Final Project Report

1. Introduction

1.1.Project overviews

This project involves the analysis and reporting of Global Energy Trends, using data visualized across four key dashboards. The overall goal is to derive actionable insights into worldwide energy consumption, the composition of energy sources, and power generation patterns across specific countries and economic blocs. The primary data covers total energy consumption (TWh) from approximately 1990 to 2020 and details the mix of renewable (Hydro, Solar PV, Biofuel, Geothermal) and non-renewable (Oil, Coal, Natural Gas) sources. The analysis specifically tracks:

- **Temporal Trends:** Changes in consumption over two to three decades (1990-2020).
- **Geographic Distribution:** Comparisons of TWh consumption across continents, economic blocs (OECD, BRICS, CIS), and a filtered list of the **Top 20 Power Generating Countries**.
- **Energy Mix Dynamics:** The relative share and growth of different energy sources, highlighting the rise of renewables versus traditional fossil fuels.
- **Key Metrics:** Calculated figures such as average TWh, variance, standard deviation, and percentage growth rates to quantify trends.

The dashboards serve as a comprehensive tool to understand the evolving landscape of global energy demand and supply.

1.2.Objectives

The primary objectives of this analysis are to derive and communicate quantitative insights from the data, which include:

- **Quantify Global Consumption Growth:** Determine the overall rate and magnitude of the **upward trend in total energy consumption (TWh)** across both countries and continents (e.g., reporting averages like **862.07K TWh**).
- **Analyze Energy Source Composition:** Detail the complete energy mix, specifying the TWh contribution and percentage share of both **non-renewable** (e.g., Oil: **25.36%**) and **renewable** (e.g., Hydro: **42.95%**) sources.
- **Evaluate Data Dispersion:** Extract and report on statistical indicators, such as the **Variance of Contribution (36.75M TWh)**, to quantify the data's volatility and the reliance on a few dominant energy sources.
- **Benchmark Country Performance:** Compare and contrast the energy consumption patterns and growth rates of specific countries (e.g., Algeria's **195.45%** growth) against regional and global peers across the 31-year period.
- **Assess Renewable Adoption:** Specifically determine the ranking and scale of the four key renewable sources (**Hydro, Biofuel, Solar PV, Geothermal**) within the **Top 20 Power Generating Countries**.
- **Identify Economic Bloc Contributions:** Clearly identify and rank the energy consumption of major economic groupings (**OECD, BRICS, CIS**) to understand global economic influence on energy demand.

- **Identify Relationships:** Report on relationships, such as the **positive correlation** between the consumption trends of Algeria and Egypt.
- **Inform Energy Strategy:** Structure the findings to offer a clear, data-driven summary of global energy trends and transitions to support future strategic planning and investment decisions.

2. Project Initialization and Planning Phase

2.1. Define Problem Statement

This document defines the core challenges faced by key stakeholders when analyzing Global Energy Trends. By addressing these issues—which center on **data integrity** and a critical **lack of predictive foresight**—our project ensures the final Power BI solution delivers high-value, strategic insights for decision-making.

PS-1: Challenge: Unreliable Data & Inefficient Renewable Energy Tracking

- **I am:** A Data Analyst.
- **I'm trying to:** Accurately measure the growth and penetration of renewable energy capacity.
- **But:** The source data is fragmented, messy, and uses inconsistent unit measurements.
- **Because:** Manual data cleaning and modeling take excessive time, delaying actionable reports.
- **Which makes me feel:** Inefficient and doubtful about the accuracy of my final analysis.

PS-2: Lack of Strategic Predictive Foresight

- **I am:** An Energy Policy Stakeholder.
- **I'm trying to:** Forecast future energy demand and supply risk to inform strategic investment decisions.
- **But:** The current report focuses only on historical data and lacks predictive modeling capabilities.
- **Because:** I cannot dynamically test "what-if" scenarios based on external factors (price, policy).
- **Which makes me feel:** Risk-averse, unprepared for market shifts, and lacking critical strategic foresight.

2.2. Project Proposal (Proposed Solution)

This project proposal outlines a solution to address a specific problem. With a clear objective, defined scope, and a concise problem statement, the proposed solution details the approach, key features, and resource requirements, including hardware, software, and personnel.

Project Overview	
Objective	To develop a comprehensive, interactive dashboard and a predictive time-series model to analyze historical global energy consumption and generation, forecast future renewable energy adoption, and provide data-driven insights into the global energy transition.

Scope	The project encompasses the analysis of energy consumption (by country/continent) and power generation (by source, 1990–2017) using the provided datasets. Deliverables include a validated data model, an interactive visualization tool (dashboard), and a 5-to-10-year forecast of renewable energy contribution (TWh).
Problem Statement	
Description	Policy makers, investors, and researchers currently lack a consolidated, easily-interpretable, and predictive tool to assess the progress and trajectory of the global energy transition. Analyzing static data reports makes it difficult to compare regional performance, identify high-impact policy areas, and quickly assess the shift in energy mix
Impact	The proposed solution will allow stakeholders to: (1) Identify high-growth vs. lagging regions in renewable adoption. (2) Quantify the historical impact of generation shifts. (3)Forecast future energy needs and potential supply gaps. (4) Accelerate the transition by highlighting actionable insights and investment opportunities.
Proposed Solution	
Approach	1. Data Ingestion & Integration: Load all provided CSV files (Continent_Consumption_TWH.csv, Renewable Total Power Generation.csv, etc.) and structure them into a unified relational data model. 2. Exploratory Data Analysis (EDA): Perform trend analysis on consumption and generation growth rates by region and energy source. 3. Interactive Dashboard Development: Create a visualization layer (using Power BI or Python visualization libraries) for historical analysis.
Key Features	1. Geographic Comparison: Side-by-side analysis of energy mix for top countries and continents. 2. Renewable Penetration Tracker: Dynamic calculation and visualization of renewable energy percentage of total generation. 3. Predictive Scenario Tool: Model output showing likely trajectory of non-renewable reduction and renewable growth (TWh) up to 2030. 4. Drill-Down Capability: Ability to filter and segment data by years, continents, countries, and generation modes.

