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## Understanding the public reaction to major United States environmental policies through Twitter

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### Abstract

This study investigates public reactions to major environmental policies through an analysis of historical tweets from 2010 to 2022, focusing on 11 key policies. Utilizing word cloud and sentiment analysis, the research identifies predominant themes and emotions in discussions surrounding each policy announcement. Results indicate that political figures tend to be the central focus, while environmental aspects receive limited attention. Negative emotions, such as sadness and anger, are prevalent in these conversations. To examine shifts in sentiment, a series of t-tests were conducted, comparing emotions before, at, and after each policy enactment day. The findings suggest that conversations increasingly focus on specific environmental policies on the day of their announcement and that initial reactions are generally positive. However, sentiment can change rapidly, irrespective of public opinion on the policy.

**Keywords:** environmental policy, natural language processing, emotion analysis, twitter

### Introduction

Every year, the environment becomes a more hotly debated issue. Climate activists, politicians, businesspersons, and realistically everyone else has an opinion on the current state of the planet and what is being done to protect it – or not. While the general vibe of how the public feels about any particular topic can be gleaned through many conversations or the now unavoidable use of social media, there are only a few who have sought to discover what the public talks about and how it feels about the current state of the environment. More specifically, as everyone has an opinion on environmental policies, as political discourse is just as certain as both death and taxes, there is value in quantifying said reactions.

Discovering what the general discussion and emotional reaction to environmental policy is could help identify ways to get the public at large on board with new changes when they are announced and implemented. Leveraging what the people talk about can make them feel more involved and connected with the issue at hand, because even though we all interact with the environment every day, discussions involving it can be difficult to have due to both the immense political polarization that currently exists and an overall lack of usable or digestible environmental data. This interlaces itself with the emotional responses of the public as well. Is the response to environmental policy one that focuses on the environment as the heart of the issue, or the policy? Surely a joyful public would be more likely to cooperate in solidifying and enhancing the environment, but does the red tape around the bureaucracy of each individual policy stop this from happening? How does the public feel about this, if so?

While the questions are endless, as are the answers, the attempt to slowly and methodically research them carries immense value in the world's current landscape, where everyone and everything is affected by a more polarizing climate, a shrinking shoreline, and a microplastic epidemic. The world looks to its leaders

to make the right call for how we navigate this changing environment, but is it satisfied with the answers? The purpose of this research is to discover what Twitter users discuss and how their emotions change as new policies are implemented and serve as a basis for understanding how the public at large responds to governmental environmental initiatives.

## Literature Review

The current literature on the environment and its relationship to the public covers a series of consistent themes. First, there is a great amount of literature that speaks on how the governments of the world play a role in not only environmental health but also communication of that health to the public. The veracity of the data that is communicated is often in question, based on the beliefs and agendas of certain administrations. This, along with the inconsistency and unavailability of governments in enforcing their own environmental protections have eroded the trust between governments and their citizens.

While policies have the potential for high environmental impact, the public may not have all the tools required to understand, from a data perspective, what their relationship with the environment truly is. Governments are certainly one figure at play here, but just as guilty is the lack of a consensus on a set of consistent and easy to understand set of environmental indicators. Beyond the public's understanding, a lack of data availability hurts governments when they try to implement environment-positive policies. A review of previous practices in determining the public's relationship to the environment shows a limited set of methodologies, though to focus on their limitations would be to ignore the understanding brought on by their insights. This section will first look at the role of government when considering the environment, followed by a review of existing studies on public reactions to environmental issues.

### Government's Environmental Role

The role of government in both environmental health and environmental understanding is essential and cannot be understated. The government can control which data is collected and by whom it is collected. Government also has a responsibility to maintain and publicize the data it collects in any context, especially when relating to the environment. Transparency is essential not only for environmental health, but also human health and general environmental improvement. While data on its own is a series of observations, supposedly free of political bias, not every administration sees it this way; this is a result of a significant lack of data literacy among politicians and the public in general.

Every administration has its own agenda that it wishes to push, and the context of data will lead the people that the government tries to maintain power over in certain directions regarding their opinions of the administration. During the Trump administration, citizen scientists reported at least twenty significant changes in wording or numbers to federal environmental websites to better align themselves with the administration's environmental agenda, which was largely to roll back protections that had been put into place during the Bush Jr. and Obama administrations (Dillon et al., 2019).

As would be expected, a government that is willing to tweak the content of data to further its agenda (regardless of which administration is responsible) may produce questionable policy around the related subject. This is one of many areas that could be counteracted by universally recognized environmental indicators. Hammond et al. (1995) believe that a common database centered around universal indicators would be a "significant step" towards both the improvement of shared knowledge of environmental pressures as well as the policies put in place to counteract them. This is not to say that governments require these indicators to act in a way that is environmentally beneficial; Germany has long been considered one of the most progressive nations on the planet when it comes to developing environmental policy despite not

using these indicators. However, even Germany is susceptible to outside forces when making environmental policy. Political scientist Rüdiger K. W. Wurzel (2010) writes that while policy creations and changes have been made and have real results in Germany, the relative youthfulness of the Germany Environmental Ministry has resulted in said policy and results having only a marginal effect on the environment lest the Economic Minister conclude that business would be hurt as a result and attempt to veto. The hands of corporate actors in government are impossible to ignore, and they are just as prevalent in environmental policy creation as they are in economic policy creation.

