs	Sum of individual PAHs	t	-	11.411
	PCB	No	No	not reported	No data available	not applicable	kg	-	-
Turkmenistan	benzo(a)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like HR 2023	t	-	1.386
	benzo(b)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like HR 2023	t	-	3.070
	benzo(k)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like HR 2023	t	-	2.129
	DIOX	No	Yes	not reported	Extrapolation of Hodjamberdiev data (2006) using population data	Sector distribution like HR 2023	g	-	52.029
	HCB	No	Yes	not reported	Copy from 2015 gap-filling	Copy from 2015 gap-filling	kg	-	1.057
	Indeno	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like HR 2023	t	-	0.460
	PAH	No	Yes	not reported	Sum of individual PAHs	Sum of individual PAHs	t	-	7.045
	PCB	No	No	not reported	No data available	not applicable	kg	-	-
Türkiye	benzo(a)	No	Yes	not reported	Extrapolation of TNO data 2010 using population data	Sector distribution like IT 2023 (gapfilled)	t	-	42.924
	benzo(b)	No	Yes	not reported	Extrapolation of TNO data 2010 using population data	Sector distribution like IT 2023 (gapfilled)	t	-	53.943
	benzo(k)	No	Yes	not reported	Extrapolation of TNO data 2010 using population data	Sector distribution like IT 2023 (gapfilled)	t	-	20.520
	DIOX	No	Yes	not reported	Extrapolation of expert data 2010 (Pulles et al. 2006) using population data	Sector distribution like IT 2023 (gapfilled)	g	-	1 277.623
	HCB	No	Yes	not reported	Extrapolation of TNO data 2010 using GDP data	Sector distribution like IT 2023 (gapfilled)	kg	-	4.713
	Indeno	No	Yes	not reported	Extrapolation of TNO data 2010 using population data	Sector distribution like IT 2023 (gapfilled)	t	-	34.575
	PAH	No	Yes	not reported	Sum of individual PAHs	Sum of individual PAHs	t	-	151.961
	PCB	No	No	not reported	No data available	not applicable	kg	-	-

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
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 2023 (gapfilled)	t	-	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 2023 (gapfilled)	t	-	83.562
	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 2023 (gapfilled)	t	-	30.610
	DIOX	Yes	Yes	Incomplete	30% of: National Implementation Plan of UA for the Stockholm Convention on POPs, extrapolated using population data	Sector distribution like PL 2023 (gapfilled)	g	0.037	235.833
	HCB	Yes	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 2023 (gapfilled)	kg	0.367	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 2023 (gapfilled)	t	-	30.160
	PAH	Yes	Yes	-	Sum of individual PAHs	Sum of individual PAHs	t	87.532	196.282
	PCB	Yes	Yes	-	not reported	reported data 2020 from submission 2023	kg	30.580	187.765
Uzbekistan	benzo(a)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like SK 2023	t	-	3.201
	benzo(b)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like SK 2023	t	-	6.263
	benzo(k)	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like SK 2023	t	-	4.871
	DIOX	No	Yes	not reported	Extrapolation of Hodjamberdiev data (2006) using population data	Sector distribution like SK 2023	g	-	177.668
	HCB	No	Yes	not reported	Copy from 2015 gap-filling	Copy from 2015 gap-filling	kg	-	1.030
	Indeno	No	Yes	not reported	Extrapolation of Zhang&Tao data (2004) using GDP data	Sector distribution like SK 2023	t	-	1.427

Country or Region	Component	Reported	Gapfilling/ replacement required	Rationale for Gapfilling/replacement	National total method	Sector method	Unit	Reported	Gapfilled
	PAH	No	Yes	not reported	Sum of individual PAHs	Sum of individual PAHs	t	-	15.762
	PCB	No	No	not reported	No data available	not applicable	kg	-	-

4. 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 (alternative code:ZT)
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 Türkiye
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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