Resource Requirements

Resource Type	Description	Specification/Allocation

Hardware		
Computing Resources	CPU/GPU specifications, number of cores	Quad-core CPU (2.5 GHz+), suitable for data processing and model training.
Memory	RAM specifications	8 GB RAM (Minimum) for in-memory data operations and running predictive models.
Storage	Disk space for data, models, and logs	1 TB SSD for storing the dataset, model checkpoints, environment, and logs.
Software		
Frameworks	Python frameworks	Python frameworks (e.g., Jupyter Lab/Notebook) for scripting and analysis
Libraries	Additional libraries	pandas, numpy, scikit-learn, matplotlib/seaborn, Prophet, or other specialized time-series libraries.
Development Environment	IDE, version control	Power BI Desktop (for dashboard visualization), Git (for version control)
Data		
Data	Source, size, format	Kaggle: Provided historical energy datasets (CSV files). Size: Small (<10 MB total). Format: CSV.

2.3. Initial Project Planning

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members	Sprint Start Date	Sprint End Date (Planned)
Sprint-1	Data Collection	USN-1	As a data analyst intern, I will collect and review	2	High	Riya Kavidayal	1/10/2025	1/10/2025 Completed

			global energy datasets (country-wise, continent-wise, renewable/non-renewable) from reliable sources such as Kaggle					
Sprint-2	Data Connection & Preparation	USN-2	As a user, I can connect the collected datasets to Power BI using Power Query and clean the data for analysis (handling nulls, renaming columns, formatting).	3	High	Riya Kavidayal	1/10/2025	1/10/2025 Completed
Sprint-3	Data Modelling	USN-3	As a Power BI developer, I will establish relationships between tables (Country, Continent, Energy Source) and create necessary calculated columns/measures using DAX.	3	High	Riya Kavidayal	2/10/2025	2/10/2025 Completed
Sprint-4	Data Visualization	USN-4	As a user, I can visualize energy generation and	4	High	Riya Kavidayal	3/10/2025	4/10/2025 Completed

			consumption using charts such as bar graphs, line charts, and geographical maps for interactive exploration.					
Sprint-5	Dashboard Design	USN-5	As a user, I can view all visualizations in a single interactive dashboard displaying , trends, and insights on renewable vs non-renewable energy.	3	High	Riya Kavidayal	4/10/2025	5/10/2025 Completed
Sprint-6	Report Generation	USN-6	As a data analyst intern, I will create a detailed report summarizing findings, key visualizations, and insights derived from the dashboard.	2	Medium	Riya Kavidayal	6/10/2025	6/10/2025 Completed
Sprint-7	Performance Testing	USN-7	As a Power BI intern, I will test dashboard performance, filter efficiency, and measure responsiveness across multiple visuals.	2	Medium	Riya Kavidayal	7/10/2025	7/10/2025 Completed
Sprint-8	Project Demonstra	USN-8	As a presenter, I	2	High	Riya Kavidayal	7/10/2025	7/10/2025 Completed

	tion & Documentation		will record an end-to-end demonstration video of the dashboard and document every project development step.					

3. Data Collection and Preprocessing Phase

3.1. Data Collection Plan and Raw Data Sources Identified

Data Collection Plan

Section	Description
Project Overview	The project is the Global Energy Transition Analytics & Forecasting Platform. The objective was to utilize historical global energy consumption and power generation data to create a comprehensive, interactive dashboard for trend analysis and insights. The project is complete, with the final output delivered as the Global Energy Trends.pbix Power BI file.
Data Collection Plan	Data collection is complete. The raw data was obtained from a single, specific Kaggle Global Energy Trends dataset which contained the 6 CSV files used for analysis. These files were subsequently ingested, cleaned, transformed, and modeled within the Power BI environment to produce the final dashboard. This plan documents the raw files used from that original source.
Raw Data Sources Identified	The raw data consists of six distinct CSV files sourced from Kaggle, plus the Power BI file which is the project deliverable.

Raw Data Sources

Source Name	Description	Location/URL	Format	Size	Access Permissions
Continent_Consumption_TWH.csv	Time-series data detailing total energy consumption in Terawatt-hours (TWh), aggregated by major geographic regions (e.g., OECD, BRICS, continents).	Kaggle Dataset (Global Energy Consumption & Renewable Generation | Kaggle)	CSV	Small (< 1 MB)	Public
Country_Consumption_TWH.csv	Time-series data detailing total energy consumption in TWh for a comprehensive list of global countries.	Kaggle Dataset (Global Energy Consumption & Renewable Generation | Kaggle)	CSV	Small (< 1 MB)	Public

