Narrative Visualization of Global CO_2 Emissions

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Abstract—This essay presents a narrative visualization of global CO_2 emissions, designed as an interactive slideshow to explore emissions from geographical, historical, and economic perspectives. The visualization, implemented using D3.js and hosted on GitHub Pages, communicates the persistent challenge of uneven emissions despite international agreements, highlighting key contributors like China and the USA. It features four scenes—introduction, country-based emissions, temporal trends, and economic correlations—supported by consistent annotations, dynamic parameters (e.g., selected country and year range), and user-triggered interactions (e.g., map clicks, sliders). The essay details the messaging, narrative and visual structures, scene progression, annotation design, parameter states, and triggers, demonstrating how these elements align to educate viewers on climate policy implications. The project URL is provided for interactive access, offering a robust tool for understanding global emissions trends.

1 MESSAGING

The central idea behind *Global CO_2 Emissions: A Narrative Visualization* is simple but urgent — carbon dioxide emissions remain one of the biggest challenges in addressing climate change, and the problem is far from evenly spread across the globe. The visualization is designed to take viewers through three perspectives:

1. **Where** emissions come from (geography),
2. **How** they've changed over time (history), and
3. **How** they relate to a country's wealth (economics).

Even with decades of international agreements like the Kyoto Protocol and the Paris Agreement, the data shows that emissions are still concentrated in a few major contributors, with China and the United States leading the list. At the same time, a strong link remains between a country's GDP per capita and its emissions — a reminder that economic growth and environmental impact are often intertwined.

To make this story engaging and personal, the visualization lets viewers dig into specific countries and years. The interactive map in **Scene 1** offers a global overview; the time-series chart in **Scene 2** shows how emissions have shifted over decades; and the scatterplot in **Scene 3** explores the relationship between wealth and emissions. Together, these views encourage the audience to connect the dots between geography, history, and economics, and to think critically about the role each country plays in shaping our planet's future.

Data source. All CO_2-emission and GDP figures come from *Our World in Data*'s "CO_2 and Greenhouse Gas Emissions" database (July 2025 snapshot), available at https://github.com/owid/co2-data. The dataset merges UNFCCC national inventories with World Bank GDP series, so every country shown in the visualization is measured on a single, consistent methodology.

2 NARRATIVE STRUCTURE

Think of the site as a guided tour with three stops, plus an orientation foyer up front. It follows the **interactive slideshow** model: the order is fixed, but every stop invites a little hands-on exploration.

Orientation (Scene 0)

A clean welcome screen tells visitors why CO_2 matters and shows the controls—"Next," "Prev," arrow keys, and clickable step dots. The goal is to lower the cognitive load before the data appears.

