Spatiotemporal Analysis of Public Sentiment in Europe and the USA on Low-Carbon Energy Sources

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Presentation date: 19.09.22

Project Background

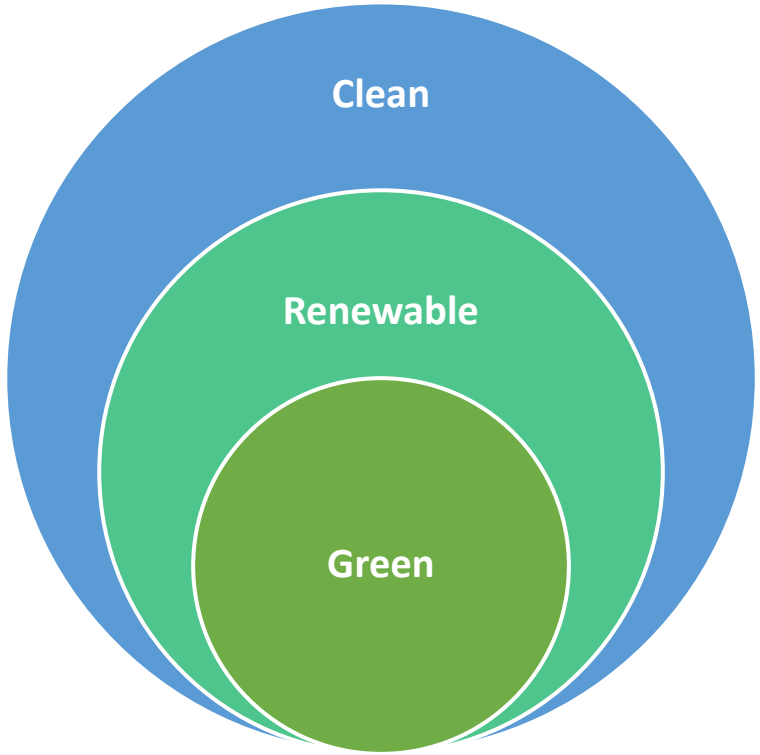
Business Problem:

- Burning fossil fuels emits the most greenhouse gas in the US
- Mitigating solution: Low-carbon energy sources
- Public willingness and active involvement is crucial

Business Objective:

- To design better policies and adoption strategies
  - Benefits governments and organisations like UN
- Lobbyists and environmentalists influencing policies (e.g. Shell)
- Using Social media to understand public perception

Low-Carbon Energy:



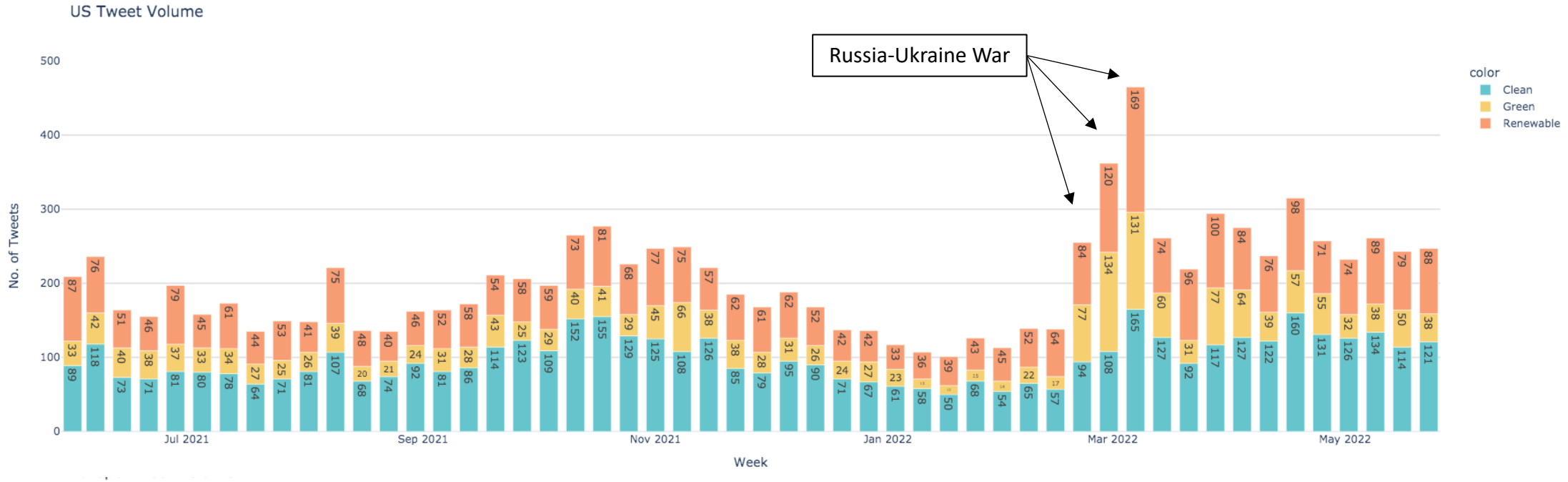
Data Collection (Twitter)