Renewable Power Generation97-17.csv	Time-series data detailing the historical contribution (TWh) of specific major renewable sources between 1990 and 2017.	Kaggle Dataset (Global Energy Consumption & Renewable Generation | Kaggle)	CSV	Small (< 1 MB)	Public
Renewables Total Power Generation.csv	Snapshot data summarizing the total global power generation contribution by various renewable modes (e.g., Hydro, Wind, Solar PV).	Kaggle Dataset (Global Energy Consumption & Renewable Generation | Kaggle)	CSV	Very Small (< 1 MB)	Public
Non Renewables Total Power Generation.csv	Snapshot data summarizing the total global power generation contribution by various non-renewable modes (e.g., Coal, Natural Gas, Nuclear, Oil).	Kaggle Dataset (Global Energy Consumption & Renewable Generation | Kaggle)	CSV	Very Small (< 1 MB)	Public
Top 20 Countries Power Generation.csv	Country-specific data detailing the power generated by the top 20 countries, broken down by major renewable sources.	Kaggle Dataset (Global Energy Consumption & Renewable Generation | Kaggle)	CSV	Very Small (< 1 MB)	Public

3.2. Data Quality Report

Data Source	Data Quality Issue	Severity	Resolution Plan
Continent_Consumption_TWh **(Kaggle)**	Null Values	Low	Filter out rows where key identifier column (Year) are blank.

Continent_Table**(Kaggle)** Country_Table**(Kaggle)**	Wide Data Format (Country/Continent across columns).	High	Unpivot Other Columns. Rename Attribute to Country/Continent and Value to TWh.
Top 20 Countries Power Generation**(Kaggle)**	Excess Decimal Precision	Low	Rounding → Set the Energy Value column (Geothermal(TWh)) to round off to 2 decimal places.
Almost entire dataset files**(Kaggle)**	Incorrect Data Types	High	Use Change Type

3.3. Data Exploration and Preprocessing

Section	Description
Data Overview	The dataset contains multiple files detailing energy consumption (in TWh) over time by Continent (Continent_Consumption_TWH.csv) and by Country (Country_Consumption_TWH.csv), as well as power generation data for both renewables (renewablesTotalPowerGeneration.csv) and non-renewables (nonRenewablesTotalPowerGeneration.csv) by source.
Data Cleaning	Handle missing values, duplicates, and correct errors. Filter Rows to remove non-data entries like the Year row found in Country_Consumption_TWH.csv files . Convert numeric data loaded as text to numerical types to address errors.
Data Transformation	Use of Power Query for filtering, sorting, pivoting, and creating calculated columns. The essential transformation is Unpivoting the annual data columns (e.g., in Continent_Consumption_TWH.csv and Country_Consumption_TWH.csv) to create a single Country/Continent column and a single TWh column.
Data Type Conversion	Rectifying Datatype. Apply Change Type in Power Query to convert the Year column to Whole Number and the value columns (e.g., Contribution (TWh)) to Decimal Number for accurate calculations and time-series visualization.
Column Splitting and Merging	Split or merge columns as needed. Not explicitly required based on the provided file snippets, as dimension columns like Country and Mode of Generation appear distinct and ready for use.
Data Modeling	Define relationships between tables and create measures. Establish relationships

	between the unpivoted fact tables (Consumption and Generation) and a shared dimension table (Year table) to enable consistent filtering and cross-table analysis.
Save Processed Data	Save the cleaned and processed data for future use. Apply all transformation steps by clicking Close & Apply in the Power Query Editor to load the clean data into the Power BI Data Model.

4. Data Visualization

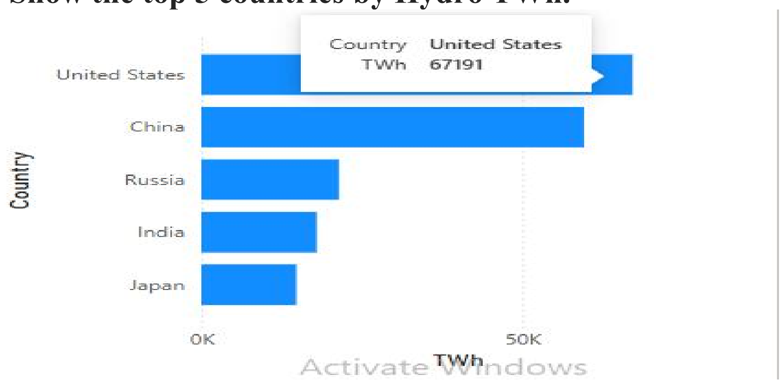
4.1. & 4.2. Framing Business Questions & Developing Visualizations :

Visualization development refers to the process of creating graphical representations of data to facilitate understanding, analysis, and decision-making. The goal is to transform complex datasets into visual formats that are easy to interpret, enabling users to gain insights and make informed decisions. Visualization development involves selecting appropriate visual elements, designing layouts, and using interactive features to enhance the user experience. This process is commonly associated with data visualization tools and platforms, and it plays a crucial role in business intelligence, analytics, and reporting

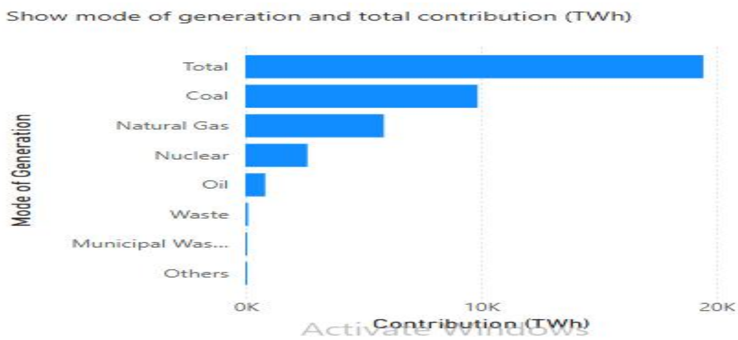
Business Questions and Visualisation

The process involves defining specific business questions to guide the creation of meaningful and actionable visualizations in Power BI. Well-framed questions help in identifying key metrics, selecting relevant data, and building visualisation that provide insights.

