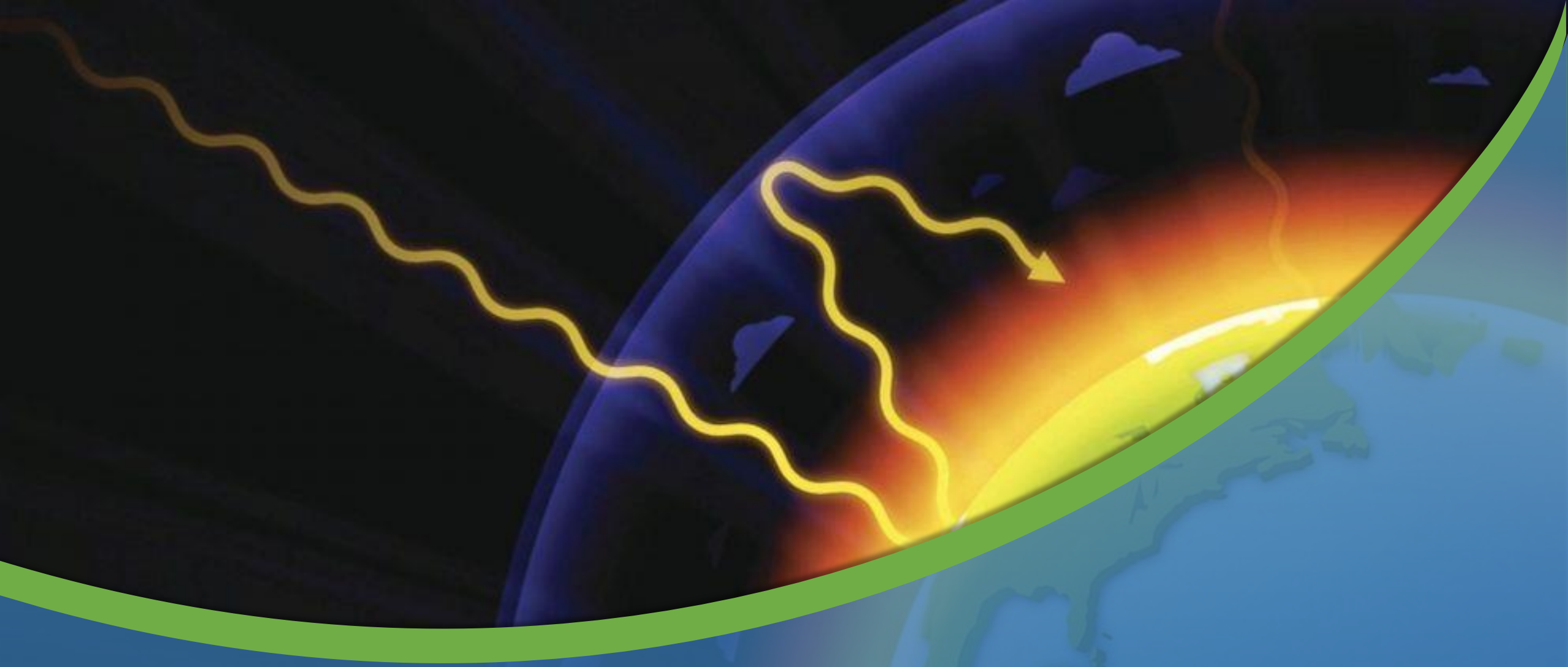

"Global Power Dynamics: Exploring Energy Source Diversity, Capacity Trends, and Nuclear Energy's Role in Sustainability"

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INTRODUCTION

GLOBAL ENERGY DATASET

*** Objective of the Analysis:**
To explore global trends in energy production, focusing on nuclear energy's role, safety impacts, and fuel dependency shifts.

*** Scope of the Study:**
The analysis covers energy production patterns, diversification, efficiency, and safety across multiple countries and regions.

*** Data Sources:**
Data was sourced from

1) Global power plant databases,
2) Nuclear energy generation records, and
3) Energy-related safety statistics (Death rates).

*** Purpose for the Audience:**
To provide actionable insights for policymakers, investors, and energy companies in shaping future energy strategies.

BUSINESS RESEARCH QUESTIONS

Question-1

How has nuclear energy production evolved globally over the years, and which countries have shown the most significant growth or decline?

***Data Selection Process:**

Three datasets were integrated:

1. World Nuclear Energy Generation for nuclear electricity (TWh) and share of total generation.
2. Power Plant Database for plant capacities and locations.
3. Death Rates from Energy Production for contextual safety insights.

