GREENPEACE

UNDERSTANDING THE CLIMATE DEBT OF EXTREME WEALTH

CONTENTS

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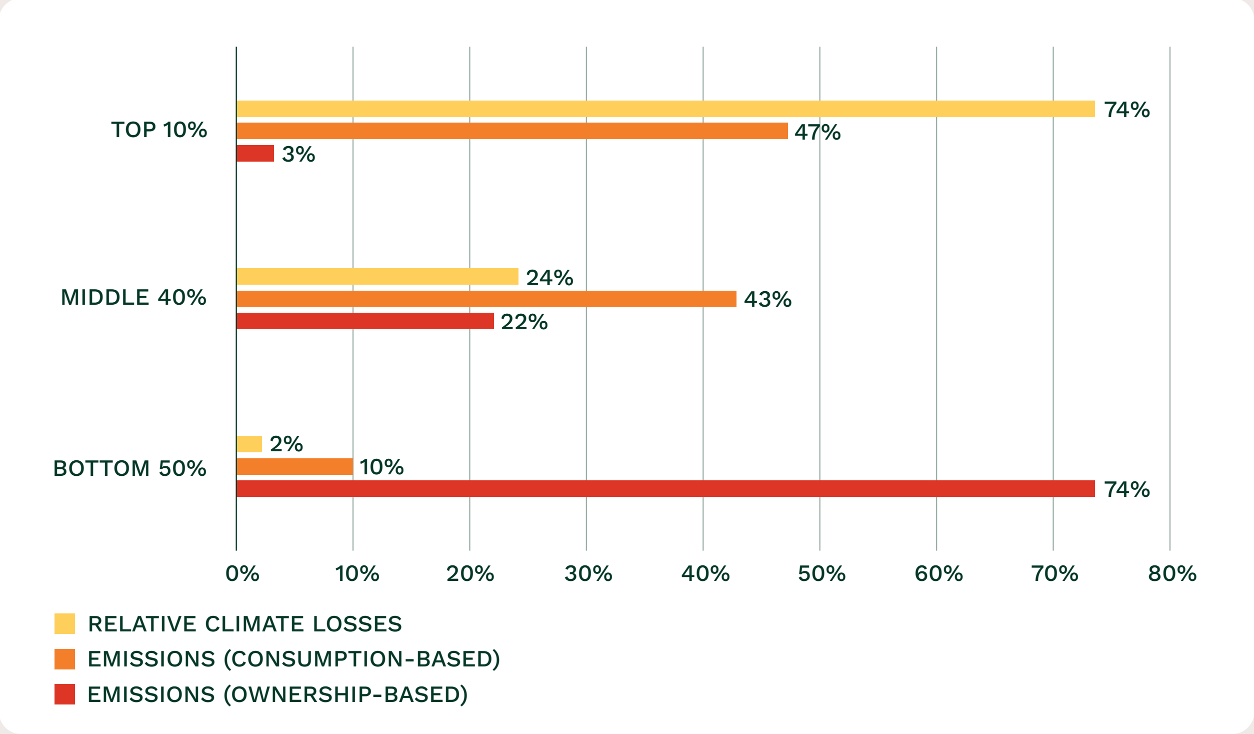
INTRODUCTION

Greenhouse gas (GHG) emissions impose costs on societies arising from the current and future damages caused by climate change. These costs are generated and borne unequally across different socio-economic groups, resulting in patterns of carbon inequality. **While carbon inequality between countries remains relevant, 63% of global inequality in individual emissions now arises from differences between low and high emitters within countries rather than across national borders, as shown by Chancel (2022).**

Since 1990, the bottom 50% have emitted significantly less CO_2 than the top 10%, and even less than the top 1% globally (see Chapter 2, Sections 2.3 and 2.4). This reflects both luxury consumption associated with high CO_2 emissions, including private yachts and private jets, and investment portfolios linked to economic activities generating high levels of GHG emissions (Chancel and Rehm, 2025b).

While these figures show that inequality drives climate change, climate change in turn is likely to have a strong concentration effect, further exacerbating income and wealth inequality. In their [Climate Inequality Report 2025], Chancel and Mohren (2025) find that the bottom 50% will suffer the most and have fewer means to cope with the consequences of climate change than the top 10% – the bottom 50% of the global population are expected to suffer 74% of relative climate losses, while the top 10% are projected to bear only 3%. Wealthier groups are more insulated from the impacts of climate-related shocks, while lower-income populations are more exposed to droughts, storms, rising temperatures, and inundations. Figure 1 illustrates this triple climate inequality.

FIGURE 1. TRIPLE CLIMATE INEQUALITY: THE POOREST LOSE THE MOST, CONTRIBUTE THE LEAST, AND LACK THE MEANS TO ACT



Source: Chancel and Mohren (2025)

Meanwhile, many climate policies, such as carbon taxes or energy price reforms, run the risk of having regressive effects – i.e. they place a higher burden on lower-income and middle-income households than on the wealthiest parts of the population. While carbon pricing and energy taxes are important and effective climate policy instruments, as shown by Stechemesser et al. (2024), it is crucial to consider their effects on lower-income households and design adequate compensation mechanisms. Otherwise, their regressive effects not only undermine fairness but also reduce political support for climate policies.

To be effective and just, climate policies must integrate inequality more centrally into their design and implementation to deliver their potential benefits to the whole population. As emphasised by Chancel et al. (2026) in the [World Inequality Report 2026:]

> *The climate crisis is also a capital crisis. To effectively address it, we must not only reduce emissions but also rethink how ownership, investment, and wealth are governed in the transition to a sustainable economy.*

In this report, we therefore propose to extend the concept of climate debt – traditionally applied to nations – to high-net-worth individuals (HNWIs). This approach, grounded in the polluter-pays and ability-to-pay principles, aims to inform progressive fiscal instruments such as wealth taxes. Revenue from such taxes should – without negating state-level responsibilities under international climate governance – finance mitigation, adaptation, and loss-and-damage efforts, but also, more broadly, ecological transition, restoration, and wider societal objectives.

To understand the scale of the potential financial contribution from taxing HNWIs based on a logic of individual climate debt, we apply a methodology to estimate the costs of the damage caused by their emissions. **This report quantifies the consumption- and ownership-based climate debt of HNWIs across the top 10%, 1%, top 0.1%, and top 0.01% of the global income and wealth distribution.** It examines this debt historically (from 1990 to 2022), in 2022, and under future emissions scenarios (from 2023 to 2050).

The results are used to identify key policy implications for progressive fiscal instruments such as carbon wealth taxation that can address the climate debt of HNWIs and inform policy debates at the international level, notably in the context of the ongoing negotiations on a United Nations Framework Convention on International Tax Cooperation (UN Tax Convention; UN DESA, 2025) and multilateral climate finance processes.

The report is structured as follows:

- Chapter 1 introduces the concept of climate debt and outlines the conceptual framework used in the report, including the application of climate debt to HNWIs.
- Chapter 2 reviews the main approaches for attributing emissions to different economic groups and explains the methodological focus on consumption-based and ownership-based emissions accounting. It further defines the population groups covered in the analysis, discusses the datasets used, and presents the corresponding emissions results across income and wealth groups.
- Chapter 3 presents the climate debt calculations for the world's top income and wealth groups, including annual, historical (cumulative), and projected climate debt estimates under both consumption-based and ownership-based approaches.
- Chapter 4 discusses potential policy pathways arising from the climate debt calculations. It compares estimated climate debt levels with existing tax proposals and climate finance needs, examines the geographical distribution of wealth, emissions responsibility, and climate vulnerability, and outlines preliminary policy implications for further work.

1. THE CONCEPT OF CLIMATE DEBT OF HNWIS

The concept of 'climate debt' is typically used to describe the unequal historical contribution of states to anthropogenic climate change and the resulting normative claims regarding responsibility, compensation, and climate finance, as reflected in the principle of common but differentiated responsibilities and respective capabilities (CBDR-RC)[1]. Rooted in the recognition that greenhouse gas (GHG) emissions accumulate over time and that the atmosphere constitutes a finite global commons, climate debt serves as a moral and political framework to highlight disparities between industrialised countries in the Global North and developing countries in the Global South (see, for example, Hickel, 2020; Fanning and Hickel, 2023; Hahn et al., 2024; and Pelz et al., 2025).

In this report, we extend the analysis of climate debt to wealth and income concentration. In line with the polluter-pays, ability-to-pay, and CBDR-RC principles, we apply the concept of climate debt to high-net-worth individuals (HNWIs). It is important to note that this report does not treat climate debt as direct fiscal liability (i.e., it does not wish to imply that the numbers should directly prescribe tax rates), but as an analytical and normative concept used to assess the scale of emissions responsibility associated with high-income and high-wealth groups. The climate debt estimates presented are intended to illustrate the potential scale and patterns of climate damages linked to excess emissions by HNWIs. They aim to inform policy discussions, including fiscal policy reforms, addressing climate inequality and fairer contributions to climate and ecological transition financing.

Applying climate debt to the level of individuals offers several analytical advantages:

- First, it reflects the reality that states are heterogeneous entities, within which responsibility for emissions and capacity to respond vary widely across income and wealth groups.
- Second, it enables a precise linkage between responsibility and capacity to contribute to mitigation, adaptation, and loss-and-damage financing.
- Third, it enables the consideration of policy instruments (such as carbon wealth taxes or progressive climate levies) to address the continued accumulation of climate debt at the very top of the distribution (i.e. the top 0.01% and above), while complementing existing policy frameworks under the United Nations Framework Convention on Climate Change (UNFCCC, 1992). The revenue from these instruments can support states in meeting their international climate finance commitments.

1 For climate debt calculations at the country level, see Grasso and Heede (2023), Fanning and Hickel (2023), and Fracalossi de Moraes (2025).

Importantly, the application of climate debt at the level of HNWIs does not negate the role of states in climate governance or the importance of the concept of climate debt and the principle of CBDR-RC at the state level, especially as the latter remains a crucial concept within the UNFCCC as well as in national and international legal proceedings. Rather, it offers an additional understanding of states as intermediaries and implementers of redistribution mechanisms that reflect underlying individual responsibilities. By doing so, it bridges climate justice debates with practical questions of tax design based on the polluter-pays principle and fiscal capacity

In this report, we define climate debt for HNWIs as the excess emissions of a specific income or wealth group above an equitable-share benchmark. Concretely, climate debt is calculated by identifying emissions that exceed an equitable per capita share of the remaining carbon budget and multiplying these excess emissions by a social cost of carbon (SCC)[2], which estimates the economic damage caused by an additional tonne of CO_2 emissions. In simplified terms:

Climate debt = excess emissions × social cost of carbon (SCC).

$$ClimateDebt_i + (E_i - E_{equitable}) \times SCC$$

E_i represents the emissions attributed to a given income or wealth group, $E_{equitable}$ represents the equitable per capita emissions share under a 1.5°C pathway, and SCC represents the social cost of carbon.

The understanding of climate debt at the individual level suggests that responsibility for ecological overshoot may be viewed not only in terms of inequality between nations but also in terms of wealth distribution, reflecting the ecological overshoot of the world's richest wealth and income groups. Recent analysis by Oxfam (2026), drawing on data from SEI's Emissions Inequality Dashboard (Ghosh et al., 2021), shows that the emissions of the richest 1% are so high that they would exhaust an equitable annual carbon budget compatible with 1.5°C warming within days.

A detailed description of the climate debt formula is provided in Annex I, and its methodological components and data constraints are explained in Chapter 2, particularly Sections 2.1 and 2.2, as well as in the methodological Annexes II–VI. This includes the attribution of consumption-based and ownership-based emissions across income and wealth groups, the determination of equitable per capita emissions shares consistent with a 1.5°C pathway, and the selection and justification of the SCC, as well as key assumptions and limitations underlying the calculations.

2 Approaches that assign monetary values to emissions through carbon pricing or an SCC can raise concerns, as these may risk commodifying climate damage, burdening low-income households, and obscuring questions of historical responsibility and climate justice. In this analysis, the SCC is, however, not used to imply that climate damages can be fully compensated financially, but rather as an analytical tool to illustrate the scale and concentration of climate debt. The approach is intended to support the debate on climate inequality and to inform discussions on progressive carbon pricing and wealth-based climate policy instruments targeting the very top of the global income and wealth distribution.

2. ATTRIBUTION OF CO_2 EMISSIONS TO HNWIs

2.1. THREE APPROACHES TO ACCOUNT FOR CO_2 EMISSIONS

A core element in calculating the climate debt of HNWIs is the attribution of emissions to the richest income and wealth groups. To understand who is responsible for CO_2 or greenhouse gas (GHG) emissions, researchers use different methods to allocate emissions. The three main approaches identified in recent literature are production-based, consumption-based, and ownership-based emissions accounting. Each method provides a distinct lens and has its own strengths and limitations.

The following tables capture the Focus and Constraints of the three main approaches to the attribution of CO2 emissions to HNWIs identified in recent literature: production-based, consumption-based, and ownership-based emissions accounting.

Production-based emissions accounting – This traditional method assigns emissions to the country where they are physically produced, regardless of who ultimately consumes the resulting goods or services.

TABLE 1. THE FOCUS AND CONSTRAINTS OF PRODUCTION-BASED EMISSIONS

FOCUS	CONSTRAINTS
The method is aligned with existing national GHG inventories and is widely used in international climate agreements, including reporting under the United Nations Framework Convention on Climate Change (UNFCCC, 1992). It is relatively easy to track and regulate at the point of emission, such as in factories and power plants.	The method penalises countries with large export industries, such as China and Thailand, while ignoring emissions embedded in imports to consumption-driven economies. Furthermore, it does not attribute emissions to individuals and fails to demonstrate the responsibility of high-consuming or investing populations in wealthy nations.

Production-based accounting is widely used in policymaking but often leads to a misallocation of responsibility, as shown in research by the Stockholm Environment Institute (SEI) (Kartha et al., 2020), data from SEI's Emissions Inequality Dashboard (Ghosh et al., 2021), and subsequent work by Oxfam (2024). Emissions from goods produced in lower-income countries are often consumed elsewhere; however, these trade-related emissions are not accounted for under the production-based approach.

Consumption-based emissions accounting – This approach underpins much of the public discourse on climate inequality and attributes emissions to individuals based on their consumption of goods and services, including emissions embedded in imported products. It assumes that people 'cause' emissions through their lifestyle choices and levels of consumption.

TABLE 2. THE FOCUS AND CONSTRAINTS OF CONSUMPTION-BASED EMISSIONS

FOCUS	CONSTRAINTS
Captures the full carbon footprint of consumer lifestyles, including emissions outsourced through international trade. For example, emissions may be released in lower-income economies but ultimately serve the consumption patterns of individuals in higher-income countries. These emissions are therefore attributed to the final consumer rather than the producer.	May underplay the role of wealthy individuals who accumulate wealth but do not display it through consumption – for example, those with low visible consumption but large investments in polluting industries – and overemphasise the responsibility of consumers as individuals, given the structural causes of emissions.

Studies applying the consumption-based approach have revealed significant disparities in consumption-based emission footprints both within and between countries. The approach is used, for example, in research by SEI and (Kartha et al., 2020), SEI's Emissions Inequality Dashboard (Ghosh et al., 2021), and subsequent work by Oxfam (2024). This is further supported by recent work highlighting the disproportionate contribution of wealthy individuals to emissions (Gössling and Humpe, 2024).

Ownership-based emissions accounting – This newer approach attributes emissions to individuals based on their ownership of capital assets, such as shares in companies or stakes in private firms. The emissions generated by these assets (for example, by fossil fuel companies) are assigned to their owners, regardless of their personal consumption. This perspective shifts the focus from consumption to ownership, which is particularly relevant for understanding emissions driven by investment decisions.

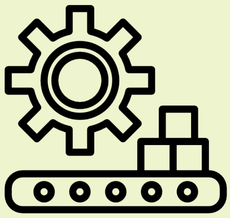
TABLE 3. THE FOCUS AND CONSTRAINTS OF OWNERSHIP-BASED EMISSIONS

FOCUS	CONSTRAINTS
Captures emissions resulting from investment decisions and asset ownership, which are often overlooked in consumption-based methods. It aligns with the principle that those who own and profit from polluting industries should be held accountable for the associated emissions.	Requires detailed data on asset ownership, which are often not publicly available. The resulting data rely on estimates. May underplay the role of wealthy individuals with high consumption of high-carbon goods, such as private jets and yachts, but low investments in polluting industries.

Ownership-based emissions accounting, introduced by Chancel and Rehm (2025a, 2025b), reveals even higher levels of emissions concentration than those identified through consumption-based approaches, as illustrated in Sections 2.3 and 2.4 below and in the corresponding tables in Annexes III and IV. **Ownership-based accounting is essential for climate policy design, as it highlights the responsibility of capital holders in driving systemic emissions and, consequently, their potential role in financing the transition to a low-carbon economy.** It shifts accountability to those parts of the population that financially benefit from emission-intensive activities and thus opens up a perspective for considering supply-side fiscal policies (such as carbon wealth taxes) rather than focusing solely on demand-side instruments (such as carbon taxes already applied in several countries).

Figure 2 summarises the methodological Pros and Cons in the context of attributing carbon responsibility to individuals.

FIGURE 2. THE PROS AND CONS OF THE DIFFERENT CARBON ACCOUNTING APPROACHES

PRODUCTION-BASED	CONSUMPTION-BASED	OWNERSHIP-BASED
Emissions are attributed to the country or sector where the emissions occur, regardless of end use.	Emissions are attributed to individuals based on their consumption, including emissions embedded in imports.	Emissions are attributed to individuals based on hteir ownership of capital assets, such as shares in companies or real-estate assets.
		
