
March 2024

The supermajors' plans could kill 11.5 million people

The emissions from burning oil and gas produced by Shell, BP, TotalEnergies, ExxonMobil and Chevron until 2050 could cause an estimated 11.5 million additional premature deaths due to heat before the end of the century, new Global Witness analysis reveals.¹

Extreme heat is deadly.² People exposed to it can suffer from heat strokes, heart attacks or exhaustion.³ Children,⁴ the elderly, low-income communities, outdoor workers, pregnant women, and socially isolated people are all especially vulnerable,⁵ but extreme heat can kill anyone.

Heat isn't a new phenomenon. But as the planet gets hotter because of human-caused emissions, scientists are detecting more heat-related deaths.⁶ These are called 'excess deaths', a clunky phrase which counts additional premature deaths attributable to increasing heat.

The effects of recent extreme heatwaves have been widely reported.⁷ We now know that 61,000 people died in searing heat across Europe in the summer of 2022.⁸ Deadly heatwaves have also been observed in many other places, including China, South America, and the United States in the past two years.⁹ It's a [climate justice issue](#) because extreme heat has the worst impact on the world's poorest, who are least able to adapt to higher temperatures, while also having contributed the least to emissions. Afghanistan, Papua New Guinea and Central America are amongst some of the places considered to be most at risk from extreme heat because of increasing temperatures and lack of access to healthcare and energy to cool off.¹⁰

The emission of greenhouse gases, primarily caused by burning fossil fuels, is driving this heat.¹¹ Increasingly, these emission-driven temperatures are killing people – a recent study found that more than one-third of nearly 30 million heat-related deaths recorded globally between 1991–2018 are linked to climate change.¹² Heat-related deaths are likely underestimated, according to environmental economist [Dr Shouro Dasgupta](#), because deaths are not always recorded as related to heat.¹³

For the first time, Global Witness analysis tries to determine corporate responsibility for these excess heat deaths. Recent studies have sought to assess what responsibility big polluting nations,¹⁴ or the top 1% of earners,¹⁵ bear for the climate crisis. But no one has yet sought to use this model to assess the impact of the companies who produce vast quantities of the oil and gas that is heating the planet, contributing to waves of early deaths.

To do this, we used two datasets. A researcher at Columbia University assessed the [mortality cost of carbon](#), taking the relationship between carbon emissions and heat-related deaths, to understand the cost of emissions in human lives. This model estimates that every 1 million metric tonnes of CO2 emitted in 2020 will cause an additional 226 excess temperature-related deaths over the next 80 years.¹⁶

We then cross reference that with supermajors' production of oil and gas. The five Western supermajors have defied calls from scientists to rapidly reduce emissions and [continue to increase oil and gas production](#).¹⁷ In the past few months, ExxonMobil and Chevron have invested more than \$100 billion into new oil and gas reserves.¹⁸ BP and Shell weakened their climate pledges.¹⁹ And TotalEnergies plans to ramp up production in the next few years.²⁰

Taken together, Global Witness analysis of Rystad Energy data (see Notes on our Methodology) suggests that these five companies will dig up oil and gas, which when burned, will add 51 billion tonnes of carbon dioxide²¹ emissions to the atmosphere between now and 2050. Using Columbia's mortality cost of carbon methodology, we calculate that **emissions from the supermajors' oil and gas would kill an additional 11.5 million people due to heat by 2100.**

The estimates we're using are based on a high emissions scenario. Simply put, this is a business-as-usual world, in which we only pursue the climate policies in place right now.²² Columbia's research also provides a lower emissions scenario. This suggests that if the world were instead to dramatically reduce emissions and reach net zero by 2050, the mortality associated with the supermajors' emissions would be reduced to 5.5 million deaths, and thus be cut by more than half, saving millions of lives.²³ Sadly at present the world is considerably off track when it comes to meeting even the climate goals we have in place now.²⁴

Asking who is responsible for these deaths is a difficult, and relatively novel question. The ethical and legal systems that we use to determine responsibility were established long before the climate crisis. There are many actors involved in burning fossil fuels. Can we really apportion responsibility for the impact those fossil fuels have?

When a company spills lethal chemicals into a river, and harms people, we hold it legally responsible. The American chemical company DuPont has paid out hundreds of millions of dollars for polluting drinking water with chemicals.²⁵ Will this responsibility extend to carbon emissions, which we can increasingly link to the deaths of millions of people? Certainly, it's an argument the supermajors and their legal teams will be extremely concerned about.

