SUPPLY CHAIN MANAGEMENT OF DOWNSTREAM RETAIL OIL DISTRIBUTION AND USE OF BIG DATA SOLUTION FOR COMPUTING ENERGY BALANCE CONCEPTUAL FRAMEWORK

ARVIND ANKALIKAR

Department of Mechanical Engineering , Sardar Patel College of Engineering Mumbai 400058

amankalikar@rediffmail.com

ABSTRACT: *As part of the overall supply chain of oil and gas industry, originating right from exploration onshore/offshore all the way up to retail distribution, finding out the energy balance is an important criteria to measure efficiency of the supply chain. Thus far, the effort has been to track the crude transportation to refineries and then the volume of oil distributed to terminals and retail stations from where customers can buy the fuel and lube products. However this distribution approach ignores an important aspect of energy balance which can track the efficiencies and losses at every stage. It must be noted that the supply chain is not merely about transporting crude but also about the native energy is properly distributed with minimum loss. Even a pilferage or adulteration could be a loss in the overall supply chain as there is a loss of energy in such cases. In today's energy starved world, it is important to track energy balance throughout the supply chain and identify vulnerabilities. Previously it was not possible to track and monitor the energy getting explored all the way upto consumption points. This paper is an attempt to develop a framework for creating a mass and energy balance of Fuel Value chain from refinery all the way up to consumption point such as vehicle, furnaces and other consuming points using contemporary techniques such as Big Data Solution, Super Clusters, GIS and mobility application.*

Key Words: Downstream, Big Data, GIS, Transportation, Retail, Oil And Gas

1. INTRODUCTION:

It is well known that the conventional energy made up of fossil fuel has a finite supply. It is not known yet for how long will we be able to source the conventional source of energy such as Oil and Gas, but it is fair to consider that the current known sources would last approximately 70 to 80 years at the current rate of consumption extrapolated for Moderate growth. The day is not far when the entire mankind would be closely controlling the way of consumption of the conventional energy, at least till such time we do not have any alternatives and discovery of credible unconventional sources of energy. The short term balance is as per the figure 1 below:

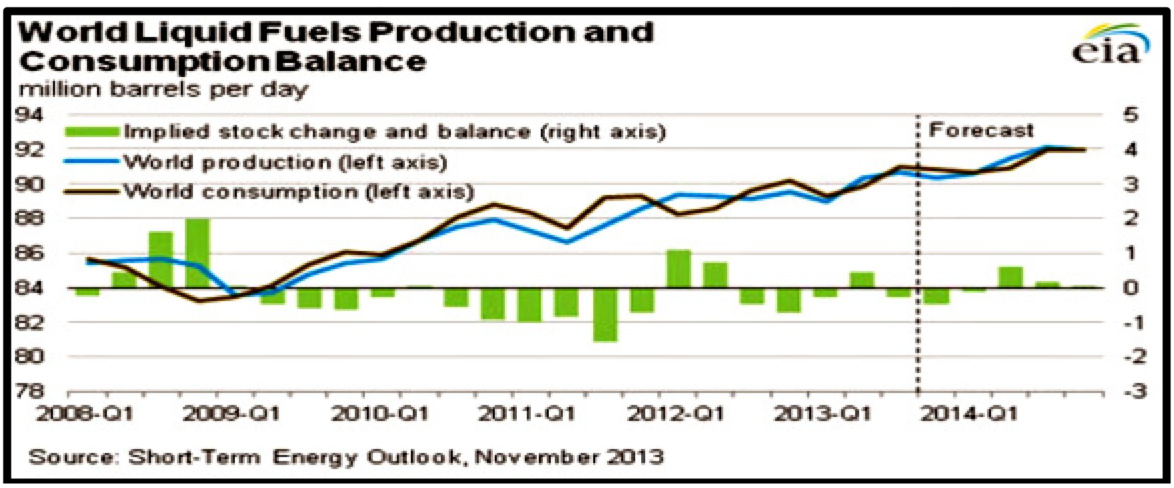

Figure 1: Global Production and Consumption Balance

It is also widely known that the currently available techniques, tools and frameworks do not adequately capture the loss in this vital source of energy across the entire supply chain. The supply chain spanning the oil exploration all the way up to consumption goes through several different process activities and transfer points. At a high level, these phases are described in the below Figure 2:

- Crude Exploration(onshore or offshore)
- Crude Transportation pipelines, barges, tankers
-
- Refinery operations
- Oil Terminal systems
- Depot operations
- Finished product transportation through pipelines, Integrated Railway Wagons and tankers to retail stations, customers, industrial and other consumers
- Retail station to individual vehicles/cars/Automobiles

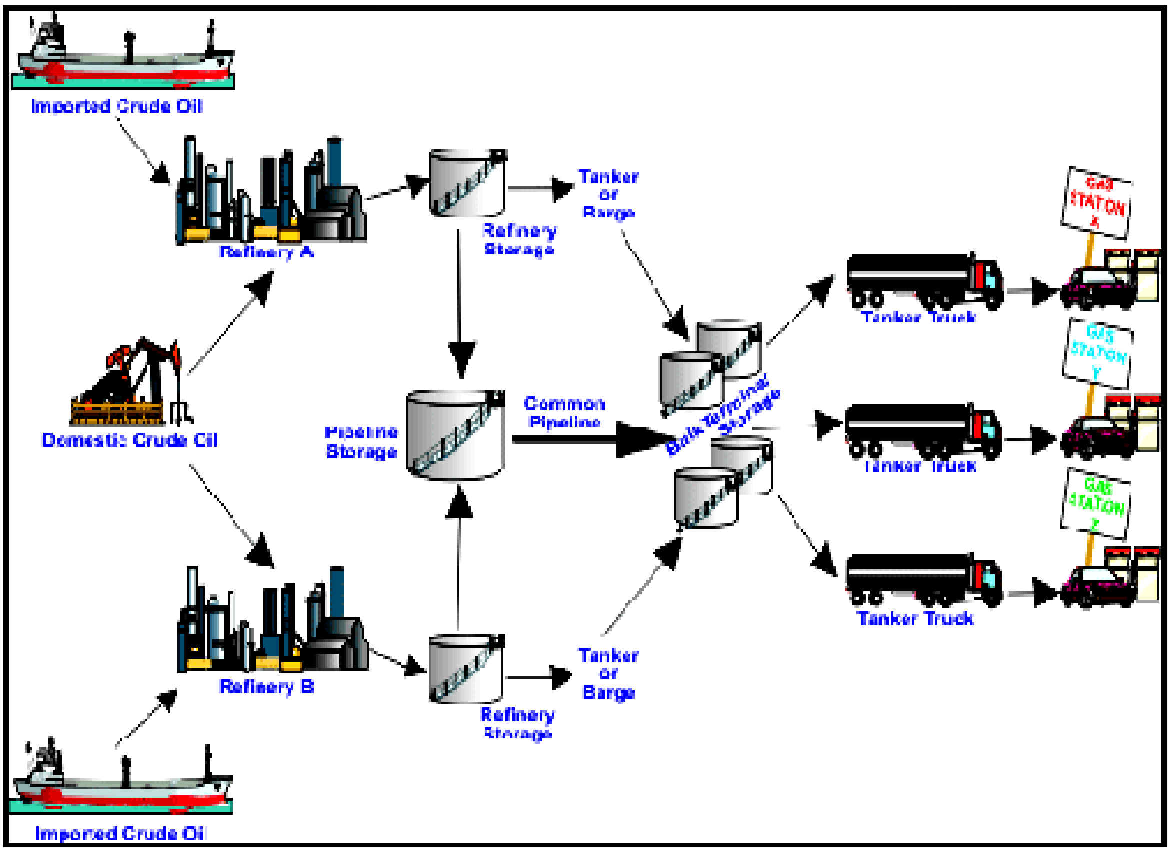

Figure 2: Supply Chain of Oil and Gas products – Exploration to Retail

It is important to know that during every process and activities, there are losses occurring in the supply chain. These losses are of various types such as emissions, loading, leakages, process wastes, pilferage, evaporation etc. As per the known statistics the losses from source of Oil to retail distribution point at gas station is of the order of approx. 0.3 to 1% *(source: US Environmental Protection Agency publications).*While the losses of this nature result in to environmental issues, they also result in to loss of energy in the overall supply chain.

This paper is an attempt to develop a futuristic framework using contemporary techniques to first identify supply chain efficiencies, understand and track the consumption of energy including wastages such that the entire energy is balanced across the supply chain all the way up to consumption point. The technologies used in creating such supply chain energy balance is Geographical Information Systems, Big Data architecture, In memory computing frameworks and host of networking protocols being used for data capture and analysis.