PROS • Aligned with UN reporting	**PROS** • Captures the carbon footprint of lifestyles, including trade-related emissions • Useful for analyzing carbon inequality	**PROS** • Captures emissions from investments • Aligns responsibility with profit from polluting industries • Usefull for analyzing carbon inequality
CONS • Ignores emissions embedded in imports • Underestimates wealthy populations	**CONS** • Underplays pollution from investments	**CONS** • Requires detailed ownership data • Underplays the role of carbon- intensive consumption by wealthy individuals (eg private jets and yachts)

Source: Green Budget Germany (Forum Ökologisch-Soziale Marktwirtschaft e.V., FÖS), own illustration.

It should be noted that the three approaches are based on the same pool of emissions but allocate responsibility for these emissions differently. They therefore cannot be summed but instead offer different perspectives on the same problem:

- Production-based emissions accounting assigns emissions to the territory where they are physically produced.
- Consumption-based emissions accounting reallocates emissions to the final consumers of goods and services, regardless of where they occur along global supply chains.
- Ownership-based emissions accounting attributes emissions to investors, and thus to the owners of productive assets.

The production-based and consumption-based approaches are widely used to understand countries' emission overshoot and state-level responsibilities. The production-based approach in particular is central to ongoing climate reporting and negotiations under the UNFCCC. However, production-based emissions accounting is not used for this analysis, as the focus here is on emissions of HNWIs rather than nation states.

This report makes use of the two approaches that assign emissions to individuals and account for inequalities between different economic groups: the consumption-based and the ownership-based approaches. While the consumption-based approach is more established and thus potentially more refined, the ownership-based approach offers a perspective on investors' responsibility that has been underdeveloped in the debate on carbon inequality to date. Considering the findings of Chancel (2022), which show that **more than 70% of emissions from the global top 1% in 2019 stem from investments rather than consumption, it is therefore crucial to include an approach focusing on emissions attribution based on ownership rather than solely on consumption.**

It is furthermore useful to consider both accounting approaches, as they imply different tax measures to address them. For example, consumption-based emissions of very wealthy groups can be addressed by luxury consumption taxes, such as those on private jets, while ownership-based emissions are better targeted by wealth-related or corporate taxes.

2.2. HNWIS – POPULATION GROUPS COVERED AND DATA USED

As emissions are assigned to deciles and centiles of the world's population (i.e. the global top 10%, top 1%, top 0.1%, and top 0.01%), it is useful to clarify how these quantiles translate into numbers of people and wealth categories such as millionaires, centi-millionaires, or billionaires. Deciles and centiles describe shares of the population (e.g. 1%), whereas wealth categories describe absolute wealth thresholds (e.g. millionaires, or those with more than X million). These two approaches are therefore not equivalent. For the purposes of contextualizing the centiles used in this report, we provide an illustration of what percentage is roughly equivalent to millionaires, billionaires etc. See Box 1 below.

Wealth and income distribution data are generally constructed for the adult population (roughly 5.6 billion individuals)[3]. By contrast, emissions data typically refer to the entire population, (roughly 8 billion individuals). This report focuses on emissions and their attribution to different groups, **adult population data are not used for the calculations in this report.** The report follows Ghosh et al (2021) and Chancel and Rehm (2025b) who assume that the income and wealth shares attributed to a given percentile group apply to all individuals of the world population. Consequently, **our analysis focuses on the entire population** (whereby - for example - the top 0.01% of the entire global population would be 800,000 individuals) rather than adult wealth groups (where the top 0.01% is 556,000 individuals).

Wealth and income distribution data such as the adult population data become more important, when considering the policy implications of the estimated climate debt and exploring fiscal instruments through which HNWIs could contribute to addressing the climate debt associated with extreme wealth concentration (as you will only tax adults not the entire population) .

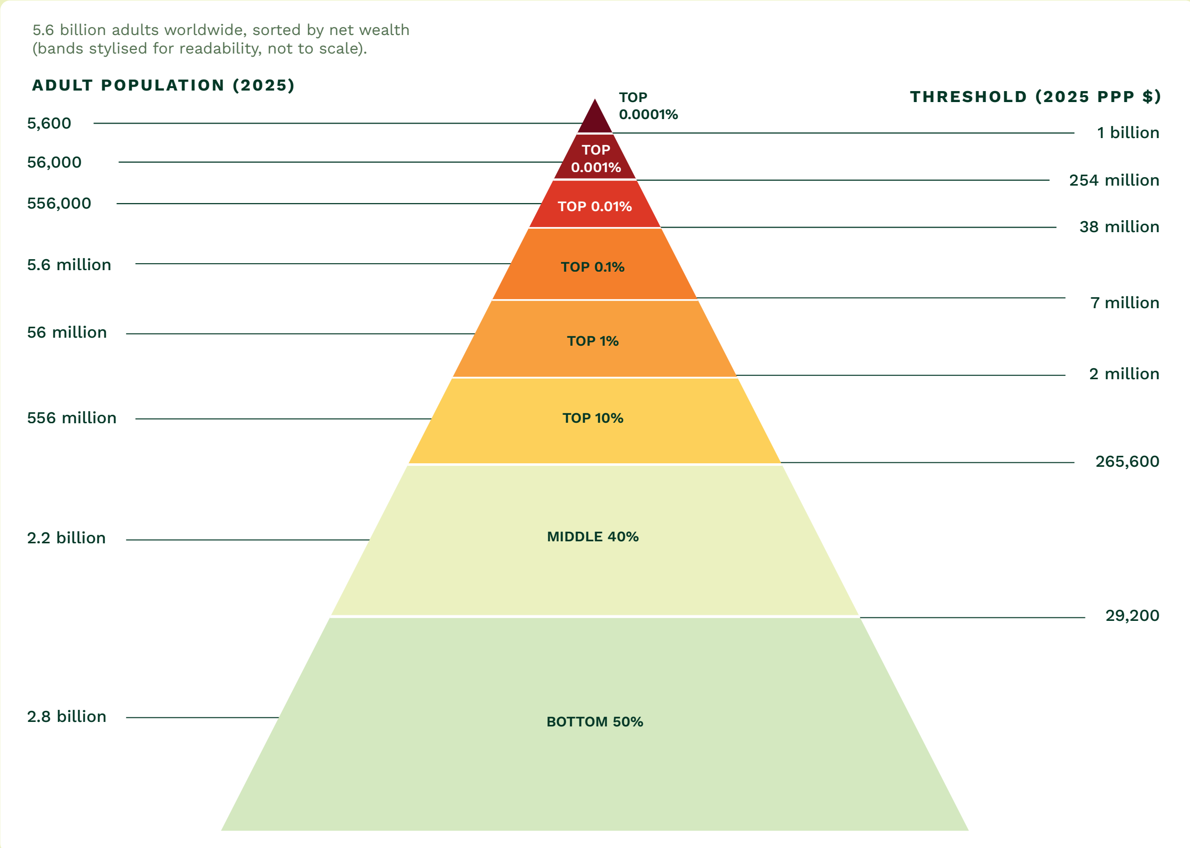
3 E.g. World Inequality Report 2026 (WIR), UBS Wealth report 2025

BOX 1. HOW DO PERCENTAGES (POPULATION GROUPS) TRANSLATE INTO NUMBERS OF INDIVIDUALS AND WEALTH CATEGORIES?

The *World Inequality Report 2026* (Chancel et al., 2026) shows that the wealth threshold of the top 10% of the world's adults is 265,600 US$ purchasing power parity (PPP)[4]. The wealth threshold for the 1% is 2 million US$ PPP, for the 0.1% the threshold lies at 7 million US$ PPP and for the 0.01% at 38 million US$ PPP . Billionaires roughly constitute the 0.0001% of the adult population (see Figure 3).

In this report, we refer to the top 0.01% (approximately 800,000 individuals when referring to the whole world population) as ultra-high-net-worth individuals (UHNWIs)

FIGURE 3. THE DISTRIBUTION OF GLOBAL WEALTH



Source: World Inequality Report 2026, Figure 1.4, p 41

As explained above, the report combines consumption-based and ownership-based emissions accounting approaches in order to capture different dimensions of climate debt among HNWIs. Consumption-based emissions are assigned to income groups and reflect emissions linked to lifestyles and purchasing power. Ownership-based emissions are assigned to wealth groups and reflect emissions linked to the ownership of productive assets and investment portfolios. This distinction is important because wealth is generally more unequally distributed than income (Chancel et al., 2026) and because

4 There are two public versions of the World Inequality Report 2026. One uses € PPP and the other uses US$ PPP. We refer to the one from the World Inequality Report 2026 website (see https://wir2026.wid.world/insight/global-economic-inequity/, Figure 1.4 or page 41 in the downloadable version). While the use of PPP is different to market exchange rates, we use the World Inequality Report to illustrate the approximate wealth of the top 10%, 1%, 0.1% and 0.01%.

wealth-based emissions allocations point to different policy instruments than income-based allocations when looking to address climate debt. Wealth-based emissions allocations highlight the need for structural interventions, such as wealth or capital gains taxes, while income-based emissions allocations inform policies such as income-based taxes and progressive carbon pricing.

Our analysis therefore draws on several existing datasets and studies selected based on their relevance to consumption- and ownership-based emissions accounting. We use:

- data from SEI's Emission Inequality Dashboard (Ghosh et al, 2021), as applied in Oxfam (2024, 2025), **for the consumption-based approach**, and
- data from Chancel and Rehm (2025b), focusing on companies' Scope 1 emissions[5], **for the ownership-based approach** (see summary in Table 4).

The statistical datasets cover emissions assigned to global income and wealth groups, including the bottom 50%, middle 40%, top 10%, and top 1% (for both the consumption- and ownership-based approaches), and the top 0.1% (for the consumption-based approach). The top 0.01% is used from Chancel (2022). Based on the data available from the consumption-based approach for the top 0.1% and top 0.01%, ownership-based emissions for these groups can be imputed. However, no statistical emissions data[6] exist for centi-millionaires or billionaires, approximately corresponding to the top 0.001% and top 0.0001%. The report therefore estimates climate debt for the top 10%, 1%, 0.1%, and 0.01%, with the main analytical interest of this report being the top 0.1% and especially the top 0.01% and above, where per capita emissions and therefore the climate debt are likely to rise most sharply.

The selected datasets differ in their emissions attribution methods as well as in their coverage of emissions. In particular, the consumption-based data are reported in CO_2, while the ownership-based data are reported in CO_2 equivalents (CO_2e)[7]. In addition, the ownership-based approach allocates only companies' Scope 1 emissions to owners, thereby avoiding overlaps (and reducing the risk of double counting) that may arise when Scope 2 emissions or indirect energy-related emissions are simultaneously attributed across different actors and sectors.

It is also important to note that the ownership-based approach provides data on the overall stock of emissions attributed to the capital ownership concept (see Chancel and Rehm, 2025b, methodological note). However, the data used for this analysis focus only on companies' Scope 1 emissions attributed to their owners. As a result, absolute figures are conservative and likely underestimate emissions across income groups. See Annex II for a fuller methodological discussion of dataset comparisons.

5 Scope 1 covers direct emissions from sources owned or controlled by a company (e.g. burning fuel, company vehicles). Scope 2 covers indirect emissions from the generation of energy purchased and consumed by a company (e.g. electricity, heating, cooling, or steam).

6 To impute the data, we draw on per capita emissions data from Chancel (2022). The calculation starts with an existing estimate for the larger group (for example, the top 1%) and then narrows it down to the smaller, even wealthier group (for example, the top 0.1%) using information about how much more they emit on average. For example, the global top 1% are assigned 41% of global emissions under an ownership-based approach. The same research also shows that the average person in the top 0.1% emits about 4.24 times more than the average person in the top 1%. Because the top 0.1% are only one tenth of the size of the top 1%, their total emissions are estimated by combining these two factors: they are a much smaller group, but each person emits much more. Mathematically, this means multiplying 41% by 0.424, which is 4.24 × 0.1. This results in an estimated emissions share of 17.4% for the global top 0.1%. See Annexes III and IV for more detailed explanations.

7 CO_2 equivalent is a standard unit used to compare the warming impact of different greenhouse gases (such as carbon dioxide, methane, nitrous oxide, and refrigerants) by expressing them as the equivalent amount of CO_2 that would produce the same warming effect over a specified timeframe, usually 100 years.

TABLE 4. DATA AVAILABILITY FOR ATTRIBUTING EMISSIONS TO ECONOMIC GROUPS

INCOME/WEALTH GROUPS	CONSUMPTION-BASED APPROACH	OWNERSHIP-BASED APPRAOCH
Top 10%	Ghosh et al (2021); Oxfam (2024) (income groups)	Chancel and Rehm (2025b) (wealth groups)
Top 1% (millionaires)	Ghosh et al (2021); Oxfam (2024) (income groups)	Chancel and Rehm (2025b) (wealth groups)
Top 0.1%	Ghosh et al (2021) (income groups)	Imputed based on data from Chancel and Rehm (2025b) and Chancel (2022) (wealth groups)
Top 0.01%	Imputed based on data from SEI (2026) and Chancel (2022) (income groups)	Imputed based on data from Chancel and Rehm (2025b) and Chancel (2022) (wealth groups)
Top 0.001% (centi-millionaires)	Not available	Not available
Top 0.0001% (billionaires)	Not available	Not available
308 billionaires	Not available	Oxfam (2025)
50 billionaires	Oxfam (2024) (emissions from private jets and yachts)	Oxfam (2024)

Technical note: *Under the consumption-based approach, emissions are attributed to typical consumption patterns of income groups. Under the ownership-based approach, emissions are attributed proportionally to the equity, private firm ownership, and pension assets owned by the respective wealth groups. In other words, companies' Scope 1 emissions are attributed based on portfolio composition patterns by wealth group (see Table 8 in Annex II for more details).*

Based on the datasets and studies mentioned in the table above, we can estimate climate debt for the most recent year for which data are available (2022), retrospectively (from 1990 to 2022), and prospectively (up to 2050). These calculations are possible for the top 10%, top 1%, top 0.1%, and top 0.01%, but not for centi-millionaires and billionaires as separate statistical groups. It is important to recognise that while emissions data for the top 10%, top 1%, and top 0.1% are estimated in the literature using established methodologies, emissions attributable to the top 0.01% are subject to substantial uncertainty due to the opacity of asset ownership and consumption patterns. Furthermore, cumulative emissions should be interpreted with caution, as the individuals who make up the different income and wealth groups change over time. These considerations should be kept in mind when using climate debt as a rationale for a progressive carbon or wealth tax.

The methodological and data-related considerations elaborated above shape the climate debt calculations used throughout this report. Based on the selected datasets and attribution approaches, the report conducts two non-additive climate debt calculations: one based on consumption-based emissions attributed to income groups, and one based on ownership-based emissions arising from investment decisions and attributed to wealth groups. See Annexes II–VI for further details on the methodology. The following sections present the underlying emissions data and projections for these two approaches, which form the basis for the climate debt calculations developed in Chapter 3.

BOX 2. COMPARISON WITH DIRECT ATTRIBUTION APPROACHES

Non-statistical sources provide additional data on emissions associated with billionaires. For example, Oxfam uses a more direct attribution approach that links emissions to identifiable billionaire ownership stakes and luxury assets, rather than inferring them from average consumption and ownership patterns within income and wealth brackets. Specifically, the approach attributes emissions to billionaires through two main channels:

- First, it accounts for consumption-related emissions arising from luxury transport, such as private jets and yachts (Oxfam, 2024).
- Second, it attributes corporate emissions to billionaires based on their ownership stakes in companies, particularly in carbon-intensive sectors such as fossil fuels, mining, and heavy industry. Emissions are allocated in proportion to equity ownership, reflecting the idea that shareholders benefit financially from emission-generating activities and exert influence over them (Oxfam, 2024, 2025).

By grounding attribution in real-world asset ownership and observable activities, Oxfam's method avoids relying on stylised assumptions about representative lifestyles or portfolio compositions of HNWIs. Two important differences between Oxfam's approach and the approach used in this study should be noted:

- The first difference concerns the emissions coverage. The ownership-based approach used in this study assigns companies' Scope 1 emissions to different wealth groups, while Oxfam's calculations include both companies' Scope 1 and Scope 2 emissions, which may create a risk of double counting.[8]
- Second, Oxfam's studies focus on a limited number of identifiable billionaires, while this report analyses broader global wealth groups. Oxfam (2025) covers 308 billionaires, while Oxfam (2024) covers 50 billionaires; by comparison, approximately 3,000 billionaires exist worldwide. While direct attribution of emissions would be more precise, it is currently not possible to apply this approach comprehensively to all billionaires, let alone centi-millionaires, due to a lack of data on corporate emissions and limited information on the ownership positions needed to link emissions to individuals.

While the approach used by Oxfam is not directly comparable to the one applied in this study, the results point in the same direction: emissions and climate debt rise steeply with wealth concentration.

8 The inclusion of Scope 2 emissions may lead to double counting where investments in energy companies are included (see also Chancel and Rehm 2025a).

2.3. CONSUMPTION-BASED EMISSIONS

Data for the consumption-based approach show that CO_2 emissions are highly concentrated among the richest global income groups. In 2022, the richest 1% alone generated about 16.5% of global emissions (6 GtCO2), far exceeding the entire bottom half of the world's population, which accounted for approximately 8% (3 GtCO2). Per capita emissions increase sharply with income, from an average of 0.8 tCO2 per year in the bottom 50% to more than 70 tCO2 per year in the top 1%.[9]

Cumulative historical emissions data confirm that the highest income groups have contributed most to climate change over recent decades: the top 1% were responsible for 167 GtCO2 between 1990 and 2022, while the bottom half contributed 77 GtCO2 over the same period. Future projections show that even under the most ambitious mitigation pathway (RCP1.9 combined with SSP1[10]), the richest income groups are expected to remain major emitters, with projected emissions far exceeding those of lower-income groups.

