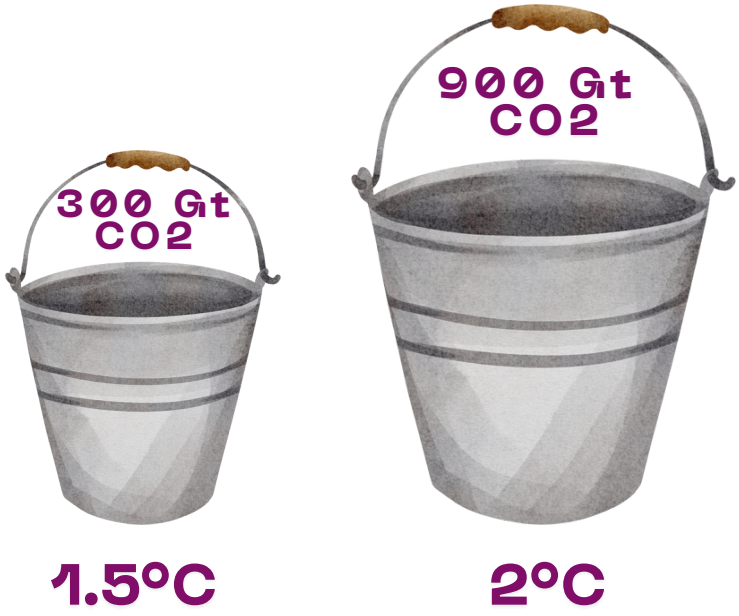
Empowering Youth through Environmental Storytelling

# The Carbon Budget




The amount of CO2 emissions that we are able to emit before hitting a temperature limit

Co-funded by the European Union

European Association Young Educators

News Decoder

TEHRA The Environment and Human Rights Academy

Authors: Jules Pye (TEHRA), Anka Stankovic (TEHRA), Andreea Pletea (TEHRA) and Amina McCauley (News Decoder).

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The Empowering Youth through Environmental Storytelling is a collaboration between The Environment and Human Rights Academy (TEHRA), News Decoder and the Young Educators European Association (YEEA).

The purpose of these educational materials is to help young people understand the climate crisis on a systems level through engaging with the topics and foster agency through the skills and techniques of journalism.

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For further information on the use of this resource, please email andreea.pletea@tehra.org or maria.krasinski@news-decoder.com.

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These educational resources have been developed to the best of our knowledge, using reliable and widely-recognized sources. While every effort has been made to ensure accuracy and clarity, we cannot guarantee that the materials are free from errors or omissions. Climate change is a field of knowledge that continues to evolve, and teachers and learners are encouraged to consult up-to-date scientific sources (e.g. IPCC, IPBES or national agencies) to complement and enrich these activities.

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## Learning objectives

1. Understand the importance of carbon budgets within the context of greenhouse gas emissions limits.
2. Be able to distinguish different ways to count and measure greenhouse gas emissions for a country and understand why their differences are important.

✅ GreenComp alignment:

- Futures literacy
- Political agency

## Unit guide

This unit explains the carbon budget, as a way of showing clearly how much we can continue to emit to stay within the temperature limits laid out in the Paris Agreement.

For a discussion starter, you can watch a video with your students of the carbon budget being explained by the IPCC to have students discuss the importance of learning about the carbon budget.

You can read through the project instructions before or after going through the Learn texts. Ultimately, students should write a pitch for a story they want to produce on their country's contributions to global emissions. This will have students research their country's emissions-heavy sectors, to practice being curious about different aspects of a broad topic, and to write a pitch – a useful skill beyond journalism.