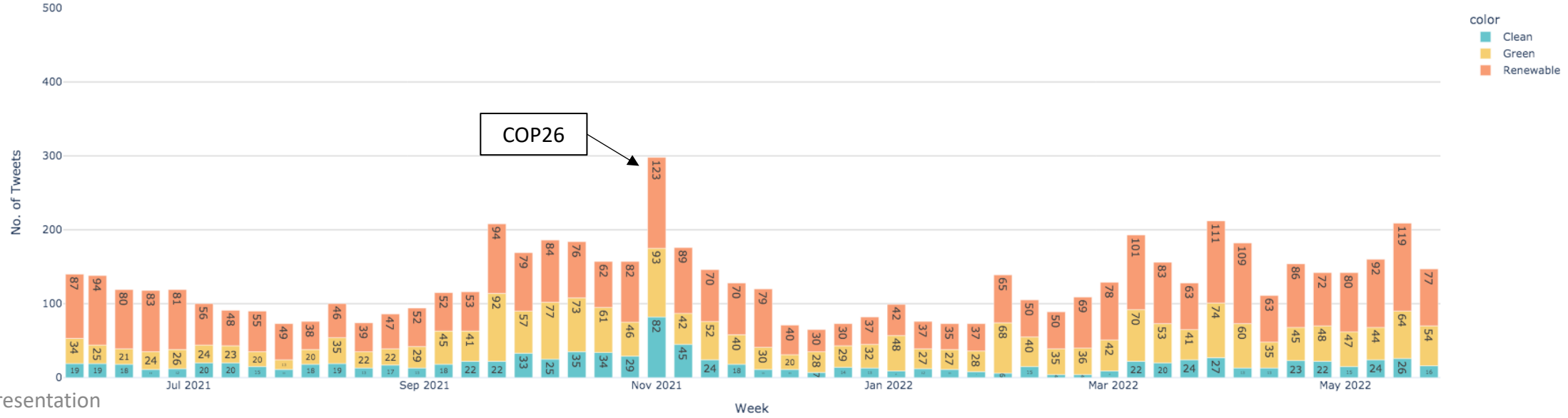
- Tweet query
  - Contains ‘renewable energy’, ‘clean energy’, and ‘green energy’ or
  - Contains ‘#renewableenergy’, ‘#cleanenergy’, and ‘#greenenergy’
- Limited time period
  - 1 June 2021 to 1 June 2022 (1 year)
- Location: Europe and the US
  - Must be geotagged and contain location data
- Language: English

date_time	content	hashtags	language	user_location	coord	place
2022-05-29 14:27:04+00:00	Ch7 News Federal Election – Business is booming for renewables. Natural Solar. #Renewables #Energy …	['Renewables', 'Energy', 'Renewable', 'GreenEnergy']	en	New Jersey, USA	Coordinates(longitude=-72.92308028, latitude=41.3115651)	Place(fullName='New Haven, CT', name='New Haven', type='city', country='United States', countryCode='US')

Volume Analysis

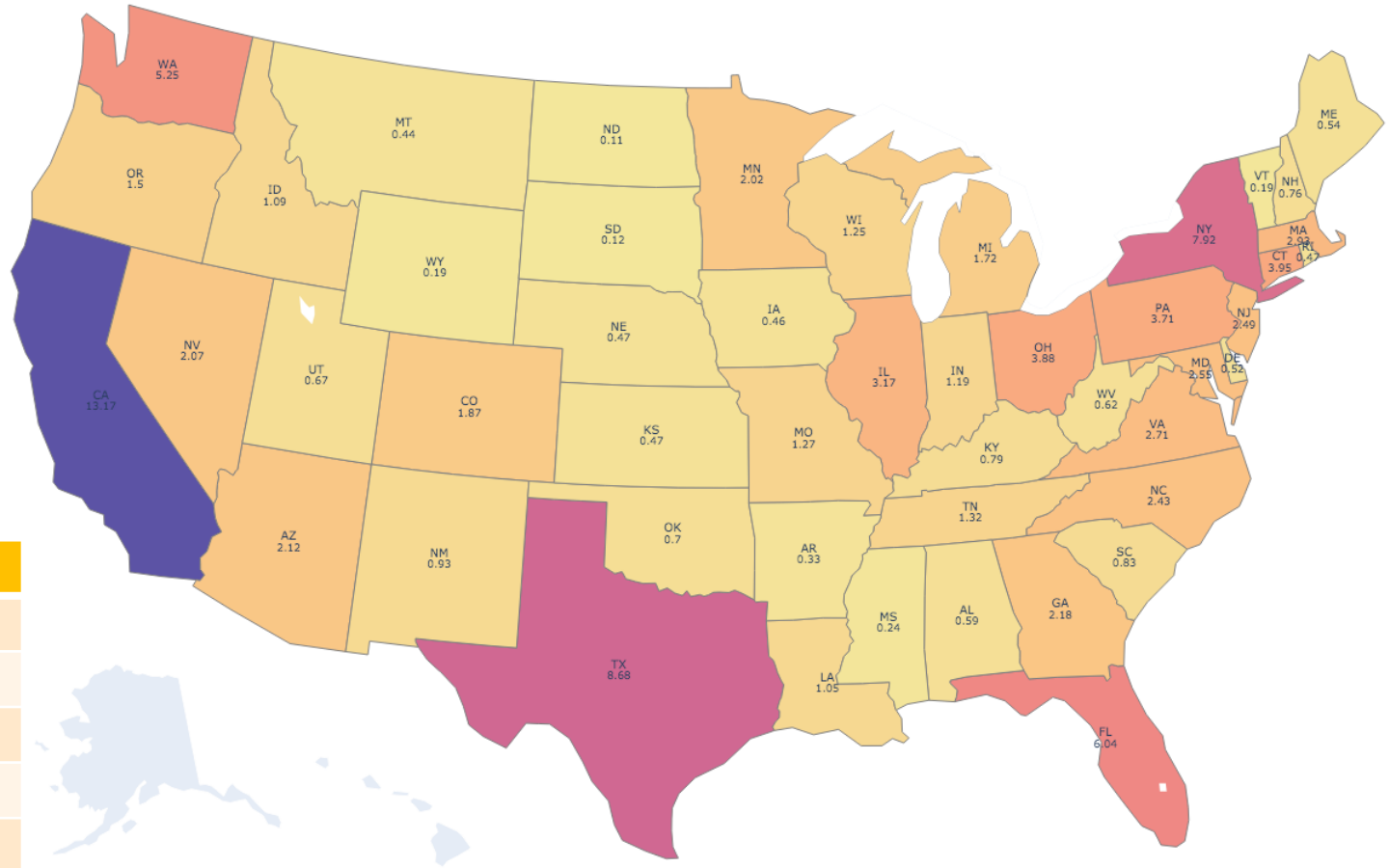
Scraped Data	No. of Tweets
Renewable Energy tweets from the US	3,637
Clean Energy tweets from the US	5,317
Green Energy tweets from the US	2,138
Total tweets from the US	11,092
Renewable Energy tweets from Europe	3,689
Clean Energy tweets from Europe	1,091
Green Energy tweets from Europe	2,344
Total tweets from Europe	7,124
Total No. of Tweets	**18,216**


US Tweet Volume
Russia-Ukraine War
color
Clean
Green
Renewable
No. of Tweets
Week
Jul 2021
Sep 2021
Nov 2021
Jan 2022
Mar 2022
May 2022


