FRAMEWORK FOR CREATING AN EFFICEINT GAS MARKET IN INDIA

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Akhil Mehrotra

Declaration

I hereby declare that this thesis **"Framework for creating an efficient gas market in India"** is my original work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor any material which has been accepted for award of any degree or diploma of the university or other institute of higher learnings, except where due reference is provided in the text.

Akhil Mehrotra
Mumbai, April 2018

UPES

Thesis Completion Certificate

This is to certify that the thesis on **"Framework for creating an efficient gas market in India"** by **Akhil Mehrotra** in partial fulfillment of the award of the Degree of Doctor of Philosophy (Management) is original work carried out by him under our joint supervision and guidance.

It is certified that the work has not been submitted anywhere else for the award of any other diploma or degree of this or any other university.

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Contents

FIGURES

TABLES

1   ENERGY AND GAS SECTOR REVIEW

1.1   Background

Energy is a key resource for the development of any country. The GDP of India on nominal terms is $2.45trillion, which makes it the sixth largest economy of the world. However, India ranks third in terms of purchasing power parity with a GDP of $9.49 trillion (IMF, April, 2017). India, home to 18% of the world population, (1.3 billion people) uses merely 5.3% (year 2014) of the world's primary energy. India has a low per capita consumption of 0.62toe as against the world average of 1.90toe (IEA, India Energy Outlook, 2015). The thirteenth plan document of government of India envisages more than doubling of the per capita energy consumption in India to 1.2toe by 2030, which would, further add pressure on the energy availability. However as per latest estimates the per capita consumption has declined to circa 0.56toe, demonstrating the efforts put in by government are either ineffective or inadequate.

Furthermore, the energy demand in India is targeted to grow at 6% with the targeted GDP growth rate of 9% (GoI M. , 12th -13th five year plan, 2013). In the year 2016-17, the government spent $70 billion (Rs 4.70 lakh crore) to import 213 million metric tonnes (MMT) of oil. This oil import bill is estimated to increase to $80 billion (Rs 5.23 lakh core) to import 213 MMT of oil the in the financial year 2017-18 (PPAC, 2017, Nov). Energy security is a key strategic priority for India. Securing access to adequate and affordable sources of energy is fundamental to supporting India's economic growth aspirations. (Kelkar, 2014). To achieve this, domestic production of oil & gas needs to increase, to reduce import dependence by 10% (from current, 77% to 67%) by the year 2022. Further, the import dependence needs to be brought down to 50% by the year 2030 (Indian Global Hydrocarbon Summit, 2015).

The challenge, for India is to ensure that, energy is available and accessible to its 1.3 billion people at affordable price, while it meets its obligations on carbon emissions. Different countries have taken different routes for meeting this objective. The route to energy availability and self-sufficiency depends upon factors like; availability of

energy sources within the country along with the infrastructure to transport such energy, import options, stage of its economic development, choice of fuel mix, and depth of development of its core institutions required for governing such development

Thus, the challenge for India is dual, making energy available at affordable price and meeting its emission targets (COP21, INDC). In this backdrop, India needs to explore clean fuel option of increasing share of gas in the energy mix along with renewables. This cannot happen without a well-developed strategy and roadmap.

The primary energy consumption of the world in the year 2016 was 13,276 Mtoe. Asia Pacific consumed around 5579 Mtoe of which India's contribution was 723.9 Mtoe.
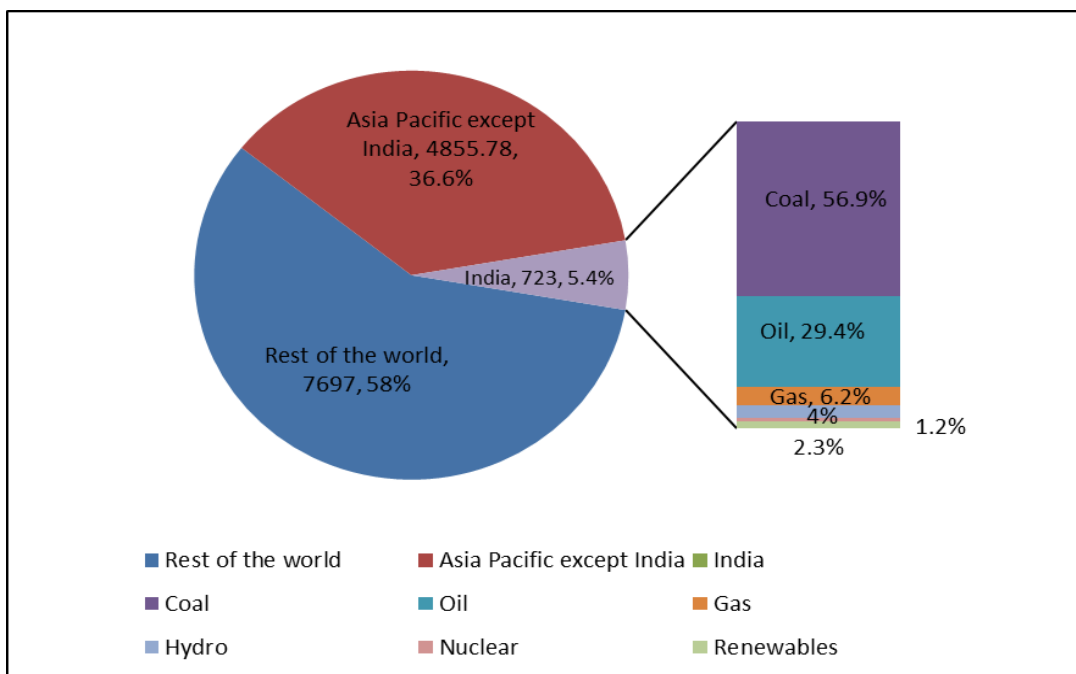
Figure 1: World Primary energy consumption (Mtoe) & India energy mix

Top 5 nations (China, US, India, Russia and Japan) consumed 54% of the total primary energy consumed in the world. India retained its position as the third largest primary energy consumer in the world in the year 2016 (after China and US) accounting for 5.4% of the world consumption. In the year 2016, oil & coal constituted 86.3% (29.4% oil & 56.9% coal) of the India's primary energy consumption. (BP, 2017).

Historically, oil and coal have dominated, the world, as the main source of energy. However, the past few decades has seen a quantum jump in development of gas and renewables as an energy resource. Gas being considered a clean fuel, has increased in importance, in the energy map of the world. Worldwide, the consumption of gas has
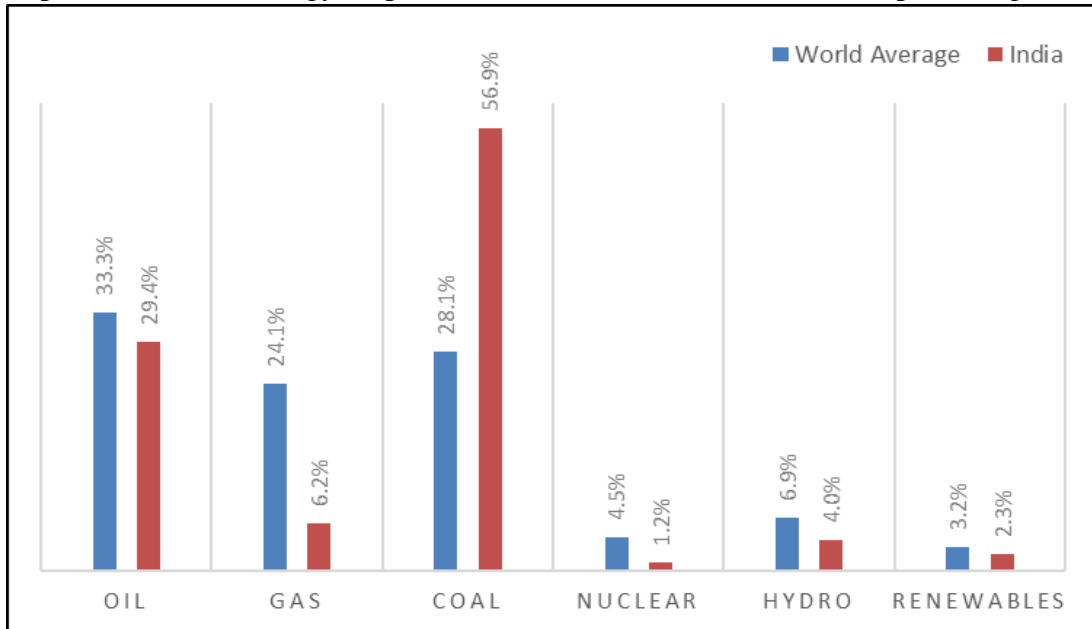
Figure 2: Energy Mix for 2016 - World v/s India

increased fivefold in the last 50 years, increasing from a meagre 644 Billion cubic meters (BCM) in 1965 to 3543 BCM in 2016. India has a higher coal usage in the energy mix compared to the world average and much lower gas in the energy mix (figure 2). (BP, 2017).

India has 0.7% (43.3 TCF) of the proven gas reserves of the world. The current production of gas in India is just 0.8% of the total world production at around 27.6 BCM while it consumes around 50.1 BCM of gas which is circa 1.4 % of the total world consumption (BP, 2017). Even with imported gas, the share of gas in the Indian energy basket has always been below 10% in last few years. In comparison, the developed world markets like United States, United Kingdom, Japan and Australia have 15-35% of the gas in the total energy mix (Figure 3) while the world average has
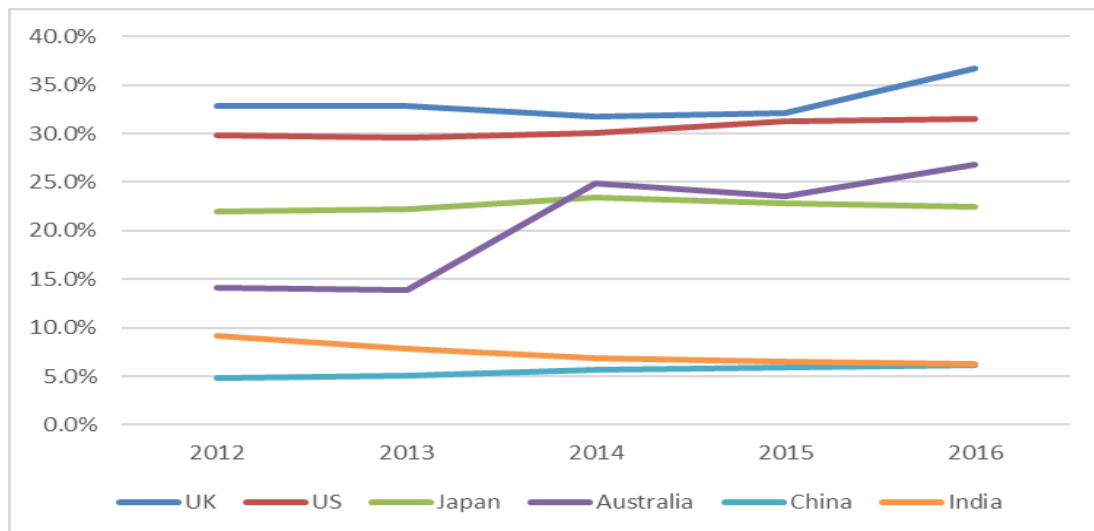
Figure 3: Comparison of Gas in energy mix - Developed world V/s India

been a healthy 24.1%. There has been a steady decline in the share of gas in India while the share of coal has increased. The decline in share of gas was primarily due to lower availability of cheaper domestic gas, which in turn as driven by lack of interest in the oil & gas acreages in India. Even with increase in capacity of the import terminals due to expansion of existing terminals and commissioning of new terminals, gas could not increase its share due to unavailability of transmission pipeline to connect markets (Kochi terminal operating at 15% capacity) and unaffordable LNG prices.

The gas production in India has always lagged the consumption. The deficit has been in the range of 20-45% in the last 10 years (figure 4) with the gap met by imported LNG. India (6.5%) is the fourth largest importer of LNG after Japan (31.3%), South Korea (12.7%) and China (9.9%). Asia remained the key market for LNG trade consuming circa 70% of the world LNG supply while Qatar retained its position as the largest supplier contributing 30.1% of the world LNG (BP, 2017). The unmet demand for gas is very high in India, but such demand is price sensitive and cannot afford high

cost of imported gas and hence the demand is met by cheaper and higher polluting fuels like coal & oil.

The growth rate of the Indian oil & gas industry in the last five years has been negative. Table 1 shows the growth rate of Indian oil & gas sector in last five years (DIPP, 2016). The negative growth rate, even after steep decline in years 2012-13 and 2013-14 is discomforting. Also, the foreign direct investment in the oil & gas sector in last 16 years, from April 2000 to September 2016 was only USD 6.7 billion. This is only 2.6% of the total FDI received in the country, during this sixteen year period. (DIPP, 2016)

Table 1: Growth of oil & Gas Sector in last 5 years

Financial Year	Oil	Gas
2012-13	-0.6%	-14.5%
2013-14	-0.2%	-13.0%
2014-15	-0.9%	-4.9%
2015-16	-1.4%	-4.2%
2016-17 (Until Dec)	-3.2%	-3.3%

The decline in gas production continues although at a slower pace (refer Table 1) demonstrating that the policy measures of government of India (GoI) is not able to reverse this trend. This despite the fact, that GoI declared in 2013 that the share of gas in the primary energy mix is projected to grow from current 8.7% to at least 20% by the year 2030 (GoI M. , 12th -13th five year plan, 2013).

