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Visualizing Global Energy Transition using Tableau

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ABSTRACTS

The global transition to renewable energy brings both challenges and opportunities. Traditional energy planning often overlooks key aspects like renewable capacity, carbon emissions, and economic indicators. This study adopts a solution-focused approach using data storytelling and Tableau's real-time visualization tools to explore energy trends from 2000 to 2019. Animated charts show rising renewable energy capacity and carbon emissions, with Brazil maintaining low emissions amid growth. Geospatial analysis reveals China's continued high emissions and GDP growth, emphasizing the need to balance development with sustainability (Mete, 2023). Orbit charts expose regional energy gaps—Africa lags in wind and bioenergy, Asia leads in hydropower, and Europe excels in solar. These insights are crucial for policymakers and business leaders to craft targeted strategies. By transforming complex data into visual stories, this approach supports informed decisions, encourages collaboration, and drives innovative solutions toward a sustainable global energy future.

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1. INTRODUCTION

The urgent need for shifting to renewable sources of energy and practices that sustainable is undoubtedly very clear considering increasing concerns about the environment and the necessity for economic growth. Navigating the difficulties of this transformation requires efficient communication and data-driven decision-making. Data visualization is an effective tool in this pursuit, aiding comprehension, and informed decision-making by transforming complicated information into understandable visual representations (Luyo, *et al.*, 2023).

Data visualization is crucial in communicating insights, trends, and patterns hidden within complex datasets. When raw data is transformed into visual representations like charts, graphs, and interactive dashboards, stakeholders may rapidly understand the meaning and ramifications of the data. According to Perdana et al, data visualization improves engagement and understanding by adding a narrative structure to data analysis, allowing various audiences to comprehend complicated material more easily. Tableau is distinguished through flexibility and efficacy in bridging the gap between data analysis and comprehension among the different data visualization solutions available (Perdana, *et al.*, 2018). Tableau's interactive dashboards, dynamic visuals, and user-friendly interfaces enable users to explore data, acquire insights, and reach educated decisions. Archambault et al. emphasize the relevance of interactive visualizations in allowing users to personalize parameters, filter data, and drill down into details, which improves their capacity to gain meaningful insights from the data given (Archambault, *et al.*, 2015). Tableau is frequently used to show complicated facts relating to energy usage, carbon emissions, and renewable energy adoption (Herodotou & Aslam 2022). Through interactive tools for data exploration and analysis, stakeholders can acquire a deeper understanding of the challenges involved in transitioning to renewable energy for sustainability.

Despite advances in data visualization approaches and platforms like Tableau, there are still obstacles in comprehending and dealing with the complexity of sustainability. While data visualization provides valuable insights and improves communication, it is not an instant for addressing sustainability issues. It is important to note that data visualization is only as good as the data based on, and it may not capture all aspects of a complex issue (Janvrin, *et al.*, 2014). Instead, it serves as an essential aid in the decision-making process, assisting stakeholders in navigating complexities while generating educated decisions toward a more environmentally sustainable future (Karsten, *et al.*, 2022).

The core objective is to improve data storytelling competencies through the use of advanced data storytelling methodologies. In order to correspond

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with the goals, we selected the global dataset on renewable energy capacity that included a number of factors, including year, latitude, longitude, and a range of numerical variables for the use of geospatial analysis and unique calculation methods. lawmakers and business executives, who have a crucial role in this regard, can gain from the project's dashboard, which will offer data on global sustainable energy trends. The purpose is to share the findings and encourage well-informed decision-making, with a focus on lawmakers and leaders in the sustainable energy sector. Lawmakers and industry leaders are the target audience in this case. Energy regulations can be made by lawmakers, but industry executives are accountable for putting them into effect. Following the outlook of this visualization, the animated line chart might have an impact on policies that push the global community toward sustainability (Kubovics, *et al.*, 2021).

An important first step in launching a stimulating discussion is to highlight the vital significance of sustainable energy. We begin the article by addressing the issue, "How have renewable energy and carbon emission trends evolved in the top 10 countries (2000–2019)"? Due to their enormous populations, increasing industrialization, and high energy consumption, the ten largest nations account for a considerable portion of the world's carbon emissions (Lombardi, et al., 2023). By soliciting interested parties to engage part in conversations about energy-related environmental protection initiatives, this introduction promotes action. The animated line charts served as they carry important information, precisely observe the variables in the dataset, enabling us to contrast the rise in carbon emissions with the capacity for renewable energy. Through showcasing a compelling summary of the ten largest countries over a 20-year period and illustrating the dynamics that have shaped their roles in the global landscape, the primary goal is to create a visual representation that will draw attention to the changes. This will be accomplished through demonstrating the percentage representation of both renewable energy capacity and carbon emission levels (Fig. 1.).