COP26
color
Clean
Green
Renewable
No. of Tweets
Week
Jul 2021
Sep 2021
Nov 2021
Jan 2022
Mar 2022
May 2022

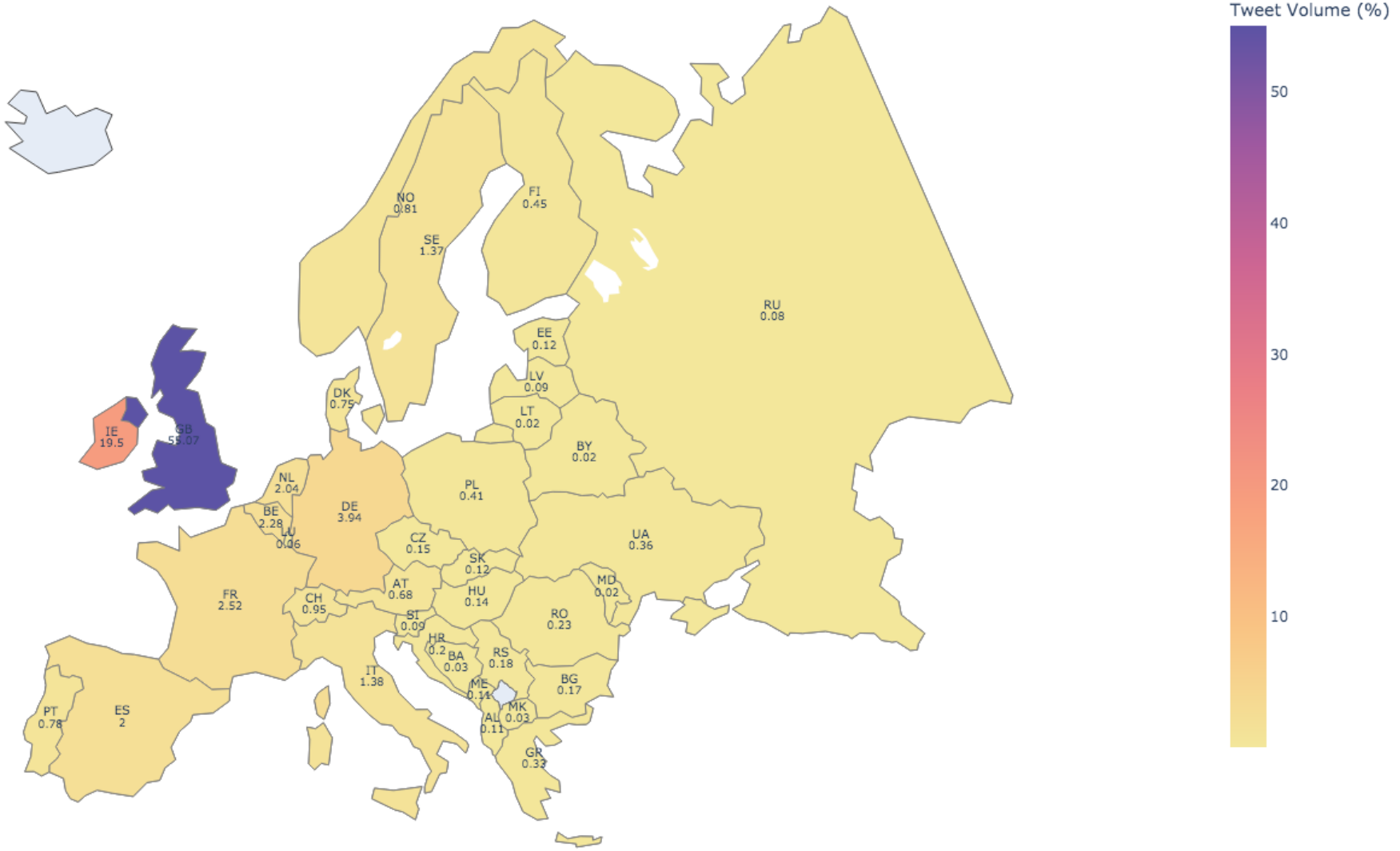
Volume Analysis (US)

State	Proportion of Tweets (%)
California	13.17
Texas	8.68
New York	7.92
Florida	6.04
Washington	5.25



Volume Analysis (Europe)

Country	Proportion of Tweets (%)
United Kingdom	55.07
Ireland	19.50
Germany	3.94
France	2.52
Belgium	2.28



Sentiment Analysis Model

- Valence Aware Dictionary for Sentiment Reasoning (VADER)
  - Robust unsupervised, lexicon-based model
  - Maps labelled lexical features according to their semantic orientation
  - Does not require training in advance and computationally efficient
  - Returns a score from -1 (strongly negative) to 1 (strongly positive)
  - Specifically attuned to handle sentiments expressed in social media content
  - Able to handle and consider emojis, punctuations, capitalisations, and repeated words

Example: Sentence	VADER score
grabngoinfo.com is a FANTASTIC website for step by step machine learning tutorials.	0.6523
grabngoinfo.com is a FANTASTIC FANTASTIC FANTASTIC website for step by step machine learning tutorials.	0.9325
grabngoinfo.com is a FANTASTIC FANTASTIC FANTASTIC website for step by step machine learning tutorials!	0.9359

