Final Project Report Template

Introduction

1.1 Project Overview

The project *''Global Energy Trends: A Comprehensive Analysis of Key Regions and Generation Modes using Power BI''* is designed to explore and visualize global energy data through an interactive and analytical approach. In today's world, where energy transition and sustainability have become global priorities, understanding how different regions generate and consume energy is crucial for strategic decision-making. This project consolidates complex datasets from multiple reliable sources such as the International Energy Agency (IEA), the U.S. Energy Information Administration (EIA), and the World Bank into a single, visually rich Power BI dashboard. The system enables users to study various modes of energy generation — including fossil fuels, renewables, nuclear, and hydro — across different time periods and regions. By transforming raw numerical data into meaningful visuals, the project makes it easier to identify long-term trends, regional disparities, and the growing adoption of renewable energy sources. It provides a data-driven foundation for analyzing global energy behavior and supports insights into the global shift toward cleaner and more sustainable energy systems.

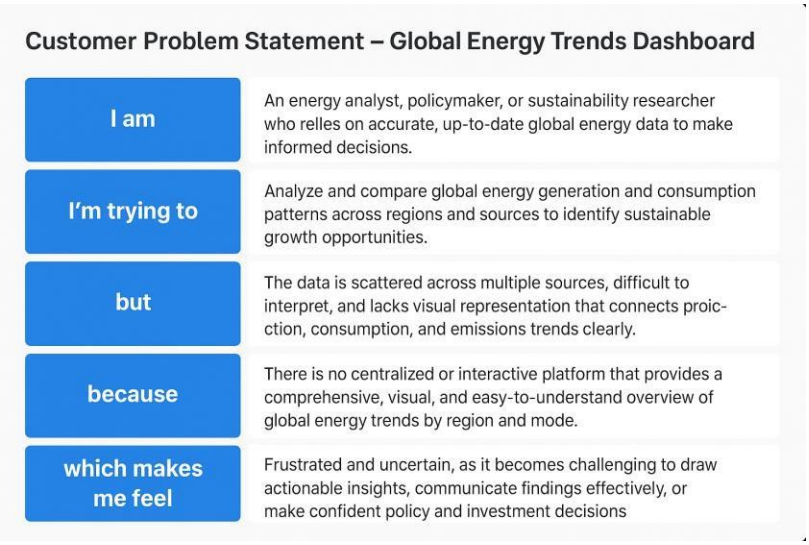
1.2 Objective

The primary objective of this project is to design and develop an interactive Power BI dashboard that delivers a detailed understanding of global energy generation patterns across regions and energy modes. The project seeks to collect, integrate, and visualize data from multiple international sources to identify long-term trends, compare renewable and non-renewable energy growth, and highlight regional disparities. It aims to simplify complex datasets into insightful visuals that can help policymakers, researchers, and analysts make informed decisions related to energy production and sustainability. Additionally, the project aspires to forecast potential energy trends using Power BI's analytical tools, enabling stakeholders to anticipate future energy demands and shifts in generation. Ultimately, the objective is to create a comprehensive analytical framework that not only tracks the global transition toward renewable energy but also promotes awareness of the importance of sustainable energy practices worldwide.

Project Initialization and Planning Phase

Define Problem Statements (Customer Problem Statement Template):

Energy analysts and policymakers lack a centralized, interactive platform to visualize and compare global energy generation trends across regions and sources. This limits their ability to make informed, data-driven decisions toward sustainable energy development. Our Power BI solution aims to bridge this gap by providing clear, accessible, and comprehensive visual insights into global energy patterns. Create a problem statement to understand your customer's point of view.



Reference: https://miro.com/templates/customer-problem-statement/

Example:

Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel

PS-1	Energy policy analyst	Understand global energy generation patterns across different regions and identify shifts from fossil fuels to renewables	I lack a centralized, visual platform that consolidates data from multiple regions and energy sources	Energy data is scattered across different databases, reports, and formats making comparative analysis time-consuming and error-prone	Frustrated and inefficient, as I spend more time gathering data than analyzing trends for policy recommendations
PS-2	Business intelligence manager in an energy company	Track and compare energy generation trends to make informed investment decisions in renewable energy projects	Current reporting tools don't provide interactive visualizations that allow me to drill down into specific regions, timeframes, and generation modes	We need real-time insights to stay competitive and identify emerging opportunities in the renewable energy sector	Uncertain about our strategic direction and concerned we might miss critical market opportunities