This trend persists across different socioeconomic pathways, suggesting that, **without targeted policies, global inequality in climate debt will continue or may even intensify.** See Annex III for all consumption-based emissions data, including the shares and absolute emissions per income group for 2022, historical emissions from 1990 to 2022, and projections from 2023 to 2050.

2.4. OWNERSHIP-BASED EMISSIONS

Calculations for the ownership-based approach show that emissions associated with investment activities (i.e. ownership-based emissions) are even more concentrated at the top of the global distribution than consumption-based emissions. This can be explained by higher investment shares among wealthier groups and by evidence showing that the asset portfolios of richer population groups are more emission-intensive than those of less wealthy groups. A 2025 study finds that 'beyond a certain wealth threshold, aside from the level of wealth that increases, the composition of asset portfolios may contribute to the increasing footprints of the wealthy' (Chancel and Rehm, 2025a).

While the bottom 90% contribute only about 23% of emissions, the top 10% are assigned the vast majority (77%) of emissions from investment activities. This disparity is also reflected in per capita emissions: an average person in the bottom 50% is assigned 0.2 tCO2e in 2022, while an average person in the top 1% is assigned 165 tCO2e in the same year, and an average person in the top 0.01% can be assigned 3,799 tCO2e in a single year. Data from Oxfam (2024, 2025; see Section 2.2), though not directly comparable to the statistical ownership-based data from Chancel and Rehm (2025b), confirm this trend of steeply increasing emissions with rising wealth.

Cumulative historical emissions data confirm that the wealthiest groups have contributed most to climate change over recent decades and show even greater disparities than data from the consumption-based approach. While the top 1% were responsible for 344 GtCO2 between 1990 and 2022, the bottom half contributed only 22 GtCO2 over the same period. **Projected ownership-based emissions through 2050 show that, across all scenarios, the concentration of emissions among the wealthiest persists and, in high-inequality scenarios, even** intensifies,

9 $GtCO_2$ refers to gigatonnes of carbon dioxide, while tCO_2 refers to tonnes of carbon dioxide. One gigatonne equals one billion tonnes; one tonne equals 1,000 kilograms.

10 RCPs (Representative Concentration Pathways) describe different greenhouse gas concentration and warming pathways, while SSPs (Shared Socioeconomic Pathways) describe different socioeconomic development trajectories. RCP1.9 combined with SSP1 refers to a 1.5°C-compatible mitigation pathway combined with a sustainability-oriented socioeconomic development scenario.

with the top 1% and above accounting for a disproportionately large share of future emissions.

These projections suggest that, without systemic changes in financial flows and asset ownership patterns, climate mitigation efforts may be undermined by the emissions linked to the investment activities of the wealthiest. See Annex IV for all ownership-based emissions data, including the shares and absolute emissions per wealth group for 2022, historical emissions from 1990 to 2022, and projections from 2023 to 2050.

The consumption-based and ownership-based datasets provide the empirical basis for the climate debt calculations developed in the following chapter. The climate debt analysis combines historical emissions data, future emissions projections, and equitable-share benchmarks in order to estimate the extent to which different global income and wealth groups exceed their proportionate share of the remaining carbon budget. Applying a social cost of carbon (SCC) to these excess emissions allows us to translate unequal emissions responsibility into monetary estimates of climate debt (see Chapter 1 for the conceptual framework and Annex I for further methodological details).

3. THE CLIMATE DEBT OF THE WORLD'S TOP INCOME AND WEALTH GROUPS

Applying the climate debt framework introduced in Chapter 1 to the emissions attribution datasets discussed in Chapter 2, this chapter generates estimates of climate debt for the global top 10%, top 1%, top 0.1%, and top 0.01% income and wealth groups. The calculations use a social cost of carbon (SCC) of US$283 per tCO_2 (2020), based on the mean estimate reported by Moore et al. (2024)[11]. They generate three categories of estimates for both consumption-based and ownership-based emissions approaches:

- annual climate debt (2022),
- accumulated climate debt (1990–2022),
- and projected climate debt (2023–2050)[12], for low-emission and high-emission scenarios.[13]

The calculations translate emissions inequality into monetary estimates of climate debt. For each income and wealth group, attributed emissions are compared to an equitable per capita share of emissions consistent with a 1.5°C pathway. Emissions exceeding this 'equitable share'[14] are treated as excess emissions and multiplied by the SCC, which represents the estimated lifetime economic damage associated with one additional tonne of CO_2 emissions. While all emissions contribute to climate change, the concept of an equitable share is used here to identify the level of excess emissions that should be addressed through policy in order to limit further climate damage (see Annex V, including Table 14, for further methodological details)[15].

The climate debt estimation results across income and wealth groups (complete results are provided in Tables 15–20 in Annexes VII and VIII) **are group-based analytical calculations derived from the methodology discussed above.** The consumption-based and ownership-based estimates represent two alternative attribution lenses for assessing the full estimated climate damages associated with emissions and are therefore non-additive and should not be combined. **The results should be understood as indicative estimates illustrating relative orders of magnitude and patterns of**

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11 This SCC is based on a meta-study by Moore et al. (2024), which synthesises 1,823 SCC estimates from 147 studies. The meta-study reports an SCC range of US$32–US$874, with a mean SCC estimate of US$283 per tCO2. This SCC value has been adjusted for inflation using the Consumer Price Index (CPI), following the approach applied by Gössling and Humpe (2024), to allow for consistent use across different years. See Annex VI for further details.

12 As explained in Chapter 1, climate debt is used in this report as an analytical concept to describe emissions responsibility translated into monetary estimates. For projected emissions, the term 'projected climate' debt is used for methodological consistency and refers to estimated future climate damage associated with projected excess emissions, rather than debt already accumulated.

13 Projected climate debt was not calculated for the top 0.01%, as emissions projections are only available up to the top 0.1%.

14 The 'equitable share' of emissions for individuals is distinct from the established concept of 'fair share' under climate governance for states. The concept of 'fair share' refers to the idea that the emissions reduction burden should be divided among states in a manner that reflects international legal principles such as equity, equality, and common but differentiated responsibilities and respective capabilities (CBDR-RC) (Rajamani et al., 2021).

15 In this analysis, we do not subtract CO_2 prices already paid through carbon taxes, emissions trading systems, or similar instruments, and we do not add fossil fuel subsidies, because it is difficult to allocate both CO_2 price payments and subsidy benefits across different income and wealth groups in a robust and transparent way. See Annex VII for further details.

climate responsibility associated with different income and wealth groups, rather than as direct tax calculations or precise policy prescriptions. The results show the following:

3.1. THE CLIMATE DEBT DATA REVEAL A STRONG CONCENTRATION OF RESPONSIBILITY AT THE VERY TOP OF THE GLOBAL WEALTH DISTRIBUTION.

Key results[16]:

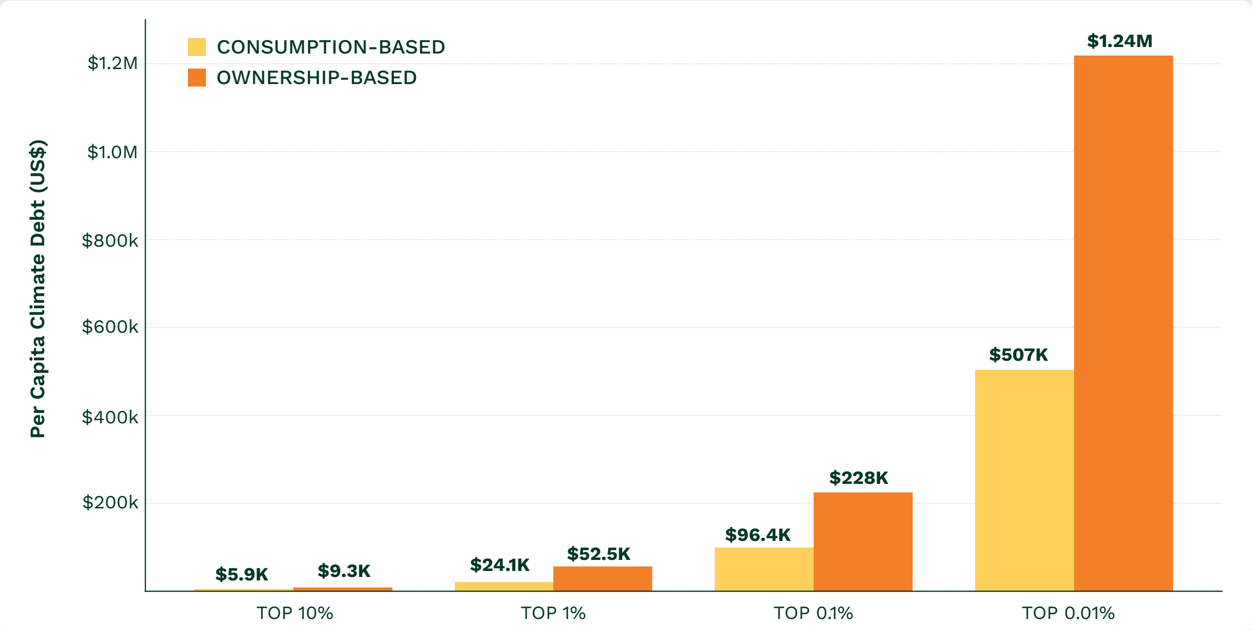
- The annual climate debt associated with the global top 0.1% is estimated to be approximately US$96,368 per person on a consumption basis and approximately US$228,062 per person on an ownership basis in 2022.
- The annual climate debt associated with the global top 0.01% is estimated to be approximately US$506,783 per person on a consumption basis and approximately US$1.24 million per person on an ownership basis in 2022.

While the top 10% already account for climate debt in the order of trillions, average per capita climate debt increases steeply and non-linearly further up the distribution. This escalation becomes particularly pronounced within the top 1% and accelerates further among the top 0.1% and top 0.01%.

Strikingly, under the consumption-based approach, the average per capita climate debt of the top 0.01% income group is roughly 100 times higher than the top 10% income group; under the ownership-based approach, the average per capita climate debt of the top 0.01% wealth group is over 130 times higher than the the top 10% wealth group, as shown in Figure 4.

This underscores that aggregate measures of high-income groups conceal substantial differences within the top decile. Treating the top 10% or even the top 1% as homogeneous groups substantially understates the role of ultra-high-net-worth individuals (UHNWIs, individuals with US$38 million or more) in driving cumulative emissions and ecological overshoot at the very top of the distribution.

FIGURE 4. ESTIMATED PER CAPITA CLIMATE DEBT BY ECONOMIC GROUP, 2022 (US$)



Source: Green Budget Germany (Forum Ökologisch-Soziale Marktwirtschaft e.V., FÖS), own illustration. Based on climate debt calculation results shown in Table 15 in Annex VII (Climate debt under consumption-based accounting) and Table 18 in Annex VIII (Climate debt under ownership-based accounting).

16 Full results can be found in in Table 15 in Annex VII (Climate debt under consumption-based accounting) and Table 18 in Annex VIII (Climate debt under ownership-based accounting)

From a policy perspective, these findings underscore the need for strongly progressive policy responses to climate debt. Given the highly non-linear increase in per capita emissions at the very top of the distribution, fiscal policy design could prioritise the top 0.01% income and wealth groups, ensuring that those with the greatest responsibility are targeted first and face the highest rates. **Under both approaches, the per capita climate debt of the top 0.01% income and wealth groups is more than five times as high as that of the corresponding top 0.1% groups. This makes the top 0.01% groups particularly relevant for early action.** At the same time, emissions across the broader top 10% remain far above equitable levels, indicating that policy approaches, including those beyond taxation, will ultimately need to extend beyond the very top to address emissions more comprehensively.

Similarly, if the focus is further narrowed to centi-millionaires and billionaires, the tax burden would be concentrated on a relatively small group of individuals worldwide (approximately 80,000 centi-millionaires and 3,000 billionaires), reducing the administrative burden of implementing a tax.

The steep rise in per capita emissions in higher income and wealth groups also raises the question of how progressively tax rates should increase, in line with the polluter-pays principle. Progressive rates would also comply with the ability-to-pay principle, as rates of return tend to increase significantly at the top of the wealth distribution (Chancel et al., 2026, *World Inequality Report 2026*).

3.2. ACROSS UPPER INCOME AND WEALTH GROUPS, BOTH AVERAGE PER CAPITA CLIMATE DEBT AND TOTAL CLIMATE DEBT FOR EACH ECONOMIC GROUP ARE SUBSTANTIALLY HIGHER UNDER THE OWNERSHIP-BASED APPROACH THAN UNDER THE CONSUMPTION-BASED APPROACH.

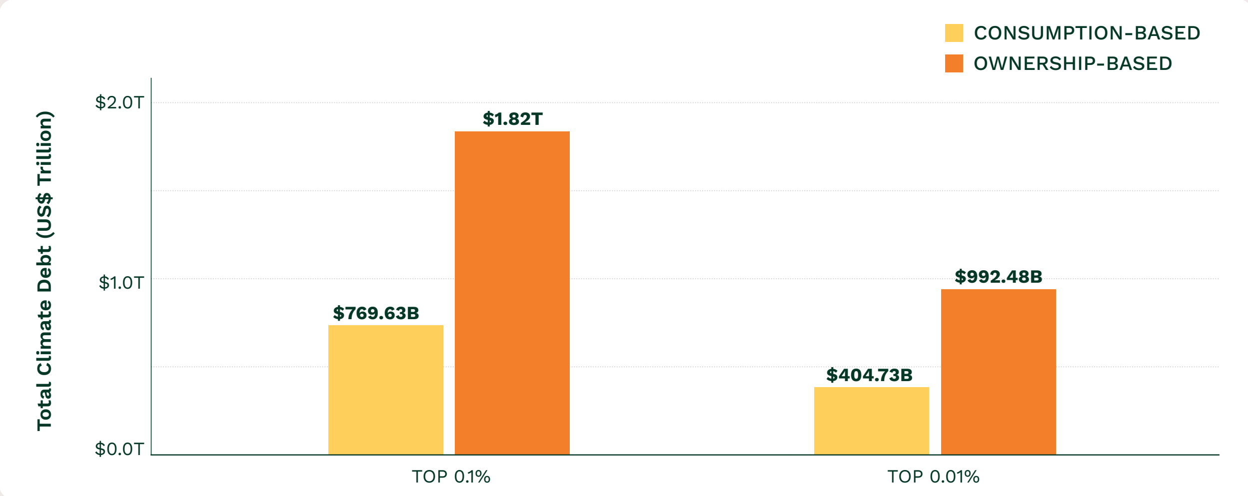
Key results[17]:

- The estimated total annual (group) consumption-based climate debt of the global top 0.1% and top 0.01% reached approximately US$770 billion and US$405 billion in 2022, respectively, whereas
- The estimated total annual (group) ownership-based climate debt of the global top 0.1% and top 0.01% reached approximately US$1.82 trillion and US$992 billion in 2022, respectively.

Figure 4 above and Figure 5 below show that both per capita and total annual (group) climate debt are roughly twice as high under the ownership-based approach as under the consumption-based approach. This indicates that emissions linked to capital ownership and investment decisions play a decisive role in driving anthropogenic climate change and the associated climate damages. The results reinforce the argument that emissions inequality is fundamentally linked to wealth concentration. The sharp increase in climate debt among the top 0.1% and top 0.01% increasingly reflects the concentration of ownership and investment assets at the top of the global wealth distribution.

17 Full results can be found in Table 15 in Annex VII (Climate debt under consumption-based accounting) and Table 18 in Annex VIII (Climate debt under ownership-based accounting)

FIGURE 5. TOTAL ESTIMATED CLIMATE DEBT BY ECONOMIC GROUP, 2022 (US$)



Source: Green Budget Germany (Forum Ökologisch-Soziale Marktwirtschaft e.V., FÖS), own illustration. Based on climate debt calculation results shown in Table 15 in Annex VII (Estimated climate debt under consumption-based accounting) and Table 18 in Annex VIII (Estimated climate debt under ownership-based accounting).

From a policy perspective, ownership-based data strengthen the case for targeted, progressive taxes on wealth, rather than for relying on consumption-oriented carbon pricing alone. While carbon pricing is important, policies that ignore the investment channel risk leaving a substantial share of climate debt unaddressed. Taxes targeting emissions-driving asset ownership should therefore be considered as policy options to reduce emissions and generate revenues to counter climate change. Nevertheless, consumption-based emissions also show a steep increase in per capita emissions within the top 1% of the income distribution. To address this, the use of private jets and yachts – which account for a significant share of average emissions among centi-millionaires and billionaires (Oxfam, 2024, 2025) – would need to be banned outright or heavily disincentivised. This can be achieved, for example, through luxury consumption taxes on the acquisition, ownership, and use of private jets and yachts.

3.3. A HISTORICAL PERSPECTIVE FURTHER HIGHLIGHTS THAT CLIMATE DEBT IS FUNDAMENTALLY A STOCK PROBLEM, NOT MERELY A FLOW PROBLEM.

Key results[18]:

- Total historical (group) consumption-based climate debt of the global top 0.1% and top 0.01% reached approximately US$13 trillion and US$6 trillion over the period 1990–2022, respectively, whereas
- total historical (group) ownership-based climate debt of the global top 0.1% and top 0.01% reached approximately US$27.2 trillion and US$14.8 trillion over the same period, respectively.