In response, the supermajors will argue that they themselves do not burn much of the fuel they produce, and that societies and individuals, not companies, are responsible. They will rightly argue

that governments have a role to play in mitigating the impacts of extreme heat. And they will say that even if you accept the science which links emissions and deaths, you also need to weigh up the alternative, a world without fossil fuels.

It's certainly true that the line of responsibility between carbon emissions and deaths from extreme heat is not as simple and direct as that of a chemical spill into a river.

But oil and gas companies are solely responsible for digging up these fossil fuels, and they're doing it eyes wide open in the face of a mountain of evidence documenting the suffering and death that fossil fuels cause,²⁶ while failing to make even the most basic investments in green energy.²⁷ Drug dealers will claim that they aren't to blame for drug addictions, and arms dealers will claim that they don't kill people - that they're simply supplying people with products they want. Fossil fuel firms saying they're not responsible for the emissions from their products is a similar line of argument.

What's more, fossil fuel companies' systematic spreading of climate change denial,²⁸ combined with lobbying, has slowed the transformation towards an energy system built on renewables.²⁹ And yet, the supermajors are asking us to trust them, to allow them to be the ultimate arbiter, despite the massive profits they're making.³⁰

Behind these figures are people. In May 2022's record breaking temperatures, 72-year-old [Gwendolyn E. Osborne](#), died at home in her Chicago apartment. In summer 2023, a [13-year-old girl](#) died from heat stroke in Japan while cycling home after a school club. These are just a few stories from the massive and growing wave of heat-caused deaths around the world.³¹ **Unless the supermajors change course quickly, the death toll will be comparable to some of history's most brutal wars.**

Every 0.1 degree of warming can be lethal.³² Governments should step in, mitigate the impact of extreme heat, and urgently ramp up the transition away from fossil fuels.

All companies were approached for comment. TotalEnergies said that it does not agree with Global Witness' inclusion in this analysis of Scope 3 emissions, namely the emissions arising from burning the oil and gas it produces. It said that it believes this represents a "fundamental bias" when apportioning responsibility for those emissions, including as relates to the role of public authorities, other companies and customers. TotalEnergies said that an approach which only takes into account scope 3 emissions (emissions arising from using their products), rather than scope 1 emissions (the direct emissions from the company's facilities), "would make all companies in the world collectively responsible for several thousands of times the greenhouse gases actually emitted".

TotalEnergies also said that it does not acknowledge the "mortality cost of carbon" methodology used in this analysis. The company added that it had set ambitious near-term emission reduction objectives for 2025 and 2030, on the path to its 2050 Net Zero ambition, "together with society."

BP noted the company's aim to become an integrated energy company, as part of which it has set an oil and gas production level for 2030, but not beyond. It said that it did "not know how Rystad Energy has generated its predictions out to 2050". Therefore, it said it does not recognise the validity of the

