

## Case Study

# Information refining and big data analysis on the crisis on the fossil fuel market to identify of Russia's hostile narratives towards European Union countries

Wiesław Cetera<sup>1</sup> · Aleksander Żołnierski<sup>2</sup> · Dariusz Jaruga<sup>1</sup> · Piotr Celiński<sup>1</sup> · Jan Grzegorek<sup>1</sup>

Received: 10 March 2023 / Accepted: 2 June 2023

Published online: 16 June 2023

© The Author(s) 2023 [OPEN](#)

## Abstract

Fossil fuels helped Russian president Putin build military power of Russia and attack Ukraine. Coal, gas and oil are being used by Putin's regime as weapons against the countries that are contractors and consumers of Russian fuels. The aim of this paper is to present a methodology based on refining information and Big Data analysis and to demonstrate the results, as well as to show trends and developments in relation to the response to the crisis on the fossil fuel market. Predictive methods and the techniques of sentiment analysis including the cluster analysis and the analysis of the variability of trends indicates that the European Union has taken over the burden of energy policy-making. This also indicates a downgrading of national policies and their weakness in resisting Russia's aggressive actions. The analysis of frequency confirms the markedly different Russian attitudes to Europe as a whole and to its individual members.

**Keywords** Behavioral data · Big data analytics · Artificial intelligence · Russia · Sentiment analysis · Fossil fuels · European economy · International relations · Political science · National security

## 1 Introduction—political background of the analysis

As fossil fuels helped Putin<sup>1</sup> both, to build military power and to use it as weapons against the countries that are contractors and consumers of Russian fuels, to identifying trends and developments in relation to the response to the crisis on the fossil fuel market is a challenge.

Russia has introduced the world to a new dimension of instability and uncertainty, and the full-scale war in Ukraine has proven that it is not just Europe, but the global dimension of this conflict in the context of fossil fuels that is changing the perception of gas, oil and coal [1].

Russia's invasion of Ukraine has had consequences for the energy security of much of the world. The implications of Russia's conflict with Ukraine in the context of energy were already discussed after the annexation of Crimea [2]. The war has increased the demand for oil and gas, above all in Europe, which is heavily dependent on Russian supplies. According to Schroders PLC—a British multinational asset management company, Russia accounts for around 12% of global

<sup>1</sup> Vladimir Vladimirovich Putin former intelligence officer, president of Russia. Putin has served continuously as president or prime minister since 1999: as prime minister from 1999 to 2000 and from 2008 to 2012, and as president from 2000 to 2008 and since 2012.

✉ Wiesław Cetera, w.cetera@uw.edu.pl | <sup>1</sup>The Faculty of Political Science and International Studies, University of Warsaw, Warsaw, Poland. <sup>2</sup>Institute of Economics, Polish Academy of Sciences, Warsaw, Poland.



oil supply and 17% of gas supply. Europe intends to reduce its dependence on Russian oil and natural gas, and the US is ready to increase its oil and natural gas exports to Europe. Planned savings in energy fuels entail a reduction in the use of other natural assets; some oil and gas companies are beginning to treat the water they use for fracking and are focusing on methane and sulphur recovery. The reduction in the supply of oil, gas and coal is putting upward pressure on mergers and acquisitions in the energy sectors and changing the investment strategies of energy companies. The shift towards wind, solar, nuclear energy and biogas (renewable natural gas—RNG)<sup>2</sup> with the development of new technologies such as batteries which allow the grid to be powered by renewable energy sources could reduce demand for fossil fuels. Another factor prompting investors to invest in energy, both in fossil fuels and renewable energy, is rising inflation [3].

Russia has begun to make increasing use of opportunities for political pressure on importers of its fossil fuels. Yegor Gaidar, the architect of post-Soviet free market reforms, warned of Putin's imperial nostalgia when Russian tanks rolled into Georgia in 2008; "the danger is that Putin may feel his time is running out" [4]. Already the power of the USSR under Brezhnev was built on high oil and gas prices. When these prices began to fall in the 1980s, Soviet rule collapsed with them. Back in 2006 and 2009, when Russia cut off supplies to Ukraine twice—and to European consumers who received gas through Ukraine—the EU began to look for alternative energy sources. As a result, between 2006 and 2013, the share of Russian gas in total consumption in Europe fell from 39 to 25%. Gazprom and its subsidiaries have therefore focused on buying up European infrastructure, and the annexation of Crimea should be a strong wake-up call for Europe on energy issues. The way to limit the power of the Russian monopoly and the influence on European politics through the use of price weapons is to establish alternative supply routes, so Gazprom has begun negotiating a 30 year agreement with Beijing. Russia had already been increasing spending since the annexation of Crimea by financing it with the sale of fossil fuels. Russia's budget was estimated to be balancing at USD 117 per barrel (compared to a break-even point of USD 45 per barrel in 2008) [5].

The Ukrainian crisis has been linked to energy security issues since its inception [6]. In the context of the energy crisis caused by Russia's invasion of Ukraine, it is hard not to mention the role of Belarus both in the course of the political and military crisis itself and the implications for the energy fuel market. From the very beginning in 2014 the military crisis in Ukraine has given Lukashenko's regime opportunities for economic cooperation with the West and to break its isolation, but the strategic alliance with Russia during the full-scale war is arguably becoming a problem for Minsk. The mobilisation in Belarus and the "support" that Lukashenko is providing to Putin may prove to be a sham (it should be remembered that Belarus did not recognise the annexation of Crimea and the regime in Minsk is playing a rather ambiguous role in this matter balancing between Russia and the EU). Supporting the pro-EU opposition in Belarus has been largely ineffective compared to similar efforts in Ukraine, Georgia and Moldova primarily due to Lukashenko's ambiguous stance. It seems that getting rid of the current government in Minsk could be tempting not only for the democratic opposition, but also for Putin, who could count on a more favourable stance from the potential new government. Fully dependent on natural gas imports from Russia, Belarus remains isolated from the West despite its inclusion in the European Union's Eastern Partnership programme. Minsk seems to be interested in closer ties with the European Union and the United States, so its role in the conflict in Ukraine is ambiguous. Belarus' international energy projects and regional connections with the Baltic States, especially Lithuania, may soon be key and could play an important role in shaping Minsk's ties with Russia and the West [7]. The role of Belarus in Russia's conflict with Ukraine, which has been smouldering for a decade and openly began with the annexation of Crimea, was and is not obvious. However, the large-scale invasion that began in February 2022, presented by the Russian side as a fight against Ukrainian fascists, had no legitimate reason [8]. The invasion has made it likely that Lukashenko intends to take advantage of the situation again and strengthen his position in Belarus, and possibly within the Union of Belarus and Russia. In the context of the Russian-Ukrainian war and the energy crisis, Romania also plays an important role. Bucharest is trying to keep Moldova in its sphere of influence by strengthening military ties with the United States, while diversifying its energy sources. Bucharest is not escalating tensions to the point where its security interests in Moldova and the Black Sea may be threatened by Russia. Putin, supporting the separatist aspirations of Transnistria, maintains some 1400 troops there. Russia is a very important political force for Moldova and a significant part of the population supports closer ties with Moscow instead of Brussels [9].

