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World's top 21 fossil fuel firms found responsible for at least \$209bn in annual climate change damages

Study makes case for those most responsible for the climate emergency to compensate victims, and for the first time puts a price tag on climate damages owed by top companies such as Saudi Aramco, ExxonMobil, Shell, BP, Chevron, and other leading fossil fuel producers.

The question of “who should pay for climate damages” is increasingly raised in the scientific literature, among climate movements, and in the policy debate, in particular with respect to the Loss and Damage mechanism. This work proposes a **morally-based responsibility** of oil, gas, and coal producers to pay **reparations**, presents a methodological approach for their implementation, and **for the first time quantifies annual payments** for the top fossil fuel companies from 2025 to 2050.

The top 21 producers of fossil fuels globally are collectively responsible for \$5.4 trillion in expected economic costs from climate change over the next 25 years, or \$209 billion per year on average, according to new work by Marco Grasso (University of Milan-Bicocca) and CAI’s Richard Heede published in the peer-reviewed journal *One Earth*: [Time to pay the piper](#).¹

Building on the Carbon Majors Database, which records data on the emissions of the largest carbon polluters, **the study quantifies annual payments owed by the top 21 fossil fuel companies from 2025 to 2050** in compensation for the expected extreme weather and other climate change damages caused by their operational and product emissions from 1988 to 2022.

Total global economic damages to be expected from climate change are estimated at **\$99 trillion between 2025 and 2050**, assessed by a consensus survey of 738 climate economists.

After accounting for non-fossil fuel sources of warming, **future economic damages due to fossil fuel emissions are estimated at \$69.6 trillion 2025-2050**. The study conservatively attributes one third of these climate costs to the global fossil fuel industry, and one third each to governments and consumers.

The global fossil fuel industry is thus found to be responsible for \$23.2 trillion in expected GDP loss from climate change impacts over 2025-2050, or \$893 billion per year.

To calculate the responsibilities of individual firms, the authors referred to their emissions since 1988, the year the IPCC was established, arguing that “since 1988, claims of scientific uncertainty about the consequences of carbon emissions are untenable.” About half of the warming experienced so far has happened since that date, and climate change impacts experienced in the coming decades will, in large part, be driven by emissions produced since the late 1980s.

Based on their share of emissions over 1988-2022, **the 21 largest oil, gas and coal firms are therefore responsible for \$5,444 billion in expected lost GDP over 2025-2050, or \$209 billion per year.**

Saudi Aramco, which has the largest emissions 1988-2022 from direct & product-related sources, is attributed annual liabilities of \$43 billion — substantial but low compared to 2022 revenues of \$604 billion and profits of \$161 billion.

Exxon, the leading investor-owned company, is attributed annual reparation payments of \$18 billion — compared to revenues of \$399 billion and profits of \$56 billion in 2022.

As an incentive to early action, **the authors propose that companies could be eligible for reduced reparations if they rapidly stop producing polluting fuels or meet their verified net zero targets.**

¹ Grasso, Marco, & Richard Heede (2023) Time to pay the piper: fossil fuel companies' reparations for climate damages, *One Earth*, vol. 6; online 19 May. [https://www.cell.com/one-earth/fulltext/S2590-3322\(23\)00198-7](https://www.cell.com/one-earth/fulltext/S2590-3322(23)00198-7) (activated at publication time)

The authors exempt four companies in low-income countries (Ex) and halve their calculated liability for companies in six middle-income countries (LR) (see table below for details).

Comments by the authors

“The proposed framework for quantifying and attributing reparations to major carbon fuel producers is grounded in moral theory and provides a starting point for discussion of the financial duty owed by the fossil fuel industry to climate victims” said lead author Marco Grasso, Professor at the University of Milan-Bicocca, who hopes that this work *“will inform future efforts to direct payments from fossil fuel companies to harmed parties.”*

“This is only the tip of the iceberg of long-term climate damages, mitigation, and adaptation costs,” said co-author Richard Heede, co-founder and director of Climate Accountability Institute, *“insofar as our measure of GDP loss to 2050, while substantial, ignores the value of lost ecosystem services, extinctions, loss of human lives and livelihoods, and other components of well-being not captured in GDP.”*

Reparations owed by seventeen of twenty-one top 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 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
	Iraq National Oil Co., Iraq	10,521	0.94%	\$109	\$4.2
	Rosneft, Russian Fed.	11,224	1.00%	\$116	\$4.5
	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	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>
99 “Carbon Major” companies		609,853	54.3%	\$12,608	NA
Global fossil fuel emissions		1,123,439	100%	\$23,225	NA

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About the Climate Accountability Institute: CAI engages in research and education on anthropogenic climate change, dangerous interference with the climate system, and the contribution of fossil fuel producers' carbon production to atmospheric carbon dioxide content. This encompasses the science of climate change, the civil and human rights associated with a stable climate regime not threatened by climate-destabilizing emissions of greenhouse gases, and the risks, liabilities, and disclosure requirements regarding past and future emissions of greenhouse gases attributable to primary carbon producers.