India would be the driver of world energy growth in future due to a) Rising Income and urban population; b) Need for large infrastructure development and c) Make in India push by the current government. (IEA, Key world energy statistics, 2015) (BP, 2017) (GoI M. , 12th -13th five year plan, 2013). GoI has envisaged that natural gas would have to play a bigger role in the Indian energy mix (20 percent target by 2030) and would be a factor in the economic growth of the country

The total investment required in the oil & gas sector in the 12th five year plan was USD 75 billion (GoI M. , 12th -13th five year plan, 2013). The investment required in the gas sector alone is to the tune of USD 38-45 billion if share of gas require to go up from current 5-6% to even a modest 15% (ibef, 2017). To achieve this, government of India needs to attract investment in the gas sector which is possible by sending right
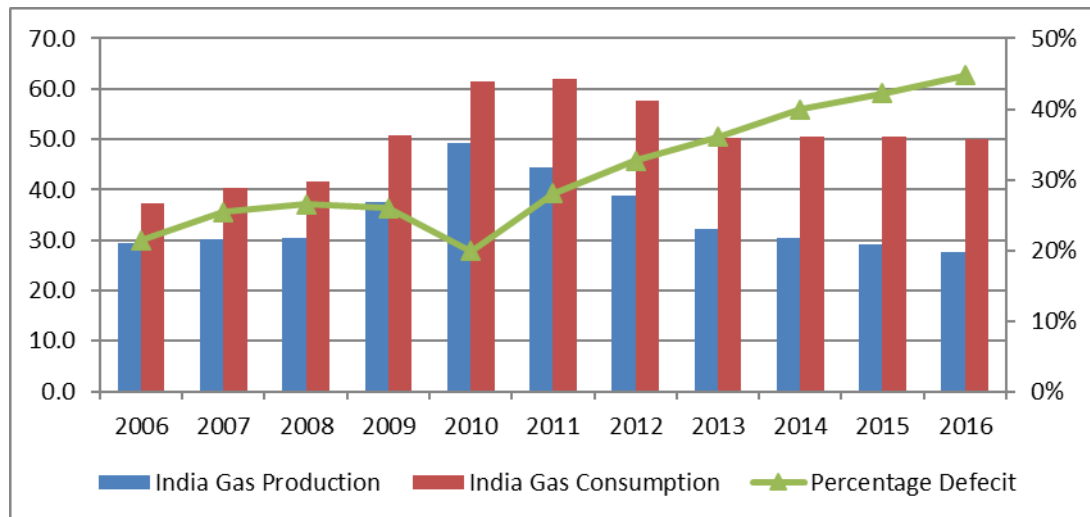
Figure 4: Deficit in gas production - India

price signals which can be achieved only through development of a vibrant, liquid, transparent and an efficient gas market.

(Mehrotra, Gupta, & Pandey, Oct, 2015)

1.2   History of Indian oil & Gas market

The start of the development in the Indian oil and gas sector started in the year 1859. The evolution of the Industry can be divided into five distinct phases for ease of understanding.

a) Pre- Independence Era (1866-1946)
b) Nomination Era (1947-1978)
c) Pre-NELP Exploration era (1979-1990)
d) Pre-NELP Field round era (1991-1996)
e) NELP era (1997 -2105)
f) HELP era (2016- until date)

a) **Pre-Independence era (1866-1946)**

The history of Indian oil & gas industry started in the year 1866. Edwin Drake, in the year 1859 drilled the world's first oil well in Pennsylvania, USA. In the year 1866, Stewart and Company, drilled 102 feet well in upper Assam, however they failed to establish satisfactory production. But, they were successful in their second attempt on March 26, 1867 when oil was stuck at 118 feet in Margherita (Makum) area of Upper Assam, which was also the Asia's first mechanically drilled well.

The first commercially successful discovery was registered in London in September 1889. This was for a production of 200 gallons per day for a well dug in Digboi Assam at a depth of 662 feet. The company to achieve this was Assam Railways and Trading company and they later drilled 10 more wells in Digboi, Assam. Assam oil company formed in 1889 by the same company and later took over the oil interests (Digboi and Makum concessions) of Assam Railways and Trading company.

In the year 1911, UK based Burma Oil company (BOC), acquired the petroleum interest of Assam oil company. The first ever license provided in India was a geophysical license by the Assam government to British Petroleum and Shell when they put forward a proposal for carrying out survey of all important plains of India. (DGH, 2014-15).

No gas pipeline was built during this period. Gas was basically flared.

b) **Nomination Era (1947-1978)**

Post-independence, the government of India provided top priority to the development of oil in the industrial policy of 1948. In the year 1953, the first oil discovery in independent India was done by Assam oil company in the Upper Assam area. The government then felt the need of a directorate to focus on the exploration activities. Keeping this in mind, Oil and Natural Gas Directorate (ONGD) was formed in the year 1955. This was later changed and named as Oil and Natural gas commission (ONGC), in the year 1956 which even continues to explore Indian basin even today. Within a year of being formed ONGC discovered oil in Cambay and many more discoveries

were made thereafter. Meanwhile Oil India Private Limited (OIL) was formed in 1959. This company was owned by Burma oil company (2/3rd) and government of India (1/3rd), which later become equal partners in the JV Company. It was in this year (1959) that OIL started gas supply in India.

Until now all exploration was onshore, however in the year 1962, ONGC, initiated the exploration in the offshore basins of Gulf of Cambay and western India. ONGC started gas supply in India in the year 1964. This led to the India's biggest commercial discovery in Bombay High in the year 1972-73. First offshore production from Bombay high was in the year 1974. This was very encouraging for both ONGC and OIL which later drilled more than 3000 wells in India.

ONGC and OIL which were the pioneers of exploration in India dominated the sector until the year 1970. Most of the licenses were awarded to these two companies on nomination basis by the government of India.
(DGH, 2014-15).

Gas produced during this phase was mostly used locally, in absence of cross country pipelines.

c)   **Pre-National Exploration Licensing Policy (NELP) exploration Era (1979-90)**

In the year 1979, to meet the future commitment and challenges of the Indian oil & gas exploration sector, the government of India took the strategic step of offering 17 offshore and 15 onshore blocks to foreign companies through bidding in order to attract foreign capital, investment and technology. Total 3 rounds under this were conducted from the year 1980 to 1986. These rounds known as Pre-NELP were not very successful, with very limited participation. The fourth round was conducted in 1990, where it was a competitive bidding in which both Indian and foreign companies participated.

The gas produce until this stage was used locally until GAIL was formed in 1984 to set up gas transportation infrastructure. The first high pressure transportation pipeline,

the Hazira-Vijapur-Jagdishpur (HVJ) was fully operational in the year 1991. The price of gas, for the fields under this era was determined on a cost plus basis, known as Administered price mechanism ("APM"). North East of India was provided a discount of 40% on the APM price so determined (DGH, 2014-15).

d) Pre-National Exploration Licensing Policy (NELP) Licensing Era (1991-96)

Most of the liberalization in the Indian economy took place in the year 1991. Licensing requirement for most of the core sectors were removed during this year, including the petroleum sector (also see liberalization in section 4).

As an outcome of this liberalization, following key changes happened

a) An independent regulatory body was conceived in the year 1993. This was essential to send signals to the market that the decisions will be made by an independent regulator. Also, the government felt that they needed a body which has expertise in oil and gas exploration and can oversee development program for the concessions granted. This body would also protect the nations interest. Therefore, on August 8, 1993, Director General of Hydrocarbons (DGH) was formed, as an arm of the petroleum ministry. However, being an arm of the ministry, I do not consider the same as totally independent.

b) ONGC was reorganized under the companies Act 1956 to Oil and Natural gas corporation limited.

c) The government of India offered 126 blocks in five rounds of bidding between the years 1994-1996.

Due to the above measures, foreign companies participated in the bidding rounds and contracts were awarded to them. The foreign companies included Shell, Enron, Amoco and Occidental.

Price of gas for such fields was decided based on the formula provided in the PSC, which is primarily linked to oil indices

e)   National Exploration Licensing Policy (NELP) Era (1997- 2015)

The demand for oil was continuously growing post liberalization of Indian economy in the 1990's. However, to increase production, India needed to attract significant risk capital, knowledge on geology of various kinds of basins, best of class management ideas and practices, latest innovations in the oil exploration and production and state of art technologies. This was available with the big international oil and gas companies. The capital was also available in India but with large corporations.

To meet these requirement, government of India came out with then new national exploration and licensing policy (NELP), under which international competitive bidding would be carried out and the winning bidders would be granted a license and entered into with a production sharing contract (PSC). The PSC was awarded based on the revenue sharing principles as were the bids.

The NELP bidding rounds were approved by the government of India in the year 1997 and became operational in February 1999. Under the NELP rounds, the government of India has come out with nine rounds of bidding and have awarded 254 exploration blocks to Indian and foreign companies

In the year 2004, the first regas terminal was operational in the western part of India, with first spot cargo reaching India shores in 2006. With the Reliance Industries declaring large finds in KGD6 block in 2002-06, the prospects of large gas being available within India was looking good. The first CBM discovery took place in 2007 and D6 started production in 2009 post commissioning of the East – West transmission pipeline. (DGH, 2014-15)

The Petroleum and Natural Gas Regulatory Board (PNGRB) was constituted in 2006, starting the phase of liberalisation in midstream and downstream sector. The downstream regulator started international completive bidding for setting up transmission line and granting city gas licenses, mandated plain vanilla third part open access for transmission pipeline and provided for accounting separation of

transmission and marketing business. These measures took taken place from 2008 till 2012.

The price under the NELP regime is based on the PSC signed between government and the contractor, which envisaged that the contractor follows a price discovery process, on an arm's-length basis for such price discovery, with the approval from the government. However, government has, since determined the price of such gas through devising of formula, with linkage to various world indices to determine the price of gas at the well head. The current formulae devised as part of a report by
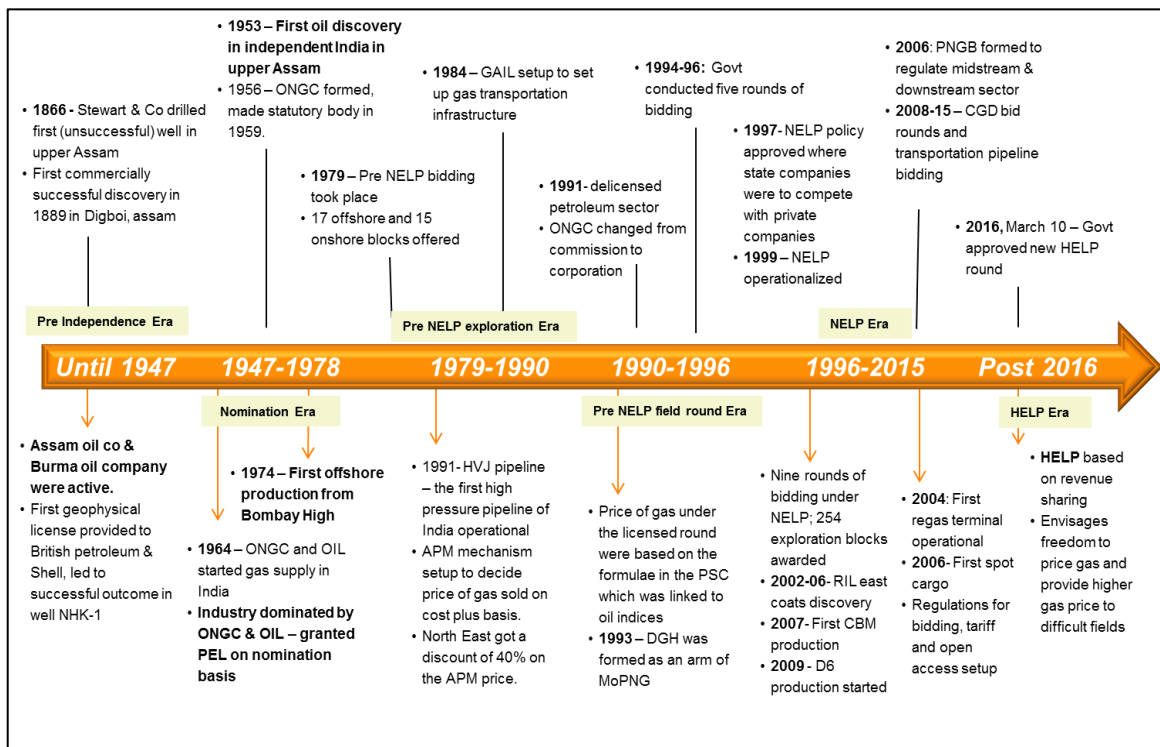
Figure 5 : History of oil & gas sector

Dr Vijay Kelkar, recommended that the price of gas be determined through volume weighted linkages to Henry Hub, National Balancing Point, Alberta and Russian Hubs (Kelkar, 2014). This changed the earlier formulae set up, as part of Rangarajan report (Dr Rangarajan, Report of the committee on PSC mechanism in petroleum Industry, Dec, 2012), dropping Japan LNG and local LNG import indices.

f)   Hydrocarbon Exploration Licensing Policy (HELP) Era (2016 until date)

The Indian Oil & Gas exploration sector has been mired with numerous issues with contractors granted license under the nine rounds of NELP. The government set up two committees first one headed by Dr Rangaranjan and the second one headed by Dr Kelkar to come out with recommendations to resolve issues and improve investment in the exploration and production sector.

