



Military Emissions Gap Conference 2023

MILITARY AND CONFLICT GHG EMISSIONS: FROM UNDERSTANDING TO MITIGATION

Tuesday 26 September, University of Oxford, and online

Akademia WSB

Dąbrowa Górnicza, Kraków, Cieszyn, Żywiec, Olkusz, Gilwice, Tychy

WSB University

Tracking unaccounted greenhouse gas emissions due to the war in Ukraine since 2022

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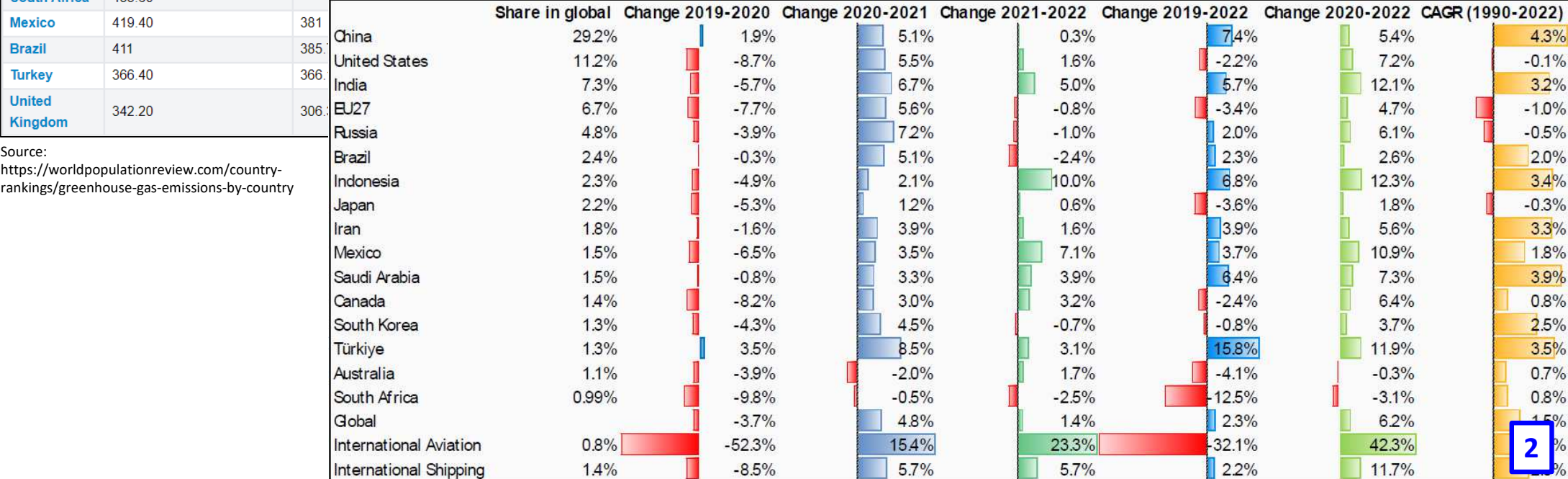
Photo: Rostyslav Bun

Countries with the highest GHG emissions

Country	CO2 emissions 2019 (Mt) v	CO2 emissions 2020 (Mt)	CO2 per capita 2019 (tons)	CO2 per capita 2020 (tons)
China	9,876.50		7.1	
United States	4,744.50	4,285.90	14.4	13
India	2,310		1.7	
Russia	1,640.30	1,555.90	11.4	10.8
Japan	1,056.20	1,024.10	8.4	8.2
Germany	644.10	585.30	7.8	7
South Korea	585.70	570.70	11.3	11
Iran	583.50		7	
Indonesia	583.40	626.60	2.2	2.3
Canada	571	523.20	15.2	13.8
Saudi Arabia	495.20		14.5	
South Africa	433.60		7.4	



Shares in 2022 global emissions, yearly GHG emission relative changes



Source: <https://worldpopulationreview.com/country-rankings/greenhouse-gas-emissions-by-country>