Consequently, policies are created around what will stimulate the economy instead of policies that will be good for the earth and the people on it. Policy reviews and reflections on policy creation are consistent in their beliefs that in a world where government's priority (when dealing with environmental issues) is the bottom line when it should be preserving nature, future generations will be committed to the idea that "good-enough" is good-enough, which would have devastating effects on the environment long term (Barkin, 2006). Furthermore, even when governments do initiate the creation of new environmental policy, there is a significant lack of consultation with environmental experts.

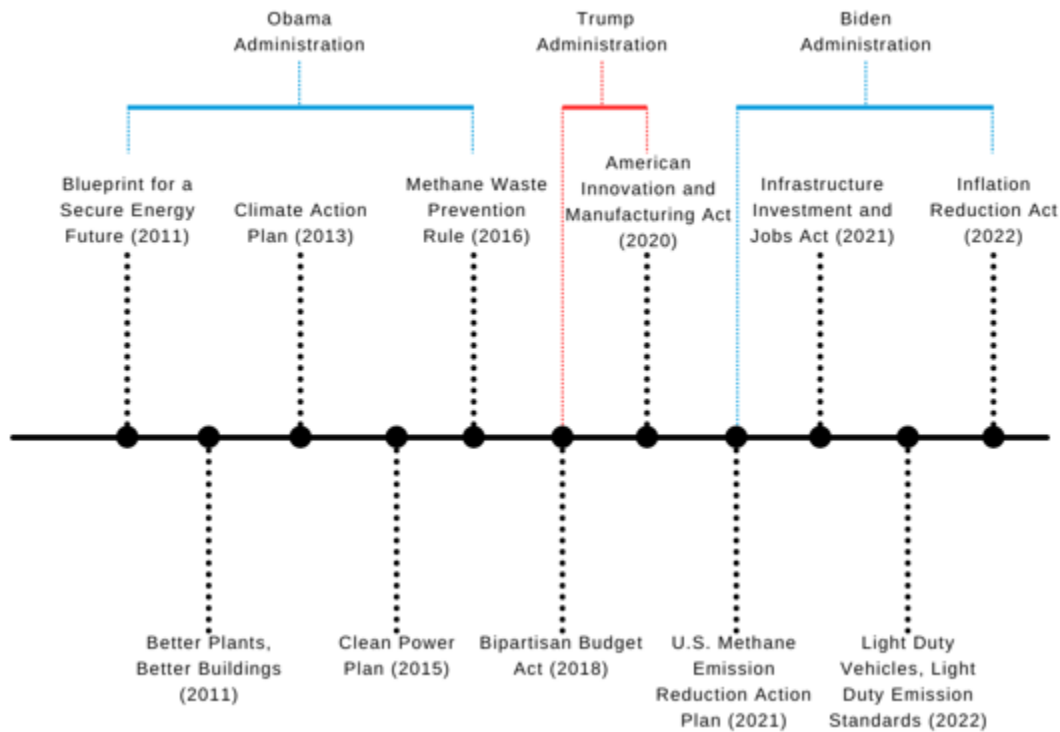
A policy review conducted by Wendy Wagner in 1999 found that it is often cheaper and faster to conduct a trial-and-error scientific methods conducted by amateur or independent researchers and attempt to solve the problem through scientific means only than it is to put time into the proper required research that would benefit the environment. In addition, there is little to no incentive for these independent researchers to do this kind of work, leading to several issues where regulators have had to crack down on products after damage has already been done (Wagner, 1999).

Existing environmental laws and regulations, because of the questionable methods used to create them, can often be entirely unhelpful. Often, despite environmental policy being tedious to work through, environmental destruction is not forbidden or even frowned upon during projects so long as the intent of destruction is reported to the government and the project in question is done in a manner where it leaves the smallest environmental impact (Phelan & Phelan, 2008).

Good policy is significantly more important than high quantities of policy as evidenced by Myanmar who, despite being a country that is a consistent world leader in environmental policy creation and sustainable forestry practices, has seen its biodiversity "degraded and destroyed" because of laws that are too broad and only occasionally enforced (Sovacool, 2012).

All of this, from governmental edits to citizen scientists to the lackluster or malicious environmental efforts by businesses show that the general perception of environmental issues is not up to the public, rather to the systems that the public exists within. As such, the public discussion around environmental issues must first be examined within the contexts of governmental regulation and policy and then through the lens of business responsibility and operation. Without these two major factors being considered by researchers, the investigation into how the public discusses environmental happenings is void.

From 2010 to 2022, the Climate Policy Database, an organization that logs the environmental laws passed by each country, identified eleven United States policies as having aspects that result in a high environmental impact. Each policy and some of its major environmental impacts are listed below. Figure 1.1 shows a timeline of those 11 policies covering three administrations (Obama, Trump and Biden).



