How Shareholders React to Sustainable Narratives about Leading European Energy Companies? An Event Study using Sentiment Data from the Global Database for Events, Language and Tone (GDELT)

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Abstract
This study aims to investigate how the shareholders of leading European energy companies value sustainability narratives. It uses news from the Global Database of Events, Location, Language, and Tone (GDELT) and analyses the cumulative average abnormal returns (CAAR) and abnormal volatilities (AV), incorporating the event study methodology. A total of 279,546 big news items were used, and 4,026 event studies were conducted. The extensive analysis of data and the segmentation of the news by tone, type of energy generation and environmental consequences helps to understand shareholders’ investment decisions. This study found that the sustainability narrative significantly impacts shareholder value; however, this narrative’s interpretation has no consensus. The sustainability news about these companies moves the stock market upwards for some shareholders, while others do the contrary. These results are observed by comparing CAAR and AV. The results found by this article are crucial for regulators to push forward an effective ecological transition. It should be legislated so that there is a common shareholders’ narrative, discouraging highly polluting investments.

Keywords: sustainability news, stock markets, event study, Europe, NLP

Introduction
The awareness of climate change and its causes has increased exponentially in recent years (Grimmer and Bingham 2013; Qader and Zainuddin 2011). More so since the Paris Agreement (COP25; United Nations Climate Change 2019), where there was an unprecedented worldwide consensus to reduce CO2 emissions and limit the increase in temperature to 1.5ºC warmings above pre-industrial levels.

Climate awareness is changing investment patterns. While environmental, social and corporate governance (ESG) financial investments remain a minority compared to traditional
investments, they have increased exponentially, motivated by the increasing attention, acceptance and awareness of climate change (Cornell and Damodaran 2020; Matos 2020; Pinney, Lawrence and Lau 2019; Ruggie and Middleton 2019). According to Bloomberg and their own compiled data, ESG exchange-traded funds have almost tripled from 2019 to 2020. In addition, the Global Sustainable Investment review of 2018 quantified approximately $31 trillion in sustainable assets, increasing by 34% since 2016.

Confirming the ESG investment trend, BlackRock Inc., the world’s largest investment fund with nearly $7 trillion under its management, announced in January 2020 that from then on, it would make sustainability the core of its investments and disinvest in fossil fuels (Sorkin 2020). However, BlackRock is not the first investment fund that reflects investors’ growing environmental awareness. For example, in December 2019, 631 investors handling $37 trillion signed a letter urging governments to curb climate change and meet the objectives of the Paris Agreement.

Still, while companies claim to be increasingly sustainable, greenhouse gases are not reducing (Elmalt, Igan and Kirki, 2021). Besides, fossil fuels remain the primary energy source, representing almost 70% of energy production in Europe (European Environment Agency 2020). Consequently, the stock market’s interests are still strongly linked to fossil energy, as they have the dominant energy position. Therefore, there is a clear incentive for companies to appear sustainable and camouflage their interest in the fossil fuel industries.

The scientific community has validated that climate change is factual, but the narrative is not evident for market participants. They face contradictions between the search for high returns and the specifics about greenhouse gas emissions.

Society, regulators, politicians and even investors have increasingly recognized sustainability. However, are companies embracing a more ecological path rewarded by shareholders? Are they more vulnerable to negative news? Or, on the contrary, do they
continue to invest in the business as usual? If investments in ESG continue to grow and greenhouse gas emissions are not reduced, are equity markets incentivising greenwashing?

Our research wants to answer how shareholders react through their investment decisions when corporate sustainability information is released. We have studied this from three different perspectives: from the point of view of profitability (Ang 2015; Friede, Busch and Bassen 2015; Kumar et al. 2016; Maiti 2020; Muhmad and Muhamad 2020; Sharma et al. 2021), from behavioural economics, to understanding the shareholders’ bias, and are shareholders able to assimilate the facts and act rationally? Do they overreact to negative information (Olsen 1998; Shleifer and Vishny 1997; Tetlock 2007), and from narrative economics, to understand if there is consensus in the sustainability narrative and which narratives go viral (Shiller 2019).

This research studies the short-term impact on the stock market of sustainability news for leading European energy companies (Thomson Reuters Top 100 Global Energy Leaders Ranking 2019). The objective is to understand the average sentiment of the energy shareholder about the sustainability narrative and its impact on its shareholder’s value. Since the economic and strategic incentives of the energy investor can vary significantly depending on their current investment portfolio, we have segmented the news according to the tone (positive, negative or neutral), type of energy generation (fossil fuels, renewables or nuclear) and environmental consequences (CO2, methane, global warming…). Thus, we can analyse shareholders’ reactions in greater detail.

