PROJECT REPORT

Project Title: Global Energy Trends: A Comprehensive Analysis of Key Regions and Generation Modes using Power BI

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Team Size:3
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Team Member: Shaik Milad
Team Member: Pendyala Niranjan Pradeep

1. INTRODUCTION

1.1 Project Overview
This project presents an in-depth analysis of global energy trends using Microsoft Power BI. The primary focus is to understand how energy is generated and consumed across key global regions, examine the shift from non-renewable to renewable sources, and visualize historical patterns. Using interactive dashboards, the project highlights insights on energy generation modes, country-wise comparison, and global energy consumption behavior.

1.2 Purpose
The purpose of this project is to provide policymakers, analysts, and researchers with a powerful visualization tool that simplifies the understanding of global energy data. By transforming raw datasets into interactive dashboards, users can derive insights for making data-driven decisions to promote sustainable energy practices.

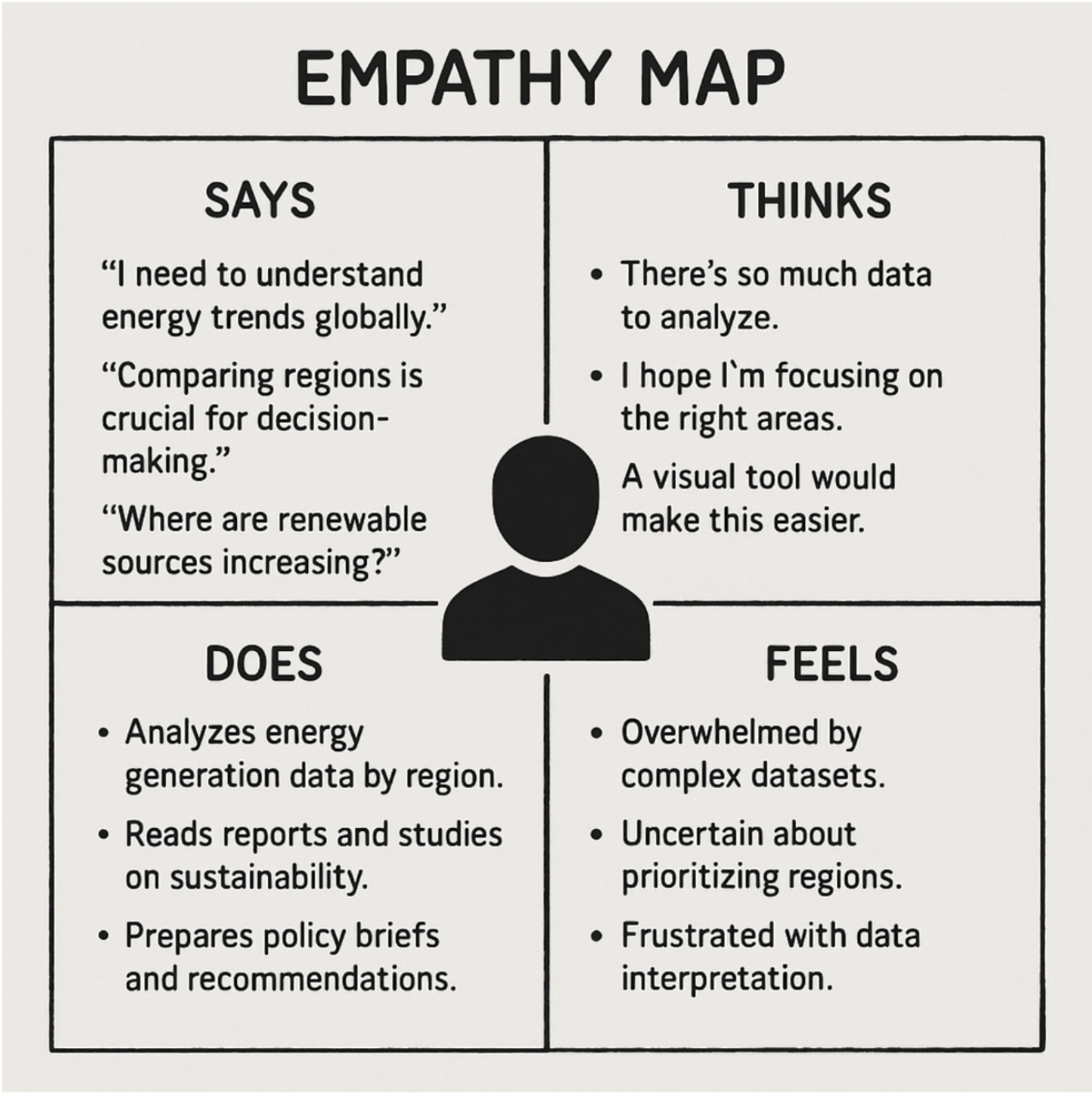
2. IDEATION PHASE

2.1 Problem Statement
Despite the availability of comprehensive global energy datasets, decision-makers and analysts face difficulties in interpreting the data due to its complexity and scale. There is a need for a visualization tool that can simplify this data, highlight patterns, and reveal actionable insights.

Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel
PS-1	A policy maker or energy researcher focused on global sustainability.	Analyze and compare energy generation patterns across regions to support strategic decisions.	I can't extract meaningful insights easily.	The data is vast, fragmented, and hard to interpret without visual tools.	Overwhelmed by data complexity and unsure of where to focus improvement efforts.

PS-2	An energy company transitioning toward renewable sources.	Monitor energy production trends and identify market opportunities using data-driven insights.	I struggle to pinpoint regional energy trends.	It's difficult to understand which regions are growing in renewables or still dependent on fossil fuels.	Uncertain about strategic investment decisions and reactive instead of proactive.

2.2 Empathy Map Canvas



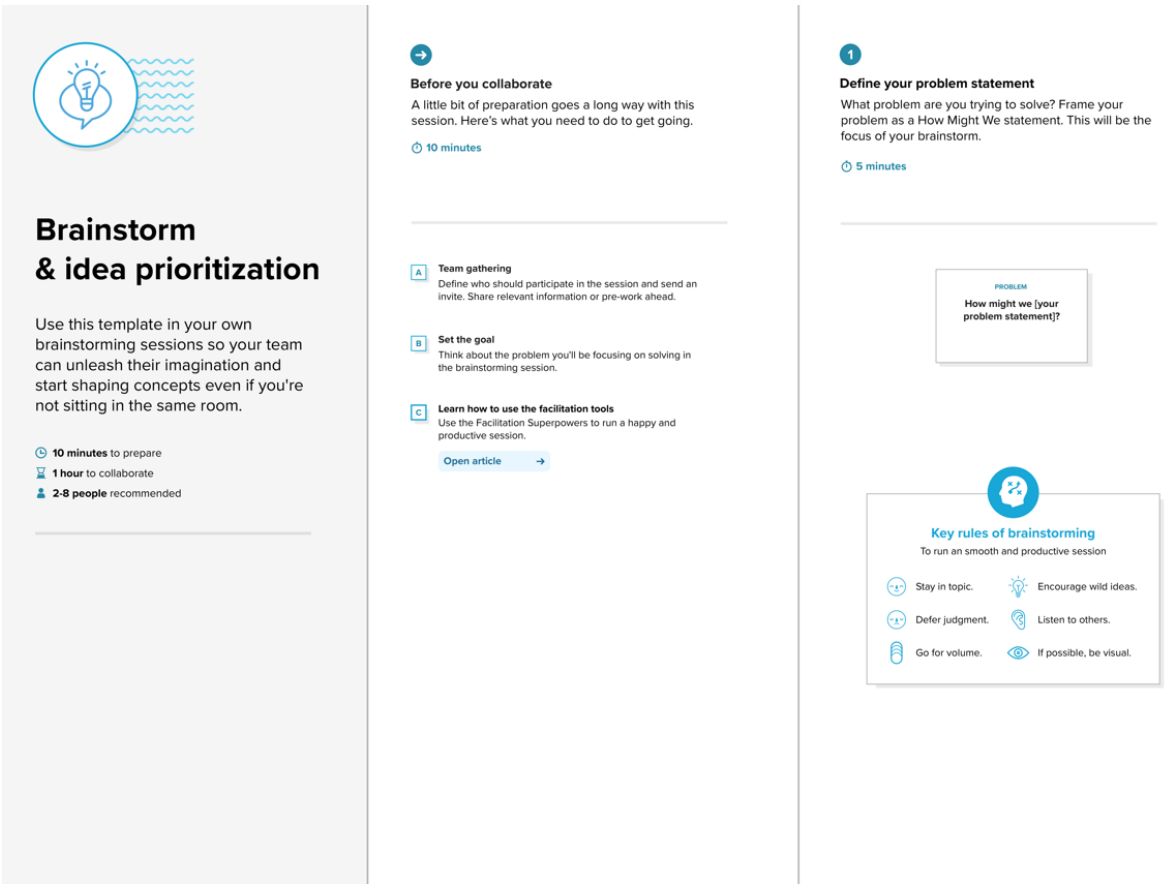
Category	Description
Thinks & Feels	Concerned about climate change and the global energy transition
Hears	nternational reports on carbon neutrality, SDG goals
Sees	Static reports, raw data tables
Says & Does	Requests clear visual reports for policymaking
Pains	Difficult to compare regions and energy types at a glance
Gains	Wants fast, visual insights for better decision-making