**Figure 1: Timeline of Relevant Policies**

- **Blueprint for a Secure Energy Future (2011):** Outlines a plan and standards to both increase renewable energy production in many areas of the United States and decrease a reliance on processes that emit excess levels of methane or carbon dioxide. Sets specific goals around reducing the nation’s need to use oil for vehicle transportation and large-scale production power.
- **Better Plants, Better Buildings (2011):** Sets specific goals and plans for both new and existing commercial and residential buildings to reduce inefficient energy use by 20% through 2020.
- **Climate Action Plan (2013):** This policy set aside federal land for renewable energy production as well as setting a goal to install renewable energy producers in locations with federally assisted housing with the end target of doubling renewable energy production in the United States by 2020.
- **Clean Power Plan (2015):** This policy set a target and standards for a 32% reduction in carbon dioxide through 2030 in the United States power sector.
- **Methane Waste Prevention Rule (2016):** Standards set in this policy outline requirements for United States businesses to lower methane emissions by 35% over the ten years after the policy was put in place.
- **Bipartisan Budget Act (2018):** Aspects of this policy aim to incentivize businesses to lower carbon outputs through providing tax credits.
- **American Innovation and Manufacturing Act (2020):** This policy aims to support environmental progress by limiting and transitioning away from the super-pollutant hydrofluorocarbon in the American manufacturing space.
- **U.S. Methane Emission Reduction Action Plan (2021):** This policy outlines key actions for the United States to take in decreasing general methane emissions and addresses how to specifically target coal mines and other abandoned methane emitters.

- Infrastructure Investment and Jobs Act (2021): This policy commits substantial amounts of money to improving the transportation structure of the United States, with improvements such as rail modernization and accessibility and general commitments to the power structure with a focus on clean energy having the potential to cut a generous portion of emissions.
- Light Duty Vehicles, Light Duty Emission Standards (2022): This policy, set by the EPA, outlines a target for emissions for all new passenger cars and light trucks through 2026.
- Inflation Reduction Act (2022): While not a policy that mainly focuses on the environment, the Inflation Reduction Act invests heavily in renewable energies targeted at lowering greenhouse gas emissions as well as encouraging development of cleaner vehicles, cleaner fuel, and general energy efficiency improvements.

Given that there is a seemingly unending amount of relevant environmental data that can be used to make decisions, a universal set of consistent environmental indicators would go a long way in increasing the accessibility of environmental data, which can often be difficult to understand without heavy context (Hammond, 1995). Wendy Wagner (1999) expands on findings from Raphael Sassower's *Knowledge without Expertise: On the status of scientists* (1993) to emphasize this in a 1999 review on environmental policy creation; Wagner writes, "Surveys also show that the public has a limited understanding of the scientific enterprise, and as a result, may tend to misunderstand and underestimate the multiple limitations and constraints of science." (Sassower, 1993; Wagner, 1999).

There are instances of data accessibility being limited by governments as well, further limiting how the public can interact with it. Members of the public may begin initiatives to collect or maintain data as a result; DataRescue's archival project during the Trump administration was admittedly an "uncritical" form of activism, largely inspired by the rhetoric of "'saving' government data from the [Trump] administration" (Dillon et al., 2019).

This, of course, is not to say that government only hinders participation in environmental initiatives. When discussing the role of government in community science, Schwoerer et al. (2021) identifies that with additional funding and resources from state or even federal government, there is potential for research to be done more effectively while also working to establish some level of trust between the government and its people.

Establishing trust with its populations would be a good move for government, as there tends to be a substantial lack of it around environmental decisions made by them. This trust can be re-established through several methods. A method that has already been proven to work is direct government outreach to communities. The Biden administration has recently been focused on attempting to restore trust with Indigenous groups through monetary compensation, but this restoration can be achieved through collaboration as well; there is no shortage of environmental researchers who would be unable to complete their projects without the assistance and efforts of citizen scientists from Indigenous groups (Rasmussen, 2023).

Businesses must also be brought on board with making the environment a healthier place, though governments do not always see it this way. Revell (2007) discusses the dual role that government and businesses play in combatting environmental issues and thus trust issues, but also shows that small and medium businesses tend to get left behind in government-business partnerships. The act of rebuilding the community has its merits but is not the only answer to the trust problem.

One of the most impactful actions the government can take would see the creation of a program or system where government collected data and information is readily available to the public in an accessible format.

Open government data is largely linked with an individual's right to information, which proponents of express to be an extension of their freedom of expression; if one wishes to fully express their thoughts, ideas, and opinions, then it is the responsibility of government to provide relevant data so those thoughts, ideas, and opinions can be freely formulated (Yannoukakou, 2014).

Even if the message is delivered, whether the message be new policy or the release of data, the public will often view the messenger as just as important to establish credibility. Wagner (1999) again states that the public would respond much better to policies created by scientists, which have previously been held in the highest regard of all professions, than by politicians, who may suffer from the same data inadequacies as their constituents.

Admittedly, Wagner's data is from over twenty years ago, and there are now more effective ways to measure public perception. One method that has been proven to accurately measure public perception on issues over time is the execution of a spatio-temporal analysis on tweets collected through a listener. Outside of surveys, this is one of the most effective proven ways to identify connections between people, locations, and general opinions quickly and on a large scale, although the effectiveness is diminished by Twitter's user demographics (Koynu, 2019). Researchers have been using twitter listeners to analyze topics for years in every possible topic area, including the environment, where they have found room to draw reasonable conclusions about how the greater public views certain environmental issues.