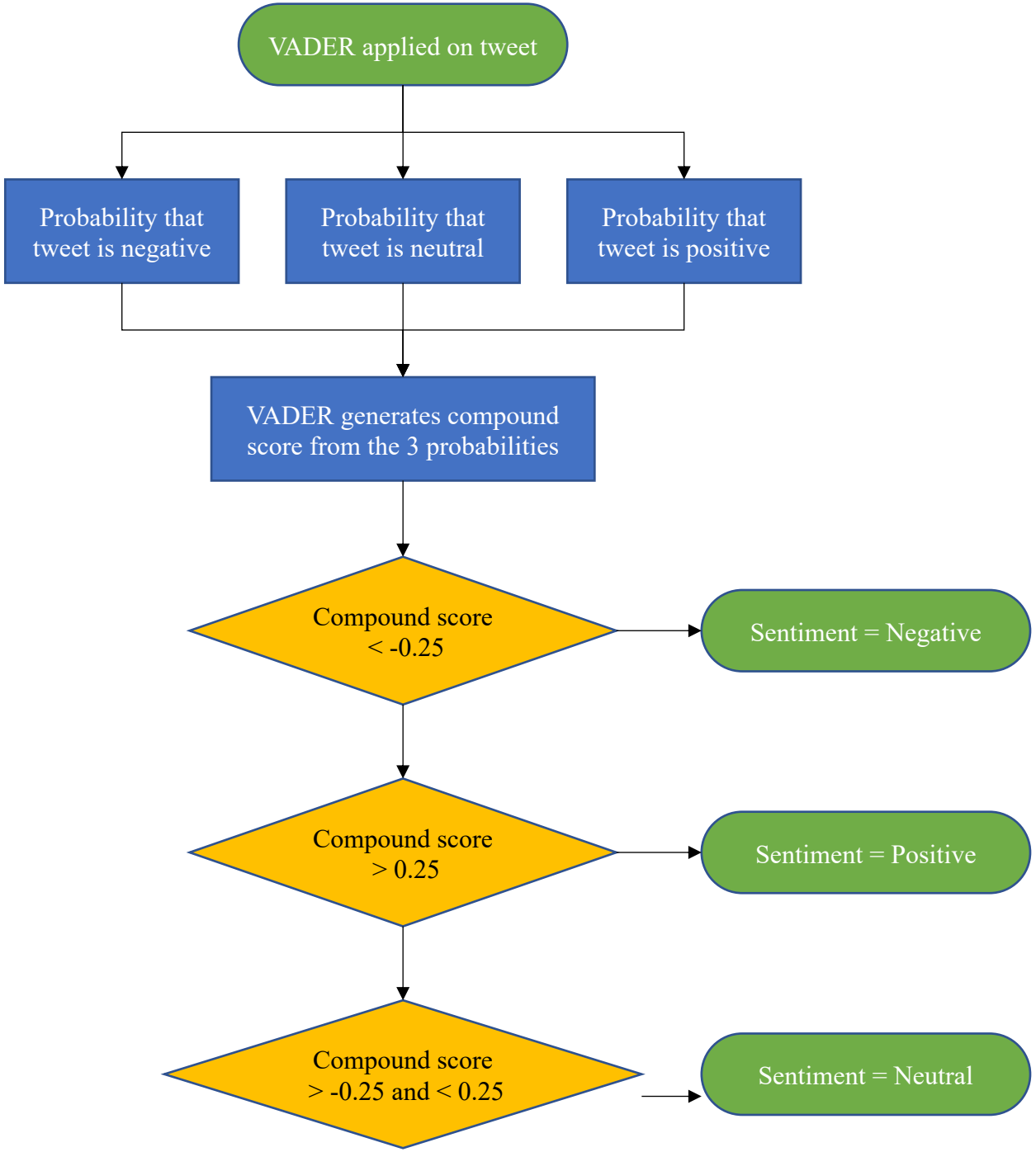
Sentiment Analysis

- Returns probabilities that the tweet is negative / neutral / positive
- Compound score is calculated from the probabilities

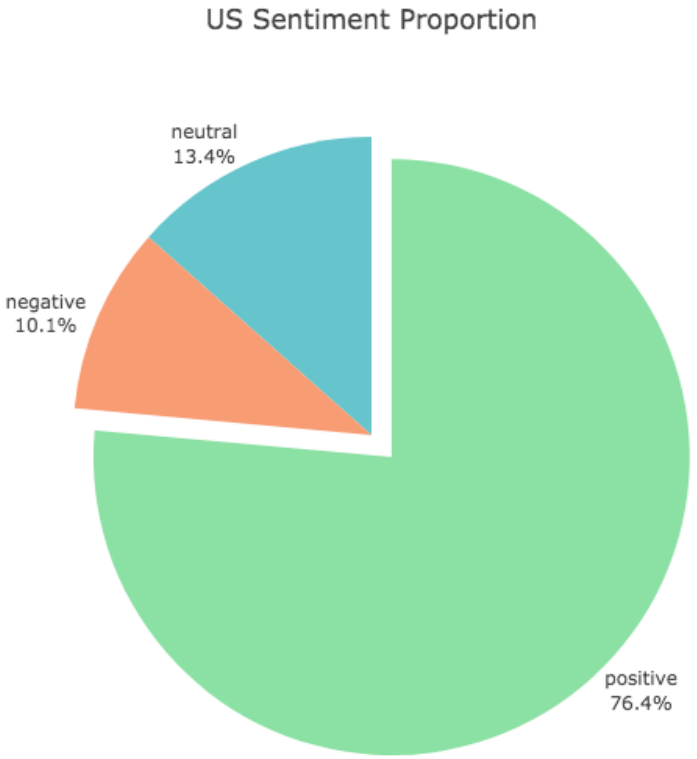
- Manual classification used to reduce false positives / negatives
- Tweets with scores between –0.25 to 0.25 as neutral

Tweet	Negative	Neutral	Positive	Compound	Sentiment
I guess he’s never spoken to the Navajo, Shosh…	0.108	0.823	0.069	-0.2895	Negative
Water is infinite. Energy to access it can be…	0.106	0.805	0.089	-0.1027	Neutral
WE NEED A MANHATTAN PROJECT TO CLEAN UP PLASTI…	0.066	0.713	0.221	0.7430	Positive