2.3 Brainstorming

Initial ideas included:

- A world map showing regional energy generation
- Pie charts for source-wise energy contribution
- Line graphs showing trends over years
- Filters by energy type, region, and year
- Comparison between renewable vs. non-renewable generation

Brainstorm & Idea Prioritization Template:



Step-1: Team Gathering, Collaboration and Select the Problem Statement

Problem Statement:

Global policymakers, researchers, and energy companies face challenges in understanding how energy generation varies across regions and over time—especially with the global transition toward renewable sources. Key factors such as geography, policy, demand, and resource availability create complex energy trends that are hard to visualize and analyze comprehensively.

Project Goal:

Utilize **Power BI** to perform a comprehensive analysis of global energy trends by:

- Comparing energy generation by mode (renewables, fossil fuels, nuclear, etc.)
- Highlighting regional patterns and shifts over time.
- Supporting data-driven energy planning and sustainability strategies.

Step-2: Brainstorm, Idea Listing and Grouping

Brainstormed Ideas for Implementation

1.Data Collection & Preparation

- Collect global energy generation data from trusted sources (e.g., IEA, World Bank, national databases).
- Include attributes like region, year, energy mode, total generation, and growth rates.
- Clean and normalize datasets for consistency across regions and sources.
- Use Power Query for importing, merging, and transforming data.

2.Data Analysis & Key Metrics

- Compare energy generation by mode across different regions and over time.
- Analyze:
    - Growth trends in renewables vs. fossil fuels
    - Regional dependence on specific energy sources
    - Top energy-producing and consuming countries
- Create DAX measures for:
    - Total generation per region

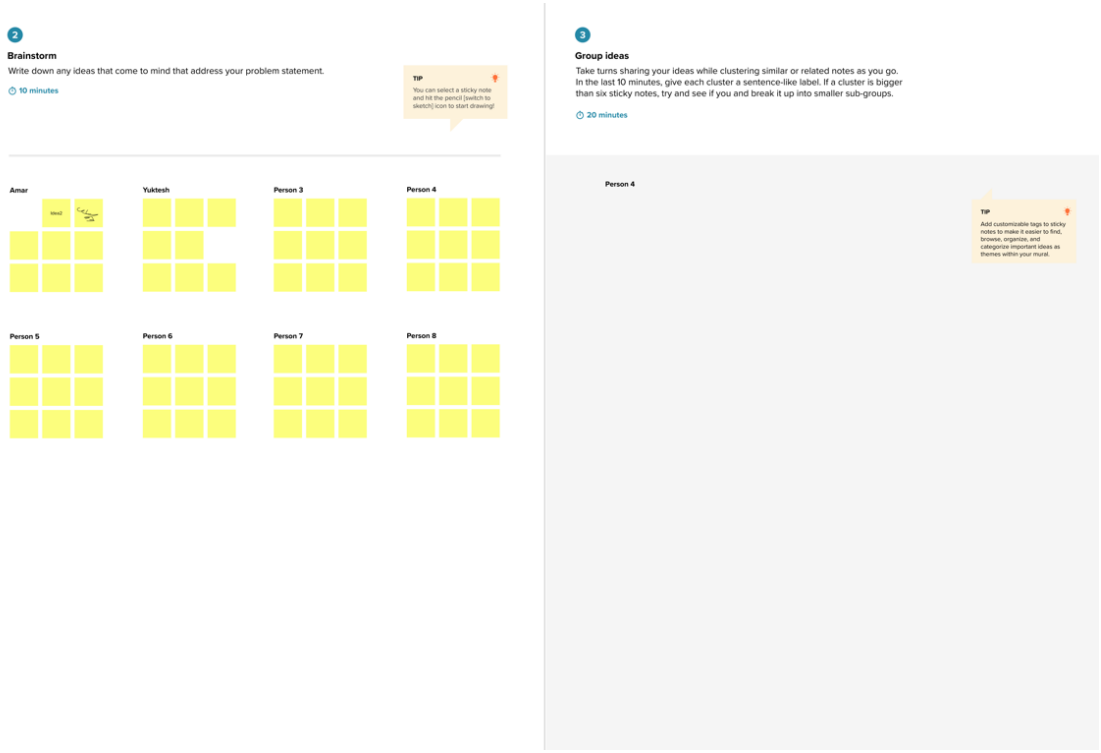
- Year-on-year growth
- Renewable vs. non-renewable share

4.Visualization & Dashboard Creation

- **Line Chart**:
  Energy Generation over Time (by Region or Energy Mode)
- **Stacked Area Chart**:
  Renewable vs. Non-renewable Share over Time
- **Map Visual**:
  Global distribution of energy generation (colored by energy type or total volume)
- **Bar Chart**:
  Top 10 Countries by Energy Generation (segmented by mode)
- **Decomposition Tree**:
  Factors contributing to energy trends (region → energy mode → year)
- **Card Visuals**:
  - Total Global Energy Generation
  - % from Renewables
  - Region with Highest Renewable Adoption

5.Predictive Insights & Business Impact

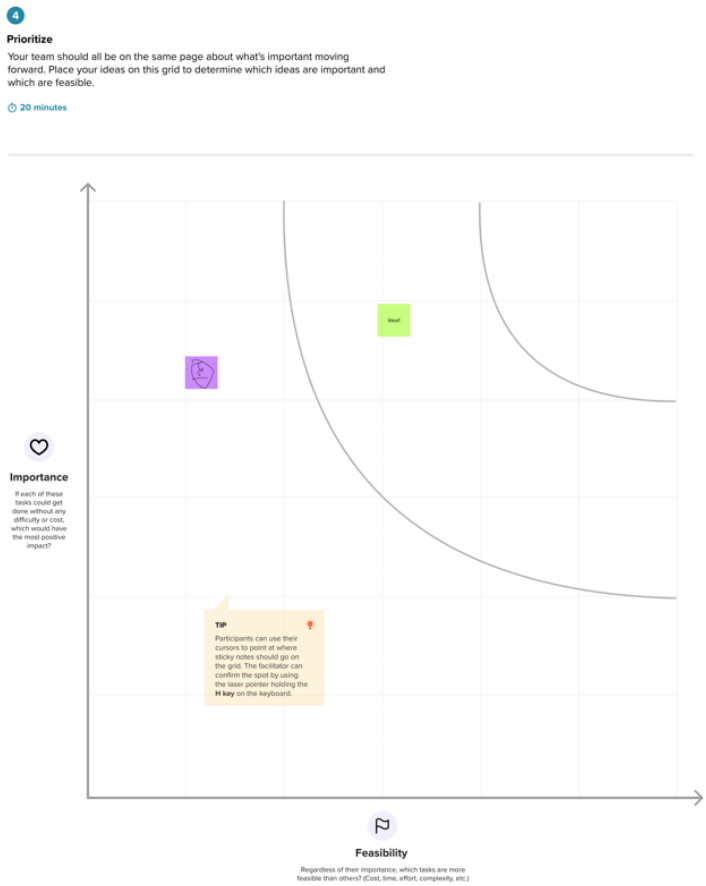
- Project future energy trends using linear projections or historical growth patterns.
- Provide region-specific recommendations:
  - Emerging leaders in renewable energy
  - Areas heavily reliant on fossil fuels
- Help energy companies and governments:
  - Align with global sustainability goals
  - Plan energy transitions and investments



