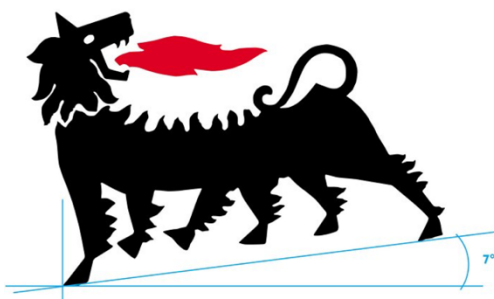
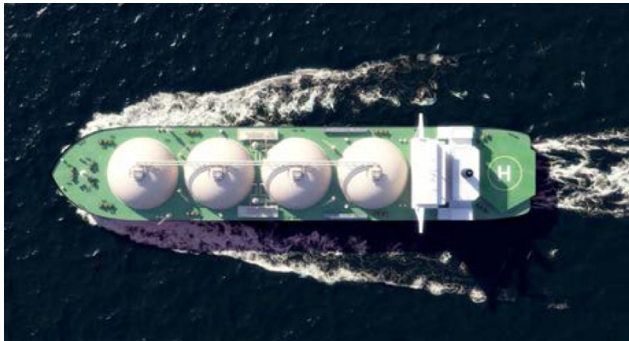


History of Eni emissions 1953-2022 and attributed climate reparations



By Richard Heede
Climate Accountability Institute
30 October 2023



Climate Accountability Institute

Principal Investigator: Richard Heede

heede@climateaccountability.org

Snowmass, CO 81654 USA

970-343-0707 mobile

Copyright © 2023 CAI



NASA image

Report commissioned by Greenpeace Italy and ReCommon APS



Note on units: International SI units are used throughout, except where reporting is in bbl of oil, cubic feet of natural gas, or (short) tons of coal. Emissions of methane are expressed in CH₄ or in CO₂-equivalent terms (CO₂e; AR5: 100-y, 28xCO₂).

Cover: earth edge; Eni LNG carrier (Eni *AnnRpt 2022* p. 72); Eni six-legged design (Noorda); gas flaring; Eni wind-power (AR p. 90).

TABLE OF CONTENTS

1. Introduction	5
2. Carbon Majors: Methodology and process	7
3. Eni's contribution to atmospheric CO ₂ and methane emissions & % of global	9
4. Eni reparations	13
5. Conclusions	15

APPENDIXES

A. Emission Factors	17
B. Eni-reported emissions and oil & gas production	18
C. References	21

FIGURES

Figure 1. Global fossil fuel & cement emissions and Carbon Majors' contribution 1820-2020	5
Figure 2. Eni oil & natural gas production, 1953-2022	7
Figure 3. Eni emissions by source, 1953-2022	11
Figure 4. Eni oil and gas product-use emissions by source, 2014-2022	10
Figure 5. Eni Scope 3 & scope 1 emissions, cumulative 1953-2022 (with detail 2004-2022)	12
Figure 6. Shares of responsibility for reparations, 2025-2050	13
Figure B-1. Eni-reported emissions, scopes 1, 2, & 3, 2018-2022	18
Figure B-2. Eni-reported emission indicators, 2018-2022	19
Figure B-3. Eni-reported emissions, scopes 1, 2, & 3, 2014-2016	19
Figure B-4. Eni-reported oil & gas production, 2020-2022	20

TABLES

Table 1. Eni oil and gas production, and % of global 1953-2022	9
Table 2. Eni emissions associated with oil and gas production, and % global, 1953-2022	9
Table 3. Eni Scope 1 operational and scope 3 emissions, 1953-2022	10
Table 4. Global emissions by source (CO ₂ only), 1953-2022; ENI %	12
Table 5. Leading Oil, Gas, & Coal companies' reparations based on 1988-2022 emissions	14

Intentionally left blank

Introduction

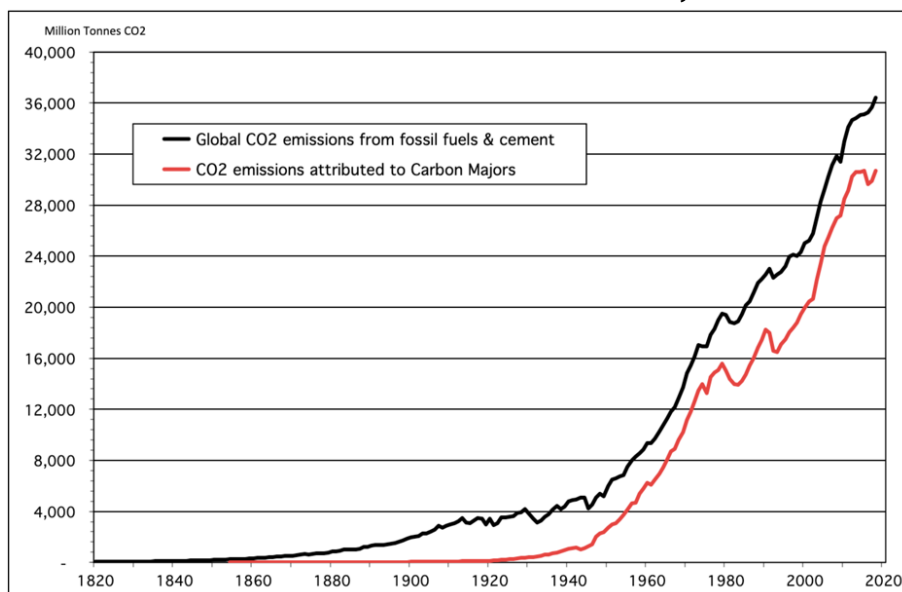
The Climate Accountability Institute has, under my direction, developed the Carbon Majors database since 2002. The extensive database now contains historical production data for 108 entities, chiefly based on company-reported data on annual net equity production of crude oil (including condensate and natural gas liquids, NGLs), natural gas, and coal.

A robust and peer-reviewed methodology is applied to the foundational production data in order to estimate both operational (scope 1) and product-related (scope 3, category 11) emissions of carbon dioxide and methane attributable to individual companies over their corporate history, to the extent such company data is publicly available.

The methodology uses international sources of emission factors per bbl of crude oil and liquids, cubic feet of natural gas, and tonnes of coal. The methodology explicitly deducts portions of produced crude oil and natural gas sequestered into non-energy products such as petrochemical feedstocks (for use in plastics, etc.), lubricants, and road oil, and (for gas) production of nitrogen fertilizers. A full exposition of the Carbon Majors methodology is available in Heede (2019) and Heede (2014a, b). Fossil fuel companies routinely report on scope 1 and scope 2 emissions (direct and indirect operational emissions, respectively).

Here we report on fossil fuel production over Eni's history since its establishment in 1953 to 2022, both for crude oil and natural gas, and emissions attributable to Eni from both operational scope 1 emissions (such as own fuel use, flaring, vented CO₂, and fugitive methane) and, more importantly, from global use of the natural gas & petroleum products made available to global markets based on the net equity production reported by Eni annually since 1953.

Figure 1. Global fossil fuel & cement emissions and Carbon Majors' contribution 1820-2020



CAI data. Global CO₂ emissions from CDIAC and Global Carbon Project.

In all, for the 108 entities for which we have quantified scope 1 plus scope 3 emissions, we have documented 70% of all global emissions from fossil fuel combustion and cement production since that dataset's beginning in 1751.