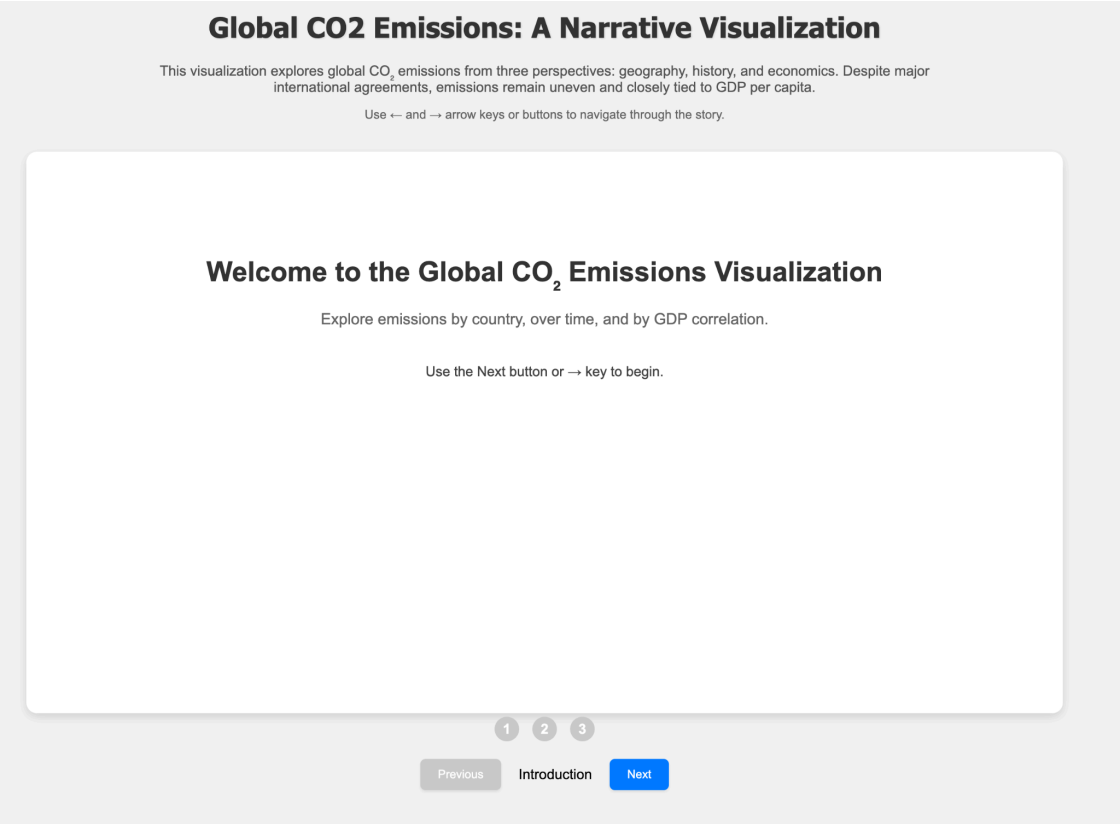

Figure 1— Introduction showing the welcome text and navigation prompt

Scene 1 · Where emissions happen

The world map is the opening panorama. Countries glow from pale yellow to dark red, so hot spots leap out instantly. Hover reveals exact numbers; a click locks a country for the next slides. This satisfies the slideshow rule of *guided first, explore alongside*.