2023 Annex I Party GHG Inventory Submissions to the UNFCCC



IPCC 2006 Guidelines: Common Reporting Format

Party	Date of CRF original submission	Latest submitted NIR	Latest submitted CRF ¹	Latest submitted SEF	Status Report
Australia ²	13 April 2023	NIR 13 Apr 2023	CRT 13 Apr 2023	SEF-CP1-2022 14 Apr 2023 SEF-CP2-2022 14 Apr 2023	
Austria	13 April 2023	NIR 13 Apr 2023		SEF-CP1-2022	
Belarus	14 April 2023	NIR 14 Apr 2023			
Belgium	14 April 2023	NIR 14 Apr 2023			
Bulgaria	12 April 2023	NIR 12 Apr 2023			
Canada	14 April 2023	NIR 14 Apr 2023 Additional Information 27 Jul 2023			

TABLE 1 SECTORAL REPORT FOR ENERGY (Sheet 1 of 2)		Inventory 2021 Submission 2023 v1 UKRAINE						
GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO ₂	CH ₄	N ₂ O	NO _x	CO	NM VOC	SO ₂
		(kt)						
7	Total Energy	159735.73	1939.04	5.14	551.04	721.18	521.09	615.83
8	A. Fuel combustion activities (sectoral approach)	157482.55	14.88	5.14	551.04	721.18	418.75	615.83
9	1. Energy industries	84810.85	3.52	1.13	173.67	33.15	4.05	481.27
10	a. Public electricity and heat production	80546.08	2.76	1.11	166.15	30.46	3.86	474.33
11	b. Petroleum refining	423.27	0.02	0.00	0.78	0.13	0.01	2.25
12	c. Manufacture of solid fuels and other energy industries	3841.50	0.75	0.02	6.73	2.56	0.18	4.69
13	2. Manufacturing industries and construction	20926.56	1.29	0.18	35.11	97.88	14.55	86.88
14	a. Iron and steel	11331.73	0.72	0.10	18.38	58.53	7.97	53.19
15	b. Non-ferrous metals	925.82	0.05	0.01	1.45	4.34	0.60	3.95
16	c. Chemicals	412.53	0.01	0.00	0.57	0.36	0.19	0.11
17	d. Pulp, paper and print	53.23	0.00	0.00	0.07	0.03	0.02	0.00
18	e. Food processing, beverages and tobacco	579.05	0.03	0.00	0.87	1.50	0.40	1.04
19	f. Non-metallic minerals	4715.93	0.36	0.05	9.15	29.67	3.61	27.53
20	g. Other (please specify)	2908.26	0.11	0.01	4.63	3.43	1.75	1.05
21	3. Transport	32337.59	9.08	3.70	311.98	559.77	386.21	36.94
22	a. Domestic aviation	187.84	0.00	0.01	0.55	0.28	0.98	0.05
23	b. Road transportation	24351.21	8.35	1.42	140.83	407.83	69.15	24.37
24	c. Railways	376.68	0.02	0.15	5.73	4.78	0.96	2.25
25	d. Domestic navigation	82.33	0.01	0.00	1.54	0.62	0.21	0.54
26	e. Other transportation	7339.53	0.70	2.13	163.32	146.27	314.92	9.73

Source: <https://unfccc.int/ghg-inventories-annex-i-parties/2023>

The war suddenly overrides the enormous efforts of many scientists and policy makers

These emissions will never be reported in NIRs !!!

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Fossil fuels ?
Industrial proc. ?
Agriculture ?
Forestry ?
Waste ?

Overriding reporting system: This is not a new problem

Gulf war (1991): Kuwait oil fires



Carbon Dioxide Information Analysis Center (CDIAC): Data

1	Nation	Year	Total CO2 emissions from fossil-fuels and cement production (thousand metric tons of C)	Emissions from solid fuel consumption	Emissions from liquid fuel consumption
9172	KUWAIT	2017	26211		13908
9173	KUWAIT	2018	26581		14134
9174	KUWAIT	2019	28682		15147
9175	KUWAITI OIL FIRES	1991	130438		123118
9176	KYRGYZSTAN	1992	3014	1041	1006
9177	KYRGYZSTAN	1993	2315	938	663
9178	KYRGYZSTAN	1994	1675	934	225

Source: Hefner, M., Marland, G., Boden, T., Andres, R., 2022. Global, Regional, and National Fossil-Fuel CO₂ Emissions: 1751-2019 CDIAC-FF

2014 Russia invasion: Occupied territories



Area: 43,300 km² (> the Netherlands' area 41,500 km²)

Industrial regions: iron and steel production, cokes, coal mining etc.