<sup>2</sup> Biogas is a renewable energy source – a mixture of gases produced from raw materials (agricultural waste, manure, sewage, green waste, wastewater, municipal waste, plant material, and food waste) primarily consisting of methane, carbon dioxide and hydrogen sulphide. Renewable natural gas (RNG) is a pipeline-quality biogas that is fully interchangeable with conventional natural gas.

The current bloody military conflict is having a particularly strong impact on Europe's energy stability, with some European Union countries—dependent on Russian fossil fuels. The right-wing governments of eastern European EU countries have made their countries' economies particularly dependent on Russian fossil fuels over recent years while blocking the development of renewable energy. Poland is a good example; the gradual reduction of coal imports (both steam and coking coal) between 2011 and 2015 (from nearly 15 million tonnes to 8 million tonnes) shot up with Law and Justice coming to power to over 19.2 million tonnes in 2018 and nearly 17 million tonnes in 2019, with over 9.6 million tonnes coming from Russia (in 2020). At the same time, on 27 July 2017, after 2 weeks from the day the draft was submitted to the Sejm, Members of Parliament of the ruling party passed another (after the one introduced in 2016) amendment to the Renewable Energy Sources Act, in practice preventing the development of this element of the Polish energy-mix. The first amendment to the RES Act (in 2016) had already caused 70% of wind power producers to start making losses. However, when facing problems in the long term, it is important to bear in mind not only the crisis caused by Russia's invasion, but the problem of global warming (the effects of which we can learn to combat earlier, primarily as a result of the war in Ukraine). The world should double its current spending on alternative energy, which can reduce carbon dioxide emissions and invest a total of USD 12 trillion by 2030 to have any chance of keeping global warming to 2 degrees Celsius [10]. Furthermore, as part of Europe's active supply diversification policy, Iran could have reduced Europe's energy dependence on Russia, but this was opposed by the White House policy of the Trump era. In addition, the Caucasus still plays a key role in connecting Europe and Asia also in terms of energy transfer. Both Iran and the Caucasus are considered reliable energy suppliers to Europe [11] as well as countries such as Norway, Qatar or USA. The problem for the EU is the potentially catastrophic cut-off of gas supplies, which has stifled the economies of the Eastern European members of the EU. The Western European members of the EU had long been decoupling their economies from the potential dangers of the Russia-Ukraine conflict and supporting new gas pipelines bypassing Ukraine, while outsourcing gas supplies to other suppliers [12]. The European Union introduced sanctions after Russia's invasion of Ukraine, initially reducing Russian energy imports by 35%. The plan to alleviate the energy crisis also included requiring fossil fuel companies that saw record profits during the energy crisis to contribute financially to help consumers [13]. Energy security has also been impacted by reduced investment in fossil fuel extraction, including oil and gas, which in turn has resulted in fertiliser shortages that could result in a global food crisis. In April 2022, BASF warned that it may have to discontinue production—a shortage of natural gas would result in insufficient energy for chemical production and a shortage of key resources for products [14]. In addition, the problem of rising energy prices is compounded by two factors—the weakening of economies operating in the reality of the COVID-19 pandemic and the rising cost of CO<sub>2</sub> emission allowances. The German economy is likely to contract by 0.4% next year due to the impact of the energy crisis [15]. The Russian invasion of Ukraine, which further disrupted global trade flows [16] primarily due to the extension of transport routes, the withdrawal of producers from the Russian market, the effects of the embargo, and the increase in energy costs. There are now developments pointing to a likely recession with severe labour shortages in all sectors [17]. The revision of economic growth forecasts will have to take into account the effects of the Russian invasion of Ukraine. In some countries (e.g. France), it is estimated that supply chain disruptions will be reduced and alternatives to Russian natural gas will be introduced, contributing to a fall in inflation as early as 2023 [18]. Faced with the crisis, Greece has proposed a plan to address the soaring energy prices, including a price cap mechanism. Market intervention has been suggested, which should protect the proper functioning of the wholesale gas market, which is under severe pressure following the worsening conflict in Ukraine, with serious spillover effects also on gas-fired power generation [19]. To trigger additional supply of hydrocarbon fuels, US President Joe Biden has softened his stance on US oil and gas extraction and has begun talks with Mohammed bin Salman, the de facto ruler of Saudi Arabia, to increase global oil production. Support was considered for small businesses and households that were struggling with energy costs. There were plans to introduce incentives for more efficient use of fossil fuels and to introduce increased subsidies for renewable energy sources and environmental technologies that reduce energy intensity [20]. OPEC members have already increased production, which was discontinued when the 2020 pandemic broke out. However, raising oil prices with increasing scarcity remains a temptation that will affect inflation [21]. Also, LNG prices have risen (more than doubling in the past year) and their increases indicate a structural imbalance between demand and supply growth, and the Russian-Ukrainian conflict and the energy crisis in Europe point to the key role of LNG in ensuring energy security and economic stability [22]. Natural gas prices in Europe rose by 14% just after the US reported that Russia might invade Ukraine. Supplies of liquefied natural gas cargoes from the US helped to ease the crisis slightly [23].

The return to conventional, hydrocarbon energy sources caused by the crisis related to the war in Ukraine is unlikely to be a long-term phenomenon. The war has increased demand for oil and gas, but EU countries are seeking independence from fossil fuels from Russia. Partly, in the short term, demand for these fuels will be met by US supplies, but a transition to renewable energy is inevitable. According to Preqin, the UK's alternative energy investment research centre, 11 oil and gas funds around the world raised a total of USD 4.6 billion in 2021, compared to 59 funds that closed at USD 46.6 billion in 2015. During the same period, 75 renewable energy funds were established, raising a total of USD 72.7 billion, compared to 66 funds with a total of USD 30.7 billion in 2015. The transition to low-carbon economies is accelerating. Rising fossil fuel prices send a negative signal to both entire economies and consumers themselves, and investments in renewable energy are becoming more interesting. The transition will be accelerated by the development of new technologies such as batteries, for example, which allow the grid to be powered by renewable energy sources. Rising inflation is also a factor driving investors to invest in renewable energy [3].

An important technology related to the energy transition is the smart grid. In both the EU and non-EU Eastern European countries directly neighbouring the conflict region, there are several drivers for smart grid investment. Investment in these technologies is primarily in advanced metering infrastructure, distribution automation, energy management, information technology and energy storage. Eastern European countries (including those in the EU and burdened by the legacy of centrally planned economies) are, on average, more energy intensive compared to other emerging markets worldwide, and smart grid infrastructure will play an important role in improving their energy efficiency. An additional incentive for smart grid development could be the launch of financial support for such investment. It is also important to implement technical standards and overcome obstacles related to political risk [24].