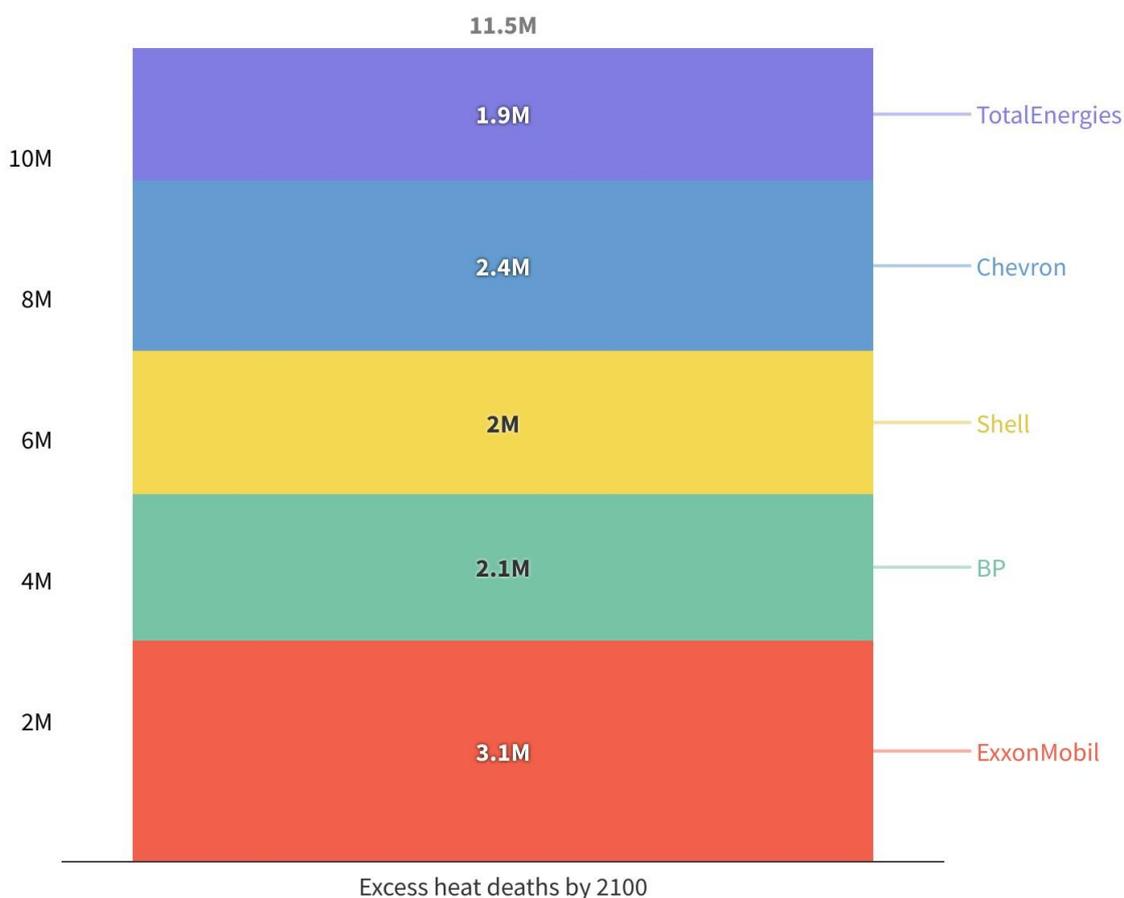
estimates of production until 2050, or of calculations or conclusions based on these. The company also referred to its net zero ambition.

Shell did not provide a comment, but noted that it does not recognise the conclusions of this analysis.

Chevron and ExxonMobil did not provide a comment.

Fossil fuel supermajors' emissions estimated to kill 11.5 million people by 2100

Cumulative global death toll by the end of the century associated with the emissions from burning the forecast oil and gas produced by BP, Chevron, ExxonMobil, Shell and TotalEnergies until 2050 in a high emissions scenario.



Source: Global Witness analysis of Rystad Energy data of forecast oil and gas production and the Mortality Cost of Carbon in the baseline emissions scenario published in the journal Nature Communications.

NOTES ON OUR METHODOLOGY

- The data on forecast oil and gas production was sourced from energy business intelligence agency Rystad Energy's UCube database. UCube is an integrated field-by-field database of the global upstream oil and gas market, covering the time span from 1900 to 2100. Rystad's data is widely referenced by major oil and gas companies, the media and international bodies such as the IEA. More information is available upon request.
- The [mortality cost of carbon](#) in the baseline emissions scenario, developed by [Daniel Bressler](#), predicts 0.000226 deaths between 2020-2100 per metric tonne of CO2 emitted in 2020. That means that adding 1 million metric tons of carbon dioxide in 2020 will cause an additional 226 excess temperature-related deaths over the next 80 years. [Baseline emissions scenarios](#) typically examine what would happen in the absence of further intervention beyond the climate policies already in place. The model's baseline emissions scenario is a high emissions scenario, which results in 4.1C warming by 2100 compared to preindustrial temperatures.³³ A lower emissions scenario, based on the assumption that the world reaches net zero in 2050, results in a mortality cost of carbon of 0.000107 deaths between 2020-2100, per metric tonne of carbon emitted in 2020.³⁴
- Calculations: The model estimates 0.000226 deaths per metric ton of CO2 emissions in 2020. The 5 majors' combined emissions until 2050 amount to 51 billion tonnes of CO2. Therefore, 51,079,759,000 multiplied by 0.000226 is 11,544,025 deaths.
- The model used to calculate the mortality cost of carbon is published in a peer reviewed journal, [Nature Communications](#). It is one of the measures used to calculate the "social cost of carbon", which assesses the monetary cost of the damages to society of one additional metric tonne of CO2 emissions.³⁵ The social cost of carbon is a widely used measure, including by the United States Environmental Protection Agency.³⁶ The methodology has also been used by organisations such as [Oxfam](#)³⁷ to calculate heat related excess deaths associated with the top 1% richest people's emissions.
- These excess heat death estimates are likely to be underestimates for the baseline emissions scenario, as they are based on the effect of additional emissions had they all occurred in 2020. The more the temperature rises past the 1.5C goal, the more heat related deaths are predicted to occur - very few excess deaths are predicted when global average temperatures are below 2C, but they [drastically increase above 2C](#).
- The five companies (Shell, BP, TotalEnergies, ExxonMobil and Chevron) were selected because they are the five largest integrated private sector oil and gas companies based on revenue as of 2023, according to Thompson Reuters data via [Statista](#).
- Forecast production data for all 5 companies were obtained from Rystad Energy on the 17th January 2024 and converted to CO2 emissions using the [European Investment Bank's Carbon Footprint Methodologies](#).