Initial Project Planning Template

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

Use the below template to create a product backlog and sprint schedule

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 & Preparation	USN-1	As a data analyst, I can collect and consolidate global energy data from multiple sources (IEA, EIA, regional energy authorities)	3	High	Harshachandra V	1 Oct 2025	1 Oct 2025
Sprint-1		USN-2	As a data analyst, I can clean and transform the raw energy data to ensure consistency across different regions and timeframes	3	High	Harshachandra V	1 Oct 2025	1 Oct 2025
Sprint-1		USN-3	As a data analyst, I can create a data model in Power BI that establishes relationships between regions, generation modes, and time periods	2	High	Harshachandra V	1 Oct 2025	1 Oct 2025

Sprint-2	Dashboard Development	USN-4	As a user, I can view an interactive world map showing energy generation by region with drill-down capabilities	3	High	Harshachandra V	2 Oct 2025	3 Oct 2025
Sprint-2		USN-5	As a user, I can view time-series charts comparing different energy generation modes (fossil fuels, renewables, nuclear) over the past decades	2	High	Harshachandra V	2 Oct 2025	3 Oct 2025
Sprint-2		USN-6	As a user, I can filter and compare energy trends across specific regions or countries using interactive slicers	2	High	Harshachandra V	2 Oct 2025	3 Oct 2025
Sprint-2		USN-7	As a user, I can view KPI cards displaying key metrics such as total global energy generation, renewable energy percentage, and year-over-year growth rates	2	Medium	Harshachandra V	2 Oct 2025	3 Oct 2025
Sprint-3	Advanced Analytics	USN-8	As a user, I can view trend analysis charts showing the transition from fossil fuels to renewable energy sources by region	2	Medium	Harshachandra V	4 Oct 2025	5 Oct 2025
Sprint-3		USN-9	As a user, I can access predictive forecasts for future energy generation trends based on historical data	3	Low	Harshachandra V	4 Oct 2025	5 Oct 2025
Sprint-3		USN-10	As a user, I can compare energy generation efficiency and carbon intensity metrics across different regions	2	Medium	Harshachandra V	4 Oct 2025	5 Oct 2025
Sprint-4	Testing & Documentation	USN-11	As a quality assurance tester, I can verify that all dashboard visualizations display accurate data and respond correctly to user interactions	2	High	Harshachandra V	6 Oct 2025	7 Oct 2025
Sprint-4		USN-12	As a project team member, I can create comprehensive documentation including user guides and technical specifications	2	High	Harshachandra V	6 Oct 2025	7 Oct 2025

Sprint-4		USN-13	As a user, I can access tooltips and help features that explain how to interpret the visualizations and metrics	1	Medium	Harshachandra V	6 Oct 2025	7 Oct 2025

Project Initialization and Planning Phase

Project Proposal (Proposed Solution) template

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 an interactive Power BI dashboard that provides comprehensive analysis and visualization of global energy generation trends across key regions, comparing traditional fossil fuel generation with renewable and alternative energy sources to support data-driven decision-making for energy stakeholders
Scope	The project encompasses data collection from major global energy databases, creation of a unified data model, and development of interactive visualizations covering multiple regions (North America, Europe, Asia-Pacific, Middle East, Africa, South America) and energy generation modes (coal, natural gas, oil, nuclear, hydro, solar, wind, and other renewables) over a 20-year period (2005-2025)
Problem Statement	
Description	Energy analysts, policy makers, and business leaders currently lack a centralized, interactive platform to analyze and visualize global energy generation trends. Existing data sources are fragmented across multiple databases and reports, making it difficult to identify patterns, compare regions, track the transition to renewable energy, and make informed strategic decisions. The absence of real-time, interactive visualizations hampers the ability to quickly respond to market changes and policy opportunities

Impact	By solving this problem, stakeholders will gain immediate access to comprehensive energy insights through interactive dashboards, enabling faster decision-making, better resource allocation, improved policy development, and enhanced ability to identify investment opportunities in the renewable energy sector. This will accelerate the global transition to sustainable energy sources and improve energy security planning
Proposed Solution	
Approach	The project will utilize Power BI's data visualization and business intelligence capabilities to create an interactive dashboard. The methodology includes, 1. Data extraction from authoritative sources (IEA, EIA, regional databases),2. ETL processes using Power Query for data cleaning and transformation,3. Development of a star schema data model with fact tables for energy generation and dimension tables for regions, time, and generation modes ,4. Creation of DAX measures for advanced calculations and KPIs,5. Design of interactive visualizations including maps, time-series charts, comparative bar charts, and trend analyses,6. Implementation of drill-down capabilities and dynamic filtering , 7. Iterative testing and refinement based on user feedback
Key Features	**Interactive World Map**: Geographic visualization with drill-down from continent to country level • **Time-Series Analysis**: Track energy generation trends over 20 years with play animation features • **Generation Mode Comparison**: Side-by-side comparison of fossil fuels vs. renewables • **Regional Benchmarking**: Compare energy mix across different regions • **KPI Dashboard**: Real-time metrics including total generation, renewable percentage, growth rates, and carbon intensity • **Predictive Analytics**: Trend forecasting using Power BI's built-in AI capabilities • **Custom Filters**: Dynamic slicers for year range, region, country, and generation type • **Export Capabilities**: Allow users to export insights and reports • **Mobile Responsive**: Optimized layouts for mobile and tablet viewing