Contrary to the actions of governments in Eastern European countries, the development of the renewable energy market has become more important than ever. Although this problem affects many countries, it is particularly relevant for countries neighbouring the line of the ongoing armed conflict (i.e. Poland and the Baltic States—thus countries with comparable socio-economic conditions) [25]. It becomes important to find an alternative not only to the fossil fuels themselves imported from Russia, but to the entire infrastructure based on these fuels [26].

## 2 Materials and methods

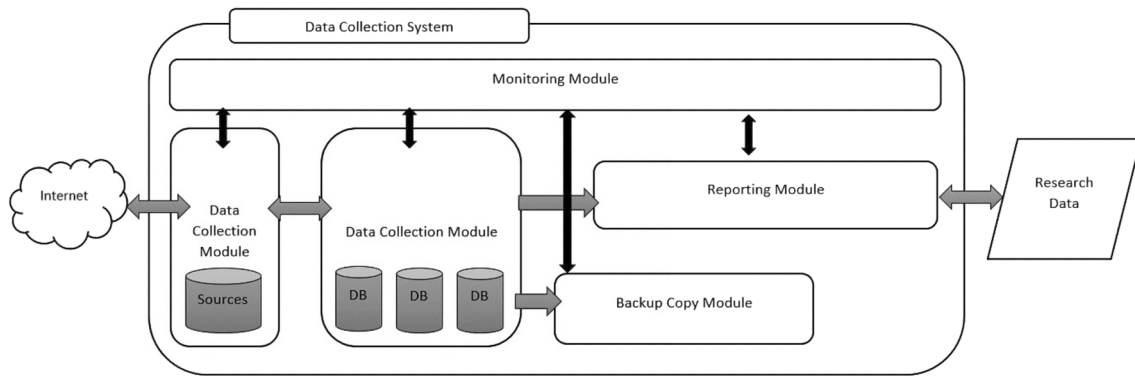
In our research, the identification of the intensity of interest in strategic energy resources is based on Big Data analysis as a quantitative assessment of the dynamics of changes resulting from the number of publications, newspaper articles, scientific and popular science commentaries and sentiment analysis. The tool we used to analyse the collected data, as well as statistical and predictive methods and the techniques of sentiment analysis is based on supervised and unsupervised machine learning-based techniques. The tools we used to analyse examines trend, the deviations from the trend and allows to estimate prediction of the trend.

For the purposes of this study, data was extracted in an automated manner through an in-house tool. The in-house research tool collects data continuously 24 h a day. The research material sourced from the Web was text material made available in open online sources.

The system for data extraction, the research material, consists of several modules such as the data acquisition module, the data collection module, the monitoring module, the reporting module and the backup module. Each module is responsible for a different area. The data acquisition module is responsible for the operation of the processes that retrieve the data, and in the collection module the retrieved information is transformed into a form that allows it to be stored in the database.

Returning to the issue of data extraction, it is worth emphasising that in the research process, during the preparation stage of the study, the researcher searches for open sources of information from the Web on the topic he or she intends to use in the study. The main objective of selecting the right data sources for the research topic is to minimise the costs (time and IT resources) that have to be incurred first in acquiring and processing the data, and then in implementing the complex computational processes.

Acquiring excessive amounts of data, unrelated to the topic of the study, causes complications at a later stage in terms of having to discard unnecessary data. Thus, the system's data acquisition is selective at such a level as is technically



**Fig. 1** data query in the Jazon system (own work)

possible for specific information sources. RSS<sup>3</sup> feeds are the primary source of information for the system. For many websites, they are a constant and accessible communication channel for all and in a way standardise the data acquisition process.

A typical RSS feed contains a list of articles, files or comments recently published on a given website together with the necessary metadata, such as publication date, subject, link to the source information, etc. When selecting sources for research, the researcher has to check whether a given source, e.g. a website, contains such an RSS feed. If the information source has it, then directly from the administrative panel he or she adds it to the data acquisition system. From the moment the source—an RSS feed—is added, the system periodically retrieves data for the study based on the information it contains.

The data extraction process using this method can be as long as desired. In a situation where the source selected for study does not have an RSS feed, then dedicated software must be developed for the source, which creates a quasi RSS structure on the fly.

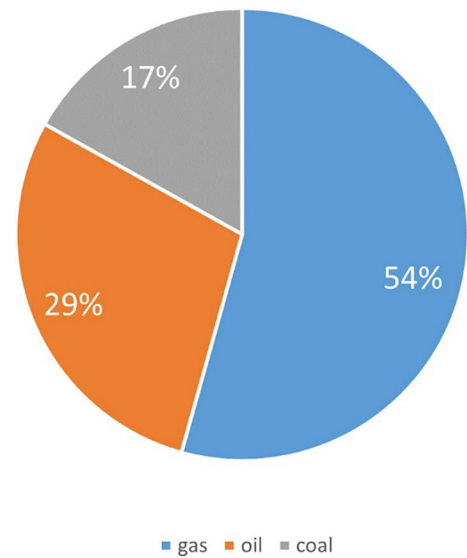
How an RSS feed is created, i.e. how the information available in the source is converted into RSS form, depends on the data structure of the source of interest. It is sometimes possible to use online RSS generators for sources that do not have them. In this respect, there are several commercial as well as free solutions available on the market that can be used by the tool in question. In other cases, for more unusual sources of information, it is necessary to write a separate module performing the conversion from one form to another.

An example is a data source provided with an API (Application Programming Interface). Once the necessary number of sources has been determined and dedicated modules for extracting data from non-standard sources have been made, the researcher adds them to the system. The system is designed to start acquiring data from an added source as soon as it is added. Files downloaded from the Web in HTML, DOCX, PDF, etc. formats are converted to plain text with UTF-8 encoding. Each retrieved piece of information, in addition to the actual content, includes the date and time of publication, if available, the date and time the information was saved to the internal database, a link to the source information (message, file, comment, etc.), the leading language of the message content, the subject (if available). If the date of publication is not known, then the date the information is retrieved from the RSS feed is taken as the date of publication. At this point, it is worth mentioning that, although RSS feeds have a standardised form, not all feed fields are always filled in by the content provider. In summary, the information acquired by the data acquisition module is passed on to the collection module for storage in the database.

The research data (the result of the work of the acquisition and collection modules) retrieved and stored in the database is the material for further processing. Separate subsystems connect to the database and retrieve selected information from it for further processing—the reporting module. A separate subsystem is the backup module, which is responsible for archiving the acquired data in a separate location in such a way that, if necessary, the database containing the research data can be rebuilt.

