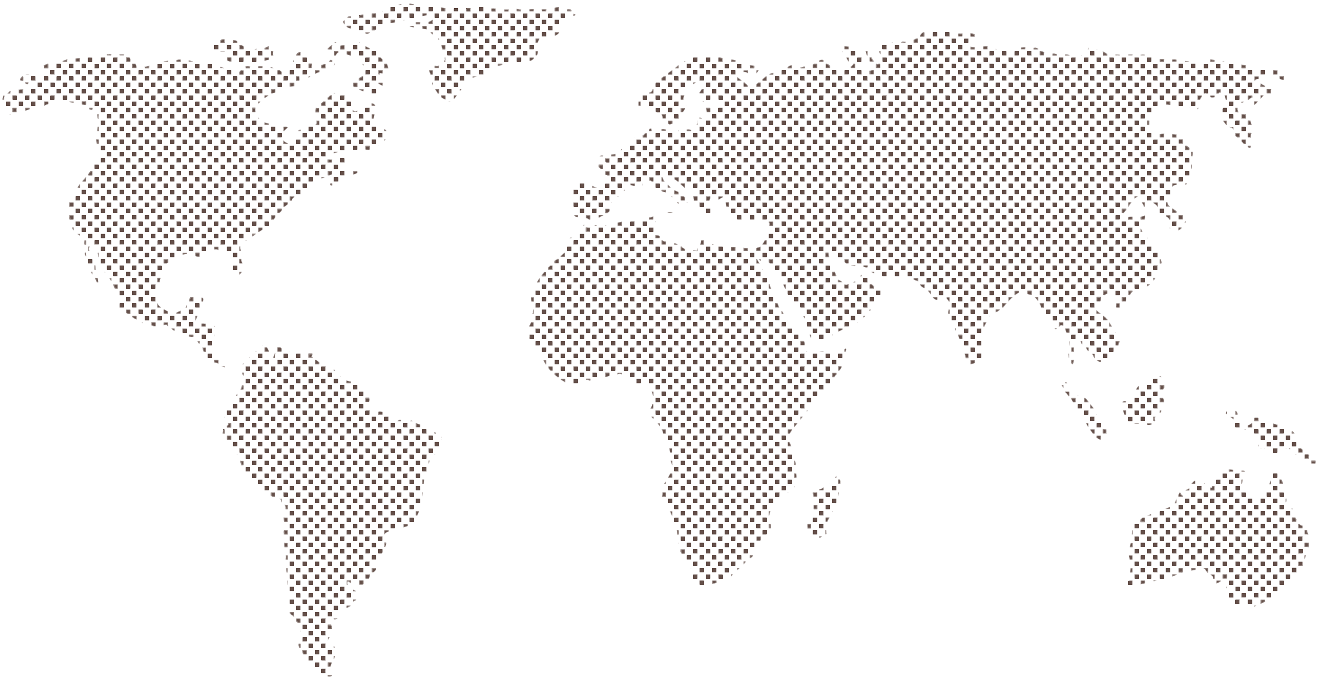

WORLDWIDE ENERGY STATISTICS

FINAL PROJECT REPORT

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Introduction

The project is using various visualization technique to display the world energy statistics in detail. A world map on the homepage is displaying the countries energy usage collaborated in a block. The user can view the percentage of different types of energy used in the world. The project has features to enable the users to visualize the rate of increase in energy consumption along with viewing the consumption of all the countries across the globe. The users can also view the exact figures of various categories of energy. The visualizations in the project is coded using D3.js[3].