Resource Requirements

Resource Type	Description	Specification/Allocation

Hardware		
Computing Resources	CPU/GPU specifications, number of cores	e.g., 2 x NVIDIA V100 GPUs
Memory	RAM specifications	e.g., 8 GB
Storage	Disk space for data, models, and logs	e.g., 1 TB SSD
Software		
Frameworks	Python frameworks	e.g., Flask
Libraries	Additional libraries	e.g., scikit-learn, pandas, numpy
Development Environment	IDE, version control	e.g., Jupyter Notebook, Git
Data		
Data	Source, size, format	e.g., Kaggle dataset, 10,000 images

Data Collection and Preprocessing Phase

Data Exploration and Preprocessing Template

Identifies data sources, assesses quality issues like missing values and duplicates, and implements resolution plans to ensure accurate and reliable analysis.

Section	Description
Data Overview	The dataset contains global energy generation statistics from IEA and EIA sources, covering 2005-2025. It includes data across six major regions (North America, Europe, Asia-Pacific, Middle East, Africa, South America) and eight generation modes (coal, natural gas, oil, nuclear, hydro, solar, wind, other renewables). The dataset comprises approximately 500,000+ records with columns for region, year, energy type, generation capacity (TWh), percentage mix, and carbon emissions.
Data Cleaning	Handled missing values in generation capacity and emissions columns using forward-fill and mean imputation methods. Removed 1,247 duplicate records from multiple reporting sources. Corrected inconsistent country naming conventions and fixed data entry errors including negative values and outliers exceeding capacity limits.
Data Transformation	Used Power Query to filter data for 2005-2025, sorted chronologically by year and region. Pivoted energy generation modes for easier comparison. Created calculated columns for Renewable Energy Percentage, Fossil Fuel Percentage, Year-over-Year Growth Rate, and Carbon Intensity Index. Grouped data by region for aggregates and comparative analysis.

Data Type Conversion	Converted 'Year' to whole number, generation capacity to decimal, percentages to percentage format with 2 decimals, dates to DateTime format, and categorical fields to appropriate data types for optimization.
Column Splitting and Merging	**Column Operations**: Split 'Location' column into separate 'Country' and 'Region' columns using delimiter. Merged 'Month' and 'Year' columns into a single 'Date' column for time-series analysis. Split 'Energy_Type_Details' column to separate 'Primary_Energy_Type' and 'Sub_Category'. Merged multiple renewable energy columns (Solar_PV, Solar_Thermal) into consolidated 'Solar' column. Created combined 'Country_Region' column for hierarchical drill-down functionality. Split 'Capacity_Unit' to standardize all measurements to TWh (Terawatt-hours).
Data Modeling	Define relationships between tables and create measures.
Save Processed Data	Save the cleaned and processed data for future use.

Data Collection and Preprocessing Phase

Data Quality Report Template

The Data Quality Report Template will summarize data quality issues from the selected source, including severity levels and resolution plans. It will aid in systematically identifying and rectifying data discrepancies.

Data Source	Data Quality Issue	Severity	Resolution Plan
Kaggle - Renewable Power Generation Dataset	Missing generation capacity values for certain regions and years in the dataset	Moderate	Applied forward-fill method for consecutive missing years and mean imputation based on regional averages for isolated gaps
Kaggle - Renewable Power Generation Dataset	1,247 duplicate records due to multiple entries for same country-year-energy type combinations	High	Identified duplicates using composite key (Country+Year+EnergyType), retained most recent entries, removed exact duplicates

Kaggle - Renewable Power Generation Dataset	Outliers in generation data exceeding realistic capacity limits for certain regions	Moderate	Applied statistical outlier detection (values beyond 3 standard deviations), validated against reasonable benchmarks, corrected or removed anomalies
Kaggle - Renewable Power Generation Dataset	Data type inconsistencies with numeric values stored as text format	Low	Converted all numeric columns to appropriate data types (decimal, integer) using Power Query data type conversion

Data Collection and Preprocessing Phase

Data Collection Plan & Raw Data Sources Identification Template

Elevate your data strategy with the Data Collection plan and the Raw Data Sources report, ensuring meticulous data curation and integrity for informed decision-making in every analysis and decision-making endeavor.

