Link to team Github: https://github.com/RohanManne/STAT436_milestone2/tree/main
Shiny app: https://mkenton.shinyapps.io/STAT436_final_proj/
Slides:https://docs.google.com/presentation/d/1OdoNhjbDP1moFtOnQ0gb6zDHaALYL6WKkQge5cXIppE/edit?usp=sharing

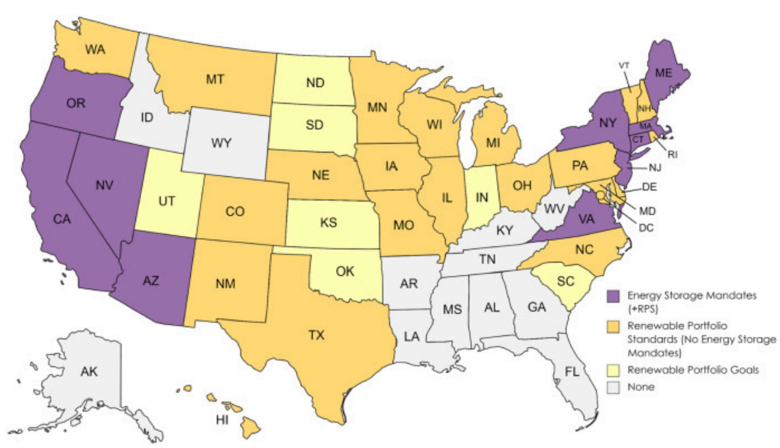
Introduction

Renewable energy adoption is a widely discussed and highly relevant topic in today's world. However, the complexity of renewable energy data and its often nuanced presentation can make the topic inaccessible to non-experts, limiting the population of informed individuals. Our project addresses this visualization challenge by designing a Shiny app with interactive and static visualizations to simplify the topic and lower the barriers to understanding renewable energy adoption. Our contributions include three visualizations: a heat map, a faceted box plot, and a density plot. These visualizations create a holistic view of how different types of renewable energy are adopted across time and place.

Literature review

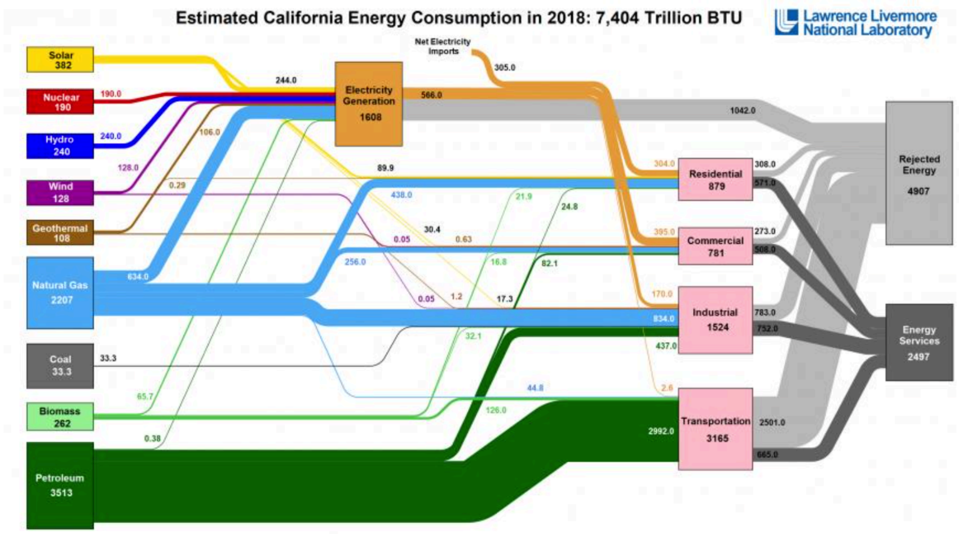
Our designs are inspired by a range of academic and professional sources, each offering unique insights into effective data visualization techniques. Our literature review guided our choices in balancing depth, clarity, and accessibility. Below, we have outlined several key sources.