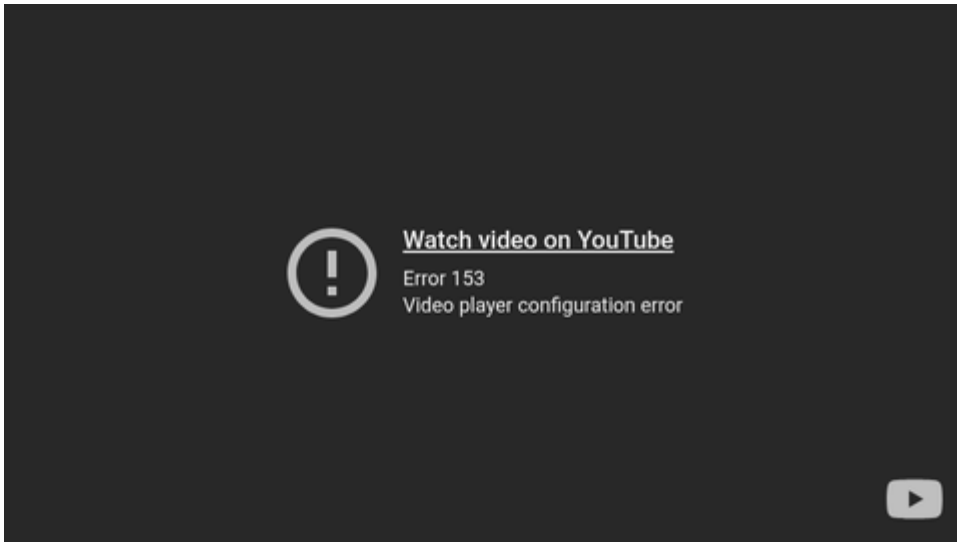
## Watch and discuss

*(10 minute activity)*

Watch Pep Canadell from the IPCC (International Panel on Climate Change) explain the carbon budget.

Discuss in pairs and then as a classroom:

1. Summarise what he said about what the carbon budget is.
2. Why is it important to learn about the carbon budget when we're talking about finding transformative and just climate solutions?



## Storytelling

### Write a story pitch

Do some research (from the below text and other sources) to answer the below questions:

- What is the carbon budget and why is it important?
- What is the carbon budget for keeping within 2 degrees celsius of warming?
- Why is it important that we keep emissions below that carbon budget?
- What could happen if we overshoot 2°C warming?

To localise this topic and find a story in your country or region, conduct some research to answer the below:

- How does your country's emissions compare to other countries?
- Which industries are emissions mainly coming from in your country?
- What policies or changes have been put in place (if any) to show that your country is working towards reducing emissions in these top sectors?

To find your country's most polluting sectors, and to compare your country's emissions to other's, you can visit Our World in Data and find your country's CO2 profile by toggling with the "Add a country to all charts" drop down box.

ourworldindata.org/co2/country/united-states

You can start by looking just at your country and then adding another one or few countries to get a comparison.

Scroll down until you find the chart titled "Greenhouse gas emissions by sector", and look at where your country's emissions are mainly coming from.

From this information, write down a few questions that you're curious about, e.g, *Why is the transport sector responsible for more emissions than any other sector in my country?* or *How much have emissions from the energy sector increased or decreased over recent years?* or *What legislation has been put in place (or needs to be) in order for my country to cut emissions in this particular sector?*

Try to be as specific as possible with your question.

Write a pitch for a journalistic piece you want to produce – an article, podcast, film, etc – including what you want to find out (what question you will answer), why it's a relevant topic, what facts and data you would use to contextualise the story, and who you would interview.

For more information, you can see our unit on *How to Write a Pitch*.

## 1. The Carbon Budget

*1.1. The Paris Agreement and 1.5˚C and 2˚C warming*

As we have seen in the unit on Climate Change 101, atmospheric CO2 levels and temperature are closely linked, with higher CO2 levels increasing temperature.

Earth systems, such as different ecosystems like forests or ice sheets, are dependent on stable temperatures, and will start to break down at specific levels of warming.

These two concepts have led to the setting by governments of 1.5˚C, and at the very most 2˚C, as the highest acceptable rises in temperature to safely avoid catastrophic climate change.