One study, conducted by Wen Shi et al. (2020), used a set of environment-related hashtags to try to group users based on how they spoke about certain topics over a ten-year period while exploring how the conversations around those hashtags changed in that span. While the main findings of Shi's research are significant, they do address a gap in their research explaining that they did not focus on interactions between public discussions and other "external factors." They do theorize, however, that factors akin to "scientific efforts, natural events, politics, and online information (or misinformation) campaigns" would influence how such topics are discussed, particularly on social media (Shi et al. 2020).

Another study, from Qiao & Williams in 2022 explores the sentiment and conversation surrounding global warming conversation over an 18-month period by detecting eight different emotions and grouping discussed topics within them, finding a strong existing link between the conversation and several political entities, including policies and political parties.

The three studies have largely shaped this research. Using topics strongly intertwined with environmental health such as climate change and global warming can yield many results, particularly when considering that the existing literature has already proven the connectedness of those specific topics with social and political discourse. Additionally, a sentiment analysis with fewer than eight emotions listed can offer a less complex view of exactly how individuals respond to certain events. Shi's suggestion that external forces such as politics can drive discussions about climate will work especially well for this research, as the findings would directly address the underlying framework of the problem at hand.

Extended from previous literature review, this research aims to explore the patterns and connections between public sentiment and new environmental policies as well as the discussions around them. The current literature suggests that a link between the two exists, but thus far has not been researched or discussed to a meaningful degree.

This research opens the door for further investigation into connections between real-world events and reactions of the general public through a digital medium. The research is conducted with the following question in mind: what is the public reaction to new, major environmental policies as seen through the

discussions and emotions exhibited by Twitter users? There were two research goals for each of the previously listed policies as well:

- *To identify if the new policy dominated conversation upon announcement and subsequent enactment by showing commonly discussed topics and the shift in topic over time.*
- *To compare the changes in emotion before, at, and after a policy's enactment, showing the reactions of Twitter users to the new policies.*

## Research Methodology

This research was done through use of tweets collected over a twelve-year span from 2010 through 2022. Tweets were collected using a Twitter listener that scraped individual tweets with the words “global warming.” Emotion analysis was performed on each tweet using a pre-trained model Hugging Face (Twitter-roBERTa-base for Emotion Recognition). This model, trained on about 58 million tweets, is a roBERTa-base model that has been tuned for basic emotion recognition using the TweetEval benchmark. Each tweet is classified into one of four emotions: anger, joy, optimism, and sadness, each of which is given a confidence score.

The dataset used for the research contained about 28 million tweets where the words “global warming” appeared from 2010 to 2022. The most tweets were collected in 2019 (about 4.4 million) and the year with the least tweets collected was 2010 (about 600,000). There were about 14.7 million unique users over this same span.

The dataset was filtered by location down to only tweets from the United States. Individual locations within the United States were dropped from the dataset if they were tweeted from less than 2000 times. The top United States locations identified in were variations of “United States” (such as “USA,” “America,” “US”) or highly populated United States cities and states (such as “California, USA,” “Los Angeles, CA,” “New York,” and “New York City”). Additionally, several steps were taken to ensure that individual tweets could be analyzed. These steps include:

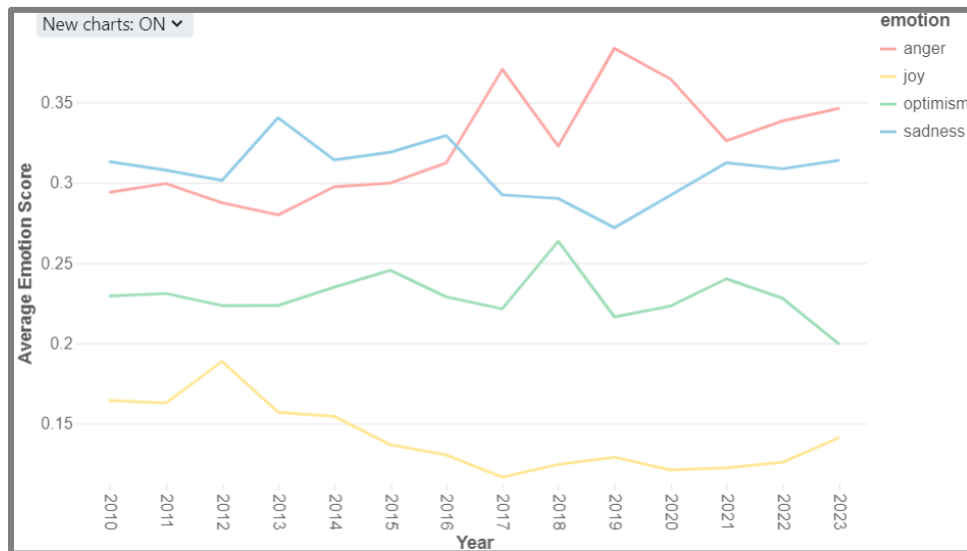
1. Converting all letters to lowercase to remove redundancies.
2. Removal of all words starting with “http,” “#,” and “@” to avoid links, hashtags, and specific Twitter users from clouding the data.
3. Removal of special characters within words.
4. Removal of stop words, including all English stop words as well as additional words that were used to extract tweets such as “climate,” “change,” “global,” and “warming” as all tweets within the dataset contain these words.
5. Lemmatization of all words to switch them to their base roots.