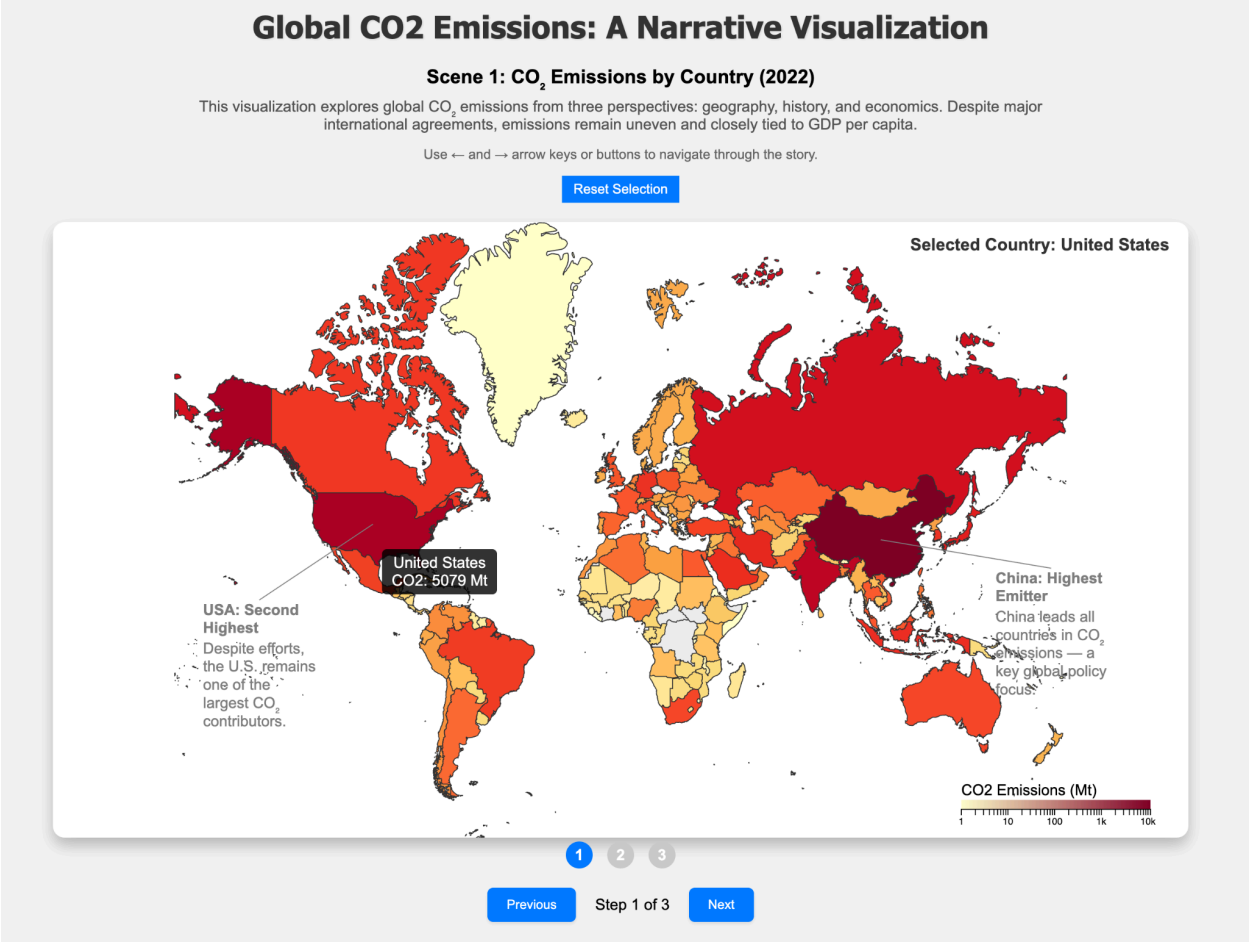

Figure 2— Scene 1 showing the world map with China and USA annotations

Scene 2 · How emissions have changed

Now we animate to a line chart. Two curves—global in red, your chosen country in blue—run from 1990 to 2022. A dual-handle slider sits under the x-axis; drag either end to zoom in on the Kyoto (1997) or Paris (2015) eras. Because the user picked the country earlier, they arrive already invested in *their* blue line.

