Design of Electricity & Energy Review Dashboard using Business Intelligence and Data Warehouse

Atharva Girish Puranik, Abhijit Gohokar, Ravi Batheja, Nirman Rathod, Ojasvini Bali

Abstract— The advances in the computer and electronics industry along with the widespread of on-the-move internet has lead an enormous of data being generated on daily basis. Such large data stored in the datacenters is critical for businesses to analyze and plan future business strategies. Business Intelligence is thus used to transform the large raw data into meaningful and useful information. In this work the concept of Business Intelligence in combination with Data warehousing is applied to design an Electricity & Energy Review Dashboard by taking a scenario which involves the use of large raw data for electricity and energy production and consumption in US for last few years.

Index Terms— Unstructured data, Business Intelligence (BI), Competitive intelligence, Data Warehouse, MicroStrategy.

I. INTRODUCTION

The business environment has been constantly changing, and has become more and more complex in the last few decades. With the view to improve financial results along with production capacity or sales figures, requires several ad-hoc decisions to be made that impact the operational, tactical and strategic levels. While facing these severe decisions which have an impact on the business, organizations feel the need for obtaining the right amount of *knowledge* to undertake actions and ensure the effectiveness of a decision. This *knowledge* requires a transformation from data (raw facts) to information (meaningful, useful data) requires the need of what is broadly referred to as Business Intelligence (BI). BI is a broad term for software technology that provides reporting and analytical tools for pulling data from various sources to generate customizable reports and support decision making. It allows administrators and other business decision makers to view reliable, timely data.

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The term BI first originated in 1958 when IBM researcher Hans Peter Luhn used the term business intelligence. He defined intelligence as:"the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal" [1]. In 1989, Howard Dresner proposed "business intelligence" as an umbrella term to describe "concepts and methods to improve business decision making by using fact-based support systems" [2].

Evelson, Boris (2008) in Forrester Research gave the broad definition of Business Intelligence. “Business Intelligence (BI) is a set of methodologies, processes, architectures, and technologies that transform raw data into meaningful and useful information used to enable more effective strategic, tactical, and operational insights and decision-making” [3]. Lida Xu, et al. (2007) also mentioned the BI definition in a research for IEEE International Conference. “Business intelligence is the process of gathering enough of the right information in the right manner at the right time, and delivering the right results to the right people for decision-making purposes so that it can continue to yield real business benefits, or have a positive impact on business strategy, tactics, and operations in the enterprises” [4].

The well utilization of Business Intelligence has become the key for the business performance of any business organization and a necessity in the competitive markets. Often BI applications use data gathered from a data warehouse or a data mart. However, not all data warehouses are used for business intelligence, nor do all business intelligence applications require a data warehouse.

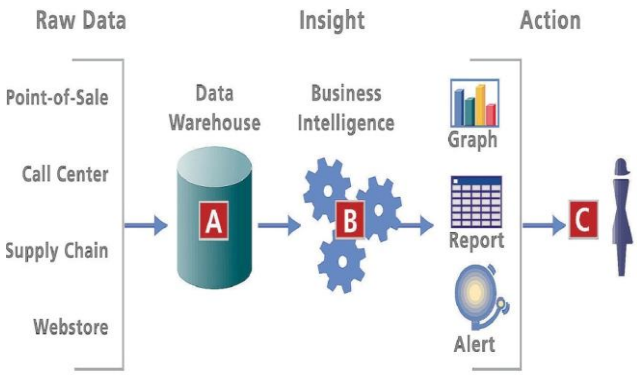

Figure 1: A high level business design

Data warehousing deals with all aspects of managing the development, implementation and operation of a data warehouse or data mart including meta data management, data acquisition, cleansing, storage management, data distribution, data transformation, operational reporting, security management, backup/recovery planning, etc.

Business intelligence, on the other hand, is a set of software tools that enable an organization to analyze measurable aspects of their business such as sales performance, profitability, operational efficiency, effectiveness of marketing campaigns, market penetration among certain customer groups, cost trends, anomalies and exceptions, etc. Typically, the term "business intelligence" is used to encompass OLAP, data visualization, data mining and query/reporting tools.

To bring out the clear distinction between the two the data warehouse can be thought of as the back office and business intelligence as the entire business including the back office. The business needs the back office on which to function, but the back office without a business to support, makes no sense. The following are some of the common terminologies that are employed when one talks about BI [5]:

KPI: Key Performance Indicator (KPI) is a measure of performance which are commonly used to help an organization define and evaluate how successful it is, typically in terms of making progress towards its long-term organizational goals.