Dataset

The datasets are extracted in CSV format from https://www.gapminder.org/data/ and used in the project. The data from Gapminder[21] has information from 1970 to 2010, but relevant data for all the countries is only available from 2000 to 2009 which is used in the project. The data from 1970 to 1999 is deleted manually in the CSV files and a python script is run to clean the data, remove zero and invalid values and delete the rows which have missing values in the CSV files. The meteorite strike JSON file [8] available on Github[22] is processed to map the energy data on the map coordinates. This file is modified according to the energy data using python script and few more files. All the CSV and JSON files are put on GitHub and their respective raw data link is used in the code for further processing. The following datasets are utilized in the project:

Dataset Name	**Data source**
Coal consumption, total	BP
Energy production, per person	Based on WDI data
Energy production, total	World Bank
Energy use, total	World Bank
Hydroelectric electricity production, total	World Bank
Natural gas production, total	BP
Nuclear electricity production, total	World Bank
Oil production, total	BP

Project Walkthrough

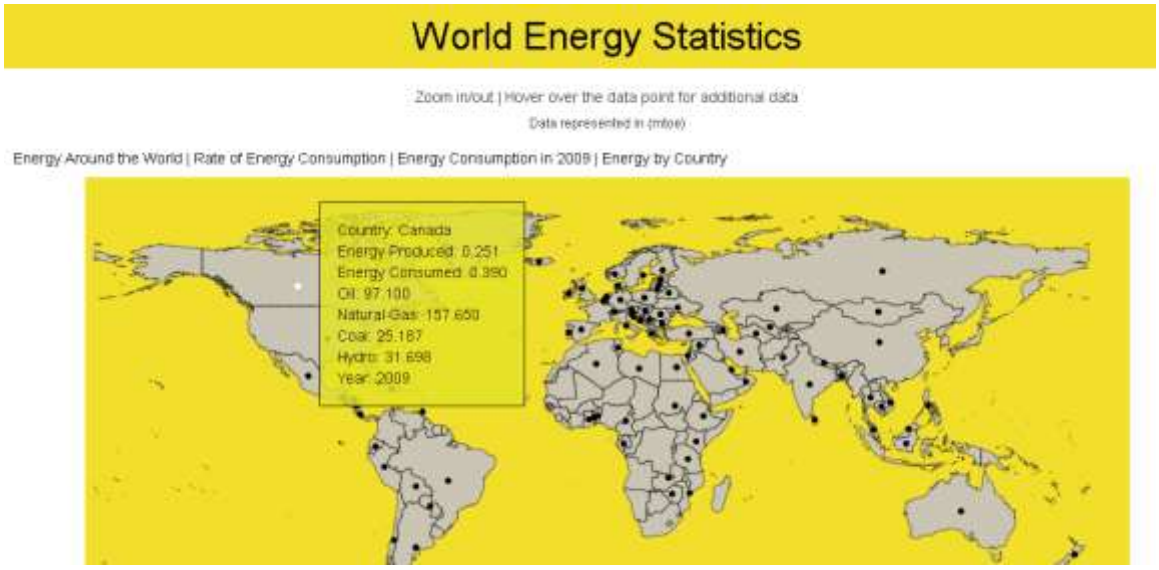
1. Homepage

The homepage has a world map with the countries reflecting the energy data. A navbar class is used to create basic format of the project. There are four hyperlinks in the homepage which are redirecting to different visualizations of the data. The countries longitude and latitude

coordinates highlighted with dots in the map, on clicking or hovering over the dot a rectangle box pops up displaying the following features:

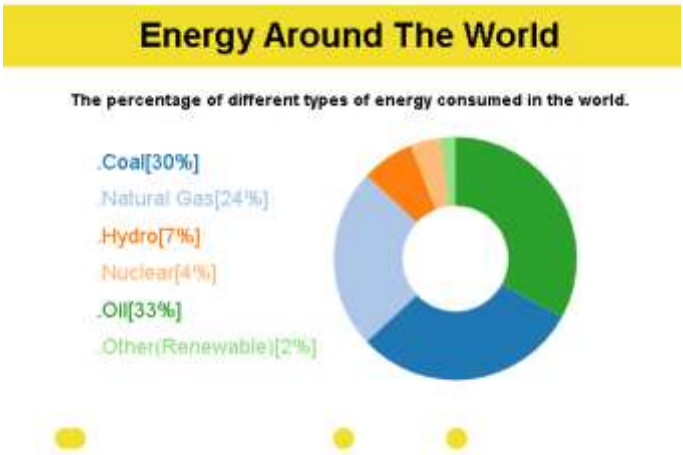
- Name of the country.
- Total energy produced in the country
- Total energy consumed in the country.
- Total oil consumption in the country.
- Total natural gas energy produced in the country.
- Total coal consumption in the country.
- Total Hydroelectric electricity production in the country.

