

Commentary

Time to pay the piper: Fossil fuel companies' reparations for climate damages

Marco Grasso^{1,*} and Richard Heede²¹Department of Sociology and Social Research, University of Milan-Bicocca, via Bicocca degli Arcimboldi, 8 – 20126, Milan, Italy²Climate Accountability Institute, 1626 Gateway Road, Snowmass, Colorado 81654, USA*Correspondence: marco.grasso@unimib.it<https://doi.org/10.1016/j.oneear.2023.04.012>

The calls for climate reparations are rapidly growing in the scientific literature, among climate movements, and in the policy debate. This article proposes morally based reparations for oil, gas, and coal producers, presents a methodological approach for their implementation, and quantifies reparations for the top twenty-one fossil fuel companies.

Human-caused climate change has long been acknowledged as essentially an ethical issue that threatens humanity and ravages the planet. While the Global North's historical carbon emissions have exceeded their fair share of the planetary boundary by an estimated 92%, the impacts of climate breakdown fall disproportionately on the Global South, which is responsible for a trivial share—Africa, Asia, and Latin America contribute only 8%—of excess emissions.¹ At the same time, the world's richest 1% of the population contributed 15% of emissions between 1990 and 2015, more than twice as much as the poorest 50%, who contributed just 7% but who suffer the brunt of climate harm.² This inequity is exacerbated by poorer societies' lack of resources to adapt to climate impacts and by the persistent reluctance of the Global North to provide them with the necessary funding and assistance as required by the principle of common but differentiated responsibilities and respective capabilities (CBDR-RC) of article 3 of the UNFCCC.

The climate crisis and its rapidly increasing economic burdens bring to the forefront a question that has been poorly investigated, but bluntly recalled in the 2022 IPCC report on impacts, adaptation, and vulnerability³: who should bear the cost of the harm caused by anthropogenic climate change? Is it states, or affected individuals, families, and businesses? Is it future generations, who had no role in creating the harm? Or should the burden fall on those agents that have contributed the most to global climate disruption, while in the meantime greatly profiting?

The costs of anthropogenic climate change are chiefly borne by states that compensate their own citizens harmed by climate impacts or contribute to international adaptation finance, by insurance companies with regard to their insureds, and by uncompensated victims of climate change. We argue that other agents bear substantial responsibility for the cost of redressing climate harm: the companies that engage in the exploration, production, refining, and distribution of oil, gas, and coal. The recent progress in climate attribution science makes it evident that these companies have played a major role in the accumulation and escalation of such costs by providing gigatonnes of carbon fuels to the global economy while willfully ignoring foreseeable climate harm.⁴ All the while they successfully shaped the public narrative on climate change through disinformation, misleading “advertorials,” lobbying, and political donations to delay action directly or through trade associations and other surrogates.⁵

Fossil fuel companies have a moral responsibility to affected parties for climate harm and have a duty to rectify such harm.^{6,7} Moral theory^{6,8} and common sense—as well as international environmental agreements through the polluter pays principle embodied in article 16 of the 1992 Rio Declaration, which calls for the “internalization of environmental costs”—demand that historical wrongdoing must be rectified. A direct way to do so is through payment of reparations to wronged parties,⁸ which in the context of the climate crisis are a historically informed account of distributive justice.⁹

In the case of the carbon fuel industry, reparations require that companies relinquish part of their tainted wealth to provide affected subjects with financial means for coping with climate harm, consistent with the climate justice movement's core demand that fossil fuel companies repay their impacts debt. This is the moral rationale for reparations in the form of financial rectification by fossil fuel companies in the context of climate change.¹⁰ Additionally, on a practical level the insufficiency of funding for adaptation under the UNFCCC Green Climate Fund and the lengthy process for the operationalization and the adequate financing of the Loss and Damage fund—so far the only tangible outcome of the 2013 Warsaw International Mechanism (WIM)—established at the 2022 Sharm El Sheikh COP 27 require other culpable agents—e.g., fossil fuel companies—to complement state-centric international governance to cope with the cost of climate damages.