We analysed all sustainability news with high volume intensity about our companies’ sample published digitally worldwide from January 2017 to December 2019, through the event study methodology. A total of 279,546 big news events were leveraged.

We conducted 4,026 event studies with five different market models, to measure the economic impact of sustainability news. The event study methodology analyses, whether a
series of events, impact a variable of interest. In this case, the shares’ returns, and volatilities are examined by analysing the behaviour of their historical prices and performances.

This study uses the open-source databases Global Database of Events, Location, Language, and Tone (GDELT) for the news and Yahoo Finance for the market data. GDELT is the largest news database worldwide.

The main contribution of this investigation to the existing scientific literature is that it empirically confirms that corporate sustainability news got viral, creating a narrative that impacts shareholder value significantly. Nevertheless, this impact is observed more significantly in the study of volatilities than in the study of returns, indicating a lack of consensus among European energy companies’ shareholders.

Our results ratify those of Elmalt, Igan and Kirki (2021), who found that Co2 emissions have not been reduced, although ESG investments continue to increase. We observe that the sustainability narrative is not the same for all shareholders. Even though the stock market is not isolated from the ecological transition, the interaction of investors is often contrary to the Paris agreements (COP25; United Nations Climate Change 2019), encouraging companies to continue with business as usual instead of decarbonization.

These results point to a regulatory need to pressure market participants to disinvest from highly carbonized companies, so climate change scientists’ narrative is the same for shareholders.

Another contribution is the magnitude of the study, which guarantees the robustness of the results. We identified 279,546 big news events and conducted 7,425 event studies. Therefore, we try to fill the existent literature gap as Grewal (2020) confirm: ‘…researchers have spent little effort to measure corporate sustainability performance… we view this space as the single biggest opportunity for researchers to advance the field.’ Carolina Rezende de
Carvalho Ferreira et al. (2016) concluded that more quantitative research is needed to analyse the relationship between sustainability and finance.

Based on the literature survey, no study has investigated the effects on the stock market’s capitalization based on all the news published worldwide on sustainability. Several studies have used the event study methodology to measure the connection between environmental measures and financial performance. However, those studies had a smaller sample size, and the information these studies analysed is provided by the companies they analysed, not the media.

Likewise, it is worth highlighting the robustness of the event study. We launched a competition of five different market models, accepting only significant results if at least three of the five models provided such a conclusion.

The rest of the article is organized as follows: the following section will be the literature review; the third section will detail the sample and the methodology; after that, the results will be shown in the fourth section, and finally, the conclusions.

**Literature review**

There is increasing pressure for companies to behave sustainably; however, if market participants do not value those efforts, companies have no real incentive to be or continue to be sustainable (Cheung 2011). Therefore, it is crucial to understand the market dynamics on sustainability to adjust the regulations that encourage sustainable investments and discourage those that are not.

The scientific literature in this field is extensive and extends to the 1970s, where investments in sustainability were perceived as a mere expense that subtracted profits from shareholders (Clotfelter 1985; Friedman 1970; Navarro 1988).

Nowadays, the literature that analyses the reactions of market participants to corporate information regarding sustainability (sustainability reports, press releases, inclusion in
sustainable rankings) is still extensive. However, the results of these studies do not show agreement on their conclusions because their samples are usually small, and they do not analyse all the information available and are mainly hand picking (Capelle-Blanchard and Petit 2019).

Another explanation for the lack of consensus, as Renneboog (2008) assures, is little scientific evidence that the investor makes decisions based on factors not related to financial performance.

However, according to Unruh et al., (2016), 60% of investors associate corporate sustainability with lower risk and lower capital costs for companies. Investors often correlate responsible behaviour and corporate stability. When companies face accusations of irresponsible behaviour, it can cause them to lose their reputation or even value in the company. Therefore, investors prefer to invest in reputable companies, as they consider them less vulnerable to negative news. Investors in these companies may justify bad news from a reputable company, as an isolated incident rather than systematic misbehaviour (Aouadi and Marsat 2016; Flammer 2013; Oberndorfer et al. 2013).