The 2015 Paris Agreement[1] is often regarded as the flagship of international climate change agreements. The outcome of the climate conference where the Paris Agreement was adopted, Conference of Parties, or COP21[2]- saw all countries[3] commit to:

"...hold global temperature increase to well below 2˚C above pre-industrial levels and pursue efforts to limit it to 1.5˚C above pre-industrial levels."[4]

These limits of 2˚C and 1.5˚C were ultimately, however, a political choice set after lengthy political discussions, informed by science briefs. These warming limits have been set as politically feasible targets. Yet, 1.5˚C or 2˚C do not necessarily represent safe levels of global warming.

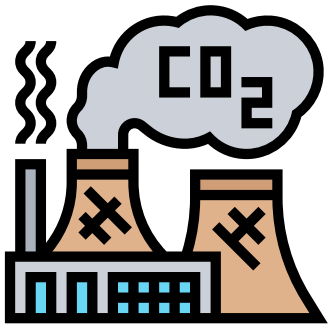
Even 1.5˚C or 2˚C leads to great changes in how Earth's systems function, leading to increased drought, heatwaves and floods, and other climate risks. And as will be explored in this module, we are currently on track for warming far beyond 2˚C, even if countries meet the "promises", or pledges as they are referred to within climate agreements.

The Paris Agreement was hailed as a success as a legally binding global climate agreement – previous agreements had faced extensive criticism as they were not legally binding.

However, the only legally binding components of the Paris Agreement is that countries have to submit pledges and updates to pledges on a prescribed timeline, as well as to pursue domestic measures to achieve their pledges.

Cutting their emissions to the levels required to limit warming to 2˚C and preferably 1.5˚C is not legally binding, and neither are any concrete steps that countries would need to take towards achieving their pledges. The content of these pledges and any action that would ensue remain voluntary.

Unfortunately, global climate inaction has proven that voluntary action is not enough to make meaningful change.



*1.2 What is a carbon budget?*

The limits of 1.5˚C and 2˚C are informed by projections of future warming and how different parts of Earth's system change under these temperature differences.

The more CO2 we release in the atmosphere, both because of burning fossil fuels and land use change such as clearing forests, the higher the temperature gets because of the greenhouse gas (GHG) effect.

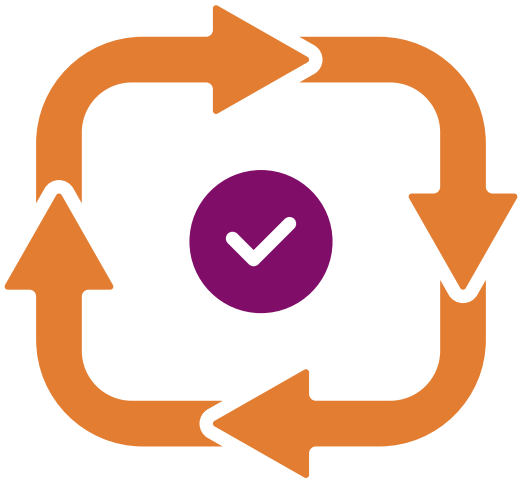
However, the relationship between CO2 concentration in the atmosphere and the level of temperature warming is not linear. This is because of how Earth's systems react to global warming.

***Note**: If you have done the unit on Tipping Points, you can use this as an opportunity to discuss how the changes in Earth's systems and feedback loops contribute to non-linear temperature change. If not, we will now briefly explain how this occurs.*

Positive feedback loops amplify the original effect, making it stronger. For example, as temperatures warm, permafrost melts. Permafrost is ice that has been frozen for hundreds of thousands of years, and releasing a lot of methane which is a very potent GHG, 30 times more effective at trapping additional heat in the atmosphere than CO2.

The released methane will amplify global warming through the trapping of additional heat, which will lead to accelerated permafrost melting, which will lead to more methane release, and so on.

This positive feedback loop is not unique to permafrost, as many other tipping elements are able to enter positive feedback loops due to global warming and climate change. At some levels of global warming, these positive feedback loops can cause Earth's systems, such as forests, coral reefs, and ice sheets, to destabilise and go out of balance, reducing their ability to support life.