Based on the recommendations of the two committees, on March 10, 2016, The Indian federal government approved the New Hydrocarbon exploration licensing (HELP) regime. The key difference between NELP and HELP policy was the mechanism of sharing profits by the contractor with the government. While the NELP production sharing contracts allowed complete recovery of costs incurred, before the profits are required to be shared with the government, which mostly were based on investment multiples quoted in the bid round, the HELP, production sharing contracts envisages upfront sharing of profits through a share of revenue which would be the bidding parameter. This mechanism although reduces administrative hurdles, but has shifted the exploration risk to contractor, which may not be very popular with the investors.

The success of HELP is yet to be tested, but the opinion is already divided that government by passing the risk to the investors will be unable to meet its target for increasing gas production in India. A more detailed discussion is provided on new hydrocarbon policies and HELP in the next section.

The history of oil & gas sector is depicted in Figure 5.

1.3   New policy initiatives in oil & gas sector since 2015

The year 2015 saw many changes in the Indian oil and gas sector. This was necessitated by the fact that the blocks awarded under the NELP rounds did not evoke the desired response from the international oil and gas majors. Also, most of the blocks which were producing and got awarded under various stages of pre-NELP and NELP rounds are surrounded with controversy. Most of the private contractors developing and operating these blocks are under various stages of litigation with the government,

due to variety of disputes arising out of the interpretation of the production sharing contract. Also mired into controversy is the control of gas price, by the government, at the well head. This move further reduced the incentives for the investors to bring in risk capital in the sector.

As explained earlier, the Government of India set up two committees to address the challenges faced in the production sharing contract (PSC) regime. The first committee was chaired by Dr Rangarajan and he released his report in December 2012. The second committee was formed under Dr Kelkar and he released his report in September 2014. While Dr Rangarajan recommended a need to move away from the existing PSC regime of Profit share to Revenue share (RSC model), Dr kelkar recommended continuation of current regime with curtailment of powers of the managing committee and the government along with developing mechanism within Profit share model to increase government take.

Let's us now discuss the recommendation of both the committees in detail since the policy measures taken by the government has elements taken from both the recommendations.

The key recommendations of the Dr Rangarajan Committee (Dr Rangarajan, Report of the committee on PSC mechanism in petroleum Industry, Dec, 2012) **are**

- Shift to Revenue sharing (RSC) model since Profit share model allows all costs recovery before arriving at profit share. To delay profit share contractors have been alleged to indulge in gold plating of costs. Most arbitration under current regime is linked with cost recovery limits and Investment multiples.
- Shift away from the cost recovery method would reduce delay in approvals of the management committee.
- Biding parameters for minimum work program and fiscal package should remain the same.
- Limit role of managing committee and the government to monitor and control technical aspects.

- Allow 10 year tax holiday for ultra-deep water blocks due to the higher risk associated with such blocks.

- Contractors should be allowed to carry out exploration throughout the mining lease period, which will help enhance recovery.

- RSC model being a new fiscal regime should be reviewed every 5 years

- Dr Rangarajan recommended gas prices to be based on volume weighted average price of a set of indices like Henry Hub, UK Balancing Point, netback of LNG prices to Japan and netback of India's contracted LNG.

The key Recommendations of the Dr Kelkar committee (Kelkar, 2014) **are**

- The main objective for the government should be to increase production by attracting investments in oil and gas industry, which will help to enhance security of supply.

- Provide stability of contractual and fiscal terms to the contractors which are a must for attracting investments.

- Dr Kelkar has actually criticized revenue share model due to its inherent misaligned risk-return structure.

- The report by Dr Kelkar proposed the following fiscal regimes
    1. Existing PSC with modified contract administration
    2. PSC model with supernormal profit tax

Kelkar committee believed that the above models can achieve the government target of higher take while still maintaining the risk reward balance.

- The kelkar report strongly recommended introduction of open acreage licensing policy (OLAP) by the government as soon as all preparations are done, but the same needs to be expedited.

- Provision of flexibility in completion of minimum work program.

- Primary responsibility of the managing committee and the DGH should be to ensure management of oil and gas resources.

- Managing committee (MC) and DGH should not get involved in checking and auditing costs and fiscal oversight. Self-certification by operating committee should be sufficient for assessment of profit petroleum.

- Higher weightage (at least 50%) for technical criteria in the bid.

- Establish model to allow contract extension of the current and future acreages until the end of the economic life of the asset.
- Gas prices were recommended to be linked to volume weighted linkages four hubs i.e. Henry Hub, National Balancing Point, Alberta and Russian Hubs

Based on the recommendation of the Dr Rangarajan and the Dr Kelkar committee, the government came out with many policy changes in the year 2015 and 2016. The key changes are captured below

Policy no # 01 - September 02, 2015 – Policy for Marginal fields (MFP) of ONGC and OIL (GoI M. , 2015)

Under the MFP, 69 oil fields discovered and held by ONGC and OIL will be opened up for competitive bidding with three key changes
- Production sharing contract would be based on revenue share principle instead of profit share basis
- Single license will be provided for all types of hydrocarbons
- Freedom provided to contractor to sell gas at arm's length prices

Policy no # 02 - March 21, 2016 – India is not bestowed with very large producing acreages. The geological structured don't seem to be the best. This calls for going deeper for increasing production and hence to attract investments, for such fields (deepwater, ultra deepwater, high temperature high pressure), government decide to provide freedom to market the gas and determine its price.

(GoI M. , Policy, 2016)

The above policy is applicable for all discoveries which are yet to start their commercial production (Jan 1, 2016). However the policy provides a ceiling on gas price to protect interest of consumers

The ceiling price shall be the, lowest of the
   a) Fuel oil imported landed price

b) Weighted average import landed price of substitute of fuels (30% x price of coal + 40% x price of fuel oil + 30% x price of naphtha) and

c) LNG imported landed price

The ceiling price will be based on 12 months lagging data, with one quarter lag and calculated once in six months.

In case there is any arbitration going on between government and the contractor on the existing discovery on gas price, the above policy will not be applicable

Policy no # 03 - March 28, 2016 - India started to award acreages in the 1990's. some of these where the PSC was signed, the PSC is going to expire in the next few years. To provide a basis for granting any license extension the government came out with the policy to grant extension to private companies
(GoI M. , Policy, 2016)

- The policy is applicable for 28 pre-NELP discovered fields
- Provides a framework for non-discriminatory extensions
- The extension would be granted for the balance economic life of the filed or 10 years whichever is more
- The application of extension can be made within 2-6 years before the expiry of the license.
- The time given before expiry will help to make right investment decisions
- The terms of the extension will be altered compared to the original concessions in the following areas
    a) No concessional royalty will be provided
    b) The profit petroleum will be higher by 10% compared to the original contract
- In case the contractor does not opt for extension, the field will either be awarded to the national oil company or take up for re-bidding

Policy No # 04 - March 30, 2016 - Hydrocarbon Exploration and Licensing Policy (HELP) (GoI M. , Policy, 2016)

The salient features of the policy are

1. Single License - A single license would be given for both conventional and unconventional resource.

2. The contractor can access the basin database and opt for an exploration block which will then be taken up for bidding without waiting for pre-defined exploration bidding rounds

3. Instead of Profit sharing mechanism, the bidding will take place on basis of highest revenue share

4. The changed bid parameter will help in reducing administrative cost since the regulator will not be required to go into details of cost recovery and hence profitability.

5. Contractors and operators will have more freedom to make day to day decisions.

6. Royalty altered for offshore blocks (refer Table 2)

<p align="center">Table 2 : Royalty under NELP and HELP regimes</p>

Blocks	Duration	NELP royalty rates		HELP royalty rates	
		Oil	Gas	Oil	Gas
Shallow Water	-	10%	10%	7.5%	7.5%
Deep water	First 7 years	5%	5%	0%	0%
	After 7 years	10%	5%	5%	5%
Ultra-Deep Water	First 7 years	5%	5%	0%	0%
	After 7 years	10%	10%	2%	2%

7. The contractors will have freedom to sell oil in the local market on an arm's length basis. However, the profit share of the government will be based on the higher of the oil price determined by the petroleum planning and analysis cell (PPAC) or the one determined on arm's length by the contractor. This will help protect the interest of the government while providing freedom to sell oil

8. Similarly, contractors will be provided freedom to sell gas in the local domestic market, but the government take will be based on the higher of that determined under the Domestic Natural Gas Pricing Guidelines and that determined through and arm's length contract.

9. Exploration phase has been increased by one year for onshore (current 7 years) and for two years for offshore blocks (current 8 years)

10. Exploration will be at the sole risk of the contractor and exploration can be carried out during the entire contract period.

11. 100% participating interest allowed for foreign and Indian companies without any requirement of participating from government or government nomine companies.

12. Exemption of custom duty on all machinery, plants, equipment's, materials and any supplies related to petroleum operations

13. Site restoration process of field/ block will be governed as per Government of India guidelines.

(DGH, 2015-16)

To understand if the policy announcement under HELP and other policies are helpful, let us discuss and understand the key differences in past and present fiscal regime and outline any issues with the new regime.

However, to compare the NELP and HELP PSC, let's first discuss each of the mechanism in detail with its advantages and disadvantages

Key features of NELP

a) 100% foreign direct investment (FDI) allowed under NELP.

b) Foreign companies will be allowed to bid without any state participation or carry over interest.

c) International competition between local and foreign companies and no blocs will be awarded on nomination basis as in the past rounds

d) Continuous availability of exploration acreages through multiple bid rounds, providing many windows of opportunity.

e) The contractors will be granted freedom to determine price on arms's length basis and market oil and gas in India (however this was not really followed and therefore the contract was not followed in letter and spirit by the government.

f) Royalty payments on crude oil will be at 12.5% for on land blocks and 10% for offshore areas. Royalty for natural gas will be 10%.

g) A hydrocarbon development fund was created to promote and fund exploration activities. This fund will receive 50 % of the royalty collected under NELP.

h) To promote deep water exploration (more than 400m bathymeter), the royalty will be half for the first seven years.

i) NELP rounds did not envisage any bonus to government in form of signature bonus when contract is granted or on discovery or on more than expected production.

j) Tax holiday from the date of commercial production for 7 years

k) Oil produced under NELP was exempted from paying any cess.

l) The Policy stipulated to provide fiscal stability to contractor during the entire period of contract i.e. no changes in fiscal and contractual terms.

m) Full cost recovery will be allowed under NELP for exploration, development, and production cost, with unlimited carry forward period on contract area basis unlike the past regime where exploration cost was allowed to be recovered on contract area basis and development cost on a field wise basis.

n) Profit share to be based on investment multiples achieved pre-tax instead of post-tax sharing.

o) Agreement between contractor and government governed through a production sharing contact

Thus, it could be appreciated from the above measures that NELP in the year 1997 was a big bang reform with complete opening up of the exploration and production sector and introduction of production sharing contracts based on best international practices.

Key features of HELP

1. Single License - A single license for all kind of hydrocarbons discovered to be provided. This does away the requirement of multiple licenses for different form of hydrocarbons discovered by the contractor.

2. Open Acreages – Contractor to decide which blocks to bid for including the timing of the same.

3. Revenue sharing model – Move to upfront profit share through share of revenues, with/without any cost recovery for the contractor.

4. Marketing and pricing freedom – Pricing to be determined based on arm's length basis.

5. Increased exploration phase

6. Reduction of royalty for deep water and ultra-deep water blocks. This would promote exploration in these high risk areas.

7. Curtailment in role of managing committee due to PSC model based on revenue share and not profit share where costs are to be audited

Comparison of NELP and HELP

Table 3 provide comparison between key features of NELP and HELP regimes.

Table 3: Comparison of NELP and HELP regimes

Sr. No.	Description	HELP	NELP
1	Fiscal terms	Revenue Sharing	Profit sharing
2	Cost Recovery	Not allowed	Allowed before sharing profit
3	Cost efficiency	Encouraged	Neutral
4	Royalty	Low rates for offshore	Standard Rates
5	Exploration Period	8 years for Onland & Shallow waters AND 10 years for deepwater and Ultradeepwater	7 years for Onland & Shallow water AND 8 years for Deepwater
6	Management Committee	Focus on reservoir management. Micro management not required since costs are not linked with profit share of government	Technical and financial examination
7	Revenue to Government	On production	After cost recovery i.e from profit petroleum
8	Exploration in ML areas	Allowed	Not allowed
9	E&P Activity for all hydrocarbons	Allowed	Not Allowed

The key difference between NELP and HELP is the mechanism of profit recovery by the government from the contractor.