## Discussion of Results

This section starts with a discussion of the overall emotion by year. Word clouds were then used to visualize and explore discussions over a few windows around the policy, notably one week before and one week after enactment, one day before and one day after enactment, and the day of enactment itself. Similarly, line graphs were created showing the timeline of each emotion’s aggregate mean over a fifteen-day period spanning the seven days before and after each policy was put into place. Finally, independent t-tests were implemented to discover significance in emotion changes over a selected grouping of date pairs.

## Overall Emotion by Year

Figure 2.1 shows the average emotion score by year. Sadness is the dominant emotion from 2010 to 2016, after which anger reigns as the dominant emotion from 2017 to 2022. Optimism consistently ranks third, and joy ranks last throughout the entire timeframe.



**Figure 2: Average Emotion Score by Year**

## Word Clouds by Policy Before, At, and After Enactment

Word clouds were used to see most frequently appeared words in each policy before, at, and after enactment. Selected results are shown in Figures 3 - 10. When observing conversation around the eleven policies utilizing wordclouds, several unique cases arose. The most common response among the communities was general conversation surrounding relevant political figures, including though not limited to the acting president at the time the policy was enacted. These conversations either centered around a political figure or around keywords related to the policy put into place.

Figure 3 shows the response to the enactment of the Climate Action Plan in 2013 on the day that the policy was announced. The Climate Action Plan is one of seven policies where a political figure was the most discussed topic on the policy's enactment day and can be used as a benchmark for how such discussions appear when put into a word cloud for analysis. Notable words include "Obama," "speech," "president," and "plan," clearly showing a reaction to then-President Obama's announcement, while some less notable words include reactions to the plan ("ambitious," "dumb") and areas that the president addressed ("coal," "epa", "construction").





around the president who was responsible for the enactment or announcement of each policy; former President Obama for the Climate Action Plan, former President Trump for the Methane Waste Prevention Rule, and President Biden for the other three. All except for the Inflation Reduction Act follow the same general pattern of fixation on the president as outlined above in the Climate Action Plan, save for the duration that the community focuses on the actual environmental initiatives. In fact, aside from the concentration on whoever is at the helm of the United States, the conversation fails to stay as anchored on the actual policy or plan over any extended period. Figure 5 shows that the Methane Waste Prevention Rule (MWPR) conversation is largely centered on former President Trump, but aside from “burn” there are no notable key words associated with environmental health.

In contrast, Figure 6 shows that the conversation over the following week pivoted towards an actual discussion of environmental factors that are likely relevant to the MWPR. Highly used words included “scientist,” “arctic,” “sea,” and “ocean.” “Ice” and “ecology” also appear on a smaller scale, showing that despite the early non-response to the plan, at some point the conversation ramped up enough to allow it to be featured within some of the week’s top words.

The reaction to one of these policies shows that sometimes the public simply does not react to the environmental aspect of a policy. Despite several plans for an increased push for the switch to renewable energies, there is little relevant reaction to the Infrastructure Investment and Jobs Act. Figure 7 shows that the focus of the community on the day that President Biden signed the Infrastructure Investment and Jobs Act into law was political and not environmental. Words such as “vaccine,” “regime,” “jan” “6<sup>th</sup>,” “concern,” “racist” are prevalent while “gas,” “greenhouse,” and “climate” sit in the background. Figure 8 shows that the following week’s conversation never returns to discussions of climate or the environment, as indicated by the lack of relevance of top words such as “million,” “cause,” and “human”, though the presence of “world”, as a top word, and “temperature”, “increase”, and “carbon”, as frequently used words shows that at the very least the conversations are still being had despite not being the most obvious.

Of course, some discussions do focus on the relevant policy, such as the response to the American Innovation and Manufacturing Act (AIM). Figure 9 shows the response, which, among what appears to be a quote (“people” “never” “cease” “amaze”), “ocean” and “acidification” are both top words indicating one of the only conversations that did not need a politician to stay on the environmental topic. Of course, this also shows that “hoax,” “believe,” and “exist” are also all top words, showing that even in a non-political situation there can still be debate.

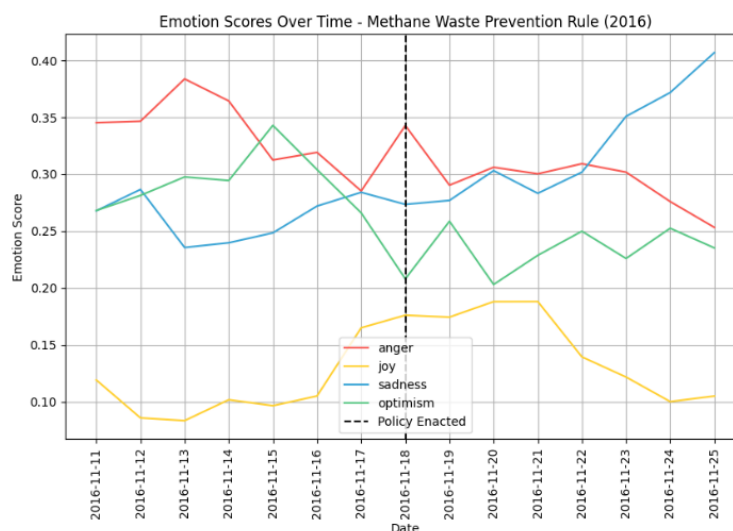
Figure 10, like in previous examples, shows the week after the policy’s enactment. While “ocean” and “acidification” are no longer two of the top words, both are still ranked close to the top. “hoax” and “belief” have also moved further down the list, and the highest-ranking words are “stop” and “petition,” apparent calls to action.