OLAP: Online analytical processing is automated processing and analysis of data, defined by olapreport.com as "fast analysis of shared multidimensional information.

OLTP: On-line Transaction Processing is characterized by a large number of short on-line transactions (Insert, Update, Delete). The main emphasis for OLTP systems is put on very fast query processing, maintaining data integrity in multi-access environments and an effectiveness measured by number of transactions per second.

Reports: These are the focus of business intelligence investigations. It is a request for specific, formatted data from the data warehouse. It comprised of a Template and Report

Filter Dashboard: An executive dashboard is a user interface, usually Web-based and often with a BI system/data warehouse on the backend, that organizes and presents information in a way that is easy to read and interpret.

II. PROJECT OBJECTIVE

This research work aims to employ the concept of Business Intelligence and Data warehousing to design and deliver optimized analytical information to a business organization. As Energy resources is very important to the global economy. All economic activity requires energy resources, whether to manufacture goods, provide transportation, run computers and other machines. Thus in this project work an Electricity & Energy Review Dashboard has been designed by taking a scenario which involves the use of large raw data for electricity and energy production and consumption in US for last few years. The data that has been used is obtained from www.census.gov and www.eia.gov. The proposed dashboard has been designed using MicroStratrgy, which is Business Intelligence and Mobile Intelligence software.

The proposed end-to-end Business Intelligence project on energy resources consists of following three parts:

A. Data Discovery
B. Extract Transformation and Loading
C. Reporting

A. Data Discovery

This is stage which involves the collection data for a business from all of its datacenters as in Fig 1. For our case the data used is available in the form of Microsoft excel sheets taken from www.census.gov and www.eia.gov. Some screenshots of these excel sheets are as show below:

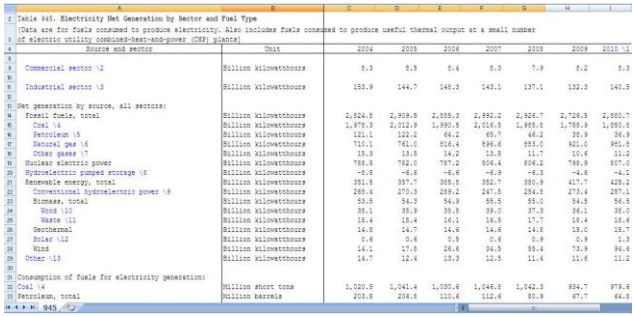

Figure 2: Electricity net generation by sector & fuel type

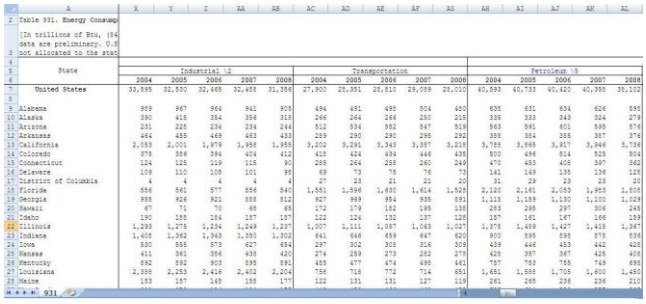

Figure 3: Sector wise energy consumption

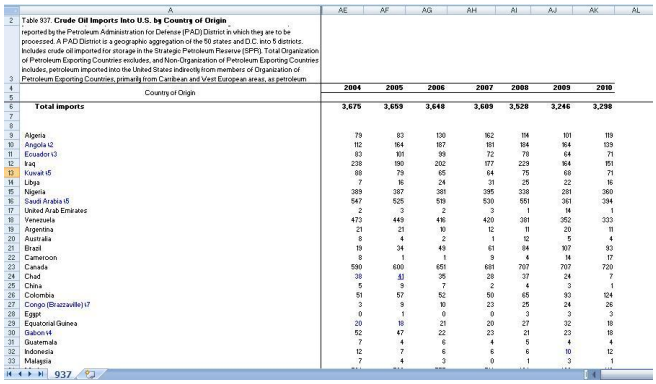

Figure 4: Crude oil import into US from different Countries

B. Extract Transformation and Loading

This is stage which involves the actual extraction of useful data from the raw data based on the metrics. These metrics in our case are Production, Consumption, Imports, Electricity Consumption and Prices, Electricity Generation, Sales and Revenue. It also includes Data type conversions and Unit conversion.

```
SQLQuery5.sql - I...AIO\Atharva (61))
INSERT INTO [Energy_DWH].[dbo].[FA_fuel_state_year]
           ([State_id]
           ,[Year_id]
           ,[Fuel_id]
           ,[Imports]
           )
(SELECT state_id, 21 as year_id, 2 as fuel_id, [2010] as Imports
FROM [Energy_Stage].[dbo].[Imports] I
JOIN Energy_DWH.dbo.dim_country C
ON (rtrim(ltrim(I.[Country])) = C.country_desc)
JOIN
(SELECT Country_id, State_id
from Energy_DWH.dbo.dim_state
where state_id < 0
) T
ON (C.country_id = T.country_id)
)
```