Our study analyses sustainability news worldwide because it is an excellent thermometer to understand the investor’s narrative on sustainability. According to Tetlock (2014), the media serve as providers of information between companies and shareholders, and significantly shape their expectations. Behavioural finance studies argue that investors affected by their cognitive bias cannot assimilate all information and act rationally and overreact to negative news (Olsen 1998; Shleifer and Vishny 1997; Tetlock 2007). Shiller (2019) argues that news can expand like a pandemic and cause significant economic events, including movement in stock markets. Our study aims to complement these studies and answer if negative sustainability news also has more significant reactions on the stock market and if they can go viral (Shiller 2019).
Recent studies that analyse news about sustainability or ESG are scarce. That is why our article wants to contribute to expanding the existing literature. First, it is worth mentioning Flammer (2013), where 117 positive and 156 negative sustainability news from the Wall Street Journal are studied from 1980 to 2009 for all US-listed companies. Its results find negative abnormal returns after the publication of negative news and positive after positive news. As previously researchers (Aouadi and Marsat 2016; Oberndorfer et al. 2013), Flammer (2013) also concludes that companies with strong environmental performance react less negatively to negative news. Krüger (2015) studies 2116 ESG news from 725 companies during 2001–2007. The results confirm that negative news causes the share price to fall, while in the case of positive news, the reaction only occurs when the relationship with stakeholders is poor. He also concludes that reactions are more significant when the news uses legal solid and economic language. The most recent paper is Capelle-Blanchard and Petit (2019). It analysed more than 33,000 ESG news from the world’s largest listed multinationals between 2002 and 2010; they conclude that market participants do not react to corporate advertisements by companies nor NGO reports. However, they do it with the news, especially the negative ones. As Flammer (2013), Capelle-Blanchard and Petit (2019) also confirm that having an ESG reputation protects against potential shareholder losses due to bad press. For this reason, they affirm that there may be an incentive for companies to publish their positive ESG news to protect themselves from the negative impacts of contrary news. Finally, finding similar conclusions, Ahsan and Qureshi (2021) find that the European firms that disclose environmental and social information increase their reputation.

**Materials and Methods**

**Materials**

The sample of this article contains all the news published digitally worldwide, which mentions the leading European energy companies and a combination of sustainability
keywords, as displayed in Table 1; for example: ‘Acea SP’ + ‘gas’ + ‘nitrogen oxides.’ The
analysis period was from January 2017 to December 2019.

Table 1. Data dictionary

<table>
<thead>
<tr>
<th>Companies</th>
<th>Type of energy</th>
<th>Environmental consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acea Sp</td>
<td>Gas</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Aker Solutions</td>
<td>Fossil Fuels</td>
<td>Phosphorus</td>
</tr>
<tr>
<td>Cairn India</td>
<td>Renewables</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>DCC</td>
<td>Nuclear</td>
<td>CO2</td>
</tr>
<tr>
<td>EON SE</td>
<td>Coal</td>
<td>Methane</td>
</tr>
<tr>
<td>EDF</td>
<td>Solar</td>
<td>Ozone</td>
</tr>
<tr>
<td>Enagas</td>
<td>Hydro</td>
<td>Pollution</td>
</tr>
<tr>
<td>Engie</td>
<td>Wind</td>
<td>Waste</td>
</tr>
<tr>
<td>Eni</td>
<td>Biomass</td>
<td>Plastic</td>
</tr>
<tr>
<td>Gruppa Lotos</td>
<td>Geothermal</td>
<td>Footprint</td>
</tr>
<tr>
<td>Hellenic Petroleum</td>
<td>Marine</td>
<td>Aerosol</td>
</tr>
<tr>
<td>Hera</td>
<td>Tidal</td>
<td>Global warming</td>
</tr>
<tr>
<td>Motor Oil Hellas</td>
<td>Petrochemical</td>
<td>Emissions</td>
</tr>
<tr>
<td>National Grid</td>
<td>Petrol</td>
<td>Greenhouse gas</td>
</tr>
<tr>
<td>Neste Oyj</td>
<td>Petroleum</td>
<td>Air quality</td>
</tr>
<tr>
<td>Lukoil</td>
<td>Ethanol</td>
<td>Sea level</td>
</tr>
<tr>
<td>OMV AG</td>
<td></td>
<td>Climate change</td>
</tr>
<tr>
<td>Orsted</td>
<td></td>
<td>Extreme weather</td>
</tr>
<tr>
<td>Pennon Group</td>
<td></td>
<td>Natural resources</td>
</tr>
<tr>
<td>Petrofac</td>
<td></td>
<td>Biodiversity</td>
</tr>
<tr>
<td>PKN ORLEN</td>
<td></td>
<td>Toxic</td>
</tr>
<tr>
<td>Repsol</td>
<td></td>
<td>Extinction</td>
</tr>
<tr>
<td>Rosneft</td>
<td></td>
<td>Nitrogen cycle</td>
</tr>
<tr>
<td>Royal Dutch Shell</td>
<td></td>
<td>Ocean acidification</td>
</tr>
<tr>
<td>Rubis</td>
<td></td>
<td>Land use</td>
</tr>
<tr>
<td>RWE</td>
<td></td>
<td>Fresh water</td>
</tr>
<tr>
<td>Saipem</td>
<td></td>
<td>Depletion</td>
</tr>
<tr>
<td>Saras</td>
<td></td>
<td>Chemical Pollution</td>
</tr>
<tr>
<td>Siemens Gamesa</td>
<td></td>
<td>Overexploitation</td>
</tr>
<tr>
<td>Snam</td>
<td></td>
<td>Sustainability</td>
</tr>
<tr>
<td>Tecnicas Reunidas</td>
<td></td>
<td>Ecosystem</td>
</tr>
<tr>
<td>Tullow Oil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tupras</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vallourec</td>
<td></td>
<td></td>
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<tr>
<td>Vestas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enel</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The databases used:

- Thomson Reuters Top 100 Global Energy Leaders Ranking 2019 for European energy companies
- GDELT (The Global Database of Events, Language, and Tone) for news
- Yahoo Finance for financial data
**Methods**

**News Analysis Methodology**

For downloading, cleaning, and analysing all global news, we developed a Python code that contains a combination of the data dictionary keywords, creating more than 28,000 different GDELT queries. This news was segmented using natural language processing techniques (GDELT Global Knowledge Graph [GKG] Version 2.0) based on the tone of the news (positive, negative, or neutral) and volume intensity (the combination of the number of times the news is read and its coverage).

Accordingly, we identified the ‘Big news,’ or high-impact news, when volume intensity was above two standard deviations from the mean. Two standard deviations above the mean represent between 2.5% and 5% of the total sample, thus guaranteeing that we are analysing the tail of the total distribution, which translates into the analysis of the news with the highest volume intensity. Finally, ‘Big News’ are the events in the event study.

**Event Study Methodology, Market Models and Significance Analysis**

We used the event study methodology to measure the economic impact of the ‘Big News’. Assuming that financial markets are semi-strongly efficient, prices should react immediately to the news and not show any unusual behaviour before or after the announcement (Fama 1970).

The event studies were defined as a combination of energy, environmental consequences, tone, and the five market models, resulting in 7,425 event studies. Finally, 4,026 were used, as they had sufficient data (news). Regarding the abnormal volatilities (AV), we performed single-day test statistics and 585 event studies segmented by tone. The average number of events was 174.
Following Bartholy, Olson and Peare (2007), event studies with less than 50 events were excluded to provide an acceptable size and power in the statistics results. This work followed the methodology of Brown and Warner (1985), with the event day being the day of publication of the ‘Big News’. Previous finance research concluded that capital markets reveal all possible information about companies in their stock prices. Thus, the event study methodology can analyse how a singular event alternates the company’s forecasts by quantifying its impact on its stock price. Among the scientific literature, this type of analysis is commonly performed using stock returns. This study examines the returns and volatilities.

According to MacKinlay (1997), to determine the lead of events to analyse the cumulative average abnormal returns (CAAR), the following characteristics should be considered:

1. Day of the event: This is the day the news is published. If various news items explain the same content within a 14-day window, the news item with the highest volume intensity index will be used as the event date.

2. Event window: The event window was [-7, 7]. Calculating the accumulated abnormal returns in 14 days can determine the variation or abnormal return that sustainability news can cause to the companies. The window is so wide that it collects all the information emitted by different media, explaining the same content.

3. Estimation window: A 120-day pre-period was considered for each event described in the previous section.

4. Expected return models: The models used for CAAR included: market model, market adjusted, comparison period mean adjusted, generalized autoregressive conditional heteroscedasticity (GARCH), and exponential generalized autoregressive conditional heteroscedasticity (EGARCH).