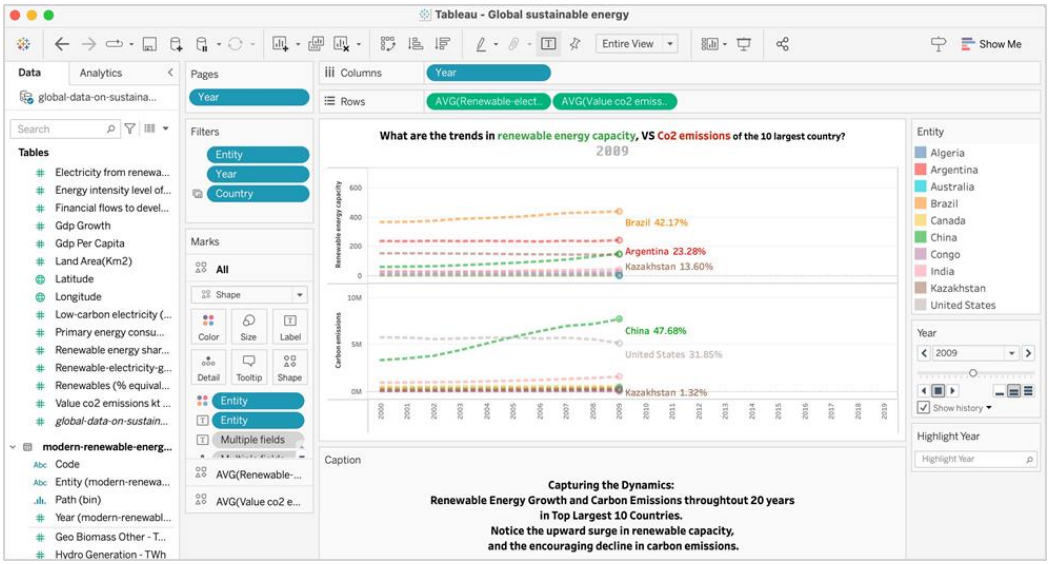

Fig. 1. Animated line chart

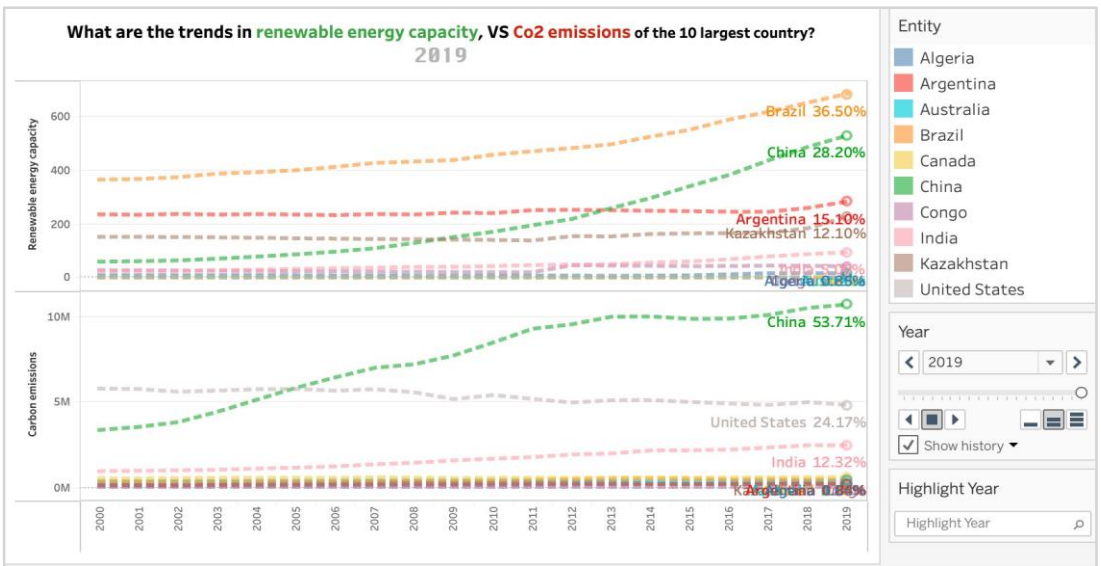

Fig. 2. A review of carbon emission and renewable energy trends

Within our analysis's scope, the patterns are incorporated into the carbon emissions and renewable energy capacity metrics. Emissions carbon and renewable energy capacity both exhibited increasing trends, according to the analytical summary. In 2009, there was a contrast surge in the capacity for renewable energy, with China and Brazil being the main producers.

The primary takeaways from this image are three patterns that emerged as a result of the significant rise in 2009. The first is the rise in carbon emissions and renewable energy capability at the same time, as China has shown. In contrast, Algeria's carbon emissions and renewable energy capability are both trending steadily rising. Lastly, Brazil's 2009

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expansion of renewable energy capacity while keeping carbon emissions steady was a positive trend.