The current emission patterns ('the flow' – referring to emissions generated in a specific year) alone – as shown in the previous figures – cannot illustrate the full scale of responsibility observed at the top. Rather, it is the historical cumulative appropriation of the atmospheric commons ('the stock' – referring to emissions accumulated over time and associated climate damage), together with the increasing costs of this damage over time, that leads to a steep rise in per capita climate debt and reveals responsibility on a much larger scale, as shown in Figures 6 and 7 below.

18 Full results can be found in Table 16 in Annex VII (Climate debt under consumption-based accounting) and Table 19 in Annex VIII (Climate debt under ownership-based accounting).

FIGURE 6. HISTORICAL CUMULATIVE ESTIMATED CLIMATE DEBT (STOCK) BY INCOME GROUP UNDER CONSUMPTION-BASED ACCOUNTING, 1990–2022 (US$)

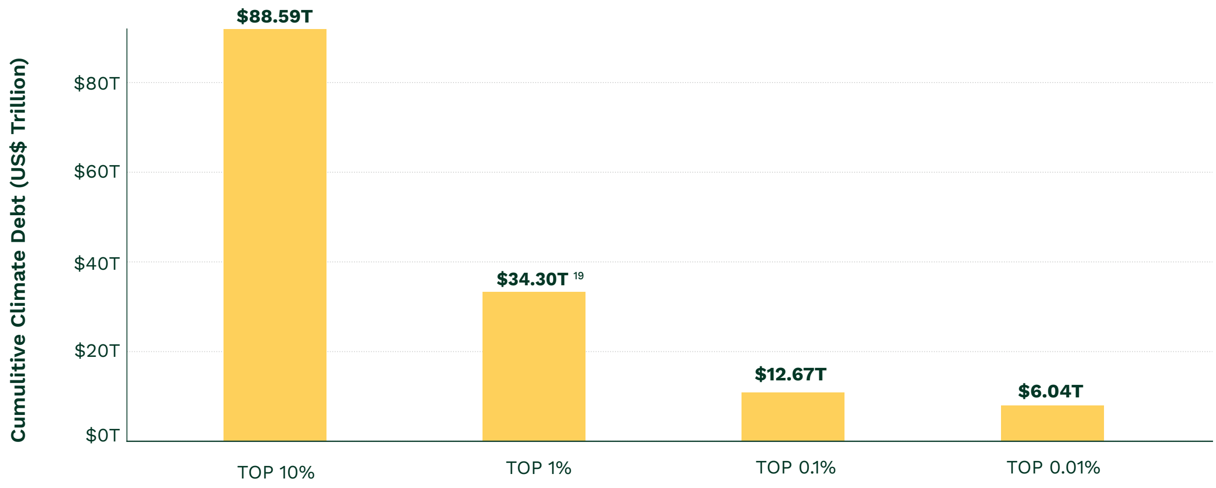
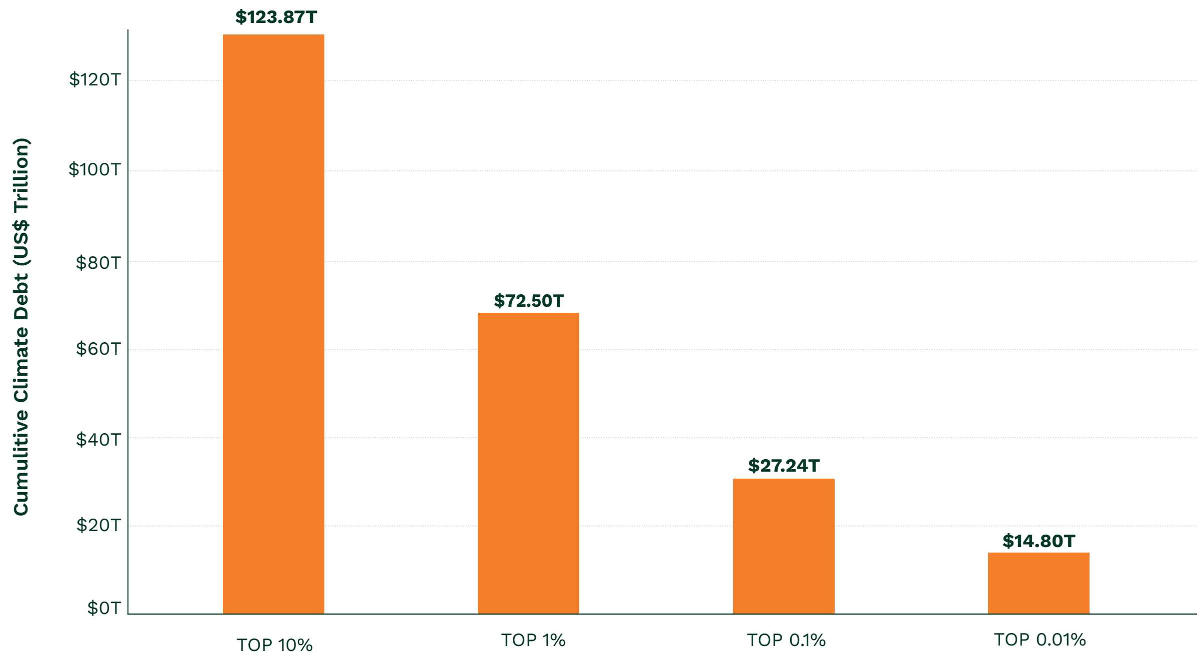


FIGURE 7. HISTORICAL CUMULATIVE ESTIMATED CLIMATE DEBT (STOCK) BY WEALTH GROUP UNDER OWNERSHIP-BASED ACCOUNTING, 1990–2022 (US$)



Source: Green Budget Germany (Forum Ökologisch-Soziale Marktwirtschaft e.V., FÖS), own illustration. Based on climate debt calculation results shown in Table 16 in Annex VII (Estimated climate debt under consumption-based accounting) and Table 19 in Annex VIII (Estimated climate debt under ownership-based accounting).

Technical note: *Accumulated climate debt estimates for 1990–2022 apply year-adjusted excess emissions as well as year-adjusted SCC values based on the 2020 benchmark estimate of US$283 per* tCO_2*. Further methodological details are provided in Annexes I–VI.*

19 Gössling and Humpe (2024) estimate a climate debt of US$29 trillion for the world's millionaires, using a carbon price of US$200 (2020 USD), which is broadly consistent with our results.

From a policy perspective, this further supports the case for strongly progressive tax responses to climate debt, with tax rates increasing in line with both wealth levels and associated emissions. At the same time, directly attributing historical climate debt to individuals living today is challenging, as the composition of wealth groups has changed over time and current individuals are not identical to those who generated past emissions. In this context, while addressing historical climate debt will still remain a matter for states, including through mechanisms such as climate reparations[20], a one-off, time-bound carbon wealth levy or fee for HNWIs could serve as a complementary mechanism for raising resources for climate finance and reparative purposes.

3.4. THE PROJECTED CLIMATE DEBT ESTIMATES INDICATE THAT FUTURE EMISSIONS TRAJECTORIES WILL SUBSTANTIALLY INCREASE CLIMATE DEBT, EVEN UNDER COMPARATIVELY OPTIMISTIC SCENARIOS, IN THE ABSENCE OF TARGETED MEASURES.

Key results[21]:

- Projected per capita consumption-based climate debt of the global top 0.1% under the lowest-emission scenario reached approximately US$4.3 million over the period of 2023–2050, whereas projected per capita ownership-based climate debt of the global top 0.1% under the lowest emission scenario reached approximately US$8.8 million over the same period.
- Projected total (group) consumption-based climate debt of the global top 0.1% under the lowest emission scenario reached approximately US$40 trillion over the period 2023–2050, whereas projected total (group) ownership-based climate debt of the global top 0.1% under the lowest emission scenario reached approximately US$81 trillion over the period of 2023-2050.

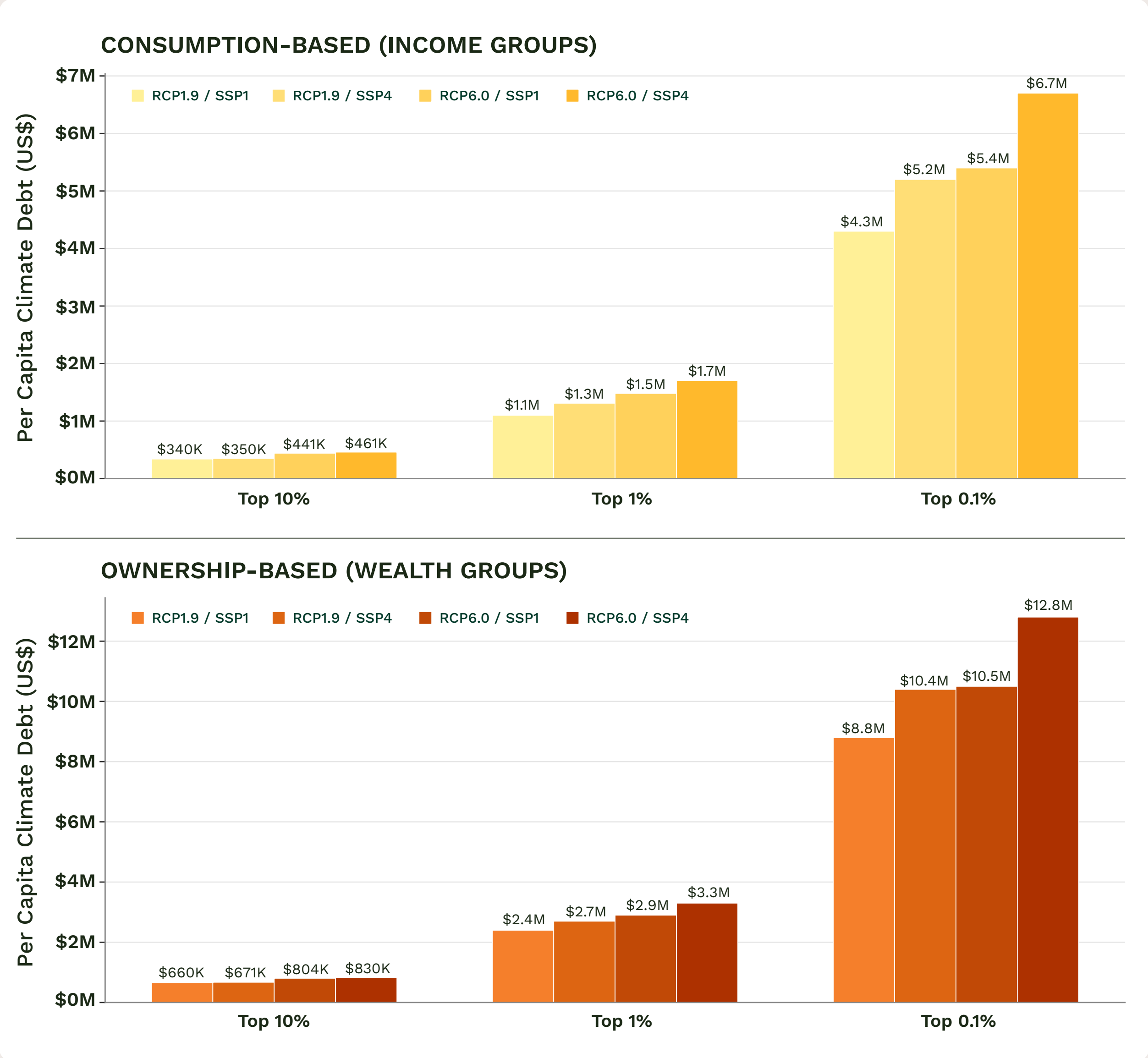
As Figure 8 shows, projected climate debt remains highly concentrated among top income and wealth groups across all scenarios considered, with per capita values increasing sharply from the top 10% to the top 0.1%.

Figure 9 illustrates the projected increase in ownership-based climate debt attributable to the top 0.1% wealth group according to different climate scenarios in the absence of policy intervention.

20 See also the contributions around historical climate debt of states in the Global North to states in the Global South. For example, Fanning and Hickel (2023) estimate that, by 2050, countries that remained below their fair atmospheric shares (mainly in the Global South) would be entitled to approximately US$192 trillion in compensation for the disproportionate use of atmospheric space by higher-emitting countries, mainly in the Global North.

21 Full results can be found in Table 17 in Annex VII (Estimated climate debt under consumption-based accounting) and Table 20 in Annex VIII (Estimated climate debt under ownership-based accounting)

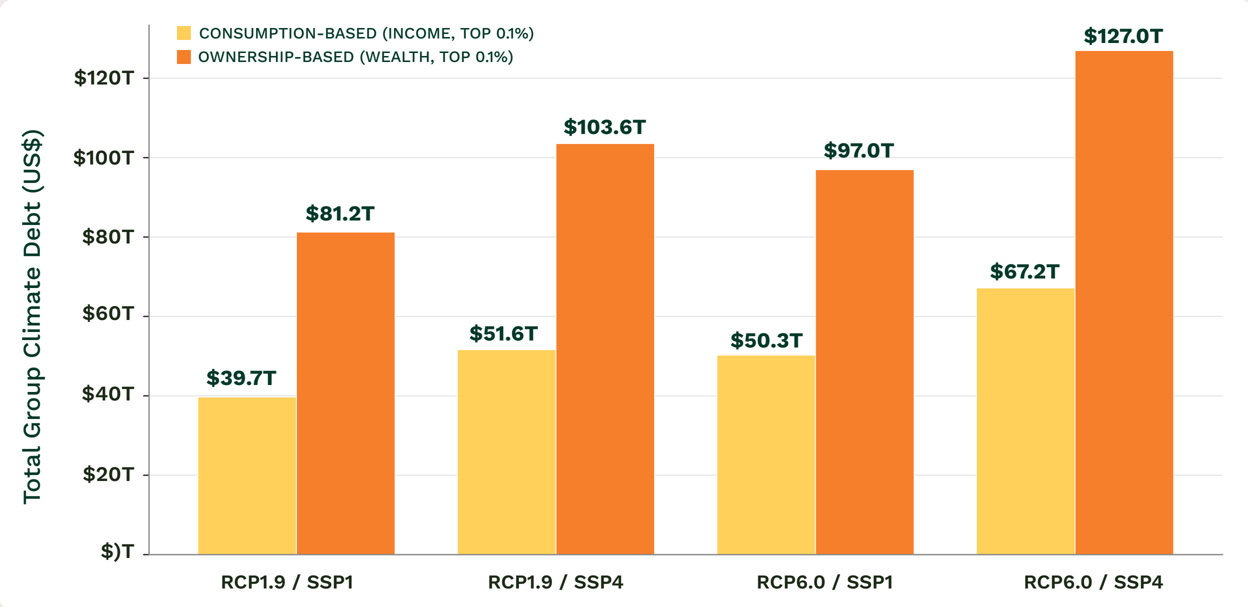
FIGURE 8. PROJECTED PER CAPITA CLIMATE DEBT BY ECONOMIC GROUP AND EMISSION SCENARIO, 2023–2050 (US$)



Source: Green Budget Germany (Forum Ökologisch-Soziale Marktwirtschaft e.V., FÖS), own illustration. Based on climate debt calculation results shown in Table 17 in Annex VII (Estimated climate debt under consumption-based accounting) and Table 20 in Annex VIII (Estimated climate debt under ownership-based accounting).

Technical note: *Projected climate debt was not calculated for the top 0.01%, as emissions projections are only available up to the top 0.1%. The projected climate debt estimates for 2023–2050 in Figure NEW 5 apply the same excess emissions and SCC approach to future emissions pathways under different SSP and RCP scenarios22. This allows the report to estimate how climate debt may evolve under different inequality and mitigation trajectories. Further details on assumptions and scenarios are provided in Annex III.*

FIGURE 9. PROJECTED TOTAL GROUP CONSUMPTION AND OWNERSHIP-BASED CLIMATE DEBT FOR THE 0.1% ECONOMIC GROUPS BY EMISSION SCENARIO, 2023–2050 (US$)



Source: Green Budget Germany (Forum Ökologisch-Soziale Marktwirtschaft e.V., FÖS), own illustration. Based on climate debt calculation results shown in Table 17 in Annex VII (Estimated climate debt under consumption-based accounting) and Table 20 in Annex VIII (Estimated climate debt under ownership-based accounting).

From a policy perspective, the projections show that, without systemic reforms, climate debt estimates will remain highly concentrated among the top income and wealth groups even under comparatively ambitious mitigation pathways. In the most favourable scenario considered (RCP1.9 combined with SSP1), projected per capita climate debt for 2023–2050 still exceeds US$8.8 million for the top 0.1% wealth group under the ownership-based approach and US$4.3 million for the top 0.1% income group under the consumption-based approach (see Figure 8). Under higher-emission and higher-inequality scenarios (SSP4), projected per capita climate debt rises further to approximately US$12.8 million and US$6.7 million, respectively.

These findings suggest that climate mitigation efforts risk being undermined if policies fail to address emissions linked to wealth concentration and carbon-intensive investment patterns. While consumption-based luxury emissions remain important – particularly emissions associated with private aviation, yachts, and large real estate holdings – the projections further reinforce the importance of addressing ownership-based emissions associated with investment portfolios and capital ownership.