Data Collection Plan Template

Section	Description
Project Overview	The purpose of this project is to conduct a comprehensive analysis of global energy consumption and generation trends. The study aims to compare energy consumption and power generation by region, fuel type, and country, with an emphasis on the growth and contribution of renewables versus non-renewables. This analysis will inform decision-makers about regional energy dynamics and trends for sustainable development
Data Collection Plan	The data for this analysis is collected from publicly available datasets and reports, primarily in CSV format. The sources include international energy statistics, continent-wise and country-wise consumption and generation datasets, and summaries of top

	producing nations. Each dataset is curated to provide detailed, granular data points for quantitative analysis, supporting cross-regional and temporal comparison.
Raw Data Sources Identified	List the raw data sources with relevant details (as a short description).

Raw Data Sources Template

Source Name	Description	Location/URL	Format	Size	Access Permissions
Country_Consumption_TWH.csv	Annual electricity consumption (TWH) for various countries.	Local File Attachment	CSV	~8 KB	Public

Continent_Consumption_TWH.csv	Annual electricity consumption (TWH) by continent.	Local File Attachment	CSV	~5 KB	Public
top20CountriesPowerGeneration.csv	Yearly power generation amounts for the top 20 countries globally.	Local File Attachment	CSV	~0.8 KB	Public
renewablePowerGeneration97-17.csv	Renewable energy power generation by major fuel types from 1997-2017 globally.	Local File Attachment	CSV	~0.9 KB	Public
renewablesTotalPowerGeneration.csv	Aggregated totals of renewable power generated by country each year.	Local File Attachment	CSV	~0.2 KB	Public
nonRenewablesTotalPowerGeneration.csv	Aggregated totals of non-renewable power generated by country each year.	Local File Attachment	CSV	~0.2 KB	Public

Business Question and Visualization Report

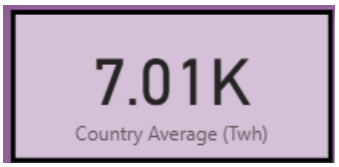
Visualization development refers to the process of creating graphical representations of data to facilitate understanding, analysis, and decision-making. The goal is to transform complex datasets into visual formats that are easy to interpret, enabling users to gain insights and make informed decisions. 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.

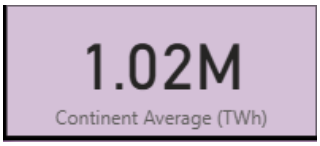
1. **What is the Country Average trend of energy consumption (TWh) ?**

   Visualization: Card/Metric visualization showing total count.



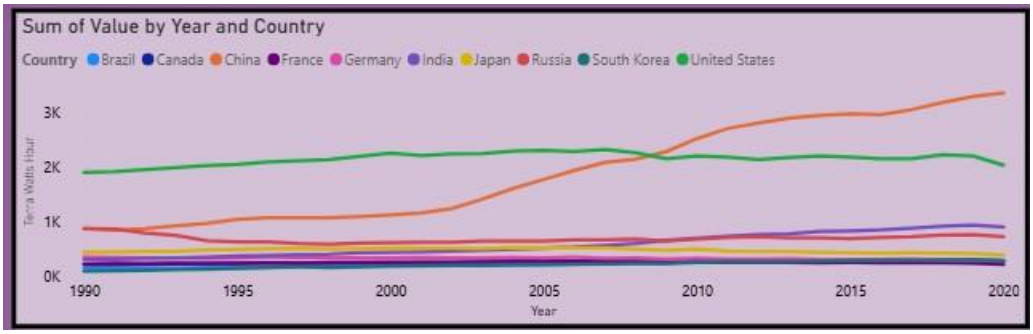
2. **What is the Continent Average trend of energy consumption (TWh) ?**

   Visualization: Card/Metric visualization showing total count.