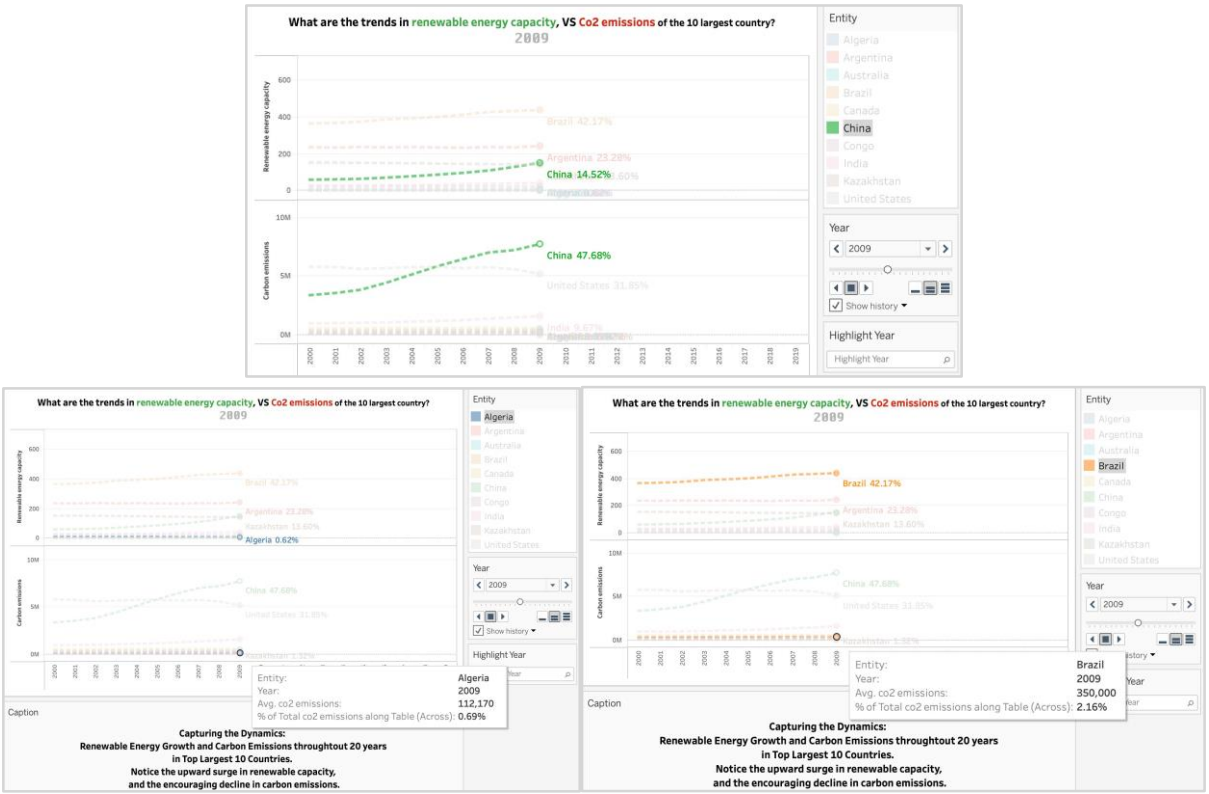

Fig. 3. The notable trends in carbon emissions and renewable energy

Capacity of renewable energy and emission carbon are generally increasing steadily, with an alteration occurring in 2009 (Zhang et al, 2023). Adopting sustainable energy is made easier by the specific patterns that were found, particularly Brazil's approach of growing renewable energy generation while maintaining constant carbon emissions. Lawmakers might see Brazil's ideal practices approach to create regulation that speed the transition to sustainable energy sources by comprehending these trends. This model can be used to the initiatives of large countries, since they can take the lead in embracing renewable energy sources.

