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Lowering Greenhouse Gases Emissions from the Energy and Oil Companies in the European Union: An Economic Overview

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In the context of the Corporate Sustainability Reporting Directive (CSRD) that has been passed by the EU Parliament in November 2022 and which fundamentally changes the ways how companies reporting are made and the type of sustainability reporting made by the companies targeted by the directive, in this paper it is analyzed and examined, according with the forerunning directive, Non-Financial Reporting Directive (NFRD), which have been made compulsory by the European Union starting with year 2014, the improvements that have been effectively made in the emissions of greenhouse gases by the largest 6 companies in terms of revenue that operate primarily in energy, oil and gas industries (either by upstream, midstream or downstream sectors) and are of continental European origins. In this article are highlighted the economical efforts of combating the greenhouse gases (GHG) and the efficiency of the measures taken, both individually and collectively by the aforementioned conglomerates. It is also discussed the economic efficiency, both cumulative and separately for each of the analyzed companies. As well, an overview of the reduction importance of greenhouse gases is presented by exposing the environmental measurements since first being reported at a scientific level.

Keywords: *oil and energy industry, sustainable profitability, environmental responsibility, non-financial directives, green investments*

Introduction

Mobility is essential for society and the economy. At the same time, transportation is also a major cause of environmental pollution in the European Union (EU) and therefore also a part to climate change. Because of this, the importance of Corporate Sustainability Reporting Directive (CSRD) compulsory reporting is growing and alongside it the requirements for corporate sustainability reporting are as well changing radically. The new non-financial reportings that has to be generated according with the new EU directive on corporate sustainability reporting originated after the European Commission published its proposal for a directive in April 2021 and after the negotiators of the Commission, Council and European Parliament agreed on a compromise on June 21, 2022. The CSRD was formally adopted by the European Parliament and the Council and after being signed by the Presidents of the European Parliament and the Council on 16 December 2022 and published in the Official Journal of the European Union in 2022. The policy came finally into effect on January 5, 2023 and the new rulings have to be implemented by the member states after 18 months at the latest

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(Directive (EU) 2022/2464 2022).

However, certain public interest entities in the EU have been already required to report on their sustainability for a number of years. These have been regulated by the Non-Financial Reporting Directive (NFRD), which has been in force since 2014 (Directive (EU) 2014/95 2014). In this way, stakeholders should have been able to better assess the contribution of companies to sustainability. However, the current reporting obligations are now with the CSRD to be expanded considerably. As previously stated, in April 2021, the European Commission published its proposal for a Corporate Sustainability Reporting Directive (CSRD), which replaced the previously applicable Nonfinancial Reporting Directive (NFRD). The proposal has gone through the EU authorities and it was approved by the EU Parliament in November 2022 (Directive (EU) 2022/2464 2022). By this it is expected from the CSRD to expand the NFRD purposes and therefore to significantly enlarge the scope of the Sustainability Reporting.

In addition, all non-capital market-oriented companies are covered by the CSRD if they meet two of the following three criteria (Directive (EU) 2022/2464 2022):

- Total Revenue / Balance sheet > 20 million euros
- Net Sales > 40 million euros
- Number of employees > 250

The estimations are that around 50,000 companies in the EU would be affected (EU Press Release: 20221107IPR49611 2022).

We focus in this paper on the reporting of the biggest energy and petroleum companies that by the nature of their profile (S&P Global 2022, Statista.com 2022) are one of the biggest Greenhouse Gases (GHG) producers and at the same time contributors to the climate changing profile in European continental context, and their improvements and necessary costs for these.

Literature Review

To better comprehend how the directives originated and their necessities, we put into perspective the Global and European context of Greenhouse Gasses and how they affect every living organism on Earth.

As already proven, the Greenhouse gases (GHG) are gases that absorb and emit radiant energy within the thermal infrared range, causing the greenhouse effect (Seinfeld and Pandis 2016). The main greenhouse gases in the Earth's atmosphere are water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and ozone (O_3). Without the greenhouse gases, the Earth’s average surface temperature would be around -18°C, (Seinfeld and Pandis 2016) instead of the current average of 15°C (Stocker et al. 2013, World Meteorological Organization (WMO 2019). The atmospheres of Venus, Mars, and Titan (moon of Jupiter) also contain greenhouse gases.

Human activities since the beginning of the Industrial Revolution (around the

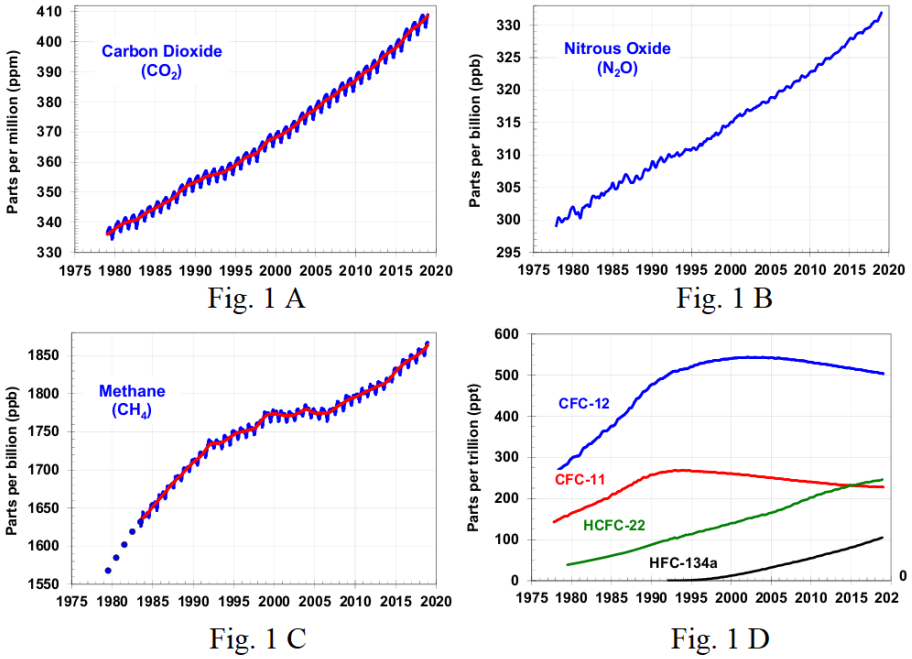
year 1750) have increased the atmospheric concentration of Carbon Dioxide by almost 50%, from 280 ppm (parts per million) in 1750 to 419 ppm in 2021 (International Energy Agency 2020). The last time the atmospheric concentration of Carbon Dioxide as high as it now was over 3 million years ago (Blunden et al. 2017). This increase occurred despite the absorption of more than half of emissions by various natural carbon sinks in the carbon cycleI (CAIT Climate Data Explorer 2023).

At current rates of greenhouse gas emissions, temperatures could rise by 2°C by 2050, which the United Nations Intergovernmental Panel on Climate Change (IPCC) says is the upper limit to avoid "hazardous" levels (Shishlov et al. 2016). The vast majority of anthropogenic carbon dioxide emissions come from the burning of fossil fuels, mainly coal, oil and natural gas, with additional contributions from cement manufacturing, fertilizer production, deforestation and other changes in land use (Grubb 2016, Rosen 2015, Kiehl and Trenberth 1997).