The contemporary technique of using big data solution primarily facilitates capturing of structured as well as unstructured data in to a standardized meta data layer. Such data collected can then be used to identify the individual consumers (including consumption patterns, efficiency parameters and would give us an opportunity to optimise the energy usage across the supply chain including areas where the consumption is not so efficient at the consumption point. The approach is for tracking only the downstream operation from Refinery to retail and then to each and every vehicle and consumption points across supply chain. Adaptation of this framework would need considerable intervention of government agencies including formulation of policies and regulations.

.

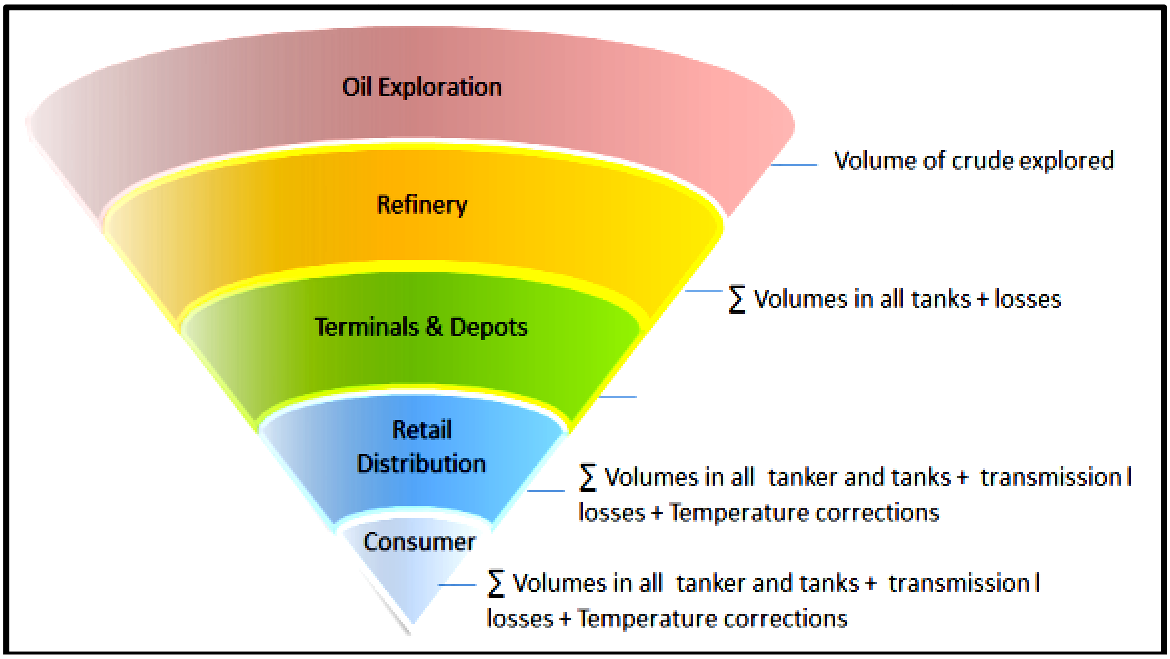

Figure 3: Constituents of mass balance during each phase within supply chain

2. PROPOSED FRAMEWORK:

Since the proposed framework covers the downstream supply chain, the energy and mass balance would be worked out from Refineries to end consumers including the retail gas stations. Typical every refineries will be holding stocks of refined oil which could include Petrol, Kerosene, Diesel. Each of these fluids have varied calorific values which determine the level of energy the stored fuel possess. This energy source stored in the refinery tanks is then distributed across multiple consumers. The typical consumers are:

- Transportation needs through vehicles, ships, barges etc
- Industrial consumers furnaces, construction work, generators etc
- Domestic consumptions

By far the transportation sector constitutes bulk of the consumption of energy.