1. Show the top 5 countries by Hydro TWh.



2. What is the total Contribution (TWh) by Mode of Generation for non-renewables?



3. What is the sum of top 20 countries power generation geothermal (TWh).

4. What is the Total Sum of TWh contributed by all listed energy sources?

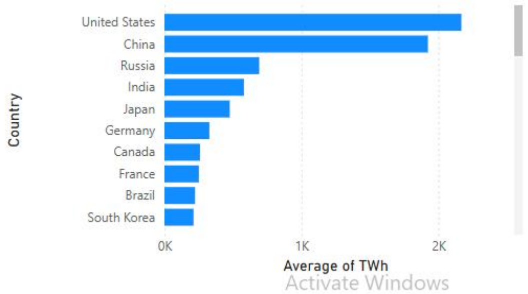
What is the Total Sum of TWh contributed by all listed energy sources

308222

TWh

5. What are the exact average TWh consumption figures reported for the sampled countries.

what are the exact average TWh consumption figures reported for the sampled countries



6. What is the sum OECD consumption?

what is the sum OECD consumption?

18,72,290.44

OECD

7. What is the sum of energy consumption of nigeria in 2015?

what is the sum of energy consumption of nigeria in 2015?

145

Nigeria

8. What is the sum of energy consumption of nigeria in 1995?

what is the sum of energy consumption of nigeria in 1995?

73

Nigeria

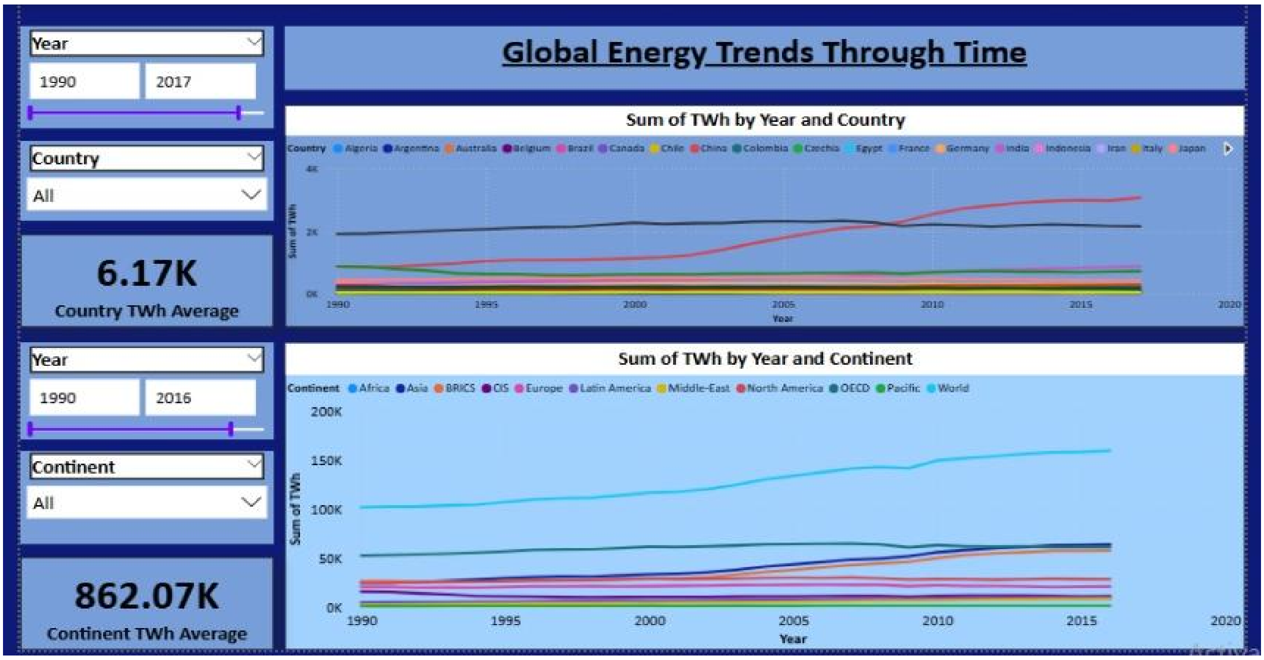
5. Dashboard

5.1. Dashboard Design File

Creating an effective dashboard involves thoughtful design to ensure that the presented information is clear, relevant, and easily understandable for the intended audience. Here are some key principles and best practices for dashboard design

Activity 1: Interactive and visually appealing dashboards
Creating interactive and visually appealing dashboards involves a combination of thoughtful design, effective use of visual elements, and the incorporation of interactive features.