For a graphical description of all these information we can look at Figure 1 which it presents the evolution of the major Greenhouse Gases (GHG) emissions which have been released at a certain point in time in the planetary atmosphere. As it can be easily noticed, the percentage of the harmful gases to organisms lives have increased steadily since 1975 until the very recent years. The trend can be regarded as upwards for the most gases, in particular CO_2 with an absolute increase of 118% and therefore an angle percentage of 43.63% for the calibrated cumulative slope of the time period of 1975-2021 (CAIT Climate Data Explorer 2023).

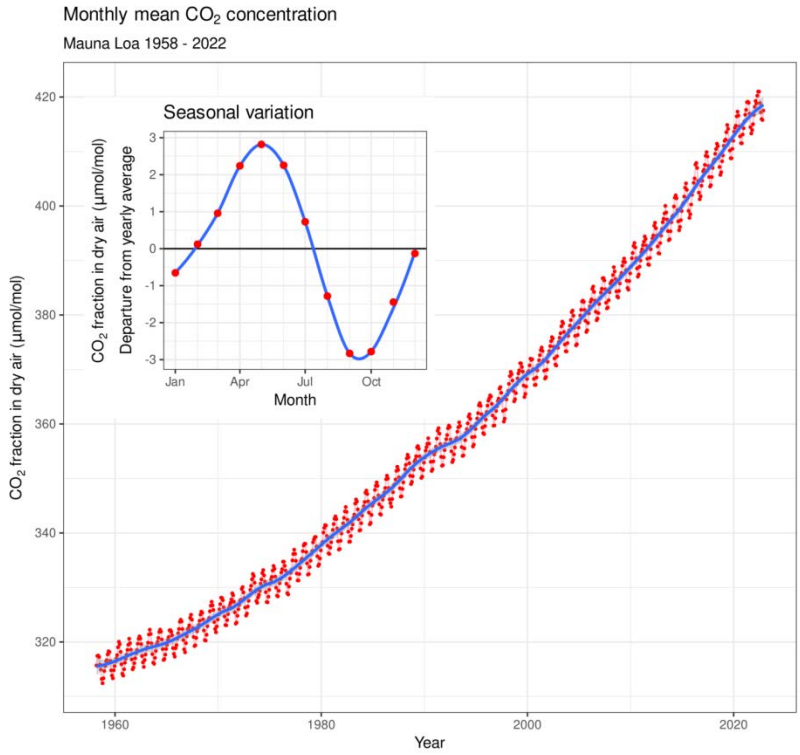
The "saw-like" functions of the carbon dioxide (Figure 1A), nitrous oxide (Figure 1B), methane (Figure 1C) and even in chlorofluorocarbons (CFCs) and hydrochloro-fluorocarbons (HCFCs) (Figure 1D) can be correlated with the seasonal fluctuation. These fluctuations happen because of the seasonal variations. The main trends, also known as the Keeling curve, is plotted and visually demonstrated in Figure 2. It comprises the measurements of atmospheric CO_2 at Mauna Loa, Haway, which is the longest record that exists of such, respectively since 1958 until present modern days (Tans 2023, Keeling et al. 2001).

Figure 1. *Evolution over Time of Atmospheric CO_2 (1.A), N2O (1.B), CH_4 (1.C), CHC- and HFC-type (1.D) Gases*



Source: CAIT Climate Data Explorer via Climate Watch. [Accessed 15 May 2023]

Figure 2. *Concentrations of Atmospheric CO_2 Measured at Mauna Loa, Hawaii, 1958-2022*



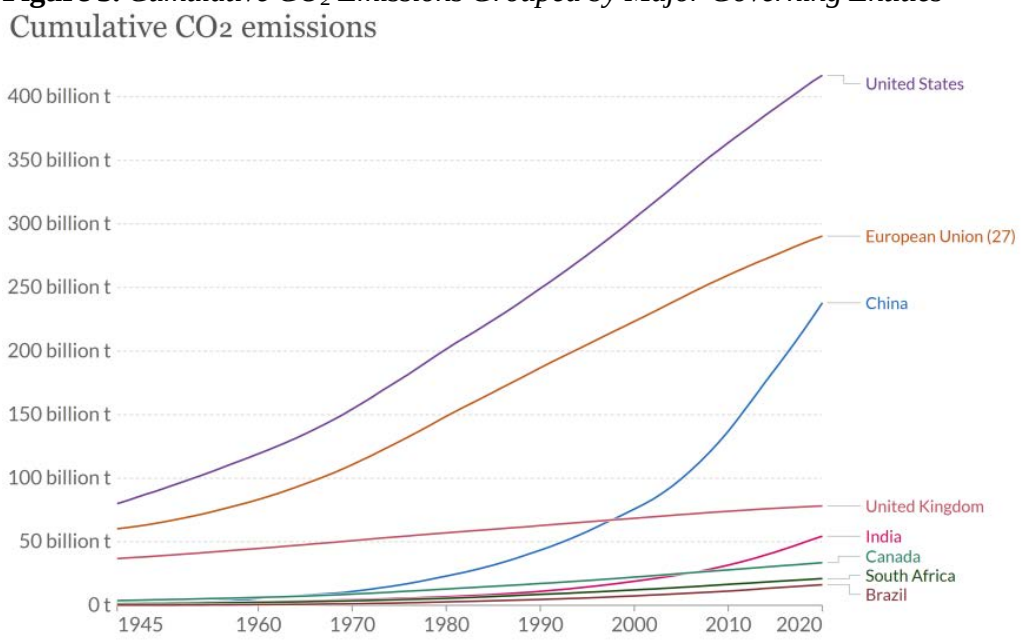
Source: https://gml.noaa.gov/ccgg/trends/data.html. [Accessed 15 May 2023]

The annually curve that can be seen in the upper-left of the Figure 2 is caused by the removal of atmospheric CO_2 by the forests and land plants. As such, the density of forests which is more noticeable in the Northern Hemisphere, more carbon dioxide (CO_2) is removed during the summer in Northern Hemisphere than in the Southern Hemisphere.

The curve that can be seen primary (central) in Figure 2 is known as the Keeling curve, after its discoverer, Dr. Ralph Keeling (Keeling et al. 2001). The trend, smothered by year's averages, can be seen as the blue curve, and the average monthly values are in this figure plotted with the color red. Independent researches in the world confirm the CO_2 measurements and altogether the Keeling curve (Norbedo et al. 2020, Gallo et al. 2019).