- Market model (mm) manages the actual returns of the analysed market and the correlation of the firm’s stock with that market. Equations (1) and (2) specify the
model. The abnormal return on a particular day in the event window describes the
difference between the actual stock return \(R_{i,t}\) and the expected return, foretold
based on two facts: the average relationship between the firm’s stock and its reference
market (expressed by the \(\alpha\) and \(\beta\) parameters), and the actual reference market’s return
\(R_{m,t}\).
\[
R_{it} = \alpha_i + \beta_i \cdot R_{mt} + \epsilon_{it} \quad (1)
\]
\[
AR_{it} = Rit - (\alpha_i + \beta_i \cdot R_{m,t}) \quad (2)
\]
- Market adjusted (mam) is a model widely used to control the event’s possible effects,
the news published in this case, in the stock market. However, it is not adjusted for
basic capital asset pricing model (CAPM) risk. Therefore, it is drawn from the focal
company’s distinctive systematic risk profile. In the market-adjusted model, the
observed return of the market on day \(t\) \(R_{mt}\) is subtracted from the return \(R_{it}\) of
observation \(i\) on day \(t\). The abnormal return:
\[
AR_{it} = Rit - R_{mt} \quad (3)
\]
- Comparison period mean adjusted model (cpmam), here, the abnormal return in the
event window is the return of observation \(i\) on day \(t\) minus the average return of the
observation \(i\) in the estimation window:
\[
AR_{it} = Rit - \bar{R}_i \quad (4)
\]
where \( \bar{R}_i = \frac{1}{T_1 - T_0} \sum_{t=0}^{T_1} R_{it} \quad (5) \)
- The market model GARCH and EGARCH error estimation (garch/egarch) use a
single factor market model with GARCH (1, 1) errors estimated, specifically:
\[
R_{it} = \alpha_i + \beta_i \cdot R_{mt} + \epsilon_{it} \quad (6)
\]
The conditional variance (Bollerslev 1986) can be written as:
\[
\sigma^2_t = \omega + \gamma_1 \cdot \epsilon^2_{t-1} + \delta_1 \cdot \sigma^2_{t-1} \quad (7)
\]
where, \(\sigma^2_t\) indicates the conditional variance, \(\omega\) is the intercept, and \(\epsilon^2_t\) is the residuals
from the mean classification process. The parameters are projected by the maximum
probability (a nonlinear solver is used for the optimisation problem).
The expected returns were obtained from the estimated coefficients for each company and event, using a pre-event period that begins on day 140 and ends at day 20, with day 0 being the day of publication of the ‘Big News’. Given the nature of the information examined, it is interesting to analyse the market reaction around the event date because there could be an anticipated reaction due to possible information leaks or a delayed response. Therefore, the period \([-7, +7]\] was used as the event window. The average abnormal returns associated with a distinct point in time before or after the event day are defined as follows:

\[
AAR_i = \frac{1}{N} \sum_{t=1}^{N} AR_{i,t} \tag{8}
\]

Cumulative abnormal return, illustrated in equation (9), adds an abnormal daily return for various intervals within the event window \([-7, +7]\).

\[
CAR(t_1, t_2) = \sum_{t_1}^{t_2} AR_{i,t} \tag{9}
\]

The hypotheses of this study were analysed using a parametric test and the skewness-adjusted t-test. The skewness-adjusted t-test improved the cross-sectional t-test for skewed abnormal return distribution. The skewness estimation is specified by:

\[
Y = \frac{N}{(N-2)(N-1)} \sum_{i=1}^{N} (CAR_i - CAAR)^3 \frac{S_{CAAR}}{S} \tag{10}
\]

moreover, let \( S = \frac{CAAR}{S_{CAAR}} \) (11)

then the skewness adjusted test statistic for CAAR is given by

\[
t_{skew} = \sqrt{N} \left( S + \frac{1}{3} yS^2 + \frac{1}{27} y^2 S^3 + \frac{1}{6N} y \right) \tag{12}
\]

Due to the many news items explored and the conflicting interests of the sample energy companies (extremely connected to fossil fuels), positive and negative abnormal returns may counterbalance each other. If this happens, the study of abnormal returns would not reveal whether certain news moved the investor’s decision to buy or sell. To solve this problem, a volatility analysis that studies absolute values was performed.

A high standard deviation indicates that the returns of the analysed assets experienced substantial variations. However, a low standard deviation indicates that these returns have
been much more stable over time. Understandably, the greater the standard deviation, the
greater is the potential loss for shareholders.

A single-day test statistic that tested the effects on the mean and conditional volatility
function on the time series simultaneously (Balaban and Constantinou 2006) was used. The
time series is utilized as a whole, so we do not need an event window. We used a market
model with GARCH errors (Bollerslev 1986).

\[ R_{ni} = \alpha_i + \beta_i \cdot Rmt + \gamma_i \cdot Di_t + \varepsilon_{it} \] (13)
The conditional variance is written as:

\[ \sigma_i^2 = \omega + \gamma_i \cdot \varepsilon^2_{t-1} + \delta_1 \cdot \sigma^2_{t-1} + \delta_i \cdot Di_t \] (14)

A parametric test was used to test whether the studied volatilities were statistically
significant: Average of the cross-sectional-corrected-Vy-t-Test,

\[ t_{AV,CBM} = \frac{s}{\left(\frac{1}{n(n-1)} \sum_{i=1}^{N}(s_i - \bar{s})^2\right)^{0.5}} \] (15)

The event studies were conducted in the Python software environment, using the

Results

The result section is divided into two parts: first, the CAAR results are presented,
followed by the AV.