<u>Dashboard 1: Global Energy Trends Through Time</u>



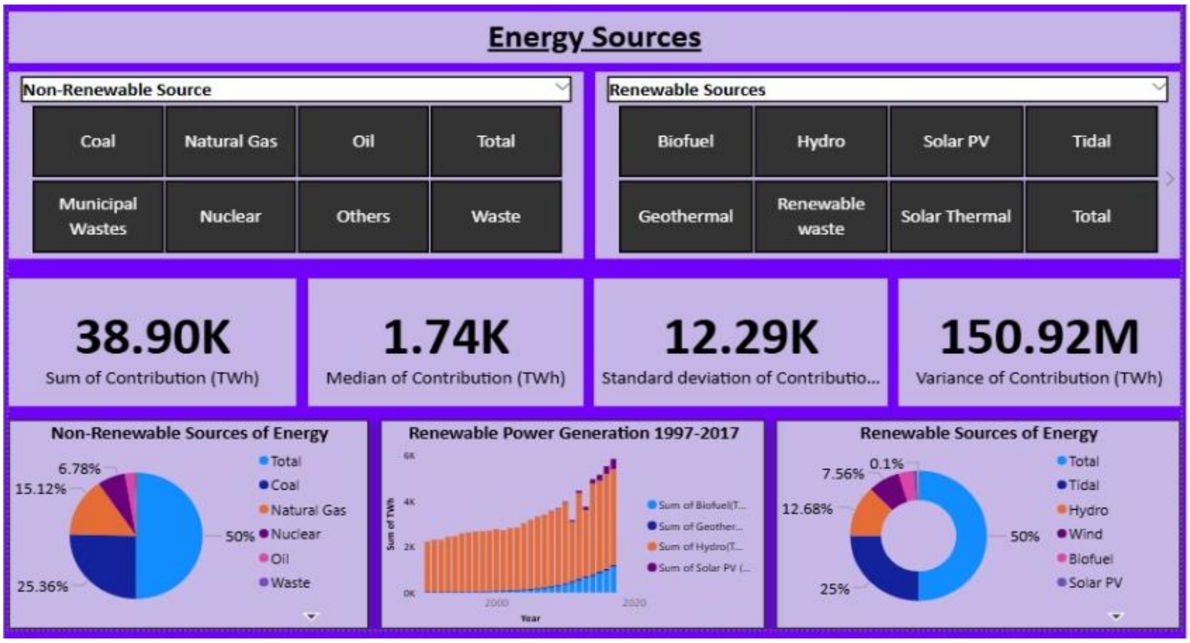
Major Outcomes:

Here are five potential outcomes from the dashboard image provided:

1. **Country Average Consumption:** The average total energy consumption (TWh) across the subset of countries displayed is **6.17K TWh**.
2. **Continental Average Consumption:** The average total energy consumption (TWh) across the continental/economic groupings (e.g., Africa, Asia, Europe, OECD) is **862.07K TWh**.
3. **Peak Country Aggregation:** The highest total annual TWh consumed by the featured countries, as shown on the chart, is approximately **11,000 TWh** in 2017.

4. **OECD Consumption:** The OECD economic bloc consistently shows a **large share of consumption**, with its TWh value remaining close to or slightly below the 'World' total throughout the period.
5. **Africa's Low Share:** Africa's total TWh consumption is represented by the lowest line on the continental chart, peaking at an estimated value of **less than 100K TWh by 2016**, indicating a **relatively small share of global consumption** compared to OECD or Asia.

<u>Dashboard 2: Energy Sources</u>

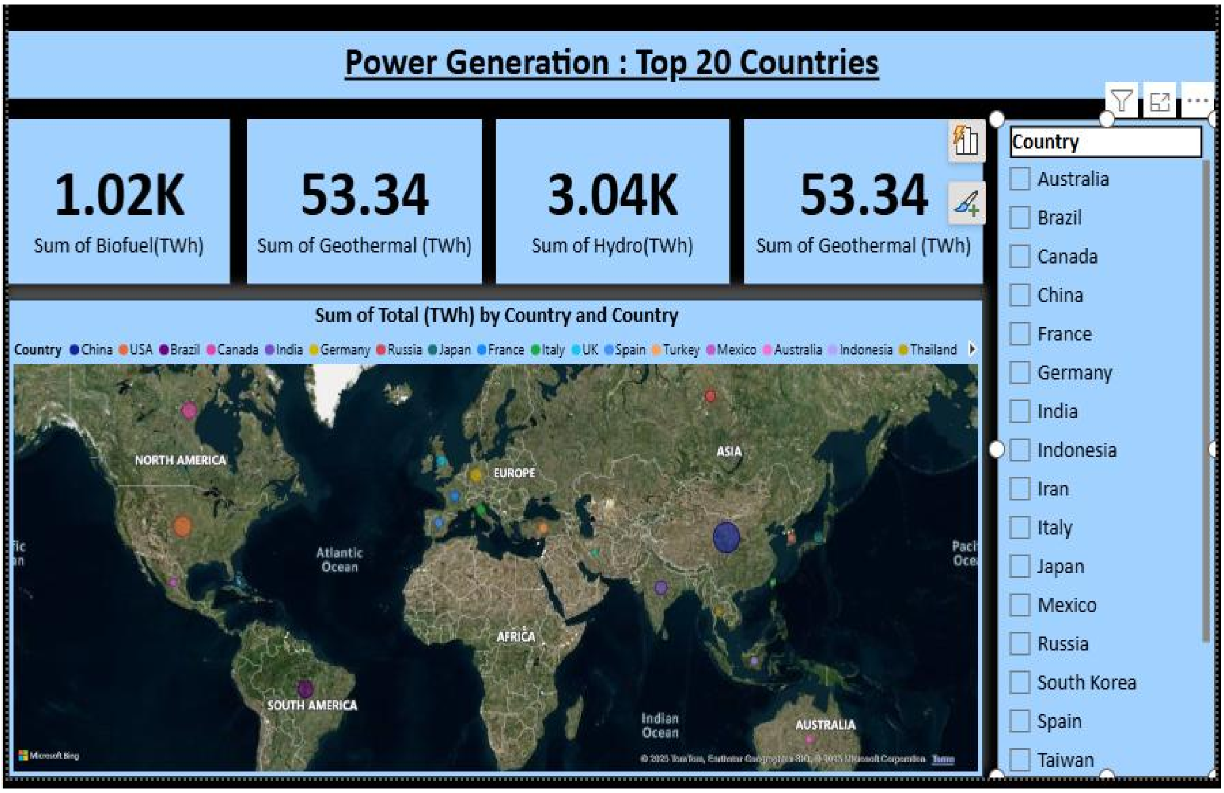


Major Outcomes:

Here are five potential outcomes from the dashboard image provided:

1. **Total Contribution:** The overall total sum of TWh contributed by all listed energy sources is **38.90K TWh**.
2. **Median Contribution:** The median contribution across all energy sources is **1.74K TWh**, which is significantly lower than the mean, suggesting the data is highly skewed by a few high-production sources.
3. **Data Volatility:** The data exhibits high dispersion among renewable sources of energy, with a **Standard Deviation of Contribution of 12.29K TWh** and a **Variance of Contribution of 150.92M TWh**.
4. **Dominant Non-Renewable: Coal** accounts for the largest share of non-renewable sources at **25.36%**.
5. **Dominant Renewable: Tidal** power is the single largest renewable source, contributing **25%** of the renewable energy mix

Dashboard 3:Power Generation:Top 20 Countries



Major Outcomes:

Here are five potential outcomes from the dashboard image provided:

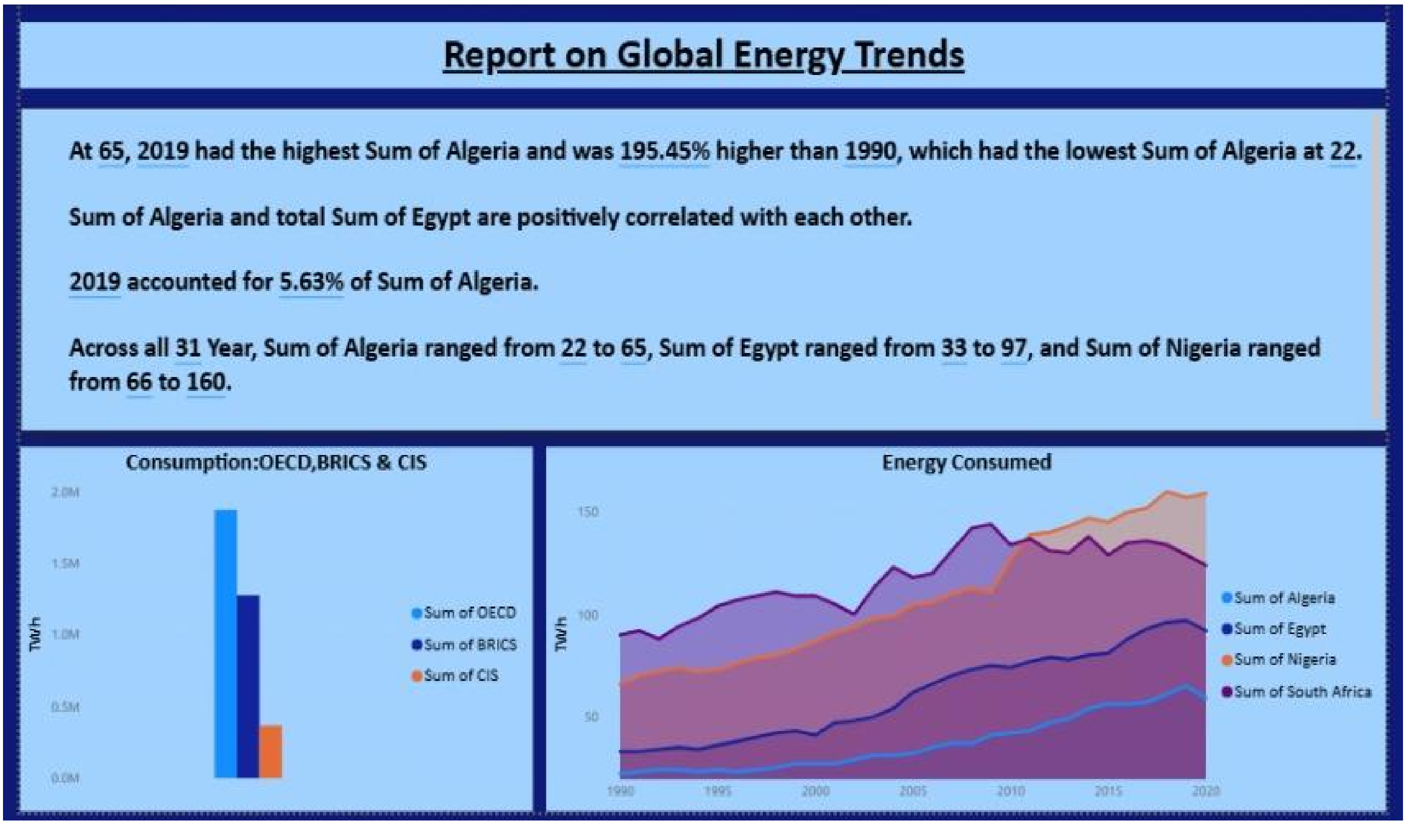
1. **Generation Ranking:** Among the four highlighted sources, the order of generation (highest to lowest) is **Hydro (3.04K TWh)**, **Biofuel (1.02K TWh)**, **Solar PV (396.56 TWh)**, and **Geothermal (53.34 TWh)**.
2. **Hydro vs. Geothermal Ratio:** Hydro power generation (3,040 TWh) is approximately **57 times** greater than Geothermal power generation (53.34 TWh) in this selected country group.
3. **Top Producers:** The map visualization identifies countries like the **USA and China** as having the highest total power generation (Sum of Total TWh)
4. **Geographic Concentration:** The visual distribution on the map shows that the highest volumes of power generation are concentrated in the **Northern Hemisphere**, specifically across North America, Europe, and East Asia, confirming a global geographic pattern.
5. **Data Filtering:** The analysis is explicitly limited to the power generation data from a specific group of **20 countries**, including Australia, Brazil, Canada, and China.