Endnotes

¹ Based on Global Witness analysis of the Mortality Cost of Carbon and Rystad Energy data (see methodology for both) on the five named companies' forecast oil and gas production between 2024-2050. Production was converted to carbon emissions using the European Investment Bank's Carbon Footprint Methodologies.

² <https://www.npr.org/sections/health-shots/2023/07/23/1189506023/heres-what-happens-to-the-body-in-extreme-temperatures-and-how-heat-becomes-dead#:~:text=Of%20all%20extreme,with%20high%20humidity.>

³ <https://www.carbonbrief.org/risk-of-heat-related-deaths-has-increased-rapidly-over-past-20-years/#:~:text=For%20example%2C%20people%20can%20suffer%20from%20direct%20consequences%20of%20heat%2C%20such%20as%20heat%20stroke%20and%20exhaustion.%20Those%20with%20underlying%20health%20conditions%20can%20suffer%20fatal%20complications%20due%20to%20the%20additional%20stress%20on%20their%20bodies.>

And <https://www.npr.org/sections/health-shots/2023/07/23/1189506023/heres-what-happens-to-the-body-in-extreme-temperatures-and-how-heat-becomes-dead#:~:text=Those%20spikes%20in%20the%20heart%20rate%20can%20be%20triggers%20for%20a%20heart%20attack%2C%20he%20says%20C%20especially%20for%20the%20elderly%20and%20those%20with%20underlying%20heart%20conditions.>

⁴ <https://www.scientificamerican.com/article/heat-waves-affect-children-more-severely/>

And <https://renaissance.stonybrookmedicine.edu/system/files/Heat-Related-Illness-in-Children.pdf>

⁵ <https://www.cdc.gov/disasters/extremeheat/specificgroups.html>

And <https://www.nature.com/articles/s41591-023-02419-z#:~:text=The%20resulting%20societal%20awareness%20of,disadvantaged19%2C22%20individuals.>

⁶ <https://www.preventionweb.net/news/risk-heat-related-deaths-has-increased-rapidly-over-past-20-years>

⁷ <https://www.carbonbrief.org/heat-related-deaths-56-higher-among-women-during-record-breaking-2022-european-summer/>

And <https://www.theguardian.com/us-news/2023/aug/01/heat-related-deaths-us-temperatures-heatwave>

And <https://www.worldweatherattribution.org/strong-influence-of-climate-change-in-uncharacteristic-early-spring-heat-in-south-america/>

⁸ <https://www.carbonbrief.org/heat-related-deaths-56-higher-among-women-during-record-breaking-2022-european-summer/>

⁹ <https://www.preventionweb.net/news/mortality-caused-heatwaves-china-has-increased-1979>

And <https://www.theguardian.com/us-news/2023/aug/01/heat-related-deaths-us-temperatures-heatwave>

And <https://www.worldweatherattribution.org/strong-influence-of-climate-change-in-uncharacteristic-early-spring-heat-in-south-america/>

¹⁰ <https://www.nature.com/articles/s41467-023-37554-1>

And <https://www.scientificamerican.com/article/these-are-the-places-at-greatest-risk-from-extreme-heat/>

¹¹ <https://www.un.org/en/climatechange/science/causes-effects-climate-change#:~:text=Fossil%20fuels%20%E2%80%93%20coal,life%20on%20Earth.>

And <https://www.carbonbrief.org/mapped-how-climate-change-affects-extreme-weather-around-the-world/#:~:text=Of%20the%20152%20extreme%20heat%20events%20that%20have%20been%20assessed%20by%20scientists%2C%2093%25%20found%20that%20climate%20change%20made%20the%20event%20or%20trend%20more%20likely%20or%20more%20severe.>