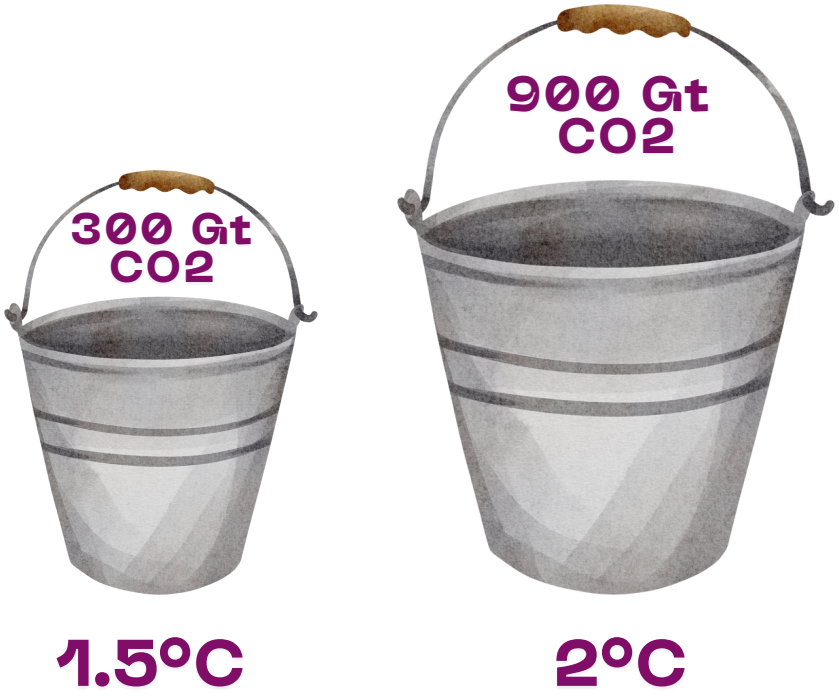
The setting of these temperature limits is aimed at ensuring that warming does not escalate uncontrollably and lead to more warming and destabilisation of Earth's systems.

Both temperature limits also have their own carbon budgets.

The amount of $CO_2$ emissions that we are able to emit before hitting a temperature limit is described as the **carbon budget**. Carbon budgets are therefore a crucial concept when talking about limiting global warming to a certain level. Not using up the budget greatly increases our chances of keeping global warming to below the temperature limits.

To help understand the carbon budget, the climate system can be imagined as buckets (whose exact sizes will be discussed in detail below). To keep global warming to below 1.5°C or 2°C, there is a finite amount of emissions we can emit. Every time we emit greenhouse gases, a drop is added to the climate system bucket. Once the bucket is full, the climate system will have reached a specific level of warming.

For example, if the 2°C bucket can contain a maximum of 900 Gt $CO_2$, then once we have emitted that amount the climate system will have warmed by 2°C. Additionally, emitting over the capacity of the bucket is to be avoided at all costs. Once the bucket is overflowing, it becomes very difficult to predict and control the knock-on effects, as the emissions are now no longer contained within our safe, well understood operating space of the bucket.



*1.3 Carbon budgets and probability levels*

Due to the complicated nature of responses of Earth's systems to temperature and how they in turn amplify or dampen warming, it is very difficult to predict exactly how much global warming will be observed for a set increase in CO2. What can be estimated is how likely an amount of CO2 emissions will lead to a global average warming of 1.5˚C or 2˚C.

This can also be explained using the bucket analogy. Once the climate system bucket has been filled with our emissions, it has to be carried through the complexities of Earth's system. Due to its complexity, there might be unforeseen bumps along the way that could rock the bucket and unexpectedly cause it to spill over even if it is not quite full yet. The fuller the bucket is, the more likely it is to spill and overflow whilst being carried through Earth's systems.

Therefore, to be more certain that our emissions and their effects on temperature stay within the safety of our bucket, the less we want to fill it.

When carbon budgets are calculated, interactions with different Earth systems (such as the absorption of CO2 by the oceans) are taken into account. Carbon budgets therefore give us clear emissions limits. If we adhere to these limits, we can be confident (to a certain degree) that global warming will not exceed the chosen limit.