As discussed in Chapter 1, the climate debt estimates presented in this report should be understood as calculations intended to illustrate the scale of emissions responsibility associated with high-income and high-wealth groups, thereby providing an additional impact-responsibility lens for fiscal policy design (without implying a direct prescription for the level of taxation) . The findings suggest that addressing climate debt requires a broad policy framework of government decarbonisation and financial democratisation, with one possible focus being progressive fiscal instruments incorporating the polluter-pays and ability-to-pay principles (for example, carbon wealth taxes or taxes targeting carbon-intensive luxury consumption such as private yachts or jets). In addition, structural reforms aimed at aligning financial and fiscal systems (including taxation, subsidies, grants, industrial policy, and investment flows) with 1.5°C pathways are essential to reduce emissions at source and reshape the patterns of wealth accumulation that drive climate debt.

4. FROM CLIMATE DEBT TO POLICY PATHWAYS

The climate debt calculations presented in Chapter 3 demonstrate that responsibility for excess emissions is highly concentrated among the wealthiest global income and wealth groups, particularly within the top 0.01% (often associated with ultra-high-net-worth individuals, or UHNWIs, also defined as individuals with net wealth of US$38 million or more). These findings raise questions about how this climate debt could be addressed in practice and what level of policy response would be required to reflect the extent of emissions responsibility identified in this report.

The chapter first contextualises the climate debt estimates by comparing them with estimates of global climate finance needs (Section 4.1). It then examines the geographical distribution of wealth, emissions responsibility, and climate vulnerability (Section 4.2), before Section 4.3 compares estimated climate debt levels with current, not-yet-adopted tax and levy proposals to assess the gap between existing policy ambition and the scale of responsibility identified in Chapter 3. Finally, Section 4.4 outlines preliminary policy design implications arising from the findings.

4.1. COMPARING CLIMATE DEBT TO GLOBAL CLIMATE FINANCE NEEDS

The climate debt estimates presented in Chapter 3 can be contextualised by comparing them with existing estimates of global climate finance needs[22]. This illustrative comparison aims to show the scale of emissions responsibility associated with extreme wealth concentration relative to current estimates of finance needs for mitigation, adaptation, and loss and damage. It is intended solely as an analytical exercise and does not imply any endorsement of a particular tax rate or financing mechanism.

The analysis focuses specifically on the top 0.01% of wealth holders, as the estimated climate debt associated with this group alone is already of a similar order of magnitude to current estimates of major global climate finance needs; extending the analysis to larger wealth groups, such as the top 1%, would substantially increase the estimated potential contribution.

To illustrate this comparison, we relate the annual ownership-based climate debt of the top 0.01% wealth group to estimates of climate finance needs. Climate Action Network (CAN, 2024) estimate that climate finance needs in developing countries[23] are at least US$1 trillion in public finance annually for mitigation, adaptation, and loss and damage. If the revenues equivalent to the annual ownership-based climate debt associated with the top 0.01% wealth group, estimated at about US$992 billion, were available, they could contribute significantly

22 It should be noted that part of these revenues could and should support not only climate finance, but also wider ecological transition and restoration needs.

23 The term ‘developing countries’ is used in this chapter primarily for consistency with the underlying data sources and reference studies on which the comparisons are based. The terminology is, however, contested, as it can imply a linear hierarchy of development and obscure significant heterogeneity between countries. Alternative terms such as ‘Global South’, ‘low- and middle-income countries’, or more context-specific classifications may provide a more accurate or politically sensitive description. Nevertheless, to ensure comparability with the referenced datasets and literature, the terminology used in the original sources is retained.

to meeting this goal.

Loss-and-damage finance needs in developing countries alone are estimated to be at least US$400 billion per year (Richards et al., 2023). If there were a proper policy response addressing ownership-based emissions associated with the top 0.01% wealth group, the resulting revenues could contribute significantly towards meeting these needs.

In other words, redistributing even a portion of the climate debt of extreme wealth could make a substantial contribution to global climate finance needs, supporting mitigation, adaptation, loss and damage, and potentially wider ecological transition and restoration, without exacerbating inequality or imposing additional burdens on lower-income populations.

4.2. GEOGRAPHICAL DISTRIBUTION OF WEALTH, EMISSIONS RESPONSIBILITY, AND CLIMATE VULNERABILITY

The climate debt calculations presented in this report also raise questions regarding their geographical distribution. As available data do not allow us to directly allocate our climate debt estimates to individual countries or jurisdictions, we use country-level household wealth data as an indicative proxy for the geographical concentration of private wealth and associated ownership-based climate responsibility and climate debt. This does not imply that private wealth is equivalent to state wealth, nor that ownership-based emissions are territorially located in the countries where wealth holders reside. Rather, the data allow us to illustrate a mismatch between the geographical concentration of private wealth and corresponding emissions responsibility on the one hand, and climate vulnerability and adaptive capacity on the other.

Ownership-based emissions are closely linked to the global distribution of private wealth. Chancel and Rehm (2025b) show that a significant share of ownership-based emissions are associated with internationally mobile capital and cross-border ownership structures. This implies that a relatively small number of jurisdictions hosting large concentrations of private wealth play a particularly important role in ownership-based climate debt and would likely be central to the implementation of fiscal instruments targeting carbon-intensive wealth and investment activities.

At the same time, indicators of climate vulnerability point in the opposite geographical direction. To illustrate this, Figure 10 combines national wealth estimates from the *Global Wealth Databook 2022* (Shorrocks et al., 2022) with data from the Notre Dame Global Adaptation Initiative (ND-GAIN) Country Index (Chen et al., 2015; University of Notre Dame Global Adaptation Initiative, 2025)[24]. The ND-GAIN Index measures countries' vulnerability to climate change as well as their readiness and capacity to adapt, drawing on indicators related to food systems, water, health, ecosystems, human habitat, infrastructure, governance, social conditions and economic readiness (University of Notre Dame Global Adaptation Initiative, 2025).

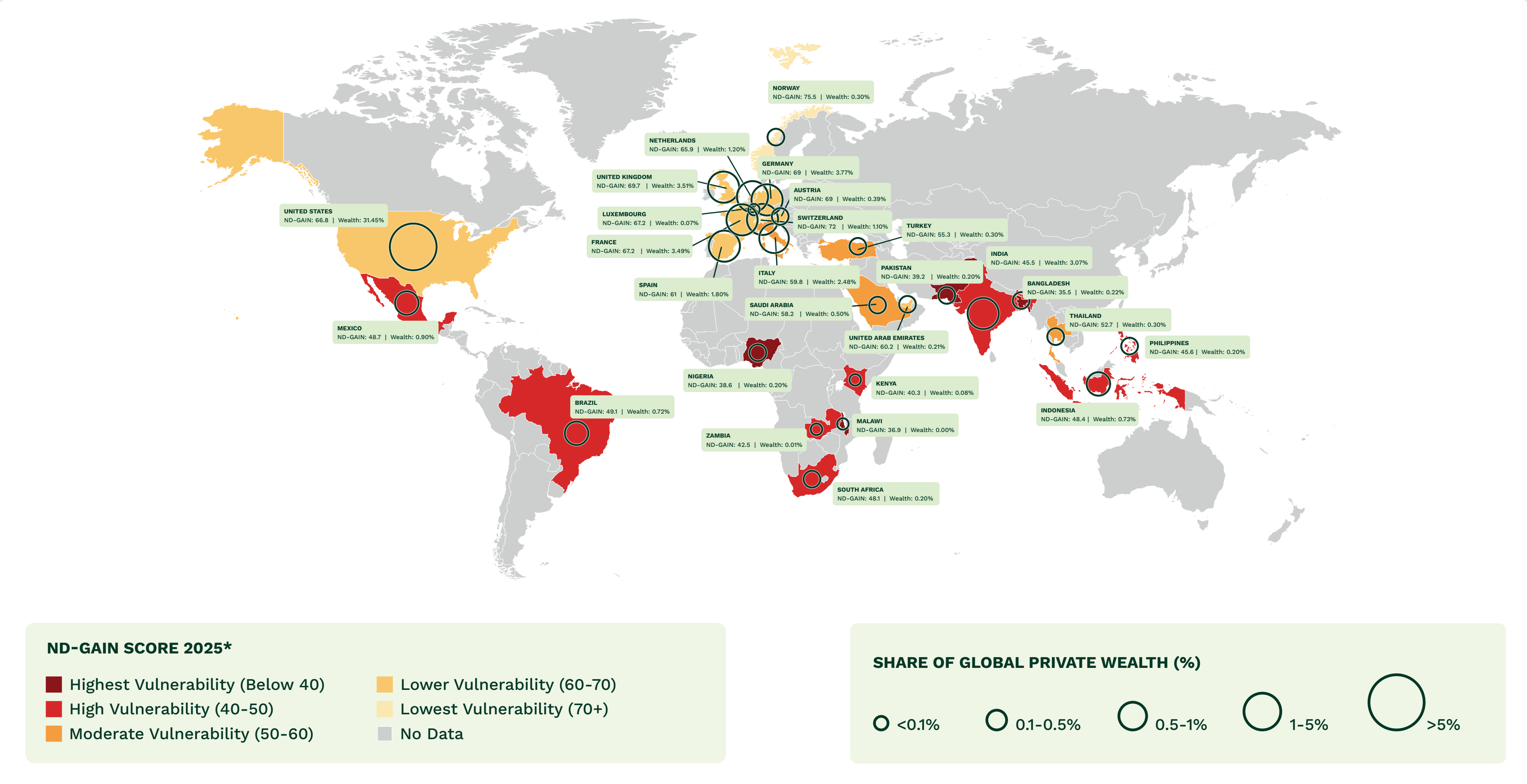
The comparison suggests that many countries holding only a very small share of global private wealth – particularly in Africa, South Asia, and other highly climate-vulnerable regions – face comparatively high levels of climate vulnerability and possess more limited capacity to adapt to climate-

24 Note: To illustrate climate vulnerability and adaptive capacity at the national level, this report uses the Notre Dame Global Adaptation Initiative (ND-GAIN) Country Index. We use the ND-GAIN Index because it aligns closely with the report's objective of illustrating the geographical mismatch between the concentration of private wealth and ownership-based climate responsibility on the one hand, and climate vulnerability and (low) adaptive capacity on the other. See Annex IX for further explanations. We acknowledge that such indexes are debatable and not without controversy; alternative datasets and indicators, such as the Germanwatch's long-term Climate Risk Index (CRI) (1995–2024), capture different dimensions of climate risk and damage.

related impacts. By contrast, countries in Europe and North America account for a disproportionately large share of global private wealth while generally exhibiting lower vulnerability and greater adaptive capacity. Figure 10 illustrates this asymmetry between the geographical concentration of private wealth and countries' ability to cope with and adapt to climate-related risks.

This does not imply that higher-income countries are unaffected by climate change. Many countries in Europe and North America are already experiencing significant climate-related impacts and economic losses, as the CRI Index shows (see Table 21 in Annex IX). However, they generally combine higher concentrations of private wealth with stronger governance readiness, greater adaptive capacity and substantially greater fiscal resources to respond to climate-related risks and damages than many lower-income countries (University of Notre Dame Global Adaptation Initiative, 2025).

FIGURE 10. GEOGRAPHICAL MISMATCH BETWEEN GLOBAL PRIVATE WEALTH AND HISTORICAL CLIMATE DAMAGE



*Categories shown in the figure are author-defined groupings of ND-GAIN scores for visualisation purposes and do not represent official ND-GAIN classifications.

Sources:Sources: Shorrocks et al. (2022), Global Wealth Databook 2022; University of Notre Dame Global Adaptation Initiative (2025), Country Index 2025. See Table 21 in Annex IX

Note: *The countries included in the figure were selected for illustrative purposes to reflect different regional contexts, levels of wealth concentration, and climate vulnerability. The selection also partly reflects countries and regions that are relevant to Greenpeace's ongoing work on tax justice and international climate finance*

This geographical mismatch highlights the importance of international coordination when developing fiscal approaches to address the climate debt of HNWIs, particularly regarding where revenues are raised, how they are allocated, and how they contribute to international climate finance and support for vulnerable countries – issues that are currently being explored, for example, in the context of the ongoing negotiations on a United Nations Framework Convention on International Tax Cooperation (UN Tax Convention; UN DESA, 2025), as well as in related international climate finance discussions.

4.3. COMPARING CLIMATE DEBT TO EXISTING TAX PROPOSALS

When compared to existing tax proposals, we estimate (see Tables 5 and 6) that even ambitious combinations of luxury-consumption and wealth-related taxes **would cover roughly just under a quarter (23%) of the annual consumption-based climate debt and less than half (42%) of the annual ownership-based climate debt of the global top 0.01%.[25] This indicates a gap between current levels of political ambition in developing appropriate policy solutions and the scale of climate debt associated with extreme wealth concentration.**

The Global Solidarity Levy Task Force (2025) proposed an international solidarity levy that would generate approximately US$93.7 billion annually, considering only those levies that are expected to have a progressive effect[26]. This compares with an estimated annual consumption-based climate debt of approximately US$404.73 billion for the global top 0.01% in 2022. Taken together, the selected aviation levies would cover around 18% of the annual consumption-based climate debt of the top 0.01% income group (see Table 5).

TABLE 5. ANNUAL CONSUMPTION-BASED CLIMATE DEBT OF THE TOP 0.01% VS. GLOBAL SOLIDARITY LEVIES

CONSUMPTION-BASED CLIMATE DEBT OF THE TOP 0.01% IN 2022	PROPOSED SOLIDARITY LEVIES	ESTIMATED ANNUAL REVENUE
US$404.73 billion	Private jet kerosene levy: €0.720 per litre	€6 billion
	Frequent flyer levy: different rates depending on distance and class	€74 billion
Total coverage gap:	**US$311.03 billion remaining**	**€80 billion total** (approximately US$93.7 billion)[27]
The combined solidarity levies on aviation would cover about 23% of the annual consumption-based climate debt of the top 0.01% income group.		

25 We focus on the top 0.01% (ultra-high-net-worth individuals, or UHNWIs) because this group, in our calculations, has the highest per capita climate debt, and therefore carries the greatest per capita responsibility for climate impacts. From an equity perspective, it is also a priority group, since effective tax rates on wealth at the very top are often lower than their economic capacity would suggest, reflecting ineffectiveness in existing tax systems.

26 We do not include the ticket or fuel levy, as both are likely to be passed on to consumers (Global Solidarity Levy Task Force, 2025).

27 Conversion based on the European Central Bank euro foreign exchange reference rate for 13 May 2026: €1 = US$1.1715. This converts €80 billion to approximately US$93.7 billion.

For ownership-based climate debt, corporate and wealth-related tax proposals are particularly relevant. We therefore include the following:[28]

- Trilling (2025) (fossil fuel industry surtax)
- Capelle-Blancard (2025) (green financial transaction tax)

The two tax proposals – the fossil fuel profit surtax and the green financial transaction tax – would generate a maximum of approximately US$420 billion annually under high-revenue estimates (see Table B). This amount remains below the annual ownership-based climate debt of the global top 0.01%, estimated in this report at approximately US$992.48 billion for 2022. Under ambitious assumptions, the proposed measures would therefore cover roughly 42% of the annual ownership-based climate debt of the top 0.01% wealth group.

TABLE 6. ANNUAL OWNERSHIP-BASED DEBT OF THE 0.01% VS. CORPORATE AND WEALTH-RELATED TAX PROPOSALS

OWNERSHIP-BASED CLIMATE DEBT OF THE TOP 0.01% IN 2022	PROPOSED WEALTH-RELATED AND CORPORATE TAXES	ESTIMATED ANNUAL REVENUE
US$992.48 billion	Fossil fuel profit surtax: 20% surtax on the top 100 oil and gas companies	US$236 billion[29]
	Green financial transaction tax (FTT): tiered tax penalising 'non-green' issuers with a base rate of 0.5% and an additional penalty of 0.5 percentage points	US$184 billion
Total coverage gap:	**US$572.48 billion remaining**	**US$420 billion total**
Using high-end revenue estimates, the tax proposals would cover roughly 42% of the annual ownership-based climate debt of the top 0.01% wealth group.		

4.4. OUTLOOK: PRELIMINARY POLICY IMPLICATIONS

The analysis presented in this report demonstrates that climate debt is highly concentrated among the wealthiest individuals globally and that a significant share of emissions is driven by ownership of capital rather than consumption alone. In terms of policy implications, this means that addressing climate change effectively and equitably requires a stronger focus on wealth and investment as drivers of emissions.

This report therefore aims to contribute not only to the quantification of climate debt in the context of individuals and capital asset ownership by suggesting a methodology for calculating that debt, but also to the structuring of the debate on how it can be addressed in practice. Several policy design questions require further work:

28 Additional tax proposals are being discussed in the literature and policy arena (for example, the OECD minimum tax on corporate profits). The proposals selected here were chosen because they explicitly target carbon-intensive wealth or emissions-related economic activities at a global scale.

29 Corporate profits (and thus surcharges on corporate profits) are very unstable over economic cycles. Trilling (2025) shows that US$236 billion represents the maximum estimated annual revenue. Estimated annual revenue ranges from US$37 billion to US$236 billion for the period from 2016 to 2024.

1. NEW TOOLS ARE NEEDED TO ADDRESS WEALTH CONCENTRATION AND RESULTING CLIMATE DEBT

A key insight of this report is that there is a clear rationale to tax wealth not just on a tax equality basis[30], but also on the basis of climate or ecological impact. **The highly non-linear increase in per capita emissions and the corresponding climate debt at the very top of the distribution point to a need for progressively higher rates, as well as a potential climate component distinguishing between carbon-intensive and low-carbon wealth.** This could be achieved through different tools, including a 'climate malus/ bonus' system, increasing tax rates with increasing wealth, or a combination of the two, in addition to the social justice wealth taxation proposals such as Zucman's proposal for a coordinated minimum effective taxation standard for ultra-high-net-worth individuals (Zucman, 2024).