¹² "Across all study countries, we find that 37.0% (range 20.5–76.3%) of warm-season heat-related deaths can be attributed to anthropogenic climate change and that increased mortality is evident on every continent." <https://www.nature.com/articles/s41558-021-01058-x>

¹³ "Many deaths due to high temperature may be under-reported... Because authorities do not attribute most deaths directly to heat, statisticians use the excess formula to give an estimate, looking at how many more people died in a given period than would be expected compared with a historical baseline." <https://www.reuters.com/business/cop/europes-heatwave-may-have-caused-more-than-20000-excess-deaths-2022-11-24/#:~:text=Because%20authorities%20do%20not%20attribute%20most%20deaths%20directly%20to%20heat%2C%20statisticians%20use%20the%20excess%20formula%20to%20give%20an%20estimate%2C%20looking%20at%20how%20many%20more%20people%20died%20in%20a%20given%20period%20than%20would%20be%20expected%20compared%20with%20a%20historical%20baseline.>

¹⁴ <https://www.carbonbrief.org/analysis-which-countries-are-historically-responsible-for-climate-change/>

¹⁵ <https://www.oxfam.org/en/press-releases/richest-1-emit-much-planet-heating-pollution-two-thirds-humanity>

¹⁶ <https://www.nature.com/articles/s41467-021-24487-w#:~:text=Baseline%20scenario%20is,twenty%20first%20century>

¹⁷ Based on Global Witness analysis of Rystad Energy data (see methodology) on the five named companies' forecast oil and gas production between 2024-2030.

And <https://www.globalwitness.org/en/campaigns/fossil-gas/five-western-oil-and-gas-majors-to-blow-nearly-an-eighth-of-the-worlds-remaining-carbon-budget/>

And <https://www.globalwitness.org/en/campaigns/fossil-gas/bp-and-shell-set-spend-15-million-every-hour-until-2030-producing-oil-and-gas/#:~:text=2nd%20October%202023%2C%20London%20%E2%80%93%20Just,Energy%20data%20by%20Global%20Witness.>

¹⁸ <https://carbontracker.org/how-many-new-emissions-did-oil-and-gas-exploration-add-last-year-nobody-knows/#:~:text=Fast%20forward%20to%20today%2C%20with%20the%20war%20in%20Ukraine%20pushing%20a%20price%20spike%2C%20>

[and%20ExxonMobil%20and%20Chevron%20have%20just%20spent%20more%20than%20%24100%20billion%20between%20them%20to%20acquire%20oil%20and%20gas%20assets%20to%20expand%20production.](#)

¹⁹ “We are now targeting a 10-15% reduction by 2025 compared to the 2019 baseline (previously a 20% reduction) and aiming for 20-30% reduction by 2030 (previously a 35-40% reduction). Reduction in the average carbon intensity of our sold energy products against the 2019 baseline.”

<https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/investors/bp-net-zero-progress-update-2023.pdf>

And <https://www.globalwitness.org/en/press-releases/shell-to-announce-climate-wrecking-u-turn-that-would-see-carbon-emissions-equivalent-to-denmark-sent-into-the-atmosphere/>

²⁰ Based on Global Witness analysis of Rystad Energy data (see methodology) on TotalEnergies’ forecast oil and gas production between 2024-2030.

²¹ Based on Global Witness analysis of Rystad Energy data (see methodology) on the five named companies’ forecast oil and gas production between 2024-2050. Production was converted to carbon emissions using the European Investment Bank’s Carbon Footprint Methodologies.

²² These estimates are based on a high emissions scenario, referred to as “baseline emissions scenario”, which is similar to the Representative Concentration Pathway 7.0 (RCP7.0). “Scenarios without additional efforts to constrain emissions (‘baseline scenarios’) lead to pathways ranging between RCP6.0 and RCP8.5.” https://ar5-syr.ipcc.ch/topic_futurechanges.php

And “Finally, RCP7.0 will represent the medium-to-high end of the range of future emissions and warming, and is a baseline outcome rather than a mitigation target. It will fill an important gap by providing a pathway similar to the SSP2 “middle of the road” baseline, and may provide a compelling alternative or complement to the commonly used RCP8.5 for studies comparing mitigation and “business-as-usual” scenarios.”

