Article:

Simpson, M. orcid.org/0000-0002-2555-6019 and Hansen, S. (2025) Exaggerated claims for carbon dioxide and other 'greenhouse gases'. Journal of Sustainable Development, 18 (4). pp. 25-46. ISSN 1913-9063

https://doi.org/10.5539/jsd.v18n4p25

Journal of Sustainable Development; Vol. 18, No. 4; 2025
ISSN 1913-9063 E-ISSN 1913-9071
Published by Canadian Center of Science and Education

Exaggerated Claims for Carbon Dioxide and Other ‘Greenhouse Gases’

Michael Simpson[1] & Søren Hansen[2]

[1] Sheffield University Management School, The University of Sheffield, UK

[2] Søren Hansen, Editor: Klimarealisme.dk

Correspondence: Michael Simpson, Sheffield University Management School, The University of Sheffield, Conduit Road, Sheffield S10 1FL, UK. E-mail: m.simpson@sheffield.ac.uk. ORCiD: 0000-0002-2555-6019

Received: April 20, 2025 Accepted: May 31, 2025 Online Published: June 6, 2025

doi:10.5539/jsd.v18n4p25 URL: https://doi.org/10.5539/jsd.v18n4p25

Abstract

Carbon dioxide (CO_2) is a harmless highly beneficial rare trace gas essential for all life on Earth due to photosynthesis which produces simple sugars and carbohydrates in plants and a bi-product Oxygen (O_2) which is essential for all animal life. CO_2 is the basis of the entire food supply chain. CO_2 has been vilified as a ‘greenhouse gas’ and is thought to be responsible for ‘global warming’. Yet CO_2 is a weak greenhouse gas and cannot be responsible for ‘dangerous’ heating of the planet. It is claimed the greenhouse effect will be multiplied by a simultaneous increase in atmospheric water vapour content. Water vapour is the most significant greenhouse gas in the atmosphere. However, the claimed increase has not been seen and we can expect much less warming. This research explains that the exaggerated claims about CO_2, methane (CH_4) and nitrous oxide (N_2O) are misleading. These gases have a limited effect on temperature and the climate. Increases in these gases will have a decreasing effect, since absorption of radiation is logarithmic. We provide a parts per million by volume (ppmv) calculator for amounts of CO_2, and parts per billion (ppbv) calculator for amounts of CH_4, and N_2O. About half of the yearly emitted CO_2 is lost to the ocean and biosphere and does not appear in the atmosphere. There is considerable uncertainty about whether the small increases in concentration of CH_4 and N_2O are human-caused or natural.

Keywords: water vapour, carbon dioxide, methane, nitrous oxide, greenhouse gases

1. Introduction

There are many journal articles and books in the social sciences and economics making claims about the disastrous effects of so-called ‘greenhouse gases’ on the climate. Most of these claims are based on rumour (Cornale et al., 2025; Whitehouse, 2025), output from faulty climate models, IPCC Summaries for Policy Makers (SPM), activists making claims and are exaggerated beyond what is reasonable from a scientific point of view. For example:

“*…this is climate breakdown in real time.*” Antonio Guterres, 2024.

“*…the era of global boiling has arrived.*” Antonio Guterres, 2023.

Yet “*observations show no increase in damage or any danger to humanity today due to extreme weather or global warming.*” (Crok & May, 2023, pp. 140–161; see also Scafetta, 2024; Dayaratna, 2025).

The present authors are a scientist and a chemical engineer with experience of these so-called ‘greenhouse gases’. We are concerned that our colleagues in the social sciences and economics do not appreciate that there is considerable doubt about the effect these gases have on the atmosphere, temperatures and climate. For example, many papers in the social sciences and economics begin by suggesting that so many tonnes of CO_2 are emitted by some country, process or by burning fossil fuels and this will result in catastrophic climate change as a justification for a paper or book (e.g. McKinnon, 2018) suggesting ways to reduce or otherwise capture CO_2 or methane (CH_4) or nitrous oxide (N_2O) despite the extremely low concentrations of these gases in the atmosphere. The point here is that it is the concentration of these gases in the atmosphere which drives chemical and physical processes not the quantities emitted (Atkins, and de Paula 2014). Given the properties of these ‘greenhouse gases’ we question the exaggeration which is used when making these claims.

2. Method

Standard chemical and physical reference texts (Rumble, 2024; Aylward and Findlay, 2002) and online searches of reliable databases were used to collate the various (well known) physical and chemical properties of CO_2, CH_4, N_2O and other materials. Toxicity of these gases was investigated following a literature search for specific gases and their toxicity. All the information we have collated is freely available in the public domain but often only subject specialists such as the authors would use this information. The literature collated and reported here covers some important specialist areas of science not normally encountered by social scientists and economists. The physics of the calculation of parts per million by volume and parts per billion by volume from quantities emitted are provided below and in detail in the Appendix. It is hoped that these formulae will allow social scientists and economists to convert quantities emitted into concentrations in the atmosphere, calculate the likely temperature change and critically evaluate the need for any interventions.

2.1 The Parts Per Million by Volume (PPMV) Calculators

We provide three simple formulae for calculating parts per million by volume for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) from gigatonnes of emissions (see Appendix for details of the physics). Noting that a gigatonne is 1 Pg (1 petagram; and Peta is 10^{15})

(i) Calculating parts per million by volume for carbon dioxide (CO_2):

Concentration, CO_2 (ppmv) = n Gt x 0.12845

Where n = number of giga tonnes of CO_2 emitted.

Multiplying the gigatonnes by the factor of 0.12845 gives the ppmv from emissions if all the CO_2 remains in the atmosphere. However, approximately half the carbon dioxide emitted disappears into the ocean and biosphere and does not appear in the atmosphere.

(ii) Calculating parts per billion by volume for methane (CH_4)

Concentration, CH_4 (ppmv) = n Gt x 0.35243

Where n = number of gigatonnes of CH_4 emitted.

Concentration, CH_4 (ppbv) = n Gt x 0.35243 x 1000

Multiplying the gigatonnes by the factor of 0.35243 gives the ppmv and multiplying this value by 1000 gives ppbv emitted if all the CH_4 remains in the atmosphere.

(iii) Calculating parts per billion by volume for nitrous oxide (N_2O)

Concentration, N_2O (ppmv) = n Gt x 0.128438

Where n = number of gigatonnes of N_2O emitted.

Concentration in parts per billion by volume, N_2O (ppbv) = n Gt x 0.128438 x 1000

Multiplying the Giga tonnes by the factor of 0.128438 gives the ppmv and multiplying the ppmv value by 1000 gives ppbv if all the N_2O emitted remains in the atmosphere.

These formulae are used to show how the exaggerated claims for amounts emitted translate into very small concentrations in the atmosphere and are therefore negligible.

3. The Properties of Carbon Dioxide, Methane and Nitrous Oxide

3.1 Properties of Carbon Dioxide (CO_2)

Carbon dioxide, CO_2, is a harmless, colourless, odourless, tasteless rare trace gas. CO_2 is not toxic and is essential for all life on Earth as it is the major component of the carbon cycle. CO_2 is absorbed by plants which, with water, photosynthesize simple sugars and carbohydrates and the waste Oxygen (O_2) is transpired out of the plant (Gerhart and Ward, 2010; Tolbert et al., 1995; Hovenden and Newton, 2018; Reich et al., 2018). A table of the properties of CO_2, CH_4 and N_2O (including toxicity) is given in table 1.

CO_2 is highly beneficial at low concentrations, is the fundamental gas in the carbon cycle, is plant food and is, therefore, the basis of the entire food supply chain. Carbon dioxide, CO_2, is respired by all animal life. Humans exhale ~4% CO_2 (i.e. 40,000ppmv) and water vapour (~5-6%) from metabolic processes which consume sugars and carbohydrates and provide energy for muscular movement. The social cost of carbon (sic) does not need to be calculated and if it were calculated would likely be a net benefit to humanity because of increased crop yields and greening of marginal lands from photosynthesis (McKitrick, 2025; Tolbert, et al., 1995; NASA, 2016).

3.1.1 CO_2 Toxicity

The toxicity of CO_2 is well known and has been known for over 100 years (Guais et al, 2011):

> "*The gas is a weak central nervous system depressant at 30,000 ppm, giving rise to reduced acuity of hearing and increasing blood pressure and pulse. Exposure at 7%-10% produces unconsciousness within a few minutes. At low concentrations, gaseous carbon dioxide appears to have little toxicological effect. At higher concentrations it leads to an increased respiratory rate, tachycardia, cardiac arrhythmias and impaired consciousness. Concentrations >10% may cause convulsions, coma and death. Solid carbon dioxide may,* [due to its low temperature]*, cause burns following direct contact. If it is warmed rapidly, large amounts of carbon dioxide are generated, which can be dangerous, particularly within confined areas. Carbon dioxide at high concentration in air causes stinging sensation in eyes, nose, and throat*." (see: National Library of Medicine: https://pubchem.ncbi.nlm.nih.gov/compound/Carbon-Dioxide#section=Toxicity-Summary)

Table 1. Properties of carbon dioxide, methane and nitrous oxide

Property	**Carbon Dioxide, CO_2**	**Methane, CH_4**	**Nitrous Oxide, N_2O**
Molecular weight	44.01	16.04	44.013
Boiling Point (°C)	-78 (sublimes) (note a)	-161.49	-89.0
Melting Point (°C)	-57 (note b)	-182.48	-91.0
Specific heat capacity: J/(mol.K)	36.33 to 36.61 (over 0°C to 15°C)	35.71 (at 300K or 27°C)	38.604 (at 298K or 25°C)
Density: g/cm^3 (cf. density of air at std pressure and 25°C is 1.19 g/L or 0.00119g/cm^3)	0.00195 g/cm^3 at STP (i.e. heavier than air)	0.000715 g/cm^3 at STP (i.e. lighter than air)	1.22 g/cm^3 (l) at boiling point. 1.799g/L (g) at STP or 0.001799 g/cm^3 (i.e. heavier than air)
Properties at Room Temperature	A colourless, odourless rare trace gas which occurs naturally and is part of the carbon cycle. It is denser than air. Soluble in water, solubility decreases as temperature increases. Is non-combustible.	A colourless, odourless, lighter than air rare trace gas which occurs naturally and is the major component of natural gas. Oxidises in air to form CO_2. Highly flammable and burns readily in air mixtures of 5.3-14%. Slightly soluble in water. May have mild anaesthetic properties.	A colourless rare trace gas, with a faint sweet odour. Supports combustion by releasing an oxygen radical. Used in medicine as an anaesthetic. Used as a propellant in rockets and as a fuel additive in car racing. Commonly known as 'laughing gas'. Soluble in water.
Current (2024) Concentration in the atmosphere	~423ppmv	1927ppbv (i.e. 1.927ppmv)	337.72 ppbv (i.e. 0.337ppmv)
LD50/LC50	Non-toxic at low concentrations (note c). LC50 470,000ppmv in rats. May asphyxiate by the displacement of air.	May asphyxiate by the displacement of air. (note d). It is not an irritant or carcinogen.	May asphyxiate by the displacement of air. Toxicity is due to inactivation of the vitamin B12. May cause neurological problems with chronic use.(note e)

Notes: (a) CO_2 sublimes at atmospheric pressure and does not have a liquid phase. (b) Under a pressure of 5.185 bar CO_2 does melt and has a liquid phase. (c) Muijser et al., (2014) and: <https://pubchem.ncbi.nlm.nih.gov/compound/Carbon-Dioxide#section=Toxicity-Summary>. (d) <https://www.ncbi.nlm.nih.gov/books/NBK208285/>. (e) <https://www.acep.org/toxicology/newsroom/jun2021/nitrous-oxide-misuse-and-abuse>.