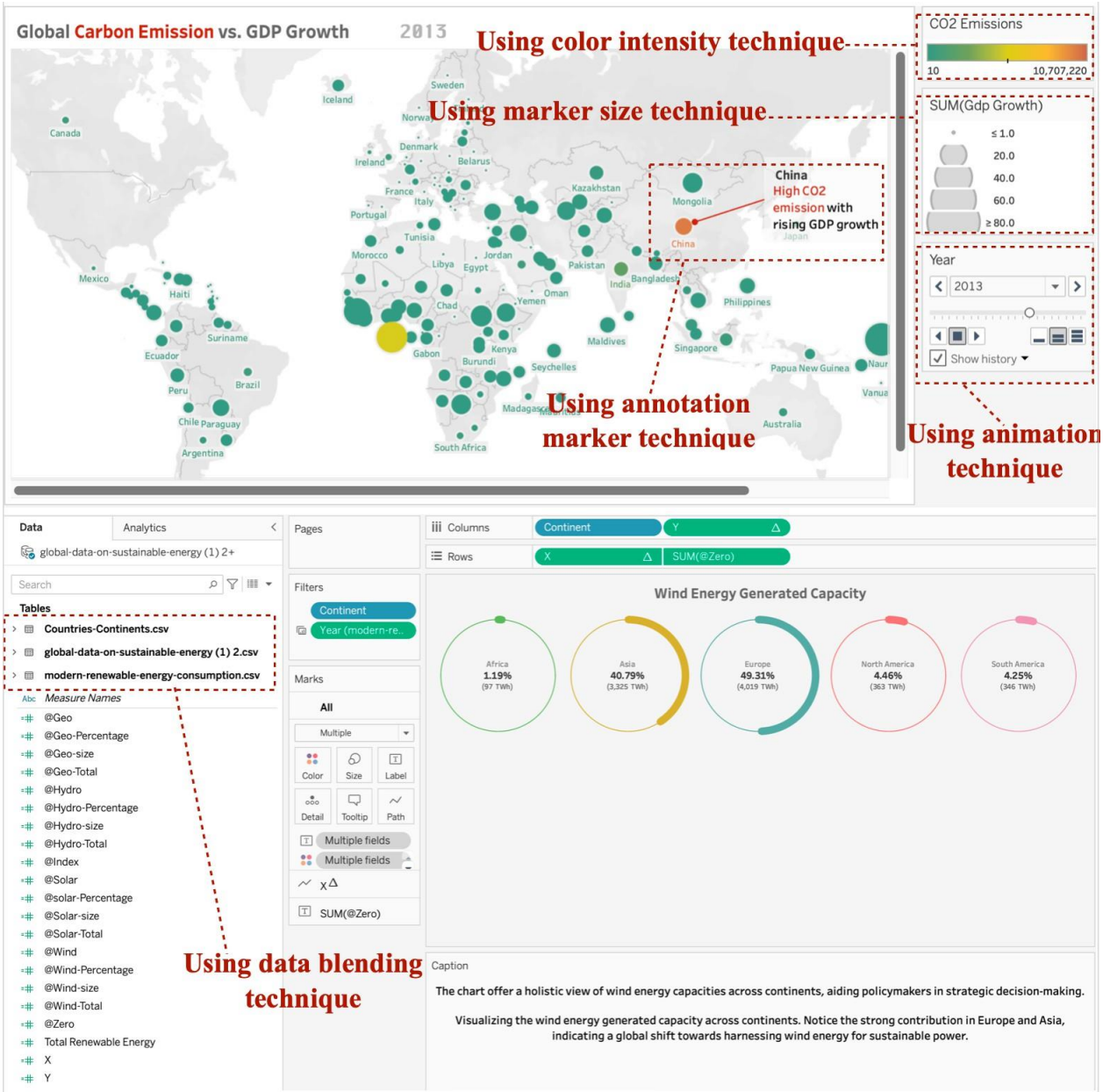

Fig. 4. Advanced tableau techniques for visualization

2. ADVANCED TABLEAU TECHNIQUES

Using an assortment of datasets, this presentation will highlight the difficulties and prospects for investigation in the field of sustainable energy, advanced Tableau techniques, and geospatial analysis.

The development of mastery in data exploration and visualization has two objectives. The first is to explore the intricate relationship between global carbon emissions and GDP growth, emphasizing the economic-environmental balance. The second is intended to assist with strategic

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decision-making by offering a comprehensive picture of energy capacity across continents.

Two datasets were selectively chosen and matched the goals. The foundation of the study is the main dataset, "Global Data on Sustainable Energy (2000–2020)," (obtained from https://www.kaggle.com/datasets/anshtanwar/global-data-on-sustainable-energy). It includes a variety of data formats, with the majority of the variables being computed values. A second dataset was chosen for further investigation of the sustainable energy landscape: "Modern renewable energy consumption" (obtained from https://www.kaggle.com/datasets/programmerrdai/renewable-energy). This dataset provides raw data on virtually every type of renewable energy capacity, such as solar, wind, bioenergy, and hydropower (Wang, 2023).

Two varieties of advanced tableau visualization methods were utilized, involving color intensity-based animated geographical analysis, animation, marker size, and annotation marker approaches to shed the spotlight on the connection between GDP growth and global carbon emissions (2000-2019). Additionally, as shown in Figure 2.1, the four-orbit charts leverage integrated data and computed fields to show how energy capacity (wind, hydropower, bioenergy, and solar) differs between continents and to propose global energy solutions.

The distinctive calculations used to create the orbit charts show how different continents have different capacities for sun, wind, hydropower, and biofuel. In order to construct the orbit chart, computed fields must be utilized. There are four distinct types of computed fields, such as "X," "Y," and "@Index," which are used to identify axis and create a sequential order for data points (the formula is given in Figure 2.2). "@..(TypeOfEnergy)-Percentage" is used to determine the percentage of energy contribution for each region (the formula is shown in Figure 2.3), and "@..(TypeOfEnergy)-Size" is used to determine the size of markers based on the relative contribution of each region's energy (the formula is shown in Figure 2.4) in order to normalize energy values for consistent comparison.

