Military carbon emissions: what does the data say about the past, present and future?

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Scientists for Global Responsibility

Download slides from: https://www.sgr.org.uk/

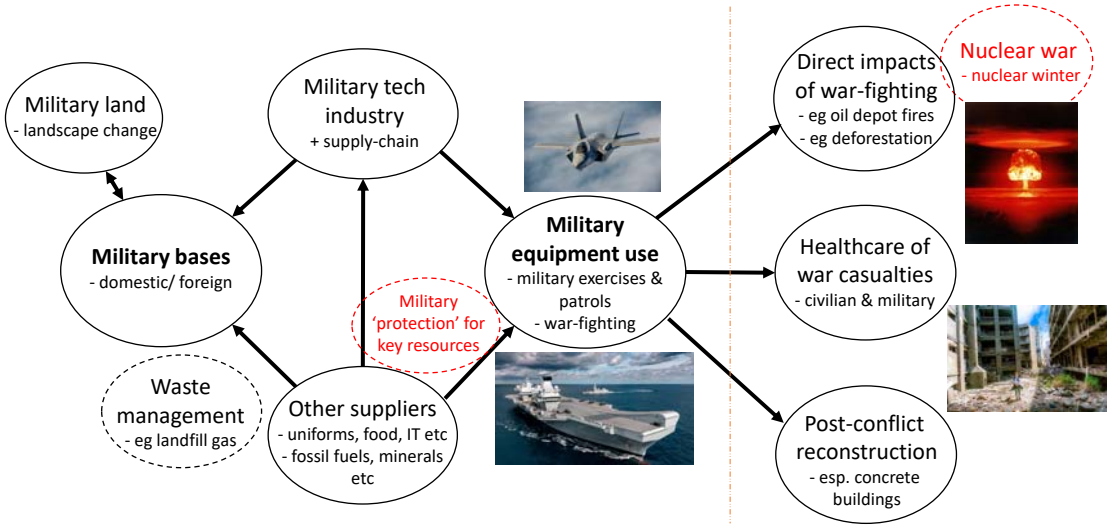
Presentation given at Bruno Kriesky Forum for International Dialogue, Vienna, 25th May, 2023
(All references listed in final slides)

About Scientists for Global Responsibility

- UK research/ advocacy organisation
- Membership includes hundreds of scientists and engineers
- Concerns include:
  - climate change; militarism in science & technology; military greenhouse gas emissions
- Publications on military GHGs
  - 3 reports on UK, EU & global military GHGs
  - 2 technical papers on UK military GHGs
  - Various partners/ funders

- Reports published in 2020, 2021, 2022; technical papers published in 2022, 2023 – all listed in references
- Articles/ presentations since 2007 – for a list of main outputs, see: https://www.sgr.org.uk/projects/climate-change-military-main-outputs
- Main collaborator: Conflict and Environment Observatory (CEOBS)

Military carbon bootprint: key components



- 'Core' carbon emissions highlighted in bold
- 'Carbon footprint' covers (black) items to the left of dotted line – and is comparable with impacts seen in civilian sectors
- 'Carbon bootprint' is broader and also includes the items to the right of dotted line
- For more analysis, see (e.g.) SGR (2020).

[image credits: MOD; Gerd Altmann; Free Photos]

Key terminology

- Core carbon emissions (organisational/ operational)
  - Direct fuel use of military vehicles
  - Direct fuel use of military bases, eg heating
  - Electricity use of military activities
- Carbon footprint
  - Core emissions plus upstream supply chain
- Carbon bootprint
  - Carbon footprint plus impacts of war-fighting
- *'Carbon emissions' and 'GHG emissions' widely used interchangeably*

- Core carbon emissions known as 'scope 1 & 2' emissions
- Upstream supply chain includes military tech manufacture, component manufacture, raw material extraction, and all military supplies – known as 'scope 3 upstream'
- Impacts of war-fighting includes urban fires, damage of ecosystems, healthcare of survivors, refugee movement, post-conflict reconstruction – known as 'scope 3+'