Step-3: Idea Prioritization

Idea	Priority Level	Reason for Priority
Data Cleaning & Transformation	High	Essential for accurate insights and consistency across countries/regions
Line Chart (Energy Trends over Time)	High	Clearly shows historical trends and shifts across energy modes
Stacked Area Chart (Renewable vs Non-renewable)	High	Highlights global sustainability progress and energy mix changes
Map Visual (Regional Distribution)	High	Offers geographic perspective on energy generation patterns
Bar Chart (Top 10 Countries by Generation)	High	Easy comparison across leading nations by energy output

Decomposition Tree (Energy Trend Factors)	High	Breaks down regional/mode-wise contributors to trends
Card Visuals (KPIs: Total Gen, % Renewables, Top Region)	High	Quick snapshot of key global energy metrics
Predictive Insights (Growth Forecasting)	Medium	Adds future-looking value but depends on quality time series data
Real-Time Data Feeds / Live Dashboard	Low	Requires APIs or streaming sources; better suited for future version
Advanced AI-based Forecasting	Low	Needs in-depth modeling and larger datasets for accurate projections



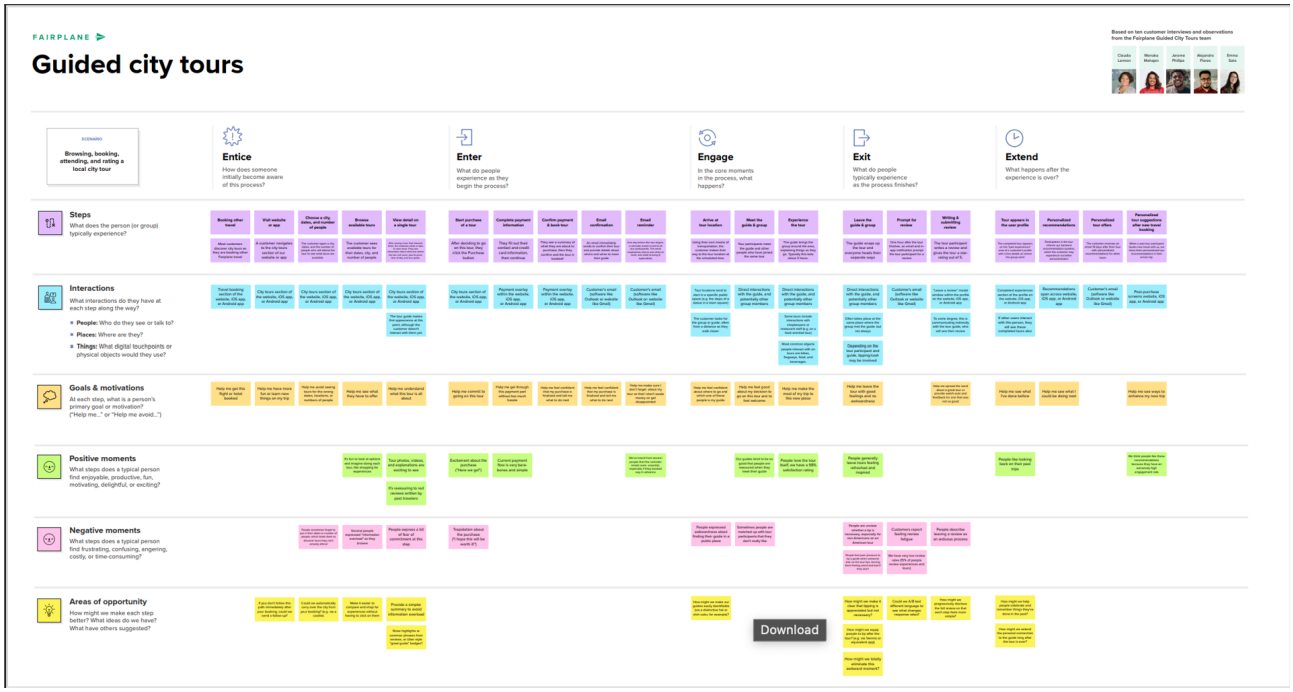
3. REQUIREMENT ANALYSIS

3.1 Customer Journey Map

User: Energy analyst or policy researcher

Journey:

1. Opens Power BI dashboard
2. Selects a specific region or country
3. Applies filters for energy type and year
4. Views visualizations
5. Downloads reports or presents data

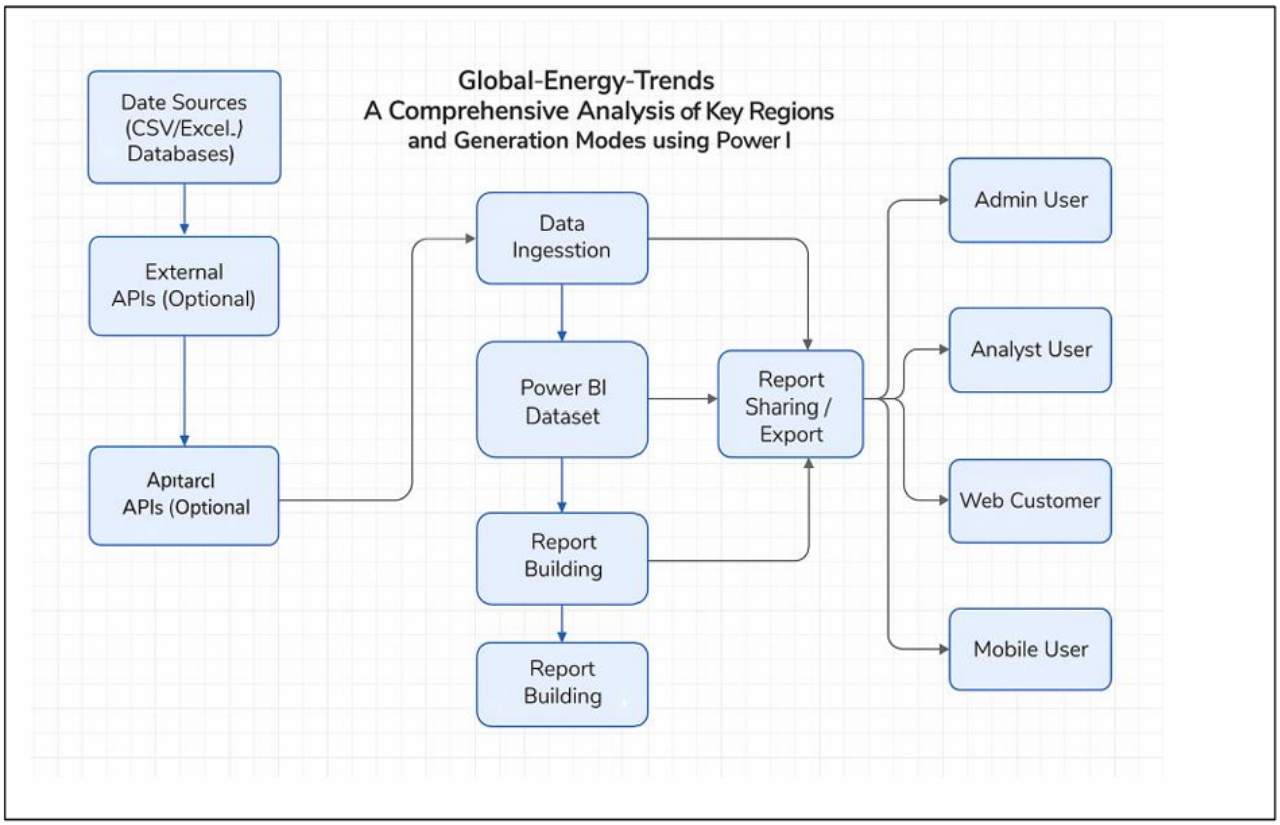


3.2 Solution Requirement

- Clean, structured dataset (global energy production by region and source)
- KPIs: Total energy, % share of renewable vs. non-renewable, year-over-year growth
- Visuals: Maps, line charts, bar graphs, pie charts
- Interactivity: Filters by region, energy source, and time