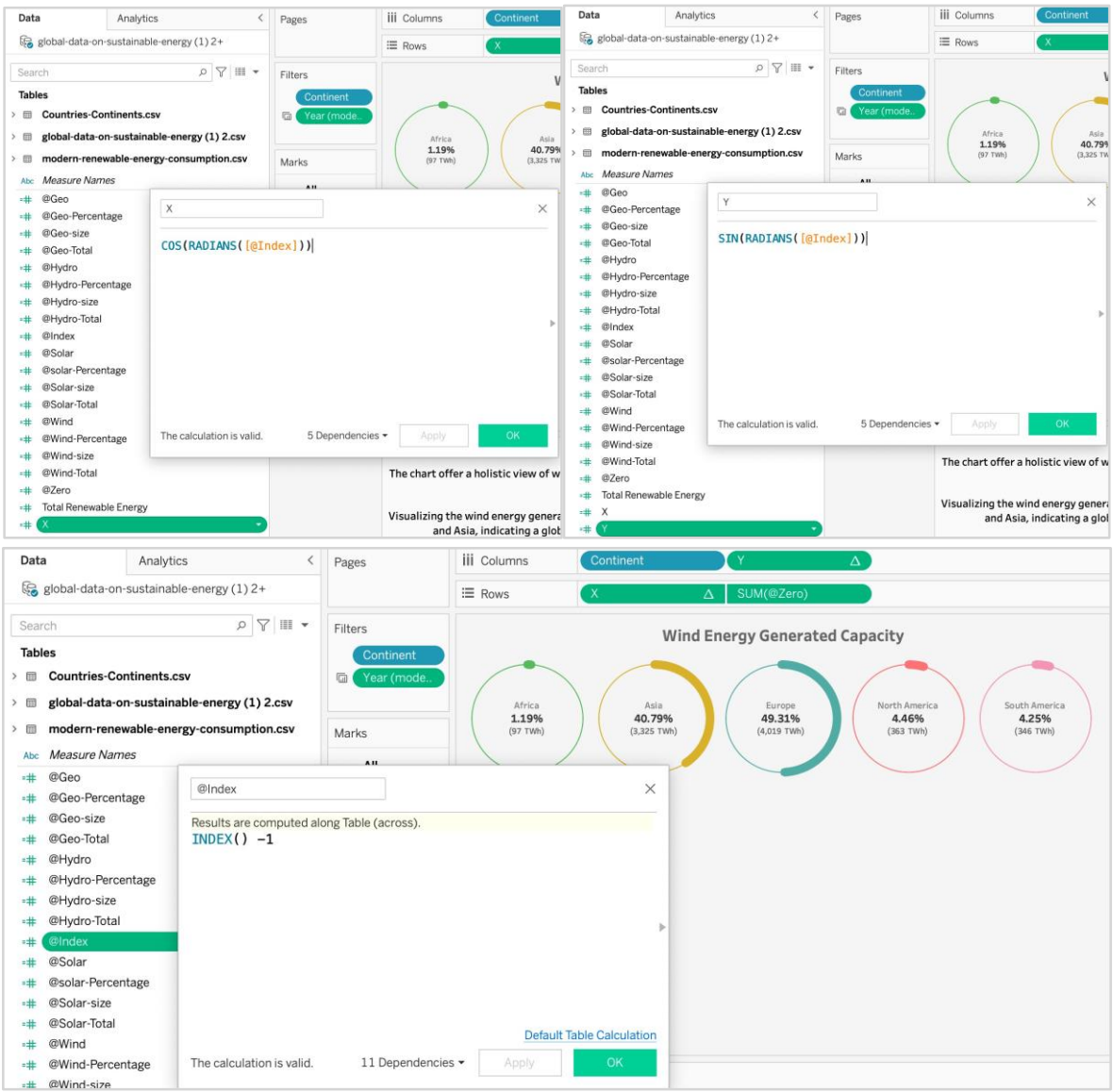

Fig. 5. "@Index," "X," and "Y" formulas

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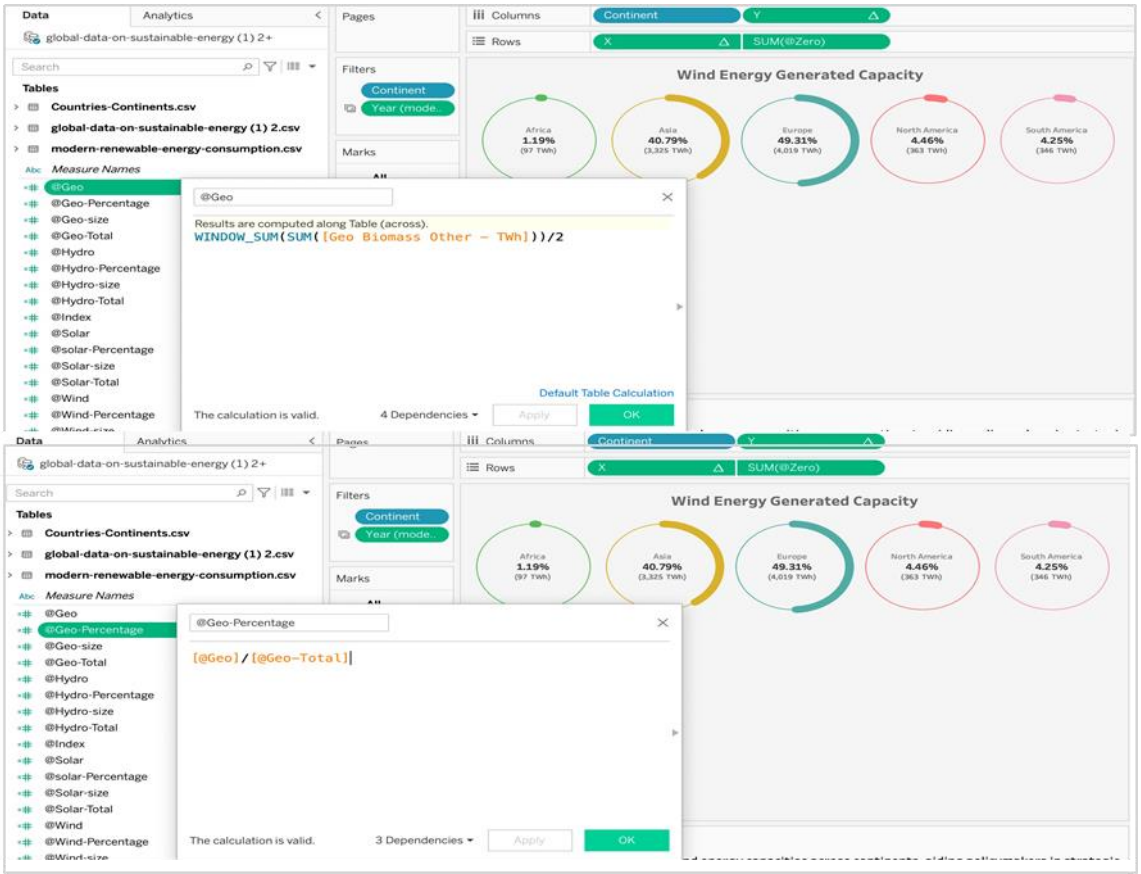