Figure 5: An example of the SQL script written

This transformed data is then loaded into the data warehouse according to the designed Data Model using SQL scripts. Fig 5 below shows screenshots of two of these scripts

C. *Reporting*

This stage is where the BI comes into picture. MicroStrategy as a tool is used to generate various analytical reports from the data in the data warehouse. These reports are then presented using a Dashboard, which can be utilized to have the desired outcomes and knowledge of present business sales, production, etc sector wise and is used to intelligently predict the business status for the next year and/or can be used to analyze the steps for future growth. The sample reports used in the project are:

- Summary page reports: (Electricity)
  - Electricity Generation by type of fuel.
  - Consumption and Prices by end use sector.
  - Revenue and Sales by States.
- Detailed page reports: (Fuel)
  - Import by country of origin.
  - Production and Consumption by states.
  - Import, Production, Consumption and their projections. (Yearly)

III. PROJECT METHODOLOGY

Following are the implementation steps of the proposed Electricity and Energy Dashboard using MicroStrategy:

- Selection of data – Source data Selection – in Excels/ MS Access/ other traditional Databases like SQL Server, Oracle, etc.
- Selection on the Reporting Tool – between MicroStrategy and Tableau
- Details User level analysis of the Source data
- Finalization of the types of Analysis to be done in the BI project
- Creation on the Data Model
  - Logical Data Model
  - Physical Data Model
- Source to Target mapping
- SQL Scripts to create the Data Warehouse based on the data model
- ETL – Extraction Transformation and Loading of the source data into the data warehouse according to the designed Data Model
- Connection of the Database with the BI Tool – MicroStrategy or Tableau
- Creation of Attributes, Facts, Metrics and required filters and prompts
- Custom SQL Queries for the reports
- Creation of Business Intelligence reports
- Creation of the Business dashboard
- Final Project and Dashboard Presentation

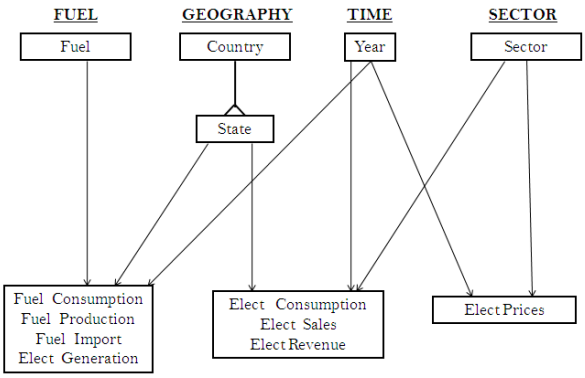

Figure 6: Logical Data Model

Fig 6 above logical model of the transformed data. It is clear from the figure that all the energy resources are categorized into the type of fuel, geography, time and sector. Thus fuel consumption is the data table with attributes such as fuel type, the consuming state, yearly consumption, sector consumption, etc.

Fig 7 below shows the practical model design of the logical model shown in Fig.6. In Fig 7 the tables orange in color are the fact tables which are obtained from the dimension tables in the "DWH" database loaded into the data warehouse.

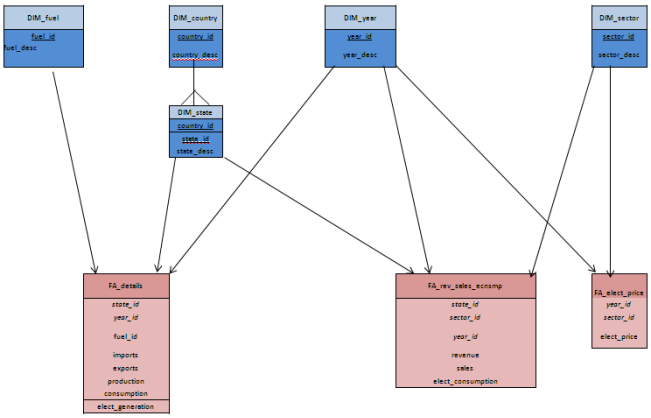

Figure 7: Physical Data Model

IV. RESULTS

Fig 8 below the report generated for Yearly Electricity Consumption by Sector, Fig 9 shows the yearly electricity generation for (fuel) report, Fig 10 shows the Yearly Electricity Prices by Sector report and Fig 11 gives the Yearly Sales and Revenue by State.