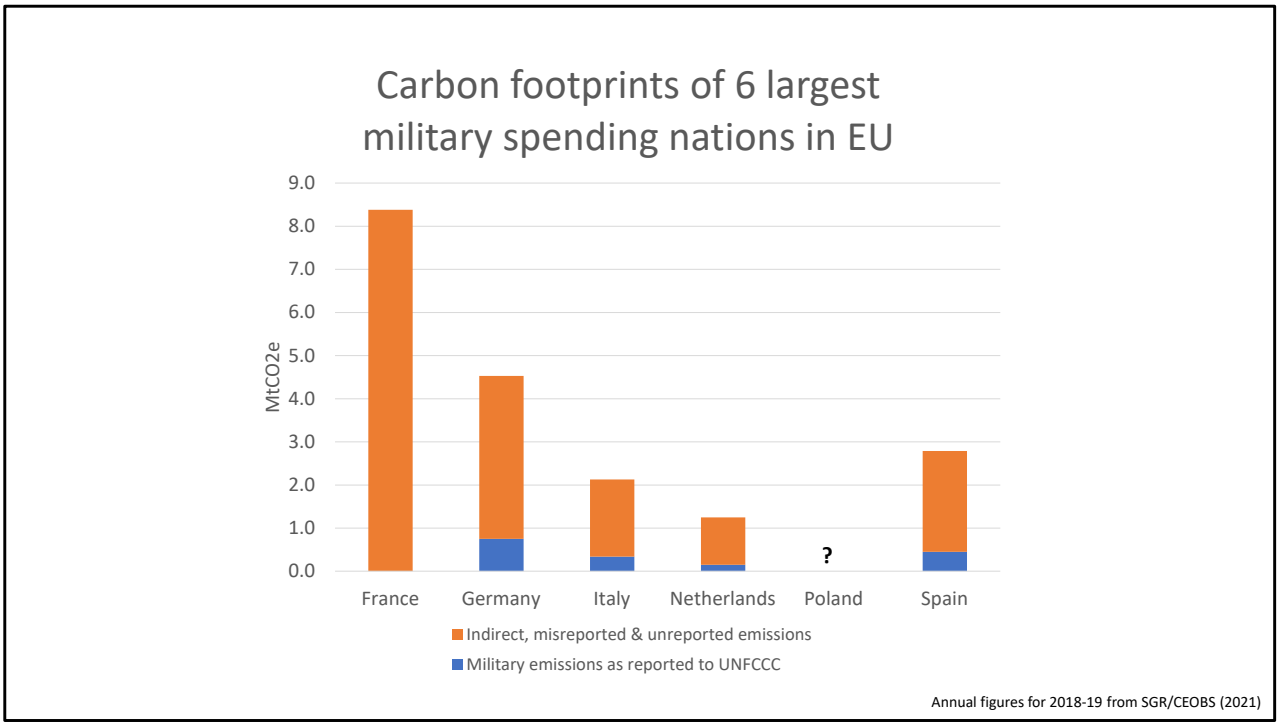
[Image: Clker-Free-Vector-Images]

GHG data sources & quality

Source	Which nations?	Quality	Problems
National GHG inventory reports (under UNFCCC)	Most industrialised/ large nations	Very poor	Inconsistent reporting; much military data mixed with civilian data; international data unreported
Defence ministry reports	Some NATO/ EU nations	Variable	Very few nations report core emissions in adequate detail
Corporate annual reports	Some large international military tech companies	Variable	Increasing number report core emissions
Academic/ NGO analyses	Some estimates for nations/ regions/ world/ specific wars	Limited analysis	Very small number, but some data on supply chain/ war impacts; IPCC reports include no data

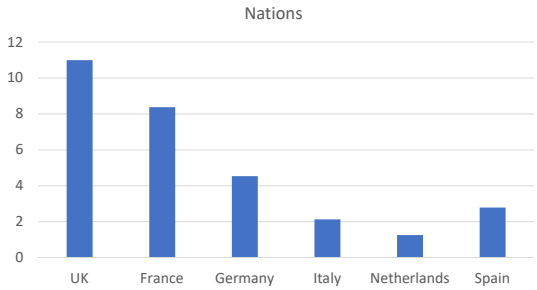
- 1997 UNFCCC decision that military emissions in international space would not be reported
- Extrapolation from data on energy use, military personnel, military equipment, civilian equivalents

- UNFCCC – United Nations Framework Convention on Climate Change
- For more on the 1997 intergovernmental decision, see: Lorincz (2015)
- See also: Military Emissions Gap (2022)