Only one LC50 value is available for a 30-minute exposure in rats to 470,000ppmv (47 volume %) as part of an investigation of the safety of carbon dioxide storage facilities and risk assessment of accidental release associated with handling, transport and storage (Muijser et al., 2014). The highest concentration without mortality was 257,000ppmv (National Library of Medicine). These figures are some 600 to 1000 times greater than current concentrations in the atmosphere. Earlier work (Burg and Bos, 2009) looking at the potential for high local concentrations of CO_2 in air from leakage from carbon capture and storage (CCS) facilities found that:

> "*The inhalation of high concentrations of CO2 can lower the pH of the blood and thus trigger effects on the respiratory, cardiovascular and central nervous systems. In summary, CO2 exposure can give rise to a variety of effects, including an increase in inhalation rate, in heart rate and in blood pressure and it can induce cardiovascular effects. Mortality is most likely due to effects on the respiratory tract and oxygen supply. These effects are caused by two mechanisms: asphyxia and by direct effects of CO2 on the regulation of respiration. Respiration is a tightly controlled phenomenon in mammals (including humans). It is primary regulated by the CO2 tension in arterial blood (PaCO2) and the concentration of hydrogen ions (pH). Arterial PaO2* [i.e. Oxygen] *is not the major driving force for ventilation under normal circumstances. So, any condition that increases PaCO2 will result in a stimulation of ventilation in order to eliminate the surplus of CO2. A too high level of CO2 in blood and tissues will lead to acidosis, which is harmful for mammalian tissues, especially those with a high sensitivity (e.g. brain)*." (Burg and Bos, 2009: p.2.)

In buildings and submarines concentrations of CO_2 are more than ten times those of ambient air with no deleterious effects observed, for example:

> "*The main contaminant of submarine air is CO_2. In ordinary buildings 1000 ppm is usually considered as a maximum concentration. This value is not based on health effects but on the rate of ventilation. In submarines, higher CO_2 concentrations are permitted, usually 5000-7000 ppm*." (Persson and Wadsö, 2002: 807)

3.1.2 Carbon and Carbon Dioxide

We note that many researchers are confused about the difference between carbon (C) emissions and carbon dioxide (CO_2) emissions with claims that both are pollutants. This has resulted in terms such as 'decarbonize' (McKinnon, 2018) and ideas of carbon capture and storage. In the strict scientific sense, there are several allotropes of carbon (e.g. carbon black, graphite, diamond, Buckminsterfullerenes, alpha and beta carbynes, graphene, Ries Crater carbon, and amorphous carbon) (Goresy and Donnay, 1968). Carbon black, created by the incomplete combustion of fuels, forms a major part of soot, and strongly absorbs light and is indeed a pollutant which may occur in fine particulates (PM10 and PM2.5) which presents some risks to human health (Royal College of Physicians, 2016; Milloy, 2016).

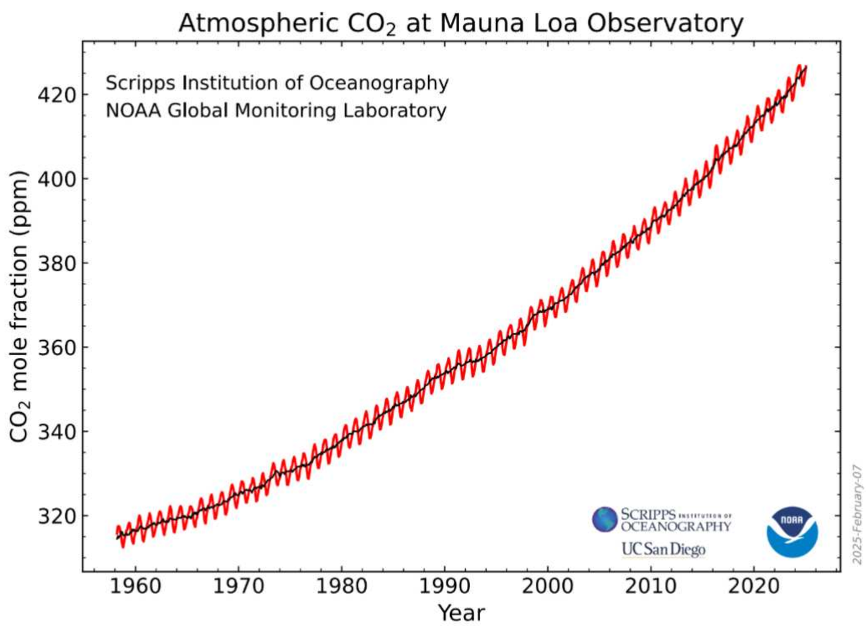

Figure 1. Atmospheric CO_2 concentrations (ppmv) at Mauna Loa Observatory

3.1.3 Effect of CO_2 on Temperature

The effect of CO_2 on atmospheric temperature is logarithmic according to the IPCC. The IPCC reports radiative Forcing (Watts per square meter) as:

$$\text{Forcing (F)} = 5.35\text{Ln}(C_t/C_0) \quad (1)$$

and that temperature change is:

$$\text{Delta(t)} = \text{Lambda x Delta(F)} \quad (2)$$

Where Lambda is thought to be 0.4 to 0.5; C_t is the concentration (ppmv) and C_0 is the starting concentration (ppmv) (Myhre, et al., 1998; Simpson 2024). There are major uncertainties about the climate sensitivity on doubling concentrations of CO_2 (Watts et al., 2022).

With an increase from 400ppmv to 800ppmv of CO_2 the cumulative expected temperature change is ~1.49°C (Lambda = 0.4) and ~1.85°C (Lambda = 0.5) which is small and certainly not cause for alarm or for declaring a 'climate emergency' (Simpson, 2024). Some authors use Lambda as 1/3.2 (i.e. 0.3125) in their calculations which gives a lower figure of 1.16°C temperature change on doubling the concentration of CO_2 from 400ppmv to 800ppmv (Happer and Lindzen, 2022). Happer (2025) calculates doubling the concentration of CO_2, without feedback, gives 0.75°C. At current rates of change in the CO_2 concentration in the atmosphere (circa 2-3ppmv per annum, Figure 1) a doubling from 400ppmv to 800ppmv would take over 130 years and the effect on temperature is expected to be 0.75°C (0.00577°C a year) or 1.16°C (0.00892°C a year) to 1.85°C (0.014°C a year) which is negligible and would result in a lower temperature than experienced in the medieval warm period (Wrightstone, 2017).

Other estimates of the temperature change range from 0°C to 6°C on doubling CO_2 concentrations (Simpson, 2024) noting that the ocean is a very large heat sink. Measured temperatures are also affected by the urban heat island effect by as much as 65% between 1895-2023 (Spencer et al., 2025) which casts doubt on the claims for human caused warming, the effect of greenhouse gases and the value of Lambda used in equation (2) which could be much lower giving much less warming on doubling CO_2 concentrations. The uncertainties are large and lead to unreliable projections and exaggerations.

Professor Happer from the CO_2 Coalition suggests:

> "*The message I want you to understand, which practically no one really understands, is that doubling CO_2* [concentration] *makes almost no difference. You could triple or quadruple CO_2 concentrations*, *and it also would make little difference* [to temperatures]." William Happer PhD, Princeton Emeritus Professor, Physics.

> "*Hence, the CO_2 greenhouse effect as used in the current global warming hypothesis is impossible. The greenhouse effect itself and the CO_2 greenhouse effect based global warming hypothesis is a politically motivated dangerous artifact without any theoretical or empirical footing. Planet Earth obeys the most fundamental laws of radiation physics.*" (Miskolczi, 2023, pp.232).

The health effects of the greenhouse gases and the forecasted moderate rise in temperatures under the extreme RCP8.5 scenario (which suggests that use of coal will be significantly increased) has been studied (Dunn and Legates, 2024) and found to be harmless and positively beneficial:

> "*Claims that global warming will have net negative effects on human health and increased atmospheric concentrations of carbon-dioxide levels are not supported by scientific evidence. Moderate warming could provide net benefits for human welfare, agriculture, and the biosphere by reducing cold-related deaths, increasing the amount of arable land, extending the length of growing seasons, and invigorating plant life. The harmful effects of restricting access to fossil fuel energy and subsequently causing energy costs to increase would likely outweigh any potential benefits from slightly delaying any rise in temperatures. Climate change is likely to have less impact on health and welfare than policies that would deprive the poor living in emerging economies of the benefits of abundant and inexpensive energy.*" (Dunn and Legates, 2024: 1).

3.2 Methane, CH_4

Methane is a common gas in the oil and gas industries, is emitted from landfill sites, coal mines, livestock facilities, wastewater treatment plants (Etheridge, et al., 1998) and occurs naturally in wetland areas from the anaerobic decomposition of animal and plant matter (Michel et al., 2024; Nisbet et al., 2023): (https://nevadanano.com/methane-gas-poisoning-and-exposure/)

For cattle, ruminants belching mainly, which produce approximately 250 to 500liters of methane a day each and with 1.5 billion cattle worldwide we obtain 0.0689ppmv or 68.9ppbv CH_4 per annum suggesting that alarmism over cattle methane emissions and demands for human dietary changes are exaggerated. There is no reason for the Irish government to attempt to cull 200,000 cattle in the name of climate change. All that will happen is that the 6.3bn Euro in 2024 Irish dairy products (milk, butter, cheese, yoghurt etc) industry will be decimated for no benefit to the climate (Leach, 2024).

> "*…the Irish Department of Agriculture would initiate a cull of 65,000 cows a year for three years, effectively reducing the national dairy herd by 10%. The proposal reportedly would be offered as a voluntary option to aging farmers as a 'retirement exit scheme…' The Irish government estimates the plan would cost the nation $640 million and assist the agricultural industry in reducing greenhouse gas emissions by 25% over the next seven years*" Leach, 2024 (https://www.dairyherd.com/news/business/ireland-proposes-culling-200-000-cows-help-meet-climate-goals-farmers-push-back)

The proposed reduction of 200,000 cattle will achieve approximately 9.2 x 10^{-6} ppmv (i.e. 9.2 x 10^{-3} ppbv) concentration per annum saving in methane concentrations which is negligible and would have no effect on the climate. It is hard to see where the 25% reduction in so-called greenhouse gases comes from and it is very difficult to see a justification for such a government policy. It certainly does not pass the cost-benefit test.