<sup>3</sup> Really Simple Syndication (RSS) is a web feed that allows users and applications to access updates to websites and both allows users to keep up with news and information and helps to avoid the conventional methods of browsing or searching for information on websites.

**Fig. 2** The share of the terms of strategic resources (coal, gas, oil). (own work)



The whole is controlled by the monitoring module. Its main task is to control the correct operation of the research data extraction process as well as its release for further stages, and to control the correct operation of the other elements of each module. Described above system for research data extraction is schematically shown in Fig. 1.

The resulting research sets were characterised by general statistics and sentiment and cluster analysis methods.

### 3 Results

#### 3.1 Trends of change of terms around strategic resources

Gas, oil and coal top the list of strategic energy resources whose importance during the Russian aggression against Ukraine cannot be overlooked. In the data collected between week 9 of 2022 and week 41, the term gas accounted for 54% of the sum of the incidence of the terms gas, oil and coal (Fig. 2). Less attention was paid to oil in the period under study, which accounted for 29% of the incidence of the mentioned resources, while the figure for coal was only 17%.

The above figures do not capture the trend of change and further the role of individual energy resources during the war period. Thus, an attempt was made to identify trends of change.

Therefore, it was assumed that the statistics on the frequency of the terms gas, oil and coal will be analysed in relative values bearing in mind the weeks of 2022 (9–41).

The following is obtained for each week:

$$F(g)_i = \frac{G_i}{G_i + O_i + C_i} \quad (1)$$

where  $F(g)_i$  represents the share of the incidence of the term gas in the  $i$ th week ( $i = 9 \dots 41$ ) in relation to the sum of the incidence of the terms gas, oil, coal.

Similarly, the variables  $F(o)_i$  and  $G(c)_i$  were defined for oil and coal respectively. The final result is Fig. 3.

The figure above shows that the analysis reveals trends of change over the period under study. With regard to oil and gas, despite high absolute values indicating interest in these resources, they are accompanied by a clear downward trend. Interest in gas and oil is gradually declining. In contrast, a clear upward trend is shown by interest in coal, the relative frequency of which has increased. The processes taking place in its immediate vicinity also play a role.

During the period under study, the names of countries occurring around the term were analysed in the context of coal (shown in the Fig. 4). Europe (understood as the European Union) was mentioned most frequently, with this term accounting for as much as 42% of the most frequently mentioned terms. This was followed by Germany (14%), Ukraine



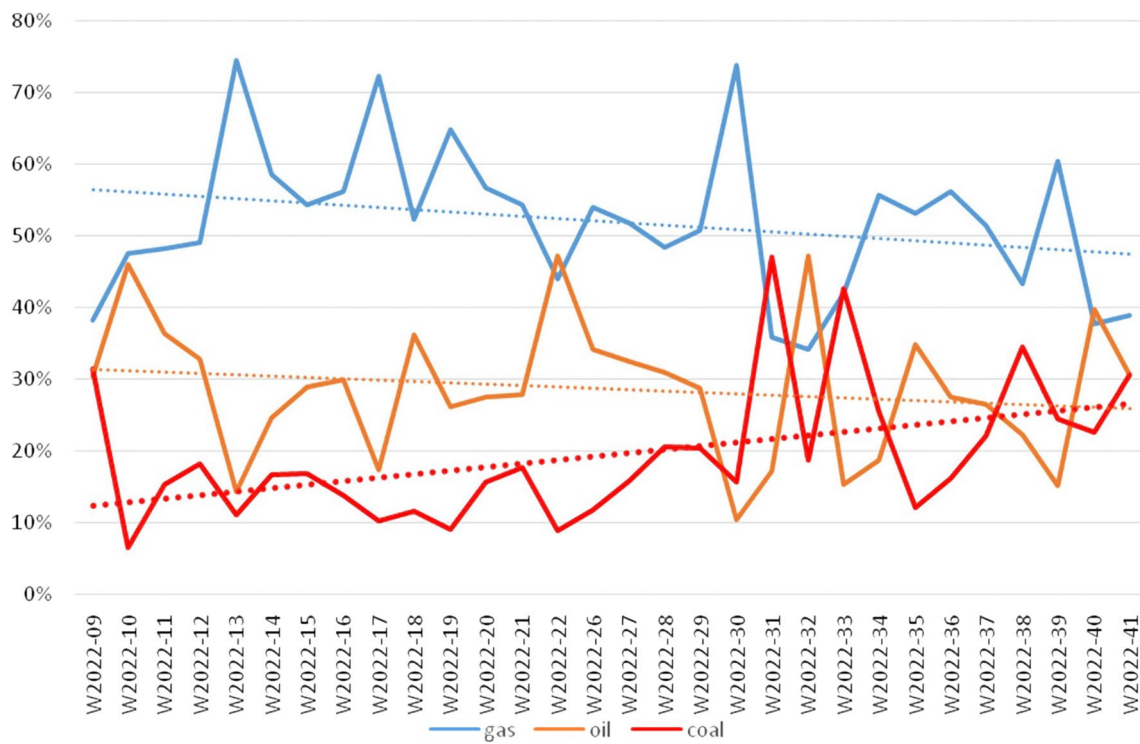


Fig. 3 Trends of change in the incidence of the terms gas, oil and coal from week 9 to week 41 of 2022. (own work)