Data was aligned by country and year in Tableau for comprehensive analysis.

***Rationale for Data Points**:

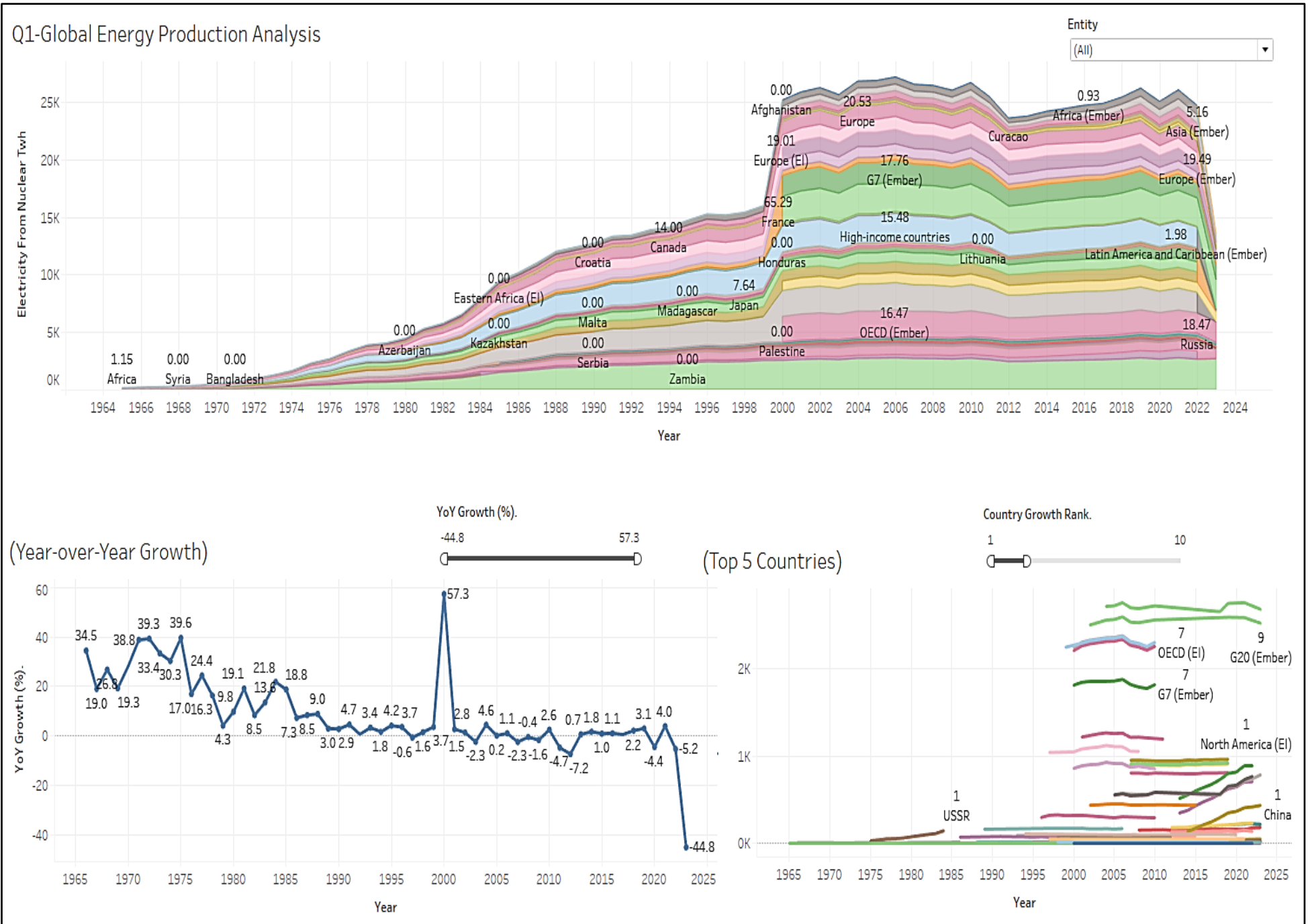
1. Electricity from Nuclear (TWh): To track global production trends over time.
2. Year-over-Year Growth (%): To highlight annual changes and significant shifts.
3. Top 5 Countries & Growth Rank: To identify leading nations in nuclear energy expansion.

These metrics directly address the evolution and key contributors to nuclear energy growth.

***Graphs Used:**

1. Stacked Area Chart – Shows global nuclear energy production (TWh) over time by country/region.
2. Time Series Line Chart – Displays Year-over-Year growth (%) in nuclear energy production globally.
3. Multi-Series Line Chart (Top 5 Countries) – Highlights nuclear production trends of the top 5 countries over time.