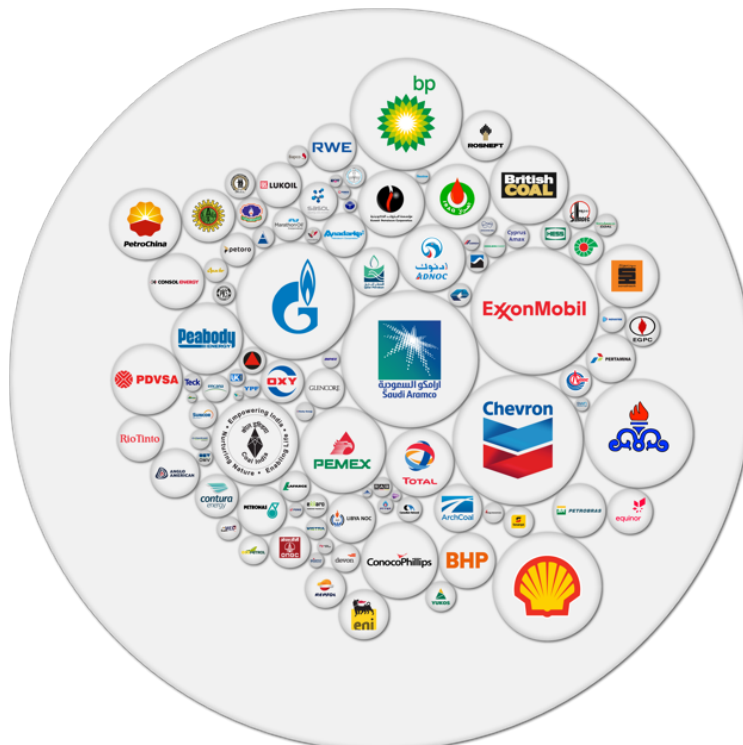
In this report we estimate the emissions attributable to Eni's self-reported net equity production of crude oil and natural as liquids (NGLs) and natural gas. Eni has not, to my knowledge, had assets or equity investment in production of coal.

We rely primarily on Eni's production as reported in various *Annual Reports* and *Factbooks*, and only use external sources (such as *Oil & Gas Journal's Oil&Gas100* [non-US companies]) if we do not have access to Eni-reported production.

Eni is encouraged to update or correct oil and gas production data for any year from 1953 to 2022. Also, if the company has measured data or engineering estimates of emissions from flaring, venting, own fuel use, or vented and fugitive methane from 1953 onwards, do contact us.

Future updates of the Carbon Majors database will be released by InfluenceMap, based in London: www.influencemap.org.

Sincerely,



Real World Visuals graphic, for CAI. The sizes of buttons are proportional to their emissions 1751-2018.

Carbon Majors: Methodology and process

CAI has developed the Carbon Majors database since 2002, and it now contains historical production data for 108 entities, chiefly based on company-reported data on annual net equity production of crude oil (including condensate and natural gas liquids, NGLs), natural gas, and coal, as well as process emissions from leading cement producers.

We collected ENI Annual Reports and ENI FactBooks covering 1953 to 2022 and using *Oil & Gas Journal* OGJ100 oil and gas production for missing years (e.g., 1987-1994). We convert

Figure 2. ENI oil & natural gas production, 1953-2022

Oil & natural gas extraction data													
Richard Heede Climate Mitigation Services File started: 11 January 2005 Last modified: September 2023													
Copyright Climate Accountability Institute													
ENI (Ente Nazionale Idrocarburi), Italy													
www.eni.com, www.eni.it Roma													
Production / Extraction data													
Year	Crude Oil & NGL			Natural Gas			OGJ data						
	Net production Thousand bbl / d	Net production Million bbl / yr	Net production Million tonnes / yr	Net production Million cfr/d	Net production Million SCM / yr	Net production Billion cfr / yr	Gross production Million tonnes / yr	Gross production Million tonnes / yr					
	ENI	AGIP, ENI	ENI	AGIP, ENI	ENI								
1950		0.04	0.01			306		10.8					
1951		0.12	0.02			724		25.6					
1952	Conversion from tonnes to bbl	0.63	0.09			1,171		41.4					
1953	shows inconsistency	0.96	0.13			2,006		70.8					
1954		0.91	0.12			2,700		95.3					
1955		0.84	0.12			3,343		118.1					
1956		0.99	0.14			4,159		146.9					
1957		1.58	0.22			4,685		165.4					
1958		2.51	0.34			4,863		170.3					
1959		2.65	0.36			5,759		203.4					
1960		4.90	0.67			6,168		217.8					
1961		4.07	0.56			6,668		235.5					
1962		34.1	0.51			6,932		244.8					
1963		46.4	0.71			7,071		249.7					
1964		64.7						265.3					
1965		60.6						269.7					
1966		60.1						304.8					
1967		50.1						321.0					
1968		51.1						342.9					
1969		59.5						388.3					
1970		68.0						427.5					
1971		86.0						437.8					
1972		105.7						485.1					
1973		136.7						517.7					
1974		108.3						515.2					
1975		105.1						496.8					
1976		114.6	15.7			14,470		511.0					
1977		112.1	15.4			13,100		462.6					
1978		129.2	17.7			13,750		485.6					
1979		126.3	17.3			13,730		484.9					
1980		121.2	16.6			14,220		502.2					
1981		86.9	11.9			14,550		513.8					
1982	interpolated	89.6	12.3			13,890	490.5	interpolated					
1983		92.4	12.7			13,230	467.2						
1984		104.2	14.3			13,730	484.9						
1985		104.4	14.3			13,750	485.6						
1986		102.9	14.1			14,770	521.6						
1987		126.1					568.5						
1988		139.3					617.9						
1989		157.6					621.5						
1990		175.9					642.7						
1991		178.1					656.8						
1992		189.1					625.1						
1993		195.0					713.4						
1994		210.3					798.6						
1995		223.4					829.4						
1996		614	224.1			2,039	810.3	370.0					
1997		646	235.8			2,036	57.94	762.2					
1998		653	238.3			2,123	60.41	794.1					
1999		674	246.0			2,281	64.92	825.7					
2000		748	273.0			2,271	64.63	828.8					
2001		857	312.8			2,309	65.72	842.8					
2002		921	336.2			2,324	66.14	851.0					
2003		981	358.1			2,508	71.39	881.0					
2004		1,034	377.4			2,687	76.49	921.0					
2005			404.0					1,447.0					
2006		1,079	393.8			3,864	98.10	1,446.9					
2007		1,020	372.3			4,114	98.96	1,501.6					
2008		1,026	374.5			4,424	104.23	1,614.8					
2009		1,007	367.6			4,374		1,596.5					
2010		997	363.9			4,540		1,657.1					
2011		845	308.4			3,763		1,373.5					
2012		882	321.9			4,118		1,503.1					
2013		833	304.0			3,868		1,411.8					
2014			302.0					1,541.0					
2015			331.0					1,709.0					
2016		678	320.5			4,329		1,580.1					
2017		852	311.0			4,734		1,727.9					
2018		887	323.8			5,261		1,920.2					
2019		893	325.9			5,287		1,929.8					
2020		843	307.7			4,729		1,726.1					
2021		813	296.7			4,613		1,683.7					
2022		751	274.1			4,523		1,650.9					
Total	na	12,439	166	na		56,358	summed 1953-2022						

CAI worksheet on Eni oil & gas production (summarized for each year in green columns).

all reported data to million bbl (Mb) per year and billion cubic feet (Bcf) per year. Over the company's history since 1953 it has produced 12.4 billion bbl (Gb) and 56.4 trillion cubic feet (Tcf) of natural gas. We carefully document sources of production data in cell notes.

Production data is linked to a separate excel worksheet that applies emission factors per bbl of crude oil and NGLs and per thousand cubic feet of natural gas. This worksheet calculates emissions per company and per year for each fuel, using well-documented emission factors.