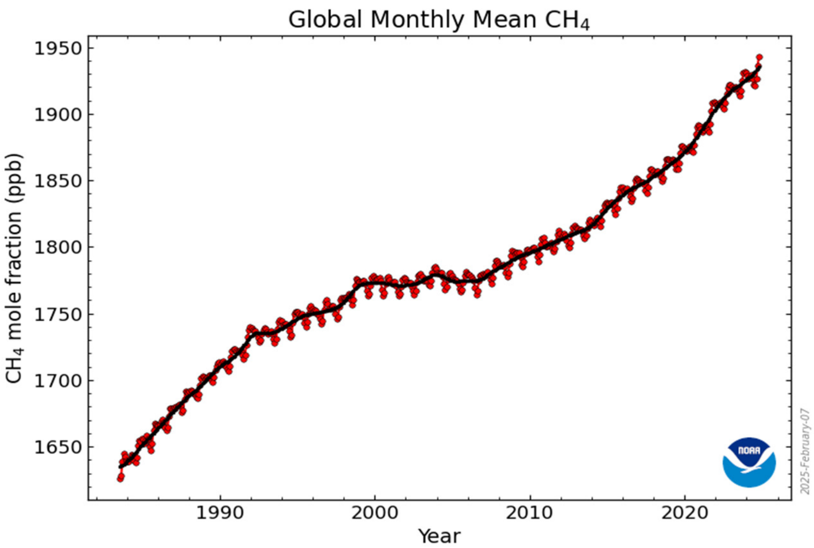

Figure 2. Global monthly mean CH_4 concentration (ppbv) 1987-2022 (source: Lan et al. 2022)

According to the US Environmental Protection Agency:

> "*A single cow produces between 154 to 264 pounds of methane gas per year. Not counting for the emissions of any other livestock, 1.5 billion cattle, raised specifically for meat production worldwide, emit at least 231 billion pounds of methane into the atmosphere each year (Our World in Data).*" (EPA, 2025) (https://www.epa.gov/snep/agriculture-and-aquaculture-food-thought)

Calculation gives approximately 0.0633ppmv (63.3ppbv) concentration per year methane from 1.5billion cattle emitting 264lbs of methane a year. The measured concentration of CH_4 is 1.95ppmv (1950ppbv) in the atmosphere. However, such small concentrations are physically negligible and can hardly affect the properties of the atmosphere. Other sources indicate a huge variation in emission estimates for methane from farming (Ritchie, 2020). Cattle do not contribute to the yearly increase in the atmospheric content of methane, if the number of cattle is unchanged. Their contribution is each year balanced by the natural removal of the gas by oxidation to CO_2. The concentration of methane in air is extremely small (Figure 2) and therefore culling cattle or changing diets for cattle and humans is not necessary.

Methane oxidises over ~9 years to carbon dioxide by reaction with OH radicals and ozone (IPCC AR6 WGI, section 6.3.1, pp. 835-836), but it seems unrealistic and unnecessary to try and increase the concentration of OH radicals to remove the small concentration of methane in the atmosphere (Liu et al.,2024; Li et al., 2018).

3.3 Nitrous Oxide, N_2O

Nitrous Oxide is commonly known as 'laughing gas' and is used in medicine as an anaesthetic. It dissolves in water and is a colourless non-flammable gas which has a slightly sweet scent and taste. At temperatures greater than 300°C N_2O is a powerful oxidising agent as it releases the oxygen radical and is used in rocket propellants and motor car racing fuels. About 40% of human-caused emissions are claimed to be from agriculture, as nitrogen fertilisers are digested into nitrous oxide by soil micro-organisms.

Nitrous oxide has been in use as an anaesthetic for nearly 200 years (https://www.acep.org/toxicology/newsroom/jun2021/nitrous-oxide-misuse-and-abuse):

> "*While morbidity or mortality related to acute toxicity are uncommon and usually related to accidental asphyxiation or trauma, chronic use has been found to result in significant neurologic toxicity, and more recently has been found to cause coagulopathy as well. Neurologic toxicity is rooted in the interaction between nitrous oxide and cobalamins, which has been known since at least 1976. Nitrous oxide irreversibly oxides the cobalt ion of cobalamin, rendering cobalamin unusable in its typical role as a co-enzyme. Vitamin B12 is a necessary co-factor for the formation of methionine from homocysteine, thus the non-functional vitamin B_{12} from nitrous oxide toxicity leads to impaired DNA synthesis and myelin production, as well as accumulation of homocysteine. This functional vitamin B_{12} deficiency can then cause demyelination of the spinal cord's dorsal column, resulting in paresthesia and ataxia, followed by extremity weakness. Physical exam will typically reveal flaccid weakness more prominent in the lower extremities, and MRI often demonstrates findings typical of posterior column degeneration. In the majority of cases, vitamin B_{12} levels are found to be low or low-normal*."

However, here we are considering long term effects of very high concentrations (perhaps >10%) usually involving nitrous oxide abuse. The very low concentrations in the atmosphere will have no effect on human health or the climate (Weimann, 2003).

Nitrous oxide is regarded as a pollutant, but it occurs naturally with a concentration of 337ppbv in 2024 and increasing at ~1ppbv per annum since 2001 which is equivalent to 7.8 x 10^{12} grams (7.8 x 10^6 tonnes) emitted per annum. Source:

https://www.epa.gov/climate-indicators/climate-change-indicators-atmospheric-concentrations-greenhouse-gases

3.4 Global Warming Potential' (GWP) and 'Carbon Dioxide Equivalent' (CO_2e)

The concentrations considered are negligible and would not be possible to detect in the atmosphere. Dawson et al., (2023) suggests that emissions of CH_4 from human breath (see later) equate to a 'carbon dioxide equivalent' (CO_2e) of 53.9Gg p.a. However, they do not equate to 53.9Gg of CO_2 (approximately 6.92x10^{-6} ppmv of CO_2) as there is no such measurable physical property as 'global warming potential' (GWP) or 'carbon dioxide equivalent' (CO_2e). Global warming potential (GWP) is defined as:

> "*A measure of how much a greenhouse gas warms the Earth compared to carbon dioxide (CO2) over a specific time period, using CO2 as a baseline with a GWP of 1."* And *"**Global-warming potential**, abbreviated as **GWP**, is a term used to describe the relative potency, molecule for molecule, of a greenhouse gas, taking account of how long it remains active in the atmosphere. The global-warming potentials (GWPs) currently used are those calculated over 100 years. Carbon dioxide is taken as the gas of reference and given a 100-year GWP of 1*." Source: <https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Global-warming_potential_(GWP)>

Carbon dioxide equivalent (CO2e) is defined as:

> *"…a metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential. Carbon dioxide equivalents are commonly expressed as **million metric tonnes of carbon dioxide equivalents**, abbreviated as **MMTCDE**. The carbon dioxide equivalent for a gas is derived by multiplying the tonnes of the gas by the associated GWP:*

*MMTCDE = (million metric tonnes of a gas) * (GWP of the gas).*

> *For example, the GWP for methane is 25 and for nitrous oxide 298. This means that emissions of 1 million metric tonnes of methane and nitrous oxide respectively is equivalent to emissions of 25 and 298 million metric tonnes of carbon dioxide*." Source:<https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Carbon_dioxide_equivalent>

However, 1 million metric tonnes of CO_2 is $1x10^{12}$ grams giving a concentration $1.2845x10^{-4}$ ppmv of CO_2 in the atmosphere which is negligible and would have no effect on the climate whatsoever. Thus, 25 times that for methane would be equivalent to $3.21x10^{-3}$ ppmv of CO_2 which is again negligible. For nitrous oxide, 298 times the figure for CO_2 gives $3.828x10^{-2}$ ppmv of CO_2 and is negligible. These figures and the fact that methane and nitrous oxide occur in very small concentrations in the atmosphere and have lifetimes less than 100 years suggests that the CO_2 equivalent figures are very small to negligible. Yet they are used to scare people into thinking there is some sort of crisis or emergency.

These concepts are used by computer modellers as *ad hoc* assumptions for convenience. Noting that the ability of CO_2 to warm the atmosphere by absorption of infrared radiation is logarithmic (a law of diminishing returns) and therefore any calculated value for the 'global warming potential' and 'carbon dioxide equivalent' will be a moving target (Sheahen, 2021). Thus, it would be currently (at ~423ppmv of CO_2) expected that the calculated value for the 'global warming potential' and 'carbon dioxide equivalent' would be low given the near saturation of the CO_2 infrared absorption bands (van Wijngaarden, & Happer, 2019, 2020, 2021a, 2021b, 2022; Sheahen, 2021).

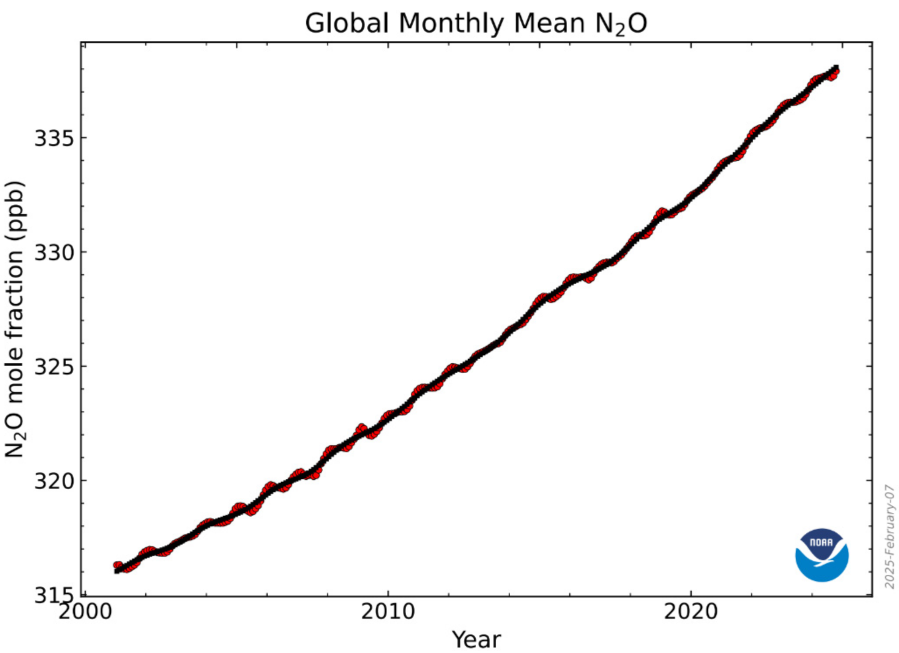

Figure 3. Global monthly mean N_2O concentrations (ppbv)

3.5 Human Breath and Flatulence

3.5.1 Human Breath

CO_2, N_2O and CH_4 occurs in exhaled human breath (Dawson et al., 2023):

> "*We estimate a total emission of 1.04 (0.86–1.40) Gg of CH_4 and 0.069 (0.066–0.072) Gg of N_2O in human breath annually in the UK, the equivalent of 53.9 (47.8–60.0) Gg of CO_2. In terms of magnitude, these values are approximately 0.05% and 0.1% of the total emissions of CH_4 and N_2O reported in the UK national greenhouse gas inventories.*" Dawson et al., 2023.