DASHBOARD



*Insights & Interpretation:

1. Steady rise from the 1970s, peaking from 2000.
2. Declines: Post-2011 Fukushima incident, global production dipped,.
3. China shows rapid growth, while traditional leaders stabilize.
4. 2024 Decline (-44.8%) Indicates a significant recent shift in global nuclear dynamics.

*Conclusion:

The dashboard reveals shifting global leadership in nuclear energy, influenced by policy, safety, and geopolitical events, guiding future strategic energy planning.

Question-2

What is the relationship between different energy sources and their death rates per TWh?

***Data Selection Process:**

Data was sourced from the Rates of Death from Energy Production per TWh and World Nuclear Energy Generation datasets.

1. Death Rates Dataset provided fatalities per TWh across different energy sources.
2. Nuclear Energy Data helped compare energy production with safety metrics globally.

The datasets were combined in Tableau to align energy sources with their respective death rates and share of electricity production per country.

***Rationale for Data Points**:

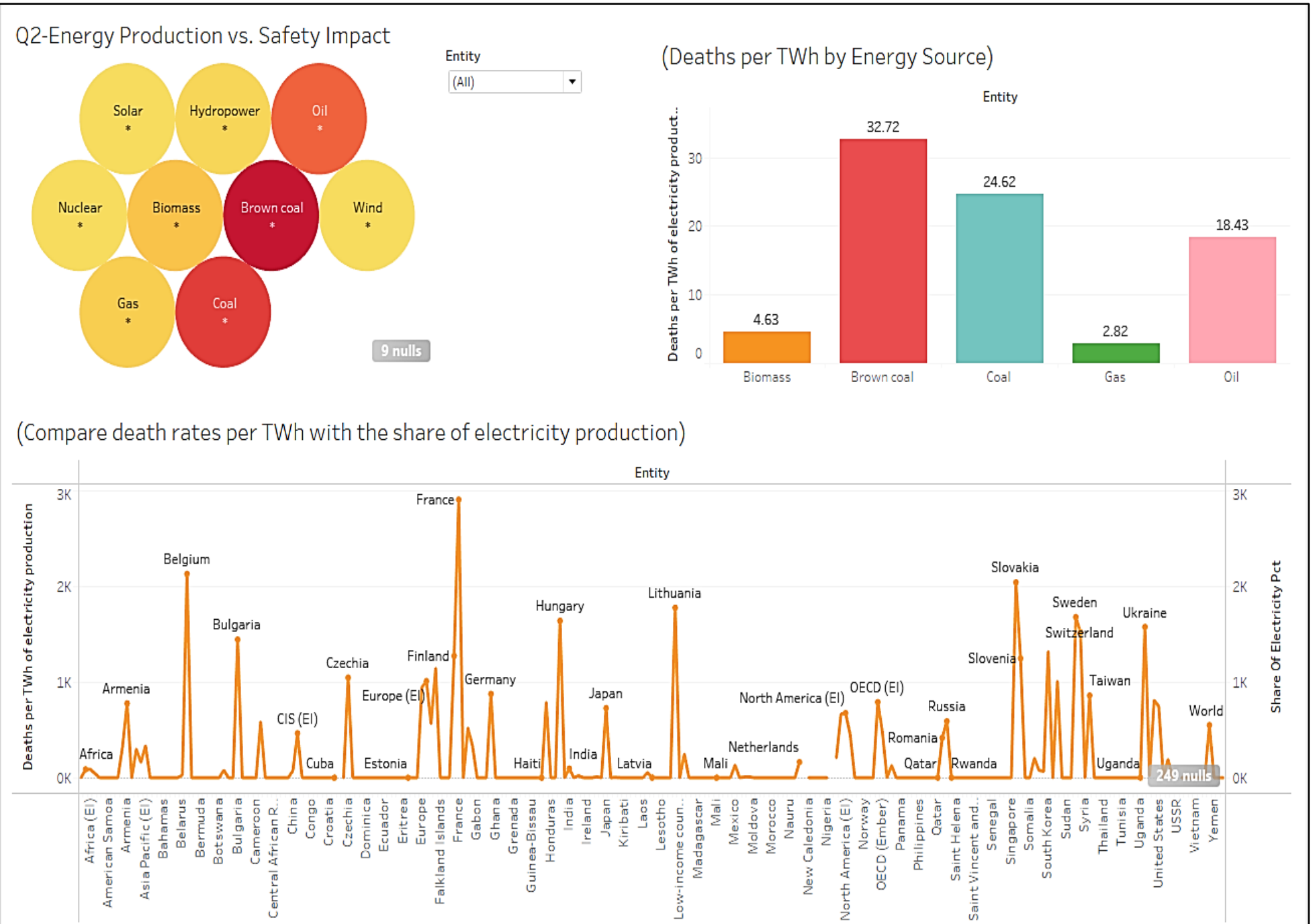
1. Deaths per TWh by Energy Source: To identify the most hazardous energy types.
2. Share of Electricity Production (%): To understand how much each country relies on high-risk energy sources.
3. Top 5 Energy Sources with Highest Death Rates: To highlight the most dangerous energy types globally.