(Mehrotra & Gupta, NELP to HELP; Indian exploration & production sector at Cossroads, 2017)

Issues with HELP and other policy Initiatives

The government of India in its new policy directives has tried to do a balancing act. While on one hand they have tried to meet the requirement of the petroleum Industry, on the other hand they have tried to protect the interest of the government; but while doing so it has not been able to provide the optimal balance which would have helped to increase investments in exploration and production sector and reduce import dependencies.

The man issues with the new HELP policy are

- It has failed to balance the risk reward between the contractor and the government. It is well documented that by moving to the Revenue sharing model, the government is asking contractors to take higher risk. In revenue sharing model the contractor shares profit with government from its revenue while the risk of cost recovery is entirely taken by him.

- Revenue Sharing mechanism is inherently inefficient since it is extremely difficult to design RSC systems to adjust to any variations to cost, timing and pricing.

- The Indian acreages (geology) are not classified among the best; also evident from the fact that India is one of the largest importers of oil and gas. It is expected that more oil & gas would be found in the deep water and frontier blocks, were cost of production would be higher. Therefore the contractors are not ready to take risk for such blocks under revenue share model.

- Since the revenue sharing model brings the economic limit forward, this makes fields susceptible to premature abandonment and hence not allowing full recovery, leaving valuable resources in the ground.

- While the government has tried to provide marketing freedom for oil and gas, it remains to be seen how this would function with the current allocation regime of the government. Even the NELP had provided for pricing on arm's length basis; however, the allocation of gas to specific sectors acted as a cap for the pricing. In addition, there remains multiple price points for various gas streams.

1.4   Structure of Indian Gas market

The current state of gas market in India can be best described as controlled largely by government with oligopolistic characteristics (few large players control the market) with government intervening across the gas chain. There are only few producers even, after opening up the sector for international competitive bidding (under the New exploration and licensing policy 1997-98). Transmission infrastructure is under development and major players act as integrated suppliers, shippers or marketers of gas. The large part of domestic gas is allocated by the Government of India under the principles of gas utilization policy and price is determined by it for such sources of supply. The gas market is in growth phase with large number of customers, like power and fertilizer are very sensitive to the price of gas they can afford largely because of the distortions which continue in the downstream markets.

1.5   Governing framework of the Indian oil & gas sector

The Indian oil and gas sector is divided into the upstream, midstream and the downstream sector. The upstream sector is controlled by the policies formulated by the Ministry of Petroleum and Natural Gas ("MoPNG") at the federal level. MoPNG is assisted in its efforts to formulate policies and grant concessions and monitor the exploration and production by Director General of Hydrocarbons ("DGH"). The planning and safety issues are dealt by petroleum, planning and analysis cell ("PPAC")
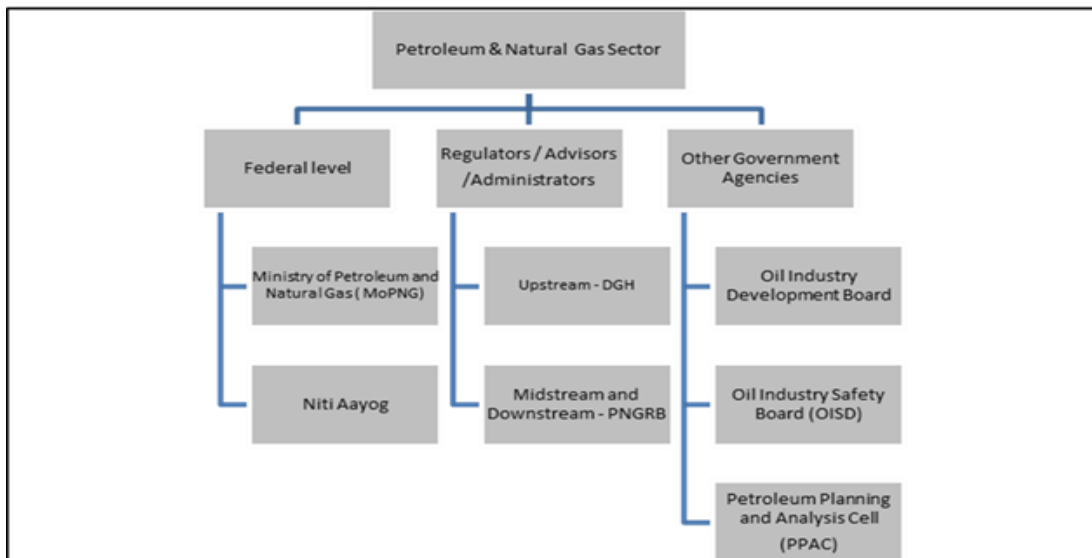
Figure 6: Indian oil & gas sector: Governing Framework

and safety issues by Oil and safety directorate ("OISD"). All these upstream agencies work under the direction of the MoPNG and hence the government is still the regulator for the sector and therefore in a position to take decisions which may be motivated by political consideration. The Government of India ("GoI"), in the year 2006 enacted through an Act of parliament the Petroleum and Natural Gas Regulatory bill ("PNGRB") to establish an independent regulator to regulate the midstream and the downstream sectors of oil & gas industry. The governing framework of oil and gas sector is depicted in figure 6.

1.6   The key attributes of the gas market in India

The government and the regulator have tried to liberalize the sector through measures like international competitive bidding, open access norms and transparency. As per the PNGRB Act, 2006 the regulations are intended to be light handed with consumer end price unregulated and competition brought in through removal of marketing exclusivity. But the midstream sector remain underdeveloped with monopoly rights

granted to the LNG regas terminal operators which coupled with allocation of gas from domestic sources is hindering any market mechanism to evolve. The key attributes of the gas market in India can be summarized as

1.0　　Domestic gas allocation and pricing determined by GoI [although Production sharing contracts("PSC") provide freedom to determine gas price on
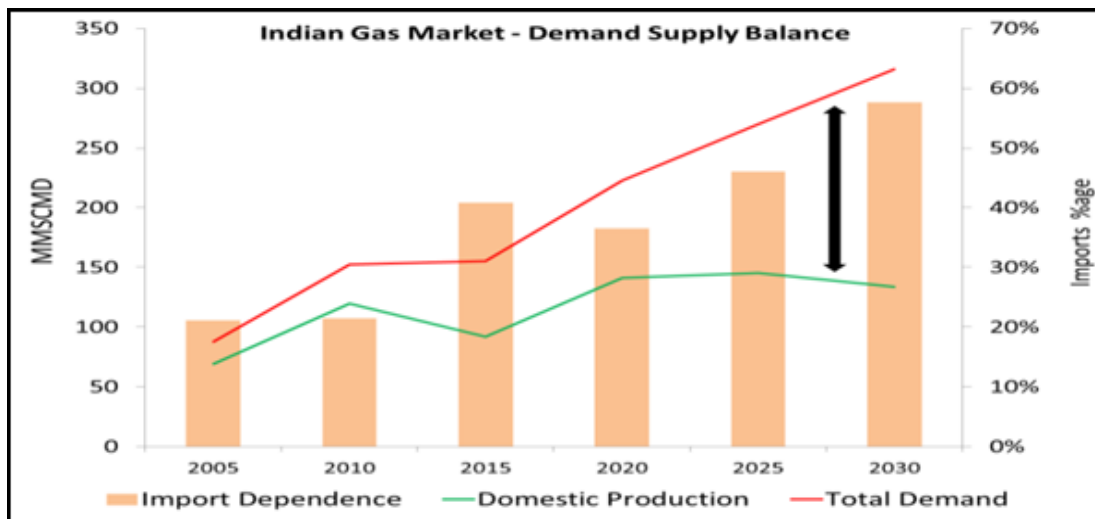
Figure 7: Indian Gas Market - Demand & Supply

competitive arm's length basis, but approved by GoI] in large part of gas production.

2.0　　Huge gap in demand and supply of gas as demonstrated in figure 7
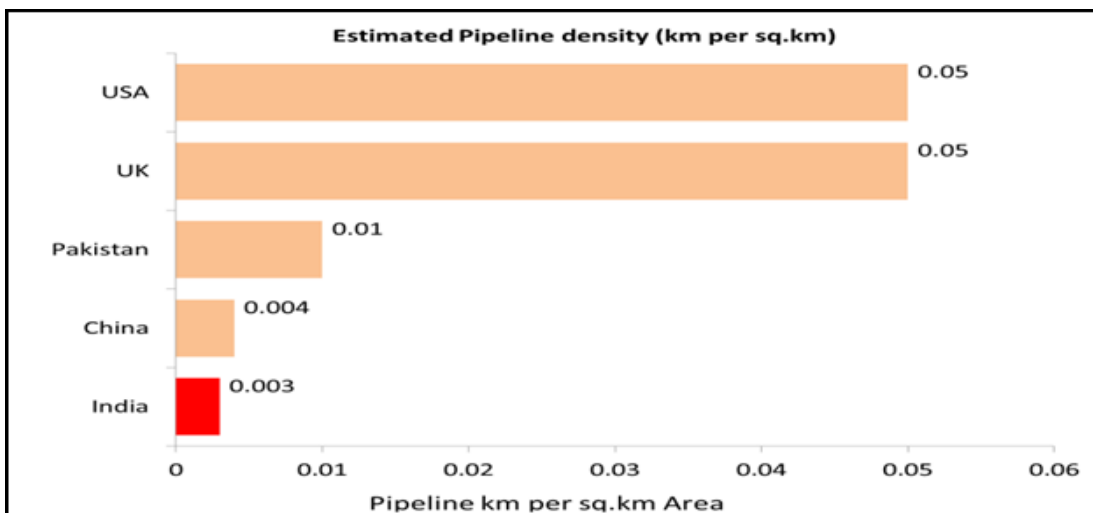
Figure 8: Pipeline Density - India v/s World

3.0　　LNG import under OGL but exclusivity rights granted to terminal owners and operators

4.0   Transmission pipeline under development with major slippages in timeline; open access norm in place, however they seem not be robust enough to be implemented. Pipeline density lowest in the world, figure 8.

5.0   Bundled entities allowed to transport and market gas with accounting separation principle

6.0   Distribution and marketing struggling due to unaffordable LNG prices coupled with distortions in Power, Fertilizer and transport fuel markets

7.0   Multiple price points of gas (discussed in more detail in next section)

1.7   Price determination of gas in India

There is multiple marker for gas price in India. The price of gas in India varies based on the source of production and type of regime. Primarily there are five types (as on January 2018); 1) APM and Non APM gas; 2) Pre-NELP gas; 3) NELP gas; 4) CBM gas; and 5) Gas from High pressure, high temperature blocks, Ultra deep and deep water blocks. Details of pricing are discussed below

1) **APM and Non APM Gas** – Initially the price was determined by the government of India on multiple basis, which from the year 2014 is governed by the modified Rangarajan or Kelkar formula. Details of price from the year 1959 to 2018 is provided in table 4 (exclusive of royalties, duties and transportation charges).

Table 4: Indian gas price and basis over years

Year	Price & basis
1959	**Rs 9/MCM** – by OIL in Assam
1964	**Rs 50/MCM** – by ONGC in Gujarat
Late 1960s	**Rs. 52.50/MCM** – by OIL and ONGC in Assam
1971-76	**Rs. 66/MCM** – by ONGC fixed for old customers in Gujarat
Early 1970's	**Rs. 115-135/MCM** – by ONGC for new customers in Gujarat
1974	**Rs. 210/MCM** – by ONGC based on thermal equivalence of Coal

1977	Rs. 350/MCM – (inclusive of royalty but exclusive of transportation)
1978	**Rs.1170-2630/MCM** for power **Rs. 633 - Rs. 3438/MCM** for fertilizer plants – by ONGC offshore in Maharashtra
1979	**Rs.320/MCM** for the tea industry **Rs.250/MCM** for the HFC Ltd and other consumers, **Rs.185/MCM** for the ASEB – By OIL in Assam
1982	**Rs.2100 - 2500/MCM** for fertilizer and other industries
1987	**Rs.1400/MC Price of gas, both onshore and offshore - Prices fixed by government from 1987**
1992	**Rs.1550/MCM** – Price of gas both onshore and offshore
1997	**Rs. 2850/MCM –** Price Linked to LSHS/fuel oil
1998	**Rs. 2239/MCM** – consumer price of gas and price discount for NE region
1999	**Rs. 2385/MCM** for first 2 quarter and **Rs. 2850/MCM** for last 2 quarter
2000-05	**Rs. 2850/MCM** and Rs. 1400/MCM for NE region
July 2005	**Rs. 3200/MCM** for consumers of power, fertilizers, covered under court and with allocation less than 0.05 mmscmd of Gas
June 2010	**US $ 4.2/MMBTU** APM price fixed by government (inclusive of royalty)
April 2014	Modified Rangarajan formula or Kelkar Formula Based on volume weighted average of various hubs across the world
Nov'14 – Mar'15	**US $ 5.05/MMBTU (GCV)**
Apr'15 –Sep'15	**US $ 4.66/MMBTU (GCV)**
Oct'15 –Mar'16	**US $ 3.82/MMBTU (GCV)**
Apr'16 –Sep'16	**US $ 3.06/MMBTU (GCV)**
Oct'16 –Mar'17	**US $ 2.50/MMBTU (GCV)**

Apr'17 –Sep'17	US $ 2.48/MMBTU (GCV)
Oct'17 – Mar'18	US $ 2.89/MMBTU (GCV)

2) **NELP gas -** Setting of price of gas, under NELP was allowed on an arm's length basis, however the government has intervened to decide the price which was initially set at $4.2/mmbtu (Based on formula decided on arm's length for crude >= US$ 60/barrel till Oct, 2014) and now based on Kelkar formulae as notified by government every six months (refer details in table 4 from the year 2014)

3) **Pre-NELP Gas** – Fuel oil linked formulae as per PSC basically for Panna Mukta Tapti and Ravva fields; The current ceiling price of PM gas is US$ 5.73/MMBTU and Tapti is US$ 5.57/MMBTU since June, 2004 on NCV basis. Current price of the Ravva satellite field is US$ 4.27/MMBTU.