The integration of a climate component supports the environmental steering function of fiscal responses to climate debt, encouraging greener investments while discouraging carbon-intensive production and infrastructure lock-in. **The need to consider such a climate component raises questions regarding the tax base and the treatment of different types of assets** – in particular, the development of robust methodologies and data to differentiate between carbon-intensive and low-carbon assets. At the same time, policy design will need to consider administrative feasibility and avoid creating undue complexity.

2. OWNERSHIP-BASED EMISSIONS AND INVESTMENT-RELATED IMPACTS REMAIN UNDERTAXED

Emissions linked to wealth and asset ownership remain insufficiently addressed in current policy frameworks. Existing climate policies and tools largely focus on carbon-intensive production and consumption, while leaving a significant share of emissions associated with wealth assets and investment decisions undertaxed (see Chancel, 2022; Chancel and Rehm, 2025b; Bastos Neves and Semmler, 2025; Trilling, 2025). This creates an inconsistency in climate policy design, contributing to the perception that climate mitigation policy (particularly carbon pricing) has regressive impacts and places an excessive burden on middle- and lower-income groups. Activities that lock in long-term emissions trajectories (such as financing fossil fuel infrastructure or investing in carbon-intensive industrial capacity) are often subject to weaker fiscal disincentives than everyday consumption choices.

As a result, current policy frameworks may inadvertently allow capital allocation decisions that drive future emissions growth to persist, despite increasingly stringent regulation of consumption and production emissions. This report's findings therefore suggest that **policy responses need to expand beyond consumption-based approaches and consider fiscal instruments that address wealth concentration, carbon-intensive investments, and thus ownership-related emissions.** Such approaches must be aligned more closely with the polluter-pays and ability-to-pay principles by linking responsibility for emissions with the capacity to contribute to climate finance – for example, through a carbon wealth tax that distinguishes between carbon-intensive and low-carbon assets.

30 For example, economist Gabriel Zucman (2024) argues that, due to loopholes and tax optimisation, the super-rich often pay a lower effective tax rate than the average citizen, a situation he deems regressive and unfair.

3. A MIX OF POLICIES IS NEEDED TO ADDRESS CLIMATE DEBT

There is a need to clarify how different policy approaches can address the dual nature of climate debt as developed here. **Instruments may need to differ in whether they target accumulated emissions (historical responsibility) or ongoing emissions (forward-looking responsibility),** and in how they balance considerations of reparative justice and future emission reductions. Importantly, fiscal instruments should be understood as part of a broader policy mix (see Oxfam, 2024). Measures such as the phase-out of fossil fuels, the alignment of public and private financial flows, both nationally and internationally, with climate goals, and the regulation or phase-out of carbon-intensive luxury consumption remain central to achieving the objectives of the *Paris Agreement* (UNFCCC, 2015). Understanding how these approaches relate to each other, how they can be combined, how potential overlaps, including risks of double taxation, can be avoided, how they may reduce emissions, and what implications they may have for broader economic development objectives, is an important area for further work.

4. WEALTH IS GEOGRAPHICALLY CONCENTRATED IN DIFFERENT PLACES THAN CLIMATE FINANCE NEEDS, MAKING INTERNATIONAL DISTRIBUTION AND COORDINATION CENTRAL

Any approach to addressing the climate debt of HNWIs through fiscal measures must consider how revenues can be mobilised and allocated effectively, fairly, and transparently. This involves determining how revenues contribute to existing national and global climate and ecological transition and restoration commitments at a scale commensurate with needs. Central to the legitimacy of any policy is the international distribution of these funds, given that wealth is heavily concentrated in a small number of countries, while the climate impacts of that wealth are widely shared and predominantly felt by the most vulnerable communities in the Global South.

Any future policy design should include a proposal on how to ensure that collected revenues for climate action are primarily channelled through UN climate funds, with support provided primarily as grants and with a significant allocation of direct-access funding for Indigenous Peoples and local communities. It should equally address concerns, particularly among countries in the Global South, that additional resource commitments arising from wealth taxation may replicate the shortcomings of existing, unpredictable and inadequate climate finance commitments. Transparency, data availability and international coordination are central to effective policy implementation.

Finally, the effective implementation of fiscal policies targeting the climate debt of HNWIs depends on a set of enabling conditions, particularly with regard to transparency, data availability, and international cooperation. The identification and valuation of wealth, especially across borders, require strengthened systems for asset registration, beneficial ownership transparency, country-by-country reporting, and international exchange of information. Without such systems, the ability of governments to design and implement effective fiscal instruments will remain limited. Ongoing international processes, including discussions under international tax cooperation frameworks, especially the ongoing negotiations on a UN Tax Convention (UN DESA, 2025), provide important entry points for advancing these issues.

ANNEXES

I. CLIMATE DEBT DEFINITION

We define climate debt as a) the consumption-based emissions by income group and b) the ownership-based emissions by wealth groups, minus the equitable share each person can emit when staying within the 1.5°C pathway, multiplied by a carbon price per ton of CO_2:

a. $\textit{Climate Debt}_{cons_i} = E_{cons_i} - E_{equitable_i} * P_{social}$

b. $\textit{Climate Debt}_{own_i} = E_{own_i} - E_{equitable_i} * P_{social}$

E_{cons_i} = *(cumulative) consumption-based emissions by income group (i representing income groups)*

E_{own_i} = *(cumulative) ownership-based emissions by wealth group (i representing wealth groups)*

$E_{equitable_i}$ = *equitable share of emissions for the respective population group*

P_{social} = *social cost of carbon (SCC) per tonne of CO2 (tCO_2) per year*

As the two formulas above imply, we will carry out two non-additive climate debt calculations: one based on consumption-based emissions of the world's top income groups and one based on ownership-based emissions, capturing emissions arising from the investment decisions of the world's top wealth groups. While consumption-based emissions are driven by carbon-intensive lifestyles (especially mobility-related emissions, such as travelling by private jets and yachts, as well as emissions associated with real estate), ownership-based emissions depend on the allocation of resources to different assets (see Chapter 2 for more details on the carbon accounting approaches underlying our calculations).

We consider the formulas above a solid way to calculate climate debt; however, some caveats must be noted:

- **Estimating individual carbon footprints for high-net-worth individuals (HNWIs) is challenging** due to the lack of transparency in consumption and wealth patterns among the richest parts of the global population. While the literature estimates emission levels for the top 10% and top 1% using established methodologies, emissions attributable to the top 0.01% and above are subject to substantial uncertainty (see Annex II below for further details).
- **No universally agreed definition of an 'equitable share' of emissions exists.**[31] In this report, we understand an equitable emission share as the amount of emissions each person can emit within the carbon budget of a 1.5°C scenario; emissions beyond this level are considered excess emissions (see Annex V below for further details).
- **There are very wide ranges for the SCC.** Ethical disagreements exist over discount rates and methodological differences in the damages covered by the SCC calculations (see Annex VI below for further details).

Overall, due to data limitations and uncertainties, we use data modelling to estimate the climate debt of the richest parts of the world's population. Much remains to be done to improve data on the greenhouse gas (GHG) emissions of the wealthiest and on the relation between wealth and emissions, especially for the

31 The 'equitable share' of emission for individuals is distinct from the established concept of 'fair share' under climate governance for states.The latter reflects the idea that the emissions reduction burden should be divided among states in a manner that reflects international legal principles such as equity, equality, as well as common but differentiated responsibilities and respective capabilities (CBDR-RC). (Rajamani et al 2021)

very wealthy groups of centi-millionaires and billionaires (approximately the top 0.001% and the 0.0001% of the world's population). The assumptions underlying our calculations are made transparent at each step of the analysis. Where appropriate, we calculate different scenarios to show the range resulting from different assumptions (for example, when using different emission projection scenarios).

II. DATA USED

The report focuses on recent studies that aim to attribute CO2 emissions to different income or wealth groups.

These include, for the consumption-based approach:

- Oxfam (2025), *Climate plunder: how a powerful few Europeans are locking the world into a climate disaster,* based on data provided by the Stockholm Environment Institute (SEI, 2026; Emissions inequality calculator: global dashboard; see also Kartha et al., 2020)
- Oxfam (2024), *Carbon inequality kills: why curbing the excessive emissions of an elite few can create a sustainable planet for all,* based on data provided by the SEI (2026; Emissions inequality calculator: global dashboard; see also Kartha et al., 2020)
- Gössling and Humpe (2024), *The social cost of carbon falling on the wealthy*

And for the ownership-based approach:

- Chancel and Rehm (2025b), *Global inequalities in ownership-based carbon footprints over 2010–2022*

Chancel (2022) is the only source in our sample that includes both consumption-based and ownership-based data (thus differing from purely consumption- or ownership-based approaches) and provides data for the top 0.01%. However, the study (including the supplementary information) does not clearly specify when it uses income groups and when it uses wealth groups as a reference, and we are unable to follow how ownership-based emissions are assigned to economic groups. We therefore rely on data from the SEI (2026) as well as Chancel and Rehm (2025b). **Nevertheless, we use data from Chancel (2022) to estimate emissions for the top 0.01%, as no other study covers this group.**

When reviewing the literature, attention must be paid to how emissions are assigned to income or wealth groups (see Box 3). Usually, existing methodologies attribute consumption-based emissions to income groups and ownership-based emissions to wealth groups. We aim not to mix emissions attributed to different groups in the climate debt calculations.

BOX 3: INCOME VS WEALTH GROUPS

A distinction when looking at the attribution of emissions is whether emissions are assigned to income or to wealth groups. Wealth is generally far more unequally distributed than income (Chancel et al., 2026) and therefore leads to different results in the attribution exercise. Further, whether emissions are attributed to wealth or income groups has implications for climate policy aimed at addressing climate debt. Wealth-based emissions allocations point to the need for structural interventions, such as wealth or capital gains taxes, while income-based emissions allocations inform policies such as income-based taxes and progressive carbon pricing.

In this report , we use data from the Emissions Inequality Dashboard of the Stockholm Environment Institute (SEI) (Ghosh, 2021) for the consumption-based approach and data from Chancel and Rehm (2025b) for the ownership-based approach (see Annex, part III and Annex, part IV below for further details). The SEI (further explained in Kartha u. a. 2020) assigns emissions to income groups, while the ownership-based approach by Chancel and Rehm assigns emissions to wealth groups, building on the methodology proposed in Chancel and Rehm (2025a). Oxfam additionally attributes emissions to billionaires, shifting from an income- to a wealth-based approach for this part of the population (Oxfam, 2024, 2025).

Based on our interest in consumption-based and ownership-based emissions from the world's richest income and wealth groups, a retrospective and forward-looking perspective, and the aim of avoiding double counting and of allocating emissions from HNWIs geographically, we assess these studies based on the criteria presented in table 7.

Importantly, the data presented in the table below show three significant differences in scope:

- When attributing ownership-based emissions to wealth groups, differences in corporate emissions arise depending on whether Scope 1 and Scope 2 emissions are used (as in Oxfam, 2024, 2025) or only Scope 1 emissions (as in Chancel and Rehm 2025b). Including Scope 2 emissions leads to higher emission volumes and may result in double counting, particularly when investments in energy companies are included. For our calculations, we use data from Chancel and Rehm (2025) focussing on corporate Scope 1 emissions.
- There are further differences in emission scope, with some approaches using CO2 only, such as the Emissions inequality Dashboard of the SEI (Ghosh et al, 2021) and others using CO2-equivalents, such as Chancel and Rehm (2025b). The European Commission, Joint Research Centre (JRC, 2025), based on data from the Emissions database for global atmospheric research (EDGAR), shows that CO2 accounts for approximately 75% of total GHG emissions. The absolute consumption-based emissions reported by the SEI are therefore around 25% lower than those including CO2-equivalents. Nevertheless, relative emissions are likely to be similar, and the difference in GHG scope used by the various approaches probably does not affect the share of emissions attributed to different income groups.[32]
- The data used from Chancel and Rehm (2025b) focus on ownership-based emissions (Scope 1) and exclude emissions produced directly by households – such as those from residential heating or private vehicle use – as well as emissions associated with government consumption or public capital ownership. As a result, the dataset covers only around 60% of global emissions that can be directly attributed to private capital ownership by individuals (see Chancel and Mohren, 2025). Consequently, absolute emissions are likely to be higher than the figures presented here suggest.

32 We understand that the use of different GHG scopes is due to data availability and is not a deliberate choice by the researchers.

TABLE 7: COMPARISON OF METHODS FOR ATTRIBUTING EMISSIONS TO ECONOMIC GROUPS

CRITERIA	OXFAM	OXFAM	GÖSSLING AND HUMPE (2024)	CHANCEL (2022)	CHANCEL AND REHM (2025B)
Scope of emissions + income/wealth groups covered	Consumption-based CO2 emissions for the global top 1% and top 10% income groups; ownership-based CO2e emissions (Scope 1 and 2) for the 50 richest billionaires.	Consumption-based CO2 emissions for global and EU bottom 10% to richest 0.1% income groups; ownership-based CO2e emissions (Scope 1 and 2) for the 308 richest billionaires.	Consumption-based CO2 emissions for millionaires.	Consumption- and ownership-based CO2e emissions for the global top 0.01%, 0.1%, 1%, and 10%, as well as the middle 40% and bottom 50%.	Ownership-based CO2e emissions (Scope 1) for the global top 1%, top 10%, middle 40%, and bottom 50% wealth groups
Years covered	1990–2019; projections up to 2099 (SEI data)	1990–2022 (EU data); 1990–2023 (global data)	1990–2050	1990–2019	2010 and 2022
Allocation logic of consumption-based emissions	National consumption-based emissions are allocated based on a functional relationship between income and emissions (SEI methodology).		Consumption-based emissions are assigned using a mathematical model that attributes emissions to wealth groups.	Based on modelled estimates using average individual income levels and country-specific income elasticities of household consumption-based emissions.	Direct household emissions are assigned using a simplified wealth-to-household emission elasticity parameter (0.11).

CRITERIA	OXFAM	OXFAM	GÖSSLING AND HUMPE (2024)	CHANCEL (2022)	CHANCEL AND REHM (2025B)
Allocation logic of ownership-based emissions	Calculated by proportionally allocating corporate Scope 1 and 2 emissions based on equity ownership.		Not applicable	Includes emissions linked to net capital stock formation and to net imports of carbon embedded in international trade; emissions are distributed equally within households.	Corporate Scope 1 emissions are allocated to individuals based on equity ownership and ownership of private firms (excluding bonds and housing).
Treatment of double-counting risks	Uses Scope 1 and 2 emissions for investment analysis (consumption generally falls under Scope 3 in corporate reporting). *Note: Scope 2 may lead to double counting if investments in energy companies are included (see also Chancel and Rehm, 2025a).*		Not reported	Not reported	Avoids double counting by using only Scope 1 emissions allocated to firm owners and excluding Scope 2 and 3 emissions.
Geographic allocation of emitting individuals	n/a	Focuses on EU consumption-based emissions (residence-based)	Based on the residence of millionaires	Provides a geographical breakdown of global emitters and the share of each region's population within each emitter group.	Emissions are traced from the location of production and reassigned to the country of the ultimate owners, based on net foreign ownership.

Based on the comparison in the table above, we chose to use data from the Emissions Inequality Dashboard of the SEI (Ghosh et al, 2021), as applied in Oxfam (2024, 2025), for the consumption-based approach. Gössling and Humpe (2024) could provide a useful complement to the consumption-based emissions data from the SEI and Oxfam, as they focus on millionaires. However, they use wealth groups as the reference, whereas the SEI and Oxfam use income groups. The two approaches are therefore difficult to combine, which is why we do not include data from Gössling and Humpe (2024) in this analysis.

For the ownership-based approach, we use data by Chancel and Rehm (2025b). As this approach has only recently been introduced, Chancel and Rehm are currently the only authors to apply it. Emissions are attributed proportionally to the equity, private firm ownership, and pension assets owned by the respective wealth groups, i.e. firms' direct (Scope 1) emissions are attributed based on portfolio composition patterns by wealth group.

III. CONSUMPTION-BASED EMISSIONS

Consumption-based emissions data are available for 1990–2050 from the Stockholm Environment Institute (Ghosh et al, 2021) Emissions Inequality Dashboard.[33] Projections for the period 2023–2050 are based on IPCC scenario modelling used in the same tool. They build on the Representative Concentration Pathways (RCPs) 6.0 and 1.9, which are standardised greenhouse gas (GHG) concentration trajectories used in climate modelling to assess possible climate futures, as outlined by the Intergovernmental Panel on Climate Change (IPCC, 2014). RCP 6.0 and RCP 1.9 represent markedly different scenarios in terms of climate policy ambition and expected climate outcomes:

- **RCP 6.0** assumes that global greenhouse gas (GHG) emissions continue to rise until around 2060, after which they decline as a result of moderate mitigation measures. This pathway results in an estimated global temperature increase of roughly **2.8°C** above pre-industrial levels by 2100 (see SEI Emission Inequality Dashboard), based on scenario estimates reported in the literature, as outlined by IPCC (2014). It reflects a world with delayed or limited climate policies and continued dependence on fossil fuels, although not at the most extreme levels.
- **RCP 1.9,** in contrast, is the most ambitious mitigation scenario, designed to be compatible with limiting global warming to **1.5°C**, in line with the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC, 2015). It requires rapid and deep reductions in GHG emissions, achieving net-zero CO_2 emissions around mid-century and possibly moving towards net-negative emissions through carbon removal technologies.