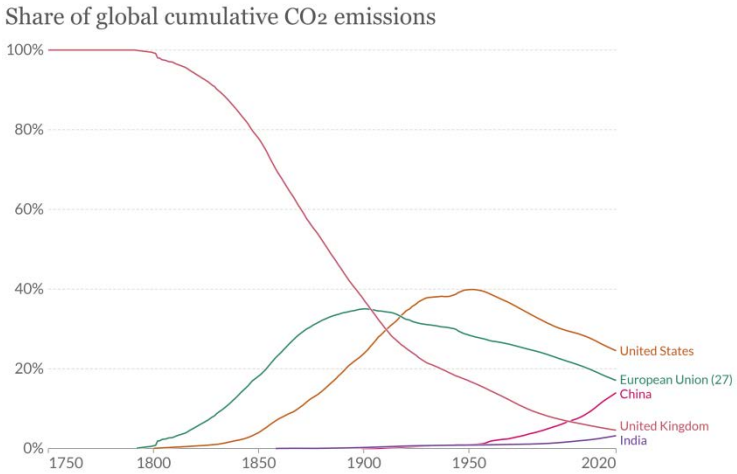
In terms of all time historical emissions to date we do mention United States, that have emitted up until now about 25% CO_2 emissions, which is about two times more than the next country responsible for this type of emission, China. The totality of countries from European Union (EU-28) are all time historically responsible for 22% of CO_2 emissions, as can be seen in Figures 3 and 4 (CAIT Climate Data Explorer 2023).

Figure 3. *Cumulative CO_2 Emissions Grouped by Major Governing Entities*



Source: CAIT Climate Data Explorer via Climate Watch. [Accessed 15 May 2023]

Figure 4. *The Share of Global Cumulative CO_2 Emissions Grouped by Major Governing Entities*



Source: CAIT Climate Data Explorer via Climate Watch. [Accessed 15 May 2023]

Methodology and Materials

The CSRD policy follows a double materiality perspective. This means that companies must record the impact of sustainability aspects on the company's economic situation. And they need to show the impact of operations on sustainability aspects. In reporting, the CSRD requires information on (Directive (EU) 2022/2464 2022):

- sustainability goals
- the role of the board of directors and the supervisory board
- the main adverse effects of the company, and
- to intangible resources not yet accounted for

In addition, with the new CSRD there is no longer the option of publishing non-financial information in a separate non-financial report. In the future, sustainability information should only be disclosed in the management report. The main innovations of the CSRD are presented as follows (Directive (EU) 2022/ 2464 2022):

- Extended, standardized reporting obligation:
  In the future, companies will have to report more comprehensively and according to more uniform standards. The measurability and comparability of the information should also be strengthened by quantifying the report content more effectively using indicators. The first drafts of the standards still to be issued by the EU Commission are currently being developed by EFRAG (European Financial Reporting Advisory Group) with the involvement of stakeholders and experts. Existing standards and regulations will be included.

- New understanding of materiality:
  The CSRD anchors the so-called double materiality. According to this, companies are obliged to report both on the effects of their own business operations on people and the environment and on the effects of sustainability aspects on the company. Previously, facts only had to be reported if both aspects of materiality applied.
- External audit:
  Sustainability reporting, like financial reporting, must be externally audited in the future. The EU Commission sets test standards for this. In addition, the depth of the audit is to be expanded step by step: In a first step, an audit with limited assurance is planned. And afterwards, according with the first audit, another audit with sufficient certainty (" reasonable assurance ") is required, which corresponds to the depths of the audit in the context of financial reporting.
- Part of the management report:
  In order to facilitate access to sustainability information, it would be a mandatory part of the management report in the future. This shows the importance of sustainability reporting, which is gradually to be given the same importance as classic financial reporting.
- Uniform electronic reporting format:
  Since January 1, 2020, certain capital market-oriented companies have been obliged to disclose their accounting documents in the so-called European Single Electronic Format (ESEF), which is equally readable for humans and machines. Here, consolidated financial statements in XHTML format are marked with so-called XBRL tags. As part of the CSRD, this requirement is to be expanded to include sustainability reporting. To this end, the European Commission is planning to publish its own XBRL taxonomy.

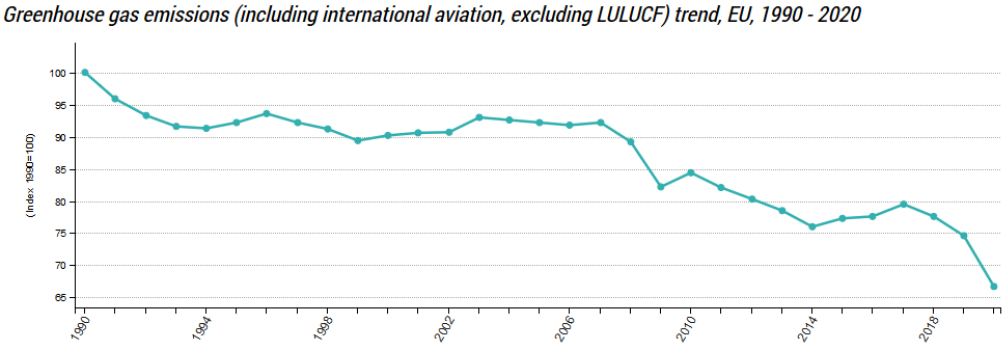
Nevertheless, as mentioned before, other parts of CSRD reporting requirements have already been made compulsory by the EU Commission and with the help of NFRD we will analyze in the following the type of data that can be expected to be processed much faster because of the nature of changes made in the new European directive. We do mention, however, that our primary focus will be the Greenhouse Gases Emissions and the financial costs required to reduce these (Directive (EU) 2022/2464 2022, Directive (EU) 2014/95 2014).

Results

We can see improvements of reducing GHG emissions which are according with the plans of European Commission to reduce the GHG emissions by 55% in comparison with the levels of year 1990 until 2030 and start been carbon neutral by year 2050 (International Energy Agency 2021) The emission reduction were in year 2020 at a level of 66.7% compared to 1990, according with the statistical data from Eurostat, as it can be seen in Figure 5 and in Figure 6 as well (International

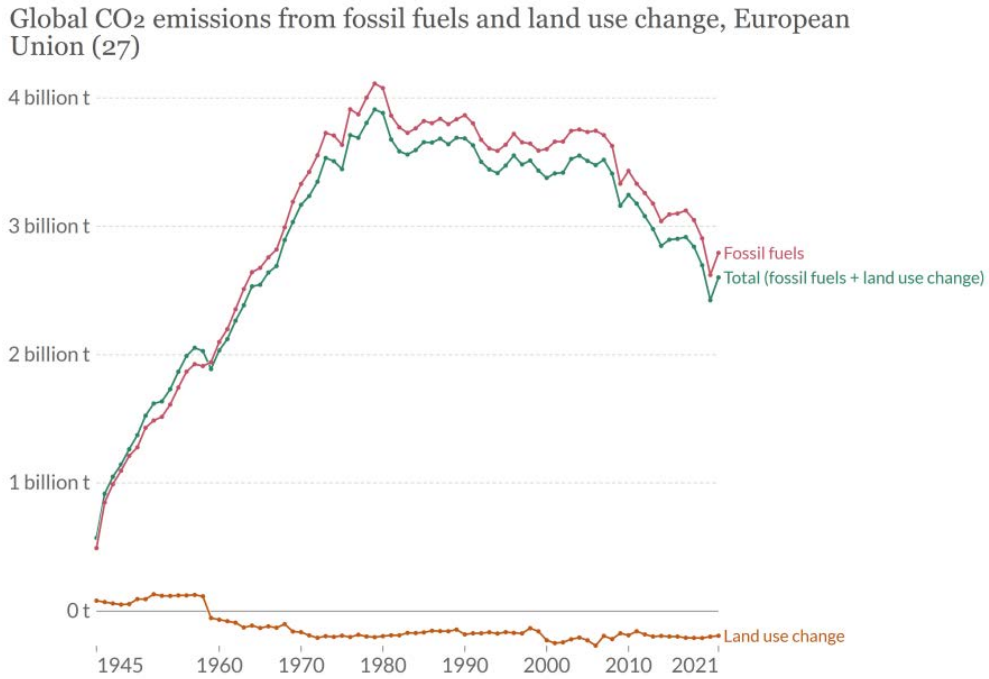
Energy Agency 2021, European Environment Agency 2023).