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form (email & password)
		Registration through Gmail
		Registration through LinkedIn
FR-2	User Confirmation	Confirmation via Email (account activation link)
		Confirmation via OTP (for secure access)
FR-3	Data Integration	Connect Power BI to energy datasets (Excel, CSV, databases)
		Enable real-time or scheduled data ingestion from APIs or cloud sources
FR-4	Data Processing	Clean and structure data related to region-wise energy consumption and generation
		Categorize data by generation mode (Solar, Wind, Hydro, Coal, etc.)
FR-5	Trend Forecasting	Apply forecasting models (e.g., linear regression, ARIMA) to predict energy consumption trends
		Enable region-wise prediction of renewable vs non-renewable energy usage
FR-6	Visualization	Develop Power BI dashboards showing key KPIs, trends, and comparative metrics by region & mode
		Include filters, slicers, and drill-downs for in-depth analysis
		Export and share reports with different user roles (admin, analyst, viewer)

3.3 Data Flow Diagram



User Stories

Use the below template to list all the user stories for the product.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance Criteria	Priority	Release
Administrator	Data Upload	USN-1	As an administrator, I can upload global energy datasets (CSV/Excel) to the Power BI service for analysis.	File is uploaded successfully, and Power BI confirms data load.	High	Sprint-1
Administrator	Data Cleaning	USN-2	As an administrator, I can clean and transform raw energy data before it's used in dashboards.	All missing/null/inaccurate values are handled and structured for analytics.	High	Sprint-1
Administrator	Report Design	USN-3	As an administrator, I can design interactive dashboards showing energy trends by region, type, and time.	Dashboard shows clear insights (filters, charts, KPIs) based on uploaded data.	High	Sprint-1
Administrator	User Access Control	USN-4	As an administrator, I can manage access to reports based on user roles (viewer/editor/admin).	Only authorized users can view or edit dashboards.	Medium	Sprint-2
Administrator	Scheduled Data Refresh	USN-5	As an administrator, I can schedule automatic data refreshes to keep dashboards up to date.	Power BI dataset is refreshed daily/weekly as per configuration.	Medium	Sprint-2
Analyst (Web User)	Trend Analysis	USN-6	As a data analyst, I can analyze patterns in energy production/consumption across regions and sources (coal, solar, wind, etc.).	I can filter data by year, source, or region and extract insights from visualizations.	High	Sprint-1
Analyst (Web User)	Export Reports	USN-7	As a data analyst, I can export Power BI visuals and insights as PDF or PowerPoint to present findings.	Exported file retains chart fidelity and selected filters.	Medium	Sprint-2
Customer (Mobile User)	Mobile Dashboard Access	USN-8	As a mobile user, I can view summarized dashboards on my device with responsive visuals.	Mobile view loads charts correctly and is responsive across screen sizes.	Medium	Sprint-2
Customer Care Executive	Insight Sharing	USN-9	As a customer care executive, I can share specific insights from Power BI to users through email or chat on request.	Users receive accurate and visual summaries based on their queries.	Medium	Sprint-3

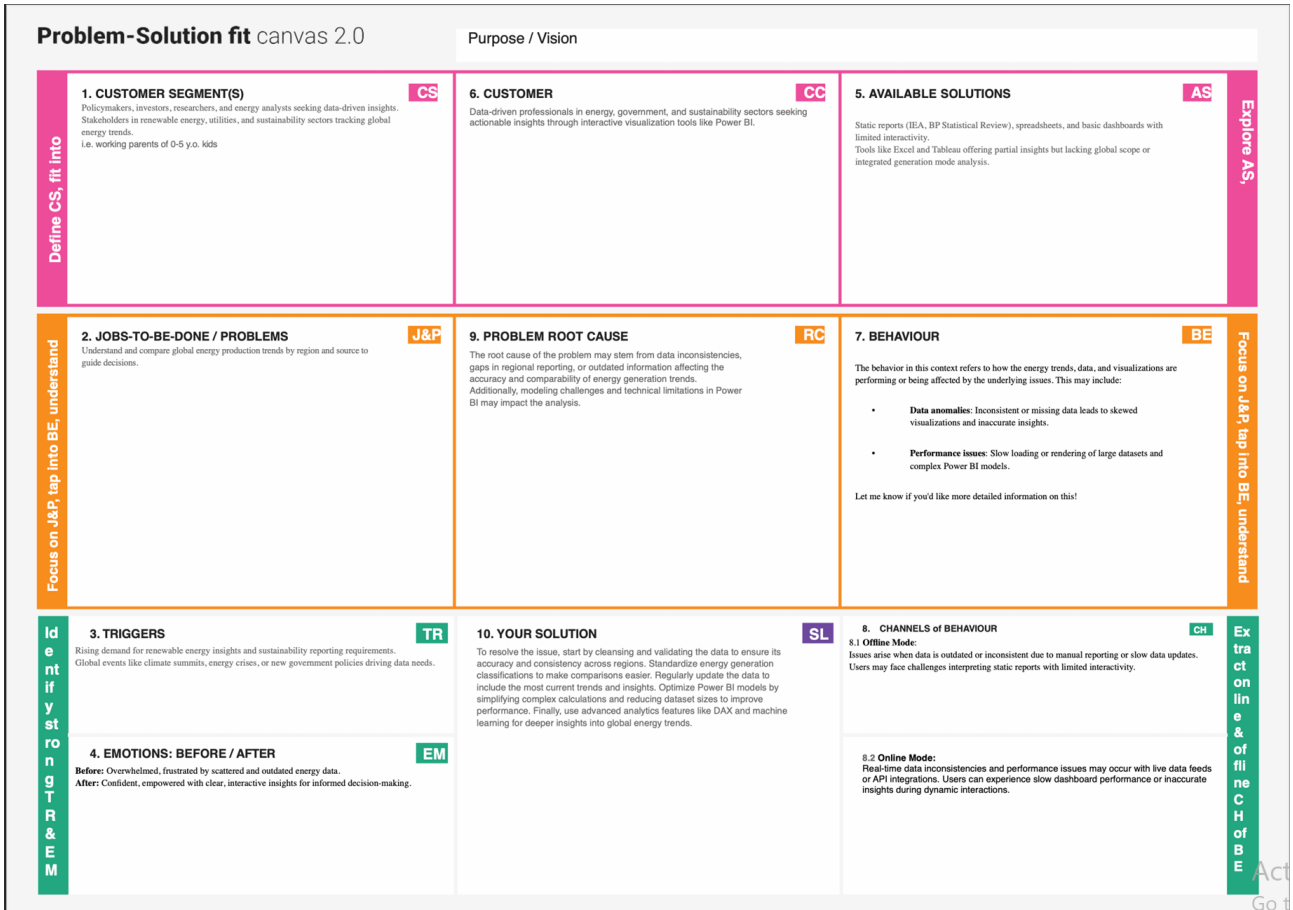
3.4 Technology Stack

S.No	Component	Description	Technology
1	User Interface	Web UI or Mobile-friendly interface for interacting with Power BI dashboards and filters	HTML, CSS, JavaScript, ReactJS
2	Application Logic-1	Data ingestion logic to extract energy data from various sources (CSV, Excel, APIs)	Python, Power BI Power Query
3	Application Logic-2	Forecasting logic to predict future energy consumption/generation trends by region & type	Scikit-learn, Prophet, Python
4	Application Logic-3	Natural language query support for end users to interact with data using keywords	Microsoft Q&A Visual in Power BI
5	Database	Stores structured and cleaned data for analytics and reporting	SQL Server, Azure SQL Database
6	Cloud Database	Centralized storage of historical and real-time energy datasets	Azure Data Lake / AWS S3
7	File Storage	Stores uploaded raw files (CSV, Excel), backups, and generated insights or exports	OneDrive, SharePoint, or Blob Storage
8	External API-1	Provides real-time energy pricing or environmental factors (temperature, solar intensity, etc.)	OpenEnergy API / National Grid API
9	External API-2	Authenticates user login or integrates with social login (Gmail, LinkedIn)	Google OAuth API, LinkedIn API