The calculation of emissions associated with Eni's production of oil and gas deducts for net non-energy uses of crude oil for petrochemicals and other non-energy uses of oil, such as lubricants, specialty products (e.g., naphtha for solvents, soaps, and cleaning products), which in aggregate deducts ~8% of production crude oil and NGL production.¹

Emissions from common fossil fuel industry sources — such as use of the company's own fuel (for power and heat in refineries, for example, or diesel for vehicles and equipment), carbon dioxide from flaring associated gas, and venting of CO₂ from gas processing facilities — are also estimated for each company, including Eni. See discussion in the following chapter.

A commissioning process is undertaken in order to assure that the data entry, analysis, and emission calculations are as accurate as possible.

Uncertainties

It is difficult to estimate uncertainty ranges for a particular company, given the long time-frame and the number of variables and data sources. Oil and gas companies, in general, vary in the quantities of crude oil and NGLs diverted to non-energy uses over time, and company -reporting of such "other and specialty" refining applications are not transparent, least of all historically. We have made a best-effort at quantifying various sources of emissions attributable to Eni over its history, and have throughout the methodology and process of estimating emissions applied conservative values.

Our aim is to provide as accurate an estimation of attributable emissions as reasonably achievable from the partial data publicly available. It is in Eni's interest to help improve both the data and the emission estimates in order to reduce uncertainties and provide the most accurate results. We are confident that our results are reasonably accurate, are roughly within +/-10% overall, and that improving accuracy and completeness is a shared objective.

¹ CAI does not have access to any of the Carbon Major oil and gas producers' historical fraction of crude oil diverted and sequestered into non-energy uses. We analyzed US EPA data on non-energy uses, netted back combustion of non-energy uses such as waste-to-energy, cement kiln, or industrial combustion of plastics or used oil. See Heede 2014a and Heede 2019 detailed discussion of the Carbon Majors methodology. Eni may have higher or lower net non-energy factor, and it has likely increased over time. Nonetheless, lacking detailed reporting of non-combustion uses of Eni's crude oil processing, we apply the 8% deduction equally for each year.

Eni's contribution to atmospheric CO₂ and methane emissions

CAI has documented fossil fuel production reported by Eni since its establishment in 1953, chiefly from company *Annual Reports*. The company produced 274 million bbl (Mb) of crude oil & natural gas liquids (NGLs) in 2022, and cumulatively produced 12,439 Mb since 1953. Eni produced 1,651 billion cubic feet (Bcf) of “natural gas available for sale” in 2022, and cumulatively produced 56,358 Bcf since 1953.

Table 1. Eni oil and gas production, and % of global 1953-2022

	Crude Oil & NGLs Mb	Natural Gas Bcf
Eni 1953-2022	12,439	56,358
Eni 1960-2022	12,429	54,440
Eni production 2022	274	1,651
Global (1960-2022)	1,506,669	4,543,573
Eni of global 1960-2022	0.825%	1.198%

Global oil production data: IEA 1960-1965; BP Statistics 1965-2022. Global oil emissions (scope 3): Global Carbon Project. Gas production: US Bureau of Mines 1963-1969; BP Statistics 1970-2022. Global oil 1960-2022; Global Gas 1963-2022. We list Eni oil and gas production from 1960 to 2022 as the baseline to calculate Eni's % of global production.

After accounting for typical blend of NGLs, condensate, and crude oil and deducting for net non-energy uses we apply the emission factor of 371.4 kgCO₂/bbl. 12,439 Mb of crude oil times 371.4 kgCO₂/bbl equals 4,620 MtCO₂ (million tonnes CO₂) from 1953 to 2022.

A full description of CAI's Carbon Majors methodology, non-energy uses, and emission factors please refer to Heede (2014a, 2014b, and 2019).

For natural gas we use an emission factor of 53.4 kgCO₂/kcf (thousand cubic feet). 56,538 Bcf of gas production times 53.4 kgCO₂/kcf totals production-based emissions of 3,011 MtCO₂. For both oil and gas, these estimates are for combustion of the petroleum products and natural gas that are used by consumers as intended over Eni's history. Note: Eni refers to these scope 3 emissions as “product-use.”

Eni's 2022 oil production of 274 Mb * 371.4 kgCO₂/bbl = 102 MtCO₂. See Table 3.

Eni's 2022 natural gas production of 1,651 Bcf * 53.4 kgCO₂/kcf = 88 MtCO₂. See Table 3.

Table 2. Eni emissions associated with oil and gas production, and % global, 1953-2022

	Crude Oil & NGLs MtCO₂	Natural Gas MtCO₂	Oil & Gas MtCO₂
Eni	4,620	3,011	7,632
Global 1953-2022	586,599	256,248	842,847
Eni of global oil & gas	0.788%	1.175%	0.906%
Global Fossil fuel and cement, 1953-2022			1,521,016
Eni of global FF & Cmmt			0.502%

CAI calculations. Global emissions from Global Carbon Project / Friedlingstein. product-use only, excludes scope 1.

Table 2 shows global emissions from fossil fuel combustion and cement production by source (oil, gas, coal, flaring, and cement) from 1953 to 2022 totaling 1,521 GtCO₂. Global emissions in 2022 total 37,115 MtCO₂ and 40,586 MtCO_{2e}.² CAI maintains a global emissions database primarily drawing on estimates from the Global Carbon Project.

Our Carbon Majors methodology also quantifies operational (scope 1) emission sources that are common among oil and gas companies, such as flaring of associated gas from oil production fields and platforms, vented CO₂ from gas processing facilities, CO₂ from the use of company fuels in refineries and transportation (including pipelines, trucks, and ships). We also estimate intentionally vented and fugitive methane. In lieu of companies, including Eni, releasing measured data on operational CO₂ and fugitive methane emissions over its history since 1953, the Carbon Majors methodology quantifies these sources using documented default factors.³ We do not claim to have better estimates than those published in Eni’s Sustainability Reports issued since 2015. Our aim, however, is estimate operational emissions since 1953. Oil & gas companies have undoubtedly improved methane capture, leakage prevention, and operational efficiency since the 1950s. We welcome Eni to report its own engineering estimates of all operational scope 1 sources for each year 1953 forward in order to help improve our emissions model for the company.

Table 3 shows estimates for scope 1 emissions for flaring and venting and own fuel use as well as vented and fugitive methane (as CH₄ gas, and converted to CO₂-equivalent at a Global Warming Potential of 28xCO₂, per IPCC *Fifth Assessment Report*) for 2022 and for the period from 1953 to 2022. We also quantify emissions from the company’s petroleum and natural gas sales. Eni’s estimated cumulative emissions 1953-2022 total 9,069 MtCO_{2e} from scope 1 and scope 3, equivalent to 0.541% of global fossil fuel emissions since 1953.

Table 3. Eni Scope 1 operational and scope 3 emissions, 1953-2022

Source	2022 MtCO _{2e}	1953-2022 MtCO _{2e}
Oil CO ₂ emissions scope 3 (product use)	102	4,620
Gas CO ₂ emissions, scope 3 (product use)	88	3,011
Oil plus Gas CO ₂ emissions, scope 3	190	7,632
Scope 1 venting, flaring, & own fuel use	10	355
Total CO ₂	200	7,987
Scope 1 methane, MtCH ₄	1	39
Scope 1 methane, MtCO _{2e}	30	1,082
Scope 1 CO ₂ plus methane CO _{2e}	40	1,437
Total company emissions, Scopes 1+3, MtCO _{2e}	230	9,069
Global energy-related emissions (CO ₂ only)	37,115	1,521,016
Global energy-related emissions (CO _{2e})	40,586	1,675,856
ENI % of global energy-related emissions	0.567%	0.541%