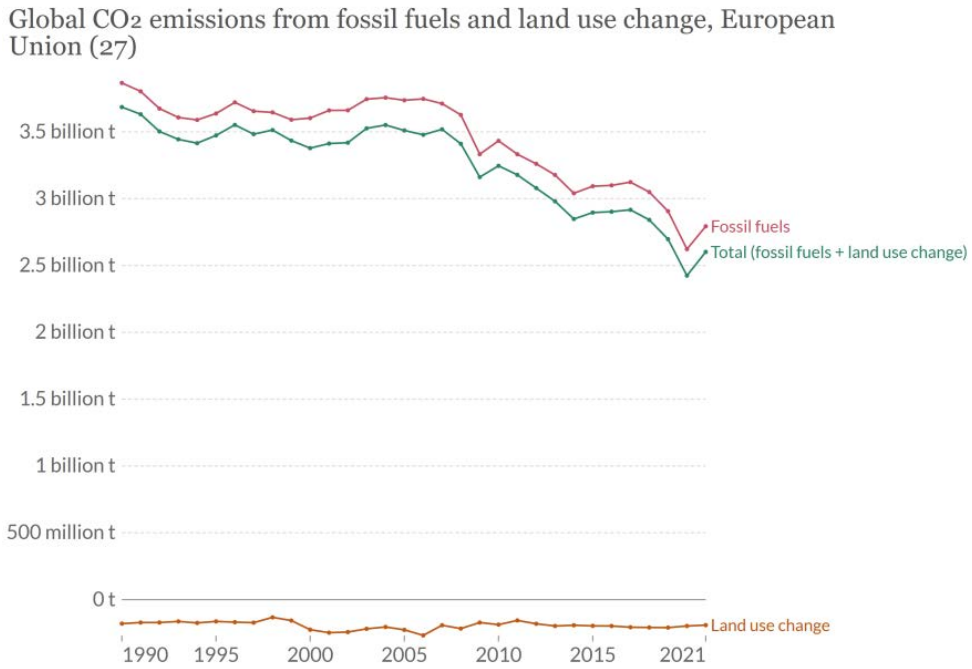
Figure 5. *Total Greenhouse Gas Emissions (Including International Aviation, excluding LULUCF) Trend, EU, 1990–2020 (Index 1990 = 100)*



Source: European Environment Agency (online data code: env_air_gge). [Accessed 15 May 2023]

Figure 6A. *Which Plots the Global CO_2 Emissions from Fossil Fuels and Land Use Change for the Time Period 1945-2021 and* **Figure 6B.** *for the Time Period 1990-2021*

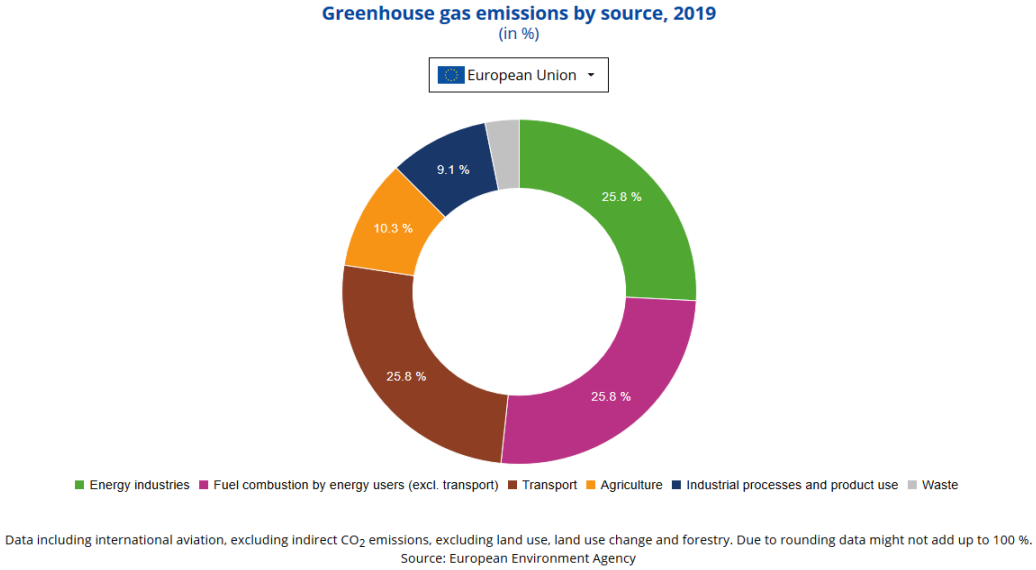




Source: CAIT Climate Data Explorer via Climate Watch. [Accessed 15 May 2023]

Out of all these emissions, around 25% are generated by energy and oil companies, as per official Eurostat data (European Environment Agency 2023).

Figure 7. *Emissions in 2019 by Industries* (Pie-Chart)



Source: European Environment Agency (EEA), online data code: ENV_AIR_GGE. [Accessed 15 May 2023]

In the following we analyze the reduction of GHG emissions by the major 6 European Continental players in energy and oil industry in terms of revenue and employees, namely: Shell plc, BP p.l.c, TotalEnergies SE, Eni S.p.A, Repsol S.A and Equinor ASA.

Discussion

In the latest five to seven years we noticed a substantial reduction of GHG emissions from the aforementioned companies and we strive to analyze the costs of such reductions according to the investments made by the respective corporations and at the same time to understand the necessary financial efforts made in order to reduce the emissions while maintaining the demanded energetic output and hold the attractiveness of the industry for the investors.

The most harmful GHG emissions are those of CO_2 and CH_4 because of the emitted quantity. However non-negligible are also those of the N_2O and of course of the HFCs nature, which even though the companies are not required by the current legislation to make public knowledge the percentages of these 2 types of emissions (required to only disclose the CO_2, CH_4 and the totality of GHG CO_2e emissions), Shell plc (N_2O and HFCs emissions) and Resposl S.A. (N_2O emissions) decided to disclose the percentages to the public at large.