4. PROJECT DESIGN

4.1 Problem Solution Fit

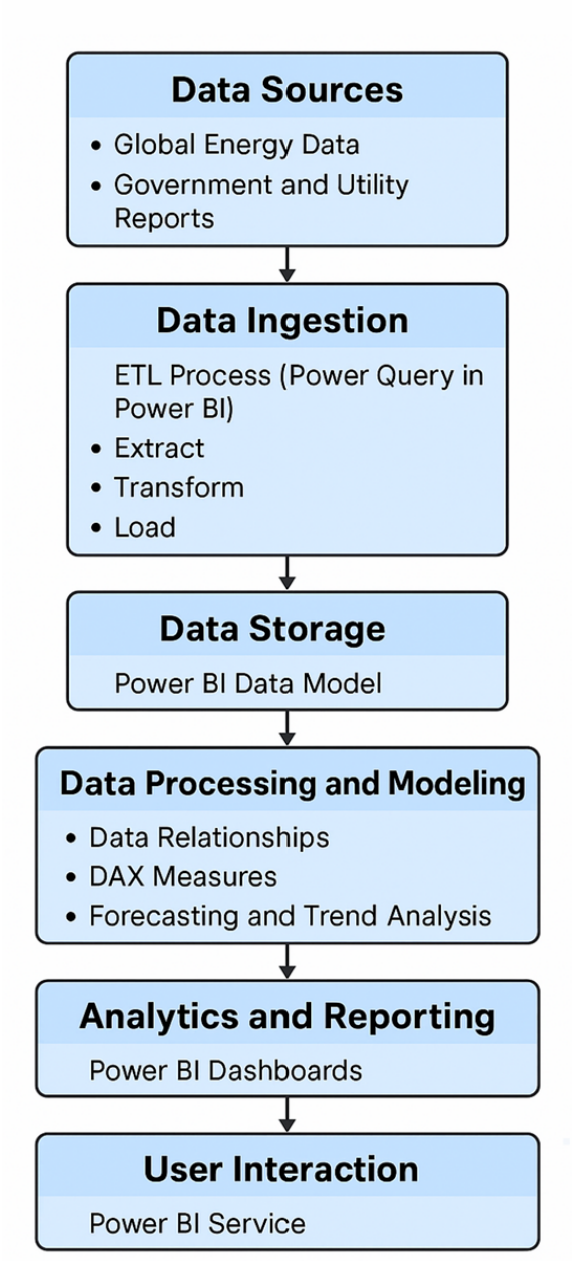
The proposed dashboard addresses the need for simplified, visual insights into complex global energy data. It bridges the gap between data availability and actionable insight.



4.2 Proposed Solution

S.No.	Parameter	Description
1	Problem Statement (Problem to be solved)	Global energy data is often scattered, inconsistent, and difficult to compare across regions and generation modes. A centralized, visual analytics solution is needed to provide meaningful insights into energy trends.
2	Idea / Solution description	This project leverages Power BI to analyze global energy production data across regions and generation sources (renewable and non-renewable). The system presents insights through dynamic dashboards for trend comparison, forecasting, and policy planning.
3	Novelty / Uniqueness	- Combines data from multiple global sources into a unified, interactive platform. - Uses Power BI for real-time visual analytics and regional benchmarking. - Enables predictive insights using DAX and AI-powered features in Power BI.
4	Social Impact / Customer Satisfaction	- Assists policymakers, researchers, and energy stakeholders in understanding and optimizing energy use. - Promotes renewable energy adoption through transparent data trends. - Encourages data-driven decisions in energy planning and sustainability.
5	Business Model (Revenue Model)	- Subscription-based access for energy analysts and institutions. - Enterprise licensing for government and global energy organizations. - Custom solutions and dashboard development for consultancy services.
6	Scalability of the Solution	- Scalable to include more countries, years, and detailed energy sub-sectors. - Cloud-based deployment allows easy expansion and multi-user access. - Can integrate with AI models for automated energy trend forecasting and scenario planning.

4.3 Solution Architecture



5. PROJECT PLANNING & SCHEDULING

5.1 Project Planning

Product Backlog, Sprint Schedule, and Estimation
Project Planning Phase

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Data Collection & Integration	-USN 1	Gather regional and generation mode-based energy data from public sources and APIs	7	High	**Milad, Lokesh**
Sprint-1	Data Preparation	-USN 2	Clean and transform data for consistency, handle missing and categorical values	8	High	**Lokesh, Pradeep**
Sprint-2	Data Analysis	-USN 3	Use Power BI to analyze data trends across regions and generation modes	5	Medium	**Pradeep**
Sprint-2	Visualization Development	-USN 4	Build visualizations for KPIs like generation share, emissions, trends	6	Medium	**Milad, Lokesh**
Sprint-2	Dashboard Design	-USN 5	Design a user-friendly dashboard with filterable visuals by region, year, energy source	8	High	**Milad, Lokesh**
Sprint-3	Implementation	-USN 6	Deploy Power BI dashboard to web, assign roles and access permissions	7	Medium	**Pradeep, Lokesh**
Sprint-3	Feedback Collection	-USN 7	Collect feedback from users on dashboard usability and insights	6	Medium	**Milad, Pradeep**
Sprint-3	Evaluation and Continuous Improvement	-USN 8	Analyze user interaction and improve visuals or filters based on feedback	9	High	**Milad, Lokesh, Pradeep**

Project Tracker, Velocity & Burndown Chart
Sprint Tracker

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	15	10 Days	22 Apr 2025	01 May 2025	15	01 May 2025
Sprint-2	19	10 Days	02 May 2025	11 May 2025	19	11 May 2025
Sprint-3	22	10 Days	12 May 2025	21 May 2025	22	21 May 2025

Velocity Calculation
- **Total Story Points Completed:** 15 + 19 + 22 = 56
- **Total Number of Sprints:** 3
- **Velocity** = 56/3 = 18.66 story points per sprint

Burndown Chart
Burndown Table

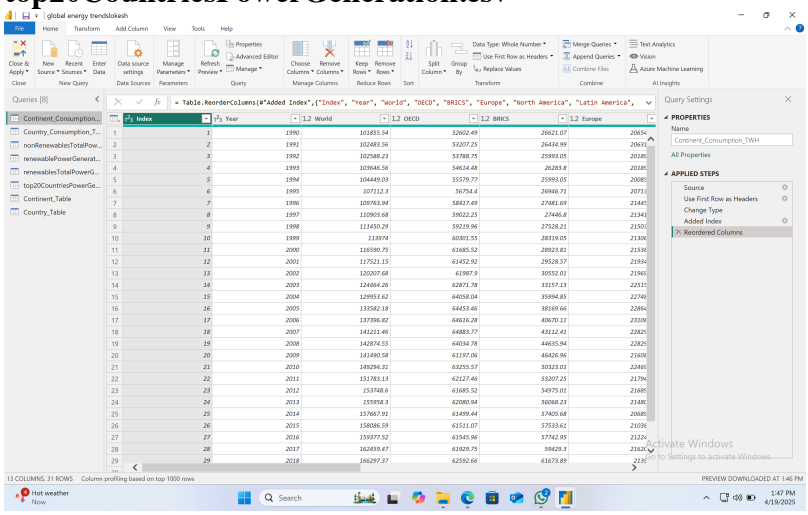
Sprint	Day	Total Story Points	Story Points Completed	Remaining Story Points
1	1	56	0	56
	2	56	0	56
	3	56	0	56
	4	56	0	56
	5	56	0	56
	6	56	0	56
	7	56	0	56
	8	56	0	56
	9	56	0	56
	10	56	15	41