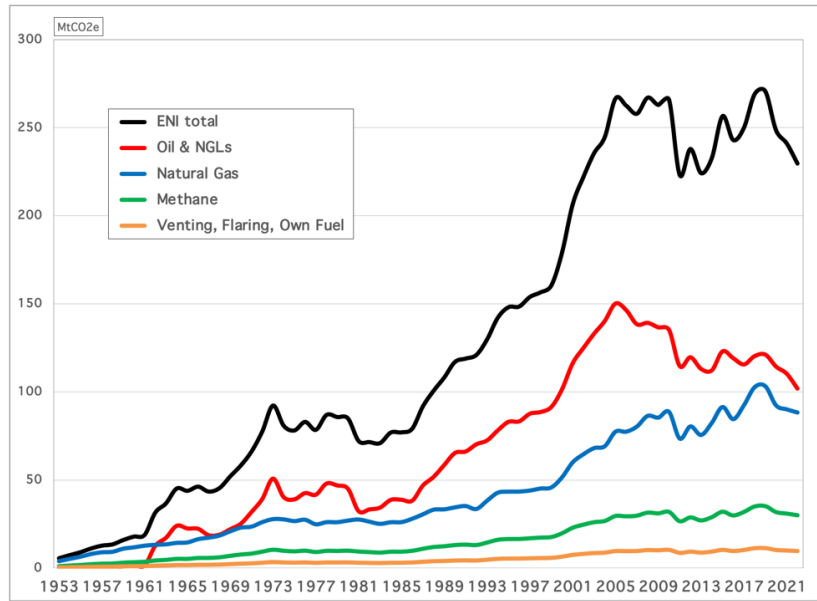
CAI calculations. Global emissions from Global Carbon Project / Friedlingstein et al.

Eni’s oil and gas production and the associated emissions increased dramatically in the economic expansion following World War 2, slowed in the 1970s, grew steadily until the late 2000s, and stagnant to declining to the present; see Figure 3. Eni, along with many international energy companies, is shifting its oil/gas production mix toward natural gas.

² Data from Global Carbon Project; see Friedlingstein et al.

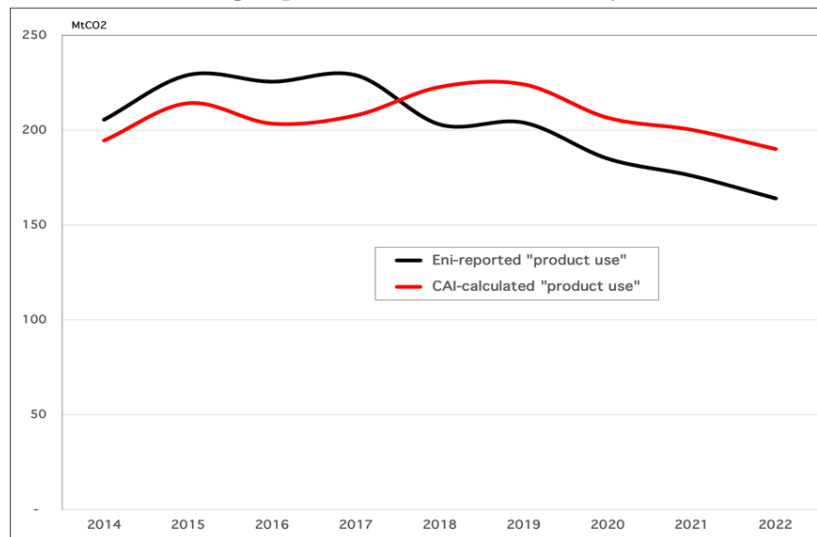
³ See Heede (2014a) and Heede (2014b) for in-depth discussion of the methodology, including default factors and sources, typically IPCC publications.

Figure 3. Eni emissions by source, 1953-2022



Eni’s own reporting of emissions from direct operational sources (scope 1) and indirect operational sources (scope 2) and use of its petroleum and natural gas products (scope 3) have been reported since ~2014.⁴ We compare our product-related emission estimates for Eni for 2014 to 2022 with Eni’s estimates for the same years in Figure 4. Both combine end-use emissions of both petroleum products and “natural gas available for sale” for distribution to global markets and used as intended for heat and power. The estimates exclude use of crude oil and NGLs for non-energy uses such as petrochemical feedstocks, lubricants, road oil (asphalt), and similar uses. The ~10% variance between the Eni and CAI estimates is reasonable and in close agreement; see Figure 4. Eni does not, to my knowledge, publish the details of its calculations. In any case, only CAI has provided both scope 3 and scope 1 emission estimates from 1953 to 2022. See Figures 3, 4, and 5.

Figure 4. Eni oil and gas product-use emissions by source, 2014-2022



⁴ We downloaded several Eni Sustainable Performance Reports, the earliest we found was for 2009. The earliest reporting of scope 3, category 11 emissions from “product use” was in the 2016 report for 2014-2016. See Appendix B.

Eni has produced a video of its expanding boundary definition and inclusion of emission sources.⁵ This is a welcome change in climate accounting and responsibility, but does not alter the results presented here.

Figure 5. Eni Scope 3 & scope 1 emissions, cumulative 1953-2022 (with detail 2004-2022)

	FE	FF	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY	FZ	GA	GB																		
Entity emissions from combustion, venting, flaring, and fugitive methane																																										
Richard Heede Climate Accountability Institute [16-Oct-23]																																										
Eni SpA, Italy																																										
2000s						2010s						2020s						Cumulative																								
2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	MtCO2e		Entity emissions																					
(except where noted) (V = verified)																						Sums 1953-2022			Entity CO2 emissions																	
140	150	146	138	139	137	135	115	120	113	112	123	119	116	120	121	114	110	102	4,620	Oil & NGLs																						
69	77	77	80	86	85	89	73	80	75	82	91	84	92	103	103	92	90	88	3,011	Natural Gas																						
209	227	224	219	225	222	224	188	200	188	195	214	203	208	223	224	207	200	190	7,632	Coal																						
1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																			
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2																			
4	4	4	5	5	5	4	5	4	5	4	5	5	5	6	6	5	5	5	5	5	5	5	5																			
2	2	2	2	2	2	3	2	2	2	2	3	2	3	3	3	3	3	3	3	3	3	3	3																			
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																			
9	10	10	10	10	10	10	9	9	9	9	10	10	10	11	11	10	10	10	10	10	10	10	10																			
																						-		Cement																		
218	237	233	228	236	232	234	197	209	197	204	225	213	218	234	236	217	210	200	7,987	Total CO2 emissions																						
																						38		42		40		42		46		46		42		41		40		(for UKS carbon intensity project, Jan17)		
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																			
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																			
1.0	1.1	1.0	1.1	1.1	1.1	1.1	0.9	1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.3	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1																			
																						9		Entity methane emissions																		
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																			
1.0	1.1	1.0	1.1	1.1	1.1	1.1	0.9	1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.3	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1																			
8	8	8	7	7	7	7	6	6	6	6	7	6	6	6	7	6	6	5	249	Methane: Oil & NGLs																						
19	21	21	22	24	24	24	20	22	21	23	25	23	26	28	29	26	25	24	833	Methane: Natural Gas																						
27	29	29	30	31	31	32	26	29	27	29	32	30	32	35	35	32	31	30	1,082	Methane: Coal																						
245	267	263	258	267	263	266	223	238	224	233	257	243	250	269	271	249	241	230	9,069	Total attributed emissions																						
																						9,069		vertical check																		
28,407	29,374	30,342	31,249	31,828	31,322	33,120	34,214	34,732	35,027	35,275	35,258	35,226	35,796	36,526	36,778	34,970	36,830	37,115	1,521,016	Global Carbon Project CO2 emissions																						
7,753	8,017	8,281	8,528	8,686	8,548	9,039	9,337	9,479	9,559	9,627	9,622	9,614	9,769	9,968	10,037	9,544	10,051	10,129	415,103	Oil, Natural Gas, Coal, Flaring, & Cement																						
0.77%	0.81%	0.77%	0.73%	0.74%	0.74%	0.71%	0.57%	0.60%	0.56%	0.58%	0.64%	0.61%	0.61%	0.64%	0.64%	0.62%	0.57%	0.54%	0.525%	Entity percent of total CO2 emissions																						
																						5,530		CDIAC/EDGAR methane																		
98.3	101.7	104.5	104.9	107.3	105.5	109.6	115.3	117.2	116.3	117.1	116.3	115.4	117.4	121.0	123.8	124.1	124.0	124.0	1,437	2022 assumed equal to 2021																						
0.97%	1.03%	1.00%	1.01%	1.04%	1.05%	1.04%	0.82%	0.87%	0.83%	0.88%	0.98%	0.92%	0.97%	1.03%	1.01%	0.91%	0.89%	0.86%	0.699%	Entity percent of total CH4 emissions																						

CAI data. Under “Entity emissions” at right, we list CO₂ emissions, first by Oil & NGLs and Natural gas and Coal (na), then scope 1 operational sources of CO₂ (venting, flaring, own fuel use) and scope 1 sources of vented and fugitive methane.

