Machine Analysis of the UK Electrical Energy Initiatives Based on the E-petitions to the UK Government and Parliament

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Abstract

In recent decades, the EU has implemented many energy programs to expand the production and consumption of clean energy and build a pan-European energy network. The UK has also accomplished energy initiatives to improve grid security, increase energy independence, and reduce renewable energy costs. However, the UK population did not always support these initiatives and facilitate their implementation. This study was analyzed the UK e-petitions using machine analysis tools to identify the main reasons for public dissatisfaction with the UK's electrical energy initiatives. The e-petitions dataset was uploaded from the UK Government and Parliament website (the 33436 petitions for 2017-2020). For our research on electric energy in the UK, the 100 petitions related to the electricity sector issues were selected. Our study shows that most UK petitions of the energy sector sample belong to installing solar panels and reducing bills for energy resources.

Keywords 1

Electrical energy initiatives, electrical energy grids, machine analysis, text mining, UK e-petitions

1. Introduction

Climate changes and negative consequences due to the intense industrial growth of world economies have caused a radical shift in the political worldview. The UK not only adopted the 2015 Paris Agreement but also transformed a growth strategy. The existence of the active 'green conservative' and the 'green liberal' movement allowed Britain to take a clean growth direction. And now the UK's Clean Growth Strategy supports low-cost, low-carbon energy innovations to achieve a path to net zero emissions [1]. Despite the possibility of creating new jobs and improving the environment, green energy initiatives have opponents in different countries, including the UK [2]. There are opinions that taxpayers' money should be spent on more critical needs and not be directed at expensive energy initiatives and projects.

Essential indicators of government initiatives perception are the quantity and quality of petitions. Thanks to the e-governance reform and the general digitalization of the economy, it is possible to track changes in citizens' opinions quickly and transparently [3]. The tools of machine analysis make it possible to carry out such research and to operate with big data to study text arrays.

This paper is structured as follows: the next section presents the literature review and consists of three subsections. The first subsection looks over the energy transformation background and clean growth. Additionally, the second subsection establishes the green growth and green finance analyses, and the third subsection informs about current text mining approaches of e-petitions. Data and methodology are presented in Section 3. Section 4 introduces the main findings based on the descriptive statistics and text analysis of the datasets. Section 5 summarizes our research and emphasizes the importance of further consideration of electrical energy initiatives.

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2. Related works

2.1. The energy transformation background and clean growth

The Global financial crisis of 2008 and further economic turbulence led to dramatic changes in all areas of the economy, including the energy sector. At that time, society put forward increased requirements for the efficiency of public administration of the world economy and stimulating investments to stabilize countries around the world [4, 5]. The economic downturn caused a decrease in demand and consumption of the population, which directly affected the generation of electricity and electric networks structure. In European countries was transformed relations between all economic agents, there was a shift to alternative development pathway characterized by greening innovation [6, 7]. In the world economies, fossil energy sources are gradually being abandoned, and the consumption of clean energy is expanding [8].

In the UK, they adopted the Climate Change Act 2008, which served as the impetus for changes on the path of energy transformation. And the subsequent Energy Act 2013 enshrined 'decarbonization target range and duties in relation to it' [9].

2.2. Green growth and green finance

Modern studies focus on the relationship between public spending and green economic growth. Some authors prove the need for green investment by the state in the economy, confirming that green investment and GDP growth are tightly coupled [10, 11]. Other studies substantiate the areas of responsible financial resource allocation to provide a balance of socio-ecological-economic development [12, 13].

Concerning the UK, many researchers point to the lack of funding for green innovation in Britain, and the need for expansion of sustainable investment [14, 15]. The capitalization of green solutions should accelerate the transition to green growth. Citizens, as a rule, play a crucial role in adapting green innovations. However, there is some latency in the civic energy sector in the UK, although its role is gradually increasing [16]. Despite the incentives and the apparent financial benefits of implementing such solutions, there is still a low demand for energy-efficient solutions. And an analysis of the petitions of British citizens gives that due confirmation.

2.3. The text mining and e-petitions

The existing machine analysis tools can fully categorize electronic petitions, semantic and linguistic analysis, and perform modeling of big unstructured data [17, 18]. The methodology for the content analysis of electronic petitions is discussed in detail by Hagen. Using LDA models, the author describes a structure for training and validating petition texts. According to Hagen [19], 87% of those generated with LDA models make sense. A slightly different modeling approach is used by Mundra et al. The authors tested their model on the database of India and US petitions, which were previously tokenized in three categories "problem, evidence and solution" [20].