According with the lawful implementations in vigor and the reports issued by the corporations in question we try to analyze in the following the connections between the GHG emissions and some of the financial data, with a special focus on financial data from the investments made in lowering the Carbon Dioxide equivalent (CO_2e) emissions, and also to comprehend to what degree / ratio have these harmful emissions been cut and how many financial efforts have been allocated especially for this purpose.

For the simplicity, in the followings, we will refer to the companies Shell plc as <<Shell>>, BP p.l.c as <<BP>>, TotalEnergies SE as <<Total>>, Eni S.p.A. as <<Eni>>, Repsol S.A. as <<Repsol>> and Equinor ASA as <<Equinor>>.

We present the Tables generated by the author, according with the Sustainability Reports and Financial Statements of the previous mentioned corporations, which contain the totality of GHG emissions, meaning the sum of Scope 1 (direct emissions from the Company's activities) and Scope 2 (indirect emissions associated with the purchase of electricity and steam from third parties) meaning, in other words, all the operated GHG emissions generated directly (Scope 1) and indirectly (Scope 2) by the corporations in question with the metric "million tonnes CO_2 equivalent", and the rest of the emissions data as been the direct emissions (Scope 1) as presented in the Sustainability Reports for operated emissions.

Table 1. *Shell GHG Emissions*

	Unit	**2021**	**2020**	**2019**	**2018**	**2017**
Total GHG Emissions (Scope 1 + Scope 2)	million tonnes CO_2 e	68 (60+8)	71 (63+8)	80 (70+10)	82 (71+11)	85 (73+12)
Carbon dioxide (CO_2)	million tonnes	58	61	67	69	70
Methane (CH_4)	thousand tonnes	55	67	91	92	123
Nitrous oxide (N_2O)	thousand tonnes	1	1	1	1	1
Hydrofluorocarbons	tonnes	25	30	29	31	22

	Unit	2021	2020	2019	2018	2017
(HFCs)						
Investments in Low-Carbon Energy	Millions ($)	2359	928	1134	748	172

Source: Shell plc Sustainability Report 2021, 2020, 2019, 2018.

Table 2. *BP GHG Emissions*

	Unit	2021	2020	2019	2018	2017
Total GHG Emissions (Scope 1 + Scope 2)	million tonnes CO_2 e	35.6 (33.2+2.4)	45.5 (41.7+3.8)	54.4 (49.2+5.2)	54.2 (48.8+5.4)	56.6 (50.5+6.1)
Carbon dioxide (CO_2)	million tonnes	30.3	38.8	43.0	43.3	45.8
Methane (CH_4)	Thousand tonnes	50	70	100	90	110
Environmental Expenditures	Million ($)	2195	412	2319	1546	971

Source: BP ESG annual reports 2021, 2020, 2019, 2018.

We also analyzed the investments made by BP in order to make the transition towards a greener future of the company which according to BP official datasheet <<majority of which related to investments in offshore wind, electric vehicle charging infrastructure and solar>> while at the same time trying to preserve the competitiveness of the market in order to be seen as healthy by investors (BP 2021).

Table 3. *Total Energies GHG Emissions*

	Unit	2021	2020	2019	2018	2017
Total GHG Emissions (Scope 1 + Scope 2)	million tonnes CO_2e	37 (34+3)	41 (38+3)	44 (41+3)	44 (40+4)	42 (38+4)
Carbon dioxide (CO2)	million tonnes	32	34	39	39	38
Methane (CH4)	thousand tonnes	1	2	2	2	2
R&D Expenditure (total)	millions (€)	849	895	968	986	912
R&D Expenditure related to decarbonization	millions (€)	114	74	102	74	72

Source: Total Sustainability reports 2021, 2020, 2019.

Table 4. *Eni GHG Emissions*

	Unit	2021	2020	2019	2018	2017
Total GHG Emissions (Scope 1 + Scope 2)	million tonnes CO_2e	40.89 (40.08+0.81)	38.49 (37.76+0.73)	41.89 (41.2+0.69)	44.02 (43.35+0.67)	43.8 (43.15+0.65)
Carbon dioxide (CO_2)	million tonnes	30.58	29.70	32.27	33.89	33.03
Methane (CH_4)	thousand tonnes	9.2	11.9	21.9	38.8	38.8
R&D Expenditure (total)	millions (€)	177	157	194	197.2	185
R&D Expenditure related to decarbonization	millions (€)	114	74	102	74	72

Source: Eni annual reports 2021, 2018.

Table 5. *Repsol GHG Emissions*

	Unit	2021	2020	2019	2018	2017
Total GHG Emissions (Scope 1 + Scope 2)	million tonnes CO_2e	19.8 (19.4+0.4)	22.9 (22.4+0.5)	25.2 (24.7+0.5)	22.4 (22.0+0.4)	23.4 (23.0+0.4)
Carbon dioxide (CO_2)	million tonnes	17.1	19.0	20.1	17.9	18.4
Methane (CH_4)	thousand tonnes	27.4	39.3	53.6	48.8	51.1
Nitrous oxide (N_2O)	thousand tonnes	0.34	0.35	0.27	0.13	0.07
Expenditures (CO_2 allowances)	million (€)	479	281	325	113	69
Net cost of carbon management	million (€)	220	96	132	44	17

Source: Repsol annual report 2021, 2019.

For the Methane and N20 it was the method of converting CO_2 equivalent to CH_4 absolute values by dividing the values (million tones CO_2e) of CH_4 and N_2O reported by the company by 84 and 298 respectively, and transformed into thousand tonnes, which is been considered in this article for the sake of the continuity as the industry standard (IPCC 2023, US Environmental Protection Agency 2023).

Table 6. *Equinor GHG Emissions*

	Unit	2021	2020	2019	2018	2017
Total GHG Emissions (Scope 1 + Scope 2)	million tonnes CO2e	12.1 (12.0+0.1)	13.6 (13.3+0.3)	14.9 (14.7+0.2)	15.1 (14.9+0.2)	15.6 (15.4+0.2)
Carbon dioxide (CO_2)	million tonnes	11.7	12.9	14.2	14.5	14.9
Methane (CH_4)	thousand	14.5	17.7	18.1	19.1	19.3

	Unit	**2021**	**2020**	**2019**	**2018**	**2017**
	tonnes					
R&D expenditure on low-carbon projects	millions ($)	95	81	59	66	55
R&D expenditure to new energy solutions and efficiency	% (of total R&D expenditures)	33	32	20	21	18

Source: Equinor Sustainability report 2021.

In the following figures we can easily see the progress made by each company in terms of emission of hurtful gasses in the Planetary Atmosphere. Figure 8 shows the reduction of the CO_2 emissions by each company that we analyzed, while Figure 9 depicts the CH_4 reduction, as well for all companies analyzed.