These degrees of certainty have been calculated by climate scientists. The below figure shows the remaining carbon budget for limiting global warming to 1.5˚C and 2˚C. The budget is shown for different confidence levels for each warming limit.

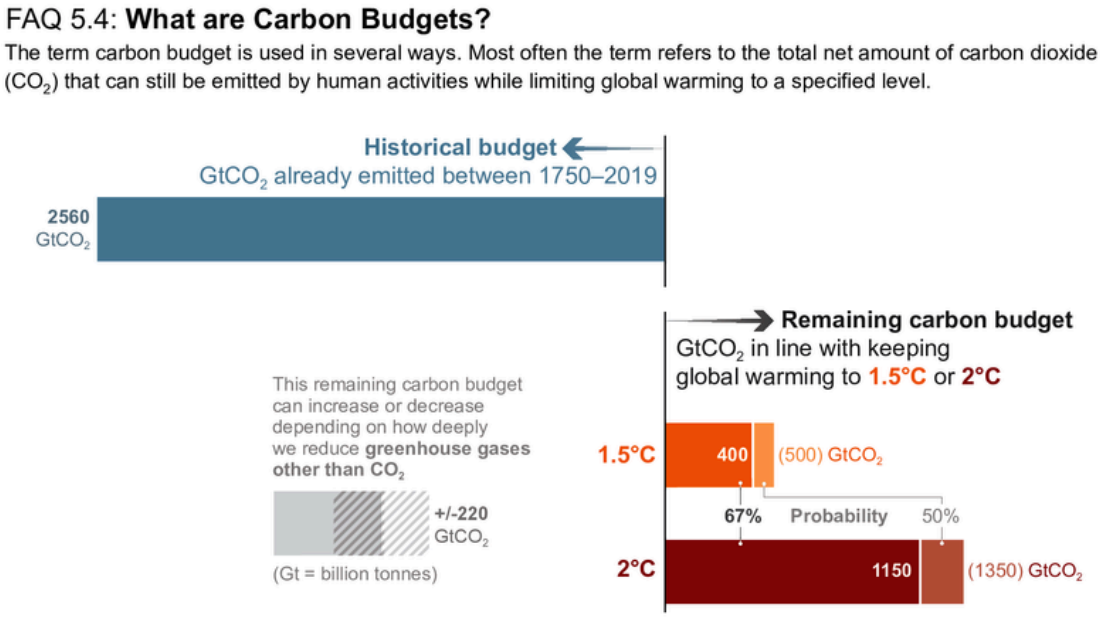



Figure 1: Various types of carbon budgets. Historical cumulative carbon dioxide ($CO_2$) emissions determine to a large degree how much the world has warmed to date, while the remaining carbon budget indicates how much $CO_2$ could still be emitted while keeping warming below specific temperature thresholds. Source: IPCC[5]

The overall trend in this data is relatively straight-forward and as expected. Overall, the carbon budget for 1.5°C is smaller than that for 2°C.

Equally, the more certain we want to be that our emissions will keep global warming to below the chosen temperature limit, the smaller the budget is going to be.

To be 83% certain that we will avoid a global warming greater than 1.5°C we can only emit 300 gigatonnes (Gt) of CO2. At the current average rate of 40 Gt CO2 per year, we are due to use up that budget by the middle of 2027, a mere two years away at the time of writing.

At current global emission rates we are due to use up our 900 Gt CO2 budget for an 83% chance of limiting global warming to 2°C before the end of 2043.


83% might sound like favourable odds, yet they are the same odds as winning the notoriously dangerous game of Russian roulette[6]: five in six. And with the livelihood of millions of people and the stability of countless ecosystems at stake, comparing climate change to Russian roulette is not as dramatic as it might seem.

Carbon budgets of lower confidence levels might seem attractive in terms of relieving the pressure from reaching carbon reduction targets in time. However, each step down in the confidence levels used in the above figure is the equivalent of adding a bullet to our increasingly loaded revolver.