Eni’s cumulative emissions since 1953 total 9,069 MtCO₂e. Also see Table 4.

Table 4. Global emissions by source (CO₂ only), 1953-2022; Eni %

Global CO ₂ emissions from Oil:	586,599 MtCO ₂
Global CO ₂ emissions from Gas:	256,248 MtCO ₂
Global CO ₂ emissions from Coal:	613,924 MtCO ₂
Global CO ₂ emissions from Flaring:	18,632 MtCO ₂
Global CO ₂ emissions from Cement:	45,613 MtCO ₂
Global CO ₂ emissions energy & Cement:	1,521,016 MtCO ₂
Eni Oil + Gas CO ₂ emissions 1953-2022 scope 3	7,632 MtCO ₂
Eni % of global Fossil Fuel & Cement CO ₂	0.502%
Eni Oil + Gas CO ₂ emissions 1953-2022 scope 1+3	7,987 MtCO ₂
Eni % of global Fossil Fuel & Cement CO ₂	0.525%
Eni Scope 1 operational emissions 1953-2022	1,437 MtCO ₂ e
Eni Scope 1 plus Scope 3 emissions 1953-2022	9,069 MtCO ₂ e
Global energy-related emissions 1953-2022	1,675,856 MtCO ₂ e
Eni % of global energy-related emissions 1953-2022	0.541%
Global energy-related emissions 1751-2022	1,957,152 MtCO ₂ e
Eni % of global energy-related emissions 1751-2022	0.463%

CAI calculations.

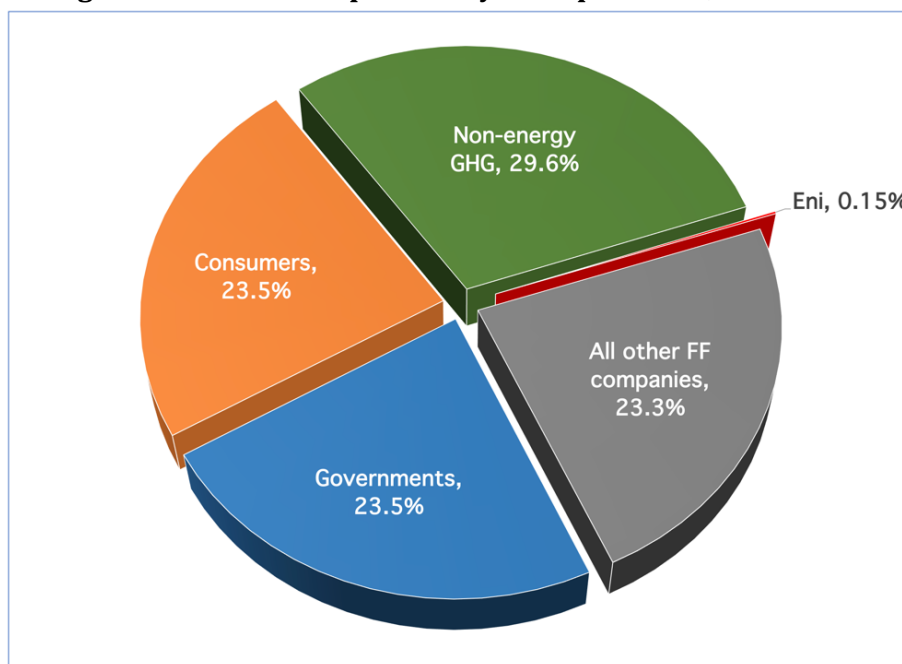
⁵ Methodology for the assessment of GHG emissions; <https://www.eni.com/en-IT/video/video-baldarelli-focus-methodology.html>

Eni reparations

Climate Accountability Institute, in collaboration with Marco Grasso of University of Milan (Bicocca), proposed a rationale for and quantification of climate reparations to fossil fuel companies on the basis of each company's contribution to atmospheric carbon dioxide and methane from their operational and product-related emissions (Grasso & Heede 2023).

The rationale is based on a moral imperative that contributors to climate damages are obliged to pay reparations for adaptation and mitigation costs in proportion to their share of quantifiable climate damages. The paper assesses the imperative question of "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?" We argue that the burden should not fall unjustly on uncompensated victims of climate damages or on tax payers or on consumers alone: a share of the burden should be borne by the fossil fuel industry that made the climate-changing carbon fuels available to global markets with actionable knowledge (at least since 1988) that their products would cause global harm. Our allocation of reparations is based on each fossil fuel company's contribution to atmospheric change with their product-related and operational emissions since 1988, when, we suggest, the fossil fuel companies clearly knew of the harms of continued production and use of carbon fuels.

Figure 6. Shares of responsibility for reparations, 2025-2050



Future climate damages are largely unknowable, and are (in my view) expanding as climate impacts accelerate. We base our climate-related economic harms on a consensus survey of

climate-knowledgeable economists (Howard & Sylvan 2021), quantify the damage function of a 3°C pathway to 2025-2050, totaling \$99 trillion. In order to allocate damages to the fossil fuel industry overall, we first accounted for anthropogenic emissions relating to non-energy sources (such as emissions from agriculture and animal husbandry, deforestation, landfills, rice fields, halocarbons, nitrous oxide, and so forth), which we estimate at 29.6% of all GHG emissions since 1988. The remaining 70.4% of energy-related carbon dioxide and methane emissions from all fossil fuel and cement production, totaling 1,123 billion tonnes CO₂e (GtCO₂e) over our allocation period from 1988 to 2022. We allocate equal one-third shares of reparations among three primary agents:

1. governments (for their climate actions, or failures to act),
2. consumers (who use the carbon fuels as intended), and
3. fossil fuel companies for their attributed emissions 1988-2022

The fossil fuel share is thus \$99 trillion less 29.6% for non-energy GHG (\$29.3 trillion) divided among the three primary agents (\$69.7 trillion / 3) equals \$23.2 trillion to all fossil fuel producers. The twenty-one Carbon Major companies analyzed in our paper are allocated \$8.3 trillion, based on their attributed emissions of 403 GtCO₂e. Table 5 shows the leading oil and gas companies' atmospheric contributions and allocated reparations.

Eni's estimated emissions from 1988 to 2022 total 7.20 GtCO₂e, and 0.641% of global energy-related emissions and 0.150% of cumulative reparations, totaling reparations of \$149 billion over the 26 years from 2025 to 2022 and averaging \$5.726 billion per year. The company's adjusted net profit rose to \$14.1 billion (€13.3 billion) in 2022.