Figure 8. *Represents the CO_2 Emissions Each Year (for the Period 2021-2017) for Each Company with the Representations A – CO_2 Emissions from the Company Shell, B from the Company BP, C from Total, D from Eni, E – Repsol and F – Equinor Respectively*

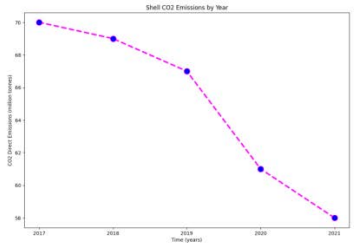


Fig. 8 A

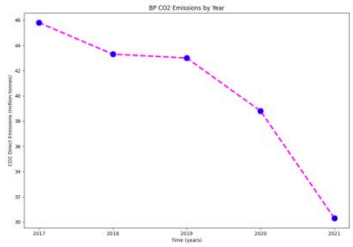


Fig. 8 B

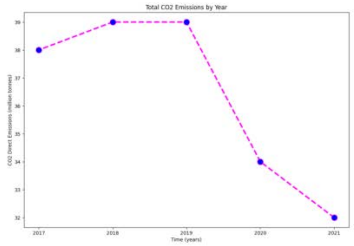


Fig. 8 C

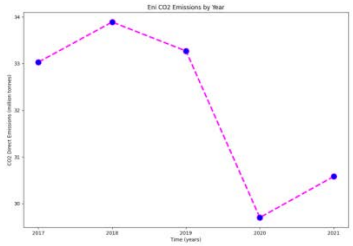


Fig. 8 D

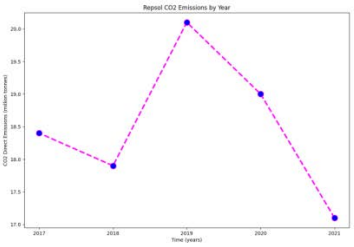


Fig. 8 E

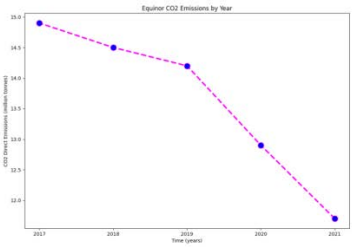


Fig. 8 F

Source: Own computation based on analyzed companies' sustainability reports.

Figure 9. *CH_4 Emissions Each Year (for the Period 2021-2017) for Each Company with the Representations A – CO_2 Emissions from the Company Shell, B from the Company BP, C from Total, D from Eni, E – Repsol and F – Equinor Respectively*

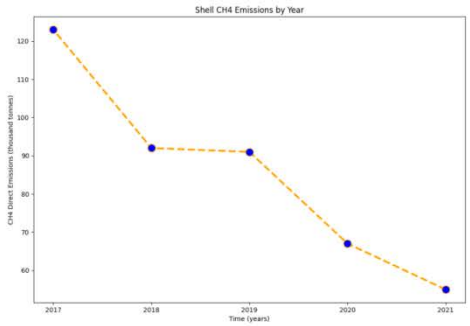


Fig. 9 A

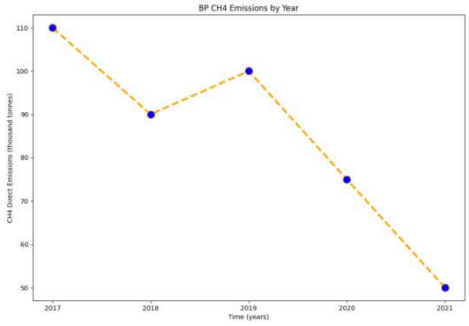


Fig. 9 B

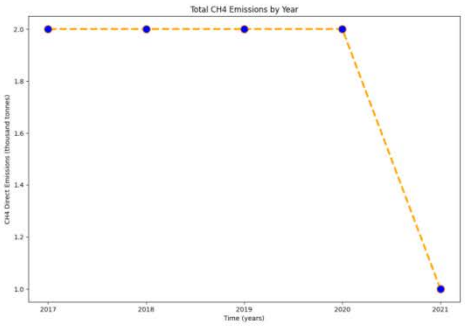


Fig. 9 C

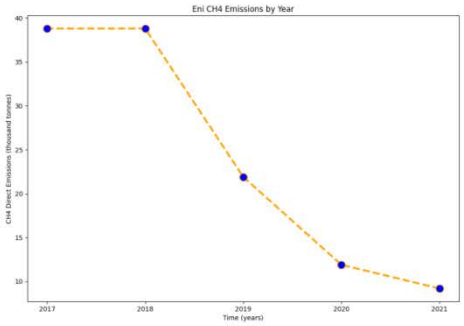


Fig. 9 D

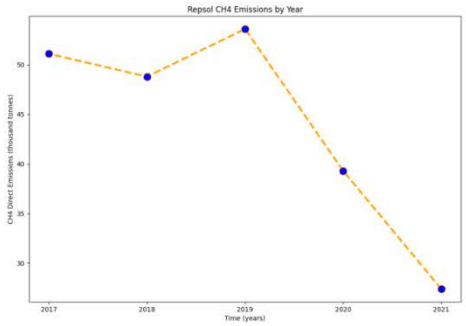


Fig. 9 E

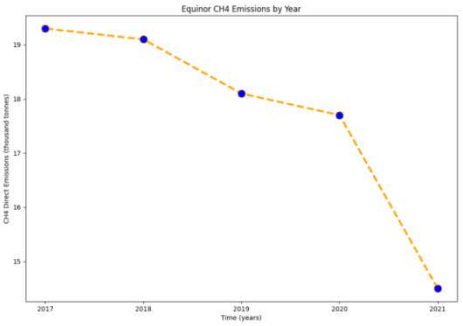


Fig. 9 F

Source: Own computation based on analyzed companies' sustainability reports.

In terms of total GHG emissions reductions (calculated in CO_2e) we see in the following the progress made by each company separately and as well side-by-side comparisons with the efficiency percentages year-on-year. With the scope of further analysis, the performances of the rest of companies not presented in this section, can be found in Annex A.

Figure 10A. & **B.** *Side-by-Side Comparison between the Companies (Shell) that Succeeded to Mostly Reduce its GHG Emissions in Figure 10A and the Least Efficient Company (Total) in Terms of Totally GHG Reductions in Figure 10B*

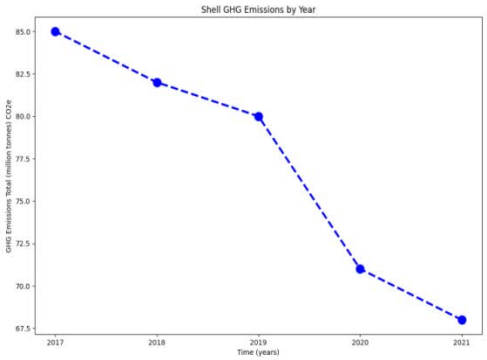


Fig. 10 A

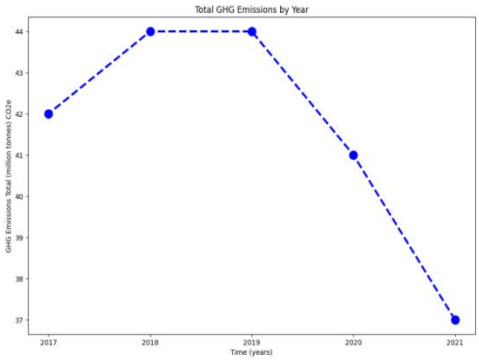


Fig. 10 B

Source: Own computation based on analyzed companies' sustainability reports.