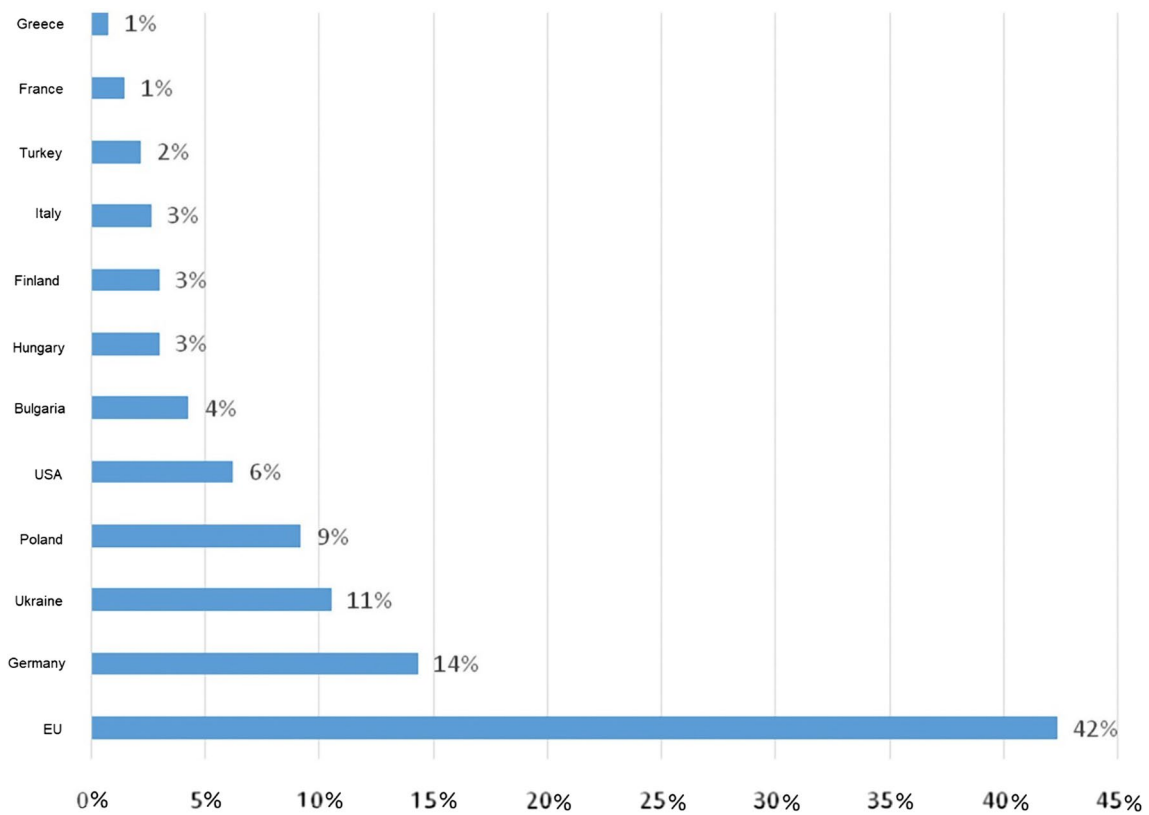
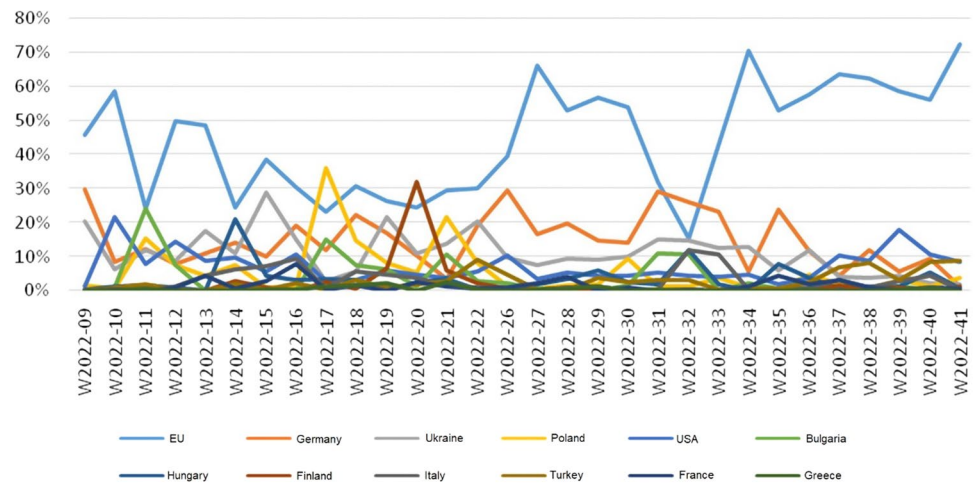


Fig. 4 The share of terms around strategic resources (coal). (own work)

**Fig. 5** Trends of change in the incidence of selected countries around the term gas from week 9 to week 41 of 2022. (own work)



**Table 1** Slope factor of a linear trend

Country	Slope factor of a trend
Europe	0.00943
Turkey	0.00177
Greece	-0.00010
Italy	-0.00012
Hungary	-0.00013
France	-0.00013
USA	-0.00042
Finland	-0.00072
Germany	-0.00145
Bulgaria	-0.00194
Poland	-0.00272
Ukraine	-0.00345

(own work)

(11%), Poland (9%), the USA (6%), Bulgaria (4%), Hungary, Finland, Italy—3% each. Turkey (2%) was at the bottom of the list, followed by France (1%) and Greece (1%).

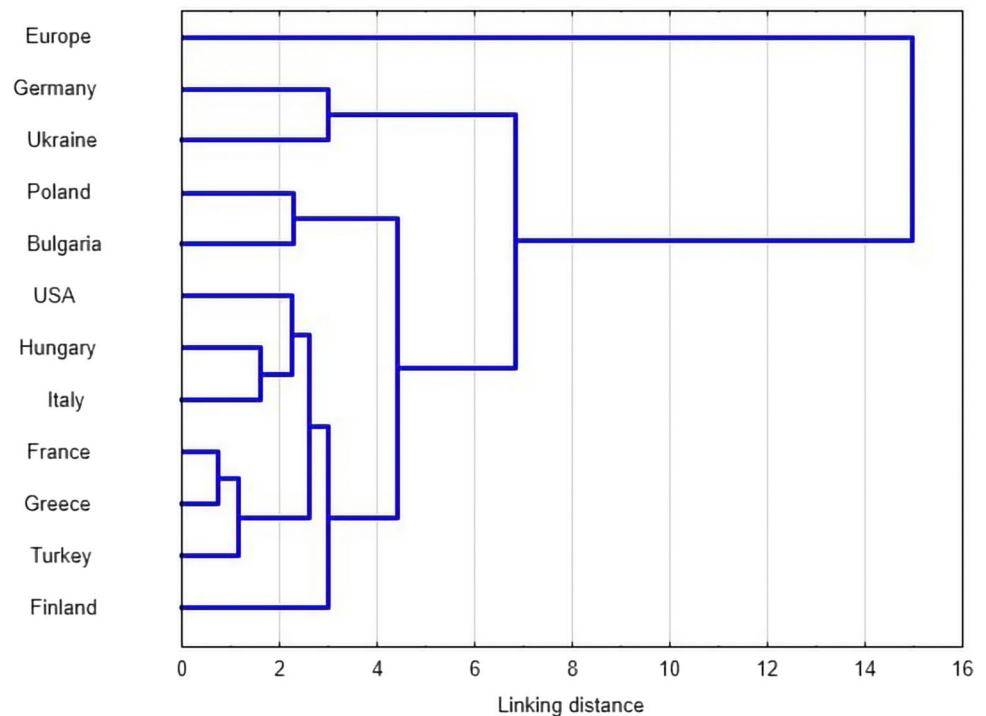
The trends in the presence of the terms under study over the period analysed clearly show changes in interest (shown in the Fig. 5). The trends analysed (a linear trend was assumed in the analysis) make it possible to identify the dominant behaviour of countries around the gas issue. Thus, in the context of gas, a clear upward trend in the incidence of Europe became apparent (shown in the Table 1). Undoubtedly, in the face of the embargo on this strategic resource, the European Union has taken responsibility for the supply of this resource and is seen as such in Russian-language resources. The share of the remaining countries is on a declining trend (apart from Turkey, not involved in the ongoing conflict).