Landing on the bullet and not being able to keep warming to below the desired limit has disastrous consequences, with the climate and other Earth systems possibly spiralling out of our control.

We simply cannot afford to lose this game, and the less we rely on good fortune the better.

Our best shot at avoiding warming of above 1.5˚C or 2˚C is to stop CO2 emissions today. Of course, this is an unrealistic target. Our next best option is to aim for an 83% chance of limiting global warming to no more than 1.5˚C, which allows us to emit 300 Gt CO2 from the start of 2020 onwards.

However, the highly emitting countries have such high annual emission rates that this too is most likely an unfeasible target given the current low political ambition to drastically reduce carbon emissions. The rest of this module will outline how to fairly attribute responsibility to different countries so that as a global society we are able to keep our emissions to the 83% chance of staying under a 2˚C warming budget.

## 2. Current emission rates and trends

### *2.1 Are current national pledges enough?*

As part of the 2015 Paris Agreement, all countries have made a specific pledge to reduce emissions. These are known as Nationally Determined Contributions (NDCs). Together, these NDCs are intended to bring global greenhouse gas emissions down and avoid catastrophic climate change. Countries submitted a first round of pledges (Intended NDCs, or INDCs) in 2016 as an immediate response to the Paris Agreement, and then updated their pledges (the actual NDCs) in 2022.

In addition to the NDCs not being legally binding under the Paris Agreement, the United Nations Framework Convention on Climate Change (UNFCCC) highlights that there is a "sizeable" difference between total global NDC commitments and the emissions reductions needed to keep global warming to below 2°C and especially 1.5°C[7].

As shown in the figure below, even if all countries meet the commitments of their NDCs by 2030, global emissions will still be much higher than emission limits necessary to keep global warming to below 1.5°C and 2°C. Currently, if all pledges are fully implemented on time, global average temperatures will rise by 2.1 to 2.8°C by the end of the century[8].