Here, we reframe the debate on international funding to tackle climate impacts by focusing on the financial responsibility of fossil fuel companies for climate harm. We argue that fossil fuel producers contributed to climate harm through their operational and product emissions, have a documented history of climate denial¹¹ and of discourse and practices of delay,¹² disinformed the public and their shareholders on climate science and corporate risks, are complicit in slowing down or defeating climate legislation, and must be held accountable for climate harm by paying reparations. To this end, we present a morally grounded methodological



approach for implementing reparations and quantify them for the top twenty-one fossil fuel producers based on their operational and product-related emissions from 1988 to 2022 and on the economic situation of the people in the countries where they are based.

The following analysis is a starting point for open discussion of shared responsibility for climate harm and in particular of the financial duty owed by the fossil fuel industry to climate victims. Our work aims to lay the groundwork for further investigation into the role of the fossil fuel industry in climate change and should not be understood as a fully fledged policy proposal. While crucial, for purposes of this analysis we ignore a thorough identification of climate victims, the mechanisms of compelling payment of reparation funds, the governance and distribution of collected reparations, as well as the political feasibility of the approach developed and its relationships with the UNFCCC. A global reparations scheme, as proposed here, complements and is neither a substitute for climate finance under the UNFCCC nor for climate-related litigation filed in numerous jurisdictions based on varying legal theories against major oil, gas, and coal companies.

Implementing reparations

Consistent with a rich literature on fossil fuel corporate climate accountability ranging from the 1950s to the 1990s,^{13,14} we conservatively start the clock for climate reparations in 1988, the year the IPCC was established and when NASA scientist James Hansen testified before the U.S. Senate that the human signal in climate change had been detected. Since 1988, claims of scientific uncertainty about the consequences of carbon emissions are untenable.

Our argument first demands that fossil fuel producers' future emissions must be reduced at a rate consistent with minimizing damages as set forth in the International Energy Agency's 2021 roadmap for a net-zero energy system.¹⁵ This requires no more investment in new fossil projects and minimal absolute emissions and offsets by mid-century.

To frame reparations, we group the top twenty-one fossil fuel companies into the categories "high requirement" (HR), "low requirement" (LR), and "exempted" (Ex). This grouping and the consequent reparations

owed are based on companies' violation of the no-harm principle, which entails disgorgements proportional to their historical emissions understood as the measure of their contribution for climate harm and by the application of the moral principle of need, which requires that people with greater need should receive more benefits. In our analysis, the principle of need has a moral primacy over the no-harm principle given the financial means that should be mobilized to ensure poorer people's right to development amidst a global climate crisis, and demands that (1) companies in less wealthy countries are charged lower reparations to allow larger contributions (in terms, for example, of tax revenues, domestic subsidies, employment, social programs) to their countries' people and that (2) companies in poorer countries are exempted from reparations because people of these countries need the maximum benefits from fossil fuel companies not burdened by reparations. Accordingly (see [Note S1](#) for specifications on involved countries' economic situation).

- (1) IOCs (investor-owned companies) and SOEs (state-owned entities) headquartered in wealthier countries are defined as HR companies: Abu Dhabi NOC, BHP, BP, Chevron, ConocoPhillips, Exxon-Mobil, Kuwait Petroleum, Peabody Energy, Saudi Aramco, Shell, and TotalEnergies.
- (2) SOEs headquartered in less-wealthy countries are deemed LR companies: Gazprom, Iraq National Oil Co., Pemex, Petrobras, PetroChina, and Rosneft.
- (3) SOEs headquartered in poorer countries are Ex companies: Coal India, National Iranian Oil, Petroleos de Venezuela, and Sonatrach.

HR companies must shoulder the full financial burden of reparations determined by the no-harm principle, since they are established in wealthier countries. The principle of need assigns LR companies partial reparations on account of the more precarious economic situation of the people of their home countries. On the same ground, given their more indispensable contribution to their weak national economies and poorer people, Ex companies are absolved from paying reparations.

In our approach, the top twenty-one companies—with the exclusion of the four Ex ones—are required to disgorge reparations over the period from 2025 to 2050 through an annual scheme declining toward zero in 2050 (see [Note S1](#)) in order to accommodate their decreasing capacity to shoulder reparations given their transition to a likely less profitable decarbonized business or, for less nimble companies, their dissolution. The postponement to 2025 should be understood as a "grace period" for companies to ramp up their financial capacity to address their estimated reparations.