Taking the worst case, these masses (1.4Gg CH_4; 0.072Gg N_2O; 60Gg CO_2 per annum) equate to concentrations in the atmosphere:

Methane (CH_4) 1.4Gg: $4.93x10^{-7}$ ppmv ($4.93x10^{-4}$ ppbv) per annum.

Nitrous Oxide (N_2O) 0.072Gg: $9.25x10^{-9}$ ppmv ($9.25x10^{-6}$ ppbv) per annum.

Carbon Dioxide (CO_2) 60Gg: $7.71x10^{-6}$ ppmv ($7.71x10^{-3}$ ppbv) per annum.

Hardly affecting the composition of the atmosphere and giving negligible atmospheric warming.

Dawson et al. (2023) concluded:

> *"Therefore, emissions of these gases are generally ignored in most environmental monitoring or inventory work as they are considered negligible. However, there are reasons to study these emissions further. The factors that affect human emissions of CH_4 and N_2O are not well understood and the impacts of an aging population and shifting diets is still relatively uncertain. Converting from high meat and protein content diets to higher fibre vegetarian options to mitigate emissions of greenhouse gases from meat production potentially results in higher production of gases in the human gut, and an element of pollution swapping could occur."* Dawson et al., 2023: 2.

Mitsui and Kondo (1999) estimated that the global emission of N_2O from 5.8 billion people breathing would be up to 12 Gg N_2O yr^{-1} giving $1.54x10^{-6}$ of a ppmv (i.e. $1.5x10^{-3}$ ppbv) N_2O in the atmosphere which is extremely small and would have no effect on the atmosphere or climate.

3.5.2 Human Flatulence

Early work by Tomlin et al. (1991) looked at human flatulence by monitoring hydrogen H_2, CO_2, CH_4 but not N_2O (which may have been in the unidentified residual volumes of gas). Total daily volume (from both men and women) ranged from 476 to 1491 ml (median 705 ml); hydrogen volume was 361ml/24hr (range 42-1060), CO_2 volume 68 ml/24 h (range 25-116) and CH_4 volume three volunteers produced methane (3, 26, and 120 ml/24 h).

Taking the highest figures for carbon dioxide (116ml/24h per person) and methane (120ml/24h per person) and calculating over a year we obtain ~$8.7x10^{-5}$ ppmv (i.e. 0.087ppbv) for CO_2 per annum and $2.22x10^{-5}$ ppmv (i.e. 0.0222ppbv) for methane per annum (assuming a population of 8.2 billion people). These are extremely small concentrations of these gases and unlikely to have any measurable effect on the atmospheric temperature or the climate according to the calculations in equations (1) and (2). Hydrogen is not a greenhouse gas because it does not have a dipolar bond between the hydrogen atoms and therefore does not absorb infrared radiation.

The research into human breath and flatulence may have some useful biochemical and physiological purposes but as far as the climate is concerned the research is rather pointless given the extremely low concentrations of N_2O and CH_4 in the atmosphere and the extremely small contribution from human respiration and flatulence.

3.6 Water and Absorption of Radiation

The temperature is governed by the energy balance at the top of the atmosphere (TOA) (Coe et al. 2021; Schwartz 2018a & 2018b).

> "*At equilibrium, energy input from the sun is balanced by the energy radiating from the earth, which is a function of its temperature. The term "greenhouse effect" is used to describe the process whereby short wavelength solar radiation is transmitted through the atmosphere, whereas components of the long wavelength radiation emitted by the earth are absorbed by the atmosphere, thus limiting reradiation into space with a consequential warming of the earth*" (Coe et al., 2021:30)

Water occurs in all three phases (solid, liquid and gas) and is claimed to be the strongest 'greenhouse gas' as it absorbs infrared (longwave) radiation over a wide range of frequencies. However, water occurs in such large quantities that it would be impossible to attempt to reduce water vapour in the atmosphere. Water (with CO_2) is essential for all life on Earth. Given the concentration of H_2O in air the infrared absorption bands are saturated and that further increases in atmospheric water content would have no effect on the climate. Thus, claims that a slight increase in temperature would result in increased H_2O concentration and this would increase temperature further (a positive feedback mechanism) (Schneider et al., 1999) are falsified by the saturation of the infrared absorption bands (Coe et al., 2021; van Wijngaarden and Happer, 2019). The fact that any increase in concentration of atmospheric water vapour has not been detected suggests that this feedback mechanism does not operate in this way (see https://climate4you.com/GreenhouseGasses.htm#Atmospheric%20water%20vapor).

3.7 Sources and Sinks

There is considerable uncertainty on the sources and sinks for the very rare trace gases CH_4 and N_2O. We do not know the total human-caused emissions of CH_4 and N_2O or indeed all the natural sources of these gases. We can only monitor the annual changes of concentration in the atmosphere. It is, therefore, difficult to justify activist assertions that we should stop eating meat (Ritchie, 2020); get rid of cows (Leach, 2024) or stop using nitrogen-based fertilisers (UNEP) to stop or slow the increase of these rare trace gases in the atmosphere. Although in nitrogen-vulnerable areas the use of nitrogen-based fertilizers is forbidden because of runoff water containing nitrates which causes algae to grow excessively and deplete river oxygen levels killing fish.

3.8 Net Zero, Henry's Law and IPCC

3.8.1 Net Zero

Spencer (2024a and 2024b) gives some detailed analysis which pointed out that a 1% per annum reduction in CO_2 emissions would result in a maximum concentration of 460ppmv in 2063 and a decline thereafter. Spencer (2024b) comments:

> "*I continue to be perplexed why Net Zero is a goal, because it is not based upon the science. I can only assume that the scientific community's silence on the subject is because politically driven energy policy goals are driving the science, rather than vice versa*." (Spencer, 2024b).

We agree that funding mechanisms by governments are focused on solving politically driven problems or targets such as Net Zero or carbon capture and storage or the development of a hydrogen energy system or achieving an energy transition with little to no funding for fundamental research which could provide a better understanding of the science of climate change and a better understanding of many other scientific problems and opportunities that face modern society (Kelly et al., 2024)

A 1% reduction in CO_2 emissions per annum is very modest and is more likely to be achieved and be more palatable for the average household than an 'all-out attempt at Net Zero' against all the rare trace 'greenhouse gases'. In this latter 1% p.a. scenario we could continue with steel making, cement manufacture, industrial production and household heating/cooling using energy derived from fossil fuels.

Net Zero is a goal that makes no sense simply because the concentrations of these rare trace gases are, as we have calculated, small and have negligible effect on the physical properties of the atmosphere. If we were to stop all emissions of CO_2 tomorrow, the absorption/emission by the ocean would continue, because it is governed by the concentration of CO_2 in the air – not by our annual additions (Henry's law).

3.8.2 Henry's Law

Henry's law is one of the gas laws formulated by William Henry in 1803 and states:

> "*At a constant temperature, the amount of a given gas that dissolves in a given type and volume of liquid is directly proportional to the partial pressure of that gas in equilibrium with that liquid*."

$$C = kP_{gas} \tag{3}$$

Where: C is the solubility of a gas at a fixed temperature in a particular solvent

k is Henry's law constant (there are tables available of these constants for various liquids at over a range of temperature)

P_{gas} is the partial pressure of the gas above the liquid.

That is, the solubility of a gas in a particular liquid is directly proportional to the partial pressure of the gas above the liquid (see Atkins and De Paula, 2014). There is also some effect of temperature, increased temperature reduces the CO_2 absorption and then the ocean can emit CO_2. At lower temperatures the ocean absorbs more CO_2. Thus, in geological time, the ocean has a large influence on CO_2 concentrations in the atmosphere compared to anthropogenic influences. The ocean holds many times the quantity of CO_2 than is in the atmosphere.

By cutting our emissions in half, we would effectively stop the increase of the atmosphere's CO_2 content but that would not stop Henry's law working and the oceans would continue to absorb or emit CO_2 depending on the ocean temperature and the concentration of CO_2 in the atmosphere above it.

However, neither Net Zero by 2030 or 2050 are expected to have much influence on the global climate. Recent reports show that achieving Net Zero (emissions of CO_2) will have a negligible effect on temperature with an averted ~0.28°C derived from heat transfer calculations (Lindzen & Happer, 2024; Lindzen, et al., 2024). Such a small, averted, temperature change would not be noticeable, hardly measurable and would have no effect on the climate. A simple cost benefit analysis would show that Net Zero is a pointless and very expensive crusade against the gas of life, CO_2 (Simpson, 2024).

3.8.3 The IPCC

The national newspapers are now beginning to see what scientists, engineers and various think tanks have known for at least 20 years:

> "*The IPCC 2018 assessment report stated that 'for most economic sectors the impact of climate*

change will be small relative to the impacts of other drivers' such as 'changes in population, age, income, technology, relative prices, lifestyle, regulation, governance...' In its most recent assessment report [The IPCC] *suggested that the global economic impacts of climate change might be higher than estimated in 2018, but they had 'low confidence' in this point.*

It seems rational, therefore, to suggest that our heavy public investment in immature technologies wastes money. Our incredibly expensive effort to prevent climate change - which Britain, being responsible for only 1% of global emissions, cannot materially affect - would be better replaced by spending, probably lower and slower, on the necessary adaptations required by global warming, in which free enterprise can lead.

Existing climate change legislation puts British business and British taxpayers on a treadmill in which we must work much harder for each megawatt hour consumed. The simple question the Tories can ask once they have broken with the orthodoxy is: 'Why?'" Moore, 2025:16.

3.9 Ocean Acidification

The power of hydrogen (pH) was developed in 1909 by the Danish chemist Søren Peter Lauritz Sørensen. The pH scale operates over 14 orders of magnitude of concentration and is a measure of the concentration of the hydrogen ion (H^+) in solution.

$$pH = -Log_{10}[H^+] \tag{4}$$

where $[H^+]$ is the molar hydrogen ion concentration.

Some sources suggest that ocean acidification is a problem because CO_2 dissolves in water including ocean water (Henry's Law) to create carbonic acid (H_2CO_3) which influences ocean carbonate chemistry. Some sources use this as a further excuse for proposing controls on CO_2 emissions (Gattuso & Hansson, 2011; National Academies, 2010). The physical chemistry (and the calculations) here is complex, but the result is simply that the ocean acidification scare is false (Moore, 2021). The ocean is almost infinitely buffered, has a pH of 7.9-8.2 on average (alkaline) and carbonates precipitate out, are used for animal shells etc. The ocean pH varies a lot, locally, over the seasons, between day and night, partly due to changes in the ocean currents, run-off from land, ice melt, river estuary volumes and some undersea vents of fresh water and volcanic vents (Kamis, 2021). Sea animals with shells can cope with a wide range of pH (down below 7, a pH of 7 is neutral, a pH below 7 is acidic, a pH above 7 is alkaline) and there is no such thing as 'harmful acidification'. The physics and chemistry places limits on how much CO_2 affects the pH. Where CO_2 is concerned the pH is also temperature dependent as, according to Henry's Law, cold water allows more CO_2 to dissolve (Atkins and DePaula, 2014).