Fig. 6. Calculating the percentage formulas and normalizing them

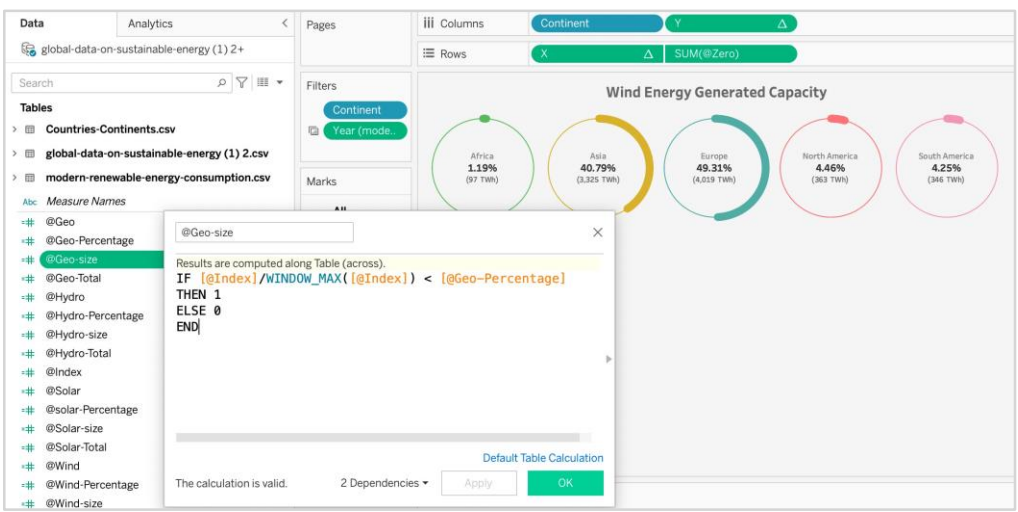

Fig. 7. Calculating marker formula sizes

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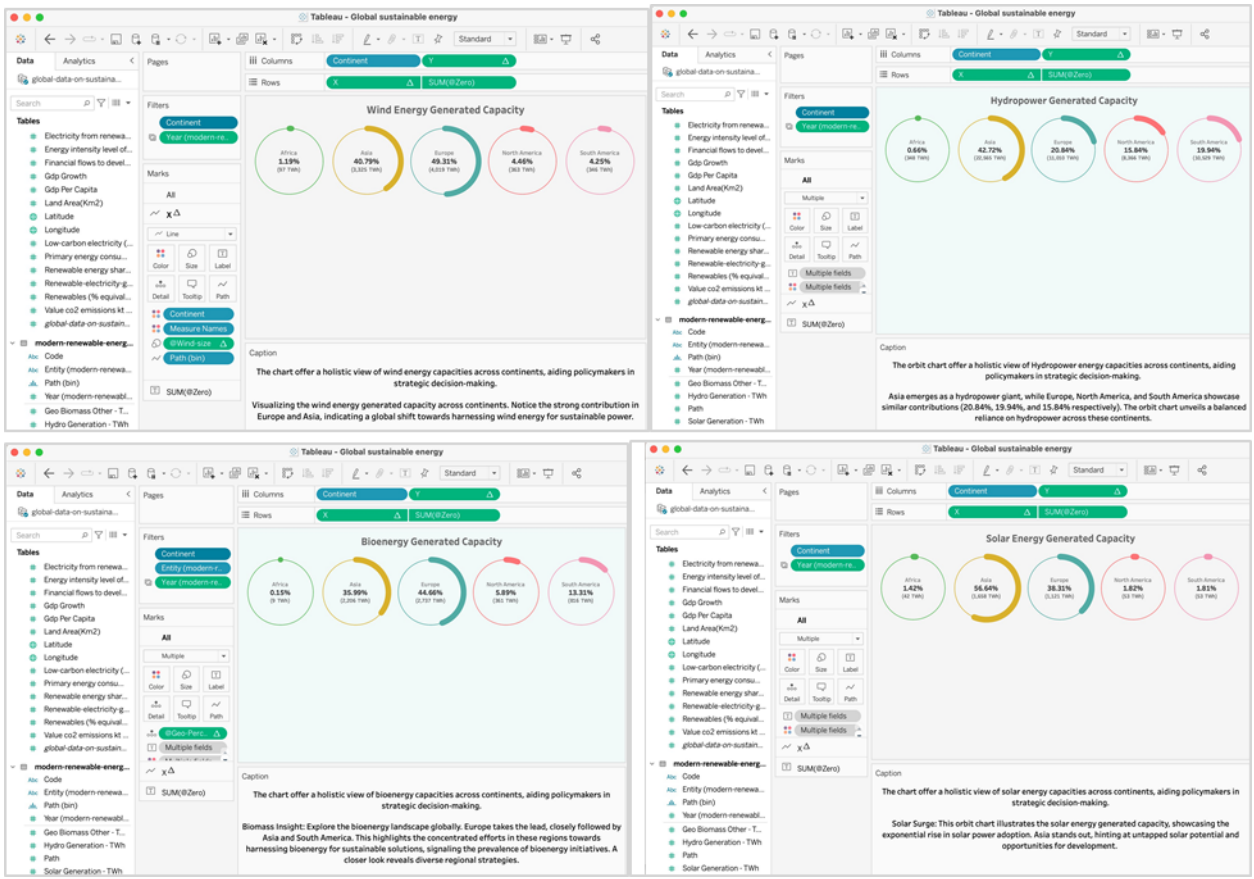