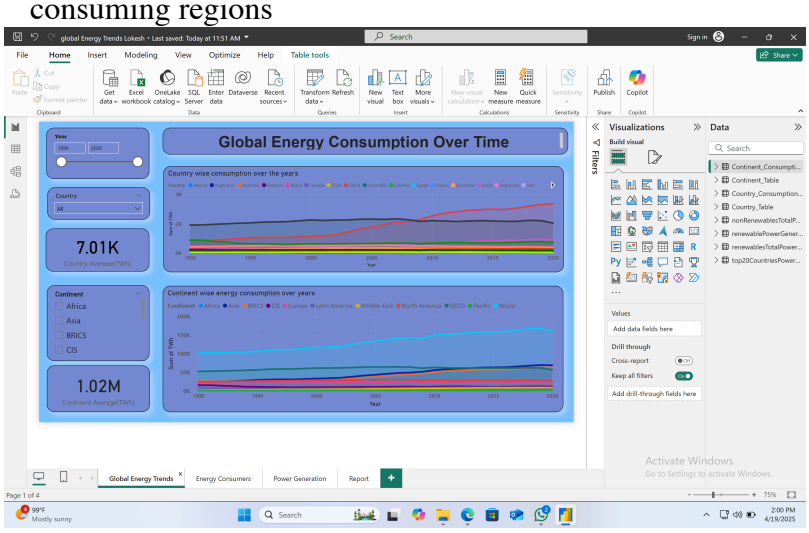
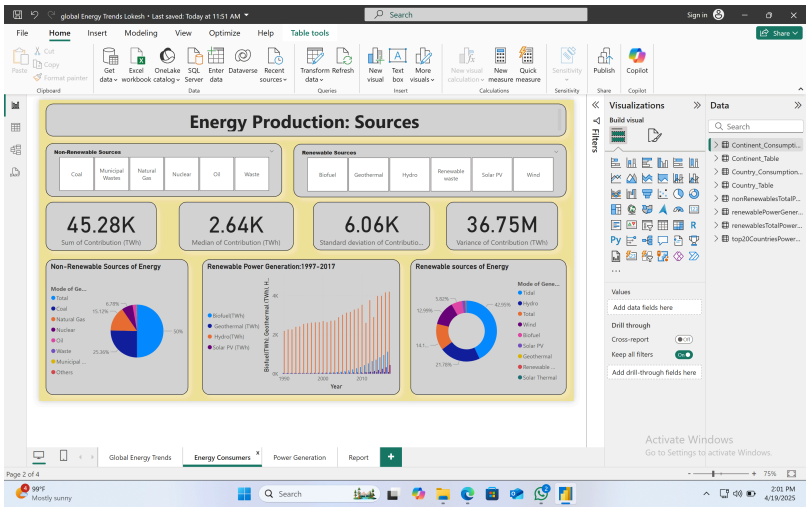
2	1	56	15	41
	2	56	15	41
	3	56	15	41
	4	56	15	41
	5	56	15	41
	6	56	15	41
	7	56	15	41
	8	56	15	41
	9	56	15	41
	10	56	34	22
3	1	56	34	22
	2	56	34	22
	3	56	34	22
	4	56	34	22
	5	56	34	22
	6	56	34	22
	7	56	34	22
	8	56	34	22
	9	56	34	22
	10	56	56	0

6. FUNCTIONAL AND PERFORMANCE TESTING

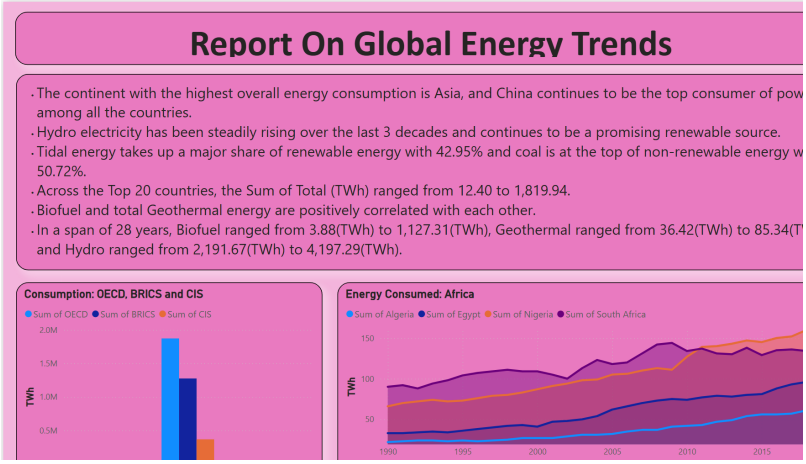
6.1 Performance Testing

Tests conducted:
- Dashboard loading time checked for various filters
- Responsiveness with large datasets
- Verified accuracy of DAX measures and KPIs
- Tested on different screen sizes for UI consistency

S.No.	Parameter	Screenshot / Values
1	Data Rendered	**Continent_Consumption_TWH.csv** **Country_Consumption_TWH.csv** **nonRenewablesTotalPowerGeneration.csv** **renewablePowerGeneration97-17.csv** **renewablesTotalPowerGeneration.csv** **top20CountriesPowerGeneration.csv** 
2	Data Preprocessing	• **Removed Null Values** – Ensured data completeness. • **Unpivoted Table** – Converted wide format data into a long format for better filtering and analysis. • **Created Two New Tables from Existing Data:** • **Country Consumption Table** – Extracted from Country_Consumption_TWH.csv for country-level insights. • **Continent Consumption Table** – Extracted from Continent_Consumption_TWH.csv for regional comparisons. • **Added Index Columns** – Assigned unique IDs to facilitate merging and analysis.