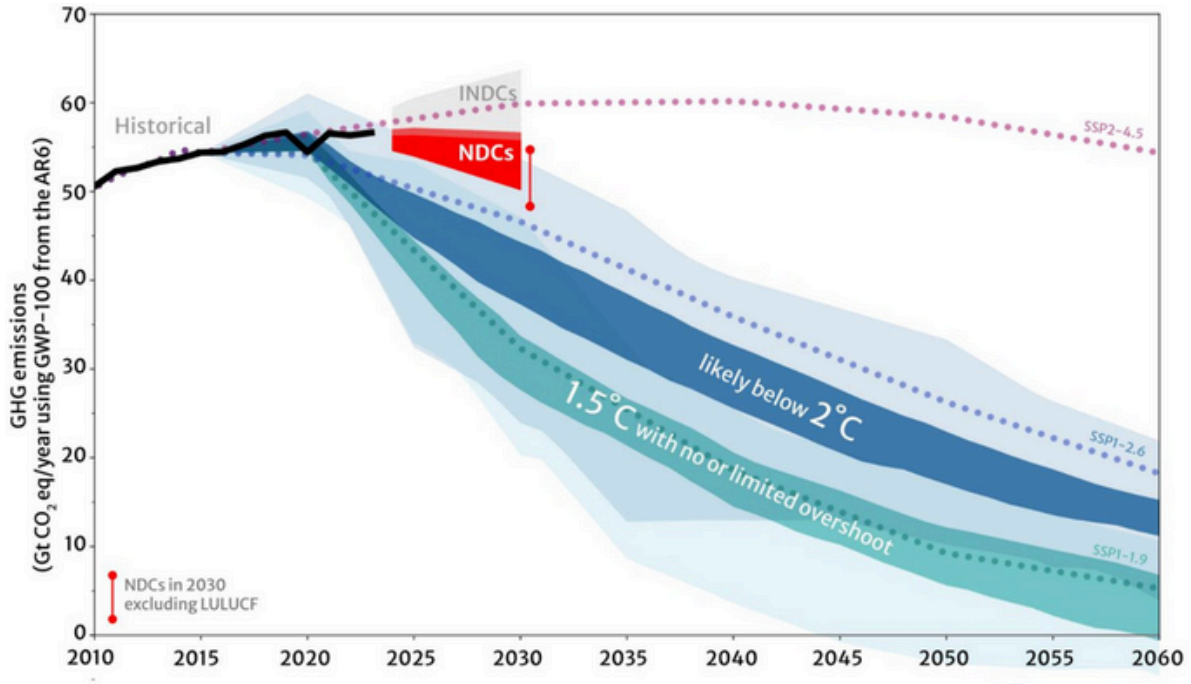



Figure 2: Global GHG Emission Trends Under Updated NDCs. Source: UNFCCC (2025b).[9]

In relation to the carbon budgets set out in the first section of this module, the UNFCCC NDC report9 informs us that even if all NDCs are implemented, they will permit total global emissions of around 435 Gt CO2 by 2030[10]. Given that the budget for our best chance at limiting global warming to 1.5°C is 300 Gt CO2, it is clear that global NDC pledges are not enough to confidently limit global warming to 1.5°C and are consuming an ever growing proportion of our 2°C budget.

Clearly, the world's nations need to cut emissions much quicker than they are currently planning to. However, as we will discuss in the next part of the unit, not all countries have to increase and strengthen their NDCs as much as other countries.


A demonstrator displays hands that read "pay up" during a protest for climate finance at the COP29 U.N. Climate Summit, Nov. 23, 2024, in Baku, Azerbaijan. (AP Photo/Rafiq Maqbool, File)

### *2.2 Different ways to measure emissions*

Some countries emit more than others – the Global North has a much larger current and historic footprint. It therefore would not be fair to ask all countries to reduce their emissions by the same absolute amount. As some countries emit CO2 while producing products to be consumed in other countries – for example almost half of the rice grown in Pakistan is exported[11] – it's important that we talk about different ways to account for a country's emissions.

A country's emissions should be measured in per capita terms, and can be counted using either territorial emissions, consumption-based emissions or historic cumulative emissions. These next sections will outline how each of these methods work.

*Territorial emissions*

Territorial emissions are all emissions that are emitted due to extraction and production of goods and services within a country's borders, irrespective of how many people live in the country or whether these products are intended for domestic consumption or for export to other countries.

*Per capita emissions*

When measuring a country's emissions it is important to always express them in per capita terms. Per capita simply means that we take the total amount and divide it by the number of people in the country. This ensures that differences in population sizes are accounted for and we compare emissions on a fair per person basis.

Comparing the emissions of Switzerland and India highlights the importance of per capita measurements. In absolute terms, Switzerland emits 121 million tonnes of $CO_2$ per year, and India emits 2,500 million tonnes (2.5Gt) of $CO_2$ annually - over 20 times more.

Looking at these numbers without taking into account population differences might lead us to think that India has a much higher emissions responsibility.

However, there are over 160 times more people in India than in Switzerland. It would not be fair to compare their emissions due to this vast population difference. Per capita emissions allows us to paint a clearer picture - Switzerland emits an annual 14 tonnes of $CO_2$ per person, compared to only 1.8 tonnes per capita for India.

*Consumption-based emissions*

Consumption-based emissions are counted as all emissions emitted to provide all goods and services *used* within a country. In the case of consumption-based emissions, the emissions caused by the production of a product count towards the emissions of the consuming, not of the producing country.

For example, the emissions associated with a product that is produced in Country A but consumed in Country B counts towards Country B's consumption-based emissions.

This allows for a better balance of responsibility between countries that have a particularly large e.g. manufacturing or mining industry, but are not the ones using these products. Instead, these products are exported to other countries and counted towards the importing country's emissions.

In some Global North countries, the difference between territorial and consumption-based emissions can be quite large. For instance, nearly half (0.272 Gt $CO_2$ out of a total 0.583 Gt $CO_2$) of the UK's 2020 total consumption-based emissions were from products produced outside the UK and imported[12].