Based on a survey of 738 economists with demonstrated expertise in climate¹⁶ and using a 2025–2075 growth model, we calculate that the 2025–2050 cumulative cost of climate damages attributed to all anthropogenic sources based on a model of loss of GDP under a 3°C scenario is \$99 trillion, of which \$70 trillion is attributed to fossil fuels (see [Note S1](#)). We further argue that greenhouse gas emissions are the result of the behaviors of three groups of agents: those who provide the global economy with the products whose combustion generates fossil fuel emissions (producers); those who use their carbon fuels as intended (emitters); and those who, under the weight of scientific evidence and international agreements, should (or fail to) act to reduce emissions (political authorities). There is no objective basis to disentangle the different weight of these three groups and for the sake of simplicity we propose that producers, emitters, and political authorities have equal one-third shares of responsibility, and thus an equal quota of climate damages of \$23.2 trillion.

Each of the companies in the top twenty-one of the Carbon Majors 2023 Dataset¹⁷ is then allocated a share of this \$23.2 trillion sum—payable over 2025–2050—based on its operational and product-related emissions as a percent of global emissions from fossil fuels from 1988 to 2022. Consistent with the moral categorization outlined, HR companies bear the full burden of their reparations, LR companies are attributed half, while Ex companies are absolved from meeting theirs. As an incentive to early action, we propose that companies are eligible to reduce reparations if they achieve aggressive targets to curtail production of carbon fuels faster than

Table 1. Reparations of top twenty-one fossil fuel companies, 2025–2050

Groups	Companies	A Cumulative emissions 1988–2022 (MtCO ₂ e)	B Percent of global emissions	C Cumulative reparations 2025–2050 (Billion US\$, current)	D Average annual reparations 2025–2050 (Billion US\$, current)
HR	Saudi Aramco, Saudi Arabia	53,714	4.78%	\$1,110	\$42.7
	ExxonMobil, USA	23,119	2.06%	\$478	\$18.4
	Shell, UK	20,487	1.82%	\$424	\$16.3
	BP, UK	18,214	1.65%	\$377	\$14.5
	Chevron, USA	16,090	1.43%	\$333	\$12.8
	Abu Dhabi, UAE	15,386	1.37%	\$318	\$12.2
	Peabody Energy, USA	13,777	1.23%	\$285	\$11.0
	TotalEnergies, France	11,760	1.05%	\$243	\$9.4
	Kuwait Petroleum Corp., Kuwait	11,733	1.04%	\$243	\$9.3
	ConocoPhillips, USA	10,082	0.90%	\$208	\$8.0
	BHP, Australia	9,602	0.85%	\$199	\$7.6
LR	Gazprom, Russian Fed.	50,492	4.49%	\$522	\$20.1
	Pemex, Mexico	18,533	1.65%	\$192	\$7.4
	PetroChina, China	18,162	1.62%	\$188	\$7.2
	Rosneft, Russian Fed.	11,224	1.00%	\$116	\$4.5
	Iraq National Oil Co., Iraq	10,521	0.94%	\$109	\$4.2
	Petrobras, Brazil	9,806	0.87%	\$101	\$3.9
Ex	National Iranian Oil Co., Iran	29,212	2.60%	–	–
	Coal India, India	26,208	2.33%	–	–
	Petroleos de Venezuela, Venezuela	12,898	1.15%	–	–
	Sonatrach, Algeria	12,070	1.07%	–	–
	<i>Top 21 companies</i>	<i>403,092</i>	<i>35.9%</i>	<i>\$5,444</i>	<i>\$209</i>
<i>99 “Carbon Major” companies</i>	<i>609,853</i>	<i>54.3%</i>	<i>\$12,608</i>	<i>NA</i>	
<i>Global fossil fuel emissions</i>	<i>1,123,439</i>	<i>100%</i>	<i>\$23,225</i>	<i>NA</i>	