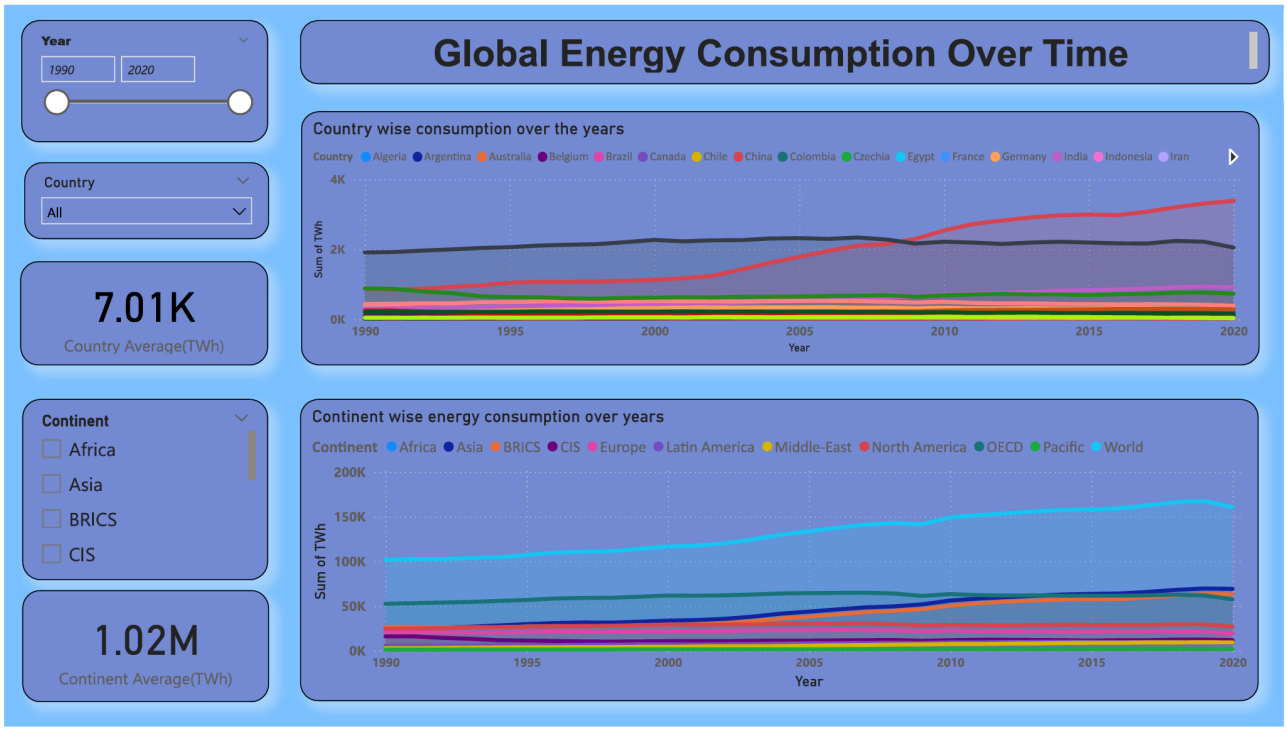
3.	Utilization of Data Filters	• **Yearly Filter** – To analyze trends over time. • **Country & Continent Filters** – To compare power consumption at different levels. • **Energy Type Filter** – To distinguish between renewable and non-renewable energy. • **Consumption Range Filter** – To focus on high-energy-consuming regions  

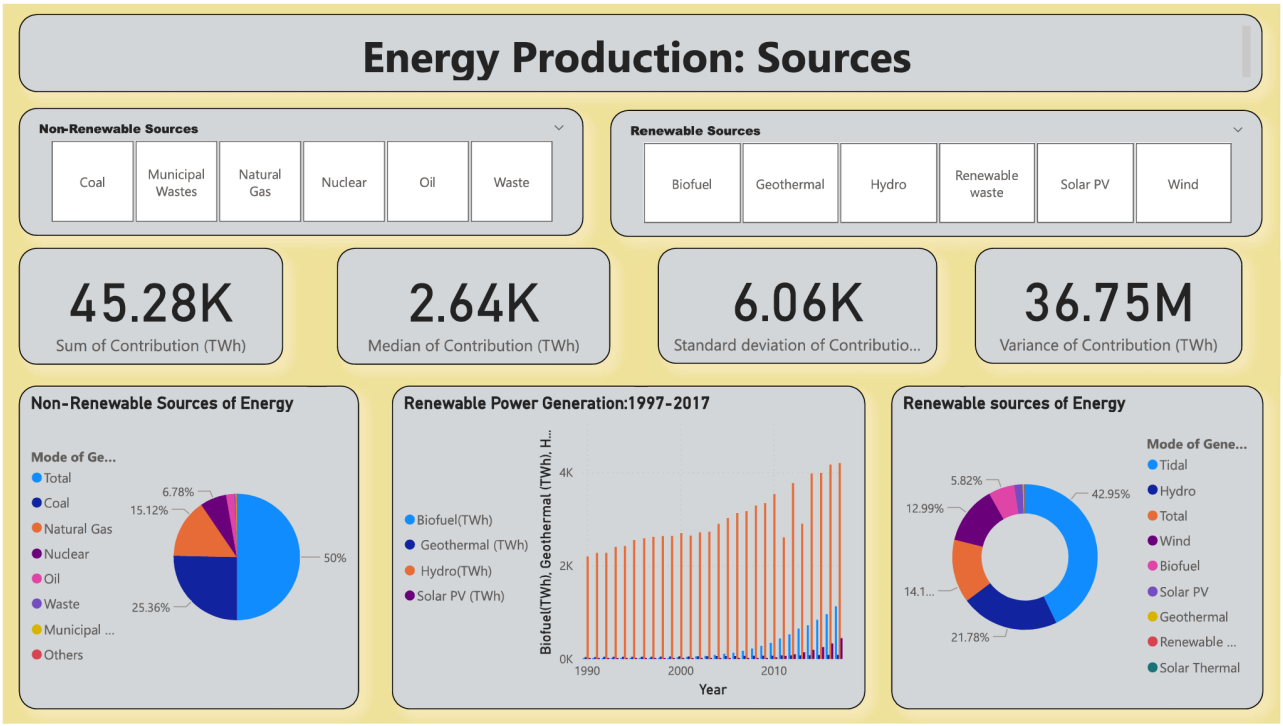
4.	DAX Queries Used	• Total Country Consumption = SUM(Country_Consumption_TWH[Total Consumption (TWH)]) • Total Continent Consumption = SUM(Continent_Consumption_TWH[Total Consumption (TWH)]) • Percentage Contribution = DIVIDE([Total Country Consumption], [Total Continent Consumption], 0) * 100 • Rank by Country = RANKX(ALL(Country), [Total Country Consumption], , DESC, DENSE) • Rank by Continent = RANKX(ALL(Continent), [Total Continent Consumption], , DESC, DENSE) • Continent Average(TWh) = AVERAGEX(SUMMARIZE('Continent_Table','Continent_Table'[Continent],"Total",SUM(' Continent_Table'[TWh])), [TOTAL]) • Country Average(TWh) = AVERAGEX(SUMMARIZE('Country_Table','Country_Table'[Country],"Total",SUM('Count ry_Table'[TWh])), [TOTAL])
5.	Dashboard design	No of Visualizations / Graphs - • Country-wise energy consumption • Continent Energy Consumption • Continent Average(TWh) • Country Average(TWh) • Non-renewable sources of Energy • Renewable Generation 1997-2017 (TWh) • Cards - Sum, Median, Standard Deviation and Variance of Contribution(TWh) • Renewable Sources of Energy • Cards - Geothermal, Biofuel, Hydro and Solar PV • BRICS, OECD, and CIS Comparison • Report Narrative • Energy Consumption in African countries