These data points directly address the relationship between energy production and safety impacts.

***Graphs Used:**

1. Packed Bubble Chart – Visualizes various energy sources and their associated risks.
2. Bar Chart – Highlights deaths per TWh by energy source, focusing on the top 5.
3. Line Chart – Compares death rates per TWh with the share of electricity production across countries.

DASHBOARD



*Insights & Interpretation:

1. Highest Risk Sources: Brown coal (32.72 deaths/TWh), Coal (24.62), Oil (18.43), Biomass (4.63), and Gas (2.82) have the highest death rates.
2. Nuclear and Hydropower show lower death rates, showing their relative safety.
3. Countries like France, Belgium, and Lithuania have high electricity shares, while others heavily rely on more hazardous fuels.

*Conclusion:

The dashboard underscores the health risks tied to fossil fuels, suggesting a potential policy shift toward safer alternatives like nuclear and renewables to reduce fatalities in energy production.

Question-3

How does nuclear energy contribute to global efforts in reducing carbon emissions compared to other energy sources?

***Data Selection Process:**

Data was sourced from the World Nuclear Energy Generation dataset and integrated with geographical data from the Power Plant Database.

1. Nuclear Energy Generation Data provided electricity output (TWh) and share of nuclear energy in each country's total energy mix.
2. Geographical Data was used to map the global distribution of nuclear energy production.

Data was combined in Tableau to visualize nuclear energy's contribution to climate goals globally.

***Rationale for Data Points**:

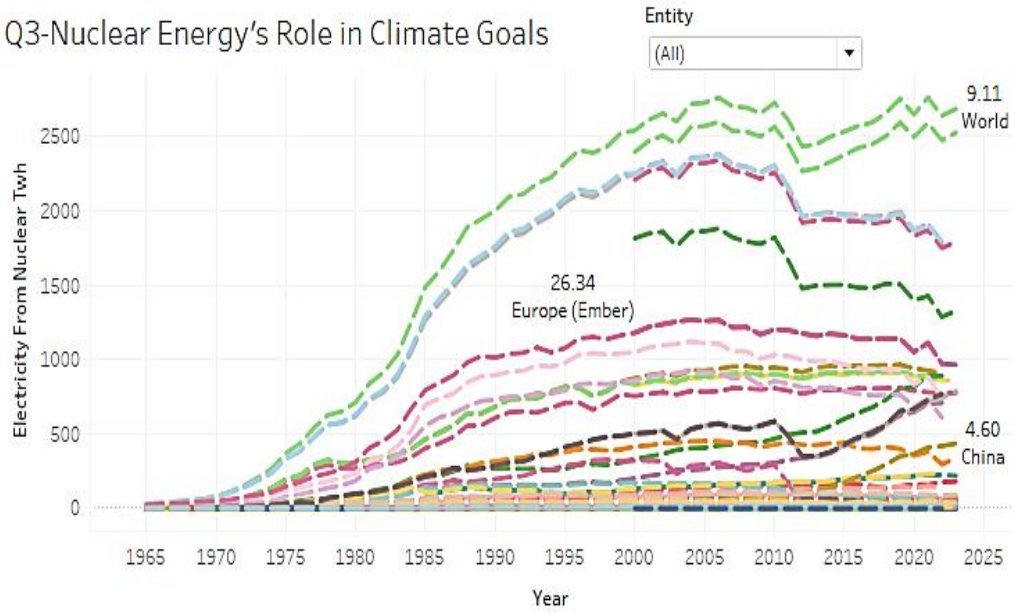
1. Electricity from Nuclear (TWh): To track the scale of nuclear energy's contribution over time.
2. Share of Nuclear in Total Energy Mix (%): To evaluate the reliance of different countries on nuclear energy for reducing carbon emissions.
3. Geographical Mapping of High Producers: To identify key contributors to potential carbon reduction through nuclear energy.