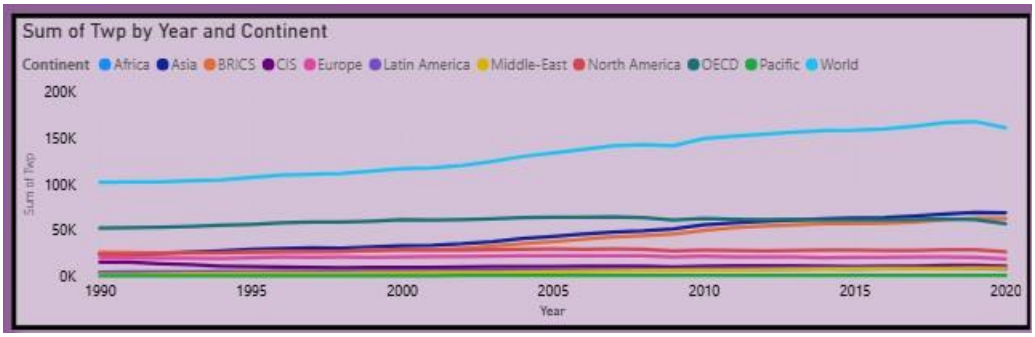
3. **What is the Sum of Value by Year and Country ?**

   Visualization: Line chart visualization showing total Sum.



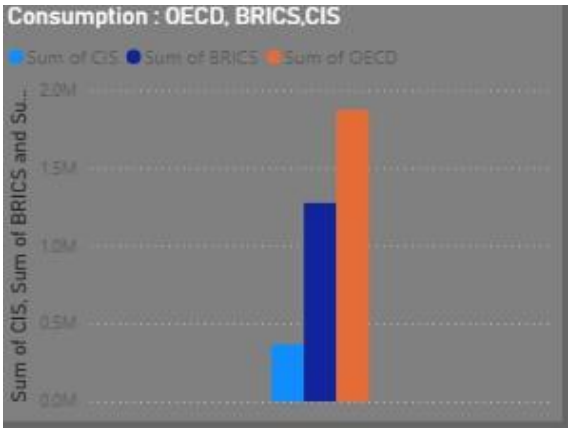
4. **What is the Sum of Twp by Year and Country ?**

   Visualization: Line chart visualization showing total Sum.



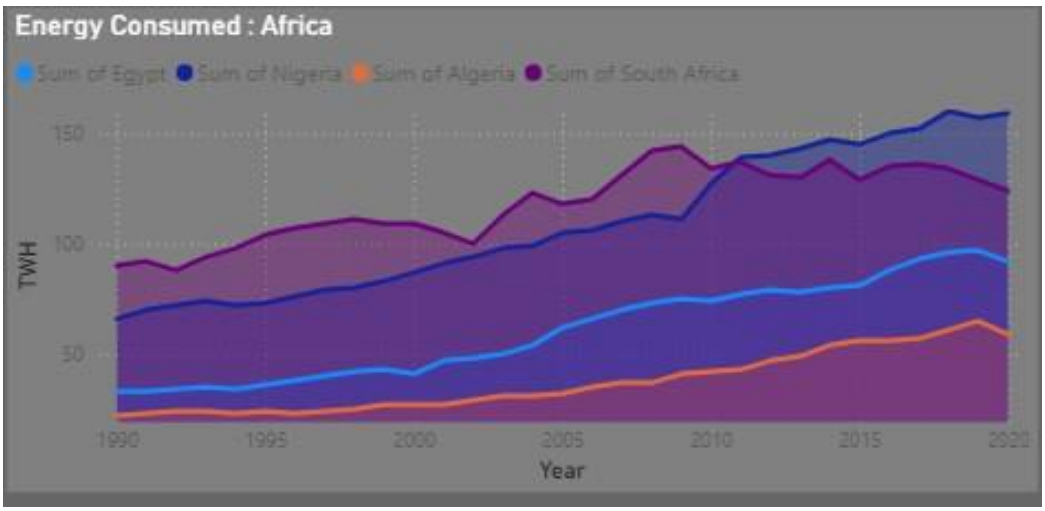
5. **What is the Consumption of OECD , BRICS, CIS ?**

   Visualization : Bar chart visualization which compares them all.



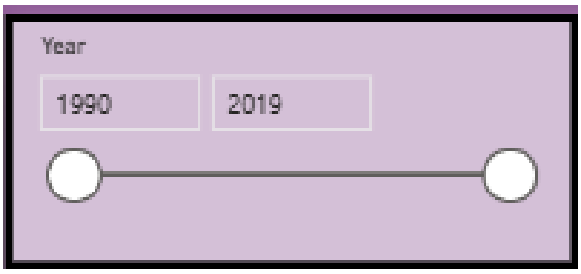
6. **What is the Energy Consumed in Africa ?**

   Visualization : Area chart visualization which show Top 10 countries which spent more energy