4. Exaggerated Claims

Observing comments from colleagues in other disciplines based on the false idea that "decarbonizing" is essential because the CO_2 is likely to destabilize the climate in some way McKinnon (2018) we have:

Logistics: 8Gt CO_2 (i.e. 8Pg/year) estimated in 2016 is ~1.03ppmv CO_2 in air is due to logistics (Alzard et al., 2019; Schwanen et al., 2011; Tacken et al., 2014). This concentration is extremely small making percentage claims of contributions from logistics negligible in terms of concentration of CO_2 in air. The atmospheric temperature increase would be 0.0065°C maximum according to equations (1) and (2).

Burning Coal: 10,000 million tonnes of CO_2 (i.e. 10gigatonnes or 10petagrams) from burning fossil fuels (Parker and deBaro, 2019) gives ~1.28 ppmv of CO_2 in air which is negligible and gives 0.008°C of warming.

Food Supply Chain: Li et al., (2022) suggests that the entire upstream food supply chain emissions equate to about 3GtCO_2e per annum (~0.38ppmv CO_2 p.a. giving 0.0028°C of atmospheric warming) and that transport accounts for about 19% of total food-system emissions. This suggests that the alarmism over such small concentrations of CO_2 is totally uncalled for. Yet the entire food supply chain is based on plants using CO_2 to produce carbohydrates and sugars which some animals and humans use for food. It would be interesting to look at the net emissions/sequestration in the food supply chain after accounting for the uptake of CO_2 by crops.

Human Population: The UN suggests there will be 10.4 billion people in 2086. If each resting person produces 500g CO_2 per day (TOXNET) this equates to 1.898×10^{15} grams (1.898 Pg) per year or approximately 0.24ppmv and will produce much more when active (circa 0.5ppmv). Again, giving negligible warming of 0.00316°C

Shipping: CO_2 emissions are estimated to be around 3% of global emissions per annum (Stallard, 2025) or approximately 1.17Gt of CO_2, equivalent to 0.15ppmv which is negligible warming of 0.0009°C (with Lambda equal 0.5). It is surprising that the UN International Maritime Trade Organization (IMO) would agree to reduce its carbon footprint and pay an excessive and unnecessary $380 penalty per tonne of carbon dioxide emitted from burning fuel. This is a development that ignores the social cost of carbon (McKitrick, 2025). Shipping oil fuels are cheap and often contain high Sulphur content which has been systematically reduced from 3.5% weight for weight to 0.5% w/w. Sulphur dioxide is an Environmental Protection Agency (EPA) priority air pollutant (CDC) and has many industrial uses. Alternative fuels (e-kerosene, ammonia) are expensive and would require substantial increases in production volumes. Shipping fuel oil can be replaced by liquified natural gas or biofuels to reduce Sulphur content, but these options are expensive (IMO, 2020) and would achieve almost nothing for the atmospheric concentration of CO_2 or the temperature.

"Carbon Bombs": aside from the highly emotive language and exaggeration, there is no such thing as a 'carbon bomb' (Kühne et al., 2022). The potential sources of CO_2 are estimated by Kühne et al., (2022) at 1182.3 Gtonnes which, if entering the atmosphere all at once (which is extremely unlikely), would give an additional ~152ppmv (total 423+152= 575ppmv; and 0.82°C increase in temperature (with Lambda equal 0.5). Kühne et al., (2022) identify 'new' sources of 419Gtonnes of CO_2 (~54ppmv) which would result in 629ppmv and a maximum of 1.06°C increase in temperature (with Lambda equal 0.5) which will not be harmful in any way. The production of CO_2 would take many years (circa 60years) and be absorbed by the ocean and biosphere, increasing crop yields and greening of marginal lands. Such is the hyperbole used to scaremonger and bamboozle the public.

4.1 Renewables

There is considerable interest in using heavily subsidised renewable energy (i.e. wind turbines and solar photovoltaic panels) to cut so-called 'carbon emissions' meaning carbon dioxide, CO_2.

4.1.1 Wind Energy

Some wind energy companies make claims in their proposal brochures for the saving of CO_2. For example, Bute Energy (2023) claim that 34 wind turbines of 200m and 220m in height with a total capacity of 192megawatts will save approximately 261,500 tonnes of carbon a year. The report is not clear if this is carbon or carbon dioxide (CO_2).

If this is CO_2 this equates to $2.615\text{x } 10^{11}$ grams or $3.359 \text{ x}10^{-5}$ ppmv (0.03359 ppbv) a year.

If this is truly carbon, then converting carbon to carbon dioxide (x 3.67) gives $9.59\text{x}10^{11}$ grams of CO_2 which would be $1.23 \text{ x } 10^{-4}$ ppmv (0.123 ppbv) a year of CO_2 saved and negligible saving in warming ($7.78\text{x}10^{-7}$°C, with Lambda equal to 0.5 and this temperature change would not be measurable).

These are very small to negligible concentrations of CO_2 and very small temperatures saved in the atmosphere for the ruin of 1307 hectares on the Parc Aberedw and 1309 hectares at Parc Bryn Gilwern (total 2616 hectares) and permanent loss of upland habitat, amenity, access and views across Open Access Land and Common Land. Noting that a conventional fossil fuel power station covers approximately 1.8m^2 per MWh (produced per year) for gas turbine generation and 17m^2 per MWh for coal (including the mining) compared to 8.4 to 247m^2 per MWh for onshore wind parks (https://www.weforum.org/stories/2022/06/energy-electricity-sources-land/) with nuclear energy at 0.7m^2 per MWh.

In the case of Bute Energy, the capacity per square metre can be calculated as:

Total area = 1309 + 1307 hectares = 2616 hectares x 10000 = 26,160,000 m^2

With generating capacity of 192 megawatts (assuming an optimistic 100% working time) giving:

192MW x 24hours x 365days a year = 1,681,920 MWh over a year.

Which gives 15.55m^2 per MWh if the wind turbines operate 100% of the time. In fact, they operate on average about a third of the time giving 46.66 m^2 per MWh which is very inefficient compared to land use by almost any other means of generating energy. There is considerable discussion regarding the footprint of wind farms. The question is whether the land between the individual machines can be utilised for anything else, such as grazing or growing of crops.

If the figures for Bute Energy are representative it is possible to calculate how much land would need to be covered in wind turbines to 'save' 1ppmv. The calculations are:

$$\text{Land required per ppmv} = \frac{26160000 \ m^2}{1.23 \text{ x } 10^{-4} \text{ ppmv}} = 212{,}215{,}523{,}439.65 \ m^2$$

Which is approximately 212,215.52 km^2 per ppmv of CO_2 saved.

The UK has a total area of 241,930 km^2 and so the area required to avoid 1ppmv of CO_2 is approximately 87.7 per cent of the UK land area would need to be covered in wind turbines, saving 0.0063°C temperature rise.

With less than 1% of the world's population (~70m) the UK emits about 1% or approximately 0.39 Peta grams equivalent to ~0.05ppmv of CO_2 then the area required to be covered with wind turbines for our 'fair share' of CO_2 emissions reduction would be:

Land required = 212,215.52 km^2 per ppmv x 0.05 ppmv = ~10,610.8km^2 which is approximately 4.38% of the land area of the UK.

This does not sound a lot for our 'fair share' of commitment to Net Zero, but these figures ignore the amounts of CO_2 emitted in the manufacture and ongoing maintenance of these wind turbines which have a limited lifetime (in the case of Bute Energy it is claimed to be 40 years – which is optimistic) and the rationale for any intervention to control the small concentrations of the rare trace gas CO_2 is pointless.

Wind energy is intermittent, variable, unreliable and not dispatchable and must be backed up by conventional energy generation called 'spinning reserve' usually gas turbines which inevitably produces CO_2. Thus, there is little to be gained in terms of emission reduction and reduction in concentration of CO_2 in air and a lot to lose in terms of area of land and loss of upland habitat, loss of amenity and loss of Open Access Land and Common Land with wind energy generation. There are also problems with destabilising the electricity grid with the accommodation of intermittent and variable sources of energy (Birkett, 2012 and 2018). Wind generation does not pass the cost-benefit test in any way.

4.1.2 Solar Photovoltaics

Two types of solar photovoltaics (PV) are available, Cadmium and Silicon and they can be installed on the ground or on rooftops. PV suffer similar intermittency and variability as wind but also suffer from seasonal changes in northern climates where winter generation may be close to zero in some northern countries due to clouds, snow cover and the fact that the sun is low in the sky and the number of daylight hours is small. Yet winter is the time of year with the highest electricity consumption. Land use figures for these energy sources are shown in Table 2.

Initially, these energy sources compare well with the wind farm example shown earlier but suffer from similar problems such as intermittency, variability, requiring 'spinning reserve' back-up, destabilizing the electrical grid system and the enormous area that needs to be covered for a reduction in CO_2 emissions. In addition, Cadmium is highly toxic and covering farmland with Cadmium-based PV panels is not sensible as it may lead to contamination if the panels are damaged (e.g. by hailstones, high speed winds, lightning strikes).

Table 2. Energy generation by solar PV (m^2 per MWh) compared

Solar Photovoltaic Type	Rooftop (m^2 per MWh)	Ground Based (m^2 per MWh)
Silicon	12.5	22
Cadmium	1.9	14

Source: <https://www.weforum.org/stories/2022/06/energy-electricity-sources-land/>.

4.1.3 The Iberian Peninsula Blackout

Following on from the electrical blackout in Portugal, Spain and France (28th April 2025) (Montford, 2025) which affected more than 50million people and the blackout near miss in the UK in January 2025 (Porter, 2025) the UK Net Zero Watch think tank reported:

> "*Grid analysts have suggested a high likelihood that the extent of yesterday's blackout in Iberia was a result of the Spanish grid operating almost entirely on renewables at the time. The stability of power grids depends on so-called 'inertia', a resistance to rapid change that is an inherent feature of large spinning turbines, such as gas-fired power stations, but not of wind and solar farms. Too much renewables capacity on a grid can therefore mean inadequate inertia. As a result, in grids dominated by wind and solar, faults can propagate almost instantaneously across grids, leading to blackouts.*" (Montford, 2025).