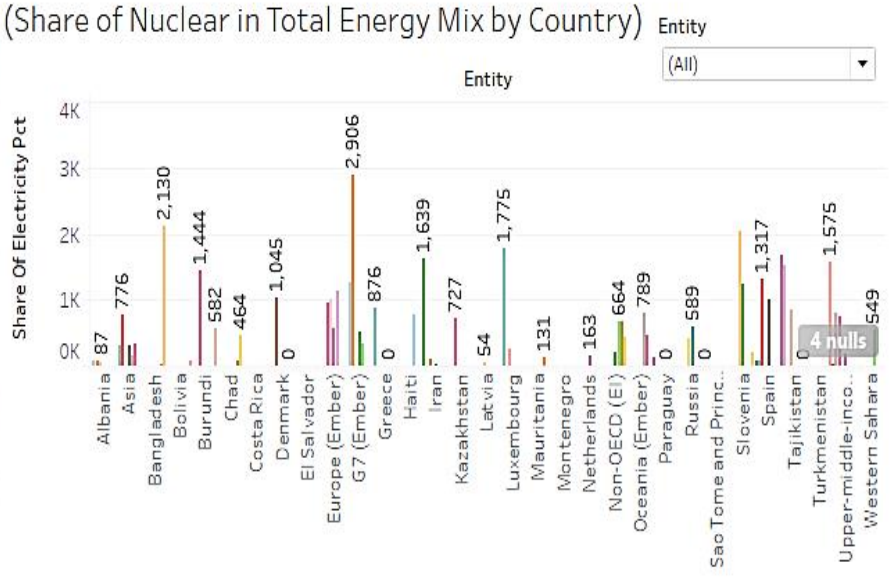
These metrics highlight the role of nuclear energy in global decarbonization efforts.

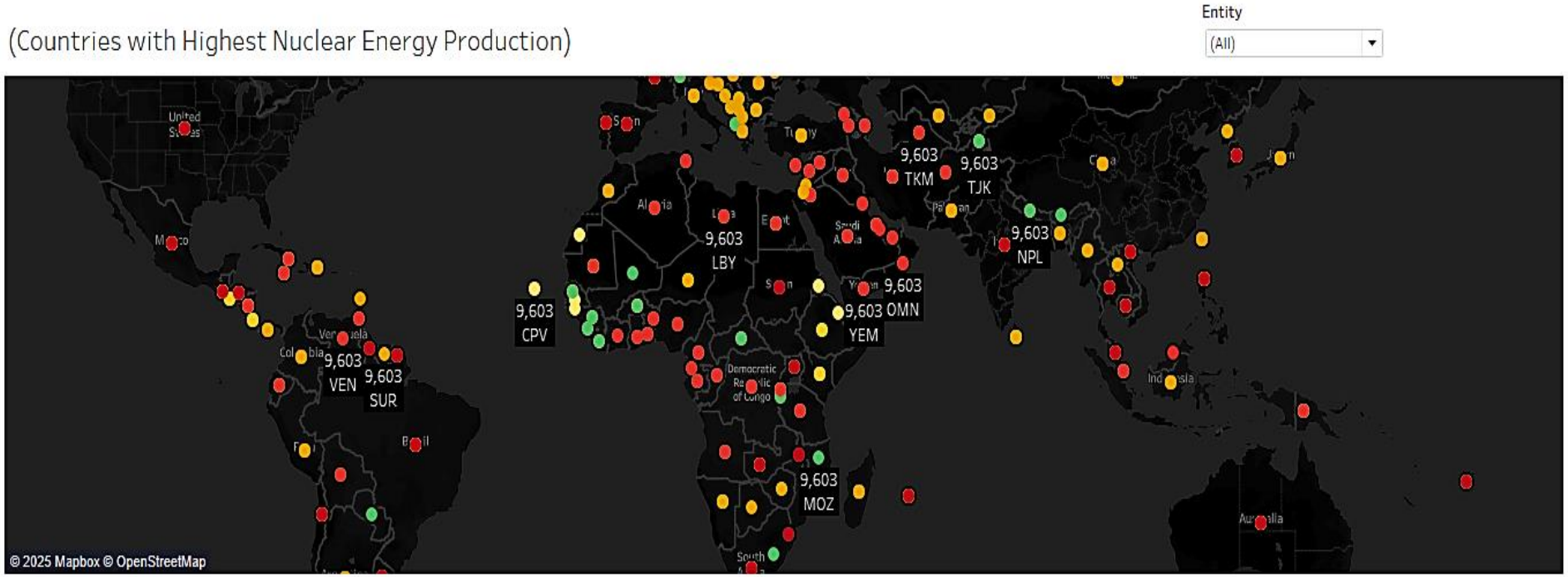
***Graphs Used:**

1. Line Chart – Shows nuclear energy production (TWh) globally over time by region.
2. Bar Chart – Compares the share of nuclear energy in total energy mix across countries.
3. Map Visualization – Highlights countries with the highest nuclear energy production to infer carbon reduction potential.