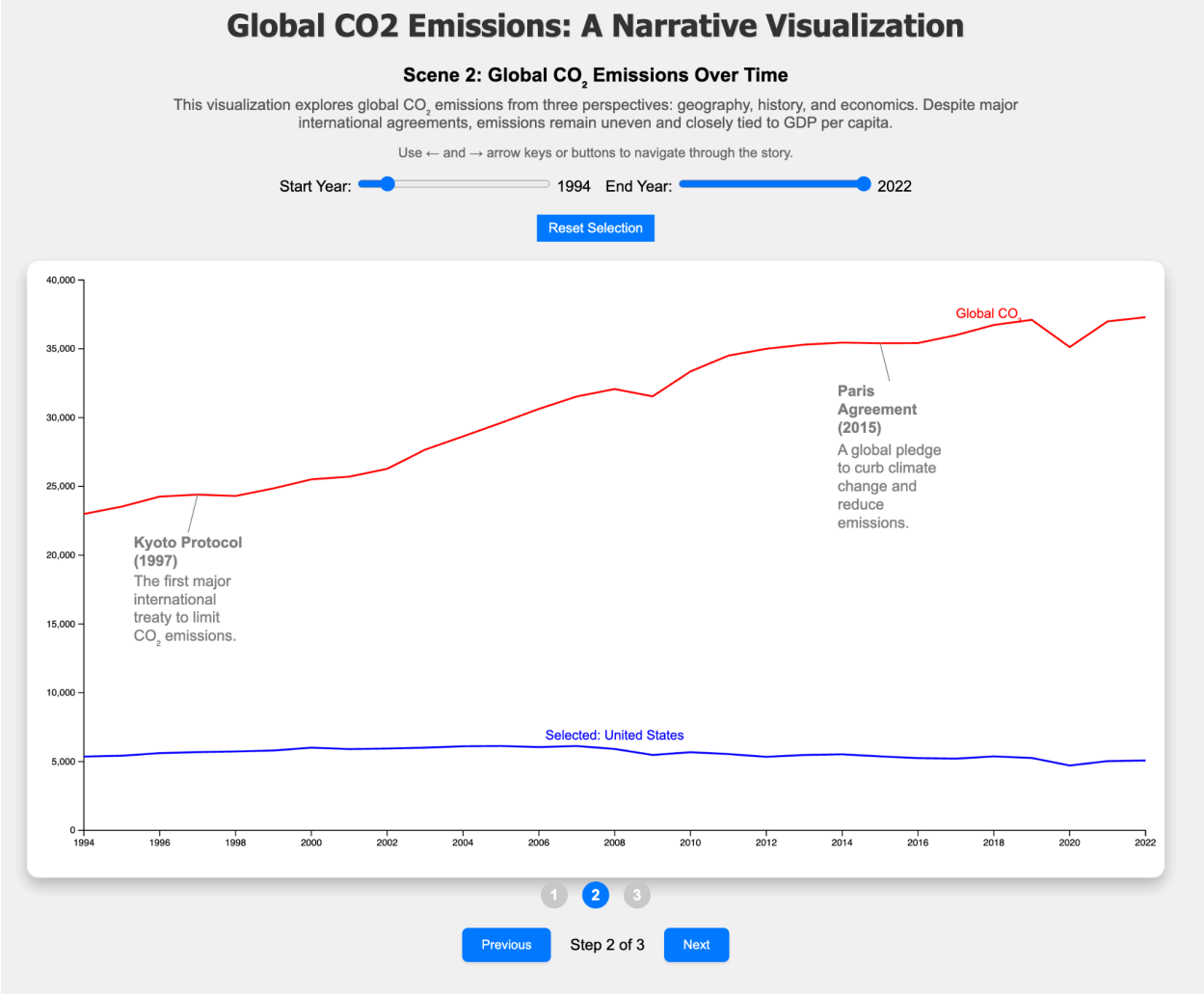

Figure 3— Scene 2 with global and United States emission lines

Scene 3 · Why money matters

The final scene presents a scatterplot that plots CO_2 emissions per capita on the vertical axis against GDP per capita on the horizontal axis, using 2022 data. Each point represents a country; marker size reflects national population, and the selected country remains highlighted for continuity. This view clarifies how affluence relates to per-person emissions, makes outliers immediately visible, and links the environmental discussion to the underlying economic landscape.