Ukraine's NIRs for 2014-2021:

"... for emission and reduction estimations on temporarily occupied by the Russian Federation territory of Ukraine expert estimation was performed ..."

What with uncertainty of such an estimate?

GHG emissions caused by military actions in Ukraine that have a chance of not being accounted for in official national reporting



1. The use of bombs, missiles, barrel artillery, mines, and small arms



GHG emissions occur during:

- firing (barrel artillery and small arms),
- flight to the destination (missiles and drones),
- explosions (missiles, bombs, shells, grenades, drones, and mines).

18 months of the war:

Emissions – 283.3 ktCO₂

2. The use of petroleum products for military actions



Both armies:

armored combat vehicles, self-propelled artillery system, tanks, multiple launch rocket systems, aircrafts, helicopters, trucks, ships etc.

18 months of the war:

Emissions – 28.69 MtCO₂-eq., including:

26.80 MtCO₂-eq. from the land military vehicles,
1.03 MtCO₂-eq. from aviation,
0.86 MtCO₂-eq. from ships.

3. Fires of petroleum products at petroleum storage depots



Destroyed due to missile attacks and shelling:

- petroleum storage depots,
- oil refineries,
- petroleum stations,
- petrol trucks.

Occupied as well as not-occupied territories.

18 months of the war:

Emissions – 5.43 MtCO₂-eq.

4. Fires in buildings and other infrastructure



Wooden constructions and things:

floors, windows and doors, furniture, roof constructions, auxiliary buildings, fences, etc.

Other combustible materials:

plastics, fabrics, clothes/shoes, books, etc.

18 months of the war:

Emissions – 18.15 MtCO₂-eq., including:

17.80 Mt CO₂, 5.0 kt CH₄, and 0.73 kt N₂O.

5. Emissions from forest fires and fires of agricultural lands



A. Forest land

1. Forest land remaining forest land

~~X~~ *Controlled burning*

~~X~~ *Wildfires*

Forest fires as a result of shelling:

Kherson, Mykolaiv, Kyiv, Chernihiv, Sumy, Kharkiv, Donetsk, Dnipropetrovsk, and Luhansk regions.

18 months of the war:

Forests fires emissions – 16.68 MtCO₂-eq., including:

14.84 Mt CO₂, 44.5 kt CH₄, and 2.46 kt N₂O;

Fires of agricultural lands – 6.44 MtCO₂-eq., including:

5.73 Mt CO₂, 17.2 kt CH₄, and 0.95 kt N₂O;

Fires of other nature landscapes – 646 kt CO₂-eq.

6. Emissions from garbage/waste



Waste from houses and commercial structures destroyed by blast waves or damaged by military vehicles:

wooden structures, windows, doors, furniture, household items, personal effects, fences, etc.

Trees were cut down to use the wood to build: trenches, dugouts, or other shelters.

18 months of the war:

Emissions – 36.8 kt CH₄

Estimated war-related GHG emissions from the first 18 months of the 2022/2023 war in Ukraine

Emissions that originated from the territory of Ukraine but due to their specificity will likely not be covered by Ukraine's next NIRs to the UNFCCC - or they may be reported in a nontransparent way with high uncertainty

Emission sources	Emissions				Relative uncertainty (2σ)
	CO ₂ , Mt	CH ₄ , kt	N ₂ O, kt	Total, MtCO ₂ -eq.	
Use of bombs, missiles, barrel artillery, mines, etc.	0.28	–	–	0.28	+/- 53.9
Use of petroleum products for military actions	28.5	0.25	0.68	28.7	+/- 40.3
Fires of petroleum products at petroleum storage depots	5.4	0.21	0.04	5.43	+/- 20.3
Fires of buildings and infrastructure objects	17.8	5.0	0.73	18.1	+/- 50.5
Forest fires and fires of agricultural fields	21.1	63.3	3.5	23.8	+/- 42.9
Emissions from garbage/waste	–	36.8	–	0.92	+/- 68.8
Total emissions:	73.1	105.6	4.96	77.2	+/- 23.3

≈ Annual total GHG emissions of Austria, Portugal, or Hungary

“Peace time” vs “War time”

First 18 months of the 2022/2023 war in Ukraine:

Conclusions