DASHBOARD







*Insights & Interpretation:

1. Nuclear energy production increased significantly from the 1970s, peaking around 2005,
2. Europe (26.34% share) and G7 countries lead in nuclear energy adoption, while China shows growing contributions.
3. Countries with the highest nuclear output, such as the United States and France, have greater potential to reduce carbon emissions by minimizing fossil fuel dependence.

*Conclusion:

The dashboard illustrates how nuclear energy plays a vital role in achieving climate goals, with leading countries positioned to make significant carbon reductions through continued or increased nuclear investments.

Question-4

How does the diversity of energy sources within a country affect its overall power generation capacity and efficiency?

***Data Selection Process:**

Data was sourced from the *Power Plant Database* and *World Nuclear Energy Generation* datasets.

1. Power Plant Database provided details on the type, capacity, and location of power plants globally.
2. Nuclear Energy Generation Data helped contextualize nuclear's role within broader energy diversification efforts.

The datasets were combined in Tableau to examine how energy source diversity impacts power generation capacity.

***Rationale for Data Points**:

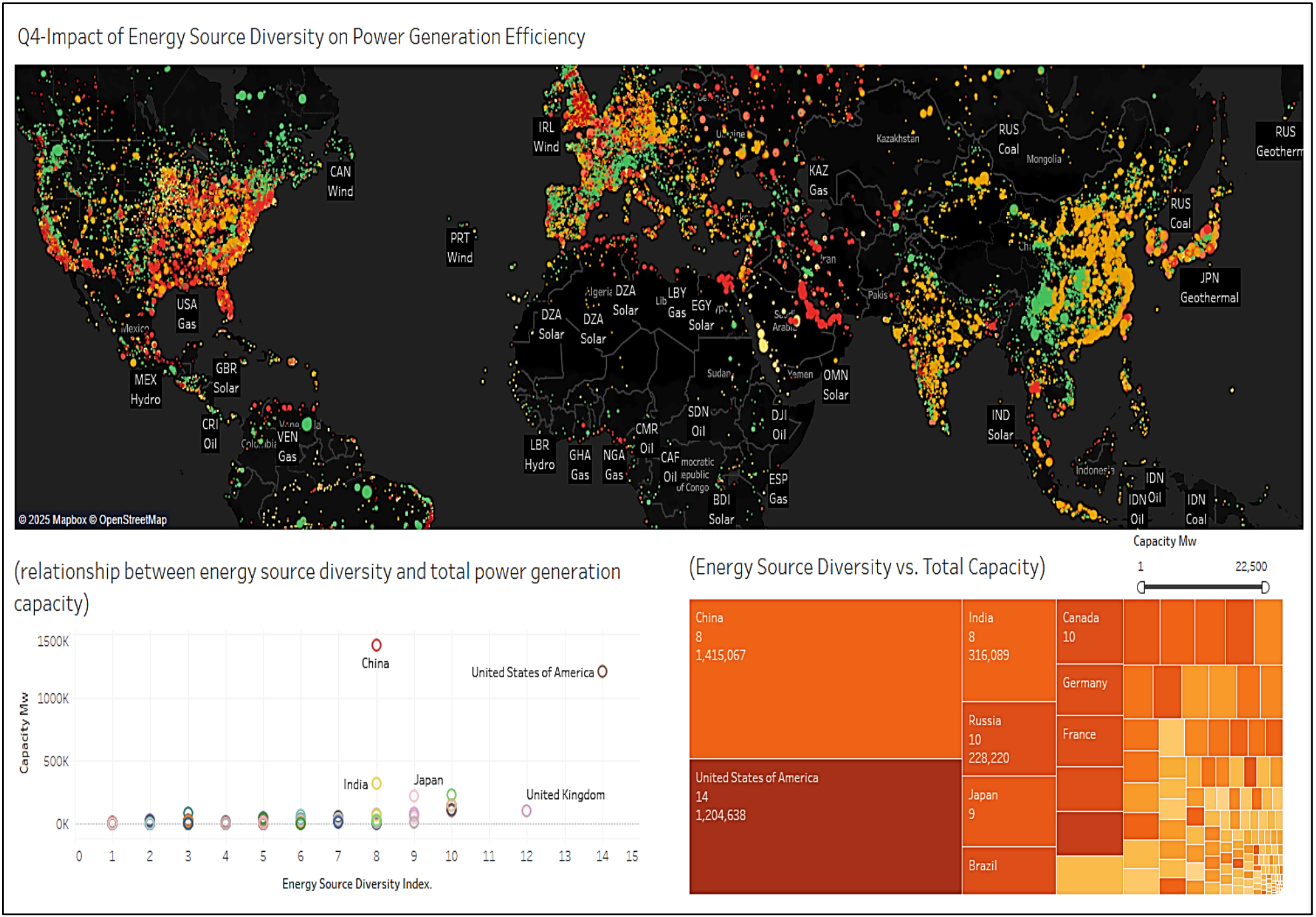
1. Energy Source Diversity Index: COUNTD([primary_fuel]) Measures the variety of energy sources in each country, reflecting energy mix diversification.
2. Total Power Generation Capacity (MW): Shoes the overall capability of countries to generate power, allowing to explorethe link between diversity and capacity.
3. Geographical Distribution of Power Sources: Highlights regional energy diversity patterns and concentrations of specific energy types.