4) **CBM gas** – Pricing for CBM blocks is based on bidding, on an arm's length basis for which approval of government required.

The contractors have freedom to sell gas in market as long as it is on arm's length basis, with prior approval from government. Till date prices are approved by the government for the following blocks:

Raniganj (South) CBM Block: July 2007 - USD $ 6.79/MMBTU
- M/s Great Eastern Energy Corporation Limited
Raniganj (East) CBM Block: May 2013 - USD $ 4.2/MMBTU
- M/s Essar Oil Limited
Jharia CBM Block: July 2009 - USD $ 5.1 /MMBTU
- M/s Oil and Natural Gas Corporation (ONGC)
Sohagpur CBM Block: May 2017 – Pricing Freedom $4.5/MMBTU
– M/s Reliance Industries Limited (RIL)

5) **HELP gas** (Gas from HP/HT blocks and DW and UDW blocks) – Price based on a formula linked to alternate fuels, capped by a ceiling price.

The price decided based on the formula for various periods are as below
Apr'16- Sep'16 – **US $ 6.61/MMBTU**

Oct'16-Mar'17 – **US $ 5.30/MMBTU**

Apr'17-Sep'17 – **US $ 5.56/MMBTU**

Oct'17-Mar'18 – **US $ 6.30/MMBTU**

1.8   Analysis of gas price determination in India

There are at least five if not more price points for domestic gas in India. In past few years the government has set up two committees, Rangarajan committee in 2012 and then the Kelkar Committee in 2014 to decide on the formulae for gas pricing. Rangarajan (Dr Rangarajan, Report of the committee on PSC mechanism in petroleum Industry, Dec, 2012) in 2012 has recommended revising the price of all domestic gas in India linking it to various indices. This was accepted by the empowered group of ministers with a slight modification. But the formulae would have increased the domestic gas price to 8$/mmbtu up from 4.2$/mmbtu prevailing at that time, at the beach. Hence this formula was challenged by the power and fertilizer sector as not sustainable for their usage. The current formulae devised as part of a report by Dr Vijay Kelkar, recommended that the price of gas be determined through volume weighted linkages to Henry Hub, National Balancing Point, Alberta and Russian Hubs (Kelkar, 2014). This changed the earlier formulae set up, as part of Rangarajan report (Dr Rangarajan, Report of the committee on PSC mechanism in petroleum Industry, Dec, 2012), dropping Japan LNG and local LNG import indices. However, it is worth stating at this point that none of the formula seems correct since these

- Fail to accurately reflect the cost of alternate fuels to gas
- It does not provide balance between producers and buyer, while providing price to producers which reflect global cost of production.

A high gas price is not workable since people of the nation believe in their entitlement on the natural resources and any high price becomes politically unacceptable. However, if the prices are too low it does not send the right signal to the market for attracting new investments and this eventually leads to shortage of commodity. Multiple price points of gas don't help in market developed either. Hence it is best to leave the gas price to the forces of demand and supply (refer section 4) to help increase domestic production.

Government of India, started in the right course by providing freedom under NELP round to the producers to determined market price of gas, but it has subsequently moved backwards by imposing riders on allocation of gas to nominated segment of customers and formulating the price formulae(s). The government is again trying to free the market by providing pricing freedom to high pressure and high temperature (HPHT) fields, however the jury is not out on this. As discussed, the multiple price points further complicate the issue. Also, the free market mechanism is further suppressed by the action of government to subsidize the key gas consuming segments of power and fertilizer.

1.9   Motivation and Need for research

A good research can be undertaken if there is enough reasons and motivation to carry out the research. My motivation to carry out this research on developing a Framework for creating an efficient gas market in India are

1) Oil and gas sector has seen a sustained negative growth rate in in last 5 years. If gas, which is an environmentally clean fuel, must play a role in Indian energy sector the decline needs to be reversed.

2) Gas needs to be positioned as the fuel for the future, along with other clean fuels like renewables. Need for clean and affordable energy should drive development of gas markets.

3) India has got 1.3 billion people, whose per capita consumption is expected to double. This would require all key forms of energy, including gas, to have substantive share in the energy basket.

4) India needs to make energy available to its people while meeting its environment obligations (COP21). Gas need to play a role along with Solar and other renewables.

5) Gas being a clean fuel should play a dominant role – world average is 24.1% (India 6.2%).

6) Solar and wind have limitations in meeting base/peaking loads. Solar can play a larger role when coupled with gas.

7) Indian gas market is unique with price sensitive power & fertilizer consumers and no heating load; hence learning's from international market cannot be applied directly, to develop gas markets.

8) Lack of systematic approach to development of gas markets – low interest in the sector and no clear way forward from the government.

9) There is lack of comprehensive work on Indian gas market. Development of gas market will need a step by step approach; gas markets internationally have taken decades to develop. This is evident from the fact that last five years has seen negative growth rate for gas sector.

10) Gas on gas competition (demand & supply mechanism) is the preferred gas price formulation mechanism; 38% of the world already uses the mechanism; Oil indexed markets moving towards market determined prices.

11) Henry Hub, proxy for most developed market has managed to deliver the cheapest gas in last many years demonstrating the power of the market.

The debate is not whether the share of gas in the energy mix needs to be increased, the debate and discussion is about how does the government and nation go about achieving the objective of attracting more investment in the sector, which would help to achieve this objective. One way to achieve the same is through creation of efficient gas market. However, we do not have any comprehensive work done in this area. My thesis attempts to address this gap.

(Mehrotra, Akhil, 2017)

2 BUSINESS PROBLEM

The section 1 of this thesis, on oil and gas sector overview clearly articulates the status of the gas sector in India, the expectations of the government bodies from the sector and the huge investments that are required in the sector, to arrest the negative growth rate seen by the sector in last 5 years.

The unique problem of the gas sector can be illustrated through the Figure 9. This figure demonstrates how the Indian gas sector is stuck, in a vicious circle, wherein
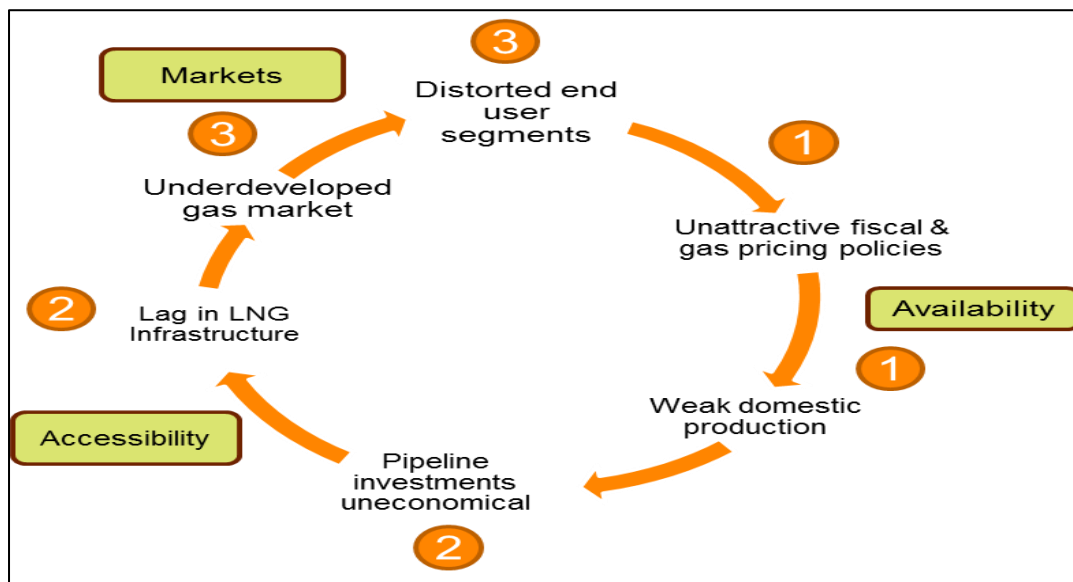
Figure 9: Gas Sector - Vicious Cycle

unattractive policies, are hampering the availability of commodity (gas), which in turn does not send signals for investment in transmission pipeline sector (a key for movement of gas) which leads to underdeveloped markets since demand is not met. Underdeveloped pipeline system creates a drag on the import terminals thus not even allowing imported gas to reach markets.

The business problem based on the above is defines as below

> **"Lack of efficient gas market, leading to negative growth rate for the gas sector thereby reducing availability of gas, a vital energy resource for India"**

3 LITERATURE REVIEW, LITERATURE THEMES AND RESEARCH GAPS

3.1 Literature Review

Indian Hydrocarbon Vision 2025 (Planning Commission, 2000) sets the following visions with respect to the gas markets in India; to develop a hydrocarbon industry which is 1) globally competitive 2) best in class across the world 3) have healthy competition and transparency 4) have free markets 5) having improved customer service. The document acknowledges the requirement of competition in the sector but does not provide details of how the competition should be developed. As per Government of India's Integrated energy policy (IEP, 2006) pricing must send the right signals to the energy users to conserve energy and where relevant switch to preferred sources. They must also send signals to producers to invest in the sector.

Chawla report states that the price discovery for D6 gas cannot be deemed to be representative of market conditions. The report also identifies a need to move towards a complete market pricing of gas, through a more rational and broad-based price discovery process then that followed for D6 gas of Reliance. (Chawla, 2011)

The technical assistance report of the gas grid study for US trade and development agency (ICF, 2011, July) states that in all major developed markets, gas prices are set by demand and supply in the market place i.e thru gas on gas competition. The report also provides main characteristics of some developed gas markets but do not provide details of steps required for Indian market.
.
Report on Vision 2030 on gas pipeline (PNGRB, 2013) states that allocation of gas by the government of India needs to be removed since any commodity which is available at subsidized prices inflated demand artificially. Report advocates for free market which is best for long term development of the sector and the nation. The second most important aspect advocated by the report is transparent and robust open access on the transmission pipelines and the import terminals. This well help movement of the gas

molecules which can be traded unless adequate pipeline capacity exists. The report talks of mandating legal unbundling which will help remove non-price barriers put up by the pipeline monopolies. This can be followed by legal separation depending upon the market openness adopted by the pipeline companies. A robust access code is also a necessity along with a fit for purpose tariff system like entry-exit system.

(Dr Rangarajan, Report of the committee on PSC mechanism in petroleum Industry, Dec, 2012) Report on PSC mechanism provides a stop gap arrangement in absence of gas market and gas on gas competition in India. The report acknowledges that the current environment is not feasible for gas on gas competition and feasibility may be done by government after 5 years to review the situation. But the report does not provide any road map for reaching this desired end state. The (GoI M. , 12th -13th five year plan, 2013) plan document also states that a price convergence would be achieved after the formation of an integrated grid and trading hubs

In the interim, the government has gone ahead and used the formula proposed in the report to decide the price of gas. The formula is based on a proxy, which is in this case the volume weighted average of prices at various world hubs. This in gact has tried to mimic the competitive price in the absence of a market mechanism as acknowledged by the report itself.

Thus, a common theme emerges from all the relevant reports published by government of India in the last decade that moving towards a competitive market for gas is the goal, but these reports do not define the desired end state of the Indian gas market and provide only broad issues to be addressed for development.

The key reason which created shortfall was inadequate price signals to the producers. Further, the market was distorted more by deregulating only new gas which further created imperfections in the market. The US president felt that price controls were important in shortage conditions. Ironically mistake done by the government of US was to regulate the well head price the price control on gas producers caused the shortage. In 1938 the congress intervened in the gas sales market when an imperfection existed only in the gas transportation market. (Pierce, 2004). The situation which US

faced from 1940 – 1980 looks very similar to what India is facing today and the government repeating the same mistakes.

The key learning from the US experience is that the development of gas market is a continuous process supported by continuous interventions from the regulatory bodies. The regulators need to first access the stage of the market and then take measures which help in market development (Juris, Andrej, April, 1998). Most of the developed countries have competition among gas producers and have unbundled supply and transportation at the wholesale level which has led to the development of vibrant gas markets with shippers/traders acting as aggregators and also taking / balancing the risks (Juris, Andrej, March 1998).

Andrej Juris (Juris, Andrej, April, 1998) has also brought forward structural models in the gas Industry based on the experience of deregulation of the gas industry in the US. These four models can be used as tools to evaluate the current stage of the India gas industry and project the probable desirable end state.