The supply chain and the complexities thereof look as per figure 4 below:

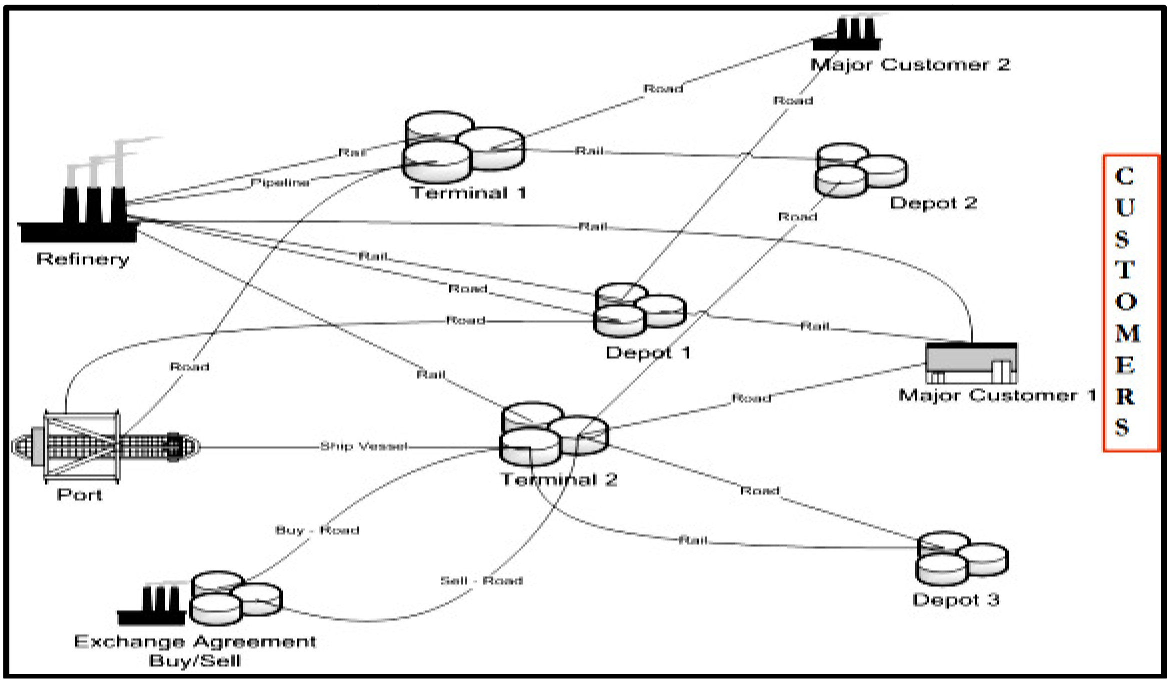

Figure 4: Supply Chain Complexities

3. BIG DATA SOLUTION:

In 2012, Gartner defined it as follows: *"Big data is high volume, high velocity, and/or high variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization.*

The framework proposes computing the consumptions at every retail point and create a network of all vehicles and track their consumption on continuous basis. The energy and mass balance will be:

Refinery Storage (Millions of Gallons)= ∑ of {Volume dispensed to tankers + Transported through other channels such as pipelines + Leakages + Temperature and density correction}

We can now use big data applications which would cater to large amount of data as well as high data velocity for capturing data of volume dispenses

Fuel in each tanker = {Fuel dispensed at each gas station + Leakages+ Temperature and density correction}

The data analysis can further be done as below:

Fuel received at each gas station = {Fuel dispensed for each vehicle + Leakage + Temperature and density correction}

The framework proposed can track and help in analysing energy balance as below:

Consumption in each vehicle = Fuel filled up periodically over a period of time (Daily / weekly)

This also can be computed by

Total energy through fuel filled per vehicle = {Useful energy utilization for displacement (to be tracked through GIS)+ inefficiencies of the engine +Temperature and density correction}

Similar consumption figures will be tracked for every consumer of energy.

The above approach while may look complex, but can easily be achieved using the big data architecture as presented in Figure 5 below:

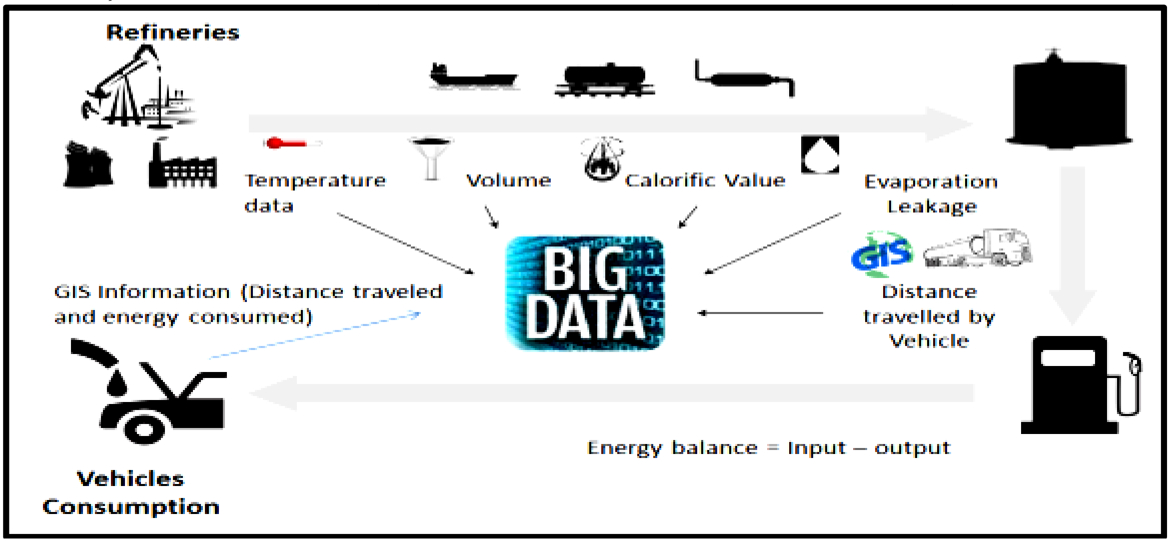

Figure 5: Big Data system capturing information from various sources

The approach will basically include the following:

- All the data about crude production, calorific values along with density and temperature information is collated and balanced against the supplies to refineries. All the wastages will be identified and captured
- The input to the refinery would then be tracked with respect to distillation process and yield derived from the process carried out. The energy of the fuel thus created will be balanced with crude supplies refinery has received
- The output/supplies from refinery will be tracked and each consumption point stored in a big data system. This will include transports through tankers, pipelines as well as corrections due to temperature
- The retail gas stations will also be subjected to energy balance with information tracked for consumption per vehicle or consumption point. This will become essential as without such tracking it will be difficult to track where the energy is getting consumed.
- Each vehicle level consumption and relative efficiencies will then be tracked.
- This will also be done for all other consuming points such as:
  - Ships
  - Airlines
  - Furnaces/heating points
  - Any other industrial consumers of energy

Such system will be need of the hour as eventually we all need to control the consumption points of the fuel. The big data architecture will enable us to analyse the data in multiple ways and help in managing our energy needs significantly better. The systems involved in managing such complex architecture are:

- Back end Enterprise Resource Planning
- Process control computers and integration will PLC/DCS/SCADA

- Big Data Servers with data structure
- Business Rule engines
- Integration architecture
- Integration with environmental data such as temperature

The key advantages of developing this framework are to not only get near accurate information on the energy balance throughout the supply chain but also to get following additional information:

- Supply chain vulnerabilities
- Overall consumptions by vehicle and ability to find out efficiency of engine
- Data analysis to propose strong regulatory framework for efficient usage of energy
- Bringing in automobile maintenance framework for superior engine efficiency
- Identifying pilferage and adulteration points and eliminating the same
- Proper town planning
- Retail outlet planning
- GIS integration will help in route and road planning

4. CONCLUSION:

Energy is precious and will get scarce. The oil and gas industry will eventually have to track energy consumption right at the point where it is getting used. This paper has presented an architecture by which not only can such data elements be tracked but a near accurate energy and mass balance can be created for a retail oil and gas supply chain. The architecture is validated with the existing applications which leverage similar architecture. The energy and mass balance will also help track all such points which make the supply chain inefficient and identify vulnerabilities from the point of view of losses. The system is capable of capturing data using unstructured sources such as temperature by locations etc.

5. NEXT STEPS:

The research steps would now be elaborating the architecture and demonstrate how the overall framework would result in to gaining significant intelligence. Research will also include developing an energy balanced equations and identify points of wastage and losses. The integrated architecture of GIS, ERP, BI and Big Data system will be developed to demonstrate operationalization of this framework.

6. REFERENCES:

1] Ministry of Petroleum and Natural Gas, Report of the working group on Petroleum & Natural Gas sector for the IX Plan (2007 -2012)

2] BP Statistical Review of World Energy, June 2013

3] Research Paper by Sartorius K, Eitzen C, Hart J on Examination of the Variables Influencing the Fuel Retail Industry, University of the Witwatersrand, Johannesburg, South Africa

4] Gartner Report on Big Data solution 2012

5] IBM demystifying Big data, Practical guide of transforming the business of government

6] Supply Chain For Liquids, Out of the box approaches to liquid logistics, By Wally Klatch

7] Sun Microsystems e-Gas station framework