These metrics explore how diverse energy portfolios influence power generation efficiency and capacity.

***Graphs Used:**

1. Map Visualization – Displays the geographical distribution of power plants by energy source globally.
2. Scatter Plot – Shows the relationship between the Energy Source Diversity Index and total power generation capacity (MW).
3. Tree map – Visualizes countries by energy source diversity and total capacity to highlight major contributors.

DASHBOARD



*Insights & Interpretation:

1. Countries like the United States (14 sources) and China (8 sources) show high diversity and large generation capacities,
2. India, Russia, and Germany also exhibit balanced diversity with strong capacity,
3. The map reveals how regions like Europe and North America leverage diverse energy sources,
   - Dark Yellow- Coal
   - Light Yellow- Oil
   - Red- Gas
   - Green- Hydro

*Conclusion:

The dashboard illustrates that countries with a more diverse energy mix tend to have higher power generation capacities, promoting energy security and potential efficiency gains through resource optimization.

Question-5

How do different countries depend on various energy sources based on their installed power generation capacity, and what trends can be observed in fuel dependency over time?

***Data Selection Process:**

Data was sourced from the *Power Plant Database* to analyze global fuel dependency and power generation capacity.

1. Fuel Type and Capacity Data provided insights into installed capacities across various energy sources (e.g., coal, hydro, nuclear).
2. Commissioning Year Data helped track historical shifts in fuel dependency over time.

The data was visualized in Tableau to illustrate changes in fuel dependency and capacity distribution.