Back in 1954, the US Supreme court decided that even though the Natural Gas Act (NGA) stated that the production of gas was exempt from jurisdiction, the NGA still applied to the pricing of that production – thus beginning a 36 year odessey of market mess. First, the regulated prices caused severe shortages (i.e, curtailment), and then congressional attempts to fix the shortage problem ended up causing several other unintended consequences. It wasn't until 1990 that ultimate solution was reached – statutory decontrol of wellhead prices. The natural gas industry in the US today, is a remarkable model of a healthy, vibrant and growing business. It is generally regulated in the right places and unregulated in the right places, with the regulated and unregulated segments interacting very efficiently. A lot of credit for this has to go to a pretty smart (and short) statute, the NGA, and a pretty smart commission where earlier colleagues created a restructured industry that works (Smead, May,2013).

The European council has stated in its findings on gas market development that the presence of pipeline and its efficient use will help shippers to freely move gas between different markets responding to the price signals. In India once the pipeline is fully developed and all parts of the country get connected this can be tested. The council

found that functioning wholesale market need ample gas from multiple sources (they advocated at least 3 sources), not many players, a good churn in trading i.e. high ratio of financial to physical trade (for delivery). (Council of European energy regulators, Dec, 2011). These finding are relevant for India since Europe is also a net importer of gas like India.

It is imperative to move from oil linked gas prices to gas-to-gas linked prices. The key condition remains availability of gas which is not allocated, many suppliers and consumers i.e a market, nondiscriminatory access and a market place to trade (Douwe kingma, June, 2002). The paper demonstrates that the price of gas will go down if linked to demand and supply (i.e gas on gas competition) compared to gas prices linked to oil index.

The key issues to be addressed for successful development of European gas markets are (European federation of energy trade, Oct, 2004)
1) Implementation of entry-exit system of transmission services
2) Network access
3) Capacity trading
4) Information and transparency
5) Market access to terminal capacity (LNG should be fungible with piped gas)
6) Unbundling of infrastructure and supply

The above paper provides in detail segments of market which should be regulated and the ones which should be not regulated and enablers for market development. But its applicability to Indian conditions need to be further explored.

The Indian government started with the hybrid model experiment in the year 2005, wherein the govt producers were allowed to sell at regulated prices but private producers were allowed market determined prices and sell to niche markets. The success of this model would depend on the transformation/ liberalization of the key consuming segments like power and fertilizers and the political will of the government. The alternate fuel in fertilizer segment may still allow absorption of market priced gas but the alternate fuel in power segment like coal etc will create major issues in gas pricing at market determined rates (Jackson, July,2005).

The paper on development of markets in natural gas industry (Juris, Andrej, March, 1998) provides principles of regulation and factors which determine the viability of gas markets (technology, size and entry barriers). The paper also demonstrates that the relatively small economies of scale call for competition in Gas production while the large economies of scale in transportation and distribution call for treating them as natural monopolies and hence to be regulated. The paper also discussed the trading models like the bilateral model and the Poolco model (single operator).

IEA has argued that role that gas will play in the Asian market will depend on the basis on which gas prices are determined in these markets. 63% of all the gas traded in the world in the year 2010 was based on gas on gas competition i.e. determined by the market forces. However most of this was based in north America which has a 25% share of the global gas market. Hence, expanding the current role of gas in the Asian market will depend on the extent of market forces which play in these market to determine its price. This will ensure presence of right price signals for gas to play its desired role. (International Energy Agency, 2013).

The above paper states that the key reasons for nonexistence of gas hubs or markets is the lack of gas availability through pipelines, lack of intention on part of governments to deregulate the sector especially the wholesale price of gas and the LNG companies treating oil as a safe alternative to price the product. The paper also clearly articulates that the price of gas should be set based on the alternate uses i.e the fuel it replaces which is predominantly coal in power sector

Natural gas is very different from other commodities in terms of how it is traded across various geographies. While most commodities like oil have a single market, gas market is fragmented into geographical zones with prominence of one type of price marker in one area compared to the other. Oil indexation originated in Europe and the moved and found its place in the Asia-Pacific region where it is still the most prominent form of price marker. In contrast, the hub prices which originated in United States has found its way into Europe, starting from United Kingdom. But the market which today seems fragmented is fast getting integrated due to movement / trade of gas in form liquid. If Asia gets isolated as the only market with oil indexation, potentially this will be forced

to change. However, oil indexation which provides a natural hedge may also find its stronghold in the older markets. (Melling, 2010).

The main problem of many market is the mandate by the local government to supply only to a segment of customers. This is also highly subsidized and leads to multiple negative impacts like

- Limited supply of commodity due to lack of price signals
- Fiscal burden of governments
- Shortage of commodity due to unnecessary consumption

(Mark C Thuber, Feb, 2011)

The solution lies in creation of a hybrid market which meets the political requirement of appeasement as well as allow part of market to open to competition. A good example of such a market is power trading market in India where part of the commodity is freed up for market based price determination.

This allows the liberalized part of the market to grow slowly but steadily with time. Once the momentum is achieved and the benefit of liberalization are visible, the growth becomes exponential. Political interference in gas allocation reduces. Non-strategic segments like Industries, help expedite such reforms.

(Mark C Thuber, Feb, 2011)

The Background paper on oil and gas deregulation (R K Narang, 1999) although dated, brings out the measures taken by the Indian government to deregulate the oil and gas sector. As can be seen some of the measure envisaged by the government themselves have either not been acted or are retracted after being implemented. The key being allowing freedom to producers to sell gas at market determined price. The paper also talks of key regulatory measures required due to the monopoly nature of the transport sector.

The key inference from the paper (Stern, Is there a rationale for the continuing link to oil product prices in the continental Europe long term gas contarcts, 2007) on oil linkage of gas prices in Europe are;

1) The basis on which oil indexed price system was developed is no longer tenable since consumers are losing their ability to switch back to fuel oil or other similar products

2) The price of gas should be between the cost of producing gas as a base and the alternate for the major consumer as the ceiling (e.g coal for the power sector)

3) The pricing of gas based on spot markets would depend upon the liquidity in the market and in absence of such liquidity alternate hubs as benchmark may be used

It is in the interest of gas producers and large players to continue with oil indexation hence the movement towards gas price determination based on demand and supply would take time.

(GAO, Feb, 2006), stated that gas price regulation becomes a bane since most regulatory controls keep prices low which creates artificial demand with producers not having any incentive to produce more or even keep producing. In the US, once the Federal process were deregulated, the price of gas actually decreased but with time became volatile. Several market participants emerged like traders, shippers, brokers etc. Gas Hubs developed along with the increase in number of market participants, with Henry Hub becoming the bell weather nub for the world.

The working paper on Natural Gas in India (Corbeau, 2010), provides a very broad overview of Indian gas sector. Although Indian market has a huge potential of growth, the capacity to pay is different for different sectors, with power sector and fertilizer sector leading the pack as most sensitive segments of the market. Whatever happens in these sectors thus impacts the gas market tremendously. In power sector gas competes with coal to gets its place in the merit order dispatch, while in fertilizer the government determines the subsidy mechanism. Thus the future of gas remains uncertain until these sensitive sectors are reformed.

The way interpretation of NELP contracts in India has shifted over time is disturbing to the least. Initially the government and policymakers pitched it as a liberalized regime where gas price can be market determined, but then moved it to a regime where sector wise gas allocation priority was provided by the government, along with a price formula.

(Anil Jain, April 2011).

It is important to understand why reform in the gas sector proving to be difficult for India. This is more intriguing since the oil markets work in a perfect way, without any major political interference. The main reason in opinion of Anil Jain are two fold; one gas is a commodity which is not fungible and needs pipelines to move and reach its customers. Th is cannot free from government intervention and need regulations and it is here that the Indian government gets it wrong by either not providing the right environment, returns or the investment climate. The second more important reason is that the two largest consuming segments of gas are highly subsidized with all kind of government interventions. Both power and fertilizer segments are in mess of its own and there is no way it can support any open price mechanism for gas. In power gas competes with coal and have a tariff mechanism which seldom increases due to lack of political will. Fertilizer sector is also highly subsidized and hence it cannot support market prices of input fuel. This directly touches the poorest section of our society and hence difficult to convince government to bring in reforms.

(Anil Jain, April 2011)

The research report on drivers of global wholesale price formation (IGU, 2012), focuses on comparing various price constructs like gas on Gas competition, Oil indexed prices etc and analyses which part of the world uses which kind of construct. The report also compares movement between various construct and regions which proves that the gas on gas competition is on the rise primarily due to changes in Europe and Russian markets. The paper discussed why gas is different from other commodities and key reason being in the concept of transportability (requires high cost of transportation, liquefaction etc), storability (costly storage options) and constant volume equilibrium (means requirement to maintain line pack to maintain security of supply – input and output needs to be maintained in equilibrium)

The role of government and policy makers in the major gas consuming countries is slowly shifting. Initially the governments played the role of developer and financer of projects (with government companies setting up unviable projects to initiate development), but now they are restricting their roles to that of regulator and help bring in private investment. This change is required due to globalization of gas industry.

However, it is not clear at this moment what path Indian and China, the two largest growing consumers of gas will adopt. They can either go the European gas was favoured for producing electricity or go the Brazil way where the governments failed to push any reform process.

(Baker Institute Study, March, 2005)

The report on the development of Australian wholesale gas market (Allan Consulting Group, June, 2005) explores options for next stage of development of gas markets in various regions of Australia. Four options were selected and each option was evaluated on the principles of

1) efficiency and transparency
2) Practicability and simplicity
3) Implementation cost
4) Gas market principles

The above provides a good basis on evaluating the same for Indian market

The IEA report (IEA, 2012) on gas price and regulation in china states that tical number of points arising from OECD experience stand out as potentially particularly relevant for China. 1) OECD experience can be relevant for china. 2) Regulators are the agencies to provide direction, 3) Third part access to infrastructure most important, 4) Freedom to price gas in upstream critical, 5) Gas market development takes long period of time, 6) Tariffs for infrastructure should provide a balance between owners and consumers, 7) Promote transparency

The above points can be studied in detail to check their relevance for Indian conditions.

3.2   Literature review Summary

The literature review was based on 4 types of documents

1) Research reports by individuals published in Journals
2) Articles and world Bank papers on the subject
3) Research reports by International agencies on gas markets, regulation and market principles on multiple countries

4) Government / Regulators led reports on burning issues in oil & gas

The table 5 summarizes the key outputs from the above four set of literature.

Table 5: Literature review summary and key outputs

Type	Sub Group of Literature survey	Key Organisation / Individuals	Key Outputs from the literature review
1&2	Research report and Articles in Journals / world bank papers /work Instituted by Universities	• **Researchers** • Andrej Juris • Richard J pierce • Mark C Thuber • J P Stern • M Jackson • Pualo Henrique • Helmuth Cremer **Journals/ Organisations** • Energy Policy • European economic review • ASEAN Economic Bulletin • World Bank	• Provide the experiences of US & UK in details and the key learning from the mistakes made by those government / regulators and the course correction done • Provide theoretical background on the evolution of gas markets which can be used to map the Indian market and determine its stage of development • Discussions on Europe as a battleground where struggle is evident between alternate fuel indexed price end price based on supply and demand. • Highlight issues in wellhead price regulation and its ill effects

			• Provide enablers for the gas market
3	Research report by International agencies & host governments	• International Energy Agency (IEA) • International Gas Union (IGU) • International association of energy economics (IAEE) • EFET • CERC • Govt / Regulators	• Provide roadmaps for countries like Australia, china etc based on the experiences in the OECD countries. • Discussion on Indian Gas market and its problems in terms of well head price regulation • Discussions on movement of gas price markers in the European market and the impediments towards this movement • Outlines issues to be addressed for successful development of gas markets in Europe • Provides theoretical concept on various stages of market development (models / framework)
4	Government / Regulators led report in India	• GoI • Planning Commission • MoPNG • PNGRB • Industry Group	• Establish the requirement of reforms and competition in the sector for attracting investments and its development

			• Establish the end state to be achieved in the gas sector i.e gas-on gas completion (gas prices to be determined through force of demand and supply) • Provide stop gas arrangements on gas pricing like linkage to developed markets/imported gas as a proxy for competition • Acknowledge that Hubs and spot market play a major role in development if markets • Provide some measures to be taken through regulatory reforms like open access, unbundling of market, tax reforms etc

Most of the literature reviewed provide the factors responsible for development of gas markets and argue for, the ultimate need of a vibrant and efficient gas market. Literature reviewed also argue the requirement to determine gas prices through forces of demand and supply i.e. gas on gas competition, however none of the literature outlines the roadmap and steps required for a market mechanism to evolve in India. Even the much discussed Rangarajan committee report stops at providing a stop gap arrangement i.e a complex pricing formulae and leave the feasibility of gas on gas competition to be done at a later stage. But international experience has demonstrated that development of markets is a long process consisting of series of steps which need

to be taken by the government and the regulator to develop a market. In some countries, this process has taken more than two-three decades to accomplish the desired end state of gas markets. Research needs to be done to identify the reasons for nonexistence of gas on gas competition and how to enable the same at the earliest, in India, so that India does not have to depend on benchmarks created by other countries and /or market hubs.