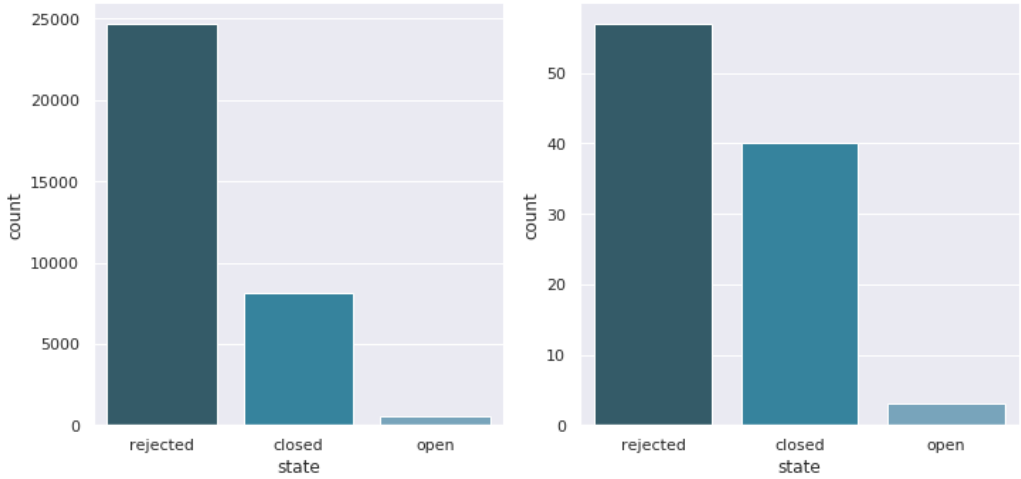
The issues of evaluating the petitions of the population occupy the minds of many researchers in different countries. British scientists Clark and Lomax [21] study the popularity of individual petitions in the UK, based on a similar study of US citizens' petitions. Their comparative analysis shows some mental differences in the popularity of petitions in the US and the UK. According to their research, linguistic factors do not significantly impact e-petitions in the UK and the US. The authors suggest that the popularity of petitions in the UK is justified by promoting social networks strategy when the petition can gain the largest number of signatures within the first 24 hours. An active surge in petition signing on the first day opens up the option of securing them as popular on the UK Government and Parliament website, which may further help collect additional signatures. Clark and Lomax [21] did not focus much on petition topics. Although they highlight the most popular petitions in different areas (including the energy sector), they do not categorize them. However, to find the critical problems, understand their interrelation, and assess citizens' reaction to government initiatives, it is necessary to cluster the concepts and underlying petitions topics.

Therefore, research questions arise about what petitions are being filed by the British regarding the UK Electrical Energy Initiatives, what issues are of concern to them, and what topics cause the most reaction from citizens? These questions formed the basis of this study.

3. Methods

The e-petitions dataset was uploaded from the UK Government and Parliament website. There was a total of 33436 petitions for 2017-2020 on the website, of which 24699 petitions were rejected, 8154 were closed, 583 were open (Figure 1, a). The structured data in CSV format were used from the website to analyze the total number of petitions. In addition to the title, the links, and the petition's status (open, closed, or rejected), the petition's number of signatures was available in the automatically generated database [22]. The petition's full text, the dates of publication, and the closing of the petition were added manually.

For our research on electrical energy in the UK, the 100 petitions were selected related to the energy sector issues, electricity generation from low-carbon sources, renewables (Figure 1, b). Petitions were collected using a keyword search, as there are no relevant petition groups on the site.



a) b)

Figure 1: State of e-petitions (Source: Conducted by authors based on the Petitions UK Government and Parliament site, https://petition.parliament.uk)

The LDA was used for topic modeling of the text of the petitions. The modeling process is formally well described, particularly in the paper of scientists from Korea [23]. The modeling for this research was carried out in the Python 3.6.12 software environment using various modules. The simulation scheme is shown in Figure 2.

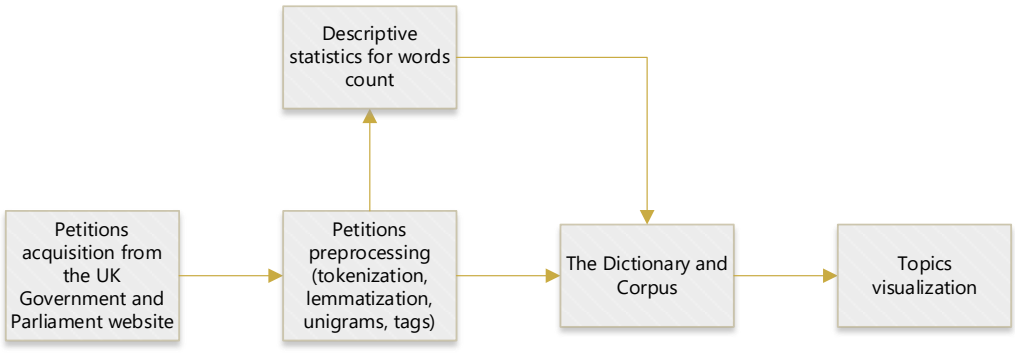


Figure 2: Topic modeling of e-petitions (Source: Conducted by authors)

4. Results and discussion

4.1. Descriptive statistics of the datasets

The words count statistics of petition titles in the UK 2017-2020 do not show significant variation. Titles of open, closed and rejected petitions have 10-11 words on average. Despite the varying size of the petition state database, the length of the petition titles is approximately the same. The title length for 75% of closed and rejected petitions consists of 13 words, while 75% of open ones have 12 words (Table 1). Due to the significant number of petitions, their distribution tends to normal (Figure 3).