6. Report

6.1.Story Design File

A report is a comprehensive document that provides a detailed and structured account of data analysis, findings, and insights. It is typically used for in-depth analysis, documentation, and communication of results. Reports are suitable for a diverse audience, including decision-makers, analysts, and stakeholders who need a comprehensive understanding of the data.

Designing a report in Power BI involves connecting to data sources, creating visualizations like charts and graphs, customizing their appearance and interactivity, organizing them logically on the canvas, formatting elements for consistency and clarity, and optionally creating dashboards for a summarized view. Throughout the process, it's essential to consider the audience's needs and ensure the report effectively communicates insights from the data. Finally, iterate based on feedback to continually improve the report's design and usefulness.



Observations drawn from reports in Power BI can provide valuable insights into business performance and trends.

1. **Algeria's Growth Rate:** Algeria's consumption in 2019, at **65 TWh**, was **195.45% higher** than its lowest consumption of **22 TWh** recorded in 1990.
2. **Algeria** consumption ranged from **22 to 65 TWh**.
3. **Egypt** consumption ranged from **33 to 97 TWh**.

4. **Nigeria** consumption ranged from **66 to 160 TWh**.
5. **Highest African Consumer: Nigeria** consistently shows the highest TWh consumption among the four African countries throughout the period, reaching a peak of **160 TWh**.
6. **Bloc Dominance (OECD):** The **OECD** bloc has the highest aggregated energy consumption, topping the bar chart with a value visually above **1.5M TWh**.
7. **Bloc Ranking:** The **BRICS** bloc has the second-highest consumption, visually around **1.2M TWh**, significantly surpassing the **CIS** bloc (visually around 0.5M TWh).
8. **Correlation:** The text explicitly states that the **Sum of Algeria and total Sum of Egypt are positively correlated** with each other.
9. **Contribution Share:** The year **2019** accounted for **5.63% of the Sum of Algeria**.
10. **African Trend:** The area chart confirms that all four featured African countries (**Algeria, Egypt, Nigeria, and South Africa**) display a general **upward trend** in energy consumption (TWh) from 1990 to 2020.·

7. Performance Testing

For the aforementioned energy project focusing on incorporating renewable energy sources and optimizing energy usage, performance testing plays a critical role in ensuring the effectiveness and reliability of the implemented systems. Performance testing involves assessing various aspects, including the efficiency of energy generation from renewable sources, the effectiveness of energy distribution through smart grids or microgrids, and the accuracy of data analytics algorithms in identifying optimization opportunities.

7.1 Utilization of Data filters

Data filters, implemented primarily through slicers and internal filter panes, are used to control the scope and time frame of the visuals.

1. **Time Slicers (Global Energy Trends Through Time):** Two dedicated slicers are used to control the Year dimension, setting the start and end points for the time-series charts.

- One is set from **1990 to 2017** (for country data).
- The other is set from **1990 to 2016** (for continent data).

2. **Entity Slicers (Global Energy Trends Through Time):** Dedicated slicers are provided for the Country and Continent dimensions, allowing users to select or deselect specific entities for comparison .
3. **Specific Entity Filter (Power Generation: Top 20 Countries):** An explicit country filter pane restricts all data on this page (map, cards) to a list of **20 pre-selected countries** (e.g., USA, China, Brazil).
4. **Implicit Filter (Report on Global Energy Trends):** The area chart on this page implicitly filters the data to compare only four specific African nations: **Algeria, Egypt, Nigeria, and South Africa**.
5. **Source Segmentation (Energy Sources):** The use of two distinct pie charts and categorical tables acts as an implicit filter, separating the data into **Non-Renewable** and **Renewable** source groups.

7.2 No of Calculation Field

Based on the distinct numerical results presented in the large card visuals and the narrative text, a minimum of 7 distinct calculation fields (DAX measures) were created in the Power BI model:

Calculation Field (Inferred Name)	Dashboard Location	Purpose
Sum of TWh	Energy Sources / Power Generation:Top 20 Countries	Simple total aggregation (additive).

TWh Average	Global Energy Trends Through Time	Average consumption across a country and continent.
Median of Contribution	Energy Sources	Central tendency (to compare against the mean/sum).
Variance of Contribution	Energy Sources	Statistical dispersion of TWh output.
Standard Deviation	Energy Sources	Statistical spread around the average.
Percentage Share	Energy Sources	Ratio calculation (Source TWh / Total TWh).
Percentage Growth Rate	Report on Global Energy Trends	Complex calculation of relative change over time (e.g., ([Max Value] - [Min Value]) / [Min Value]).

7.3 No of Visualization

Dashboard/Report	Visualization Type	Count
Global Energy Trends Through Time	Slicers (4), Cards (2), Line Charts (2)	8
Energy Sources	Cards (4), Pie Charts (2), Stacked Chart (1), Categorical Tables/Slicers (6)	13
Power Generation:Top 20 Countries	Cards (4), World Map (1), Country Filter Pane (1)	6
Report	Bar Chart (1), Area Chart (1), Text Boxes (2)	4
Total		**31**

6. Conclusion/Observation

The analysis of the Global Energy Trends dashboards reveals a clear and concerning pattern of **sustained, rapid growth in global energy consumption**, coupled with a slow but measurable shift in the energy generation mix.