Other experts have suggested it was due to a '*solar drop*' (a reduction in solar panel generated electricity) with a solar farm tripping off the grid. (GWPF, 2025; Net Zero Watch Samizdat, 2025; https://www.sciencemediacentre.org/expert-reaction-to-power-outages-across-spain-and-portugal/) (Gae et al., 2025). Thus, taking renewables on balance, we take the advice of Derek G. Birkett an ex-grid engineer:

"*Forget renewables*" (Birkett, 2010:14)

4.2 Total Emissions of CO_2

When taken overall, for 2023, the total emissions of CO_2 from fossil fuel use amounted to some 39Gt, (39Pg) equivalent to circa 5.0ppmv (half of the CO_2 does not appear in the atmosphere) which accounts for the slow increase in atmospheric CO_2 concentration (circa 2-3ppmv a year in Figure 1, ~0.02°C temperature saving) (Spencer, 2024a). The main uses resulting in CO_2 emissions are burning fossil fuels for electricity, transportation, heating and industry (e.g. steel and cement manufacture) and there is no scientific reason to stop using them or change our behaviour or lifestyle. The atmosphere is an almost a perfect example of a stable system (Coe, et al., 2021) and in common with most natural systems operates with negative feedback according to Le Chatelier's Principle so there are no tipping points in the climate system caused by CO_2, CH_4, or N_2O.

4.3 Other Greenhouse Gases

There are many so-called 'greenhouse gases' based on hydrochlorofluorocarbons with various combinations of hydrogen, chlorine and fluorine around a backbone of carbon atom(s). The dipolar nature of the carbon-halogen bond allows for absorption and emission of infrared electromagnetic radiation and therefore they are considered to be greenhouse gases. The fact that 'greenhouse gases' occur in extremely small concentrations, and some are liquids at room temperature, suggests they will have negligible effect on the atmospheric temperature. These gases have been controlled since the Montreal Protocol was adopted 16th September 1987 (https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol) because of their supposed effects on the ozone layer (Maduro and Schauerhammer, 1992).

Since then, activists have been attempting to make the medical profession abandon effective anaesthetics in favour of less effective and riskier alternatives because of the 'climate scare' associated with greenhouse gases. However, a recent report (Soepyan et al., 2024) sums up our views on this:

> "*Based on our estimates, the continued emissions of nitrous oxide (both non-anaesthetic and anaesthetic), sevoflurane, isoflurane and desflurane would cause a combined temperature increase of about 0.032°C in 50 years and of about 0.064°C in 100 years. Such a rise in temperature is negligible and cannot be measured or felt. Therefore, curbing the emissions of anaesthetic gases into the atmosphere is unnecessary and would have minimal effect on the climate. Given this conclusion, the selection of anaesthetic gases should be based on the health and safety of the patients, rather than on a purported environmental benefit.*"

5. Conclusions and Recommendations

Given the information above we note that CO_2 on balance does no harm and is highly beneficial (May and Crok, 2024) hence the research on the "climate effect" of various activities makes no sense. The very small concentrations of these naturally occurring rare trace gases (CO_2, CH_4, N_2O) will be very difficult if not impossible to control without enormous costs and major changes to the way people live. There is no evidence that such changes would have any effect on the temperature or the climate.

There is no doubt that a small amount of warming is due to CO_2, CH_4, N_2O which are in small concentrations but most of the warming has already occurred because of the logarithmic nature of absorbance (Beer-Lambert Law) and so making exaggerated claims about the effects of greenhouse gases on the climate is disingenuous. There is an element of false causes here because the climate has changed in many ways in the geological past without the influence of 'greenhouse gases' and without the influence of humans (Wrightstone, 2017 and 2023).

> "*What matters is the realisation that we still do not understand climate change well enough to implement costly solutions that may not have the desired effects*." (Vinós, 2023:8)

Measuring everything in CO_2 emissions, carbon dioxide equivalent (CO_2e), carbon footprints, air miles, global warming potentials (GWP) etc., is meaningless given the concentration figures and analysis shown earlier (e.g. Gorst et al., 2024; McKinnon and Woodburn, 1994; McKinnon, 2018). Global warming potential and carbon dioxide equivalent are not measurable physical properties of gases, but *ad hoc* parameters developed for climate models.

Claims based on CO_2, CH_4 and N_2O emissions are exaggerated, and these gases are not responsible for much of the warming (Skrable et al., 2022; Coe et al., 2021; Spencer et al, 2025). The small increase (2-3ppmv p.a.) in CO_2 concentration in the atmosphere is not dangerous, will have negligible effect on the physical properties of the atmosphere and is good for plants and crops. Crop yields have increased in concert with increases in CO_2 concentrations. Methane is oxidised over a short period of time (circa 9 years) by OH radicals and ozone to CO_2. The concentrations of methane, CH_4, and nitrous oxide, N_2O, are currently extremely low (CH_4 is 1.927ppmv and N_2O is 0.337ppmv) and are not cause for alarm. Doubling CO_2 concentration may take 130 years or more and the effect on temperature is expected to be small 0.75°C (~ 0.00577°C a year) to 1.85°C (~0.014°C a year) and certainly not a 'climate emergency'.

Curbing emissions in small countries with small populations like the UK or Denmark has no impact on the global climate whatsoever. The costs of such radical reforms are expected to be enormous (Simpson, 2024). The loss of amenity and loss of access to Open Access Land and Common Land because of large wind farms and solar photovoltaics will be permanent and regrettable. The area covered is many times that of a conventional power station producing dispatchable energy. Industrialising the countryside, which is a national tourist asset, with wind turbines and photovoltaics is foolish.

Net Zero is a goal that makes no sense scientifically. If we were to stop all emissions tomorrow, the absorption/emission by the ocean would continue, because it is governed by the concentration of CO_2 in the air – not by our annual additions (Henry's law). Hence, by cutting our emissions in half, we would effectively stop the increase of the atmosphere's CO_2 content (Spencer, 2024a & b) and lose the benefits of increased crop yields and greening of marginal lands.

Statements by activists and claims of amounts and percentages of greenhouse gases saved are misleading and should be ignored in favour of calculated values of concentrations in the atmosphere using the calculators we have provided and decisions (if any are required) should be based on those values in the context of the physics and chemistry involved. Noting that the increase is 2.5 to 3ppmv of CO_2 per annum in total which is slow and not cause for declaring a climate emergency.

Funding mechanisms by governments are focused on solving politically driven problems created by activists and gullible politicians with no scientific background or training. This has led to extremely expensive solutions to non-problems such as climate change and the attempt to control the concentrations of the rare trace gases CO_2, CH_4 and N_2O.

Virtue signalling or claiming to be world leaders has no place in the decision-making process concerning greenhouse gas concentrations in the atmosphere and as such trying to reduce or control these tiny concentrations will prove to be very expensive indeed.

> "*Don't let us make imaginary evils, when you know we have so many real ones to encounter*."
> Oliver Goldsmith.

References

Alzard, M. H., Maraqa, M. A., Chowdhury, R., Khan, Q., Albuquerque, D. B., Mauga, T. I., & Aljunadi, K. N. (2019). Estimation of greenhouse gas emissions produced by road projects in Abu Dhabi, United Arab Emirates. *Sustainability, 11*, 2367. https://doi.org/10.3390/su11082367

Atkins, P., & de Paula, J. (2014). *Physical chemistry* (10th ed.). Oxford University Press.

Aylward, G., & Findlay, T. (2002). *SI chemical data* (5th ed.). John Wiley & Sons Australia Ltd.

Birkett, D. G. (2010). *When will the lights go out?* Independent Minds, Stacey International.

Birkett, D. G. (2012). Accommodation of renewable energy – Have the problems become unaffordable? *Energy & Environment, 23*(8), 1319–1325. https://doi.org/10.1260/0958-305X.23.8.1319

Birkett, D. G. (2018). *Is renewable energy affordable?* Cambridge Scholars Publishing.

Burg, W. T., & Bos, P. M. J. (2009). *Evaluation of the acute toxicity of CO_2* (Report No. 20091002). RIVM Centrum voor Stoffen en Integrale Risicoschatting (SIR). https://www.rivm.nl/sites/default/files/2018-11/20091002_Evaluation_toxicity_CO2.pdf

Bute Energy. (2023). *Aberedw and Bryn Gilwern energy parks: Consultation brochure November 2023*. https://bryngilwernenergypark.wales/wp-content/uploads/231113_Bute_AberedwBryn-Gilwern_Brochure_English_v1.4.pdf

Centers for Disease Control and Prevention. (n.d.). *Medical management guidelines for sulfur dioxide*. https://wwwn.cdc.gov/TSP/MMG/MMGDetails.aspx?mmgid=249&toxid=46

Coe, D., Fabinski, W., & Weigleb, G. (2021). The impact of CO_2, H_2O and other 'greenhouse gases' on equilibrium earth temperatures. *International Journal of Atmospheric and Oceanic Sciences, 5*(2), 29–40. https://doi.org/10.11648/j.ijaos.20210502.12

Cornale, P., Tizzani, M., Ciulla, F., Kalimeri, K., Omodei, E., Paolotti, D., & Mejova, Y. (2025). The role of science in the climate change discussions on Reddit. *PLoS Climate, 4*(5), e0000541.

https://doi.org/10.1371/journal.pclm.0000541

Crok, M., & May, A. (2023). *The frozen climate views of the IPCC: An analysis of AR6*. Andy May Petrophysicist LLC.

Dawson, B., Drewer, J., Roberts, T., Levy, P., Heal, M., & Cowan, N. (2023). Measurements of methane and nitrous oxide in human breath and the development of UK scale emissions. *PLoS ONE, 18*(12), e0295157. https://doi.org/10.1371/journal.pone.0295157

Dayaratna, K. D. (Ed.). (2025). *Cooling the climate hysteria: Separating fact from fiction*. The Heritage Foundation.

Dunn, J. D., & Legates, J. R. (2024). *Human health and welfare effects from increased greenhouse gases and warming* (Special Report No. 293). Center for Energy, Climate, and Environment, The Heritage Foundation. https://report.heritage.org/sr293

Environmental Protection Agency. (2025). *Agriculture and aquaculture: Food for thought*. https://www.epa.gov/snep/agriculture-and-aquaculture-food-thought

Etheridge, D. M., Steele, L. P., Francey, R. J., & Langenfelds, R. L. (1998). Atmospheric methane between 1000 AD and present: Evidence of anthropogenic emissions and climatic variability. *Journal of Geophysical Research, 103*(D13), 15979–15. https://doi.org/10.1029/98JD00923

Gae, A., Loyola, M., & Weiss, A. (2025). *Restoring reliability to the Texas electric grid* (Backgrounder No. 3905). The Heritage Foundation. https://report.heritage.org/bg3905

Gattuso, J.-P., & Hansson, L. (Eds.). (2011). *Ocean acidification*. Oxford University Press.

Gerhart, L., & Ward, J. (2010). Plant responses to low CO_2 of the past. *New Phytologist, 188*(3), 674–695. https://doi.org/10.1111/j.1469-8137.2010.03441.x

Goresy, A. E., & Donnay, G. (1968). A new allotropic form of carbon from the Ries crater. *Science, 161*(3839), 363–364. https://doi.org/10.1126/science.161.3839.363

Gorst, J., Ballantyne, E., & Dodd, N. (2024). Measuring CO_2 emissions from transportation in a UK retail returns supply chain. *Journal of Supply Chain Management, Logistics and Procurement, 7*(2), 194–206.