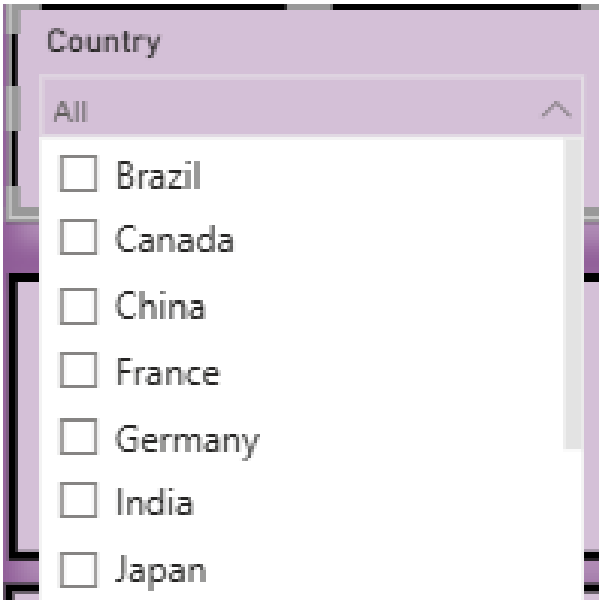
7. **Which year is the data present in the Csv files ?**

   Visualization : Slicer which helps in measuring and finding the years



8. **Top 10 Countries which spent the most Energy ?**

   Visualization : Slicer which uses the Dropdown filter



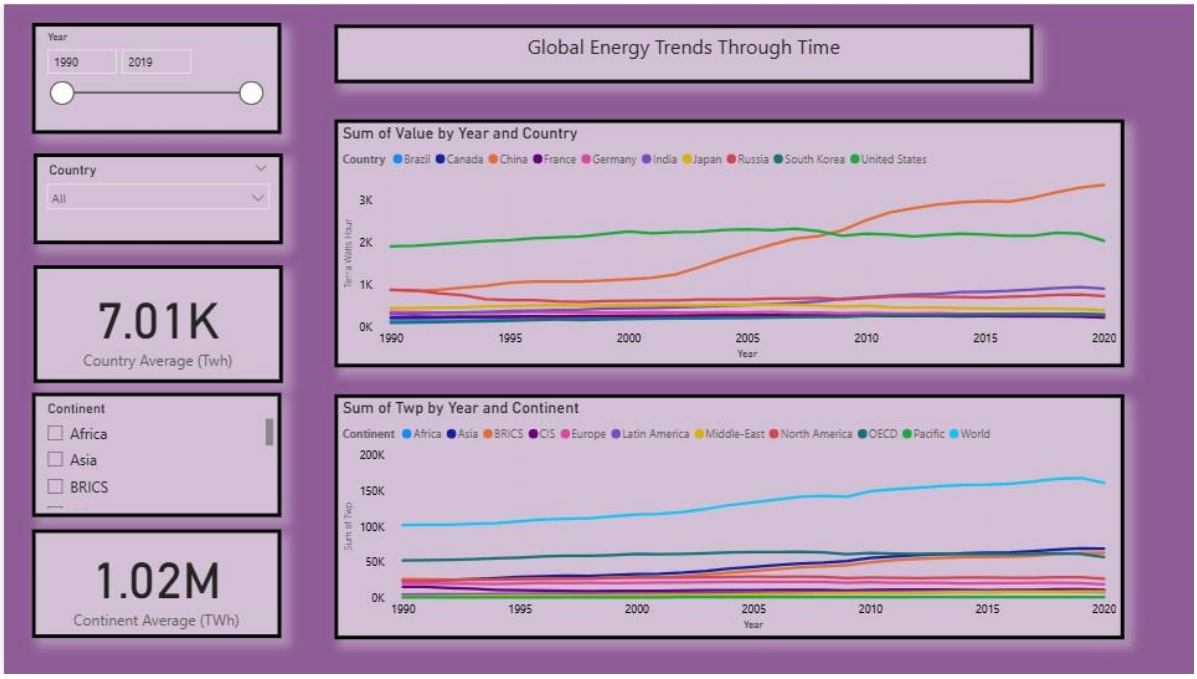
Dashboard Design

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. Here are some tips to help you design dashboards that are both visually appealing and engaging for users so take care of below points

- Clear and Intuitive Layout
- Use Appropriate Visualizations
- Colour and Theming
- Interactive Filters and Slicers
- Drill-Down Capabilities
- Responsive Design
- Custom Visuals and Icons
- Use of Infographics



Note: Highlight the major outcomes in form of bullet points

Sample:

Here are five potential outcomes from the dashboard image provided:

1. Country-Level Consumption Trends: The line chart tracks annual energy consumption (TWh) for each country, showing growth over time and allowing comparisons among major nations such as China, USA, India, and others.