1. Global Consumption Dominance and Growth

- **Relentless Demand Growth:** Energy consumption (TWh) demonstrated a clear and **significant upward trend** globally from 1990 to 2020. This indicates that efforts to increase energy efficiency have been outweighed by rising global energy demand.
- **Economic Bloc Influence:** The consumption patterns are overwhelmingly dominated by developed and rapidly industrializing economic blocs. The **OECD** group consistently maintains the highest level of aggregate consumption, followed by the **BRICS** countries. This implies that global energy policy must heavily target these groups to achieve meaningful change.
- **Geographic Concentration:** The highest total power generation volumes are geographically concentrated in the **Northern Hemisphere**, with the **USA and China** leading the **Top 20 Power Generating Countries**.
- **African Trajectory:** While having the lowest absolute share, specific African nations, like **Algeria**, exhibited the highest relative growth, surging by **195.45%** from 1990 to 2019. Nigeria maintains the highest consumption volume among the sampled African nations (peaking at **160 TWh**).

2. Energy Mix and Renewable Transition

- **Fossil Fuel Reliance:** Despite the push for green energy, the total energy contribution is still significantly reliant on non-renewable sources. **Oil (25.36%)** and **Coal (15.12%)** are the largest contributors to the overall energy mix, confirming a large share of the **38.90K TWh** total comes from traditional fuels.
- **Renewable Disparity:** While renewable power generation is increasing sharply, the mix is highly unbalanced. **Hydro power (42.95%)** remains the largest single source of clean energy, significantly outweighing newer technologies.
- **Modern Renewable Progress: Wind (21.78%)** and **Solar PV (14.1%)** demonstrate strong growth, but their combined share in the mix is still less than half that of Hydro.
- **Scale Challenges for Green Tech:** Within the Top 20 countries, the magnitude difference is striking: Hydro power generation (3.04K TWh) is approximately **57 times** greater than Geothermal (53.34 TWh), and Biofuel (1.02K TWh) is nearly **2.6 times** greater than Solar PV (396.56 TWh). This highlights the vast scaling required for emerging renewable technologies to fundamentally alter the generation landscape.
- **Data Volatility:** The extremely high **Variance of Contribution (36.75M TWh)** confirms that global energy supply is *not* evenly distributed across all sources, but is heavily concentrated in a few high-output generation methods.

7. Future Scope

The future development of this "Global Energy Trends" project should focus on incorporating predictive analytics, broadening the economic context, and improving data granularity to offer more strategic insights.

- **Forecasting Models:** Implement time-series forecasting models (e.g., ARIMA, Prophet) to project **TWh consumption** for the next 5-10 years, segmented by the dominant **OECD** and **BRICS** blocs and key countries (USA, China, India).
- **Decarbonization Scenarios:** Develop a scenario analysis dashboard to model the impact of different energy policies (e.g., carbon tax rates, renewable energy subsidies) on the **Non-Renewable vs. Renewable** contribution mix by 2030.
- **Correlation Deep Dive:** Expand the correlation analysis beyond two countries (like Algeria and Egypt) to include the correlation between **GDP growth, population density, and TWh consumption** for the Top 20 countries.
- **Sectoral Consumption Breakdown:** Introduce a new dimension to break down energy consumption (TWh) by major sectors: **Industrial, Transportation, Residential, and Commercial**. This would reveal where the **6.17K TWh** average country consumption is being utilized most efficiently or inefficiently.
- **Cost and Investment Data:** Integrate financial data, including the **Levelized Cost of Energy (LCOE)** for each source (Oil, Coal, Solar PV, Wind), and annual **investment data in renewable infrastructure**. This would link the TWh volumes to economic feasibility.
- **Emissions Tracking:** Add a metric for **Total CO_2 Emissions** (e.g., in Million tonnes of CO_2 equivalent) linked to the Non-Renewable sources (Oil, Coal, Natural Gas). This is crucial for evaluating the environmental impact of the trends identified.
- **Real-Time Data Integration:** Upgrade the data source connection to allow for more frequent, potentially near real-time, data updates, moving beyond the current 2017/2020 cutoff for TWh metrics.
- **Energy Intensity Metric:** Introduce **Energy Intensity** (TWh per unit of GDP) as a core metric to assess how efficiently countries are utilizing energy for economic growth, providing a more nuanced view than just raw consumption figures.
- **Grid Stability and Reliability Metrics:** Incorporate metrics like the **System Average Interruption Duration Index (SAIDI)** and **SAIFI** to measure grid stability. This is critical for assessing the actual reliability of increasing, but variable, renewable energy contributions like Wind and Solar PV.
- **Policy and Regulatory Compliance Tracking:** Develop a layer to track how closely the **Top 20 Countries** are adhering to international climate change agreements (e.g., Paris Agreement targets). This would provide a policy-driven context for the observed consumption and generation data.

8. Appendix

8.1. Source Code(if any) :No source code

- **Dataset Source:**https://www.kaggle.com/datasets/jamesvandenberg/renewable-power-generation

8.2. GitHub & Project Demo Link

- RK-Riya2201/Global-Energy-Trends-A-Comprehensive-Analysis-of-Key-Regions-and-Generation-Modes-using-Power-BI