The composition of companies in the sample is strongly linked to fossil fuels, such
that the results reflect shareholders’ opinions in this sort of industry.

**Cumulative Average Abnormal Returns (CAAR)**

The results are shown aggregated in the following section.

Figure 1. Number of event studies and CAAR results.
General

Figure 1 summarizes the results of the 4,026 event studies, differentiated by the tone of the news. The bar graph analyses whether the event studies’ results are significant or not.

The first conclusion is that regardless of the tone of the news, most of them did not impact the behaviour of shareholders. Of the 4,026 event studies, only 255 were statistically significant with any of the five market models, and only 148 had statistically significant results refuted by three or more models. There are several reasons for this. First, as Shiller (2019) demonstrated, only some news stories go viral, and it is challenging to find out which ones and why. Second, the data dictionary spans many words that encompass news items that could not interest the shareholders. Figure 1 shows that neutral news event studies were almost 30% more abundant than positive news event studies and 13% more frequent than negative news events. However, the number of significant event studies on positive news was 35% higher than negative and neutral news.

Table 2 shows the average statistics for all event studies with significant results with three or more market models. This table’s main conclusion is that negative news tended to cause negative reactions in shareholders, causing a drop in stock prices. This finding aligns with the negativity theory bias. Bad has a more significant impact than good, around four times more, in this case, three times more. Tierney and Baumesiter (2019) and Corns (2018)
describe it as a proven empirically psychological principle that affects humans in everyday life situations. In addition, specific finance studies argue that shareholders affected by cognitive bias overreact to negative news (Olsen 1998; Shleifer and Vishny 1997; Tetlock 2007).

However, positive, and neutral news tended to compensate for their impact when calculating averages, as the reading of positive and neutral news for shareholders is not homogeneous.

Table 2. CAAR Statistics summary from all significant event studies.

<table>
<thead>
<tr>
<th>Tone</th>
<th>Event window</th>
<th>Average of Skewness Corrected T</th>
<th>Average of CAAR Value</th>
<th>Average of p_val</th>
<th>Average sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>(-7,7)</td>
<td>-1,1494</td>
<td>-0,0079</td>
<td>0,0182</td>
<td>116</td>
</tr>
<tr>
<td>Neutral</td>
<td>(-7,7)</td>
<td>0,3018</td>
<td>0,0026</td>
<td>0,0217</td>
<td>142</td>
</tr>
<tr>
<td>Positive</td>
<td>(-7,7)</td>
<td>-0,3904</td>
<td>-0,0016</td>
<td>0,0168</td>
<td>107</td>
</tr>
</tbody>
</table>

Table 3 summarizes the results of the 4,024 event studies, differentiated by the tone of the news and aggregated by type of energy. The event window was [-7, 7].

The table shows that there is more negative and neutral news than positive. However, renewable energy news and positive tone news were more frequently statistically significant. This finding refutes the negative bias theory, stating that humans focus more strongly on negative news than positive. It is also important to stress that significant positive news about fossil fuels was more abundant than negative or neutral news, indicating that positive sustainability narrative benefits more than negative news penalising them (Capelle-Blanchard and Petit 2019), a clear incentive for greenwashing.

Table 3. CAAR event studies’ summary segmented by type of energy.
Table 4 presents the average of all statistically significant abnormal return event studies aggregated by type of energy; in addition, the average skewness corrected T, average CAAR value, and average P-value. The event window was [-7, 7].

This table shows that the statistically significant results correspond to the neutral news on fossil and nuclear energies, with a positive sign, implying an increase in the share’s profitability. Additionally, we find significance in positive nuclear news, with a negative sign indicating a dropped in share prices.

Even without finding statistical significance, the news on renewable energies always obtained results with a negative sign. On the other hand, fossil energies obtain more significant reactions when they are neutral and positive. Nuclear energies showed statistically significant positive reactions with neutral news and negative with positive news, indicating that their narrative was different for all shareholders.

The news with a positive tone on sustainability caused more frequent negative reactions in the stock market, except when they covered fossil fuel companies.

Regarding the positive reactions, the shareholders valued positive news about fossil fuel companies, sending a signal that their efforts to appear greener are valued.

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Table 4. CAAR for significant queries aggregated by type of energy.