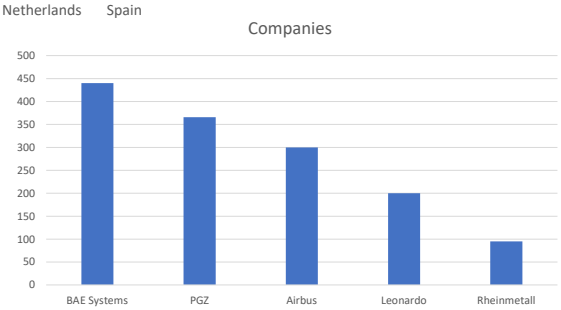
- MtCO2e – million tonnes of carbon dioxide equivalent – standard measure of GHG emissions
- Data from SGR/ CEOBS (2021) – United Nations Framework Convention on Climate Change (UNFCCC) figures from 2018; total estimates based on 2019 data
- Some reasons for national differences:
    - Level of military spending – France and Germany especially high
    - Numbers of high-consumption vehicles, especially planes & ships – France especially high
    - Size of military technology industries – France especially high
    - Level of overseas military operations – France especially high

Comparing UK and EU military carbon footprints



- UK footprint 30% higher than France
- BAE Systems emissions 20% higher than PGZ

- UK military carbon footprint per head of population 3x that of Germany

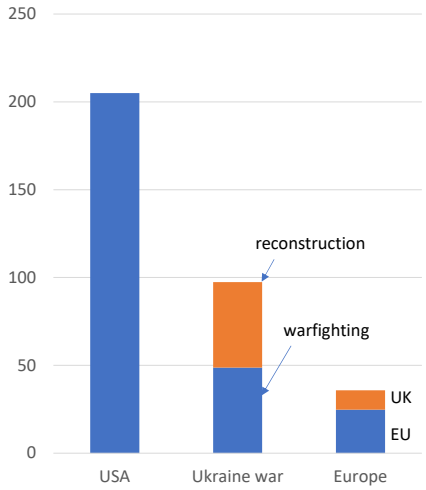


Annual figures: 2017-18 from SGR (2020); 2018-19 from SGR/CEOBS (2021)

- UK military carbon footprint per head of population 25% higher than France – other three nations broadly similar to Germany
- Companies: PGZ based in Poland; Airbus - mainly France; Leonardo - Italy; Rheinmetall - Germany

GHG emissions:
US & European militaries v Ukraine war

- US core: 56 million tonnes CO2e
- US footprint: approx. 205 MtCO2e
- US footprint approx. 6x EU+UK
- Ukraine war emissions
  - Data on first 7 months
  - Warfighting emissions greater than European footprint
  - Post-conflict reconstruction over several years

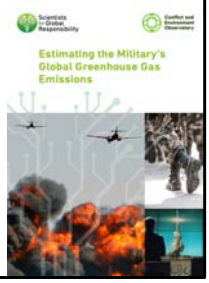


Sources: Brown University (2019); SGR (2020); SGR/CEOBS (2021); Climate Focus et al (2022)

- US figures from 2018; Ukraine war figures from 2022; other figures dated as in previous slides
- US military carbon footprint – SGR estimate based on US figure for core military emissions (56Mt) and scaled up assuming the ratio is the same as for UK military situation (3.7)
- Ukraine war emissions – warfighting (49Mt) includes military fuel use (9Mt), fires (24Mt), gas pipeline leaks (15Mt), refugee movement (1Mt)
- Data sources: USA: Brown University (2019); UK: SGR (2020); EU: SGR/CEOBS (2021); Ukraine war: Climate Focus et al (2022)

Global estimate: core military emissions

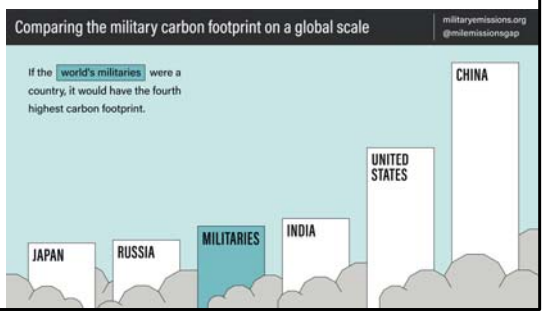
- Global total (best estimate): **500 MtCO2e/ 1.0%**
- Extrapolated from US/UK/EU data, using proxy data
- Uncertainty range
  - 284 to 602 million tonnes of carbon dioxide equivalent
  - 0.6% to 1.2% of global GHG emissions
- Report gives breakdown by geo-political region
- Averaging means estimates for country-level less reliable



- Data from 2019 (i.e. before COVID-19 pandemic)
- Proxy data includes: number of military personnel; ratio of stationary to mobile emissions
- SGR/CEOBS (2022)

Global estimate: military carbon footprint

- Global total (best estimate): **2,750 MtCO2e/ 5.5%**
- **Larger than Russia's** total carbon footprint
- Uncertainty range
  - 1,644 to 3,484 million tonnes of carbon dioxide equivalent
  - 3.3% to 7.0% of global GHG emissions
- Averaging means estimates for country-level less unreliable