Table 1

Descriptive statistics for words count of titles of petitions, the UK 2017-2020 (Source: Conducted by authors based on the Petitions UK Government and Parliament site, https://petition.parliament.uk)

State	Count	Mean	Std	Min	25%	50%	75%	Max
closed	8154.0	10.881531	2.807744	1.0	9.0	11.0	13.0	19.0
open	583.0	10.615780	2.618312	3.0	9.0	11.0	12.0	18.0
rejected	24699.0	10.865703	3.053505	1.0	9.0	11.0	13.0	21.0

However, an analysis of the full text of petitions on electric energy issues has already shown differences in the number of petition words. The standard deviation ranges from 22.5 words for open petitions to 44.6 words for rejected petitions. While for rejected petitions the maximum number of words was 237, the minimum was 31 words (Table 2). Due to the small dataset, the distribution of values tends to be more uniform without evident peaks (Figure 4).

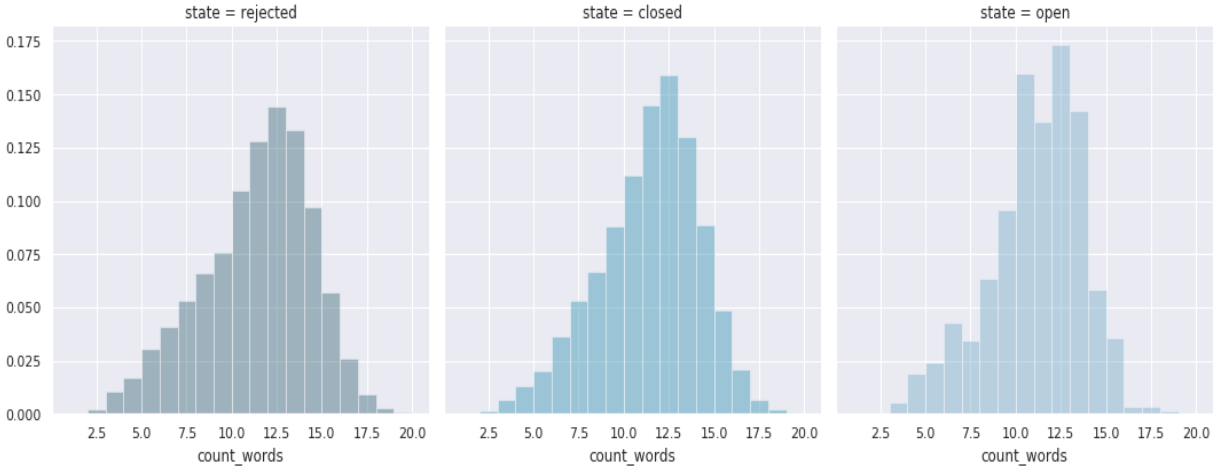


Figure 3: The distribution of the petition state, the UK 2017-2020 (Source: Conducted by authors based on the Petitions UK Government and Parliament site, https://petition.parliament.uk)

Table 2

Descriptive statistics for words count of the full-text of petitions on electrical energy issues, the UK 2017-2020 (Source: Conducted by authors based on the Petitions UK Government and Parliament site, https://petition.parliament.uk)

State	Count	Mean	Std	Min	25%	50%	75%	Max
closed	40.0	116.050000	38.178360	45.0	90.5	128.5	142.25	184.0
open	3.0	125.666667	22.501852	108.0	113.0	118.0	134.50	151.0
rejected	57.0	109.596491	44.648972	31.0	62.0	117.0	141.00	237.0