The convergence of perceptions of individual countries is interesting in a situation of EU dominance. For this purpose, a cluster analysis based on the incidence of countries in the consecutive weeks studied was carried out (shown in the Fig. 6). The analysis shows in the figure indicate the greatest convergence of attention to Germany and Ukraine, Poland and Bulgaria, Italy and Hungary, as well as France and Greece. The analysis of frequency confirms the markedly different frequency of Europe (European Union). The relationships (cluster analysis) and variability (trends) presented above in this way in relation to the real conditions in the market for strategic energy resources, indicates that the European Union (as an institution) has taken over the burden of policy-making in this area and national policies are far less important (indicating their weakness<sup>4</sup>).

<sup>4</sup> Lack of coherence of actions, which leads to chaos and ineffectiveness; small scale of impact compared to the scale of EU activities; lack of resources—inadequate personnel to carry out complex activities; in the EU, decisions are made at the international level, which allows for a more objective approach to problems; bureaucracy making national policy ineffective.



**Fig. 6** A dendrite of the cluster analysis of the relative incidence of countries in the context of oil (own work)



### 3.2 Sentiment analysis regarding the EU, Poland, the USA and Ukraine

The sentiment analysis was performed in R using the Russian sentiment dictionary. The dictionary included categorised emotions: anger, anticipation, disgust, fear, joy, negative, positive, sadness, surprise and trust. Further on, only negative and positive opinions (N, P) for each of the terms (e.g. Poland, Ukraine, Belarus) under study were included in relation to all emotions for the following terms ( $n$ ) in the following weeks ( $i$ ):

$$I_{(n,i)}^N = \frac{N_i}{\sum S_i} \quad (2)$$

$$I_{(n,i)}^P = \frac{P_i}{\sum S_i} \quad (3)$$

where  $I$  represents sentiment index,  $S$  shows marked expression—sentiment (no symptom, any),  $P$  express positive sentiments, and  $N$ —negative sentiments. In the equation shown,  $n$  represents term “ $x$ ”, and  $i$ —ith week.

Finally, the difference between the positive and negative sentiment indices (hereafter sentiments) is taken as the measure of the characteristic in the  $i$ th week [ $M(i)$ ]:

$$M(i) = I_{(n,i)}^P - I_{(n,i)}^N \quad (4)$$

The sentiment calculations performed, based on the relationship defined above (4), reveal clear trends in the change of emotions regarding the countries included in the materials on oil (shown in the Table. 2). Trends exposed in the Fig. 7 confirms the overwhelming dominance of negative assessments of countries shown in the table. The trend revealed and proves by examples showed that Russian-language sources, which is obvious in a situation of the ongoing aggression, are building a negative narrative around all countries that were (are) consumers of Russian oil.

In an atmosphere of conflict and an outright hostile narrative towards the countries mentioned, shown in the Fig. 7, shows varying trends of negative emotions. Thus, the most important object of negative opinions is the European Union, which is perceived to be the creator of energy policy. The number of negative opinions towards

**Table 2** Sentiments (M) around the EU, Poland, the USA and Ukraine

	Europe	Poland	USA	Ukraine
W2022-09	-0.133	-0.400	-0.261	-0.224
W2022-10	-0.188	-0.391	-0.233	-0.394
W2022-11	-0.148	-0.481	-0.250	-0.400
W2022-12	-0.194	-0.367	-0.318	-0.361
W2022-13	0.000	0.000	-0.286	0.250
W2022-14	-0.124	-0.448	-0.394	-0.200
W2022-15	-0.129	-0.262	-0.245	-0.110
W2022-16	-0.114	-0.222	-0.311	-0.250
W2022-17	-0.066	-0.106	-0.308	-0.126
W2022-18	-0.067	-0.163	-0.133	-0.219
W2022-19	-0.060	-0.186	-0.204	-0.126
W2022-20	-0.081	-0.204	0.091	-0.016
W2022-21	-0.070	-0.134	-0.149	-0.219
W2022-22	-0.065	-0.400	-0.262	-0.156
W2022-23	-0.128	-0.391	-0.295	-0.180
W2022-24	-0.092	-0.381	-0.259	-0.275
W2022-25	-0.092	-0.268	-0.079	-0.053
W2022-26	-0.098	-0.382	-0.045	-0.170
W2022-27	-0.117	-0.357	-0.164	-0.190
W2022-28	-0.085	-0.333	-0.267	-0.207
W2022-29	-0.089	-0.286	-0.104	-0.161
W2022-30	-0.113	-0.065	-0.031	-0.141
W2022-31	-0.233	-0.269	-0.500	-0.222
W2022-32	-0.127	0.083	-0.333	-0.308
W2022-33	-0.114	0.000	-0.121	0.063
W2022-34	-0.086	-0.281	-0.224	-0.176
W2022-35	-0.134	0.500	0.125	-0.246
W2022-36	-0.139	-0.194	-0.306	-0.050
W2022-37	-0.096	-0.409	-0.256	-0.219
W2022-38	-0.096	-0.480	0.250	0.000
W2022-39	-0.126	-0.200	-0.067	-0.179
W2022-40	-0.115	0.250	-0.167	-0.207

(own work)

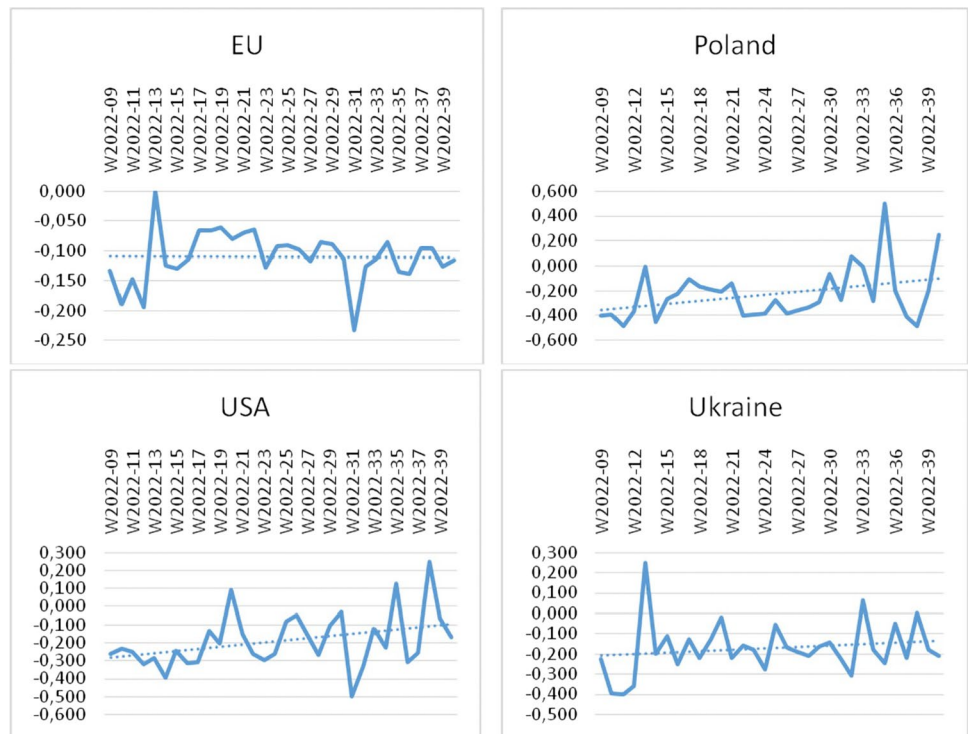
the UE is increasing. However, in the case of other countries (the figure below also includes Poland, Ukraine and the USA), although negative sentiments predominate, their number is decreasing.