## 3. Historic cumulative emissions

*3.1 What are historic cumulative emissions?*

The total amount of emissions released since the Industrial Revolution (around 1750) by a country are measured as their historic or cumulative emissions. As CO2 emissions stay in the atmosphere for many hundreds of years and impact the climate for even longer than that[13], emissions of the past very much matter for the future.

Once every country's historic cumulative emissions have been calculated, it becomes easy to identify who has contributed the most to the climate crisis. The Global North was the first to be industrialised and to start emitting large amounts of greenhouse gases.

Therefore they have accumulated a larger historical footprint and are thereby more responsible for the climate crisis.

For example, the USA has historically emitted 1299 tonnes of CO2 per person since 1850, compared to 2 tonnes per person for DR Congo. The emissions that the Global North has historically emitted allowed them to build roads, schools, hospitals and many other important infrastructure, while there is little climate budget left to allow Global South countries to do the same.

This is unjust and is why Global South countries should be allowed a higher climate budget.

*3.2 How could we address historic cumulative emission differences?*

As we have learned, to try and rectify this injustice of huge differences in historic emissions, as well as heavier climate change impacts in the Global South due to the larger emissions of the Global North, we can turn to the concept of climate reparations.

Climate reparations mostly take the form of financial support and compensation from the Global North to the Global South to try and balance out historic and current emission injustices[14].

## Endnotes

1. See for instance https://unfccc.int/process-and-meetings/the-paris-agreement

2. COP (Conference of the Parties) is an annual meeting of political world leaders as members of the United Nations Framework Convention on Climate Change (UNFCCC), the UN framework that specialises in tackling climate change. These COP meetings are where the most important global climate agreements are discussed and agreed on. COP21 in Paris is where the 2015 Paris Agreement was signed.

3. Iran, Libya and Yemen are the only UN member states not to have ratified the agreement. The USA withdrew in 2020 but rejoined in 2021.

4. https://www.un.org/en/climatechange/paris-agreement

5. Figure 1 in IPCC, 2021: Chapter 5. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Canadell, J.G., P.M.S. Monteiro, M.H. Costa, L. Cotrim da Cunha, P.M. Cox, A.V. Eliseev, S. Henson, M. Ishii, S. Jaccard, C. Koven, A. Lohila, P.K. Patra, S. Piao, J. Rogelj, S. Syampungani, S. Zaehle, and K. Zickfeld, 2021: Global Carbon and other Biogeochemical Cycles and Feedbacks. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 673–816, doi: 10.1017/9781009157896.007 .]

6. In Russian roulette a single bullet out of a possible six is placed within a revolver. The cylinder that holds the bullets is then spun, giving the bullet a one in six chance of being lined up with the barrel when the trigger is pulled with the gun pointed at one's head.

7. UNFCCC, 2023: NDC Synthesis Report

8. UNEP, 2024. Press Release: Nations must close huge emissions gap in new climate pledges and deliver immediate action, or 1.5C lost.

9. Reconnecting Climate Governance With Sustainable Development: Evidence From Three Decades of COP1–COP29 - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Global-GHG-Emission-Trends-Under-Updated-NDCs-Source-UNFCCC2025b_fig4_396901626 [accessed 3 Nov 2025]

10. A figure given in the budget as 87% of a 500 Gt CO2 budget

11. ICRA, 2023. Available at https://www.icra.in/Rating/DownloadResearchSpecialCommentReport?id=4829#:~:text=Around%201 0%25%20of%20the%20global,21%20million%20MT%20(40%25)

12. Office for National Statistics, 2024: Measuring UK greenhouse gas emissions. Available at: https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/measuringukgreenhousegas emissions

13. Alan Buis (NASA), 2019: The Atmosphere: Getting a Handle on Carbon Dioxide

14. Here is an example of how climate reparations could be measured: Fanning & Hickel (2023): Compensation for atmospheric appropriation. Available at: https://www.nature.com/articles/s41893-023-01130-8

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