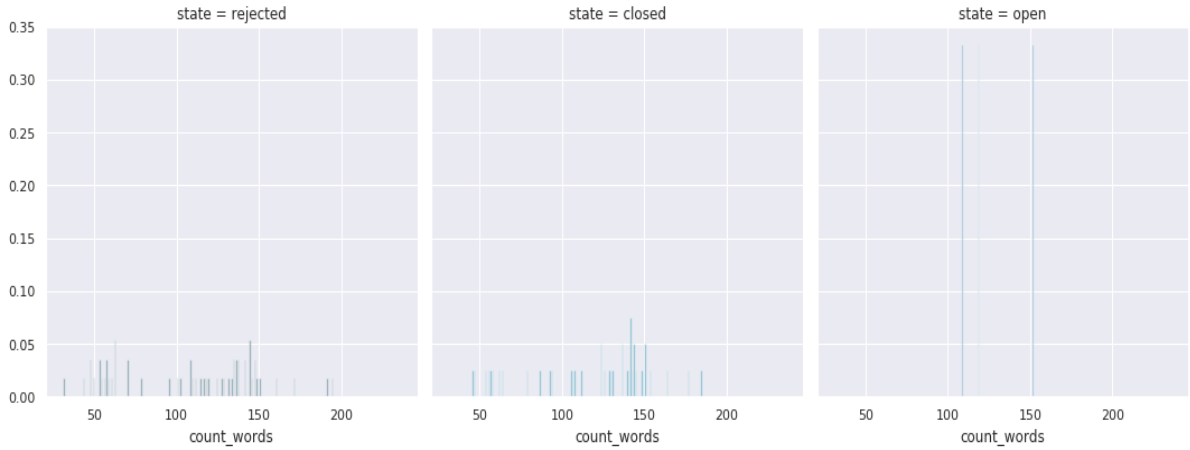


Figure 4: The distribution of the petition state, the UK 2017-2020 (Source: Conducted by authors based on the Petitions UK Government and Parliament site, https://petition.parliament.uk)

4.2. Text analysis of the datasets

It is hard to say that e-petitions to the UK Government and Parliament are actively supported by the British. Only 510 petitions (1.53% of the total number petitions) got the required number of signatures to receive a response from the UK government. And only 90 petitions (0.27%) were considered for a debate in the UK Parliament. According to the study results, the UK population massively supported petitions that dealt with stressful and critical issues: the electoral voting system, Brexit, COVID-19. Several petitions regarding renewable energy sources also passed through the barrier.

It can see similar results by analyzing the most popular unigrams of petitions (Figure 5). Among all unigrams, the third most used was 'stop.' The unigrams 'no,' 'not,' 'ban,' 'leave' have a negative meaning as well. This allows us to argue that the British are more active in registering petitions if there is a need to respond to unwanted influences than in the presence of comfortable and favorable conditions. It should be noted that the unigram 'elect' was the tenth most frequently used. However, the use of this unigram is more explained by changes in the electoral sphere than in energy.

In the selected set of petitions on electrical energy issues, only one petition scored the required number of signatures to receive a response from the UK Government. All other petitions did not pass the barrier. This petition was related with the utility prices. Tellingly, the unigram 'bill' is the eleventh most frequently used in the sample of petitions on energy issues. In 2020, there has been a leap in the use of this unigram (Figure 6). Unfortunately, this was not connected with the energy efficiency calls, but because of the consequences of the COVID-19 pandemic, the most vulnerable parts of the population's inability to pay utility bills.

It is quite understandable that items 'electr,' 'solar,' 'gas,' 'gener,' 'grid' exist among the 21 most common unigrams of full-text petitions on energy issues. It should be clarified that the unigram 'gener' is used in UK petitions in connection with aspects of traditional energy sources (for example, nuclear power) and the promotion of renewable energy production.

The unigram 'grid' is found in petitions mainly in connected with the programs of building new houses with solar panels, and to develop more robust and reliable grids. The phrase 'solar panels' is mentioned over 30 times in petitions (Figure 7).

There were petitions regarding the issues of power stations in Oxfordshire, onshore wind turbines, a grant from Ofgen, 'direct investment in nuclear new build projects.' However, these petitions did not collect the proper number of signatures also. Although on the trigram, these phrases are quite often expressed (Figure 8).