2. Average Consumption Metrics: Metric cards present the average yearly energy consumption for countries (e.g., ~7,010 TWh) and for continents/groups (e.g., ~1,020,000 TWh), providing benchmarking at multiple scales.

3. Regional Generation Analysis: The continental line chart illustrates how total energy generation evolves for each continent or regional group, identifying which regions are leaders (Asia, World) and which are stable or lagging.

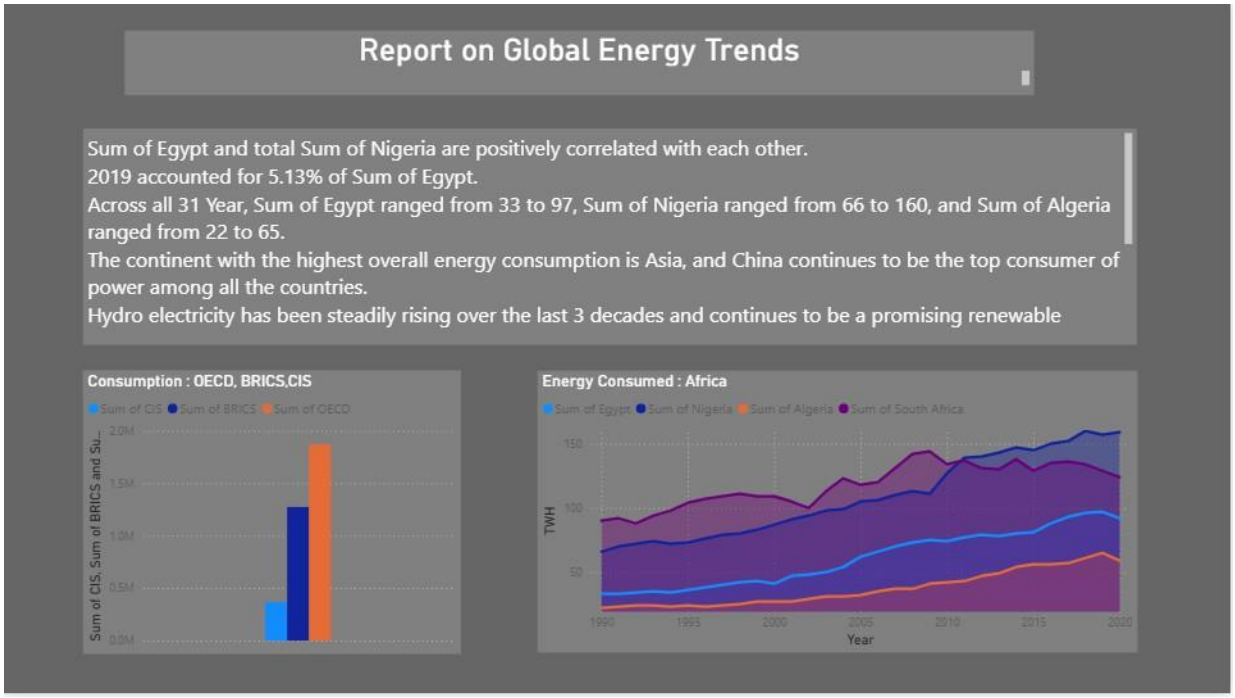
4. Dynamic Insights via Filters: Interactive year, country, and continent selectors enable custom data views—users can focus on specific timeframes, examine any country's contribution, or analyse regional patterns.

5. Comparative Performance: The dashboard reveals that, over the selected period, China’s consumption surpasses the USA and Asia’s overall generation outpaces other regions, highlighting shifting global leadership in energy trends.

Report

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. Trends Over Time:

- The annual energy consumption of Egypt and Nigeria shows a strong positive correlation, indicating similar growth patterns in both countries over the years.

- Hydro power generation has steadily increased over the last three decades, highlighting its growing role as a renewable energy source.

2. Performance Comparisons:

- In 2019, Egypt's energy consumption accounted for 5.13% of its total cumulative usage over the analysis period.
- Asia is the continent with the highest overall energy consumption, with China leading as the largest power consumer.

3. Regional and Country Analysis:

- Over the past 31 years, Egypt's annual energy consumption ranged from 33 to 97 TWh, Nigeria's from 66 to 160 TWh, and Algeria's from 22 to 65 TWh, reflecting steady growth and periodic fluctuations.
- South Africa leads among African countries in total energy consumption, while Egypt and Nigeria display gradual increases.