1. “Emergent landscapes of renewable energy storage: Considering just transitions in the Western United States” published in the journal *Perspective.*



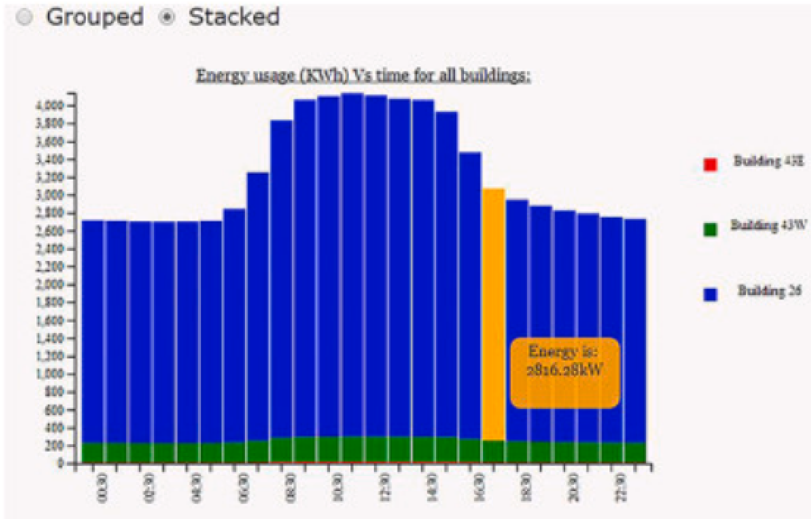
This paper focuses on visualizing the transition towards clean energy sources through various maps. Their data focuses on available resources and infrastructure as well as the restrictions and other legal and social issues impacting the adoption of renewable energy. All of the included visualizations are maps, and while their visualizations are not advanced, they clearly communicate the data. The map we included above is simple, prioritizing a four-category variable on the state-level. Geographic patterns are easily discernible. This article emphasizes the importance of clarity and accessibility in visualizations.

2. The Sankey diagram from Lawrence Livermore National Laboratory



This graph visualizes California's estimated energy consumption in 2018, totaling 7,404 trillion BTU. This type of visualization is important for understanding how energy is sourced, distributed, and utilized across different sectors. It also highlights inefficiencies in energy use, represented by "rejected energy" — energy that is lost during conversion processes or not used effectively. This visualization prioritizes depth and maximizes the amount of information presented in one sitting. It is complex, offering both granular details and a holistic view of energy consumption and waste. While this complexity allows for a deep understanding of the energy landscape, it also presents a challenge for non-expert audiences, who may find the number of pathways and categories overwhelming. The visualization aligns with best practices discussed in the literature, particularly using flow diagrams to show proportional relationships and trade-offs. It exemplifies the trade-off between clarity and user-friendliness for depth and comprehensiveness.

3. “Visualisation in energy eco-feedback systems: A systematic review of good practice” published in the journal of *Renewable and Sustainable Energy Reviews*