We note that actual damages are likely higher than we use as our baseline, and which estimates loss of global GDP out to 2050 (we ignore likely rising damages beyond 2050) and we also do not include non-economic but potentially devastating harms such as species extinction, biosphere collapse, human mortality, human rights abuses, and the like.

Crucially, we also allow for reduced reparations payments for companies and that are "eligible to reduce reparations if they achieve aggressive targets to curtail production of carbon fuels faster than required by a net zero by 2050 pathway under a 1.5°C scenario."

Table 5. Leading Oil, Gas, & Coal companies' reparations based on 1988-2022 emissions

Company	Rank	Cumulative emissions 1988-2022 MtCO ₂ e	% of global emissions	Cumulative reparations \$ billion	Average reparations \$ billion/yr
Saudi Aramco	1	53,714	4.78%	\$1,110	\$42.71
ExxonMobil	5	23,119	2.05%	\$478	\$18.38
Shell	6	20,487	1.82%	\$424	\$16.29
BP	8	18,214	1.62%	\$377	\$14.48
Chevron	10	16,090	1.43%	\$333	\$12.79
Peabody Energy	12	13,777	1.23%	\$285	\$10.95
TotalEnergies	15	11,760	1.05%	\$243	\$9.35
ConocoPhillips	19	10,082	0.897%	\$208	\$8.02
Equinor	26	7,355	0.655%	\$152	\$5.85
Eni	27	7,202	0.641%	\$149	\$5.73
Glencore	29	6,286	0.560%	\$130	\$5.00

CAI calculations.

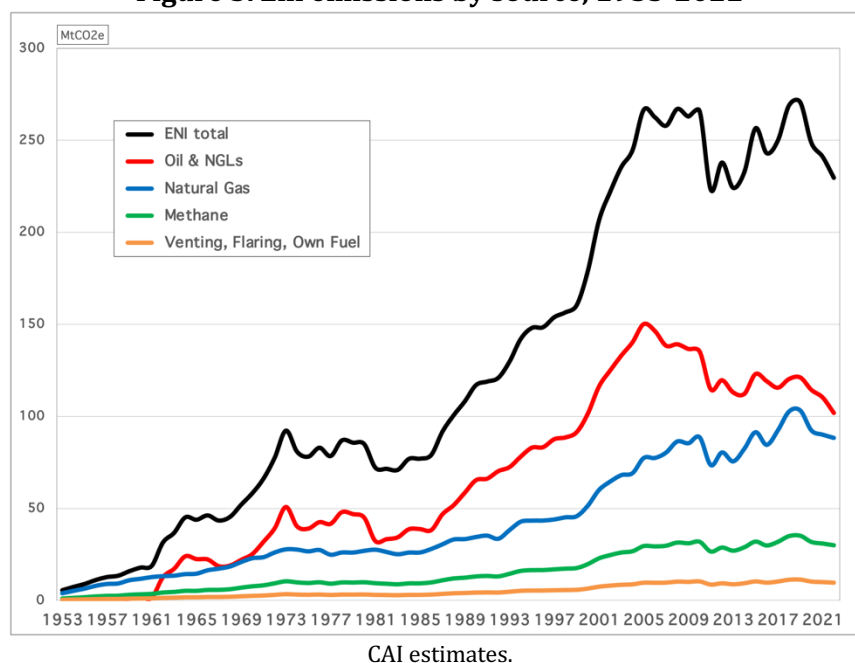
Conclusions

The Italian oil and gas company Eni has since its inception in 1953 to the present (2022) has produced 12.4 Gb (billion bbl) of crude oil and NGLs and 56.4 Tcf (trillion cubic feet) of natural gas, which, cumulatively resulted in 4,620 MtCO₂ from combustion of petroleum products supplied (estimated, on the basis of production less net non-energy crude oil uses). Combustion of “natural gas available for sale” results in emissions of 3,011 MtCO₂. In addition, we estimate scope 1 operational emissions of 1,437 MtCO₂e, for total attributed emissions of 9,069 MtCO₂. Global emissions for the same period of time from 1953 to 2022 total 1,675,856 MtCO₂e; Eni represents 0.541% of global emissions since 1953.

We also attribute a proportion of attributable reparations (as proposed and quantified in Grasso & Heede, 2023) on the moral argument that the entities and companies that have contributed materially to climate change and thus to climate damages should assist in global efforts to address climate harms and, where appropriate, compensate victims of climate damages. This work is based on each fossil fuel company’s contribution of energy-related emissions over the period from 1988 to 2022, of which Eni has contributed 7,202 MtCO₂e, or 0.641% of global emissions. On that basis, after deducting for non-energy Greenhouse Gas emissions and apportioning responsibility equally to three primary climate impact agents — governments, consumers, and fossil fuel companies — Eni is attributed annual reparations of \$5.73 billion per year for 26 years from 2025 to 2050. This is 0.15% of total estimated climate damages attributed to all fossil fuel producers totaling \$99 trillion, of which \$23.2 trillion is allocated to all fossil fuel producers.

Eni’s estimated emissions by source from 1953 to 2022 is shown in Figure 3.

Figure 3. Eni emissions by source, 1953-2022



Eni, in this writer's view, shares responsibility for the climate impacts of its emissions and bears commensurate responsibility to address the harms. Henry Shue (2017) argues that:

"The time has come for the major carbon producers to face the reality of the unsafe products they persist in marketing and the safer world they could help to create. Otherwise, they risk turning themselves into enemies of humanity..."

The present work provides both the quantitative assessment of attributable emissions to Eni and a starting point for estimating the company's proportional reparations.

Appendix A

Emission factors

Table A-1. Combustion emissions factors for Carbon Majors ⁶

Energy source	Carbon tC/unit	Carbon dioxide tCO₂/unit
Crude oil & NGLs	101.4 kgC/bbl	371.4 kgCO ₂ /bbl
Natural gas	14.6 kgC/kcf	53.4 kgCO ₂ /kcf
Lignite	328.4 kgC/tonne	1,203.5 kgCO ₂ /t
Subbituminous	495.2 kgC/t	1,814.4 kgCO ₂ /t
Bituminous	665.6 kgC/t	2,439.0 kgCO ₂ /t
Anthracite	715.6 kgC/t	2,621.9 kgCO ₂ /t
“Metallurgical coal”	727.6 kgC/t	2,665.9 kgCO ₂ /t
“Thermal coal”	581.1 kgC/t	2,129.3 kgCO ₂ /t

Crude oil prior to non-energy deduction & adjustment for NGLs: 115.7 kgC/bbl, 423.8 kgCO₂/bbl;
 Gas prior to non-energy deduction: 14.86 kgC/kcf, or 54.44 kgCO₂/kcf; (kcf = thousand cubic feet).