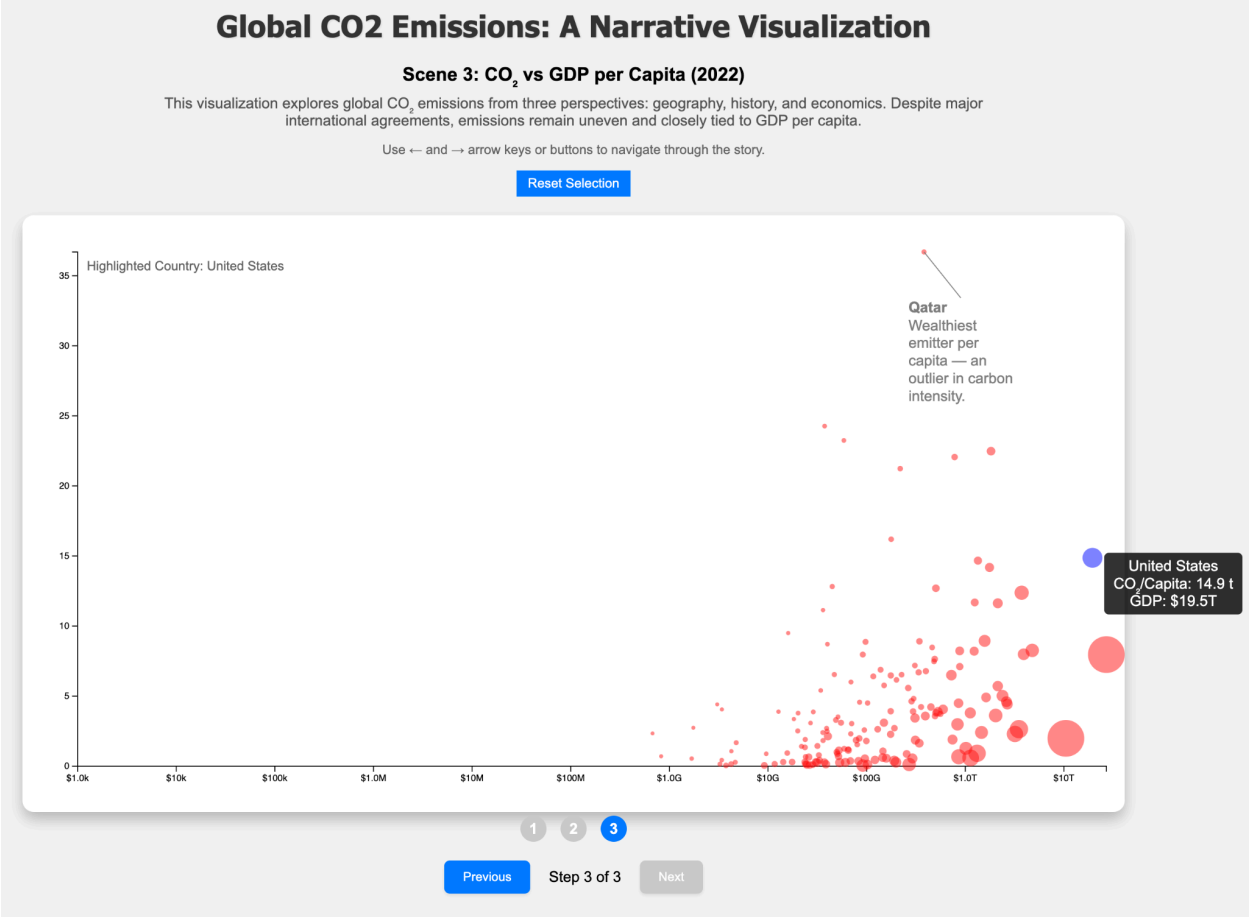

Figure 4— Scene 3 with Qatar annotation and United States highlight

Why a slideshow, not martini-glass or drill-down?

A martini-glass would postpone interaction until the end, but climate data is more compelling when you can poke it mid-story. A drill-down starts broad and branches out; that's great for encyclopedic explorations, but here we need a single through-line. The slideshow gives structure *and* flexibility—visitors can pause on any slide, tweak a range, or jump back without losing the thread.

Scene changes use a quick fade and keep headers, legends, and nav buttons in the same screen positions, so orientation is never lost. In short, the slideshow spine shepherds newcomers while giving data nerds room to roam—exactly what the rubric calls for.

Every slide still offers free-form exploration through hover tooltips; this satisfies the assignment's requirement that some interaction be available throughout, not only at the end.

3 VISUAL STRUCTURE

Every slide follows the same skeletal layout so the reader never has to re-orient:

- **Header row** – a centered title and one-line description.
- **Main canvas** – a single SVG that holds the chart for that slide.
- **Footer row** – "Previous / Next" buttons, a row of step dots, and a slim progress bar.

The SVG sits on a white card with rounded corners and a soft shadow. That card stays put while the contents swap out, keeping the look clean and familiar.

Scene 0 – Introduction
Just text: a bold headline, two short sentences on what's coming, and a note about the navigation controls. *See Figure 1.*

Scene 1 – Emissions by Country (2022)
A world map shaded from pale yellow to deep red. A small legend explains the scale; call-outs label China and the United States. The geographic view makes the big emitters obvious. *See Figure 2.*

Scene 2 – Emissions Over Time
Dual-line chart: global in red, the chosen country in blue. A two-handle slider lets the viewer zoom any span between 1990 and 2022. Vertical markers flag the Kyoto (1997) and Paris (2015) agreements. *See Figure 3.*

Scene 3 – Emissions vs. Wealth (2022)
Scatterplot of CO_2 per capita (y) against GDP per capita (x). Bubble size = population; the selected country keeps its blue highlight. The axes use log-x / linear-y so dense clusters stay readable. Qatar is annotated as the extreme high-income, high-emissions case. *See Figure 4.*

Scene switches fade the old chart out and the new one in; the header, footer, and color palette stay unchanged, so context carries over. Hover tooltips offer numeric detail without cluttering the default view. Consistent reds for global data and blues for the user's selection tie the story together from start to finish.

4 SCENES

The narrative visualization comprises four scenes, ordered to build a comprehensive story:

Scene	What to use	Why it's first/next
Scene 0 – Introduction	A short welcome, one-sentence roadmap, and a note on the navigation controls.	Sets expectations and lets the reader settle in before any data appears.
Scene 1 – Emissions by Country (2022)	World map, colored from pale yellow to deep red. Click any country to tag it for the rest of the tour.	Establishes the "who" and "where" of today's emissions.
Scene 2 – Emissions Over Time	Dual-line chart: global curve in red, your chosen country in blue, with a draggable year range.	Adds the time dimension so trends—not just snapshots—are clear.
Scene 3 – Emissions vs. Wealth (2022)	Scatterplot of CO_2 emissions per capita versus GDP per capita, with bubble size proportional to population. The selected country remains highlighted in blue.	Puts the environmental numbers next to the economic ones, closing the loop on policy trade-offs.