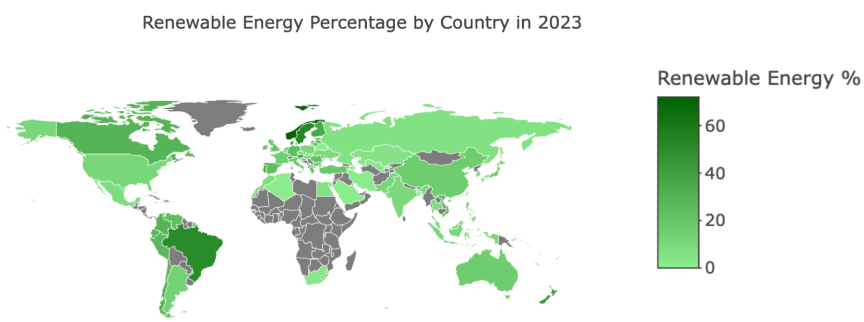


This paper critiques visualizations used to represent data from renewable energy plants and provides a framework for determining “best practices” in renewable energy visualizations. One key focus is tailoring visualizations to the target audience and context, a concept reinforced in our coursework. The authors offer a "When to use" guide, detailing the strengths and limitations of various graph types, and include specific examples, such as the stacked bar chart depicted above. The stacked bar chart is highlighted as an effective method for presenting sub-categorical data breakdowns, such as energy usage across multiple buildings over time. Its design allows viewers to compare contributions of different categories while maintaining an overall sense of the total energy usage. However, the paper also critiques the potential drawbacks of this visualization, such as reduced clarity when too many subcategories are included. Instead of establishing the existing visualization methods as simply strong or weak, the authors emphasize context-dependent effectiveness. This combination of theoretical insight and practical application gives readers a deeper intuition for selecting appropriate visualizations.

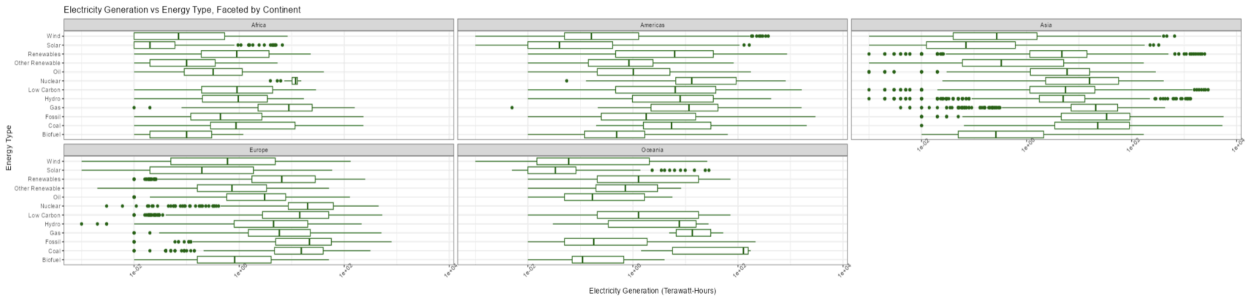
Design

When discussing renewable and sustainable energy, two of the biggest challenges are accessibility and complexity. Renewable energy uses complex technology that many people are not familiar with, and numerous factors are considered when analyzing how “sustainable” a country or area is. Many existing visualizations are also created for an audience of people in the industry or with a technological background. This can be overwhelming or discouraging for non-experts, making them less interested in viewing the visualization or even in the topic itself. We wanted to create visualizations that addressed both of these concerns, conveying the information in an understandable way.