The cluster analysis carried out (the analysis was made using the Statistica package) illustrates the convergence of the narratives towards the countries under analysis (shown in the Fig. 8). The figure reveal convergence in negative opinions is noticeable in relation to Germany, Ukraine, the European Union, the USA and Poland. The second group of countries is made up of Greece, Italy, Finland, Turkey and France, which were in fact not among the main consumers of Russian oil. Outside of the aforementioned groups is Hungary, whose policy is actually stretched between support for the Russian regime and rational membership of the Union.

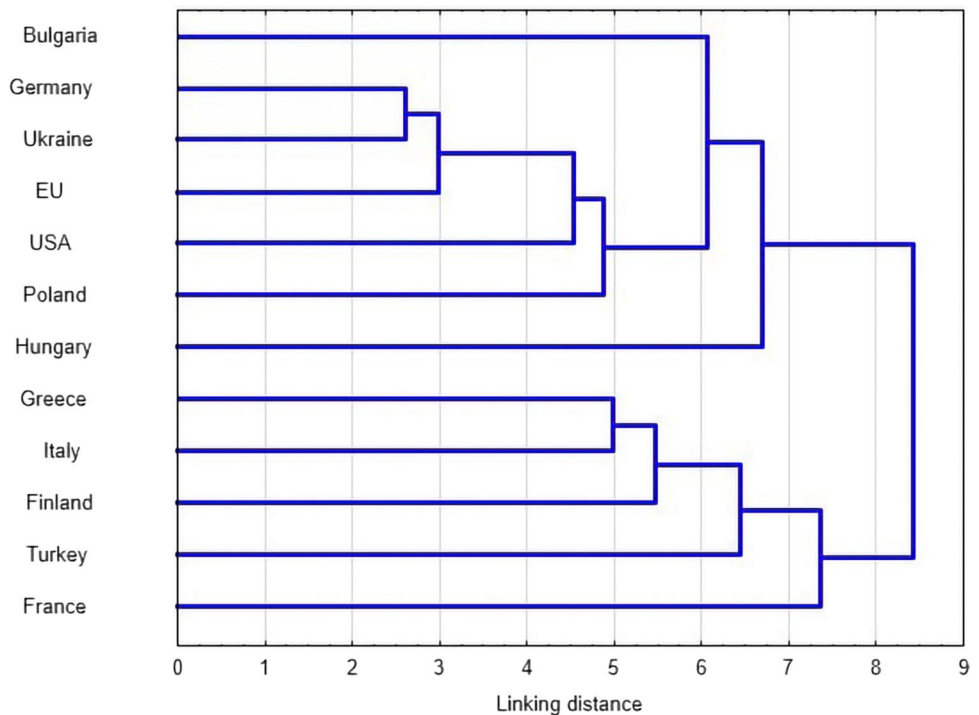
## 4 Discussion

The identification of the intensity of interest in strategic energy resources is based on a quantitative assessment of the dynamics of changes resulting from the number of publications, newspaper articles, scientific and popular science commentaries and sentiment analysis. The complex IT system set up for this purpose is based on the use of big data analysis functionalities applied to unstructured data sets extracted from online sources. This system

**Fig. 7** Sentiments (M) around the EU, Poland, the USA and Ukraine. (own work)



**Fig. 8** A dendrite of the cluster analysis of sentiments around countries in the context of oil. (own work)



enables identification and distinguishing of strategic information sources used to identify the technological trends. The tools used in automatic source data collection, lemmatisation and identification of keywords and sentiment are supplemented by an advanced statistical processing system used in quantitative analysis of historical, current and predictive data. The system also includes tools enabling interesting visualisations of the results. The system includes the Analytical Warehouse containing dedicated source materials and software for feeding the warehouse with new data. The scalability of the tools is a result of their layered architecture and modular design. The tool we

used to analyse the collected data in terms of keywords, sentiment analysis and statistical and predictive analysis is based on supervised and unsupervised machine learning-based techniques. The statistical analysis methods used in our tools enable identification of the trend and of the deviations from the trend, caused by various external factors.

An analysis of sentiments and emotions about energy using social listening analysis on Twitter allows sentiments about energy sources to be assessed and national policy of energy mix. The results of the analyses allow the adaptation of promotional activities in terms of policies and actions focused on the development of fossil-based fuels and “traditional” energy sources or that favour renewable energy. A study already conducted during the Ukrainian-Russian conflict allows an analysis of sentiment before and after the invasion; the conflict changed public sentiment on the energy transition to green energy. With a view to the wider implementation of renewable energy solutions, these should be promoted especially among the nations of Eastern Europe, which are dependent on Russian hydrocarbon supplies [27].

Putin is financing the war by selling vast oil, gas and coal resources. The sale of fossil fuels has helped Putin to build a military power that is fighting in Ukraine, but also generates huge profits held in foreign banks for the oligarchs. However, Putin has miscalculated and understated the impact of the rapidly changing world of energy technology. The Kremlin regime has underestimated the technological, economic and political potential, as well as the determination of the European Union to become independent of supplies from an aggressor state such as Russia.

Highly industrialised countries are in the midst of a “great transition” away from fossil fuels. Russian oil and gas are now seen as linked to autocracy and war crimes in Ukraine, and man-made climate change and the war against Ukraine have the same root: fossil fuels. Putin’s invasion has already damaged Russia and, in the long run, the war spells the end of Russia as an energy superpower [28].

The results of our research allow us to assess the attention paid by the Russian media to fossil fuel consumer countries, primarily: Germany, Ukraine, Poland and Bulgaria. The results of our research indicate that the Kremlin is diversifying its approach to individual EU countries and to the European Union as a whole by adapting not only its instruments of political leverage, but by building a narrative about these countries based on responses to the energy crisis.