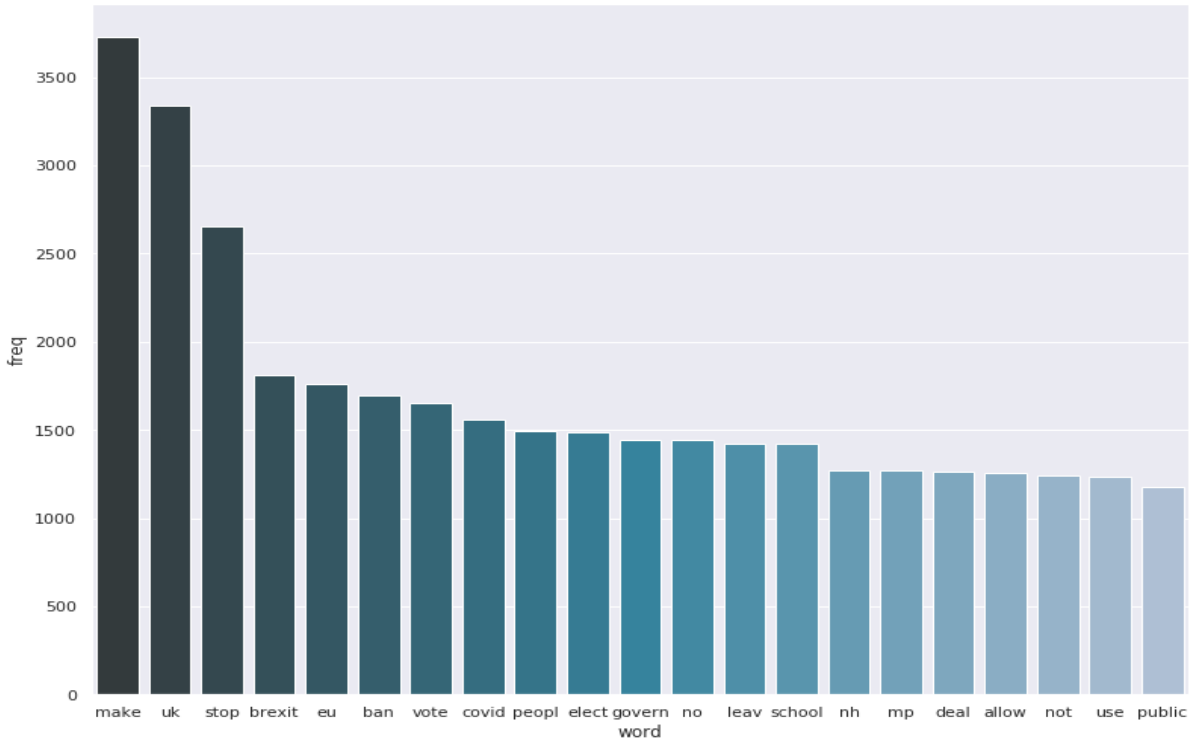


Figure 5: The unigram of the petition's titles, the UK 2017-2020 (Source: Conducted by authors based on the Petitions UK Government and Parliament site, https://petition.parliament.uk)

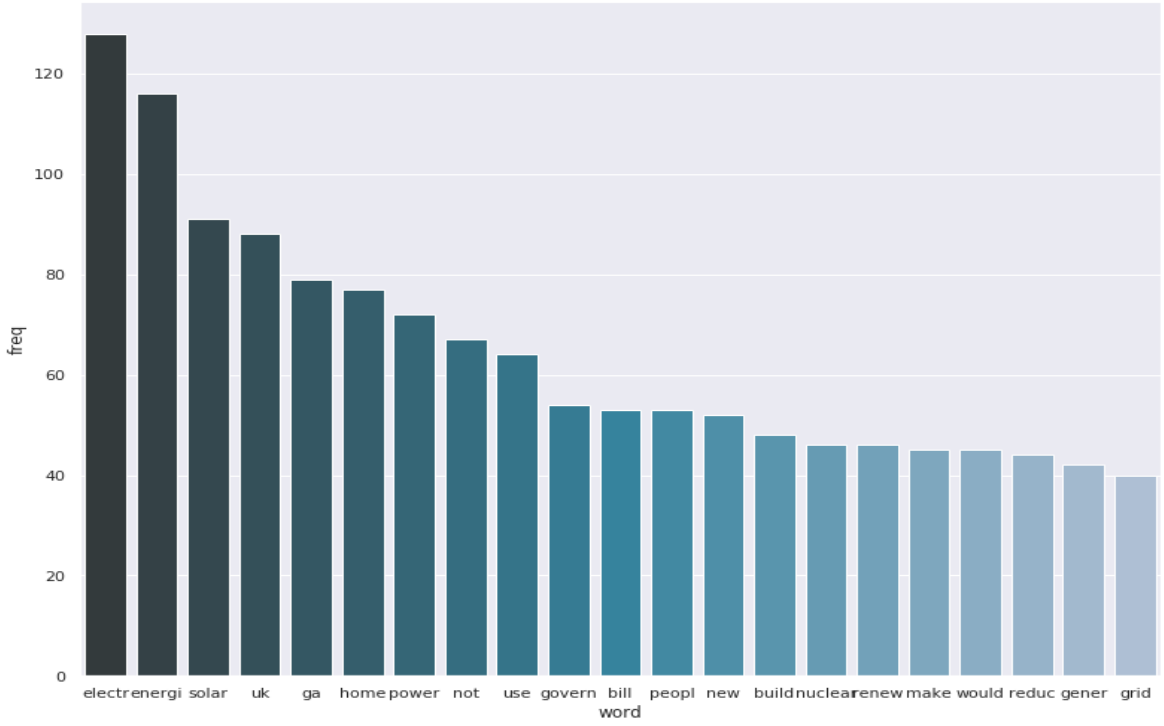


Figure 6: The unigram of the full-text petitions on electrical energy issues, the UK 2017-2020 (Source: Conducted by authors based on the Petitions UK Government and Parliament site, https://petition.parliament.uk)