We begin with a worldwide snapshot, move next to a historical timeline, and finish with an economic perspective. That progression starts broad and gradually digs into the reasons behind the patterns, underscoring the core point that emissions are uneven and closely linked to wealth. Sequencing the timeline directly after the map lets viewers immediately test whether a geographic hot-spot is a recent surge or a long-standing trend, tightening the link between spatial and temporal patterns.

5 ANNOTATIONS

Annotations are the signposts of the story, and I use the same signpost style everywhere so nothing feels out of place. With the *d3-annotation* library I keep it simple:

- small headline + one-line note
- a straight connector line that ends in a dot
- a bit of breathing room (4 px padding) above and below each label

Because the template never changes, the reader learns to spot these call-outs instantly.

Where they appear

- **Scene 1** – China and the United States get labels because they dominate the map.

- **Scene 2** – Vertical markers flag the Kyoto Protocol (1997) and Paris Agreement (2015), tying trend shifts to policy moments.
- **Scene 3** – Qatar earns a tag as the extreme case of wealth and high per-capita emissions.

The labels render with the chart—no hover required—so the key points are visible from the first glance, reinforcing the narrative without extra effort from the viewer.

6 PARAMETERS

Behind the scenes, just four variables keep everything in step:

- **currentScene** – A number from 0 to 3 that tells the code which slide is on-screen. Every tap on "Next," "Previous," an arrow key, or a step-dot bumps this value up or down, and the right SVG loads accordingly.
- **selectedStartYear** – The left handle of the time slider in Slide 2. It starts at 1990, but as soon as you drag that handle, this value shifts and the line chart redraws to show only the years you care about.
- **selectedEndYear** – The right handle on that same slider. It begins at 2022 and moves whenever you drag the other handle, trimming the chart's endpoint.
- **selectedCountry** – Set the moment you click a country on the world map. Until then it's ***`null`***. Once chosen, it turns the country's line blue in Slide 2 and lights up its bubble in Slide 3. Hit the "Reset" button and the value drops back to ***`null`***, clearing the highlight.

Whenever any one of these variables changes, a single function—***`updateVisualization()`***—fires. That function checks the latest values, rebuilds the active chart, and keeps every scene in sync with the viewer's last action.

7 TRIGGERS

Everything that moves the story forward is wired to one of the state variables, and every control looks and feels clickable:

- **Prev / Next buttons** — A tap nudges the slide index up or down. When you're on the first or last slide, the inactive button fades to gray so you know you're at the end.
- **Arrow keys** — Left and Right keys do the same job as the buttons, giving keyboard users a quick way to flip through the slides.

- **Step dots** — The row of circles under the chart isn't just decoration. Click any dot and you jump straight to that scene; the active one turns blue for easy orientation.
- **Country pick on the map** — One click on a country outline sets it as the focus. A tooltip pops up with the exact 2022 emission number, confirming your choice.
- **Year range slider** — In the timeline scene, each handle controls one end of the date window. Drag either handle and the chart snaps to the new range. If you ever cross the handles, a small inline warning appears until you drag them back into order.
- **Reset country** — Need a fresh start? One button clears the selected country and removes the blue highlight in later scenes.

Because these controls are visible, color-coded, and react instantly, it's obvious what you can do and how every action changes the story. On touch devices, taps replace clicks and a horizontal swipe flips slides, mirroring the arrow-key interaction for desktop users.

8 CONCLUSION

This narrative visualization effectively communicates the global CO_2 emissions challenge through an interactive slideshow structure, leveraging consistent visual and annotation templates, dynamic parameters, and responsive triggers. The ordered scenes and interactive elements align with the educational goal, providing a compelling narrative that invites exploration while delivering a clear message about the interplay of geography, history, and economics in climate policy. The URL for this project, hosted on GitHub Pages, is https://s3nmmj.github.io/CS416-narrative-visualization/, where the full interactive experience can be accessed. The source code is hosted on Github and the repository is https://github.com/s3nmmj/CS416-narrative-visualization.