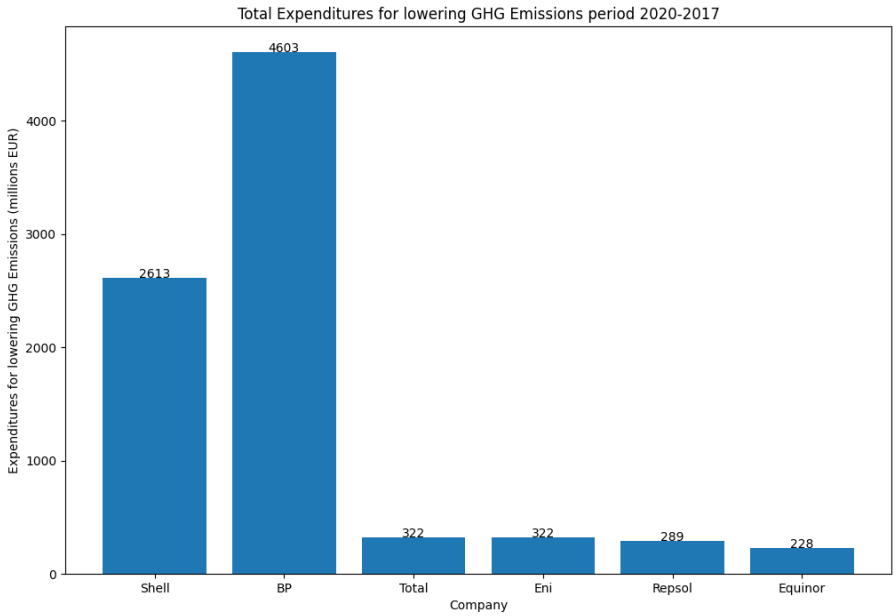
Analysis

We also present in the following figure the total costs of the 6 companies over all the years presented in this article and the following the efficiency in millions EUR per 1 million tonne CO_2e over all the same period of time. In order to do this and thoroughly analyze the financial costs and theirs efficiency we convey the following formulas that will be used essentially to calculate the efficiency of the investments in lowering the CO_2e fingerprint for each of the six companies:

$$TotalInvestments(company) = \sum_{year=2017}^{2020} investment_{year}(company) \quad (A)$$

Please note the beginning and end-years that were chosen for this particular formula. The investments sums start from the first year analyzed and stop at the penultimate year from this study, the reasoning being that the investments made in year x are first to be seen (in terms of GHG-emissions reductions) during year $x + 1$ (e.g., investments made in year 2018 are first to be seen during year 2019, those made in year 2019 will be first seen during the emissions for 2020 and so on).

Figure 11. *Total Sums Invested over the Period of Time 2020-2017 for all the Companies Analyzed*



Source: Own computation based on analyzed companies' sustainability reports.

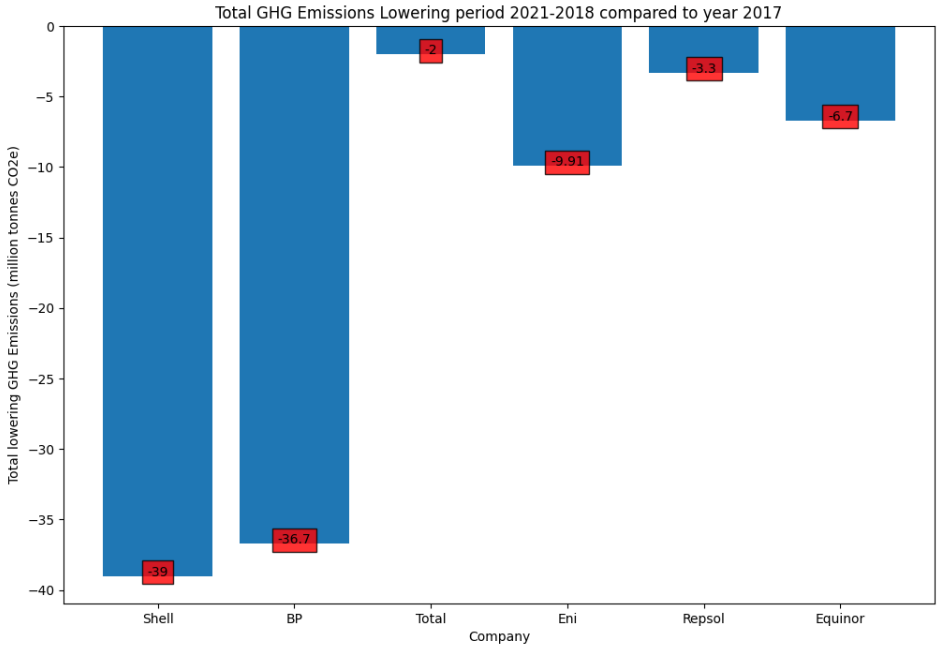
The method for which the differences in terms of total GHG emissions reductions are calculated with regard to the first year analyzed (2017) if the emissions would have stayed at the same level of year 2017, is the following:

$$TotalGHGemissionsreductions(company)=$$

$$\sum_{year=2018}^{2021}\left[GHGemissions_{year}(comapny)-GHGemissions_{2017}(company)\right]^{(B)}$$

Again, please note the begin and end-years of the formula, which are in according with the previous equation,(A).

Figure 12. *Totality of GHG Emissions Reductions Calculated in Million Tonnes CO_2e over the Time Period 2021-2018 Compared to Year 2017*



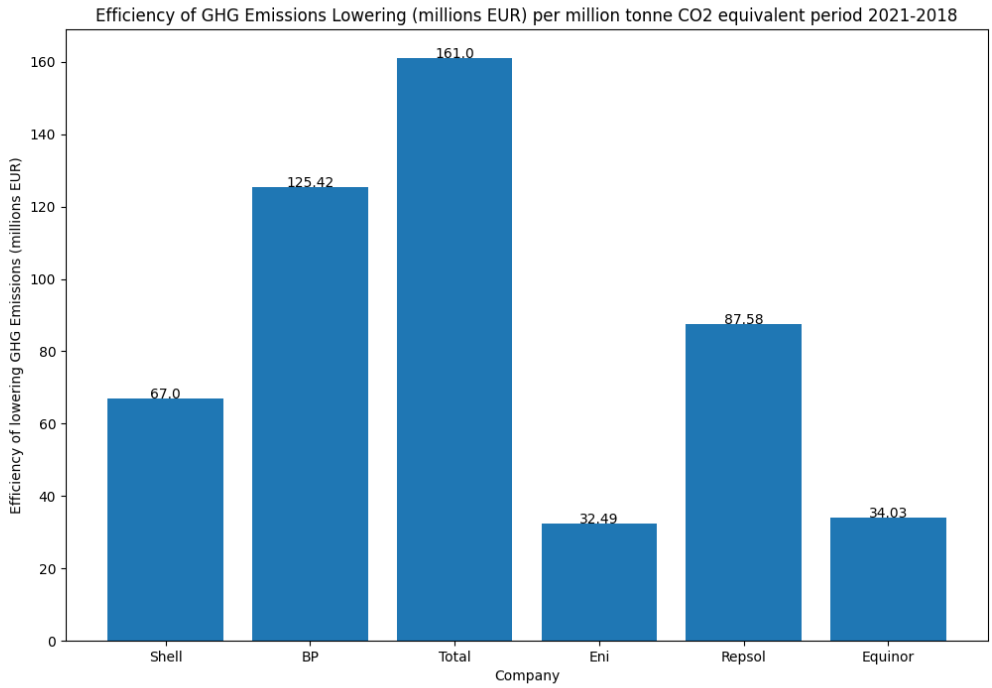
Source: Own research.