The unit of representation is mtoe (Million tonne of oil equivalent)[1]. If any of the above data is not available in the dataset 'Data not available' is reflected on the box. The map also has zoom in and zoom out feature. The basic format of the homepage is created using CDNJS [2] library repository 's stylesheet[3] and jquery[4] libraries. The d3 topjson[5][7] template is used to draw the structure of world map. The locations and the energy data are implemented with the code.



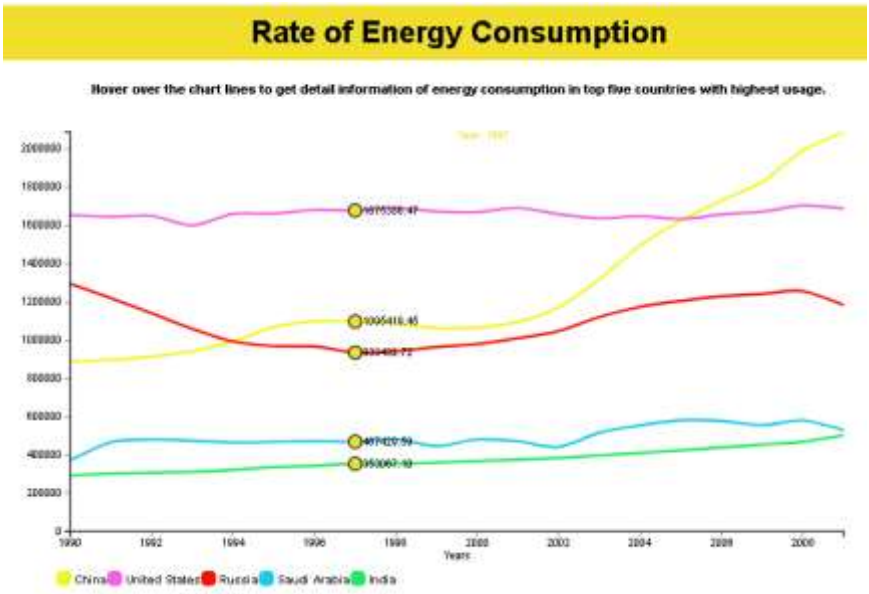
2. Energy Around the World

An interactive pie chart is representing the percentage of diverse types of energies used in the world. The small-scale data [6] is hardcoded in the code and each color is depicting a kind of energy.



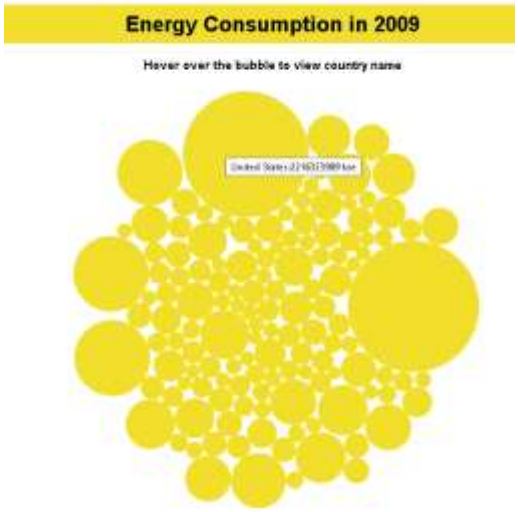
3. Rate of Energy Consumption

A multi-line interactive bar chart is visualizing the rate of increase in the energy consumption in five countries with highest rates of usage in 2010. The code is implemented to give detailed figures in a year to the user by hovering over the lines. The lines of the chart are created as per the data available for past 20 years, while circles are continuously giving values at the line breaks. On the top of the graph the year is also displayed for the circle point