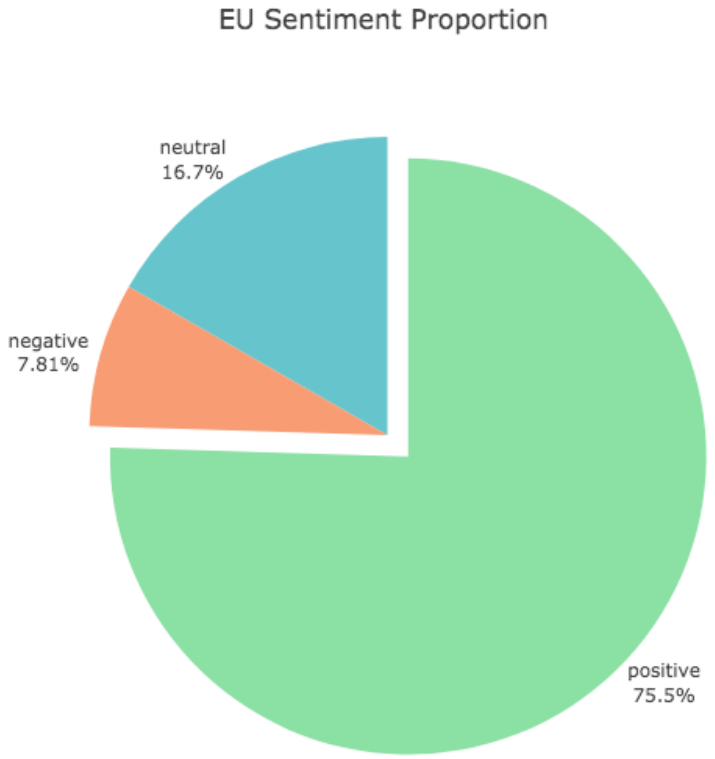
VADER Process



Results (Sentiment Proportion)



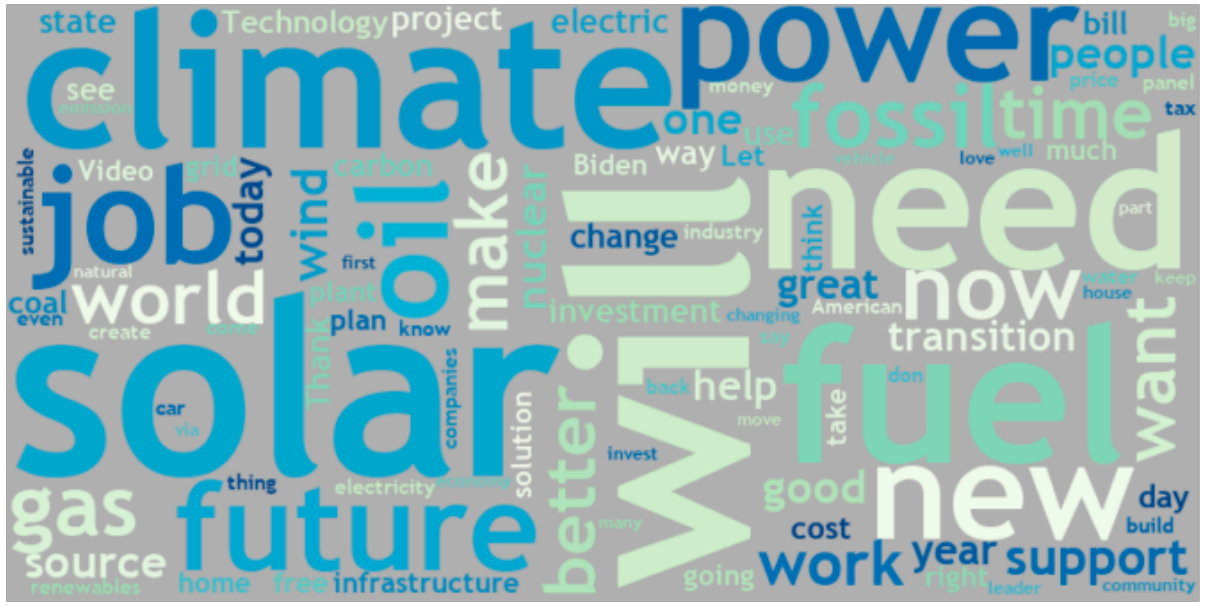
US Tweets	Count
Positive Tweets	8070
Neutral Tweets	1419
Negative Tweets	1070



Europe Tweets	Count
Positive Tweets	5023
Neutral Tweets	1112
Negative Tweets	520

Results (US Word Cloud)

US Positive Tweets:



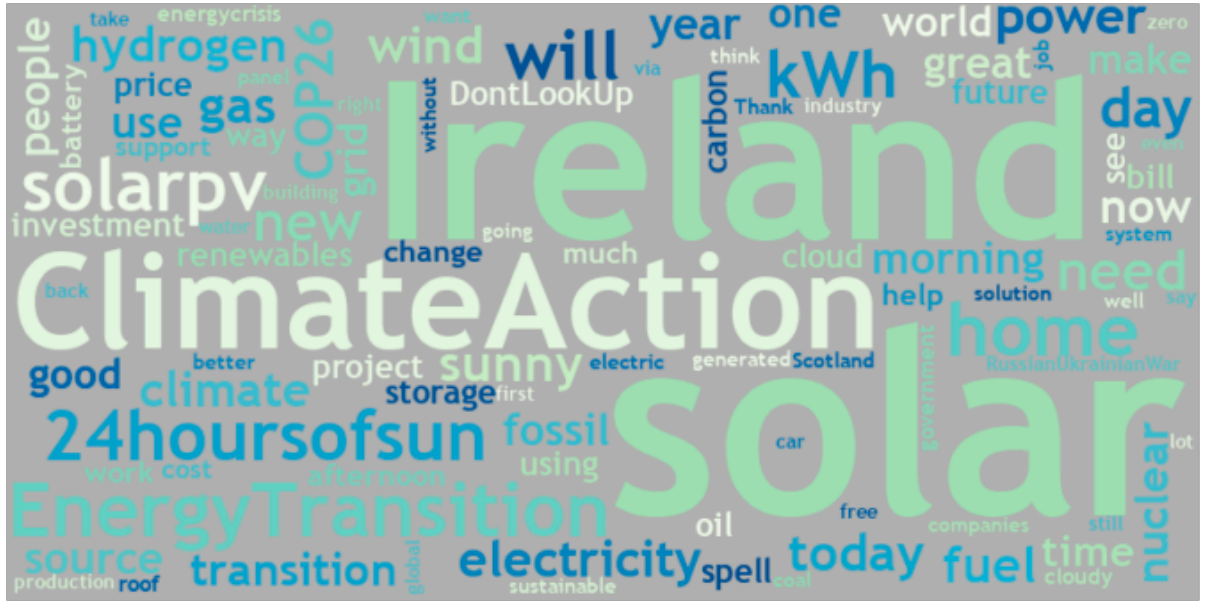
Word	Frequency
will	1,024
solar	984
climate	707
fuel	707
need	692