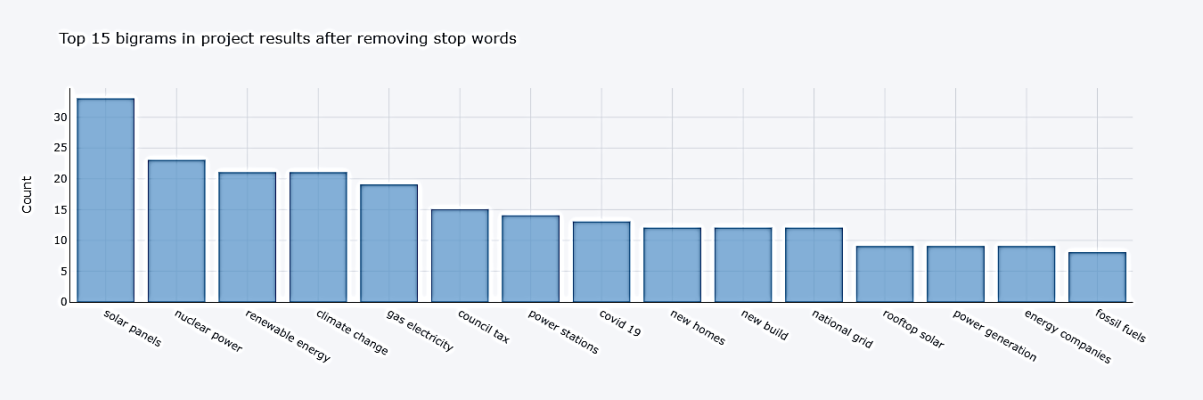


Figure 7: The bigram of the full-text petitions on electrical energy issues, the UK 2017-2020 (Source: Conducted by authors based on the Petitions UK Government and Parliament site, https://petition.parliament.uk)

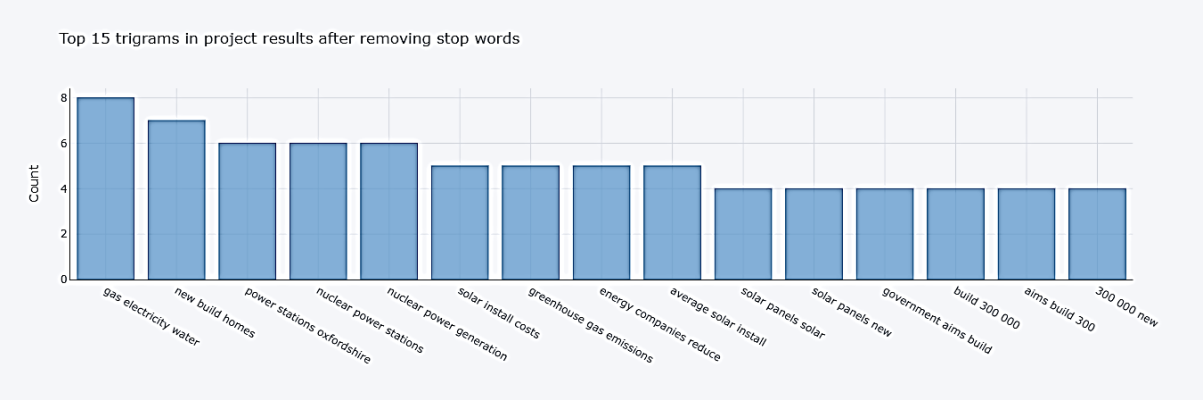


Figure 8: The trigram of the full-text petitions on electrical energy issues, the UK 2017-2020 (Source: Conducted by authors based on the Petitions UK Government and Parliament site, https://petition.parliament.uk)

Before moving on to modeling petitions' text, it is good to check connections between terms using the WordCloud (v.1.4.1). The authors generated a WordCloud object for 5000 words. Figure 9 visually shows the relationship between the petitions' most 'valuable' words listed above.

Figure 9: The Word cloud of the full-text petitions common words on electrical energy issues, the UK 2017-2020 (Source: Conducted by authors based on the Petitions UK Government and Parliament site, https://petition.parliament.uk)

4.3. Topic modelling

According to the found tokens, the Gensim's phrases class was used to group and model the most powerful words in UK petitions. This class of models belongs to LDA topic models. The results for the 15 models are presented in Table 3.

Table 3
Topic models' parameters of the full-text of petitions on electrical energy issues, the UK 2017-2020 (Source: Conducted by authors based on the Petitions UK Government and Parliament site, https://petition.parliament.uk)