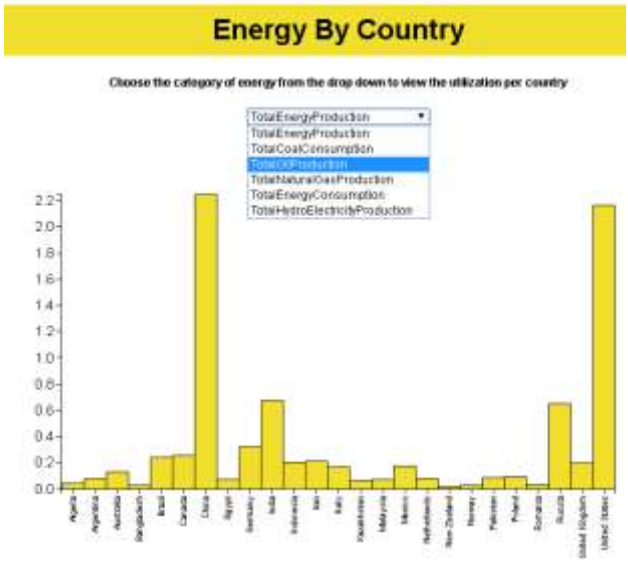
4. Energy Consumption in 2009

The bubble chart is coded to visualize the energy consumption in 2009 (as the latest data available in the dataset is for the year 2009), each bubble is denoting the country and the size of the bubble is dependent on the amount of energy consumed in the country, for example China has the largest bubbles because the energy consumed in China is highest in the world.



5. Energy by Country

The dynamic bar chart is adjusting the data as per the value selected from the dropdown menu. All the categories of energy data are available only for 27 countries which can be viewed in the bar chart. The bar chart is also coded to dynamically change the y-axis along with the rectangle bars depicting data as per the selection made by user.

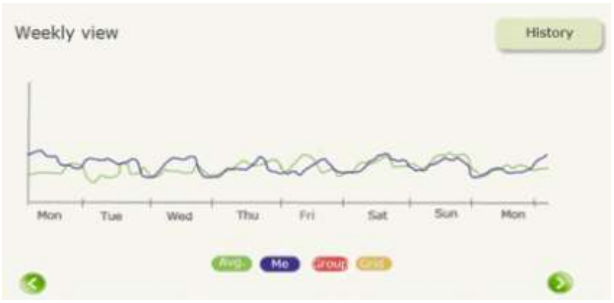


Related Work:

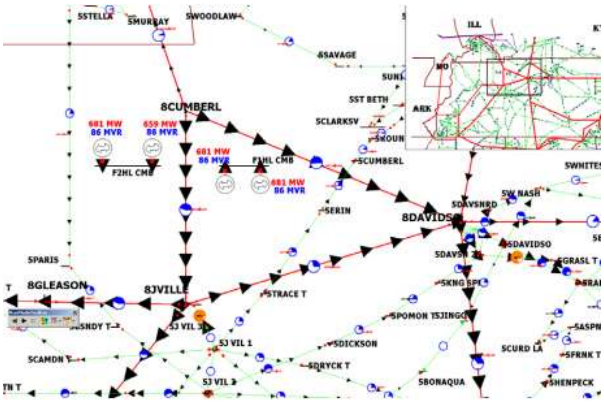
Visualization techniques have proven to be of great use in studying systems in an off-line environment. The research paper *'Real-Time Data Retrieval and New Visualization Techniques for the Energy Industry'* [9] analyzed the large amount of data related to the electric power system by using animated arrows, dynamically sized pie charts, contouring, etc. The simple

visualization methods, pie and stack performance charts (on the left) were efficiently utilized to show the energy consumption among building sub-systems in the research *'Enabling Complex Building Energy Visualization by Integrative Event-Driven Data Provisioning'* [10]. In the similar field of research, *'SAGA: Tracking and Visualization of Building Energy'* [11] used the bar chart to signify individual device energy plotting like the dynamic bar chart used in the project which is representing a unique category of energy.