The most notable find from this area of the research is that the main driver behind the conversations are not typically about the policies being put into place but rather the characters and general political activity happening around those policies. Even apart from the examples listed above, this is a trend that continues across all eleven policies. Discussion around the Clean Power Plan focuses just as much on Senator Ted Cruz as former President Obama. Edward Scott Pruitt, one of former President Trump’s Administrator of the Environmental Protection Agency, was the dominant topic when his boss signed the Bipartisan Budget Act into law. This is likely due to the extreme politicization that has come with discussions around climate change and global warming, especially throughout the 2010s and now the 2020s. Appendix A contains a full library of word clouds for each of the eleven policies, including the day before a policy’s announcement/enactment, the day of enactment, and the seven days after enactment. Another key finding

from this analysis is that there is a clear shift from topic to topic once a policy is enacted, and while the conversation rarely sticks to being a discussion of the policy at hand from an environmental perspective, each dominates the general global warming discussion for at least a week after each enactment.

## Emotion Pattern Changes for Each Policy

As previously explored in this discussion, there are several clear patterns in emotion expression both within each policy and across the dataset at large. Anger and sadness are typically the highest-scored, where optimism and joy are typically the lowest scored. Figure 11 uses the Methane Waste Prevention Rule to show a typical emotion pattern for a fifteen-day period centered around a policy's enactment; while this figure does not show the exact pattern for each policy, its standout features do represent the results shown by many of the other fifteen-day enactment windows. Note that anger is the most dominant detected emotion, followed by sadness and, rarely, optimism. Joy stands alone at the bottom of the figure, and rarely ranks any higher at any point. All other figures referencing emotion levels over similar spans are contained in Appendix B, and most of them reflect the general trend. Anger was the most dominant emotion on the day of nine policy enactments, where sadness took two and optimism only led once.



**Figure 11: Emotion Levels Around the Methane Waste Prevention Rule's Enactment**

The results showing dominant emotions for policy enactment days reflect this trend. Anger is the dominant emotion on the enactment days of eight of the eleven observed policies. Sadness and optimism round out the group, with sadness standing as the emotion with the highest score on two such days and optimism being most prevalent on one such day. There were no policies where joy was the most detected emotion. Instead, joy was the emotion with the lowest overall score on all eleven policy enactment days.

Independent t-tests were used to compare the differences in each emotion within each policy in the following date pairs with a significance level of  $\alpha = 0.05$ :

- Day Before Enactment, Day of Enactment
- Day of Enactment, Day After Enactment
- Day of Enactment, 2<sup>nd</sup> Day After Enactment
- Day of Enactment, 3<sup>rd</sup> Day After Enactment
- Day of Enactment, 4<sup>th</sup> Day After Enactment

The results show that 25 out of 44 (57%) tracked emotions were significant in this regard, with seventeen of them being “good” changes (increases in joy or optimism or decreases in anger or sadness) and the other eight being “bad” changes (decreases in joy or optimism or increases in anger or sadness). Notably, despite the general trend of joy remaining low across all the policy timeframes, joy showed five significant increases on policy enactment days while only significantly decreasing once. Similarly, optimism significantly increased more often than it significantly decreased and anger, despite being the most detected emotion across the observed timeframes, experienced six significant decreases and only two positive increases. These suggest initial satisfaction with policies in general.

The policy that best captures the trends of significance and general daily change is the Infrastructure Investment and Jobs Act of 2021. In this example, significance is found in anger, joy, and optimism once the policy is enacted, and the trend is clear enough to be able to see the stark decrease in anger and increases in optimism and joy upon enactment. While not wholly representative of every such t-test and plot indicating emotion, the results of this policy stand as a good benchmark for a meaningful result in this area. Figures 4.1.a and 4.1.b show the t-test results for the Infrastructure Investment and Jobs Act and the difference in emotion across each day.

	Emotion	Date1	Date2	T-Statistic
IIJA (2021)	anger	11/14/2021	11/15/2021	11.05*
		11/15/2021	11/16/2021	5.28*
		11/15/2021	11/17/2021	6.84*
	joy	11/15/2021	11/18/2021	5.11*
		11/15/2021	11/19/2021	5.28*
		11/14/2021	11/15/2021	-7.12*
	optimism	11/15/2021	11/16/2021	-1.71
		11/15/2021	11/17/2021	-2.86*
		11/15/2021	11/18/2021	-4.17*
11/15/2021		11/19/2021	-2.68*	
11/14/2021		11/15/2021	-12.64*	
sadness	11/15/2021	11/16/2021	-0.24	
	11/15/2021	11/17/2021	1.51	
	11/15/2021	11/18/2021	1.19	
	11/15/2021	11/19/2021	-2.11*	
	11/14/2021	11/15/2021	-0.14	
	11/15/2021	11/16/2021	-5.44*	
	11/15/2021	11/17/2021	-7.89*	
	11/15/2021	11/18/2021	-4.72*	
	11/15/2021	11/19/2021	-2.58*	