***Rationale for Data Points**:

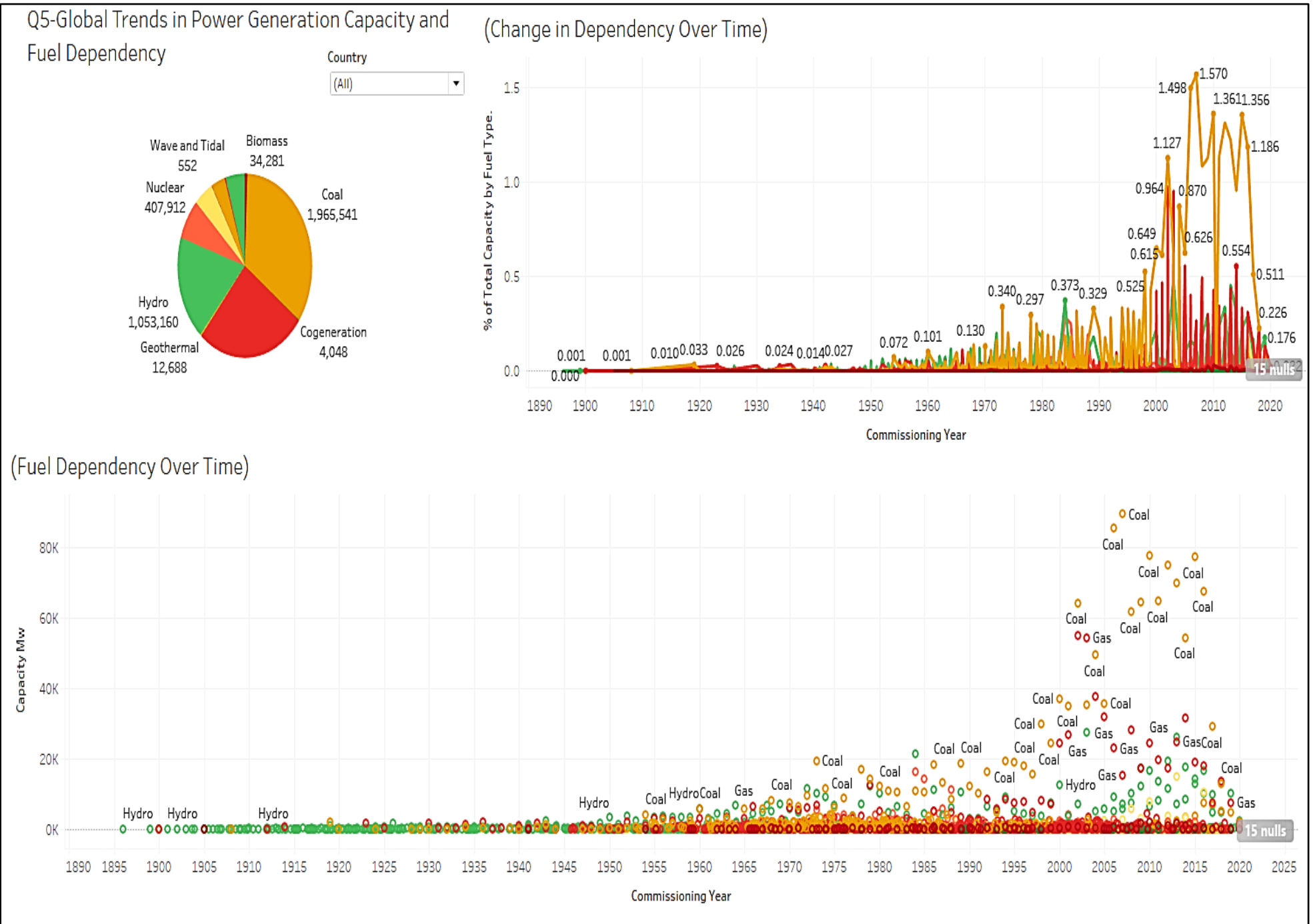
1. Installed Power Generation Capacity (MW): To evaluate how much power is generated from each fuel type globally.
2. Fuel Type Distribution (% of Total Capacity): SUM([capacity_mw]) / TOTAL(SUM([capacity_mw])) * 100
   To track shifts in fuel dependency across different time periods.
3. Commissioning Year Trends: To observe how the adoption of specific fuels has changed over time.

These metrics were chosen to directly address the evolution of global fuel dependency and capacity trends.

***Graphs Used:**

1. Pie Chart – Displays the distribution of global power generation capacity by fuel type.
2. Line Chart – Tracks changes in fuel dependency over time (% of total capacity by fuel type).
3. Scatter Plot – Illustrates fuel-specific capacity trends over time based on commissioning years.

DASHBOARD



*Insights & Interpretation:

1. Coal dominates global power generation capacity (1,965,541 MW), but there's been a steady rise in hydro and nuclear capacity,
2. The peak in coal dependency occurred around the 2000s, followed by a gradual decline as renewables and nuclear-gained traction.
3. Recent decades show increased adoption of cleaner energy sources like hydro and biomass, while coal and gas capacities plateau or decline

*Conclusion:

The dashboard highlights the global shift from fossil fuels toward more sustainable energy sources, driven by environmental policies and technological advancements, signaling a broader trend toward decarbonization.

CONCLUSION

1. Energy Diversification is Essential:

   Countries with diverse energy mixes show higher power generation capacity and resilience against fuel dependency risks.

2. Nuclear & Renewables Drive Carbon Reduction:

   Nuclear and renewable energy sources play a critical role in meeting global climate goals by reducing reliance on fossil fuels.

3. Shifts in Global Energy Leadership:

   Emerging economies like China are rapidly expanding nuclear and renewable capacity, while traditional leaders stabilize.

4. Safety & Efficiency Influence Energy Choices:

   Fossil fuels like coal and oil have higher death rates, pushing the need for safer, more sustainable alternatives.

Audience Action:

1. Policymakers: Develop sustainable, diversified energy strategies aligned with climate goals.
2. Investors: Target high-growth, low-risk sectors like nuclear and renewables.
3. Energy Companies: Optimize energy portfolios for efficiency, safety, and sustainability.
4. Environmental Advocates: Promote the adoption of cleaner energy to reduce emissions and health risks.

The Purpose of Visualization is Insight, not Pictures.

-Ben.A . Shneiderman

THANK YOU.