33 The consumption-based approach, as calculated by the SEI (2026), provides data for the period 1990–2050. The ownership-based approach by Chancel and Rehm (2025b) provides data only for 2010 and 2022, but these can be interpolated and extrapolated to match the 1990–2050 timeline. As 1990 is a recognised baseline for historical responsibility and international reporting under the United Nations Framework Convention on Climate Change (UNFCCC, 1992) and the Kyoto Protocol (UNFCCC, 1998), we consider it an appropriate starting point for our climate debt calculations.

TABLE 8: OVERVIEW OF REPRESENTATIVE CONCENTRATION PATHWAYS (RCPS)

RCP	CLIMATE POLICY	APPROX. WARMING BY 2100	DESCRIPTION
RCP8.5	None	Approximately 4.3°C	High emissions, worst-case scenario
RCP6.0	Moderate	Approximately 2.8C	Medium--high emissions
RCP4.5	Intermediate	Approximately 2.4°C	Stabilisation pathway
RCP2.6	Very strong	Approximately 1.6°C	2 °C pathway
RCP1.9	Maximum	≤1.5 °C	1.5 °C Paris target

Source on approximate warming: continuuiti

Shared Socioeconomic Pathways (SSPs) are often used in combination with RCPs, including in the SEI Emissions Inequality Dashboard (Ghosh et al, 2021). SSPs are scenarios developed to explore how different trends in society, the economy, technology, and policy may influence GHG emissions. The SEI uses two contrasting pathways: SSP1 ('Sustainability – Taking the Green Road') and SSP4 ('Inequality – A Road Divided'). These are characterised as follows:

- **SSP1 outlines a world that moves towards greater sustainability, with low regional and social inequality, high investment in education and health, and strong institutions.** Economic growth is inclusive, environmental goals are prioritised, and technological innovation supports clean energy and efficient resource use.
- **SSP4 depicts a world marked by high inequality, both within and between countries**. Wealthy elites benefit from advanced technologies and resilience to climate impacts, while poorer parts of the population face limited access to resources, education, and adaptation capacity. Technological progress is uneven, and social fragmentation undermines global cooperation.

TABLE 9: OVERVIEW OF SHARED SOCIOECONOMIC PATHWAYS (SSPS)

SSP	NARRATIVE NAME	INEQUALITY	GROWTH	CLIMATE POLICY	MITIGATION CHALLENGE	ADAPTATION CHALLENGE
SSP1	Sustainability	Low	Moderate	Strong, coordinated	Low	Low
SSP2	Middle of the road	Medium	Moderate	Moderate, uneven	Medium	Medium
SSP3	Regional rivalry	High	Low	Weak and fragmented	High	High
SSP4	Inequality	Very high	Uneven	Elite-driven, limited	Low (for rich)	High (for poor)
SSP5	Fossil-fuelled development	Low medium	High	Delayed or absent	Very high	Low

Source: O'Neill et al. 2017

TABLE 10[34]: CONSUMPTION-BASED EMISSIONS PER INCOME GROUP[35]

INCOME GROUP	SHARE OF GLOBAL EMISSIONS (2022)	PER CAPITA EMISSIONS (2022, TCO_2)	TOTAL EMISSIONS (2022, $GTCO_2$)	CUMULATIVE EMISSIONS (1990–2022, $GTCO_2$)
Bottom 50%	8%	0.8	3	77
Middle 40%	43%	5	16	401
Top 10%	49%	23	18	509
Top 1%	16.5%	75	6	167
Top 0.1%	6.5%	300	2.4	58
Top 0.01%	3.5%*	1552*	1.2*	27*
18–23 billionaires		7746**		

*Data imputed based on SEI data (Ghosh et al., 2021), drawing on Chancel (2022). To impute the data, the calculation approximates the share of global emissions attributable to the top 0.01% of emitters using per-capita emission ratios from Lucas Chancel (2022). The underlying assumption is that the relative differences in per-capita emissions within the global top emitters from Chancel (2022) can be used to calculate the emissions of the 0.01% for the consumption-based approach. The average individual in the top 0.01% emits 5.42 times more than the average individual in the top 0.1%. Since the top 0.01% represent one tenth of the population size of the top 0.1%, their total emissions can be estimated as 0.1 × 5.42 = 0.542 times the emissions of the top 0.1%. Assuming that the top 0.1% under the ownership-based approach account for 6.5% of global emissions, the emissions share of the top 0.01% can be approximated at 3.5% of global emissions (0.542 × 6.5%).

** Emissions from private jets (based on data for 23 billionaires) and private yachts (based on data for 18 billionaires), according to Oxfam (2024)

TABLE 11: CONSUMPTION-BASED EMISSIONS PROJECTIONS PER INCOME GROUP, 2023–2050 ($GTCO_2$)

	LOW-EMISSIONS SCENARIO (RCP1.9)		HIGH-EMISSIONS SCENARIO (RCP6.0)	
INCOME GROUP	SSP1	SSP4	SSP1	SSP4
Bottom 50%	85	74	119	103
Middle 40%	390	376	535	535
Top 10%	470	521	610	685
Top 1%	162	195	205	255
Top 0.1%	60	77	75	101

34 Please note that data in this and the following tables do not add up to 100% as the top 1% wealth group and thomas above are part of the top 10% wealth group.

35 Data for the 23 billionaires are drawn from Oxfam International (2024, 2025). See Chapter 3 for an explanation of differences in the approach taken by Oxfam International.

IV. OWNERSHIP-BASED EMISSIONS

Based on Chancel and Rehm (2025b), the following data are available for ownership-based emissions. Data on total emissions for 2022 and cumulative emissions for 1990–2022, as well as projections for 2022–2050, are used for the climate debt calculations.

Data for the 308 and 50 billionaires are drawn from Oxfam (2024, 2025). In contrast to the ownership-based approach, which focuses on corporate Scope 1 emissions, Oxfam includes both Scope 1 and Scope 2 emissions (see Chapter 3).

TABLE 12: OWNERSHIP-BASED EMISSIONS PER WEALTH GROUP[36]

WEALTH GROUP	SHARE OF GLOBAL EMISSIONS (SCOPE 1, 2022)	PER CAPITA EMISSIONS (SCOPE 1, 2022, TCO$_2$/TCO$_2$E)	TOTAL EMISSIONS (2022, GTCO$_2$/ GTCO$_2$E)	CUMULATIVE EMISSIONS (1990–2022, GTCO$_2$/ GTCO$_2$E)[37]
Bottom 50%	3%	0.2	0.8	22**
Middle 40%	20%	2	6	165**
Top 10%	77%	33	26	665**
Top 1%	41%	165	13	344**
Top 0.1%	17%*	701*	6	123**
Top 0.01%	9%*	3799*	3	67**
308 billionaires		1.9 million***		
50 billionaires		2.6 million****		

* Data imputed based on Chancel and Rehm (2025b), drawing on Chancel (2022). To impute the data, the calculation approximates the share of global emissions attributable to the top 0.1% and top 0.01% of emitters using per-capita emission ratios from Lucas Chancel (2022). The underlying assumption is that the relative differences in per-capita emissions within the global top emitters from Chancel (2022) can be used to calculate the emissions of the 0.1 and 0.01% for the ownership-based approach. The average individual in the global top 0.1% in Chancel (2022) data emits 4.24 times more than the average individual in the top 1% (467 tCO$_2$e compared to 110 tCO$_2$e per capita). Since the top 0.1% represents one tenth of the population size of the top 1%, its total emissions are estimated as 0.1 × 4.24 = 0.424 times the emissions of the top 1%. Given that the top 1% under the ownership-based approach account for 41% of global emissions, the top 0.1% are therefore estimated to account for approximately 17.4% of global emissions (0.424 × 41%).

The same approach is then applied to estimate the emissions share of the top 0.01%. Chancel reports average emissions of 2,531 tCO$_2$e for the top 0.01%, compared to 467 tCO$_2$e for the top 0.1%, implying a per-capita multiplier of 5.42. Since the top 0.01% represent one tenth of the top 0.1%, their aggregate emissions are estimated as 0.1 × 5.42 = 0.542 times the emissions of the top 0.1%. Applying this ratio to the estimated 17.4% emissions share of the top 0.1% yields an estimated global emissions share of approximately 9.4% for the top 0.01%.

** Data linearly interpolated based on Chancel and Rehm (2025b)

*** Data from Oxfam (2025) , using corporate Scope 1 and 2 emissions for 2023

**** Data from Oxfam (2024), using corporate Scope 1 and 2 emissions for 2023

36 Per capita emissions in Chancel and Rehm (2025b) are based on the total number of individuals, both adults and their dependents such as children, living in households belonging to each wealth group (e.g., emissions of the richest 1% adults are divided among these adults and their dependents). We assume as an approximation that these per capita emissions can be scaled up to represent groups defined by shares of the world's population. The methodological assumption for this report is that children are distributed equally among wealth groups. This results in slightly higher total ownership-based emissions for the 1% than used by Chancel and Rehm (2025b), who for the calculation of total emissions assume that higher wealth groups have fewer children than lower wealth groups.

37 Interpolation based on Chancel and Rehm (2025b).

TABLE 13: OWNERSHIP-BASED EMISSIONS PROJECTIONS PER WEALTH GROUP, 2023–2050 ($GTCO_2E$)*

	LOW EMISSIONS-SCENARIO (RCP1.9)		HIGH-EMISSIONS SCENARIO (RCP6.0)	
WEALTH GROUP	SSP1	SSP4	SSP1	SSP4
Top 10%	912	999	1111	1234
Top 1%	343	408	412	502
Top 0.1%	122	155	145	190

* Projected data are based on Chancel and Rehm (2025b) with growth rate scenarios derived from the Stockholm Environment Institute (Ghosh et al, 2021) Emissions Inequality Dashboard, accounting for population and inequality developments.

Projections for the years 2023–2050 are imputed based on the RCPs and SSPs used in the consumption-based approach of SEI (Ghosh et al, 2021). However, growth rates are adjusted based on the observed differences in the mean growth rates between consumption-based and ownership-based CO_2 emissions for the period 1990–2022.

It is assumed that the mean factors calculated for the top 10%, top 1%, and top 0.1% remain constant over the projection period (2023–2050). Accordingly, ownership-based emissions of the top 10% (factor of 1.006) are expected to grow, on average, slightly faster than consumption-based emissions. For the top 1% and top 0.1%, growth is expected to be slightly slower than for consumption-based emissions in the same groups (factors of 0.996 and 0.987, respectively).

V. CALCULATING AN INDIVIDUAL 'EQUITABLE SHARE' OF EMISSIONS

For the purpose of this analysis, we use the concept of an 'equitable share' of emissions **as the level of emissions each person can generate within the carbon budget of a 1.5 °C scenario; emissions beyond this level are considered excess emissions.**[38] While all emissions are acknowledged to cause harm, the equitable share is used here to identify the level of excess emissions that should be addressed through policy in order to limit further damage from climate change.

The principle of common but differentiated responsibilities and respective capabilities (CBDR–RC) lies at the heart of international climate governance, recognising that while all nations share a common responsibility to address climate change, their obligations must reflect historical emissions, differing levels of economic development, and varying capacities to respond (Fanning and Hickel, 2023). Originally formalised in the United Nations Framework Convention on Climate Change (UNFCCC, 1997; see also Holz et al., 2018), CBDR–RC can can also be extended to within-country contexts, highlighting disparities in contributions and vulnerabilities across population groups. In the context of climate debt, this principle underscores the ethical and political imperative for the world's wealthiest, who have contributed disproportionately to greenhouse gas emissions, to bear a greater share of the burden of financing mitigation and adaptation efforts, both globally and domestically.

While the emissions data in Annex, Section III and IV of this report demonstrate the historical responsibility of the richest income and wealth groups, we include an equitable share of CO_2 emissions by income/wealth group ($E_{equitable}$) that can be generated while remaining within planetary boundaries. This equitable share of emissions is included in the climate debt calculations. Excess emissions beyond this equitable share can be considered 'climate debt'. For the calculations, individual equitable shares of a safe global carbon budget consistent with

38 The 'equitable share' of emission for individuals is distinct from the established concept of 'fair share' under climate governance for states.The latter reflects the idea that the emissions reduction burden should be divided among states in a manner that reflects international legal principles such as equity, equality, as well as common but differentiated responsibilities and respective capabilities (CBDR-RC). (Rajamani et al 2021)

a 1.5 °C pathway (with a 50% probability of limiting warming in 2100) were derived from the Intergovernmental Panel on Climate Change (IPCC, 2021). With the efforts of the international community to limit the increase in global temperature to 1.5 °C above pre-industrial levels (UNFCCC, 2015), average per capita CO2 emissions must reach a certain level to achieve this objective. Currently, this level is estimated at 2.3 tonnes of CO2 (tCO2) per person per year by 2030, as reported by the Institute for European Environmental Policy (IEEP, 2021). This is considered the equitable share of emissions by the Stockholm Environment Institute (Ghosh et al, 2021), based on data from the United Nations Environment Programme (UNEP, 2021) Emissions gap report 2021 (see also Ghosh et al., 2021). Future targets are estimated at 0.9 tCO2 per capita by 2050 (UNEP, 2021).

In 2022, average per capita emissions worldwide were 4.7 tCO_2 (Friedlingstein et al., 2025), implying a required reduction of 51.1% by 2030 and 80.9% by 2050 for the average person to reach the respective targets of 2.3 tCO_2 and 0.9 tCO_2. This implies an approximately 8.6% annual reduction in per capita emissions from 2022 levels until 2030, followed by a 4.6% annual reduction thereafter until 2050 to reach the RCP1.9 pathway goal.

To operationalise equitable shares over time, two approaches are applied. For the period prior to 2022, equitable shares are approximated using average global per capita emissions, due to the absence of a defined equitable share benchmark for earlier years. For the RCP1.9 pathway, the equitable share of 2.3 tCO2 per capita in 2030 is used as a reference point and is back-calculated for the period from 2022 to 2030, assuming a continuous reduction pathway. To assign equitable shares for the period prior to 2022, average global per capita emissions are used as a proxy for equitable shares. For population development until 2050, data based on the SSP1 and SSP4 pathways from the International Institute for Applied Systems Analysis (IIASA, 2025) are used. For the RCP6.0 pathway, expected cumulative emissions from the SEI (Ghosh et al, 2021) database are evenly distributed as ‘equitable share’ emissions over the period from 2023 to 2050, with total annual emissions peaking after 2050. Based on these assumptions, the equitable share of emissions by economic group and scenario is shown in Table 16.

TABLE 14: EQUITABLE SHARE OF EMISSIONS BY ECONOMIC GROUP AND SCENARIO (GTCO2)

			LOW-EMISSIONS SCENARIO (RCP1.9)		HIGH-EMISSIONS SCENARIO (RCP6.0)	
Income group	**2022**	**Cumulative (1990–2022)**	**2023–2050 (SSP1)**	**2023–2050 (SSP4)**	**2023–2050 (SSP1)**	**2023–2050(SSP4)**
Top 10%	3.74	98.19	48.11	49.55	126.35	130.28
Top 1% (approx. the world's millionaires)	0.37	9.82	4.81	4.96	12.64	13.01
Top 0.1%	0.037*	0.98*	0.48*	0.49*	1.26**	1.31**
Top 0.01% (approx. US$ 38 million and above)	0.0037*	0.098*	0.048*	0.0049*	0.13**	0.13**

* Calculations based on UNEP (2021), IIASA (2025), and Friedlingstein et al. (2025)

** Additional use of the SEI (Ghosh et al, 2021) database for cumulative emissions trends under the RCP6.0 pathway

From 2022 onwards, the remaining carbon budget (RCB) for staying below 1.5 °C of pre-industrial warming (with a 50% probability) is estimated at 275 gigatonnes of CO_2 (GtCO2) until 2030, according to the Potsdam Institute for Climate Impact Research (PIK, 2021). This budget corresponds to approximately seven years from January 2024 onwards, assuming an average annual reduction of 1.5 $GtCO_2$, or 4% of total 2022 emissions, which were approximately 37.1 $GtCO_2$. For the 1.7 °C and 2 °C pathways, the carbon budget amounts to between 625 $GtCO_2$ and 1,150 $GtCO_2$, corresponding to approximately 15 years for the 1.7 °C pathway and 22 to 28 years for the 2 °C pathway. At current projections, the remaining the carbon budget for 1.5 °C warming is expected to be exhausted by the end of 2026 (Friedlingstein et al., 2025).

VI. SOCIAL COST OF CARBON

CO_2 emissions generate negative externalities, as their social and environmental costs are not reflected in market prices, thereby imposing a burden on society and future generations. The social cost of carbon (SCC) quantifies these costs by estimating the economic damages associated with generating one additional tonne of CO_2 (tCO_2). It is defined as the 'present value of all future impacts from an additional metric ton of CO_2 emissions.' (Moore et al., 2024, p. 1). Projected damages include impacts on health, agriculture, infrastructure, and ecosystems, as well as the long-term consequences of climate change. By assigning a monetary value to CO_2 emissions, the SCC allows policymakers and project evaluators to incorporate these externalities into decision-making, thereby accounting for the opportunity costs of CO_2 emissions in economic and environmental planning.