<table>
<thead>
<tr>
<th>Type of Energy</th>
<th>Negative Average of Skewness Corrected T</th>
<th>Negative Average of CAAR Value</th>
<th>Negative Average of P value</th>
<th>Neutral Average of Skewness Corrected T</th>
<th>Neutral Average of CAAR Value</th>
<th>Neutral Average of P value</th>
<th>Positive Average of Skewness Corrected T</th>
<th>Positive Average of CAAR Value</th>
<th>Positive Average of P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewables</td>
<td>-0.8493</td>
<td>-0.0060</td>
<td>0.023</td>
<td>-0.4885</td>
<td>-0.0033</td>
<td>0.025</td>
<td>-1.4978</td>
<td>-0.0084</td>
<td>0.015</td>
</tr>
<tr>
<td>Fossil fuels</td>
<td>-1.1284</td>
<td>-0.0081</td>
<td>0.018</td>
<td>2.5198</td>
<td>0.0253</td>
<td>0.022</td>
<td>1.4710</td>
<td>0.0100</td>
<td>0.020</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0.0160</td>
<td>-0.0013</td>
<td>0.017</td>
<td>2.9321</td>
<td>0.0126</td>
<td>0.004</td>
<td>-3.2168</td>
<td>-0.0201</td>
<td>0.010</td>
</tr>
</tbody>
</table>
The CAAR results indicated no consensus among shareholders concerning the sustainability narrative, probably because of the incentives for the companies in the sample, highly linked to fossil fuels. News that GDELT algorithms classify as positive tone can be interpreted by shareholders as negative for their economic interests and vice versa. It should also be noted that CAAR reactions could compensate when there is not an aligned narrative.

To obtain a clear view of the shareholder’s opinion, the AVs were studied. The AV values are squared, so unlike the CAARs, they cannot be offset.

**Abnormal Volatilities (AV)**

Figure 2 summarizes the impact of all AV event studies. In contrast to CAARs, the proportion of event studies with statistically significant results was much higher. For example, for negative news, 39% significant results were found, 45% on neutral news, and 36% for positive news. On CAARs, the statistically significant proportion of event studies did not reach 5% of the total. These results indicate, as suspected, that shareholders were not sharing the sustainability narrative. Therefore, CAAR results were counterbalanced.

Figure 2. Number of event studies and AV results.
Table 5 shows the average statistics for all the event studies with significant results. It corroborates that the CAAR results were compensated. Because, when working with absolute values, there was greater volatility in the days of sustainability news publication.

Table 5. AV Statistics summary from all significant event studies.

<table>
<thead>
<tr>
<th>Tone</th>
<th>Average of Cross-Sectional-Corrected-Vy-t-Test</th>
<th>Average of p_val</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>1,9451</td>
<td>0,1178</td>
</tr>
<tr>
<td>Neutral</td>
<td>2,0545</td>
<td>0,1000</td>
</tr>
<tr>
<td>Positive</td>
<td>1,9040</td>
<td>0,1266</td>
</tr>
</tbody>
</table>

Table 6 summarises all event studies segmented by energy type. Remarkably, the most frequent news and those with more significant results were renewable energies, regardless of the tone. The same happened in Table 3, where CAARs were analysed. The differences from Table 3 were found in nuclear energy. Although the number of nuclear energy news was small, it was the one that had the higher significant results, where more than half of the event studies performed were statistically significant.

Table 6. AV event studies’ summary segmented by type of energy.

<table>
<thead>
<tr>
<th>Type of energy</th>
<th>Negative tone news</th>
<th>Neutral tone news</th>
<th>Positive tone news</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No statistical significance</td>
<td>Statistical significance</td>
<td>No statistical significance</td>
</tr>
<tr>
<td>Renewables</td>
<td>67</td>
<td>39</td>
<td>64</td>
</tr>
<tr>
<td>Fossil fuels</td>
<td>43</td>
<td>27</td>
<td>34</td>
</tr>
<tr>
<td>Nuclear</td>
<td>9</td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 7 highlights the average of all statistically significant abnormal volatile event studies aggregated by type of energy. In addition, the table details the average of the Cross-Sectional-Corrected-Vy-t-Test and the average of p-value. This table shows that all types of energies and news tones had a statistically significant impact, in contrast with Table 4, where CAAR results were not.
Table 7. AV for significant queries aggregated by type of energy.