In order to determine the efficiency of the many invested during period of time 2020-2017 we do use the following equation:

$$InvestmentsEfficiency(company) = \frac{TotalInvestments(company)}{TotalGHGemissionsreductions(company)}$$

$$= \frac{\sum_{year=2017}^{2020} investment_{year}(company)}{\sum_{year=2018}^{2021}\left[GHGemissions_{year}(comapny) - GHGemissions_{2017}(company)\right]}$$

Figure 13. *Totality of GHG Emissions in CO_2e Million Tonnes over the Period 2021-2018 Compared to Year 2017*



Source: Own research.

One can easily see from Figure 13. that the most efficient company in terms of expenditure per reduced million tonne CO_2e was Eni and the least efficient one in terms of investments was Total with 161 millions EUR per million tonne, meaning a difference of almost ~500% between the two companies.

Conclusions

The introduction of the non-financial statements by the European Union through Reporting Directives was and still is of great environmental and economic value for all the parties involved, not only for research purposes, but also for informative ones, that could be used by investors or by the general public in order to see and recognize the evolution of the environmental progresses according with the United Nations' Sustainable Development Goals (SDGs) or with the European goals.

According to the official financial and non-financial statements issued yearly in the past 5 years (2017-2021) by the 6 companies in relationship to the NFRD, an estimated cumulative effort of these companies by more than 5 billions EUR has been made only in year 2021, in order for the GHG emissions to be reduced by a weighted ~ 9% compared to the prior year (2020) and by almost ~ 19% compared to reference year 2017.

We can also see, after closer examination, that total year by year CO_2e emission reduction progress averaged from ~ 10.06 % (year 2020 compared to 2019) to a negative progress of ~ -0.71 % (from year 2019 to year 2018) for the 5 year period analyzed. As well, across the companies analyzed in this paper, the most expensive spending done during this period was made by the company BP p.l.c. with ~ 4.6 bn EUR and the least sum was spent by Equinor ASA with the total sum of 228 millions EUR. With the total absolute cost spent during the period 2021-2017 of ~ 8377 millions EUR it was possible an average reduction year-on-year by ~ 5 % of total GHGs emissions starting from the reference year 2017 and until 2021, with an average of ~ 101.5 millions EUR per million tonnes CO_2e reduction. The total sum in oil, gas and energy industry spent during the years 2017 – 2021 for reducing the output of CO2e by all the 6 companies analyzed was 12756 millions EUR, which prevented, during the same period of time, more than 1234 million tonnes CO_2e to be emitted.

The Non-Financial Reporting Directive (NFRD) implementation in 2014 was an initiative that shed light on many industries that contributes to the pollution of the Planetary Atmosphere, and one of the industries that could be categorized as a big polluter is the oil, gas and energy industry. In the light of the new special directive, Corporate Sustainability Reporting Directive (CSRD), that extends the previous directive, NFRD, we examined and compared the reported non-financial data provided by the largest 6 European based energy companies and correlated it with the financial investments and analyzed the efficiency of each company in reducing the greenhouse gasses (GHG) emissions and its effects.

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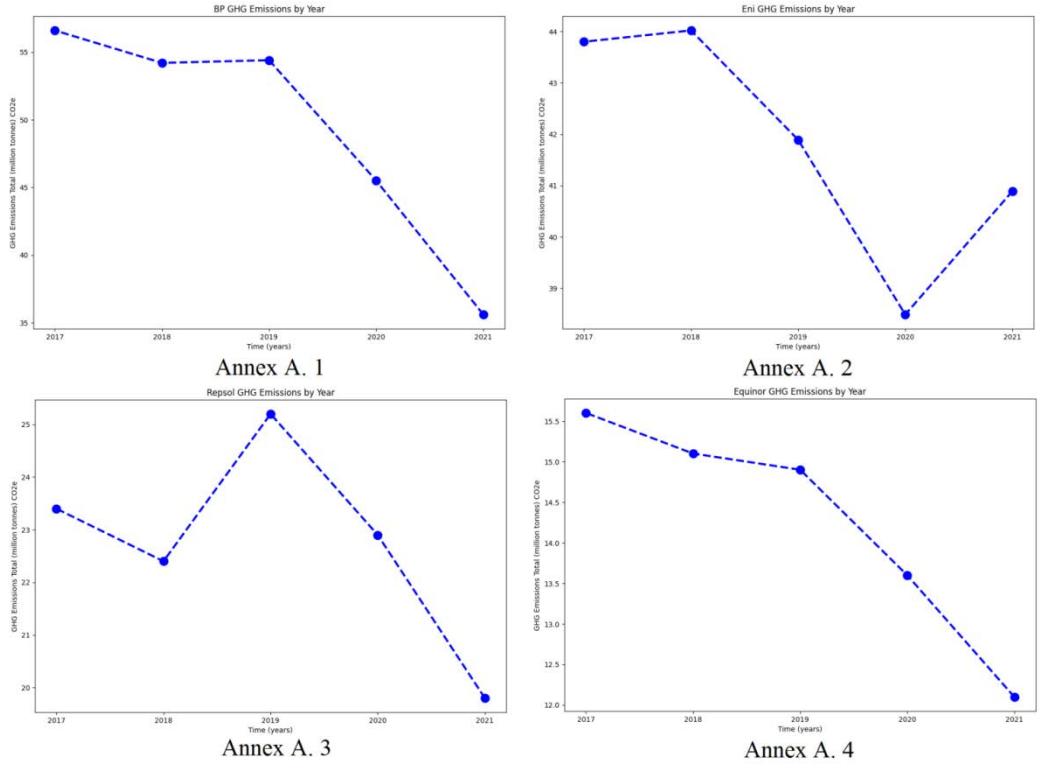
Appendix

Total GHG Emissions Reductions (Calculated in CO_2e) from BP (**Annex A.1**), *Eni* (**Annex A.2**), *Repsol* (**Annex A.3**) *and Equinor* (**Annex A.4**) *for the Period 2017–2021*



Source: Own illustration based on analyzed companies' sustainability reports.

Historical Reference Rates 2017-2021 USD to EUR

Year	2021	2020	2019	2018	2017
USD/EUR Rate	0.8458	0.877	0.8931	0.8475	0.8865

Source: European Central Bank. [Accessed 15 May 2023]