US Negative Tweets:

Word	Frequency
will	158
oil	153
need	117
climate	116
fuel	109

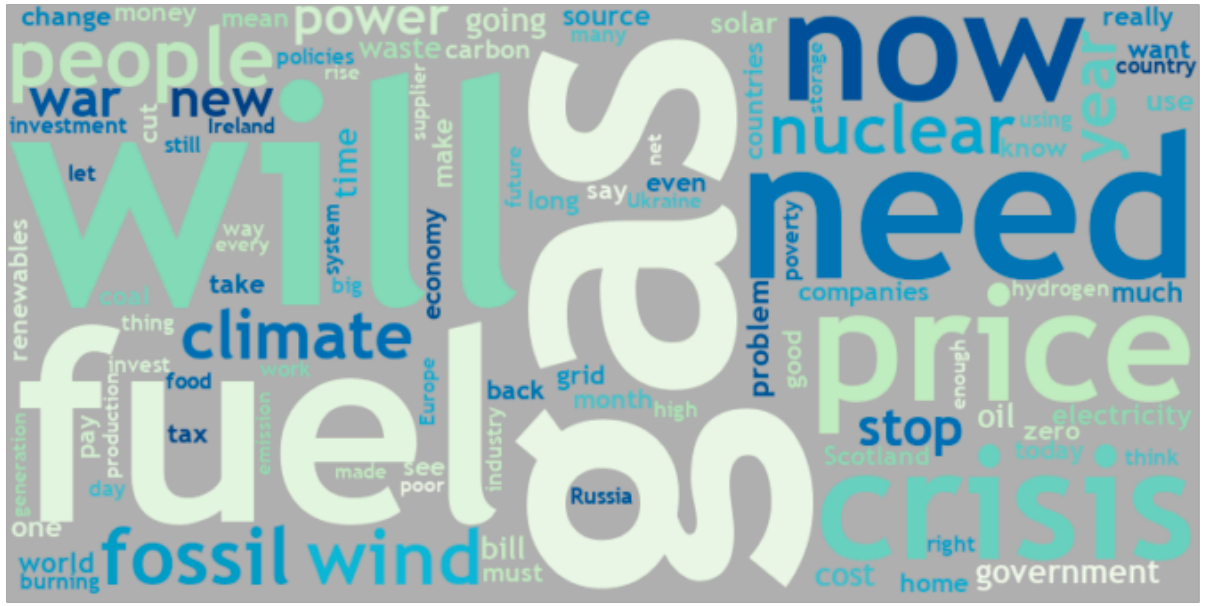
Results (Europe Word Cloud)

Europe Positive Tweets:



Word	Frequency
solar	1,115
Ireland	802
ClimateAction	777
EnergyTransition	724
home	700

Europe Negative Tweets:



Word	Frequency
gas	85
will	83
fuel	60
need	59
price	54

Average Sentiment of US States

- The average score of all US states is **greater than 0**

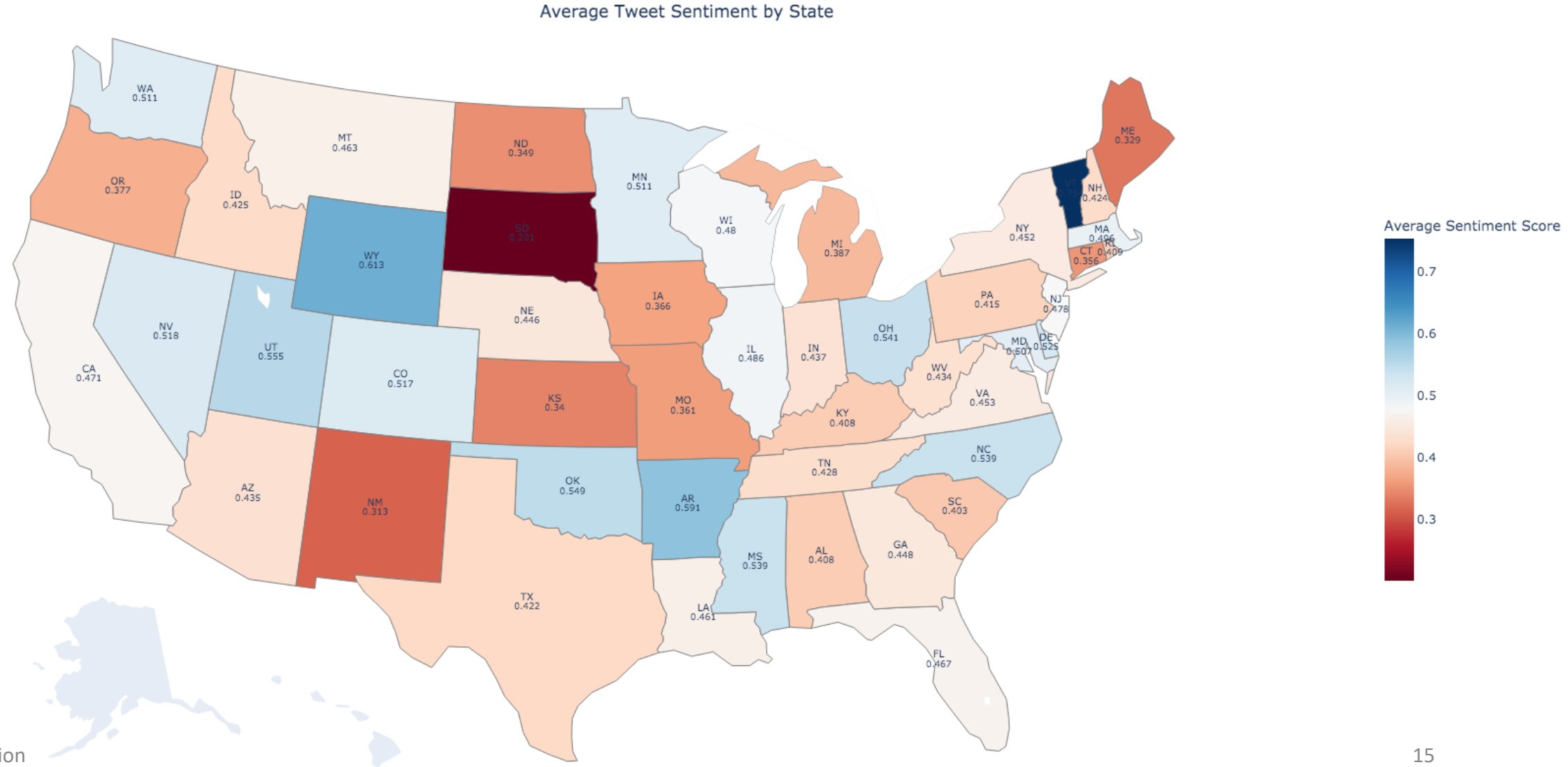
Top 5 states with highest sentiment

State	Average Sentiment
Vermont	0.754
Wyoming	0.613
Arkansas	0.591
Utah	0.555
Oklahoma	0.549

Top 5 states with lowest sentiment

State	Average Sentiment
South Dakota	0.201
New Mexico	0.313
Maine	0.329
Kansas	0.340
North Dakota	0.349

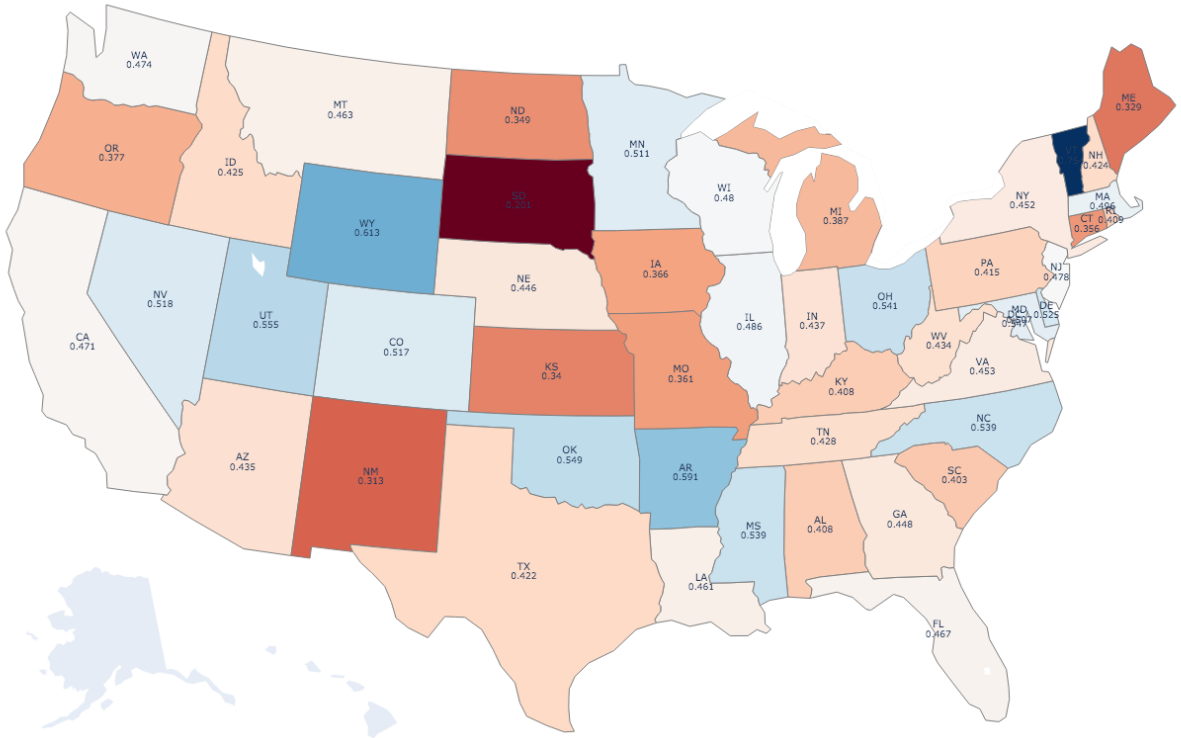
Average Sentiment of US States

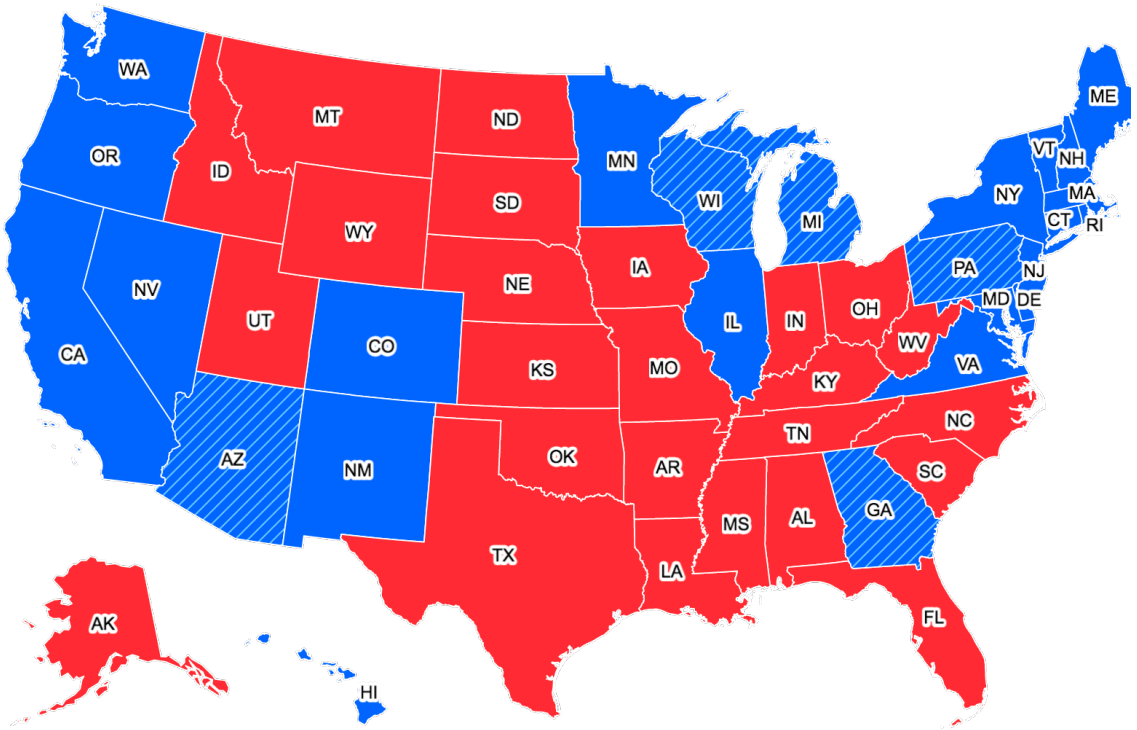


Average Sentiment of US States

Average sentiment by political landscape:

Blue States (Democratic)	Red States (Republican)
0.460	0.448





Average Sentiment of European Countries

- Apart from the Republic of Slovenia, the average score of all European countries is **greater than 0**

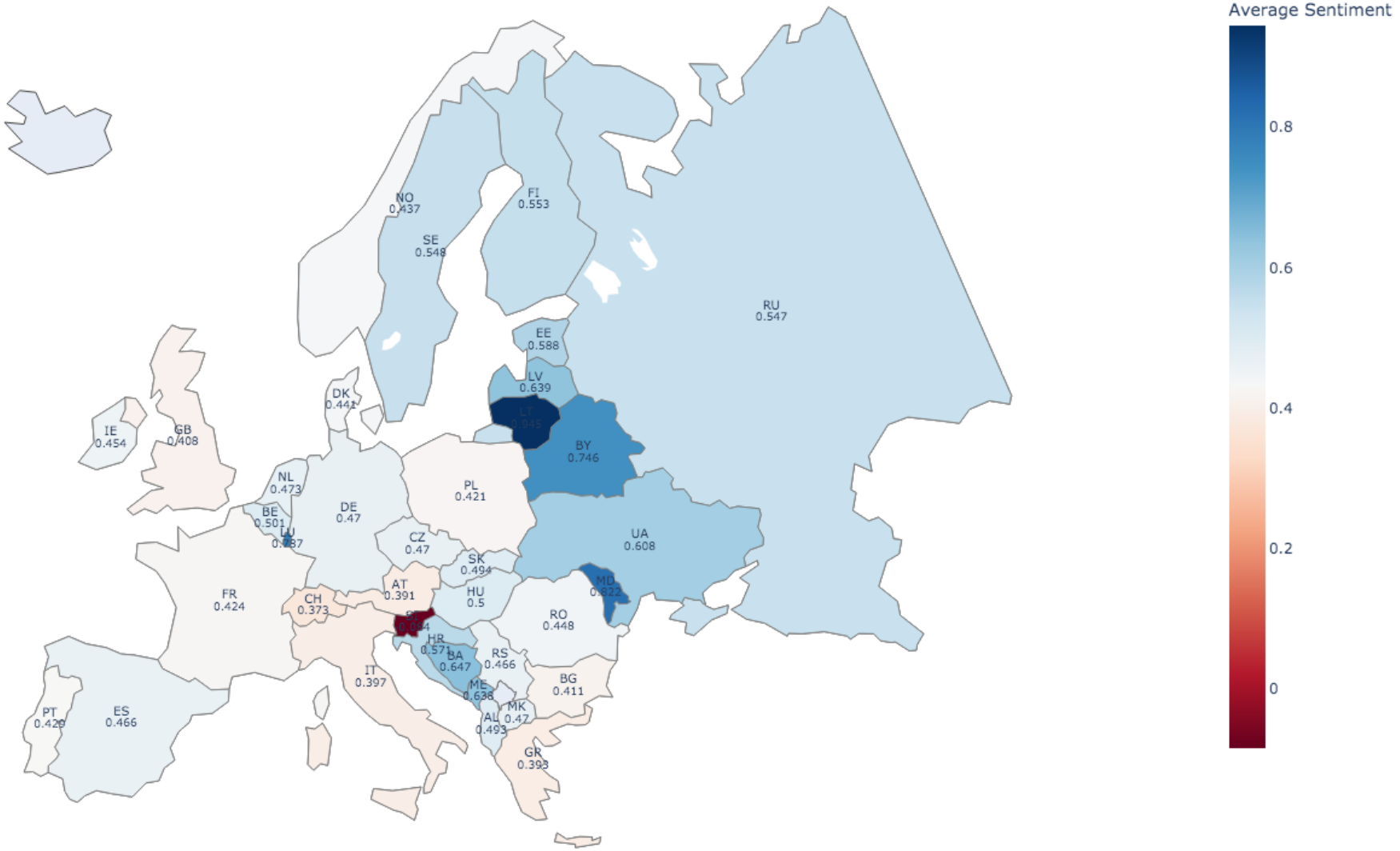
Top 5 countries with highest sentiment

Country	Average Sentiment
Lithuania	0.945
Monaco	0.858
Moldova	0.822
Luxembourg	0.787
Republic of Belarus	0.746

Top 5 countries with lowest sentiment

Country	Average Sentiment
Republic of Slovenia	-0.084
Isle of Man	0.039
Turkey	0.240
Malta	0.354
Gibraltar	0.372

Average Sentiment of European Countries



Future Works

Improvements for future works given more time:

- Expand sources for data collection
  - Tweet data may not be fully representative due to platform demographics (Kim et al., 2021)
  - Twitter users are younger and usually more politically liberal
  - Consider expanding to more platforms and including conventional collection methods
- Expand to include languages
  - European languages were not captured due to limitations in language capabilities
  - This resulted in significantly less data for countries where English may not be native
  - Dahal et al. (2019) suggests translating tweets or adopting a supervised technique that can handle multiple languages if there is enough data in foreign languages

Conclusion

- Comprehensive overview of geographical variation in public sentiment
- The majority of public sentiment in US and Europe is positive
- Keywords from positive/negative tweets suggest topics of high importance to the public
  - States or countries that wish to gain public support for energy transition can consider looking into these areas of high importance
  - Aids governments and organisations like UN to design better adoption strategies and low-carbon emission policies
- Use of social media to evaluate sentiment in real-time
  - Social media offers valuable, updated data which may be beneficial during the lack of formal statistics