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Illustrations:

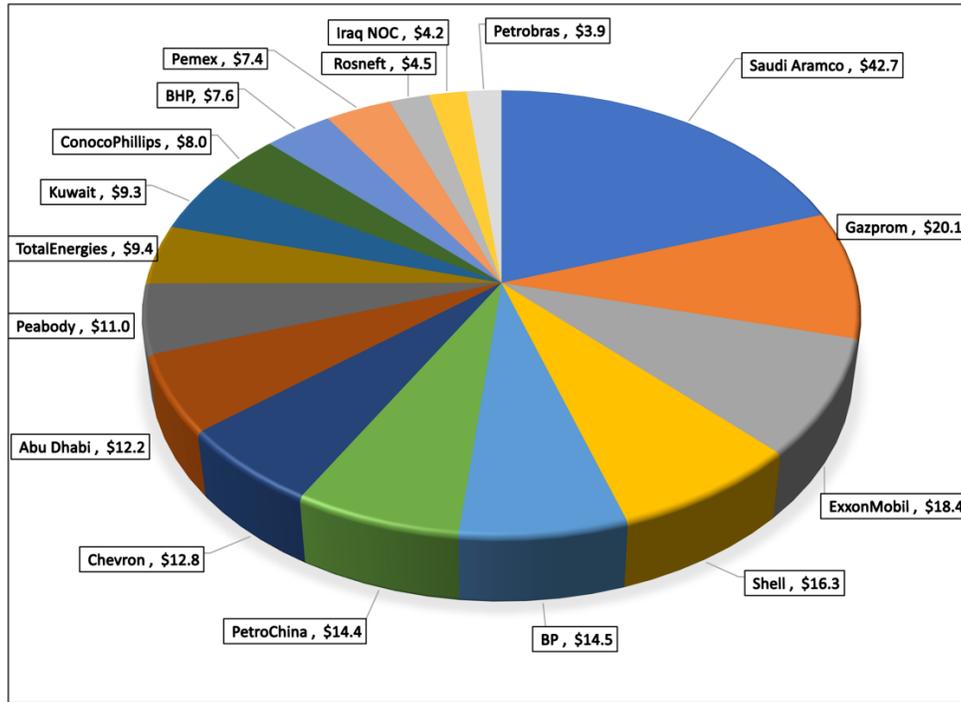
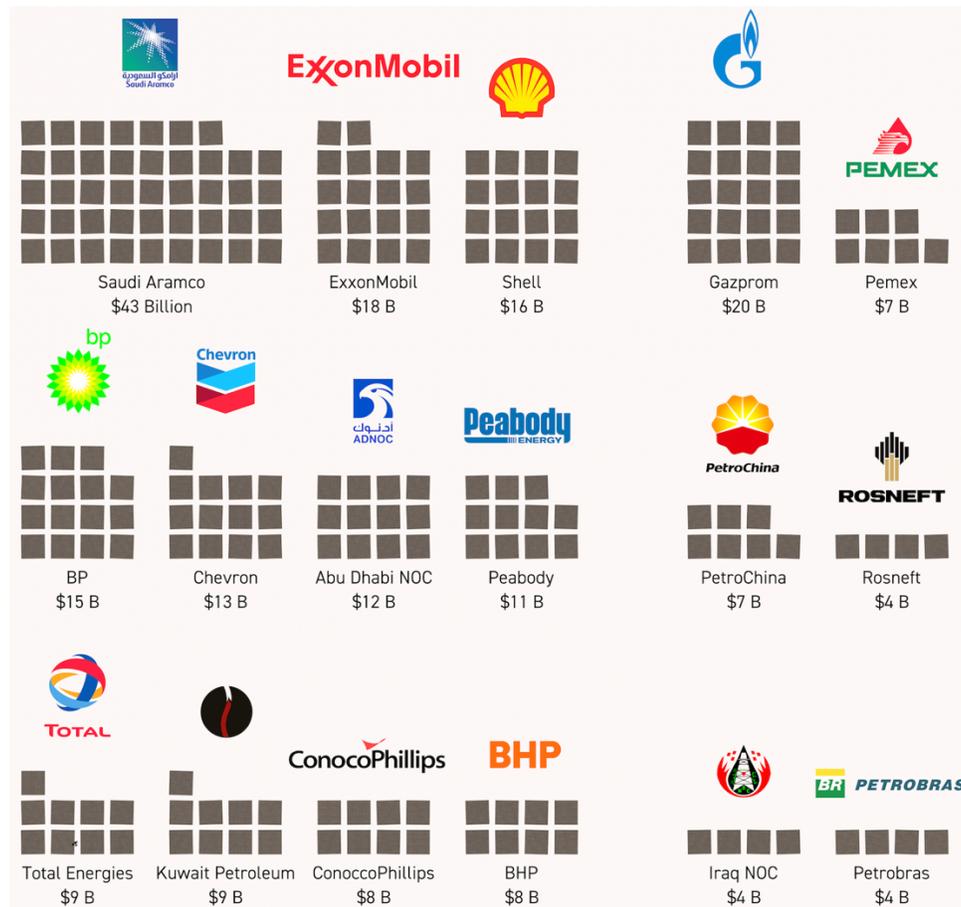


Illustration by Climate Accountability Institute.



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