Guais, A., Brand, G., Jacquot, L., Karrer, M., Dukan, S., Grevillot, G., Molina, T. J., Jacques Bonte, J., Regnier, M., & Schwartz, L. (2011). Toxicity of carbon dioxide: A review. *Chemical Research in Toxicology, 24*(12), 2061–2070. https://doi.org/10.1021/tx200220r

Guterres, A. (2024, January 1). UN chief Antonio Guterres warns of climate breakdown in New Year's speech [Video]. Sky News. https://news.sky.com/video/un-chief-antonio-guterres-warns-of-climate-breakdown-in-new-years-speech-13281821

Guterres, A. (2023, July 27). The era of global boiling has arrived, warns the UN [Video]. *The Guardian*. https://www.theguardian.com/world/video/2023/jul/27/the-era-of-global-boiling-has-arrived-warns-the-un-video

Happer, W. (2025). Dr. William Happer on carbon dioxide and warming. CO_2 Coalition. https://files.constantcontact.com/c9e43177001/559d83b0-5ea5-473b-b888-9bfddb806727.pdf

Happer, W., & Lindzen, R. (2022). *Responses and declaration on the CFTC climate-related financial risk RFI* (87 Fed. Reg. 34856). CO_2 Coalition. https://co2coalition.org/wp-content/uploads/2022/08/Happer-Lindzen-CO2C-CFTC-8-7-22-b.pdf

Hovenden, M., & Newton, P. (2018). Plant responses to CO_2: A question of time. *Science,* 360 (6386), 263–264. https://doi.org/10.1126/science.aat5976

International Maritime Organization. (2020). *IMO2020 fuel oil sulphur limit – Cleaner air, healthier planet*. https://www.imo.org/en/MediaCentre/PressBriefings/pages/02-IMO-2020.aspx

Intergovernmental Panel on Climate Change. (2021). Annex VII: Glossary. In V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, R. van Diemen, ... & B. Zhou (Eds.), *Climate change 2021: The physical science basis* (pp. 2215–2256). Cambridge University Press. https://doi.org/10.1017/9781009157896.022

Intergovernmental Panel on Climate Change. (2021). *Climate change 2021: The physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Section 6.3.1, pp. 835–836). Cambridge University Press.

Kamis, J. E. (2021). *Plate climatology: How geological forces influence, alter or control earth's climate and* *climate related events*. Retrieved from http://www.plateclimatology.com [YouTube video: Kamis, J. E. (2021). *Plate tectonics and climate change*]. https://www.youtube.com/watch?v=Zyk7ZI2ftxs

Kelly, M., Hambler, C., Koppl, R., Ridd, P., & Wilkinson, H. (2024). *Improving science advice to governments* (Report No. 59). The Global Warming Policy Foundation. https://www.thegwpf.org/publications/scientists-call-for-radical-reform-of-scientific-government-advice/

Kühne, K., Bartsch, N., Tate, R. D., Higson, J., & Habet, A. (2022). Carbon bombs – Mapping key fossil fuel projects. *Energy Policy, 166*, 112950. https://doi.org/10.1016/j.enpol.2022.112950

Lan, X., Thoning, K. W., & Dlugokencky, E. J. (2022). *Trends in globally-averaged CH_4, N_2O, and SF_6 determined from NOAA Global Monitoring Laboratory measurements* (Version 2025-02). https://doi.org/10.15138/P8XG-AA10

Leach, T. (2024, September 26). Ireland proposes culling 200,000 cows to help meet climate goals, farmers push back. *Dairy Herd Management*. https://www.dairyherd.com/news/business/ireland-proposes-culling-200-000-cows-help-meet-climate-goals-farmers-push-back

Li, M., Jia, N., Lenzen, M., Malik, A., Wei, L., Jin, Y., & Raubenheimer, D. (2022). Global food-miles account for nearly 20% of total food-systems emissions. *Nature Food, 3*, 445–453. https://doi.org/10.1038/s43016-022-00531-w

Li, M., Karu, E., Brenninkmeijer, C., Fischer, H., Lelieveld, J., & Williams, J. (2018). Tropospheric OH and stratospheric OH and Cl concentrations determined from CH_4, CH_3Cl, and SF_6 measurements. *npj Climate and Atmospheric Science, 1*(1), 29. https://doi.org/10.1038/s41612-018-0041-9

Lindzen, R., & Happer, W. (2024, July 14). *Net zero policies will have a trivial effect on temperature, but disastrous effects on people worldwide*. CO_2 Coalition. https://co2coalition.org/publications/net-zero-policies-will-have-a-trivial-effect-on-temperature-but-disastrous-effects-on-people-worldwide/

Lindzen, R., Happer, W., & van Wijngaarden, W. (2024, June 11). *Net zero averted temperature increase*. CO_2 Coalition. https://co2coalition.org/publications/net-zero-averted-temperature-increase/

Liu, Y., Yao, X., Zhou, L., Ming, T., Li, W., & de Richter, R. (2024). Removal of atmospheric methane by increasing hydroxyl radicals via a water vapor enhancement strategy. *Atmosphere, 15*(9), 1046. https://doi.org/10.3390/atmos15091046

Maduro, R. A., & Schauerhammer, R. (1992). *The holes in the ozone scare: The scientific evidence that the sky isn't falling*. 21st Century Science Associates.

May, A., & Crok, M. (2024). Carbon dioxide and a warming climate are not problems. *American Journal of Economics and Sociology, 84*(1), 43–57. https://doi.org/10.1111/ajes.12579

McKinnon, A. (2018). *Decarbonizing logistics: Distributing goods in a low-carbon world*. Kogan Page Ltd.

McKinnon, A., & Woodburn, A. (1994). The consolidation of retail deliveries: Its effect on CO_2 emissions. *Transport Policy, 1*(2), 125–136.

McKitrick, R. (2025). Extended crop yield meta-analysis do not support upward SCC revision. *Scientific Reports, 15*, 5575. https://doi.org/10.1038/s41598-025-90254-2

Michel, S. E., Lan, X., Miller, J., Tans, P., Clark, J. R., Schaefer, H., Sperlich, P., Brailsford, G., Morimoto, S., Moossen, H., & Li, J. (2024). Rapid shift in methane carbon isotopes suggests microbial emissions drove record high atmospheric methane growth in 2020–2022. *Proceedings of the National Academy of Sciences, 121*(44), e2411212121. https://doi.org/10.1073/pnas.2411212121

Milloy, S. (2016). *Scare pollution: Why and how to fix the EPA*. Bench Press, Inc.

Miskolczi, F. (2023). Greenhouse gas theories and observed radiative properties of the Earth's atmosphere. *Science of Climate Change, 3*(3), 232–289. https://doi.org/10.53234/scc202304/05

Mitsui, T., & Kondo, T. (1999). Vegetables, high nitrate foods, increased breath nitrous oxide. *Digestive Diseases and Sciences, 44*(6), 1216–1219. https://doi.org/10.1023/A:1026696728368

Montford, A. (2025, April 29). Net Zero Watch warns of growing GB grid instability [Press release]. Net Zero Watch. https://www.netzerowatch.com/press-releases

Moore, P. (2021). *Fake invisible catastrophes and threats of doom*. Ecosense Environmental Inc.

Muijser, H., Triel, J. J. v., Duistermaat, E., & Bos, P. M. J. (2014). Acute toxicity of high concentrations of carbon dioxide in rats. *Regulatory Toxicology and Pharmacology, 69*(2), 201–206. https://doi.org/10.1016/j.yrtph.2014.04.007

Myhre, G., Highwood, E. J., Shine, K. P., & Stordal, F. (1998). New estimates of radiative forcing due to well mixed greenhouse gases. *Geophysical Research Letters, 25*(14), 2715–2718. https://doi.org/10.1029/98GL01908

National Aeronautics and Space Administration. (2016). CO_2 is making Earth greener for now. https://science.nasa.gov/earth/climate-change/co2-is-making-earth-greener-for-now/

National Academies of Sciences, Engineering, and Medicine. (2010). *Ocean acidification: A national strategy to meet the challenges of a changing ocean*. The National Academies Press.

National Library of Medicine. (n.d.). Carbon dioxide: Toxicity summary. PubChem. https://pubchem.ncbi.nlm.nih.gov/compound/Carbon-Dioxide#section=Toxicity-Summary

Net Zero Watch Samizdat. (2025, May 2). Spain and Portugal achieve net zero (power). https://www.netzerowatch.com/samizdat-archive

Nisbet, E. G., Manning, M. R., Dlugokencky, E. J., Michel, S. E., Lan, X., Röckmann, T., ... (2023). Atmospheric methane: Comparison between methane's record in 2006–2022 and during glacial terminations. *Global Biogeochemical Cycles, 37*, e2023GB007875. https://doi.org/10.1029/2023GB007875

Parker, J., & de Baro, M. E. Z. (2019). Green infrastructure in the urban environment: A systematic quantitative review. *Sustainability, 11*(11), 3182. https://doi.org/10.3390/su11113182

Persson, O., & Wadsö, L. (2002). Indoor air quality in submarines. In *Proceedings: Indoor Air 2002*. Retrieved from https://www.irbnet.de/daten/iconda/CIB7571.pdf

Porter, K. (2025). *Blackout risk in the GB grid*. Net Zero Watch. https://static1.squarespace.com/static/656f411497ae14084ad8d03a/t/679a24b62b650015dd2baba2/1738155194172/Porter-Blackouts.pdf

Randall, D. A. (2024). *ppmv* [Class handout]. Colorado State University. https://hogback.atmos.colostate.edu/~dave/pdf

Reich, P. B., Hobbie, S. P., Lee, D. T., & Pastore, M. A. (2018). Unexpected reversal of C_3 versus C_4 grass response to elevated CO_2 during a twenty-year field experiment. *Science, 360*(6386), 317–320. https://doi.org/10.1126/science.aar4628

Ritchie, H. (2020). Less meat is nearly always better than sustainable meat, to reduce your carbon footprint. *Our World in Data*. https://ourworldindata.org/less-meat-or-sustainable-meat

Royal College of Physicians. (2016). *Every breath we take: The lifelong impact of air pollution*. London. https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution

Rumble, J. (Ed.). (2024). *CRC handbook of chemistry and physics: A ready-reference book of chemical and physical data* (105th ed.). CRC Press.