<https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change#:~:text=Finally%2C%20RCP7.0%20will,as%20Usual%E2%80%9D%20scenarios.>

And <https://www.nature.com/articles/s41467-021-24487-w#:~:text=scenarios%20that%20results%20in%204.1%E2%80%89%C2%B0C%20warming%20above%20preindustrial%20temperatures%20by%202100>

And [https://www.eea.europa.eu/help/glossary/eea-glossary/baseline-scenario#:~:text=Baseline%20scenarios%20\(also%20known%20as,not%20have%20a%20discernable%20influence](https://www.eea.europa.eu/help/glossary/eea-glossary/baseline-scenario#:~:text=Baseline%20scenarios%20(also%20known%20as,not%20have%20a%20discernable%20influence)

And <https://www.washingtonpost.com/weather/2020/01/30/we-may-avoid-very-worst-climate-scenario-next-worst-is-still-pretty-awful/>

²³ Based on Global Witness analysis of the Mortality Cost of Carbon and Rystad Energy data (see methodology for both) on the five named companies’ forecast oil and gas production between 2024-2050. Production was converted to carbon emissions using the European Investment Bank’s Carbon Footprint Methodologies. These estimates are based on a lower emissions scenario, drawing on the assumption that the world reaches net zero in 2050.

²⁴ <https://news.sky.com/video/un-report-reveals-nations-are-falling-short-on-climate-change-goals-13008127#:~:text=News%20%7C%20Sky%20News,UN%20report%20reveals%20nations%20are%20falling%20short%20on%20climate%20change,by%20almost%20half%20by%202030.>

And <https://www.theguardian.com/environment/2023/dec/07/visualised-how-all-of-g20-is-missing-climate-goals-but-some-nations-are-closer-than-others>

²⁵ <https://www.theguardian.com/environment/2023/aug/03/chemical-companies-pfas-payouts-forever-chemicals>

And [https://www.reuters.com/article/idUSKBN15S18T/#:~:text=\(Reuters\)%20%2D%20DuPont%20and%20Chemours%20Co%20have%20agreed%20to%20pay%20%24671%20million%20in%20cash%20to%20settle%20thousands%20of%20lawsuits%20involving%20a%20leak%20of%20a%20toxic%20chemical%20used%20to%20make%20Teflon%2C%20the%20companies%20said%20on%20Monday.](https://www.reuters.com/article/idUSKBN15S18T/#:~:text=(Reuters)%20%2D%20DuPont%20and%20Chemours%20Co%20have%20agreed%20to%20pay%20%24671%20million%20in%20cash%20to%20settle%20thousands%20of%20lawsuits%20involving%20a%20leak%20of%20a%20toxic%20chemical%20used%20to%20make%20Teflon%2C%20the%20companies%20said%20on%20Monday.)

²⁶ <https://www.nature.com/articles/s41558-021-01058-x>

²⁷ <https://www.channel4.com/news/energy-companies-investing-just-5-of-profits-in-renewables>

²⁸ <https://www.science.org/doi/10.1126/science.abk0063>

And <https://www.theguardian.com/environment/2021/nov/18/the-forgotten-oil-ads-that-told-us-climate-change-was-nothing>

And <https://news.harvard.edu/gazette/story/2021/09/oil-companies-discourage-climate-action-study-says/>

²⁹ <https://influencemap.org/report/Big-Oil-s-Agenda-on-Climate-Change-2022-19585>

And <https://influencemap.org/report/How-Big-Oil-Continues-to-Oppose-the-Paris-Agreement-38212275958aa21196dae3b76220bddc#:~:text=This%20research%20finds%20that%2C%20in,climate%2Drelated%20branding%20and%20lobbying.>

³⁰ <https://www.globalwitness.org/en/campaigns/fossil-gas/crisis-year-2022-brought-134-billion-in-excess-profit-to-the-wests-five-largest-oil-and-gas-companies/>

³¹ <https://www.nature.com/articles/s41558-021-01058-x>

³² <https://edition.cnn.com/2023/05/23/asia/global-warming-billions-dangerous-climate-heat-report-intl-hnk/index.html#:~:text=Every%20fraction%20of%20a%20degree%20will%20make%20a%20difference%2C%20Lenton%20said.%20%E2%80%9CFor%20every%20.1%20degrees%20Celsius%20of%20warming%20above%20present%20levels%2C%20about%20140%20million%20more%20people%20will%20be%20exposed%20to%20dangerous%20heat.%E2%80%9D>