Column A reports the atmospheric contributions of the top twenty-one carbon fuel producers, 1988 to 2022, including scope 1 operational and scope 3 product-related emissions of both carbon dioxide and methane (million tonnes CO₂e), and Column B reports each company’s percent of global fossil fuel emissions. Cumulative reparations, once reductions and exemptions required by the principle of need are accounted for, total \$5.4 trillion and are included in Column C, while Column D reports their average annual amounts over the 26-year period 2025–2050. HR: high requirement companies; LR: low requirement companies; Ex: exempted companies. Source: authors’ elaborations based on the Carbon Majors 2018 Dataset, updated 2023.¹⁷

required by a net zero by 2050 pathway under a 1.5°C scenario.

Paying reparations

Table 1 shows the reparations owed by the top twenty-one fossil fuel companies over the period 2025–2050.

The largest twenty-one companies analyzed would disburse \$5,444 billion over the period 2025–2050. ExxonMobil, Saudi Aramco, and Shell—the companies most often accused of delaying action on climate change (see Note S1)—would have the first, third, and fourth highest reparations. HR companies would disgorge the largest cumulative reparations (\$4,218 billion), whereas LR entities account for \$1,228 billion, or 77% and 23% of total reparations, respectively. The proposed annual reparations are comparable to in-

dustry net profits in recent years. For instance, ExxonMobil third quarter 2022 profits of \$19.7 billion exceed its annual reparation payment. The global oil and gas industry has, according to recent research,¹⁸ amassed “profit without effort” (i.e., rents) of \$1 trillion per year (\$2.8 billion per day) since 1970 (for details on the top twenty-one companies’ 2022 profits and revenues see Note S1) (Figure 1).

Including fossil fuel companies in the climate discourse and negotiations clarifies how these culpable agents can positively engage in the global effort to address the climate crisis. Their role in climate governance, along with that of states, emitters, and other agents, should be aligned with the objectives of the best available science if they want to retain their social license to operate.¹⁴ Payment of reparations can

help address market failures, such as reduced competitiveness of renewables compared to heavily subsidized fossil fuels, increase cost of companies’ products, restrict expansion of their carbon business, induce them to leave reserves in the ground, and engender greater difficulty in capitalizing and insuring new carbon projects. In essence, such responsibility and burden would challenge these entities to adopt sustainable business practices—transitioning from profit-maximizing bystanders of climate disruption—while at the same time addressing their historical tortious conduct through reparations to harmed parties.

This perspective would also make it possible, coherent with the increasing interplay between state and non-state agents in climate governance, to