Fig. 8. The orbit charts

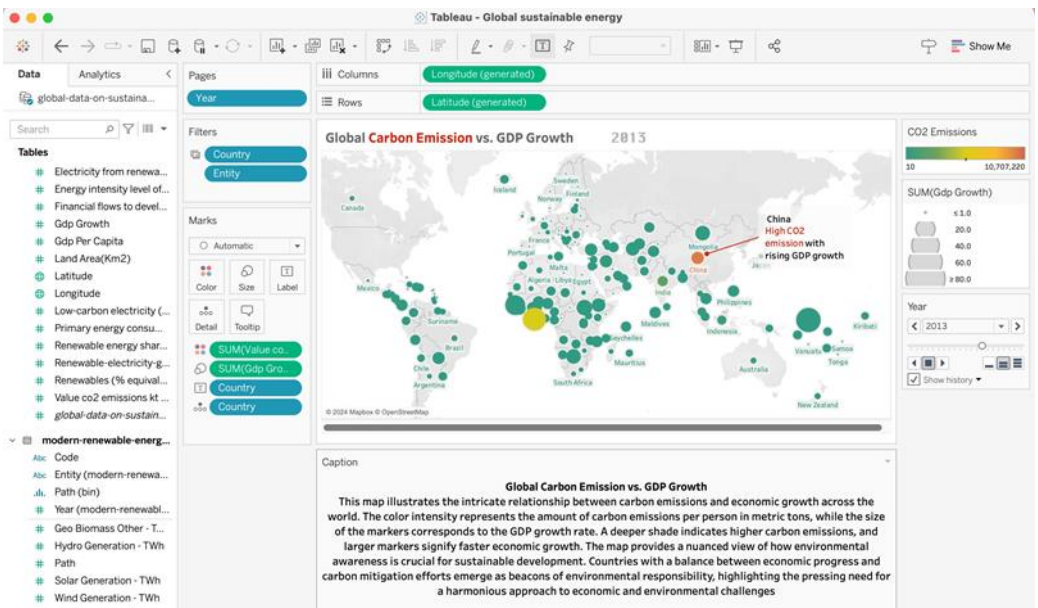

Fig. 9.The Geospatial Analysis

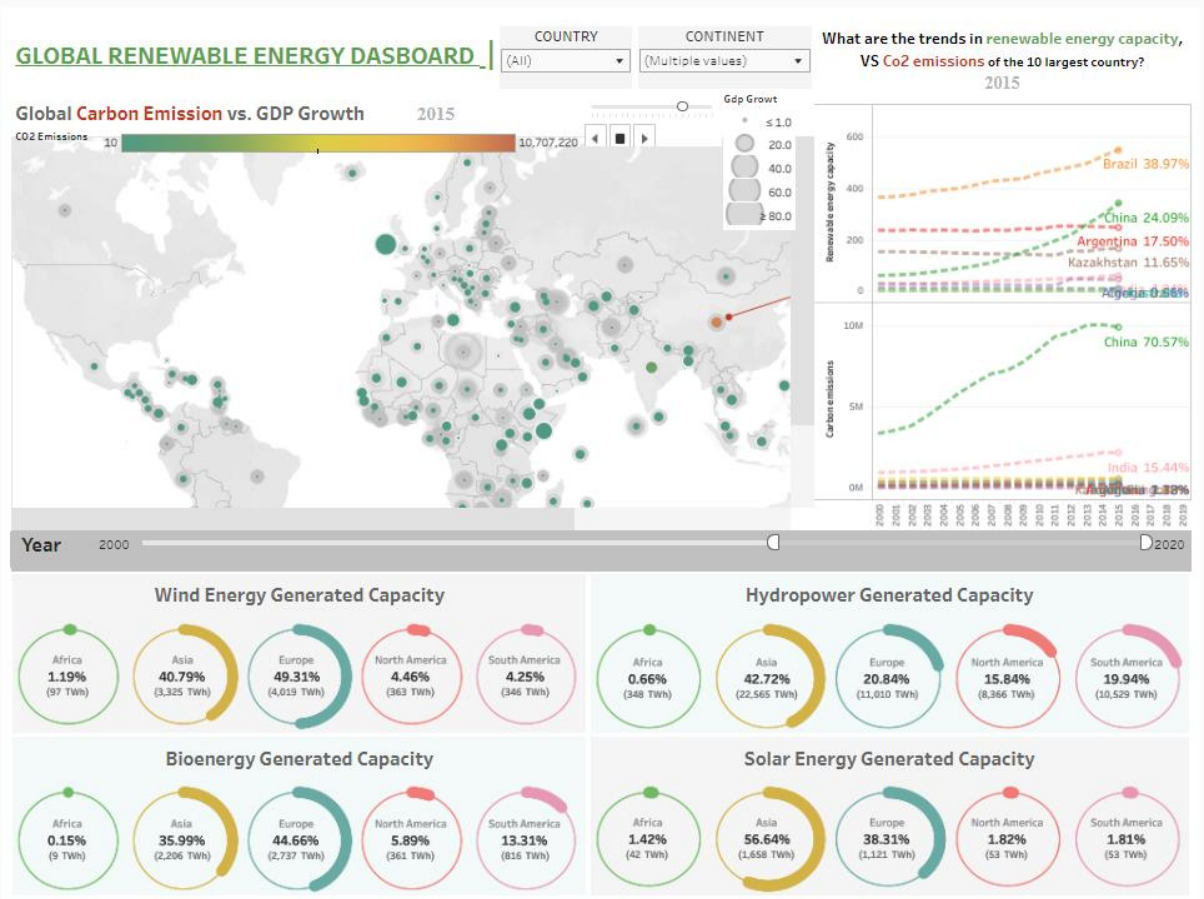

Fig. 10. Tableau Global Renewable Energy Dashboard

(https://public.tableau.com/views/GlobalRENEWABLEENERGYDASBOARD/Dashboard1?:language=en-US&:sid=&:display_count=n&:origin=viz_share_link**)**

Table 1. Identification of Analytical Use Case

Chart	Key Finding	Analytic Use Case
Animated Line Chart	Show increasing trend in renewable energy capacity, with notable growth in 2009 led by China and Brazil.	Understanding the contributors to significant growth allows policymakers to recognize successful strategies or initiatives, guiding future efforts for sustainable energy development.
Animated geospatial map	Highlights China's consistent medium-sized orange color, simultaneously indicating high carbon emissions and high GDP	Policymakers can investigate policies that balance economic growth with environmental responsibility.