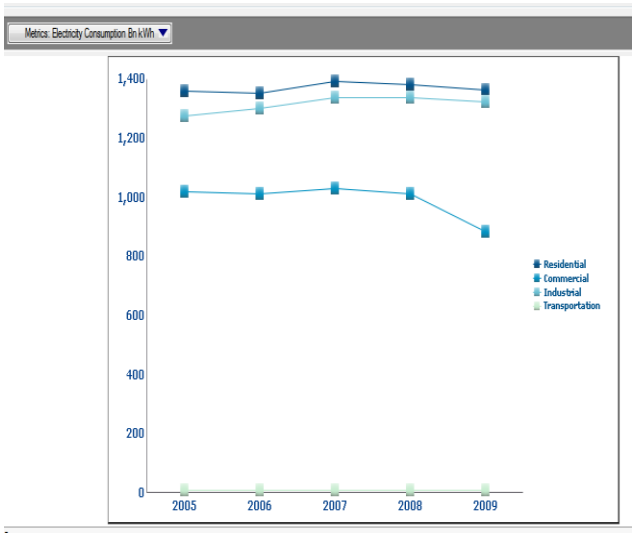

Figure 8: Report for - Yearly electricity consumption by sector

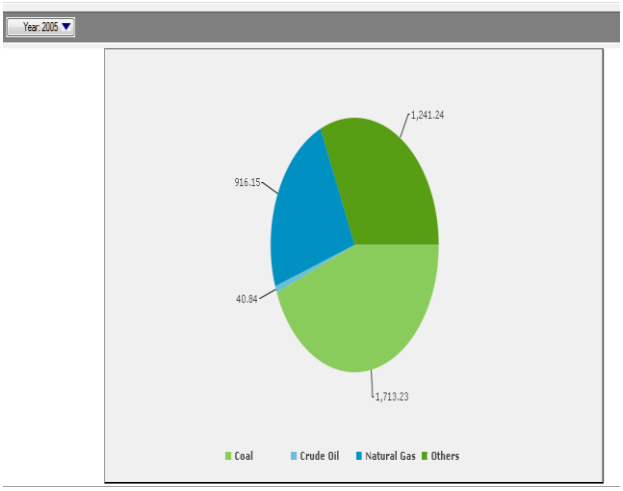

Figure 9: Report for - Yearly electricity generation for (fuel)

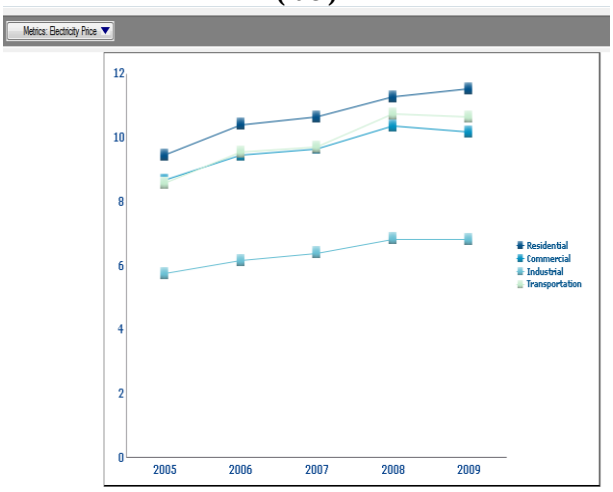

Figure 10: Report for - Yearly electricity prices by sector

Year: 2005

State	Metrics	Sales Bn Kwh	Revenue Cents per kWh
Alabama		89.20	20.02
Alaska		5.91	34.15
Arizona		69.39	22.11
Arkansas		46.16	18.92
California		254.25	40.52
Colorado		48.35	27.43
Connecticut		33.10	43.35
Delaware		12.14	39.73
District of Columbia		11.82	22.82
Florida		224.98	32.27
Georgia		132.27	27.49
Hawaii		10.54	55.53
Idaho		21.85	15.61
Illinois		144.99	26.32
Indiana		106.55	27.63
Iowa		42.76	20.79
Kansas		39.02	19.35
Kentucky		89.35	16.18
Louisiana		77.39	31.78
Maine		12.36	31.14
Maryland		68.37	32.16
Massachusetts		57.23	39.88
Michigan		110.44	34.64

Figure 11: Report for - Yearly sales and revenue by state

Fig 12 at the end of this paper shows the complete design of the designed US Electricity and Energy Dashboard. All the reports can be seen using the dashboard which includes:

- Electricity Generation by Type of Fuel.
- Electricity Consumption and Prices by End Use Sector.
- Electricity Generation, Sales and Revenue by State.
- Fuel Imports by Country of Origin
- Fuel Production and Consumption by State.
- Projections for Imports, Production and Consumption

As in Fig 12 the lower figure gives the statewise electricity generation, sales and revenue. The size of the block for each of the state gives the electricity generated by it and the color gives the revenue generated in cents per KWh, where green color gives the maximum revenue and red color indicates the minimum revenue. Thus Texas is the major electricity generator and New York is the one with the maximum revenue generator.