3.3   Themes from Literature reviewed and Research Gaps

Four prominent themes emerge from literature review pointing to the research gaps and the need for such a research

1) **Literature providing cause for change for the Indian gas market**
2) **Literature providing theory of economic reforms, gas reforms and efficient markets by key economists**
3) **Literature providing variables for development of efficient gas markets**
4) **Literature providing framework/stages for development of efficient gas markets**

Table 6 provides the key themes, the main outputs from the literatures review and the research gaps emanating from the analysis of such papers

Table 6: Summary of research gaps emanating from key themes

Sr. No	Themes	Key Outputs	Research Gaps
1	Literature providing cause for change for the Indian gas market	**IGU 2012** - 38% countries follow gas –on –gas competition; 23% follow oil indexation but moving towards gas on gas competition	Reasons and benefits for development of gas market discussed for various international markets. Also statements made why this should also be

		BP2016 / BP2017 – Comparisons of gas prices across markets demonstrate benefit of market based mechanism	developed for India with no detailed work on how to do the same.
		12th – 13th plan document – The investment potential in the gas sector can be only realized with policy initiative. …….	
		Rangarajan 2012 - India does not have a competitive gas market. It is unlikely that in future also India will see any market, hence it is prudent to use mixture of world indices to mimic competition in India.	
		IEA 2013 – The extent to which gas will play a role in the Asian market will depend on the price marker basis in future……..	
		Indian Hydrocarbon Vision 2025 - Even hydrocarbon vision envisaged that free market is essential to promote competition and enhance customer service.	
2	Literature providing theory of economic reforms, gas reforms and	**Fernando** – Provides three pillars of economic reform; 1) Liberalization –Delicensing and free flow of goods and access to capital; 2) Privatisation –	The classical economic theory provides key stages for reforms however the applicability of all

	efficient markets by key economist	Transfer of ownership from govt to private players, regulators setup; 3) Globalization – Global integration of Product, technology and information. **Katri lehtonen** - Theory of Economic reform (Institute of Economics in Transition, BOFIT): Most reform packages push for complete transition from the start and are usually built around the following pillars, 1) Stabilisation; 2) Liberalisation; 3) Privatisation & Restructuring **Katri Lehtonen** - Liberalisation can be gradual (Gradulaism) and immediate (shock therapy). Far reaching economic reform applied simultaneously to all sectors of the economy is called Shock therapy. A gradualist approach by contrast, may prioritise certain sectors first. **Howard Stein** – Describes role of Institutions in formation of markets within the neoclassical viewpoint.	stages for gas markets is not discussed. Also, the gas market reforms provide its stages however the application to Indian condition is not discussed

		George A Akerlof – Government intervention increases the welfare of the parties in certain conditions….. (Akerlof, 1970)	
3	Literature providing variables for development of efficient gas markets	**Andrej Juris; J P Stern; M Jackson ; Paulo Henique ; Helmuth Cremer; Asean Economic Bulletin / Energy Policy; Jonathan P stern ; Richard J Pierce; Michel Polo; Anil Jain; Kingma Dowe; Corinne Chaton; Giulio Federico; R K Narang et al;Roselion; Shukla & Dhar; Mark C Thuber; Gijsbert T J Zwart** – Literature by all these authors, provide variables which were the potential reasons, for success of market development in developing countries.	Applicability of variables for Indian gas market or for Indian condition not discussed in the literature.
4	Literature providing framework/stages for development of efficient gas markets	**IEA, 2012-** Provides theoretical models and concept on various stages of market development **IGU -** provide roadmaps for countries like Australia, China etc based on the experiences in the OECD countries	The conceptual framework on how gas markets evolved in developed markets are comprehensively provided, but the same for India is left at the stage of identifying that gas markets are required to be developed /

		Andrej Juris / Richard Pierce (Energy Policy / World Bank) - Provide key learning's and experiences of US and UK	promoted without discussing a path to follow for such evolution
		Richard J Pierce / M Jackson: Providing experience of US & UK in details and the key learning's from the decisions made by those governments / regulations and the course correction done.	
		Studies by the World Bank & the OECD provide evidence that State ownership is economically inefficient & leads to budget deficits. The key reform steps that should be taken are: Change in ownership/ Ability to create conditions for reforms / Formal Planned Change	

The review of literatures listed in sr no 3 in the table 6 provides the following 16 variables which would help in creation of an efficient gas market, which we are calling universal variables

1. Existence of cross country gas grid
2. Existence of sufficient number of import terminals
3. An independent upstream regulator
4. Access to infrastructure – robust access code
5. Unbundled transportation and marketing segments of gas sector

6. An independent system operator for pipelines

7. Transparency in regulated businesses

8. Bulletin Board for information sharing

9. Stable long term policy from the government

10. No well head price regulations

11. Entry / exit system for pipeline tariffs

12. Existence of physical hubs and financial markets

13. Secondary trading in pipeline capacity

14. Efficient downstream (power & Fertilizer) markets

15. Presence of unconventional like Shale/CBM

16. Presence of gas imports through pipelines

These universal variables will be used as an input to this research.

4 THEORETICAL UNDERPINNING OF GAS MARKET REFORMS

The review of literature provides great insights for the development of gas market and provided theories which can be used for underpinning the research being undertaken for creating an efficient gas market. These theories include theory of economic reforms which provide stages in forms of pillars for development of markets, theories on advantages of developing efficient markets and concepts emerging from developed markets in form of theory/ stages for gas market development

4.1 Theory of economic reform

Indian government, as deliberated in the previous sections, did embark on a path of reform but, lost direction somewhere both in its intent, and certainly on the direction, to reform the entire energy sector.

The three pillars of economic reforms are
1. Liberalisation
2. Privatisation
3. Globalisation
(Fernando, 2013)

Liberalisation, the first pillar generally includes measures by government to decontrol and eliminate license for business activities. Major industries are free from government licensing and have free access to capital markets. Any restriction on movement, sale and purchase of goods are removed and tax structures are simplified. As described in section 1 of this thesis, GoI as part of it liberalization measures, did allow 100% foreign direct Investment and initiated international competitive bidding in the gas chain. However, the liberalization was done only for the upstream oil and gas sector and did not take place for the midstream and downstream sector. Also, the tax structures were not simplified.

Privatisation, the second pillar does not necessarily only means transfer of ownership from government to private enterprises. Privatisation also means that market forces can take care of decisions of production, trade, distribution and consumption. Decisions are made by private economic units while government would require regulation at this stage to prevent any abuse of market power by large companies. GoI, has shown intentions to privatise, but has not done enough under this stage i.e. transferred ownership in few cases but not allowed market forces to function.

Price controls on product market were removed to a large extend by GoI, but price controls on energy market remains. Most energy companies still remain under government control. Regulators are set up in many sectors including energy but competency within regulatory bodies remain an issue.

Globalisation, the third and most important pillar means global integration of products, technology, labour, investment, information as well as culture. Globalisation
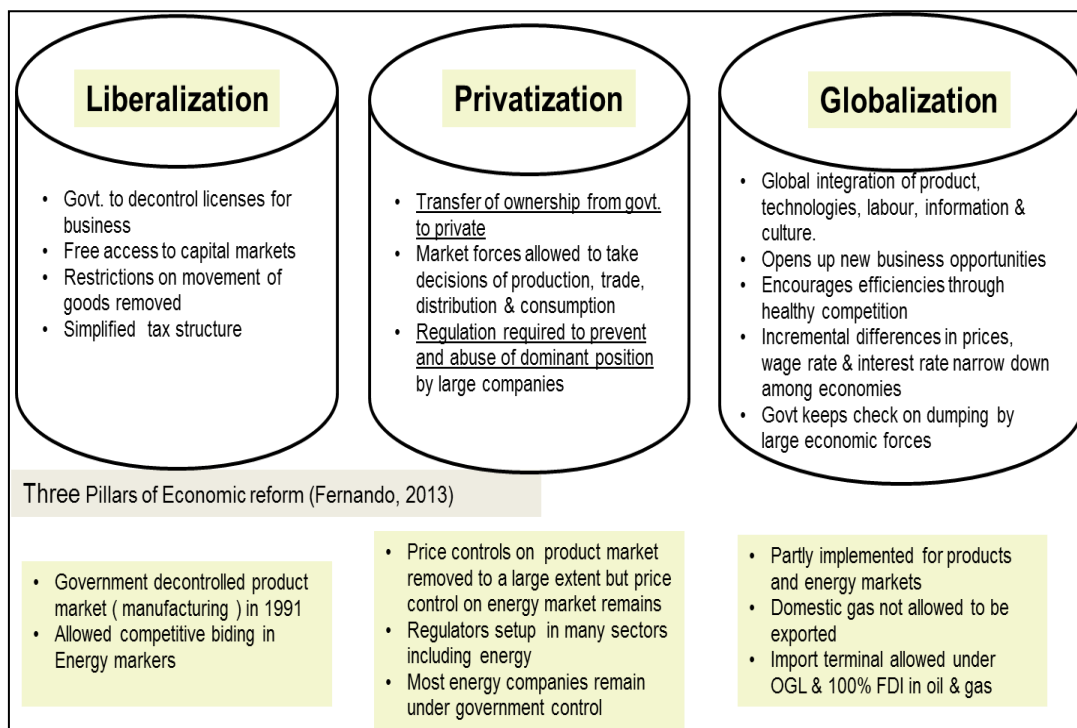

Figure 10: Three pillars of Economic Reform

tends to open new business opportunities and encourages efficiencies through healthy competition. Incremental differences in prices, wage rates and interest rates tend to narrow down among economies while government keeps a check on dumping by large economic forces.

100% foreign direct investment allowed in oil and gas including import terminals. However, domestic gas is not allowed to be exported.

4.2   Economic reforms in India

The Indian government initiated the process of economic reforms in the year 1991, compelled by ballooning fiscal deficit and balance of payment crisis. The reforms included freedom from licensing, controls and inspector raj. This was achieved by controlling the fiscal deficit through measures like macroeconomic stabilization (demand side management) and structural reforms (supply side management). Demand side management was done by the government by taking measures to control inflation and fiscal adjustments. Supply side management included deregulating the industries to increase production, reforming the financial sector and public enterprises. Supply side management was also done by managing capital flow.

In the first generation of reforms the government focused to end license raj i.e. removing control and stopping unnecessary interventions by the government. In the second generation of reforms the attempt is to address market failure by addressing structural issues.

India, to a large extent, has reformed the products market but failed to reform the factors market. The key steps taken by India to reform the products market were removal of licensing requirement for manufacturing or importing any product. The companies could freely, produce, buy and sell any product based on the principles of demand and supply. All price controls were removed and government stopped controlling prices of end products, but price controls on energy markets remain to a large extend. However, factors market such as those for labour and land remain unreformed, being state subjects, acting as stumbling block on doing business in India (ease of doing business).

Figure 10, provides a summary of 3 pillars of economic reforms and what specific development have taken place in India under each pillar of reform.

Let's now discuss and understand the importance of efficient markets.

4.3   Efficient gas markets

"An allocation of resource that maximizes the sum of consumer and producer surplus is said to be efficient. Consumer surplus equals buyer's willingness to pay for a good minus the amount they pay for it and it measures the benefit buyers get from participating in a market. Producer surplus equals the amount sellers receive for their goods minus their cost of production, and it measures the benefit sellers get from participating in a market". (Mankiw G. N., 2007)

"The equilibrium of supply and demand maximizes the sum of consumers and producer surplus. That is the invisible hand of the market-place leads buyers and sellers to allocate resources efficiently. Markets don't allocate resource efficiently in the presence of market failures such as market power or externalities". (Mankiw G. N., 2007)

"Pareto efficiency (or sometimes just efficiency) occurs when no possible reorganization of production or distribution can make anyone better off without making someone else worse off. Under conditions of allocative efficiency, one person's satisfaction or utility can be increased only by lowering someone else's utility". (Samuelson A. P., 2010)

Coase theorem (attributed to the Noble Prize winner Ronald Coase) has also attempted to explain market principles. As per Coase theorem, if the transaction cost is low (i.e. low barriers of entry) and trade is possible under condition of externality, barraging will result in an outcome where supply and demand forces are balanced (Pareto's efficiency). However, in practice this can be frustrated since property rights are not properly defined and there may be obstacles created for bargaining.

However, Coase himself has argued in his paper in 1960 that in practical world the barriers and cost of doing business or transaction costs are high and hence perfect bargaining does not take place. The importance of perfect information has also been demonstrated by other since then.

(Coase, The nature of the firm, 1937); (Coase, The problem of social cost, 1960);

"Information on market and system operations and capabilities at all stages of the supply chain should be publicly available and frequently updated for a reliable, competitive and efficient gas market" (MCE, 2005)

"Gas on gas competition (determination of gas price through forces of demand & supply) is the soundest of all mechanisms (for gas price determination) when free trade prevails in the gas markets" (Dr Rangarajan, Report of the committee on PSC mechanism in petroleum Industry, Dec, 2012)

Thus, the theoretical framework can be used to argue that the best interest of both consumers and the suppliers is served if the markets are efficient. However, it would be necessary to study the evolution of markets in developed markets of US and UK to understand the key interventions which would help Indian market to develop into an efficient market.