A substantial body of literature has assessed **the SCC using a variety of methods and modelling techniques since the 1990s. Estimated SCC values depend on the complexity of the models employed and the assumptions made about future economic, technological, and climatic developments.**

Estimates suggests that the SCC ranges from approximately US$32 to US$874 per tCO_2 (Moore et al., 2024)$_2$[16], although some studies incorporating additional damage channels report substantially higher values (e.g. around US$2,520, see Wenz et al., 2024), reflecting both uncertainties in projections and the wide-ranging impacts of CO_2 emissions on society and the environment. These wide-ranging estimates highlight the inherent difficulty of projecting climate damages far into the future and of aggregating impacts across regions, sectors, and generations (Moore et al., 2024). Because of these challenges, SCC estimates require continuous scrutiny and regular updating as new data, improved methodologies, and an enhanced understanding of climate impacts become available. Consequently, scholarly debate on the SCC remains active and is unlikely to converge on a single definitive value.

Within this ongoing discussion on SCC calculations, Integrated Assessment Models (IAMs)17, such as DICE and GIVE, play a central role in quantifying the SCC, alongside systematic literature reviews and meta-analyses. IAMs have traditionally been used to estimate the SCC by linking economic growth, emissions, climate dynamics, and monetised damages in a single framework. Rooted in neoclassical growth theory[39] (for example, Solow 1970), these models project population and gross domestic product (GDP) to derive emissions pathways, simulate climate impacts, and discount future damages to a present-value SCC. However, many IAMs have been criticised for oversimplifying the climate–economy system, often omitting extreme events, tipping points, and complex socio-economic feedbacks, which can lead to conservative estimates. The DICE model (Dynamic Integrated Model of Climate and the Economy), one of the earliest and most influential IAMs, has been repeatedly updated since the 1990s. Its latest version, DICE-2023, incorporates risk-adjusted discounting and estimates an SCC of US$66 per tCO2 in the baseline scenario (Barrage and Nordhaus; 2024). Models such as the open-source GIVE framework[40] (Rennert et al., 2022) address earlier limitations by explicitly incorporating probabilistic uncertainty, climate tail risks, non-market damages, and improved damage functions, resulting in substantially higher SCC estimates (Rennert et al., 2022). The model typically follows four steps: (1) projecting the population and GDP that define the CO2 emission pathway; (2) using this pathway to drive a climate model that projects temperature changes, greenhouse gas (GHG) concentrations, and other variables; (3) expressing these climate impacts in monetary terms and aggregating them into economic damages; and (4) discounting all future damages into a single present value (Johnson and Hope, 2012). By combining diverse elements, the model enables a comprehensive valuation of the risks arising from interacting uncertainties, grounded in improved scientific, economic, and demographic data that were previously unavailable. Rennert et al. (2022) estimate a mean SCC is US185$ per tCO2, at a discount rate of 2%.Wenz et al. (2024) estimate US$2,520 per tCO2 using an expanded damage framework. Appropriate climate adaptation measures within the next 23 years could reduce the SCC to below US$1,000, provided that economic vulnerability to climate impacts is substantially reduced over this period.

Yet, as the saying goes, 'All models are wrong, but some are useful' (see Pox 1987). 21 The simplicity of models such as DICE and GIVE makes it easier to understand how changes in parameters influence outcomes, providing valuable intuition. However, as they simplify a highly complex world and must account for significant risk and uncertainty, their results should not be taken at face value (Ursin, 2024). Instead, the outputs should be interpreted with caution, and

39 According to this theory, individuals or firms choose to forgo some current consumption to invest in capital, skills, and technology in order to raise future consumption possibilities.

40 It is used by researchers and various governments, including the U.S. Environmental Protection Agency (EPA) and the German Environmental Agency (UBA).

no SCC can be considered the 'right' one. Systematic literature reviews and meta-analyses can therefore support the choice of an SCC, as they cover a wide range of methodologies and allow for upper-, lower- and mid-range SCC values to be used in calculations.

The latest meta-study by Moore et al. (2024) synthesises 1,823 SCC estimates from 147 studies and complements this with a survey of the study authors. The literature-based SCC is highly skewed, with a median value of US$39 per tCO2. The authors find that existing studies tend to underestimate the SCC for various reasons, including differences in discount rates, damage-function specifications, model structures, and utility-function assumptions. To address this bias, Moore et al. (2024) generate an improved 'synthetic distribution', which yields a mean estimate of US$283 per tCO2 (range: US$32–US$874).

BOX 4: THE DISCOUNT RATE – A KEY PARAMETER IN SCC CALCULATIONS

The choice of the discount rate is crucial for policy recommendations, as it leads to significant differences in SCC estimates. A discount rate converts future costs and benefits into present values. It is used in economics in market-based approaches, where it typically reflects the opportunity cost of capital (Van der Ploeg, 2020). In the context of the SCC, it determines how much we value future climate damages compared to present-day impacts. It is a normative choice based on ethical considerations, such as valuing future generations similarly to the current generation, and on assumptions about the trajectory of economic growth (Van der Ploeg, 2020). A low discount rate (1–3%) assigns greater weight to future damages and therefore increases the SCC, whereas a high discount rate (>3%) places less weight on the future and results in a lower SCC, effectively making long-term climate damages nearly disappear in present-value terms.

For the calculation of climate debt, the mean SCC from the meta-study by Moore et al. (2024) is used, amounting to US$283 per tCO_2 (2020 USD)[41]. The upper and lower bound (US$874 and US$32, 2020 USD) can be used in sensitivity analyses to reflect the range of values reported in the literature.

The SCC value is adjusted for inflation using the consumer price index (CPI), as in Gössling and Humpe (2024). The CPI is used to convert nominal SCC estimates into inflation-adjusted values, allowing for the consistent use of SCC values across different years.

VII. ESTIMATED CLIMATE DEBT UNDER CONSUMPTION-BASED ACCOUNTING

The following tables present the results of our analysis, showing the climate debt of the highest income and wealth groups. For each year and each group, an equitable share is subtracted from total emissions and the resulting emissions gap is multiplied by an inflation-adjusted carbon price of US$283 (2020 USD).

In this analysis, climate debt is calculated without subtracting CO_2 prices already paid through carbon taxes, emissions trading systems (ETS), or similar instruments. This reflects a deliberate methodological choice. While such pricing mechanisms do internalise parts of the environmental costs, they currently cover around 28% of global emissions (World Bank 2025) yet are often

41 Other studies by Greenpeace apply different estimates of the SCC. In this analysis, we use the SCC outlined above, as it represents a mid-range value derived from a meta-analysis of 147 studies and therefore provides a balanced basis for estimating climate debt.

set well below estimated social cost levels. At the same time, a consistent accounting framework would require that fossil fuel subsidies (which effectively lower the cost of carbon-intensive activities) are also incorporated. Including both paid CO_2 prices and received subsidies would therefore be necessary to capture the net price signal faced by emitters. As fossil fuel subsidies are higher than carbon prices in most countries (IMF 2024 Fossil Fuel Subsidies Data: 2023 Update) the incorporation of both aspects is likely to increase climate debt further.

A further challenge is a practical one. It is difficult to allocate both CO_2 price payments and subsidy benefits across different income and wealth groups in a robust and transparent way. As far as we know, existing data do not allow for an attribution of how much of the total carbon pricing burden or subsidy support is borne or received by specific wealth segments, especially at the very top of the distribution. Given these limitations, the analysis focuses on climate debt accounting neither for CO_2 prices already paid, nor for fossil fuel subsidies received.

TABLE 15: ESTIMATED CONSUMPTION-BASED CLIMATE DEBT BY INCOME GROUP, 2022 (US$)

Climate debt of the top 10% income group	4.73 trillion
Average per capita climate debt	5,928
Climate debt of the top 1% income group	1.9 trillion
Average per capita climate debt	24,096
Climate debt of the top 0.1% income group	769.63 billion
Average per capita climate debt	96,368
Total climate debt of the top 0.01% income group	404.73 billion
Average per capita climate debt	506,783

Average per capita climate debt of 50 billionaires, based on emissions from private jets and yachts (Oxfam, 2024)	2.4 million

* Please note that these figures are based on a different emission calculation approach according to Oxfam (2024)

TABLE 16: ESTIMATED CONSUMPTION-BASED ACCUMULATED CLIMATE DEBT BY INCOME GROUP, 1990–2022 (US$)

Accumulated climate debt of the top 10% income group	88.59 trillion
Average per capita climate debt	110,933
Accumulated climate debt of the top 1% income group	34.3 trillion[42]
Average per capita climate debt	429,532
Accumulated climate debt of the top 0.1% income group	12.67 trillion
Average per capita climate debt	1.58 million
Accumulated climate debt of the top 0.01% income group	6.04 trillion
Average per capita climate debt	7.6 million

42 Gössling and Humpe (2024) estimate a climate debt of US$29 trillion for the world's millionaires, using a carbon price of US$200 (2020 USD), which is broadly consistent with our results.

TABLE 17: ESTIMATED CONSUMPTION-BASED PROJECTED CLIMATE DEBT BY INCOME GROUP, 2022–2050 (US$)

Projected climate debt of the top 10% income group (low-emission scenario, SSP1)	312.94 trillion
Average per capita debt	340,263
Projected climate debt of the top 10% income group (low-emission scenario, SSP4)	346.79 trillion
Average per capita debt	350,053
Projected climate debt of the top 10% income group (high-emission scenario, SSP1)	405.8 trillion
Average per capita debt	441,213
Projected climate debt of the top 10% income group (high-emission scenario, SSP4)	456.38 trillion
Average per capita debt	460,670
Projected climate debt of the top 1% income group (low-emission scenario, SSP1)	107.83 trillion
Average per capita debt	1,1 million
Projected climate debt of the top 1% income group (low-emission scenario, SSP4)	130 trillion
Average per capita debt	1.31 million
Projected climate debt of the top 1% income group (high-emission scenario, SSP1)	136.9 trillion
Average per capita debt	1.48 million
Projected climate debt of the top 1% income group (high-emission scenario, SSP4)	169.8 trillion
Average per capita debt	1.7 million
Projected climate debt of the top 0.1% income group (low-emission scenario, SSP1)	39.7 trillion
Average per capita debt	4.3 million
Projected climate debt of the top 0.1% income group (low-emission scenario, SSP4)	51.63 trillion
Average per capita debt	5.2 million
Projected climate debt of the top 0.1% income group (high-emission scenario, SSP1)	50.25 trillion
Average per capita debt	5.4 million
Projected climate debt of the top 0.1% income group (high-emission scenario, SSP4)	67.17 trillion
Average per capita debt	6.7 million

VIII. ESTIMATED CLIMATE DEBT UNDER OWNERSHIP-BASED ACCOUNTING

TABLE 18: ESTIMATED OWNERSHIP-BASED CLIMATE DEBT BY WEALTH GROUP, 2022 (US$)

Climate debt of the top 10% wealth group	7.4 trillion
Average per capita climate debt	9,277
Climate debt of the top 1% wealth group	4.2 trillion
Average per capita climate debt	52,510
Climate debt of the top 0.1% wealth group	1.82 trillion
Average per capita climate debt	228,062
Climate debt of the top 0.01% wealth group	992.48 billion
Average per capita climate debt	1.24 million

Average per capita climate debt of 308 billionaires	590 million*
Average per capita climate debt of 50 billionaires	807 million*
* Please note that these figures are based on a different emission calculation approach and include corporate Scope 1 and 2 data, whereas the other climate debt estimates focus on Scope 1 only. The difference between billionaires and the top 0.01% group would be smaller if the billionaire estimates were restricted to Scope 1 emissions.	

TABLE 19: ESTIMATED OWNERSHIP-BASED ACCUMULATED CLIMATE DEBT BY WEALTH GROUP, 1990–2022 (US$)

Accumulated climate debt of the top 10% wealth group	123.87 trillion
Average per capita climate debt	155,109
Accumulated climate debt of the top 1% wealth group	72.5 trillion
Average per capita climate debt	907,794
Accumulated climate debt of the top 0.1% wealth group	27.24 trillion
Average per capita climate debt	3.41 million
Accumulated climate debt of the top 0.01% wealth group	14.8 trillion
Average per capita climate debt	18.53 million

TABLE 20: ESTIMATED OWNERSHIP-BASED PROJECTED CLIMATE DEBT BY WEALTH GROUPS, 2022–-2050 (US$)

Projected climate debt of the top 10% wealth group (low-emission scenario, SSP1)	607.16 trillion
Average per capita debt	660,155
Projected climate debt of the top 10% wealth group (low-mission scenario, SSP4)	665.2 trillion
Average per capita debt	671,457
Projected climate debt of the top 10% wealth group (high-emission scenario, SSP1)	739.78 trillion
Average per capita debt	804,348
Projected climate debt of the top 10% wealth group (high-emission scenario, SSP4)	822.2 trillion
Average per capita debt	829,933
Projected climate debt of the top 1% wealth group (low-emission scenario, SSP1)	228.94 trillion
Average per capita debt	2.4 million
Projected climate debt of the top 1% wealth group (low-emission scenario, SSP4)	271.68 trillion
Average per capita debt	2.7 million
Projected climate debt of the top 1% wealth group (high-emission scenario, SSP1)	274.35 trillion
Average per capita debt	2.9 million
Projected climate debt of the top 1% wealth group (high-emission scenario, SSP4)	334.8 trillion
Average per capita debt	3.3 million
Projected climate debt of the top 0.1% wealth group (low-emission scenario, SSP1)	81.21 trillion
Average per capita debt	8.8 million
Projected climate debt of the top 0.1% wealth group (low-emission scenario, SSP4)	103.55 trillion
Average per capita debt	10.4 million
Projected climate debt of the top 0.1% wealth group (high-emission scenario, SSP1)	96.97 trillion
Average per capita debt	10.5 million
Projected climate debt of the top 0.1% wealth group (high-emission scenario, SSP4)	126.98 trillion
Average per capita debt	12.8 million

IX. GEOGRAPHICAL DISTRIBUTION OF WEALTH AND CLIMATE VULNERABILITY

To show the mismatch between the geographical distribution of wealth, emissions responsibility, and climate vulnerability, the report combines national wealth estimates from the Global Wealth Databook 2022 (Shorrocks et al., 2022) with data from the Notre Dame Global Adaptation Initiative (ND-GAIN) Country Index.

The ND-GAIN Index measures countries' vulnerability to climate change as well as their readiness and capacity to adapt. It combines indicators relating to exposure, sensitivity and adaptive capacity across six sectors (food, water, health, ecosystem services, human habitat and infrastructure), together with measures of economic, governance and social readiness for adaptation. Countries with lower ND-GAIN scores are generally more vulnerable to climate change and possess lower adaptive capacity, while countries with higher scores tend to have greater resilience and readiness to respond to climate-related risks.

We use the ND-GAIN Index because it provides a comprehensive measure of climate vulnerability and adaptive capacity, aligning closely with the report's objective of illustrating the geographical mismatch between the concentration of private wealth and ownership-based climate responsibility on the one hand, and climate vulnerability and adaptation capacity on the other. Table 21 below presents the wealth data alongside the ND-GAIN indicators used in the analysis.

TABLE 21. DATA COMBINING NATIONAL WEALTH ESTIMATES FROM THE GLOBAL WEALTH DATABOOK 2022 (SHORROCKS ET AL., 2022) WITH CLIMATE VULNERABILITY AND ADAPTATION READINESS INDICATORS FROM THE ND-GAIN COUNTRY INDEX. THE LONG-TERM CLIMATE RISK INDEX (CRI) FROM GERMANWATCH IS INCLUDED FOR COMPARISON.

COUNTRY	TOTAL WEALTH (USD BN) 2021	SHARE OF WORLD WEALTH (%) 2021	ND-GAIN SCORE 2025*	CRI 1995-2024**
Austria	1.825	0,39	69	100
Bangladesh	1.026	0.22	35,5	13
Brazil	3.327	0,72	49,1	40
France	16.159	3,49	67,2	12
Germany	17.489	3,77	69	29
India	14.225	3,07	45,5	9
Indonesia	3.405	0,73	48,4	48
Italy	11.512	2,48	59,8	16
Kenya	369	0,08	40,3	39
Luxembourg	332	0,07	67,2	126
Malawi	22	0,00	36,9	25
Mexico	4.167	0,90	48,7	51
Netherlands	5.422	1,20	65,9	74
Nigeria	752	0,20	38,6	61

COUNTRY	TOTAL WEALTH (USD BN) 2021	SHARE OF WORLD WEALTH (%) 2021	ND-GAIN SCORE 2025*	CRI 1995-2024**
Norway	1.413	0,30	75,5	155
Pakistan	790	0,20	39,2	15
Philippines	992	0,20	45,6	7
Saudi Arabia	2.073	0,50	58,2	133
South Africa	938	0,20	48,1	53
Spain	8.431	1,80	61	24
Switzerland	4.878	1,10	72	105
Thailand	1.341	0,30	52,7	22
Turkey	1.142	0,30	55,3	107
United Arab Emirates	994	0,21	60,2	173
United Kingdom	16.261	3,51	69,7	65
United States	145.793	31,45	66,8	18
Zambia	27	0,01	42,5	104

*ND-GAIN scores range from 0 to 100, with higher values indicating lower vulnerability and greater readiness to adapt to climate change.

**the CRI ranking measures how strongly countries have been affected by past extreme weather events using normalized indicators on fatalities, affected populations, and economic damages. The most affected country is assigned a score of 100. All other countries are ranked as percentage points behind this leader. A lower numerical rank (e.g., Rank 1, 2, or 3) indicates a higher level of affectedness.

Sources: Total Wealth and Share of Wealth : Shorrocks et al. (2022), Global Wealth Databook 2022; ND-GAIN Score : University of Notre Dame Global Adaptation Initiative (2025), CRI 1995-2024: Country Index 2025; Adil et al. (2025), Climate Risk Index 2026.

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