V. CONCLUSION

In this project work an Electricity & Energy Review Dashboard by taking a scenario of electricity and energy generation, consumption, import and export for US for last few years has been designed. The project involves the use of concept of BI and data warehousing. MicroStrategy has been used as a tool for the implementation. The designed dashboard gives the graphical analysis of the huge data and can be used to further the business enhancement as far US Electricity & Energy Generation and Consumption are concerned. The same BI model can be designed and applied for any sector.

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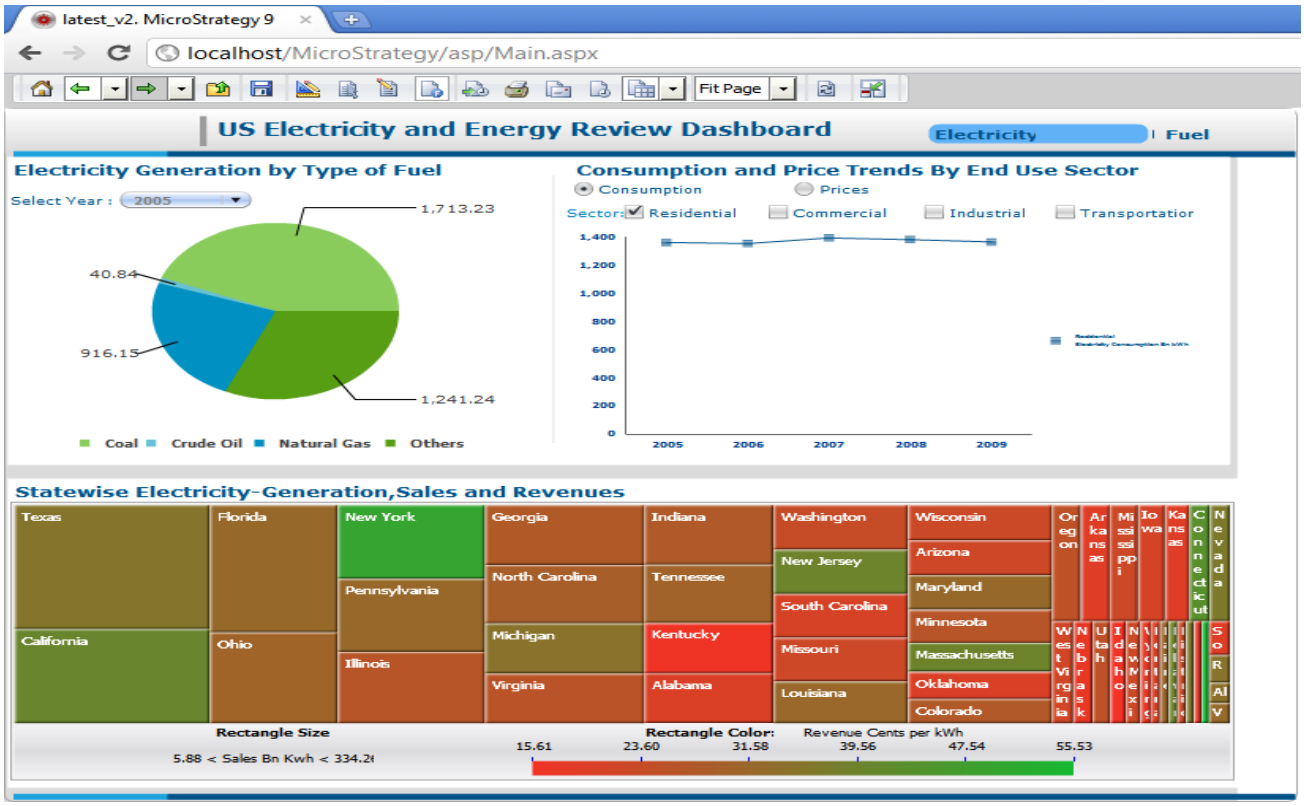

Figure 12: Design of Proposed Dashboard