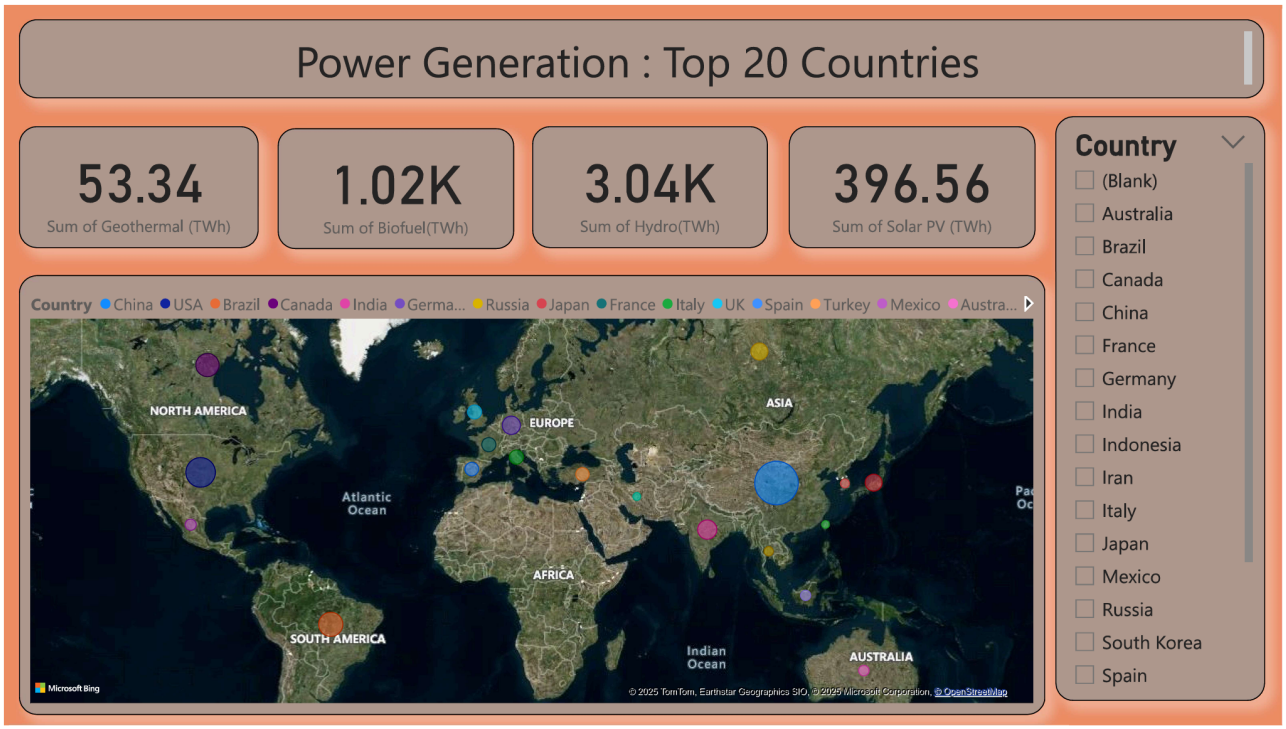
6	Report Design	No of Visualizations / Graphs - • **Number of Visualizations:2** • **Additional Insights Included:** • Top energy-consuming countries vs. continents. • Regional energy consumption trends over the years. Forecasted energy consumption based on past trends. • Impact of renewable adoption across regions. 

7. RESULTS

7.1 Output Screenshots




Energy Production: Sources
Non-Renewable Sources
Coal
Municipal Wastes
Natural Gas
Nuclear
Oil
Waste
Renewable Sources
Biofuel
Geothermal
Hydro
Renewable waste
Solar PV
Wind
45.28K
Sum of Contribution (TWh)
2.64K
Median of Contribution (TWh)
6.06K
Standard deviation of Contributio...
36.75M
Variance of Contribution (TWh)
Non-Renewable Sources of Energy
Mode of Ge...
Total
Coal
Natural Gas
Nuclear
Oil
Waste
Municipal ...
Others
6.78%
15.12%
50%
25.36%
Renewable Power Generation:1997-2017
Biofuel(TWh)
Geothermal (TWh)
Hydro(TWh)
Solar PV (TWh)
Biofuel(TWh), Geothermal (TWh), H...
4K
2K
0K
1990
2000
2010
Year
Renewable sources of Energy
Mode of Gene...
Tidal
Hydro
Total
Wind
Biofuel
Solar PV
Geothermal
Renewable ...
Solar Thermal
5.82%
42.95%
12.99%
14.1...
21.78%


Power Generation : Top 20 Countries
53.34
Sum of Geothermal (TWh)
1.02K
Sum of Biofuel(TWh)
3.04K
Sum of Hydro(TWh)
396.56
Sum of Solar PV (TWh)
Country
China
USA
Brazil
Canada
India
Germa...
Russia
Japan
France
Italy
UK
Spain
Turkey
Mexico
Austra...
NORTH AMERICA
EUROPE
ASIA
Atlantic Ocean
AFRICA
SOUTH AMERICA
Indian Ocean
AUSTRALIA
Microsoft Bing
© 2025 TomTom, Earthstar Geographics SIO, © 2025 Microsoft Corporation, © OpenStreetMap
Country
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Germany
India
Indonesia
Iran
Italy
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Mexico
Russia
South Korea
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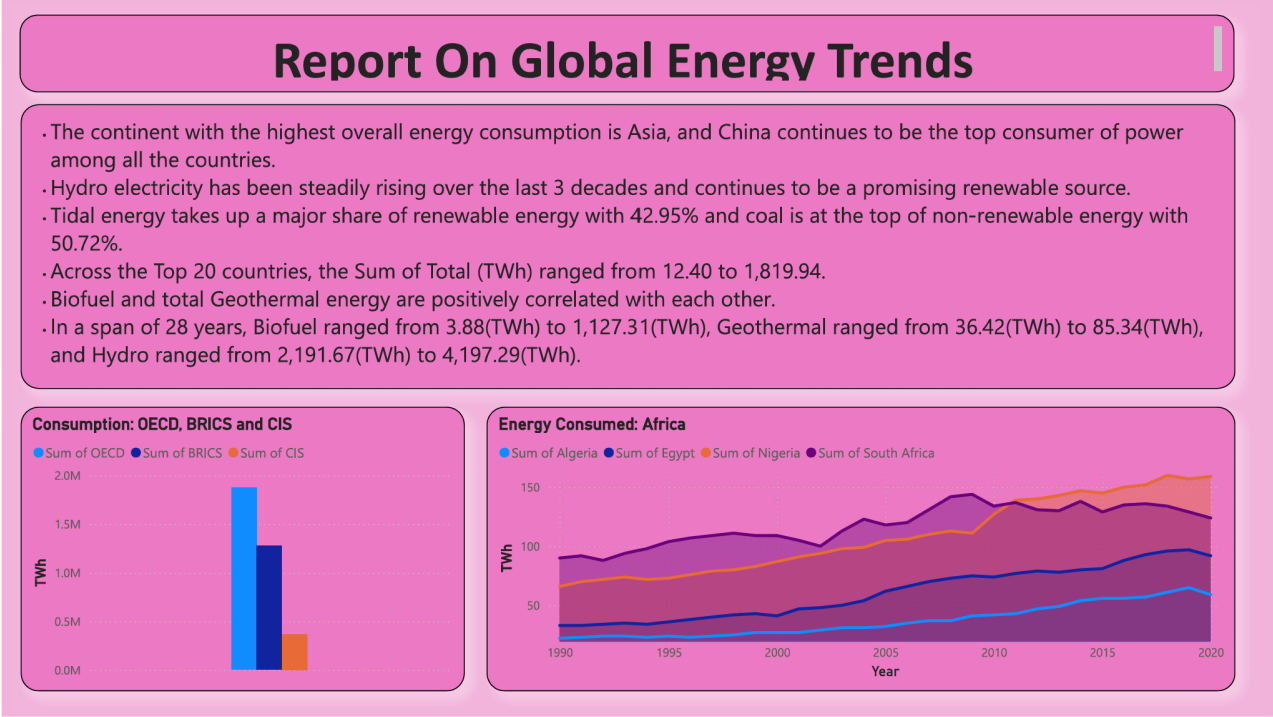

8. ADVANTAGES & DISADVANTAGES

Advantages:
- Interactive and user-friendly dashboard
- Quick insights from large datasets
- Easy filtering and customization
- Visual comparisons between countries and energy types

Disadvantages:
- Dataset is not real-time
- Some regions may lack historical data
- Performance may vary with very large datasets

9. CONCLUSION

The project successfully transformed raw energy production data into a powerful visual tool using Power BI. The dashboard allows stakeholders to quickly assess energy trends across regions, evaluate the progress of renewable energy adoption, and make informed decisions. It bridges the gap between complex data and actionable insight.

10. FUTURE SCOPE

- Integration of real-time data sources
- Predictive analytics for energy demand and generation
- Addition of CO_2 emissions and economic indicators
- Mobile-optimized version of the dashboard
- Localization of dashboards by language or region

11. APPENDIX

Dataset Link:

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

GitHub Link:

https://github.com/lokesh5A8/Global-Energy-Trends-A-Comprehensive-Analysis-of-Key-Regions-and-Generation-Modes-using-PowerBI

Project Demo Link:

https://drive.google.com/file/d/1GSw_qZw4z7Z0svOtA8D3Li7y7Qz4MShU/view?usp=drivesdk