The research paper *'Visualization and analysis of electrical energy consumption in laboratories'* [12] also used dynamic bar chart (on the right) to present a time series of the energy consumption, were the time scale and period could be changed by making a selection in the calendar. In her research*,' Combining smart energy meters with social media: Increasing energy awareness using data visualization and persuasive technologies'* [13], Julie used a bubble chart in the form of a light bulb, which shows the percentage of energy usage in each room of the house hold and a line chart to give detailed overview of each user's usage, now and over a period of time.



In the paper '*Displaying Aggregate Data, Interrelated Quantities, and Data Trends in Electric Power Systems'* [14] the wider-area view of electric power system was displayed by a thumbnail like the rectangular box displaying data in the world map. The thumbnail occupied the upper right corner of the display. The rectangular box appeared in the center of the thumbnail and outlines the contents.



The research *'Can Twitter Save Lives? A Broad-Scale Study on Visual Social Media Analytics for Public Safety'* [15] used a world map along with the zooming feature to visualize the tweets across the globe. Also, *'Visualization of Real-World Web Services Based on Fuzzy Logic'* [17] investigates techniques for supporting individual users in choosing appropriate Web services according to their specific needs and accessing their favorite Web services by using a map to display similar web services in a business domain and results of a particular web service in the rectangular block.

The research *'Correlation and Visualization Analysis of Large Scale Dataset GDELT'* [18] shows the media who are interested in reporting the events occurred in South Korea using a bubble chart. The larger circle denoted the higher frequency like the higher radius of bubble chart in the project are depicting higher energy consumption and vice versa.

Various systems have been proposed in recent years to assist users by providing them with better feedback about their energy use, mentions the research paper *'Visualization Support for Comparing Energy Consumption Data*' [19]. A particular type of normative comparison is one in which individuals compare their energy consumption against those of others in their collective settings. An example of this would be people living in the same house, or working in the same office building, comparing their own individual energy usage with those of others in the same household or office [30]. An interesting research worth mentioning is *'Temporal Visualization of Energy Consumption Loads Using Time-Tone*' [20] that used color coded timelines to assist users by displaying variations in energy consumption by different categories of household devices over time, and their respective contributions to the total energy usage load.

Hurdles in the Implementation:

In the complete project implementation, many obstacles were faced. The main obstacle was to clean the dataset and mold it as per the requirements of the project. The JSON file reflecting the data in the world map is originally a meteorite strike JSON file [8] on GitHub, due to less knowledge of nested JSON files, writing a python script to modify and add the values from multiple datasets to this file was a complicated task. Moreover, if any issue occurs in the code it is easy to debug using Console but difficult to fix although sometimes the reason might be just a

single semicolon missing in the code. Some implementations were almost impossible to crack, for example, the addition of text on the bubble chart. Despite trying assorted options it could not be achieved. Getting the dimensions of the container right was another stumbling block.

CONCLUSION:

D3js is a language with endless possibilities and with such type of versatile dataset, it is difficult to comprehend where to stop. The project can give an overview of the statistics and information on how many number of different categories of energies are being consumed and produced in the world. But it has few limitations, for example, due to sparse datasets, a sizable number of countries reflect 'Data not available' in the map, which is a minor drawback, but it could be rectified if the data is available. The magnitude of implementation is huge but with the visualization techniques used in the project the user can effortlessly contemplate the statistics.

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[5] https://cdnjs.cloudflare.com/ajax/libs/jquery/2.2.2/jquery.min.js

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