Topic mod. No	Topic model parameters
1	'0.020*"electricity" +0.015*"price" +0.015*"windfarm" +0.015*"offshore" +0.013*"grid"+ + 0.013*"covid" + 0.012*"gas" + 0.011*"time" + 0.011*"reduce" +0.011*"energy"
2	'0.028*"price" + 0.020*"pump" + 0.020*"oil" + 0.012*"grid" + 0.012*"line" + +0.012*"national" + 0.012*"transport" + 0.011*"fuel" + 0.010*"pay" + 0.008*"barrel"
3	0.015*"energy" + 0.015*"solar" + 0.015*"payment" + 0.014*"people" + 0.013*"work" + + 0.012*"make" + 0.012*"gas" + 0.012*"pay" + 0.012*"bill" + 0.011*"power"
4	0.016*"water" + 0.016*"electricity" + 0.013*"waste" + 0.013*"plastic" +0.013*"charge" + + 0.013*"worker" + 0.013*"fuel" + 0.011*"energy" + 0.011*"bill" + 0.011*"gas"
5	0.036*"nuclear" + 0.033*"power" + 0.031*"solar" + 0.029*"build" + 0.027*"new" + + 0.024*"home" + 0.021*"station" + 0.016*"generation" + 0.015*"world" + 0.013*"panel"
6	0.031*"pay" + 0.020*"bill" + 0.016*"energy" + 0.014*"charge" + 0.014*"people" + + 0.013*"freeze" + 0.013*"exam" + 0.013*"work" + 0.013*"water" + 0.012*"gas"
7	0.026*"energy" + 0.023*"electricity" + 0.021*"gas" + 0.015*"renewable" + 0.014*"tidal" + +0.013*"source" +0.012*"government" +0.011*"home" + 0.011*"reduce" + 0.009*"make"
8	0.052*"energy" + 0.019*"home" + 0.018*"electricity" + 0.016*"solar" + 0.013*"tariff" + + 0.013*"renewable" + 0.012*"gas" + 0.011*"reduce" +0.008*"work" +0.008*"household"
9	0.024*"people" + 0.014*"project" + 0.013*"bill" + 0.012*"electricity" + 0.010*"deal" + + 0.010*"rent" + 0.009*"gas" + 0.008*"lose" + 0.008*"support" + 0.008*"home"
10	0.026*"energy" + 0.025*"solar" + 0.019*"panel" + 0.018*"electricity" + 0.015*"would" + + 0.015*"supplier" + 0.015*"cost" + 0.011*"broadband" + 0.011*"sustainable" + + 0.011*"produce"
11	0.024*"company" + 0.024*"gas" + 0.016*"power" + 0.014*"time" + 0.012*"support" + + 0.011*"need" + 0.009*"everyone" + 0.009*"electricity" + 0.008*"utility" + 0.008*"work"
12	0.033*"solar" + 0.028*"panel" + 0.017*"make" + 0.016*"plant" + 0.016*"tax" + +0.015*"build" + 0.014*"new" + 0.014*"house" + 0.014*"would" +0.012*"electricity"
13	0.024*"power" + 0.022*"turbine" + 0.019*"hydrogen" + 0.016*"energy" + 0.015*"solar" + +0.014*"home"+0.013*"fuel" +0.011*"wind" +0.011*"produce" +0.011*"climate_change"
14	0.039*"home" + 0.025*"solar" + 0.025*"rooftop" + 0.018*"owner" + 0.018*"site" + + 0.014*"resident" + 0.011*"electricity" + 0.011*"year" + 0.011*"energy" + 0.011*"grid"
15	0.020*"build" + 0.019*"power" + 0.015*"sea" + 0.015*"impact" + 0.015*"process" + +0.014*"stop" +0.014*"development" +0.014*"bradwell" +0.013*"new" +0.012*"nuclear"

To interpret UK petitions' simulation results, the intertopic distance map was built using the pyLDAvis package (Figure 10). Some words (energy, solar, electricity, home, gas) occur quite often

in topics. For example, the word ‘grid’ better describes the first topic, ‘energy’ the third, ‘development’ the fifth, ‘bill’ the sixth. The map visually shows that the first topic model describes 13.2% of tokens. This model also considers the British's critical questions regarding the reduction of utility bills for energy resources for households (electricity, and gas). Moreover, the first model explains one of the most talked-about government energy initiatives by the British – the installation of personal solar panels in citizens' homes.