⁶ Heede, Richard (2014) Tracing anthropogenic CO₂ and methane emissions to fossil fuel and cement producers 1854-2010, *Climatic Change*, vol. 122(1): 229-241; <http://link.springer.com/article/10.1007/s10584-013-0986-y?view=classic>

Appendix B

Eni-reported emissions and oil & gas production

Figure B-1. Eni-reported emissions, scopes 1, 2, & 3, 2018-2022

GHG EMISSIONS

	2018	2019	2020	2021	2022	
Direct GHG emissions (Scope 1)	43.35	41.20	37.76	40.08	39.39	
(million tonnes CO ₂ eq.)						
of which: CO ₂ equivalent from combustion and process	33.89	32.27	29.70	30.58	29.77	
of which: CO ₂ equivalent from flaring ^(a)	6.26	6.49	6.13	7.14	6.71	
of which: CO ₂ equivalent from venting	2.12	1.88	1.64	2.12	2.72	
of which: CO ₂ equivalent from methane fugitive emissions	1.08	0.56	0.29	0.24	0.20	
Direct GHG emissions (Scope 1) by sector:						
Exploration & Production	24.07	22.75	21.10	22.29	21.53	
Global Gas & LNG Portfolio	0.62	0.25	0.36	1.01	2.09	
Refining & Marketing and Chemicals	8.19	7.97	6.65	6.72	6.00	
Plenitude & Power	10.46	10.22	9.63	10.04	9.76	
Corporate and other activities	0.01	0.01	0.01	0.02	0.02	
Direct GHG emissions (Scope 1) by geographical area:						
Italy	19.28	18.69	16.80	17.17	16.39	
Rest of Europe	1.43	1.22	1.13	1.10	0.71	
Africa	19.15	18.45	17.24	19.24	19.57	
Americas	0.68	0.67	0.41	0.37	0.40	
Asia and Oceania	2.81 ^(a)	2.17	2.18	2.20	2.32	
Direct GHG emissions (Scope 1) by gas:						
CO ₂	40.53	39.37	36.12	38.44	37.89	
CH ₄	2.60	1.63	1.40	1.37	1.24	
N ₂ O	0.21	0.20	0.25	0.27	0.27	
Carbon efficiency index (Scope 1+2)	(tonnes CO ₂ eq./kboe)	33.90	31.41	31.64	31.95	32.67
Direct GHG emissions (Scope 1)/100% operated hydrocarbon gross production		21.44	19.58	19.98	20.19	20.64
Direct GHG emissions (Scope 1)/Equivalent electricity produced (EniPower)	(gCO ₂ eq./kWh _{eq})	402	394	391.4	379.6	392.9
Direct GHG emissions (Scope 1)/Refinery throughputs (raw and semi-finished materials)	(tonnes CO ₂ eq./ktonnes)	253	248	248	228	233
Direct methane emissions (Scope 1)	(ktonnes CH ₄)	104.1	65.3	55.9	54.5	49.6
of which: fugitive upstream		38.8	21.9	11.2	9.2	7.2
Methane Intensity (upstream)	(%)	0.16	0.10	0.09	0.09	0.08
Volumes of hydrocarbon sent to flaring	(billion Sm ³)	1.9	1.9	1.8	2.2	2.1
of which: routine flaring (upstream)		1.4	1.2	1.0	1.2	1.1
Production of hydrocarbons in equity	(kboe/day)	1,851	1,87	1,733	1,682	1,610
Gross production hydrocarbons 100% operated	(million boe)	1,067	1,114	1,009	1,041	980
CO ₂ emissions from Eni plants subject to EU ETS ^(b)	(million tonnes CO ₂ eq.)	19.92	19.57	17.32	17.74	16.72
Quotas allocated to Eni plants subject to EU ETS ^(b)		7.24	7.73	6.84	5.32	4.95
Indirect GHG emissions (Scope 2)	0.67	0.69	0.73	0.81	0.79	
(million tonnes CO ₂ eq.)						
Indirect GHG emissions (Scope 3)						
of which: from use of sold products ^(c)	203	204	185	176	164	
of which: from processing of sold products	11.3	11.8	11.6	11.1	9.9	
of which: from electricity (purchased and sold) ^(d)	5.5	6.3	6.0	6.1	1.7	
of which: from purchased goods and services (supply chain)	2.0	2.0	1.3	1.4	1.5	
of which: from transportation and distribution of products	1.8	1.6	1.3	1.4	1.3	
of which: from business travel and employees commuting	0.2	0.2	0.2	0.1	0.1	
of which: from other contributions	0.5	0.5	0.4	0.4	0.4	
Sold production of biofuels	(ktonnes)	219	256	622	585	428

Eni note (c) Category 11 of GHG Protocol Corporate Value Chain (Scope 3) Standard. Based on upstream production, Eni's share, consistently with IPIECA methodologies. Eni (2023) *Eni for 2022: Sustainability Performance*, page 8.

Figure B-2. Eni-reported emission indicators, 2018-2022.

MAIN TARGET INDICATORS^(a)

		2018	2019	2020	2021	2022	Objectives
Net carbon footprint upstream (Scope 1+2)	(million tonnes CO ₂ eq.)	14.8	14.8	11.4	11.0	9.9	UPS Net Zero 2030
Net carbon footprint Eni (Scope 1+2)		37.2	37.6	33.0	33.6	29.9	Eni Net Zero 2035
Net GHG Lifecycle Emissions (Scope 1+2+3)		505	501	439	456	419	Net Zero 2050
Carbon credits		0	0	1.5	2	3	<25 2050
Net Carbon Intensity (Scope 1+2+3)	(gCO ₂ eq./MJ)	68	68	68	67	66	Net Zero 2050
Renewable installed capacity ^(b)	(MW)	40	190	351	1,188	2,256	15 GW 2030
Capacity of biorefineries	(million tonnes/y)	0.36	1.1	1.1	1.1	1.1	>5 million tonnes/y 2023

(a) KPIs accounted for on an equity basis.

(b) KPI represents Eni's share and relates primarily to Plenitude. 2020 and 2019 values have been appropriately restated.

Figure B-3. Eni-reported emissions, scopes 1, 2, & 3, 2014-2016

		2014	2015	2016
Direct GHG emissions ^(a)	(million tonnes CO ₂ eq)	42.02	41.56	40.10
- of which CO ₂ equivalent from combustion and process		30.92	31.49	30.61
- of which CO ₂ equivalent from flaring		5.73	5.51	5.40
- of which CO ₂ equivalents from non-combusted methane and fugitive emissions		3.48	2.77	2.43
- of which CO ₂ equivalents from venting		1.89	1.80	1.67
Total direct GHG emissions by sector:	(million tonnes CO ₂ eq)			
- E&P		23.4	22.8	20.4
- R&M and Chemicals		8.45	8.19	8.50
- G&P		10.12	10.57	11.22
GHG emissions/100% operated hydrocarbon gross production (E&P)	(tonnes CO ₂ eq/toe)	0.201	0.182	0.166
GHG emissions/kWheq (EniPower)	(gCO ₂ eq/kWheq)	409	409	398
GHG emissions/crude oil processing and semi-processed oil (R&M) ^(c)	(tonnes CO ₂ eq/kt)	287	237	272
Non-combusted methane and fugitive emissions (E&P)	(tonnes CH ₄)	124,553	99,013	84,785
Volumes of hydrocarbon sent to flaring	(MSm ³)	1,767	1,989	1,950
Volumes of hydrocarbon sent to process flaring		1,678	1,564	1,530
Volumes of hydrocarbon vented		15.47	10.81	11.52
CO ₂ emissions from Eni plants subject to EU ETS	(million tonnes CO ₂)	19.16	19.68	20.27
Quotas allocated to Eni plants subject to EU ETS		8.80	6.83	7.06
Eni plants subject to EU ETS	(number)	43	41	41
Indirect GHG emissions from purchases from other companies (Scope 2) ^(a)	(tonnes CO ₂ eq)	687,554	616,267	710,558
Indirect GHG emissions other than those due to purchases from other companies (Scope 3) ^{(a)(b)}		221,439,934	247,764,279	246,139,041
- of which use of sold products ^(b-i)		205,571,088	229,135,805	225,619,708
- of which processing of sold products ^(b-ii)		8,718,185	10,189,811	10,614,787
- of which electricity purchased and sold ^(b-iii)		5,381,573	5,442,945	5,857,207
- of which purchased goods and services (supply chain) ^(b-iii)		197,384	1,421,428	1,943,711
- of which transportation and distribution of products ^(b-iv)		1,049,981	1,171,214	1,440,998
- of which business travel and employees commuting ^(b-v)		115,613	99,054	400,946
- of which other contribution ^(b-vi)		406,111	304,022	261,685
Capacity of biorefinery	(ktonnes/year)	360	360	360
Production of biofuels	(ktonnes)	105	179	191

(a) The GHG includes emissions of CO₂, CH₄ and N₂O; the Global Warming Potential used is 25 for CH₄ and 298 for N₂O.