\* indicates significance at alpha = 0.05

Figure 12: T-Test Results for the Infrastructure Investment and Jobs Act

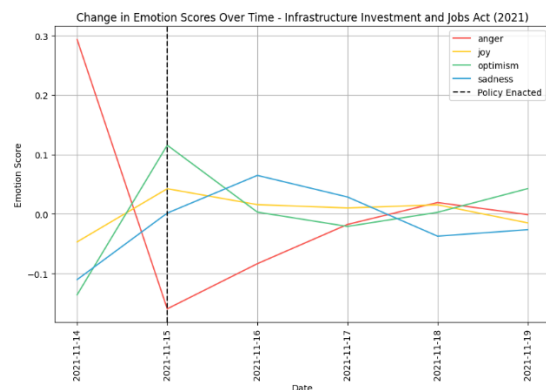


Figure 13: Rate of Emotion Change Over Tested Period for the Infrastructure Investment and Job Act

The results of the Infrastructure Investment and Jobs Act are unique for a couple of other reasons as well. For one, they contain the single largest increases in joy and optimism (across policy enactment days) and single largest decrease in anger (across policy enactment days). Additionally, a rare result is found in the t-test, that being that after day one significance is found, optimism remains at the same level over the next three days. There are only two other cases of emotions persisting for this long after day one significance: The significant joy found in the Clean Power Plan, seen in Figure 14 and 15 and the significant optimism in the Light Duty Vehicles, Light Duty Emission Standards Act, seen in Figure 16 and 17, continue until after the tested window.

In sum, the results of the emotion-based analysis conducted as a part of this research show that when it comes to policy, Twitter users do generally react positively when they react significantly. This indicates a general acceptance of measures when they are put in place, even after the enactment of policies that may not wholly focus on the environment. While the initial reactions are typically positive, there is no concrete

indication that this positivity lasts for longer than the initial enactment day, though there is indication that some emotions can persist at their changed levels for a few days. This is an area that warrants further exploration, though the simple answer may just be that the speed of social media erases clear emotion changes over an extended period.

	Emotion	Date1	Date2	T-Statistic
CPP (2015)	anger	8/2/2015	8/3/2015	-0.91
		8/3/2015	8/4/2015	-2.63*
		8/3/2015	8/5/2015	-1.06
	joy	8/3/2015	8/6/2015	2.17*
		8/3/2015	8/7/2015	-3.66*
		8/2/2015	8/3/2015	2.40*
		8/3/2015	8/4/2015	0.89
optimism	8/3/2015	8/5/2015	1.60	
	8/3/2015	8/6/2015	-0.70	
	8/3/2015	8/7/2015	1.73	
	8/2/2015	8/3/2015	-2.19*	
	8/3/2015	8/4/2015	7.39*	
sadness	8/3/2015	8/5/2015	6.20*	
	8/3/2015	8/6/2015	3.54*	
	8/3/2015	8/7/2015	9.51*	
	8/2/2015	8/3/2015	1.91	
	8/3/2015	8/4/2015	-5.44*	
	8/3/2015	8/5/2015	-6.67*	
	8/3/2015	8/6/2015	-5.86*	
	8/3/2015	8/7/2015	-6.62*	

\* indicates significance at alpha = 0.05

Figure 14: T-Test Results for the Clean Power Plan

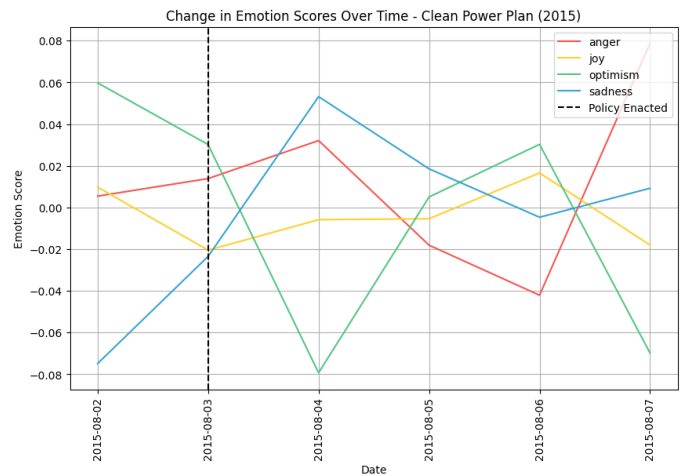


Figure 15: Rate of Emotion Change Over Tested Period for the Clean Power Plan

	Emotion	Date1	Date2	T-Statistic
LDVLE (2021)	anger	12/29/2021	12/30/2021	-1.05
		12/30/2021	12/31/2021	-1.77
		12/30/2021	1/1/2022	-18.01*
	joy	12/30/2021	1/2/2022	-7.09*
		12/30/2021	1/3/2022	-1.15
		12/29/2021	12/30/2021	-0.78
		12/30/2021	12/31/2021	3.19*
		12/30/2021	1/1/2022	8.58*
		12/30/2021	1/2/2022	4.19*
		12/30/2021	1/3/2022	1.69
optimism	12/29/2021	12/30/2021	4.57*	
	12/30/2021	12/31/2021	-1.63	
	12/30/2021	1/1/2022	0.47	
	12/30/2021	1/2/2022	-0.31	
	12/30/2021	1/3/2022	-1.88	
sadness	12/29/2021	12/30/2021	-2.01*	
	12/30/2021	12/31/2021	0.25	
	12/30/2021	1/1/2022	14.47*	
	12/30/2021	1/2/2022	4.70*	
	12/30/2021	1/3/2022	1.19	