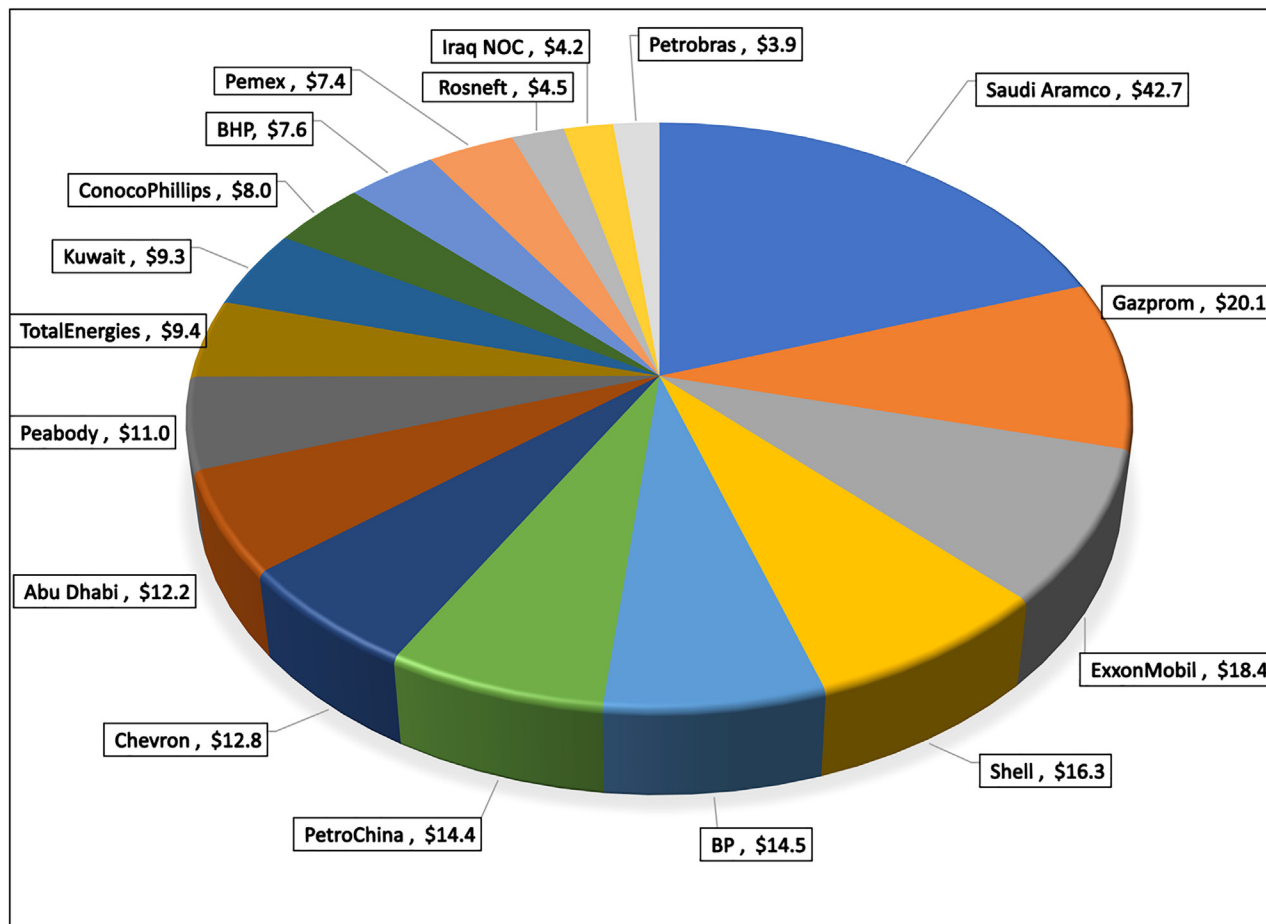


Figure 1. Fossil fuel companies' average annual reparations, 2025–2050 (billion US\$, current)
For each HR and LR company the average annual reparations for 2025–2050 is shown. Source: authors' calculations.

challenge old geopolitical groupings (e.g., North vs. South; developed vs. developing; responsible vs. vulnerable) and to complement significantly the so far inadequate international climate financing.

Reparations for a fairer climate harmed world

Considering fossil fuel companies as moral agents of the global climate system and attributing them financial reparations help balance the distribution of burdens and benefits. The proposed framework for quantifying and attributing reparations to major carbon fuel producers will inform future efforts to direct payments to harmed parties. While this will not indemnify them from current or prospective climate litigation, it may, for companies that pay reparations and show strong progress on reducing operational and product emissions, defer or even avoid being named as defendants in future law-

suits. The focus on the fossil fuel industry, despite persistent market distortions, governance, and policy failures common in the fossil fuel world, will help bridge the divide between “the rich” and “the poor” worlds that still hampers climate progress. It would also lead to a fairer distribution of the burden of fighting climate change among the various responsible agents, while at the same time providing necessary funding to mitigate emissions, fund adaptation, and compensate subjects more vulnerable to climate harm such as climate migrants and refugees, Indigenous peoples, racial and ethnic minority communities, people with disabilities, and people who are socially and economically disadvantaged.

SUPPLEMENTAL INFORMATION

Supplemental information can be found online at <https://doi.org/10.1016/j.oneear.2023.04.012>.

ACKNOWLEDGMENTS

The authors thank Ben Batros, Michael Burger, Kristin Casper, Ben Franta, Peter Frumhoff, Philip Gregory, Dario Kenner, Richard Lord, Kathryn Mulvey, and Laurie van der Burg, as well as the editors of the journal and two anonymous reviewers for their insightful comments on the various versions of this article. Richard Heede gratefully acknowledges funding from Rockefeller Brothers Fund and Rockefeller Family and Associates.