(b) The data includes indirect emissions of GHG associated with (i) use and processing of sold products (oil and natural gas), (ii) electricity produced by third parties and sold to final customers, (iii) drilling activities outsourced to third parties and since 2015 other purchased goods and services, (iv) transportation and distribution of products and since 2016 includes also the vessels used by Upstream, (v) business travel and employees commuting and since 2016 for Upstream are included cars and helicopters transportation to sites, (vi) other minor contributions associated with end-of-life treatment of lubricating products and waste management.

(c) The index refers to traditional refineries: Livorno, Sannazzaro, Taranto and Gela in 2014; Livorno, Sannazzaro and Taranto since 2015.

Figure B-4. Eni-reported oil & gas production, 2020-2022

DAILY OIL AND NATURAL GAS PRODUCTION^{(a)(b)(c)}

	Liquids (mmbbl)	Natural gas (bcf)	Hydrocarbons (mmboc)	Liquids (mmbbl)	Natural gas (bcf)	Hydrocarbons (mmboc)	Liquids (mmbbl)	Natural gas (bcf)	Hydrocarbons (mmboc)
	2022			2021			2020		
Consolidated subsidiaries									
Italy	36	242.0	82	36	251.0	83	47	316.6	107
Rest of Europe	20	125.0	44	19	119.3	41	23	159.1	52
United Kingdom	20	125.0	44	19	119.3	41	23	159.1	52
North Africa	122	748.6	264	124	720.1	259	112	758.4	255
Algeria	62	171.5	95	54	165.1	85	53	152.5	81
Libya	58	567.0	165	67	541.7	168	56	594.4	168
Tunisia	2	10.1	4	3	13.3	6	3	11.5	6
Egypt	77	1,413.2	346	82	1,474.8	360	64	1,203.0	291
Sub-Saharan Africa	139	481.0	230	198	489.5	291	218	679.0	345
Angola	52	27.4	57	91	53.9	101	89	58.2	100
Congo	40	197.8	78	44	135.5	70	49	131.1	73
Ghana	16	85.6	32	20	83.8	36	24	87.6	41
Nigeria	31	170.2	63	43	216.3	84	56	402.1	131
Kazakhstan	88	198.6	126	102	233.0	146	110	282.2	163
Rest of Asia	78	507.2	174	80	516.5	177	88	465.0	176
China	1		1	1		1	1		1
Indonesia	1	323.5	62	1	321.2	61	1	248.5	48
Iraq	15	82.1	31	24	70.7	37	31	76.3	45
Pakistan		56.2	11		59.8	11		76.8	15
Timor Leste	1	19.0	4	1	42.5	9	2	46.8	10
Turkmenistan	4	6.4	5	6	6.3	7	7	6.2	9
United Arab Emirates	56	20.0	60	47	16.0	51	46	10.4	48
Americas	59	80.7	74	53	73.0	67	57	97.1	75
Mexico	14	18.1	17	11	14.8	14	12	10.9	14
United States	45	62.6	57	42	58.2	53	45	86.2	61
Australia and Oceania		52.3	10		85.0	16		91.0	17
Australia			10		85.0	16		91.0	17
	619	3,848.6	1,350	694	3,962.2	1,440	719	4,051.4	1,481
Equity-accounted entities									
Angola	36	84.6	53	3	85.8	19	4	98.8	23
Mozambique		32.4	6						
Norway	89	295.3	145	111	322.7	172	116	365.0	185
Tunisia	3	2.9	3	3	3.2	3	2	2.9	2
Venezuela	4	259.2	53	2	239.2	48	2	211.0	42
	132	674.4	260	119	650.9	242	124	677.7	252
Total	751	4,523.0	1,610	813	4,613.1	1,682	843	4,729.1	1,733

(a) Includes Eni's share of equity-accounted equities.

(b) Includes volumes of hydrocarbons consumed in operations (124, 116 and 124 kboe/d in 2022, 2021 and 2020, respectively).

(c) Effective January 1st, 2022, the conversion rate of natural gas from cubic feet to boe has been updated to 1 barrel of oil = 5,263 cubic feet of gas (it was 1 barrel of oil = 5,310 cubic feet of gas). The effect on production has been 8 kboe/d in the full year 2022.

Eni Annual Report 2022, page 54.

Appendix C

References

- Andrew, Robbie, & Glen P. Peters (2022) *The Global Carbon Project's fossil CO₂ emissions dataset: 2022 release*, CICERO, Oslo, November, 27 pp.
- Columbia Center on Sustainable Investment (2021) *Life-Cycle Greenhouse Gas Emissions from the Oil Refining and Petroleum Products Sales Sectors: How Much Have the Carbon Majors Contributed to Global Warming?* By Jiarui Chen, Perrine Toledano, & Martin Dietrich Brauch, March, 82 pp.
- Eni (2023) *Eni for 2022: Sustainability Performance*, Rome, 41 pp.
- Eni (2023) *Annual Report 2022*, Rome, 451 pp. (and numerous earlier Annual Reports 1953-forward.)
- Eni (2020) *Methodology for the assessment of GHG emissions along the value chains of Eni products*, rev., Rome, 8 pp. See also: <https://www.eni.com/en-IT/video/video-baldarelli-focus-methodology.html>
- Friedlingstein, Pierre, et al. (2022) Global Carbon Budget 2021, *Earth Syst. Sci. Data*. <https://doi.org/10.5194/essd-14-1917-2022>
- Global Carbon Project (2022) *Global Carbon Budget*, November <https://www.globalcarbonproject.org/carbonbudget/index.htm>
- Grasso, Marco, & Richard Heede (2023) Time to pay the piper: fossil fuel companies' reparations for climate damages, *One Earth*, 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)
- Heede, Richard (2019) *Carbon Majors: Accounting for carbon and methane emissions 1854-2010 Methods & Results Report*, ISBN 978-3-659-57841-0, OmniScriptum, Riga, 148 pp.
- Heede, Richard (2014a) Tracing anthropogenic CO₂ and methane emissions to fossil fuel and cement producers 1854-2010, *Climatic Change*, vol. 122(1): 229-241; doi:10.1007/s10584-013-0986-y. URL: <http://link.springer.com/article/10.1007/s10584-013-0986-y?view=classic>
- Heede, Richard (2014b) *Carbon Majors: Accounting for carbon and methane emissions 1854-2010 Methods & Results Report*, commissioned by Climate Justice Programme (Sydney) & Greenpeace International (Amsterdam), Climate Mitigation Services, Snowmass, CO, 104 pp. plus pdf worksheets, 674 pp.
- Howard, Peter, & Derek Sylvan (2021) *Gauging Economic Consensus on Climate Change*, Institute for Policy Integrity, New York University School of Law, March, 64 pp.
- Intergovernmental Panel on Climate Change (2013) *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, 1535 pp.
- Le Quéré, Corinne, et al. (2018) Global Carbon Budget 2018, *Earth System Science Data*, vol. 10:1-54. DOI: 10.5194/essd-10-2141-2018.
- Marland, Gregg, & Ralph Rotty (1984) Carbon dioxide emissions from fossil fuels: a procedure for estimation and results for 1950-1982, *Tellus*, vol 36b:232-261.
- Shue, Henry (2017) Responsible for What? Carbon Producer CO₂ Contributions and the Energy Transition, Springboard Commentary on Ekwurzel et al., *Climatic Change*, vol. 144:591-596, online 7Sep. <https://link.springer.com/article/10.1007/s10584-017-2042-9>
- World Resources Institute & World Business Council for Sustainable Development (2004) *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard*, Revised, 112 pp.