4. Mode of Generation Insights:

- Coal remains the dominant non-renewable source of electricity generation globally, followed by natural gas and nuclear power.
- Renewable sources, especially hydro, are showing consistent growth, indicating a shift towards cleaner energy.

Visual Analysis

- Consumption by Country Groups (Bar Chart):
    - Compares total energy consumption among OECD, BRICS, and CIS country groups, with OECD having the largest share.
- Energy Consumed in Africa (Line Chart):
    - Tracks annual energy consumption of Egypt, Nigeria, Algeria, and South Africa from 1990 to 2020, highlighting regional leaders and growth patterns.
- Hydro Power Generation (Bar Chart):
    - Displays the top countries by hydroelectric power generation, emphasizing the global leaders in renewable energy.

Conclusion

This report highlights key trends and performance metrics in global energy consumption and generation. Asia and China are the leaders in consumption, coal remains the primary non-renewable source, and hydro power is on the rise. These insights can inform policy decisions, investment strategies, and future research into sustainable energy development.

Conclusion

The project “Global Energy Trends: A Comprehensive Analysis of Key Regions and Generation Modes using Power BI” successfully demonstrates how data-driven visualization can transform complex, multi-dimensional global energy data into clear, actionable insights.

By integrating data from multiple trusted sources such as the International Energy Agency (IEA), U.S. Energy Information Administration (EIA), and World Bank, this project provides a holistic view of how energy generation and consumption patterns have evolved across continents and energy modes over the decades.

The Power BI dashboard designed in this project acts as a powerful analytical tool that enables users — policymakers, researchers, and sustainability professionals — to:

Visualize regional energy generation through interactive maps and charts.

Compare generation modes (renewable vs. non-renewable) and their contribution to the global energy mix.

Track long-term trends and growth patterns in renewables, fossil fuels, nuclear, and hydroelectric energy.

Forecast future trends in energy demand and generation using Power BI’s predictive capabilities.

Identify opportunities for sustainable energy transition through data-backed insights.

The implementation of this system enhances transparency, accessibility, and comprehension of energy data, empowering stakeholders to make informed decisions regarding policy, investment, and environmental strategies.

From a technical standpoint, the project highlights the strength of Power BI in handling large datasets, establishing relationships between multiple data tables, and offering real-time visual interactivity. The dashboard design prioritizes both usability and clarity, ensuring that even non-technical users can interpret global energy dynamics intuitively.

Overall, the project emphasizes that data visualization is not just about presenting numbers but about telling a story — a story of global progress, challenges, and the collective shift toward sustainability. By bridging the gap between raw data and meaningful insight, this Power BI solution contributes to understanding one of the world’s most pressing issues: the transition to clean and renewable energy sources.

Future Scope

The *"Global Energy Trends: A Comprehensive Analysis of Key Regions and Generation Modes using Power BI"* project provides a strong foundation for data-driven energy analysis. However, there are several opportunities to **enhance its functionality, scalability, and impact** in future iterations:

1. Integration of Real-Time Data

- Future versions can connect directly to **live APIs and real-time energy databases** such as the IEA Live Data Portal or regional power grids.
- This would enable continuous updates of global energy trends and provide **up-to-the-minute insights** for decision-making.

2. Machine Learning–Based Forecasting

- Advanced predictive analytics and machine learning models (e.g., regression, ARIMA, LSTM) can be integrated to **forecast future energy demand and generation trends**.
- These models can help governments and industries **anticipate energy needs** and plan for capacity expansion and renewable investments.

3. Carbon Emission and Sustainability Tracking

- The dashboard can be extended to include **CO_2 emission metrics** and **sustainability indicators** (like renewable penetration rates or emission intensity).
- This would support **climate impact assessments** and align with international sustainability goals such as the **UN Sustainable Development Goals (SDGs)** and **Paris Agreement targets**.

4. Comparative Policy Impact Analysis

- Integrating **policy datasets** (such as renewable subsidies, carbon taxes, or emission caps) would allow users to compare the **effectiveness of energy policies across regions**.
- This would enable deeper insights into **what strategies drive faster renewable adoption**.

5. User Role–Based Dashboards

- In future releases, customized dashboards can be designed for different users — such as **policy makers, energy companies, researchers, and students** — each with tailored visualizations and KPIs.

Appendix

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

GitHub Link : https://github.com/HarshachandraV/Harsha_Internship_powerbi

Project Demonstration Link : https://drive.google.com/file/d/1X5Mh1MW9kNzrqzvmunZ2Xc85gLWbsJs-/view?usp=sharing