The analysis of frequency confirms the markedly different attitudes to Europe (the European Union) as a whole and to its individual members. The trend of change and the role of individual energy resources during the war period is a significant part of our study. Gas, oil and coal are strategic energy resources. With regard to oil and gas they are accompanied by a clear downward trend. In contrast, a clear upward trend is shown by interest in coal. The cluster analysis and trends presented in indicates that the European Union has taken over the burden of policy-making in the area of energy and is seen as such in Russian-language resources. This also indicates a downgrading of national policies in this respect, which is tantamount to an acknowledgement of their weakness in resisting Russia’s aggressive actions.

The sentiment analysis carried out shows clear trends of changing emotions (in the context of fossil fuels) in relation to European Union countries. The results of the research show a strong dominance of negative assessments of countries in this context, with Moscow building a negative and aggressive narrative around countries that were (or still are) consumers of Russian oil. The results of our research also show varying trends of negative emotions, with the European Union being the central object of negative opinions. Moscow sees the Union as the creator of an energy policy based on renewables and, in this context, moving away from Russian exports. It should be stressed that the number of these negative opinions about the European Union is steadily increasing. It is interesting to note that, at the same time, other countries (e.g. Poland, Ukraine or the USA) are experiencing declining dynamics despite the dominance of negative sentiments.

The methodology proposed in the paper makes it possible to identify the sentiments and, further, the directions for policies pursued by Russia towards countries involved in economic relations based on energy resources. The results obtained confirm the actual international relationships and can be used in the future as a tool enabling their immediate identification (in real time). In fact, the processes identified during quantitative research (BigData analyses) of large text data resources can be the first premise to formulate hypotheses subject to qualitative research. The precision of the formulation of research hypotheses also plays a role in this methodology.

**Author contributions** Wiesław Cetera, Aleksander Żołnierski - main manuscript, discussion Wiesław Cetera - results Dariusz Jaruga, Piotr Celiński - materials and methods Jan Grzegorek - calculations.

**Funding** The National Centre for Research and Development, Cybersecident/489281/IV/NCBR/2021, Cybersecident/489281/IV/NCBR/2021, Cybersecident/489281/IV/NCBR/2021, Cybersecident/489281/IV/NCBR/2021, Cybersecident/489281/IV/NCBR/2021.

**Data availability** The generated data that form the basis of the analysis can be found in the attached file (Responding data.xlsx). The source data (repository access) is available upon request from interested parties.

## Declarations

**Competing interests** The authors declare no competing interests.

**Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

## References

1. Muir A. Challenging times: the importance of productivity and the productivity practitioner cannot be overstated. *Manag Serv.* 2022;66(3):4.
2. Is the Ukrainian Crisis an Energy Challenge to Russia?. *International Affairs: A Russian Journal of World Politics, Diplomacy & International Relations*; 2014 60(5): 208–24.
3. Jacobius A. War and sanctions ramp up oil prospects: Ukraine conflict, rise in traditional energy prices could prompt investors to reconsider fossil fuels. *Pensions Invest.* 2022;50(5):1.
4. Kirby J. How Russia's energy problem fuels unrest. *Macleans.* 2014;127(10):48.
5. Matthews O, Powell B. As in the cold war, Russia is vulnerable on energy. *Newsweek Global.* 2014;162(15):31–40.
6. Koranyi, D. (2014). Transatlantic energy security and the Ukraine-crisis: a blessing in disguise? *NATO Review.* p. 5. <https://search.ebscohost.com/login.aspx?direct=true&db=f5h&AN=99606966&lang=pl&site=ehost-live>. Accessed 8 June 2023
7. Lithuania Courts Belarus With Economic Incentives. (2014). *Stratfor Analysis*, 26.
8. Calisher CH. Simple-minded solutions to complex problems. *Croat Med J.* 2022;63(4):399–401. <https://doi.org/10.3325/cmj.2022.63.399>.
9. Romania Reacts to the Ukraine Crisis. (2014). *Stratfor Analysis*, 45.
10. Helman C. Over a barrel. *Forbes.* 2022;205(3):102–8.
11. Abolhosseini S, Heshmati A, Rashidghalam M. Energy security and competition over energy resources in iran and caucasus region. *AIMS Energy.* 2017;5(2):224–38. <https://doi.org/10.3934/energy.2017.2.224>.
12. Racanska, L. (2009). *Russia-Ukraine Energy Conflict: A Rise of New Cold War?* Conference Papers Northeastern Political Science Association. 1.
13. Gangitano A, Budryk Z. Ukraine gains heighten fears that putin will use winter as a weapon. *Hill.* 2022;29(45):6.
14. Newswire PR. Germany teeters on the brink of energy disaster—global food crisis looms says friends of science. Chicago: PR Newswire; 2022.
15. Kowalcze, K. German Economy Seen Shrinking Next Year Due to Energy Crisis. *Bloomberg.Com, N.PAG*; 2022
16. Patel-Campbell C, Liu S. Chinese Ferro-Chrome Prices Lag behind Global Rally amid Russia-Ukraine Conflict. *Metal Bulletin Daily*, 2022, N.PAG.
17. Shah, O. Hunt Hunt Is on for Directors Who Can Guide Boards through the Inferno of Inflation. *Sunday Times, The*, September, 2.2022
18. Patel, T. (2022). France Plans to Revise Economic Growth Forecasts Due to War. *Bloomberg.Com, N.PAG*.
19. Nikas, S. (2022). Greece Suggests Price-Cap to Address Energy Price Surge. *Bloomberg.Com, N.PAG*.
20. Ending the Energy Crisis Doesn't Mean Giving Up on Climate. (2022). *Bloomberg Opinion, N.PAG*.
21. Gupta, K. (2022). OPEC+ Output Is Coming Back Much Quicker Despite the Complaining. *Bloomberg.Com, N.PAG*.
22. Shiryavskaya, A. (2022). LNG Trading Dropped Last year as Price Rally Deterred Buyers. *Bloomberg.Com, N.PAG*.
23. Almeida, I. (2022). European Gas Surges as U.S. Says Russia May Soon Attack Ukraine. *Bloomberg.Com, N.PAG*.
24. Eurasia Smart Grid Market Forecast 2016–2026: Eurasian Countries Are Projected to Invest \$23bn in Smart Grid Infrastructure Over the Next Decade. (2017). *M2PressWIRE*.
25. Chomać-Pierzecka E, Sobczak A, Soboń D. The potential and development of the geothermal energy market in Poland and the baltic states—selected aspects. *Energies.* 2022;15(11):4142. <https://doi.org/10.3390/en15114142>.
26. Wagner G. New energy imperative: Russia's invasion of Ukraine highlights the crisis and opportunity of the energy transition. *Finance Dev.* 2022;59(2):56–8.
27. Ibar-Alonso R, Quiroga-García R, Arenas-Parra M. Opinion mining of green energy sentiment: a Russia-Ukraine conflict analysis. *Mathematics.* 2022. <https://doi.org/10.3390/math10142532>.
28. Goodell J. Fossil fuel gangster. *Rolling Stone.* 2022;1362:44–5.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.