Scafetta, N. (2024). Impacts and risks of "realistic" global warming projections for the 21st century. *Geoscience Frontiers, 15*(2), Article 101774. https://doi.org/10.1016/j.gsf.2023.101774

Schneider, E. K., Kirtman, B. P., & Lindzen, R. S. (1999). Tropospheric water vapor and climate sensitivity. *Journal of the Atmospheric Sciences, 56*(11), 1649–1658. https://doi.org/10.1175/1520-0469(1999)056<1649:TWVACS>2.0.CO;2

Schwanen, D., Banister, D., & Anable, J. (2011). Scientific research about climate change mitigation in transport: A critical review. *Transportation Research Part A: Policy and Practice, 45*(10), 993–1006. https://doi.org/10.1016/j.tra.2011.09.002

Schwartz, S. E. (2018a). Resource letter GECC-1: The greenhouse effect and climate change: Earth's natural greenhouse effect. *American Journal of Physics, 86*(8), 565–576. https://doi.org/10.1119/1.5039809

Schwartz, S. E. (2018b). Resource letter GECC-2: The greenhouse effect and climate change: The intensified greenhouse effect. *American Journal of Physics, 86*(9), 645–656. https://doi.org/10.1119/1.5047806

Sheahen, T. (2021). Getting it right: Scientifically 'success' means 'agreement with observation'. Paper presented at the 14th Conference on Climate Change, Heartland Institute, Las Vegas, NV. Video available at: https://www.youtube.com/watch?v=-m73QYdhoCw

Simpson, M. (2024). The scientific case against net zero: Falsifying the greenhouse gas hypothesis. *Journal of Sustainable Development, 17*(6), 137–157. https://doi.org/10.5539/jsd.v17n6p137

Skrable, K., Chabot, G., & French, C. (2022). World atmospheric CO_2, its ^{14}C specific activity, non-fossil component, anthropogenic fossil component, and emissions (1750–2018). *Health Physics, 122*(2), 291–305. https://doi.org/10.1097/HP.0000000000001485

Soepyan, F. B., Happer, W., & Wrightstone. (2024). *Emissions of anaesthetic gases cause negligible warming*. CO_2 Coalition. https://co2coalition.org/wp-content/uploads/2024/12/Emissions-of-Anaesthetic-Gases-Cause-Negligible-Warming.pdf

Spencer, R. W., Christy, J. R., & Braswell, W. D. (2025). Urban heat island effects in U.S. summer surface temperature data, 1895–2023. *Journal of Applied Meteorology and Climatology*, Advance online publication. https://doi.org/10.1175/JAMC-D-23-0199.1

Spencer, R. W. (2024a, April 18). Net zero CO_2 emissions: A damaging and totally unnecessary goal. *Dr. Roy Spencer*. https://www.drroyspencer.com/2024/04/net-zero-co2-emissions-a-damaging-and-totally-unnecessary-goal/

Spencer, R. W. (2024b, April 23). Unnecessary net zero, part II: A demonstration with Global Carbon Project data. *Dr. Roy Spencer*. https://www.drroyspencer.com/2024/04/unnecessary-net-zero-part-ii-a-demonstration-with-global-carbon-project-data/

Stallard, E. (2025, May 1). Global breakthrough to tackle shipping emissions. BBC News. https://www.bbc.co.uk/news/articles/c20xxv22wl9o

Tacken, J., Rodriques, V. S., & Mason, R. (2014). Examining CO_2e reduction within the German logistics sector. *International Journal of Logistics Management, 25*(1), 54–84. https://doi.org/10.1108/IJLM-01-2013-0005

Trenberth, K. E., Christy, J. R., & Olsen, J. G. (1987). Global atmospheric mass, surface pressure, and water vapor variations. *Journal of Geophysical Research: Atmospheres, 92*(D12), 14815–14826.

Tolbert, N., Benker, C., & Beck, E. (1995). The oxygen and carbon dioxide compensation points of C_3 plants: Possible role in regulating atmospheric oxygen. *Proceedings of the National Academy of Sciences (USA), 92*(24), 11230–11233. https://doi.org/10.1073/pnas.92.24.11230

Tomlin, J. C., Lowis, C., & Read, N. W. (1991). Investigation of normal flatus production in healthy volunteers. *Gut, 32*(6), 665–669.

United Nations Environment Programme. (n.d.). Four reasons why the world needs to limit nitrogen pollution. https://www.unep.org/news-and-stories/story/four-reasons-why-world-needs-limit-nitrogen-pollution

Vinós, J. (2023). *Solving the climate puzzle: The sun's surprising role*. Critical Science Press.

Weimann, J. (2003). Toxicity of nitrous oxide. *Best Practice & Research Clinical Anaesthesiology, 17*(1), 47–61. https://doi.org/10.1053/bean.2002.0264

Whitehouse, D. (2025, May 16). Climate debate fuelled by hearsay and rumour. Net Zero Watch. https://www.netzerowatch.com/all-news/climate-debate-fuelled-by-hearsay-and-rumour?ss_source=sscampaigns&ss_campaign_id=68270d8c36156340e5b1004a&ss_email_id=68274c5f5abe6806e70c3255&ss_campaign_name=NZW+Samizdat%3A+The+truth+about+power+bill+increases&ss_campaign_sent_date=2025-05-16T14%3A32%3A05Z

van Wijngaarden, W. A., & Happer, W. (2019). *Infrared forcing by greenhouse gases*. CO_2 Coalition. https://co2coalition.org/wp-content/uploads/2022/03/Infrared-Forcing-by-Greenhouse-Gases-2019-Revised-3-7-2022.pdf

van Wijngaarden, W. A., & Happer, W. (2020). *Dependence of Earth's thermal radiation on five most abundant greenhouse gases* (arXiv preprint arXiv:2006.03098). https://arxiv.org/abs/2006.03098

van Wijngaarden, W. A., & Happer, W. (2021a). *Relative potency of greenhouse molecules* (arXiv preprint arXiv:2103.16465). https://arxiv.org/abs/2103.16465

van Wijngaarden, W. A., & Happer, W. (2021b). *Methane and climate*. CO_2 Coalition. https://co2coalition.org/wp-content/uploads/2021/08/Methane-and-Climate.pdf

van Wijngaarden, W. A., & Happer, W. (2022). *2n-stream radiative transfer*. CO_2 Coalition. https://co2coalition.org/publications/van-wijngaarden-and-happer-2n-stream-radiative-transfer/

Watts, A., Taylor, J., & Burnett, H. S. (Eds.). (2022). *Climate at a glance for teachers and students*. Heartland

Institute.

Wrightstone, G. (2017). *A very convenient warming: How modest warming and more CO_2 are benefitting humanity*. Silver Crown Productions, LLC.

Wrightstone, G. (2023). *Inconvenient facts: The science that Al Gore doesn't want you to know*. Silver Crown Productions, LLC.

Appendix

The Calculations for CO_2, CH_4 and N_2O in ppmv and ppmb

Sources: Randall (2024), Trenberth et al., (1987), Atkins and De Paula, (2014).

Data on air

Mass of the Atmosphere (dry air) = 5.123×10^{21} grams

Molecular weight of the atmosphere is 28.96 grams per mole

$$\text{Number of moles} = \frac{\text{mass of air}}{\text{molecular weight}} = \frac{5.123 \times 10^{21} \text{ grams}}{28.96 \text{ grams per mole}}$$

Number of moles of air = 1.769×10^{20}

Note: A mole is the amount of a substance that contains the same number of elementary entities (atoms, molecules, ions, etc.) as there are atoms in 12 grams of carbon-12. This number is known as Avogadro's number, approximately 6.022×10^{23} entities per mole. Essentially, a mole is a way to count the number of particles in a substance.

For Carbon Dioxide, CO_2

Mass of CO_2 in air = 3.290×10^{18} grams (in 2024)

Molecular weight of CO_2 = 44.01 grams per mole

$$\text{Number of moles of } CO_2 \text{ in air} = \frac{3.290 \times 10^{18} \text{ grams}}{44.01 \text{ grams per mole}}$$

Number of moles of CO_2 in air = 7.476×10^{16} moles

We know that a mole of gas is 22.4 litres in volume (the gram molecular volume), so to calculate the parts per million by volume the figures need to be multiplied by 22.4 (22400 cubic centimetres which simply cancels out in the calculation for both gases reducing to moles divided by moles) giving:

$$CO_2 \text{ by volume} = \frac{7.476\ 10^{16} \text{ moles} \times \cancel{22.4L}}{1.769 \times 10^{20} \text{ moles} \times \cancel{22.4L}}$$

CO_2 by volume = 4.226×10^{-4} moles per mole

CO_2 parts per million by volume = 422.6 ppmv (NB multiply by 1×10^6)

Converting Giga Tonnes of CO_2 to ppmv

Note: 1 Gtonne = 1Pg = 1×10^{15} grams (Peta, P is 10^{15})

Molecular weight of CO_2 = 44.01 grams per mole

$$\text{Number of moles of } CO_2 \text{ in 1 Gtonne of } CO_2 = \frac{1 \times 10^{15} \text{ grams}}{44.01 \text{ grams per mole}}$$

Number of moles of CO_2 in 1 Gtonne of CO_2 = 2.27221×10^{13} moles

$$\text{Therefore, 1 Gtonne of } CO_2 = \frac{2.27221 \times 10^{13} \text{ moles of } CO_2}{1.769 \times 10^{20} \text{ moles of air}}$$

1 Gtonne of CO_2 = 1.2845×10^{-7} which is 0.12845 ppmv (NB multiply by 1×10^6)

This is the result for the calculator shown earlier.

For Methane, CH_4

Converting Giga Tonnes of CH_4 to ppmv

Note: 1 Gtonne = 1Pg = 1 x10^{15} grams (Peta, P is 10^{15})

Molecular weight of CH_4 = 16.04 grams per mole

Number of moles of CH_4 in 1 Gtonne of CH_4 = $\frac{1 \times 10^{15} \text{ grams}}{16.04 \text{ grams per mole}}$

Number of moles of CH_4 in 1 Gtonne of CH_4 = 6.2344 x10^{13} moles

Therefore, 1 Gtonne of CH_4 = $\frac{6.2344 \times 10^{13} \text{ moles of } CH_4}{1.769 \times 10^{20} \text{ moles of air}}$

1 Gtonne of CH_4 = 3.52425 x10^{-7} which is 0.352425 ppmv (NB multiply by 1 x 10^6)

This is the result for the calculator shown earlier.

For Nitrous Oxide, N_2O

Converting Giga Tonnes of N_2O to ppmv

Note: 1 Gtonne = 1Pg = 1 x10^{15} grams (Peta, P is 10^{15}) grams per mole

Molecular weight of N_2O = 44.013

Number of moles of N_2O in 1 Gtonne of N_2O = $\frac{1 \times 10^{15} \text{ grams}}{44.013 \text{ grams per mole}}$

Number of moles of N_2O in 1 Gtonne of N_2O = 2.27206 x10^{13} moles

Therefore, 1 Gtonne of N_2O = $\frac{2.27206 \times 10^{13} \text{ moles of } N_2O}{1.769 \times 10^{20} \text{ moles of air}}$

1 Gtonne of N_2O = 1.28437 x10^{-7} which is 0.128438 ppmv (NB multiply by 1 x 10^6)

This is the result for the calculator shown earlier.

Or alternatively:

1 Gtonne of N_2O = 1.28437 x10^{-7} which is 128.438 ppbv (NB multiply by 1 x 10^9)

Acknowledgments

Not applicable.

Authors contributions

M. Simpson was responsible for design, literature search, drafting, writing, checking calculations and final corrections. S. Hansen was responsible for design, writing, correcting, and checking. All authors read and approved the final manuscript. The paper was a joint work.

Funding

There was no funding for this research.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Not applicable.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

Not applicable.

Data sharing statement

No additional data are available. All information and data used is in the public domain and cited in the references.