<table>
<thead>
<tr>
<th>Type of energy</th>
<th>Average of Cross-Sectional Corrected-Vy-t-Test</th>
<th>Average of P value</th>
<th>Average of Cross-Sectional Corrected-Vy-t-Test</th>
<th>Average of P value</th>
<th>Average of Cross-Sectional Corrected-Vy-t-Test</th>
<th>Average of P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewables</td>
<td>2,5361</td>
<td>0,0230</td>
<td>2,7903</td>
<td>0,0168</td>
<td>2,6560</td>
<td>0,0202</td>
</tr>
<tr>
<td>Fossil fuels</td>
<td>2,8404</td>
<td>0,0135</td>
<td>2,6904</td>
<td>0,0164</td>
<td>2,6833</td>
<td>0,0163</td>
</tr>
<tr>
<td>Nuclear</td>
<td>2,4001</td>
<td>0,0141</td>
<td>2,5860</td>
<td>0,0230</td>
<td>1,9867</td>
<td>0,0250</td>
</tr>
</tbody>
</table>

Discussion

This study confirms that sustainability news is followed by the European energy companies’ shareholders and affects the stock market. However, there is no shareholder consensus on their narrative, indicating that while some value positively the companies’ efforts to be more sustainable, others penalize it. These results align with Elmalt, Igan and Kirki, 2021, where they confirm how CO2 emissions are not being reduced even when there are more companies than ever claiming to be sustainable. If all shareholders do not share incentives, and it remains profitable to invest in high polluters, no progress can be made towards a green transition.

These results are of critical importance for policymakers, who must, through regulation, change the shareholders’ narrative towards decarbonization. To do this, we propose 1) Standard and mandatory sustainability audit for companies to increase transparency and accountability, 2) increase CO2 dividend to reduce pollution incentives (Akerlof et al. 2019) and 3) increase the pressure on fake news, media independence must prevail, and fact-based information must be guaranteed.

The limitations of this research are the classics of the event study methodology: First, the abnormal returns cannot entirely be the result of the market reaction to the sample’s sustainability news, as other events cannot be isolated. Second, it is difficult to determine precise estimation periods. If we do not take a long window event, the risk is not to catch the
real media repercussion, and at the same time, the confounding effect with other events can occur. The data dictionary should also be highlighted as a limitation, as it could be missing keywords to make the news search more efficient.

**Conclusions**

The objective of this research was to analyse the impact on the stock market capitalisation of sustainability news for leading European energy companies. This research intended to capture the average shareholder’s reactions to companies’ sustainability narratives and the consequences on shareholder value leveraging global news data.

We identified “Big News” as high impact news, publicly available at GDELT from January 2017 to December 2019, mentioning a combination of terms (Table 1) that includes: the sample companies, type of energy generation, environmental consequences, and the news’ tone. Then, using the event study methodology, we analysed how shareholders value sustainability news and companies’ impact on getting good or bad press. It is remarkable the magnitude of the study. We identified 279,546 news events and conducted 7,425 event studies.

This study analysed CAARs and AVs. However, due to multiple news events and the conflicting interests at the energy companies of the sample, mainly fossil fuel producers, the positive and negative CAAR, could cancel each other. Consequently, a volatility study was conducted, which answered this potential problem by studying absolute values.

The main contribution of this investigation to the existing scientific literature is the confirmation that sustainability events got viral, creating a narrative that impacts shareholder value significantly. Nevertheless, the ratio of significant events is much higher in terms of AV than CAAR, showing no shareholder consensus about the narrative.

As Tetlock (2007) argued, negative news impacts the market around three times more than positive news (Table 2) with CAAR, while in terms of AV are very similar (Table 5).
Ergo, sustainability is on the shareholders’ agenda, as AV results show. All types of energies and all tones have a high statistically significant impact, and all of them have very similar magnitudes (Table 7).

In terms of the statistically significant CAAR, shareholders show consensus increasing the stock market value when neutral, fossil, and nuclear events are released. In contrast, they decrease when positive/nuclear events take place. This result confirms the impact of the European denuclearisation narrative after the Chernobyl disaster in 1986.

The number of news articles analysed, and the number of event studies conducted, is much higher than in any previous research, allowing robust results to be obtained. In addition, to further guarantee the robustness of the study, results were only considered significant with a consensus of more than three out of five market models.

To ensure and facilitate replicability, all the databases used are open source: GDELT for the news and Yahoo Finance for the market data.

Finally, future research based on this study should analyse other markets to compare reactions and to understand possible cultural biases. It will also be interesting to identify which news items have had the most impact and study these cases individually, see how they have affected the different industries, fossil fuels, nuclear and renewables, and identify the conflicts of interest found in this research.

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Disclosure statement

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References