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	growth.	
Orbit charts	Showcase Asia as a leader in hydropower and solar energy, while Europe dominates in bioenergy and wind energy, with Africa having the least capacity.	Policymakers can use this information to tailor regional strategies, fostering collaboration or addressing disparities. It guides decisions on resource allocation and development projects based on regional strengths.

3. RESULTS AND DISCUSSION

Our dashboard's primary illustration is a geospatial analysis that uses a map to illustrate regional differences in the adoption of renewable energy and pinpoint places that need specific investment. The marker size and color intensity, which indicate carbon emissions per person, which indicates GDP growth rate, aid the interpretation and study of the patterns and relationships found in this investigation. This section will concentrate on developing suitable interactive elements that complement the global renewable energy dashboard's data narrative. The following are three key features, "Country" and "Year" filters by excluding particular continents and time frames, users may personalize their views. Tooltip Information is when users hover over data points, interactive tooltips provide further information. Dynamic Animations, animated components draw users in and show patterns in charts over time. 1-6.

The goal of the geospatial study is to highlight the balance between the economy and the environment by examining the intricates connection of GDP growth and global carbon emissions. The one outstanding data point is China. The medium-sized orange chart indicates that China has both strong GDP growth and high carbon emissions at the very same time. Strategic investment decision-making based on the geographical landscape of the continent and the geographical capability of the country is aided by the four-orbit maps, giving a comprehensive perspective of energy capacities (wind, hydropower, bioenergy, and solar) across continents. Each orbit chart contains information on which regions are most effective at getting various types of energy. According to the data visualization, Europe leads the world in wind and bioenergy capacity, while Asia is the leader in hydropower and solar energy capacity (Zachrisson et al, 2023). Africa's capability for renewable energy is the lowest. Identifying the

proportionate contributions is necessary for interpretation, which shows changes in energy adoption throughout the world. The primary advantage of using data exploration expertise is that it may support data-driven innovation by facilitating decision-makers in discovering fresh perspectives and patterns, which will promote innovation in renewable energy policy, technology, and business models. The main goal of the research is to draft a report for policymakers that will accelerate the world's shift to sustainable energy. It pinpoints an analytical or commercial use case, designs an advanced Tableau dashboard link: https://public.tableau.com/views/GlobalRENEWABLEENERGYDASBOARD/Dashboard1?:language=en-US&:sid=&:display_count=n&:origin=viz_share_link, and facilitates data-driven decisions.

The primary objective in this section is to create an advanced Tableau dashboard, with a particular emphasis on a well-organized style through the implementation of five essential elements (Murray, 2013; Anoshin, *et al.*, 2019; Nerogic, *et al.*, 2023) in creating an engaging experience through data storytelling. The presentation of a geographic map, which provides a thorough summary of the investigation, opens the data story. The map is paired with an interactive line chart that provides more information on the 10 biggest nations. The audience is led from left to right by this layout, which follows the natural reading flow. At the top of the dashboard, there are 'Country' and 'Continent' filters that allow you to customize your investigation. Furthermore, four-orbit charts are placed at the bottom to explore more specific details and make cross-continental comparisons easier, which improves user engagement and concentration. The purpose of the 'year' filter is to allow users to obtain specific insights by focusing on particular locations or time periods. The dashboard's filters feature helps policymakers make data-driven choices by enabling them to personalize the information presented to their own interests, whether that be by concentrating on particular locations or time periods. Stakeholders may get practical insights that fulfill their needs and make decisions based on a better understanding of the complex linkages between energy capacity, economic development, and carbon emissions through a personalized exploration experience. As a summary, the report's interactive features allow users to compare energy, economy, and emissions data, explore trends, and make decisions based on those findings. These features also improve the creation of powerful insights through user engagement, customization, comparative analysis, data-driven decision-making, and effective communication.

4. CONCLUSION

The report's conclusion highlights the main conclusions and revelations

from the dashboard that was generated, highlighting successes and lessons learned in efficient data exchange to inform sustainable energy investments and policy. The analytical use cases have enhanced our ability to convey data-driven narratives and uncover deeper insights, while advanced visualization techniques, following the five-step data storytelling approach, have strengthened the presentation of critical developments. Progress in data storytelling has improved how we communicate complex global energy trends, with compelling visuals and narratives, particularly on green tunnel solutions, adding depth to our analysis. Transparency in policy and investment choices is reinforced by the development of a dashboard for tracking research data requests and the use of Tableau for visual analysis, which highlights the significance of efficient and effective communication (Sun et al, 2023). By integrating these insights, this report highlights key achievements, reflects on advancements in data narrative, and reiterates the vital role that transparent data sharing plays in achieving sustainable energy initiatives.

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