- NB Supply chain multiplier significantly higher than in country-level studies due to discovery of gaps in earlier data
- SGR/CEOBS (2022)

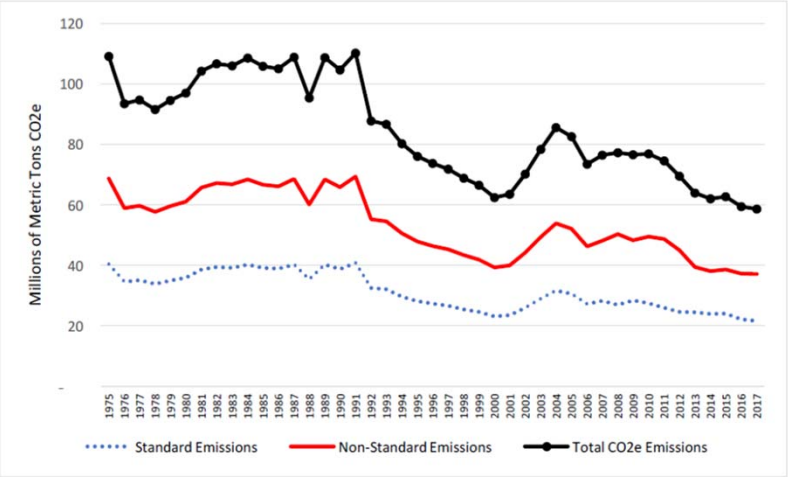
Assumptions/ data not included

- All military data assumed to be reliable
- Carbon footprint estimates
  - Emissions from warfighting impacts not included
  - Radiative forcing by aviation in stratosphere not included
  - Supply chain multiplier is especially uncertain

➢Global military carbon *bootprint* could be larger

[image credit: State Emergency Services of Ukraine]

Historical data: US military core emissions



Brown University (2019)

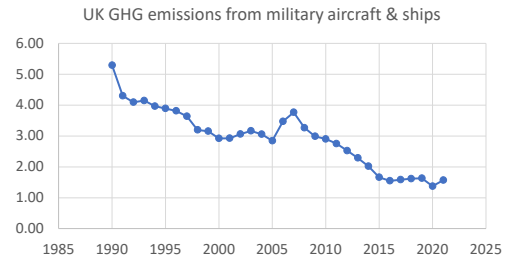
Major decreases due to:

- Reduction in military activity/ bases/ personnel/ vehicles (especially after: Vietnam War; Cold War; Iraq War)
- Reduction in coal & oil use for heating at bases
- Reduction in coal use for national electricity supply (especially since 2007)

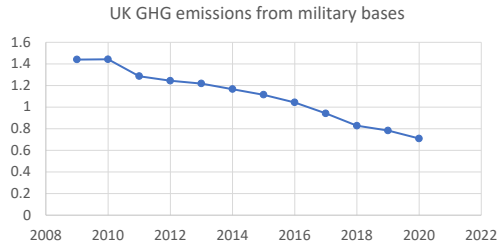
Role of energy efficiency improvements/ shifts in military tech is unclear

- After end of Cold War (1991-2000), US armed forces emissions fell by 44%
- US active military personnel fell by 36% between 1975 and 2014 (Coleman, 2015) – little change since
- However, since around 2000, the use of private military and security companies has replaced some military functions, including in combat zones (e.g. Iraq War)
- At US military bases, use of fuel oil fell by 74% and coal by 59% between 1975 and 2018 (Brown University, 2019)
- Coal use for national electricity generation fell by 43% between 2007 and 2018 (Wikipedia, 2023)

Historical data: UK military core emissions



DESNZ (2023)



MOD (2017-22)

Major decreases due to:

- Reduction in military activity/ bases/ personnel/ vehicles (especially after: Cold War; Iraq War & 2010 cuts)
- Reduction in coal use for national electricity supply

Role of energy efficiency improvements/ shifts in military tech is unclear

Latest data for military bases revised upwards by 40%

- After end of Cold War (1991-2000), UK air force & navy emissions fell by 32% (DESNZ, 2023)
- 2010 Defence and Security Review led to significant cuts in military spending/ equipment/ personnel (part of national 'austerity' policies following Global Financial Crisis)
- UK active military personnel numbers fell 23% between 2009 and 2019, accompanied by sell-off of military buildings (MOD, 2009-19)
- Unit carbon emissions of UK electricity fell 53% between 2009 and 2020 due to UK climate strategies (DESNZ, 2022)
- COVID-19 pandemic led to temporary emissions drop in 2020
- Military base data revised upwards by 40% (SGR, 2023)
- Further analysis of fall in military base emissions given in: SGR (2023)

Effect of military spending increases?