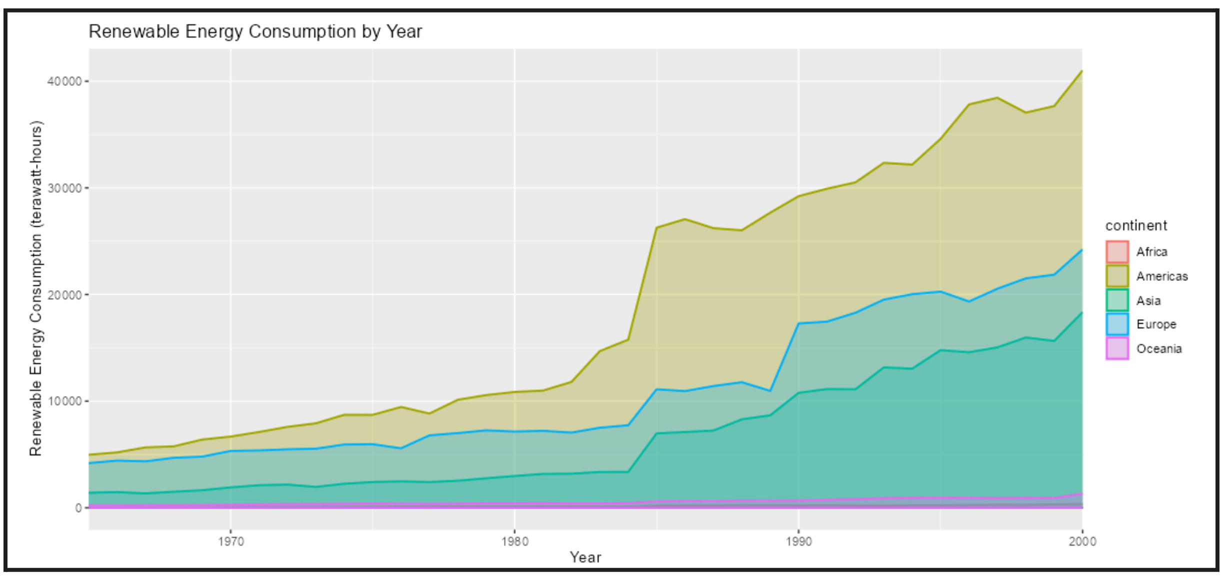
First, we wanted to start with a world map. We wanted a way to convey lots of information without it being visually overwhelming to the user. We chose a green color gradient for each country to encode the amount of renewable energy being used, and when users hover over a country they can see the exact percentage of renewable energy being used, as well as the country name and year. Users can interact with a slider above the map that selects a specific year, or scrolls through all of them. This slider also animates our other two visualizations concurrently for consistency. This visualization was partially inspired by the map shown above from "Emergent landscapes of renewable energy storage: Considering just transitions in the Western United States" published in the journal *Perspective*. However, instead of focusing on specific metrics that while they may be relevant to the paper are less commonly known, we wanted to give a quick introduction and overview of how renewable energy is being used. Being our first visualization, we opted for simplicity and did not go into more depth beyond renewable energy usage. We also wanted to expand the boundaries to include all countries as opposed to splitting up data by state. Our map representation focuses on representing renewable energy at a high level, giving users an understanding of how different countries compare in their usage.



Next, we wanted to introduce users to the different types of clean energy and how they're used. This design was very loosely inspired by the Sankey diagram from Lawrence Livermore National Laboratory. The Sankey diagram conveys a lot of information about how energy is created and consumed in California. While it is visually interesting and complex, it is also limited to the state of California and can be overwhelming for people who are learning about renewable energy for the first time. Instead of focusing on the complex technologies used to generate each type, or the myriad of ways each type is consumed, we simply wanted to show the different types of energy, and metrics for each continent. We created boxplots to show the distribution of renewable energy electricity generation for each energy type, then faceted it by continent for comparison between them. This allows users to gain a foundational understanding of which types of renewable energy are being generated, and where. We avoid overly technical language while still presenting accurate data.



Lastly, we wanted to create a visualization that clearly shows how renewable energy consumption changes from year to year. For simplicity, we grouped all types of renewable energy together, and for consistency with our other visualizations, we grouped countries by their continent. This ribbon plot was created with the same goals in mind as our other visualizations, focusing on simplicity and accessibility. It creates a very general overview of how renewable energy consumption has changed over the years on each continent, without including distracting or overwhelming information. It is a good place to start for people who are new to renewable energy, and still provides relevant data to people with an already proficient understanding.



Conclusion

The main takeaway from our project is the importance of bridging the gap between data complexity and accessibility for the non-expert audience. We understand that visualisations can convey strong calls to action, given that they are not misunderstood and clearly convey unbiased information. By designing visualizations that simplify renewable energy data without losing depth, we aim to empower this audience lacking in necessary expertise to engage with these critical issues such as renewable energy. Moving forward, we will refine our designs to enhance interactivity and clarity, ensuring that these tools not only inform but inspire change in more renewable energy adoption.

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