\* indicates significance at alpha = 0.05

Figure 16: T-Test Results for the Light Duty Vehicles, Light Duty Emission Standards Act

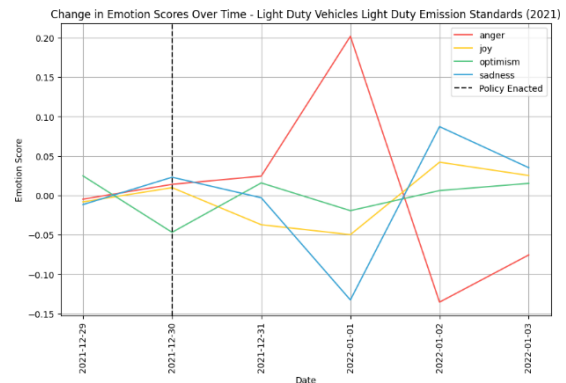


Figure 17: Rate of Emotion Change Over Tested Period for the Light Duty Vehicles, Light Duty Emission Standards Act

### Conclusion

In meeting the research goals of this project, several trends in the discussion of environmental policies on Twitter came to light. Conversation analysis revealed that the political figures that exist among the policies being put into place are often the focus of conversation. The obsession with talking about these political figures drowns out any environmental-related conversation happening within the observed community. Despite this, there was still a clear indication that policies do impact the conversation in environmentally conscious spaces on Twitter.

This result makes the general trends in emotion across policies seem understandable. Politics are often highly debated issues and are rarely discussed in a truly positive light, which could indicate why the roBERTa-base model was confident in predicting anger as a consistent top emotion (along with sadness, to a lesser degree) and joy as a consistent low emotion. Statistical tests on the daily changes in emotion showed that people within these spaces responded well to policies put in place most of the time (when a clear emotional response was apparent at all). Due to the fast-moving nature of Twitter and social media in general, it is not a surprise that emotions do not typically persist for longer than the day a policy is enacted. The surprising outcomes of optimism and joy occasionally breaking through this trend, as well as the fact that word clouds revealed a consistent policy discussion in the week after each policy was put into place do suggest that that conversations about environmental policy changes are able to remain relevant in social media spaces for a reasonable amount of time.

## Limitations and Future Research

There are limitations to this research that may present a skewed result. The biggest is that the dataset is very precise. Since it only contained one country from one site using one set of keywords, this research in no way fully captures the picture of how the public reacts to political events. While the research does show that there is general significance in the public's reaction, the specificity of the dataset renders the results difficult to apply to a more general context. The policies that were looked at are a built-in limitation to the research as well, as the eleven policies were selected to give an overall view of governmental choices with a high impact on an aspect of the environment. This could obscure results, as high-impact policies may not be the most popular to talk about, especially if the areas relevant to environmental health are tucked into small portions of large laws. Due to the limitation of the data available in this study, it is impossible to examine contextual nuances and organic connections between words cloud that could provide a richer understanding of the announcement's evolution. This presents a potential direction for future research.

Additionally, while Twitter's user pool has been consistently growing every year, the demographics still remain a major obstacle to getting an even sample of gender (56% of twitter users who choose to supply one the two assigned-at-birth gender identifiers identify as male per Twitter), and age (Twitter's users are typically under 50, and the platform is heavily dominated by younger members of Generation X, Millennials, and Generation Z, per Twitter). Another similar issue in determining demographics of users, especially age, gender, and location is the ability for a user to choose what to display on their profile. Most users do not use their real information if they supply it at all, and thus a true representative demographic population is difficult to determine. This makes determining how certain groups, notably location-based groups, react to certain local policies, so the study will likely be forced to focus on the federal level of policy changes and environmental disasters. Of course, the demographic information and specificity of twitter-based datasets may now be a moot point given the current state of Twitter, which has since rebranded to X and has increasingly made information that these datasets are built off harder to get through paywalls and limitations on what information can be pulled through its application programming interface (API).

As far as future research is concerned, one logical step to take – especially with the seeming downfall of the usability of Twitter/X's API, is to use another social media if possible. Difficulties may arise when taking speed and use of other platforms into consideration. The only platforms that seem to react as quickly as Twitter/X, at least as far as the eye test goes, are Facebook and TikTok, one of which is a proven cypher of misinformation and the other of which is strictly video media, making similar types of analysis difficult. If the same or a similar dataset were to be used, one could choose to focus on how different policies, those with medium or low impacts on environmental health, sway public opinion and public conversation instead.

Additionally, there may be benefits to comparing how different demographics react to distinct types of policy, whether they be Twitter user demographics or even the factoring in of other countries and their policies as well. To bring research such as this full circle with its inspirations, topic modeling could also be implemented to further explore and prove what the public tends to talk about as policies are both announced and enacted.

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