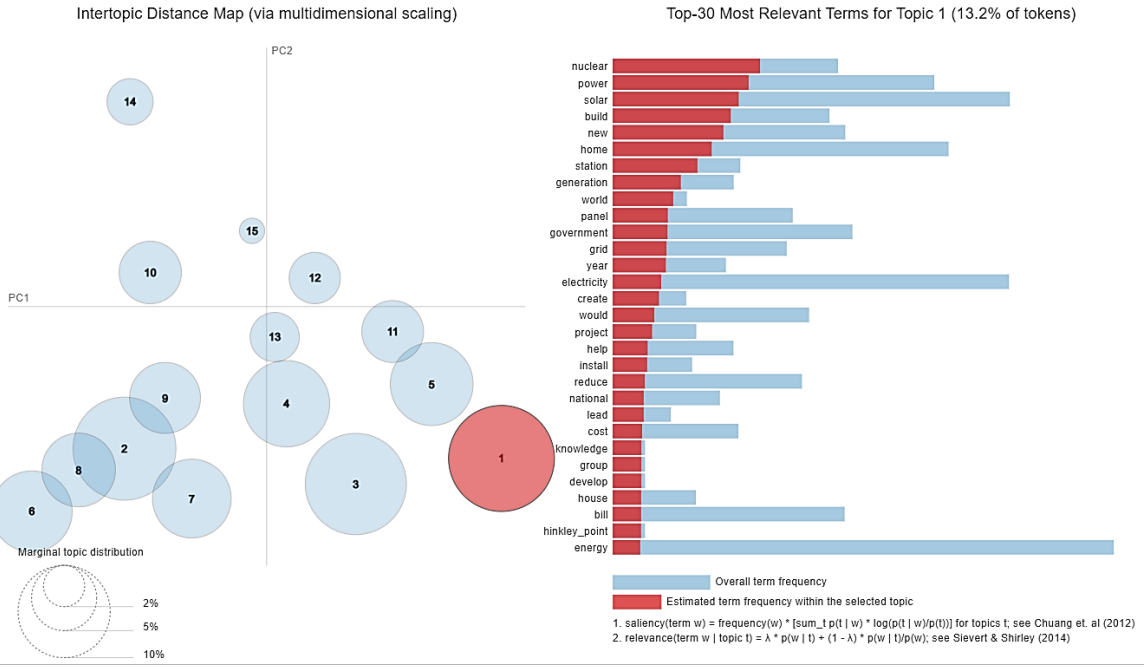


Figure 10: The intertopic distance map of the full-text petitions common words on electrical energy issues, the UK 2017-2020 (Source: Conducted by authors based on the Petitions UK Government and Parliament site, https://petition.parliament.uk)

Figure 11 presents the results of the number of topics estimating in a corpus. When interpreting the results, one can say that the optimal value will be 15 topics in the corpus. In this case, the score of the mean coherence will be 0.383.

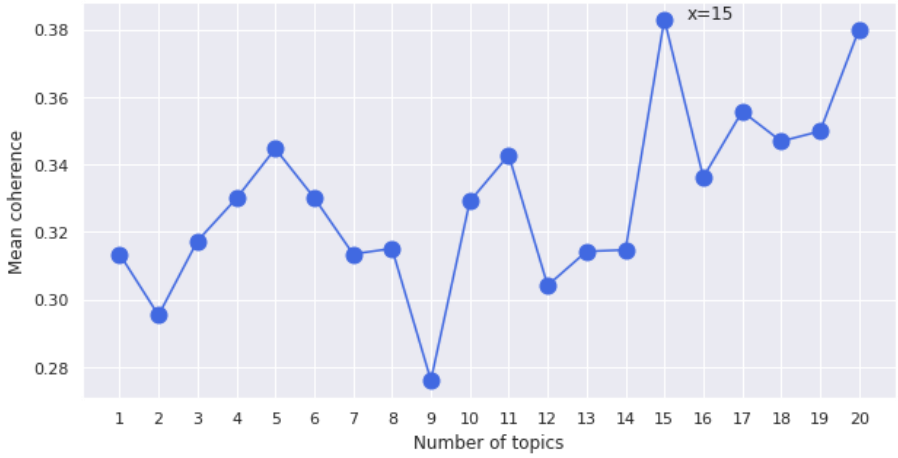


Figure 11: The coherence value of the full-text petitions topic models on electrical energy issues, the UK 2017-2020 (Source: Conducted by authors based on the Petitions UK Government and Parliament site, https://petition.parliament.uk)

Usually, the mean coherence score gives good results for choosing the number of topics [24, 25]. However, for this sample of petitions, the evaluation did not show a stable and steady increase in the indicator's values – the results change with a certain level of periodicity.

5. Conclusions

In recent years, the UK Government and Parliament have implemented many electrical energy initiatives. Not all of them found citizens' support, and some projects received active opponents among the British.

But there were successful projects accepted by the population. Based on machine analysis of a sample of petitions, it can be seen that the British have responded positively to the construction of new homes with solar panels and the conversion of old buildings to use renewable energy sources.

The leap in petition registration on the energy industry aspects happened in 2020. Unfortunately, this was not connected with the energy efficiency calls, but because of the consequences of the COVID-19 pandemic, the most vulnerable parts of the population's inability to pay utility bills. A critical issue for the British was reducing utilities' prices for energy resources (electricity and gas).

Also, citizens' complaints express dissatisfaction with the unjustifiably expensive financing of energy initiatives, the construction of new power plants, the imposition of smart meters with a subsequent increase in bills for their use.

There were also petitions concerning power plants in Oxfordshire, onshore wind turbines, an Ofgen grant, 'direct investment in nuclear new build projects.' However, public interest was low in implementing such projects; there was a lack of understanding of their effectiveness. As seen from the textual analysis of the petitions, there is a need for a more comprehensive information campaign on energy initiatives in the UK in the future. And the LDA models can be easily used to understand the opinions of the population on government initiatives.

6. Acknowledgements

Authors appreciate the copyright holder: © Crown, and to the source of the extracted data which is the Petitions UK Government and Parliament site @ https://petition.parliament.uk/. The data contains public sector information licensed under the Open Government License v3.0.

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