- Available historical data shows military GHG emissions rise and fall with levels of military activity, personnel, bases, vehicles
  - And therefore *spending* (although relationship is more complicated)
- Global military spending at $2,200,000,000,000
- Large increases in military spending in 2022
  - Global: 3.7%
  - Europe: 13% - with more to come
- Very difficult to avoid increases in GHG emissions

SIPRI (2023)

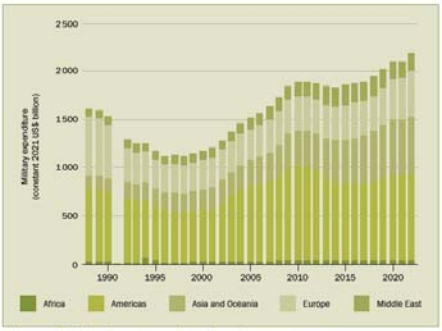


Figure 1. World military expenditure, by region, 1988–2022

Data from: SIPRI (2023)

‘Green militaries’

- “Defence will seek to use the transition to add to capabilities”
- Reducing carbon emissions of weapons systems?
  - Improving energy efficiency of existing tech
    - Little evidence this makes much difference
  - Technology shifts
    - Drones – but AI arms race
    - Nuclear power – but radiological & proliferation risks
    - Batteries – but heavy & limited minerals
    - Biofuels – but lack of sustainable sources
    - Synthetic fuels – but huge energy cost
  - Offsetting
    - planting trees on military land/ buying credits – but ineffective

➢We need a better approach to security

- Quotes and info from (e.g.) MOD (2021)
- Title of US DoD report shows the main motivation for energy saving measures - from: Lorincz (2015)
- Some of these options are at an early stage of technological development for military use, so it will be 10-20 years before they can make *any* difference to emissions
- In general, this approach will simply fuel arms races and therefore increase the risk of war

References

Brown University (2019). Pentagon Fuel Use, Climate Change, and the Costs of War. https://watson.brown.edu/costsofwar/papers/ClimateChangeandCostofWar

Climate Focus et al (2022). Climate damage caused by Russia's war in Ukraine. https://climatefocus.com/publications/climate-damage-caused-by-russias-war-in-ukraine/

Coleman (2015). U.S. Military Personnel 1954-2014. https://historyinpieces.com/research/us-military-personnel-1954-2014

DESNZ (2022). Government conversion factors for company reporting of greenhouse gas emissions. https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting

DESNZ (2023). Final UK greenhouse gas emissions national statistics: 1990 to 2021. https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2021

Lorincz (2015). Demilitarization for Deep Decarbonization. Presentation. https://www.sgr.org.uk/events/messages-paris-conference-forgotten-dimensions-climate-change

Military Emissions Gap (2022). https://militaryemissions.org/

MOD (2021). Climate Change and Sustainability Strategic Approach. https://www.gov.uk/government/publications/ministry-of-defence-climate-change-and-sustainability-strategic-approach

MOD (2022). Annual report and accounts, 2003-04 to 2021-22. https://www.gov.uk/government/collections/mod-annual-reports

SGR (2020). The environmental impacts of the UK military sector. Report. https://www.sgr.org.uk/publications/environmental-impacts-uk-military-sector

SGR/ CEOBS (2021). Under the Radar: the carbon footprint of Europe's military sectors. Report. https://www.sgr.org.uk/publications/under-radar-carbon-footprint-europe-s-military-sectors

SGR (2022). Comparing official UK statistics for military greenhouse gas emissions. https://www.sgr.org.uk/publications/comparing-official-uk-statistics-military-greenhouse-gas-emissions

SGR/ CEOBS (2022). Estimating the military's global greenhouse gas emissions. https://www.sgr.org.uk/publications/estimating-military-s-global-greenhouse-gas-emissions

SGR (2023). UK military GHG emissions and the Greening Government Commitments. Forthcoming. https://www.sgr.org.uk/publications/uk-military-ghg-emissions-and-greening-government-commitments

SIPRI (2023). Trends in World Military Expenditure, 2022. https://www.sipri.org/publications/2023/sipri-fact-sheets/trends-world-military-expenditure-2022

Wikipedia (2023). https://en.wikipedia.org/wiki/Electricity_sector_of_the_United_States