³³ <https://www.nature.com/articles/s41467-021-24487-w#:~:text=We%20find%20that%20in%20the%20DICE%20baseline%20scenario%20that%20results%20in%204.1%E2%80%89%C2%B0C%20warming%20above%20preindustrial%20temperatures%20by%202100%2C%20the%202020%20MCC%20is%202.26%E2%80%89%C3%97%E2%80%8910%E2%88%924%20lives%20per%20metric%20ton%20in%20the%20central%20estimate>

³⁴ “On the optimal emissions path, the 2020 MCC drops by 53% from 2.26×10^{-4} lives per metric ton in the baseline emissions scenario to 1.07×10^{-4} lives per metric ton” [https://www.nature.com/articles/s41467-021-24487-w#:~:text=On%20the%20optimal%20emissions%20path%2C%20the%202020%20SCC%20drops%20by%2039%25%20from%20%24258%20in%20the%20baseline%20emissions%20scenario%20to%20%24158%20per%20metric%20ton%20\(see%20Table%2%A02\)%20and%20the%202020%20MCC%20drops%20by%2053%25%20from%202.26%E2%80%89%C3%97%E2%80%8910%E2%88%924%20lives%20per%20metric%20ton%20in%20the%20baseline%20emissions%20scenario%20to%201.07%E2%80%89%C3%97%E2%80%8910%E2%88%924%20lives%20per%20metric%20ton](https://www.nature.com/articles/s41467-021-24487-w#:~:text=On%20the%20optimal%20emissions%20path%2C%20the%202020%20SCC%20drops%20by%2039%25%20from%20%24258%20in%20the%20baseline%20emissions%20scenario%20to%20%24158%20per%20metric%20ton%20(see%20Table%2%A02)%20and%20the%202020%20MCC%20drops%20by%2053%25%20from%202.26%E2%80%89%C3%97%E2%80%8910%E2%88%924%20lives%20per%20metric%20ton%20in%20the%20baseline%20emissions%20scenario%20to%201.07%E2%80%89%C3%97%E2%80%8910%E2%88%924%20lives%20per%20metric%20ton)

And “A Optimal climate policy in DICE-2016 involves gradual emissions reductions starting in 2050 while optimal climate policy in DICE-EMR involves immediate emissions reductions and full decarbonization by 2050.” <https://www.nature.com/articles/s41467-021-24487-w#:~:text=A%20Optimal%20climate%20policy%20in%20DICE%20D2016%20involves%20gradual%20emissions%20reductions%20starting%20in%202050%20while%20optimal%20climate%20policy%20in%20DICE%20EMR%20involves%20immediate%20emissions%20reductions%20and%20full%20decarbonization%20by%202050.>

³⁵ “The calculations below use a concept called the mortality cost of carbon, which assesses excess deaths due to temperature changes caused by climate change. It is one of the metrics used to calculate the social cost of carbon (SC-CO2).³⁶ The SC-CO2 measures the monetized value of the damages to society caused by an incremental metric ton of CO2 emissions, including also changes in agricultural productivity, damages caused by sea level rise, mortality and decline in human health and labour productivity. The SC-CO2 is widely used, for instance, by the United States Environmental Protection Agency (US EPA) to evaluate the impact of mitigation policies. The concept is used to calculate the cost-benefit analysis required when agencies propose environmental rules.” p. 13 <https://oxfamlibrary.openrepository.com/bitstream/handle/10546/621551/mn-climate-equality-201123-en.pdf?sequence=5>

And [https://www.nature.com/articles/s41467-021-24487-w#:~:text=The%20social%20cost%20of%20carbon%20\(SCC\)%20is,damages%20with%20the%20cost%20of%20reducing%20emissions.](https://www.nature.com/articles/s41467-021-24487-w#:~:text=The%20social%20cost%20of%20carbon%20(SCC)%20is,damages%20with%20the%20cost%20of%20reducing%20emissions.)

³⁶ [https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html#:~:text=EPA%20and%20other,CO2%20reduction\).](https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html#:~:text=EPA%20and%20other,CO2%20reduction).)

And p. 13 <https://oxfamlibrary.openrepository.com/bitstream/handle/10546/621551/mn-climate-equality-201123-en.pdf?sequence=5>

³⁷ see p. 13-14 <https://oxfamlibrary.openrepository.com/bitstream/handle/10546/621551/mn-climate-equality-201123-en.pdf?sequence=5>