AUTHOR CONTRIBUTIONS

Conceptualization: M.G.; methodology: M.G. and R.H.; investigation: M.G. and R.H.; writing: M.G. and R.H.

DECLARATION OF INTERESTS

The authors declare no competing interests.

REFERENCES

- Hickel, J. (2020). Quantifying national responsibility for climate breakdown: an equality-based attribution approach for carbon dioxide emissions in excess of the planetary boundary.

- Lancet Planet. Health 4, e399–e404. [https://doi.org/10.1016/S2542-5196\(20\)30196-0](https://doi.org/10.1016/S2542-5196(20)30196-0).
2. Kartha, S., Kemp-Benedict, E., Ghosh, E., Nazareth, A., and Gore, T. (2020). The Carbon Inequality Era (SEI and Oxfam). <https://www.sei.org/wp-content/uploads/2020/09/research-report-carbon-inequality-era.pdf>.
 3. IPCC – International Panel on Climate Change (2022). *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press).
 4. Heede, R. (2014). Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers. *Climatic Change* 122, 229–241. 1854–2010. <https://doi.org/10.1007/s10584-013-0986-y>.
 5. Supran, G., and Oreskes, N. (2021). Rhetoric and frame analysis of ExxonMobil's climate change communications. *One Earth* 4, 696–719. <https://doi.org/10.1016/j.oneear.2021.04.014>.
 6. Shue, H. (2017). Responsible for what? Carbon producer CO₂ contributions and the energy transition. *Climatic Change* 144, 591–596. <https://doi.org/10.1007/s10584-017-2042-9>.
 7. Grasso, M. (2020). Towards a broader climate ethics: Confronting the oil industry with morally relevant facts. *Energy Res. Social Sci.* 62, 101383. <https://doi.org/10.1016/j.erss.2019.101383>.
 8. Goodin, R.E. (2013). Disgorging the fruits of historical wrongdoing. *Am. Polit. Sci. Rev.* 107, 478–491. <https://doi.org/10.1017/S0003055413000233>.
 9. Táiwò, O.O. (2022). *Reconsidering Reparations* (Oxford University Press).
 10. Grasso, M. (2022). *From Big Oil to Big Green. Holding the Oil Industry to Account for the Climate Crisis* (MIT Press).
 11. Dunlap, R.E., and Brulle, R.J. (2020). Sources and amplifiers of climate change denial. In *Research Handbook on Communicating Climate Change* (Elgar, D.C. Holmes and L.M. Richardson, eds., p. 49).
 12. Lamb, W.F., Mattioli, G., Levi, S., Roberts, J.T., Capstick, S., Creutzig, F., Minx, J.C., Müller-Hansen, F., Culhane, T., and Steinberger, J.K. (2020). Discourses of climate delay. *Glob. Sustain.* 3, E17. <https://doi.org/10.1017/sus.2020.13>.
 13. Franta, B. (2018). Early oil industry knowledge of CO₂ and global warming. *Nature Clim. Change* 8, 1024–1025. <https://doi.org/10.1038/s41558-018-0349-9>.
 14. Frumhoff, P.C., Heede, R., and Oreskes, N. (2015). The climate responsibilities of industrial carbon producers. *Climatic Change* 132, 157–171. <https://doi.org/10.1007/s10584-015-1472-5>.
 15. International Energy Agency – IEA (2021). *Net Zero by 2050. A Roadmap for the Global Energy Sector*. <https://www.iea.org/reports/net-zero-by-2050>.
 16. Howard, P., and Sylvan, D. (2021). *Gauging Economic Consensus on Climate Change* (Institute for Policy Integrity – New York University School of Law). <https://policyintegrity.org/publications/detail/gauging-economic-consensus-on-climate-change>.
 17. Heede, R. (2020). *Carbon Majors 2018 Data Set, 2023*, released December 2020. https://climateaccountability.org/carbonmajors_dataset2020.html. Updated to 2022 by the author.
 18. Verbruggen, A. (2022). The geopolitics of trillion US\$ oil & gas rents. *Int. J. Sust. Energy Plan. Manag.* 36, 3–10. <https://doi.org/10.54337/ijsepm.7395>.