4.4   Stages of gas market development in mature markets

Gas, being a commodity, which is essential as well as vital for economic development follows its own evolution curve. The evolution curve captures the sensitivity and uniqueness of gas as a commodity, including its political import and requirement of large infrastructure to make it fungible. Since gas produced cannot be stored (storage difficult and cost prohibitive), the gas sector needs either pipeline infrastructure to transport gas to markets or liquefied and stored for export. All parts of the gas chain from exploration & production to transportation and distribution requires very large risk capital.

Evolution of gas markets can be classified into four to five broad stages based the stage of evolution (model in figure 11 adapted from Juris) (Juris, 1998)

a) **Monopoly/Government controlled gas chain:**

It is not possible to attract investment in infrastructure sector including gas chain
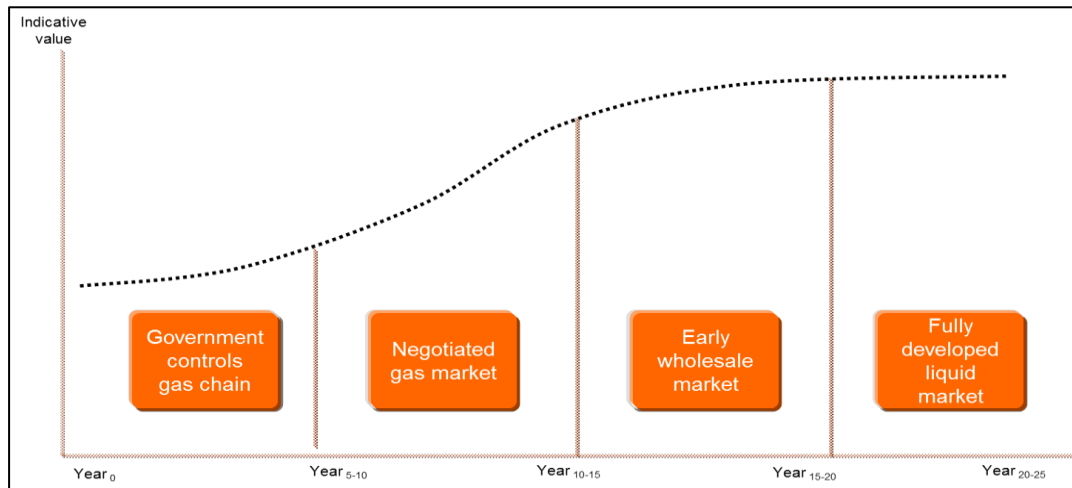

Figure 11: Gas market evolution curve

during the initial stage of development of any country. No foreign or local private player would invest due to lack of confidence in the country's institutions and poor bankability of projects, in absence of ready markets. Government or government owned institutions need to invest in the sector to initiate the development of the sector. This is then followed by investments by the local private investor. In addition, these sectors require large investments with long pay back periods. To make the projects bankable in the initial stage of development, government needs to provide monopoly to the sector. In most countries large government companies end up controlling the gas chain. UK is a good example of this where British Gas was provided monopoly status which helped the initial development of gas infrastructure. Government also acts as the regulator for the sector, during this stage. This stage may last from 5 to 10 years.

b) **Negotiated gas market:**

After the initial investments are made the gas sector becomes viable to attract private risk capital. The governments during this stage establish independent regulator for the sector. The setting up of an independent regulator is required for sending signals to the market that private players can come and compete with the existing well established government players and expect a fair and transparent treatment for their investments and returns. Any subsidies should be unwound at

this stage. It is also seen that governments tend to corporatize or privatize their companies at this stage to bring in efficiencies and professionalism. Wellhead prices are normally decided through negotiations while midstream and downstream tariffs are based on cost plus mechanism and set by independent regulators. Regulators work with incumbents to bring in efficiencies by forcing reduction is tariffs. Any country would take 5 to 10 years to reach this stage. This stage may take 5 years to develop.

c) **Early wholesale market:**

Once the infrastructure for the gas sector, especially the cross country trunk transmission lines and distribution networks are broadly established, the market is initially opened for competition on the wholesale side. Well head price deregulation is a prerequisite for this stage. Also, the monopoly and monopsony powers of incumbents need to be dismantled through legislations and regulatory interventions. Access to infrastructure with fairness and transparency is important in this stage. This helps more market participants to emerge. It may take around 10 to 15 years to reach this stage.

d) **Developed Gas Markets / fully developed market:**

Once the wholesale competition develops, the regulators start opening the gas retail segment for competition. Unbundling of transmission and supply business is done to push open access on all pipelines. Large number of players help develop commodity markets at this stage i.e. derivatives and secondary capacity trading. All customers are free to choose their suppliers. The role of regulators at this stage is to monitor the sector for any anti-competitive behavior and practices. It normally takes two decades to reach this stage.

Therefore, it can be argued that the efficient markets are the markets which help send the correct price signals for investment in any sector and that the government and the regulators should aid the gas markets to evolve gradually for its successful development. The theory on gas market reforms, efficient gas markets and evolution

of gas markets would underpin the research on developing a framework for creating a efficient gas market in India.

5 RESEARCH PROBLEM, RESEACH QUESTIONS AND RESEARCH OBJECTIVES

5.1 Research Problem

Having understood the challenges in India in the gas sector and the evolution of gas markets across various developed geographies, the research problem can be stated as below

> **"How to develop an efficient gas market in India"**

5.2 Research Questions

Based on the literature survey and the gaps identified, following three research questions need to be explored

Q1   What are the variables which help create an efficient gas market.

Q2   What is the identified framework & model for moving from a government controlled to an efficient gas market (based on learning's from US/UK/EU)

Q3   What is the framework and elements of the framework applicable for creation of an efficient gas market in India.

5.3 Research Objectives

Based on the research problem at hand and the three research questions, following are the three research objectives which we will try and achieve in this research

Objective 1: To identify factors for development of efficient gas market in India

Objective 2: To identify conceptual framework for an efficient gas market based on learning's from developed market like US, UK and EU and factors identified in Objective 1

Objective 3: To develop framework for an efficient gas market in India

6   RESEARCH DESIGN

The research design must be chosen based on the philosophical assumptions (world view) and the strategy of Inquiry. This is influenced by end objective to be accomplished and the research questions at hand. Softer issues like researchers experience and audience of the research report are also often considered in the research design.

6.1   Types of Philosophical assumptions/worldview

The philosophical assumption/world views can be of four types

Postpositivism – works for something more definitive, i.e. where cause will lead to an outcome. In postpositivism data is also reduced into smaller set if data or ideas. In this approach, the researcher starts with a concept and collects data which either disapproves the concept or accepts. Hence with this approach the researcher needs to apply quantitative techniques or methods.

Constructivism – this is also known as social constructivism. Social constructivism is about developing better understanding of the place we live and work. The researcher tries to convert their experiences into theory and concepts which are very wide. The idea is to capture all the varied and complex views to build in the theory rather than narrowing the data as was the case in postpositivism. The view of participant becomes most important in such study. This approach helps in development of a theory or concept.

Advocacy / Participatory – This philosophical view believes that the constructivism does not help to address the issues of the lower end of the society. Thus, this worldview helps in addressing the issues and coming out with an action agenda for the marginalized section of the society. This approach basically works better with qualitative research but quantitative research can also be used here.

Pragmatism – Unlike in Postpositivism, where actions would lead to results, this worldview works based on certain actions, situations which exist. This uses all or most of the approaches which are available to understand the problem and seek solutions. As discussed, this approach has an issue with the problem to solutions associating of situations.

(Patton M. , 1990). (Rosman & Wilson, 1985).

Pragmatism is not linked to a specific method of research. This worldview or philosophy believes in using liberally from all available methods. Thus, this applies to mixed methods where both qualitative and quantitative techniques are used. The researcher is free to choose his method which best suits his research objective and design. This provides the researcher the freedom and flexibility to use both methods of analysis, whereby helping to get a better understanding of the problem at hand.

The four worldviews are summarized in Table 7

Table 7: Four Worldview

Positivism	Constructivism
• Definitive • Help in reducing data • Cause and effect relationship • Verifies a theory	• Considerate of the situation • Varied and complex views • Expand understanding • Deduces a theory
Advocacy / Participatory	**Pragmatism**
• Better social understanding • Change in the society • Combined approach	• Addressing real world problems • Liberal use of all methods

(Creswell J. W., 2009)

6.2   Strategies of Inquiry

Strategies of enquiry is a phrase used along with the phrase approach to an equiry or more commonly called research methodologies.

As discussed in world view or the philosophical assumption the researcher can choose either the quantitative method, qualitative method or the mixed method approach. However there exists procedures within each of these research design or methodology and the researcher needs to use these as per the questions to be answered in the research design and the end objective to be achieved.

(Creswell, J W, 2007) (Mertens, 1998).

A summary of these strategies of enquiry is shown in Table 8

Table 8: Alternate strategies of enquiry

Quantitative	Qualitative	Mixed Methods
• Experimental designs • surveys	• Phenomenology • Ethnograpies • Grounded theory	• Sequential • Concurrent • Transformative

Mixed Method Strategies

Mixed method strategies of enquiry are of recent origin and hence are not as widely used as the quantitative and the qualitative techniques. It was in the year 1959 that the concept of mixing methods was first used by Campbell and Fisk. Once the advantage of mixed method became apparent to researchers. They started using the same which led to further development of approaches relating to data collection and sampling in mixed methods. Since both quantitative and qualitative method has its limitations, the researchers came to a view that using mixed methods help in negating any bias which creeps in while using a single method approach. Therefore, for the first time the concept of Triangulation was born which was achieved by seeking convergence inherent in mixed methods.
(Jick, 1979).

The mixed method strategy was originally built on the pillars of triangulation, however its use after few decades also diversified into methodologies of mixing these methods to achieve a certain objective of the research. These were based on integrating the data collected as part of the quantitative and qualitative phase. The mixing can be done

sequentially when results of one phase can help ask relevant questions for the next phase.

(Tashakhori & Teddlie, 1998)

Alternatively, the results of both quantitative and qualitative phase can be used side by side to reinforce the understanding for example the statistical analysis can be supported by qualitative quotes or vice versa

(Creswell & Clarke, 2007)

There are three types of mixed method strategies which are discussed below

Sequential mixed method is a method in which the researcher may like to elaborate its understanding of a phenomenon achieved through one method by the other method. In this the researcher, may start with say quantitative method in which a theory is tested followed by qualitative method in which individuals provide their views on such a theory.

Concurrent mixed method is a method in which the researcher merges the data collected in quantitative and qualitative phases. Thus, the data for both phases is collected together. After the data is collected, it is mixed to provide a comprehensive analysis of the research question.

Transformative mixed method can use both sequential or concurrent data collection approach. This design makes use of a theoretical lens which acts as an input in the study, which is then tested by these methods.

(Creswell J. W., 2009)

6.3   Research Methods

After deciding on the philosophical assumption and the strategies of inquiry in a research design, it is important to understand the third element which is the research

methods to be used. Research method means the data collection methods and the method used for statistical analysis. It is useful to consider all the available methods to choose the most applicable to the research objectives. Data collection can range from pre-determined question (closed ended) to open ended questions with a possibility to have a mix of both kind of questions. Similarly, statistical technique which is chosen can be purely statistical to purely non-statistical in nature.

Thus, the research method can be of three types

a. Quantitative research method
b. Qualitative research method
c. Mixed research method

(Creswell J. W., 2009)

Table 9: Qualitative, mixed and quantitative methods

Quantitative Methods	Mixed Methods	Qualitative Methods
• Existing or pre-decided • Questions based on set instruments mostly closed ended • Data can be from census or observation • Analysis and interpretation done by statistical methods.	Uses concepts from both Quantitative and Qualitative data	• Use methods which are new or evolving • Mostly questions are open ended • Data collected thru interviews using audio visual techniques • Analysis of textual data and analyzing emerging patterns

It can be inferred from the above discussion that there is a very thin line which separates each of these methods. Thus, as we go from quantitative to qualitative methods, this should be a visualized as a continuum rather than discrete phases. (Newman & Benz, 1998).

With the world becoming more and more complex, studies can only tend towards quantitative or qualitative techniques. Mixed method resides at the middle of the continuum.

(Creswell & Clarke, 2007)

The combination of qualitative and quantitative techniques would depend on the type of the research, the research question and the end objective.

Six types of mix methods were identified by Creswell et al in 2003, which he has discussed further in his book in 2009, using four important aspects in the designing process. These four aspects used by Creswell are timing, weighting, mixing and theorizing.

Timing

Researchers need to decide the timing of data to be collected when using both quantitative and qualitative methods. The approach can be either sequential in which the data is collected one after another or concurrent in which case the data for both phases is collected simultaneously.

The choice depends upon the intent of the researcher.

Weighting

Weight is the importance the researcher gives to one part of study cpmared to the other part. The weights can be either equal i.e. both quantitative and qualitative phase of the research are equally important or there can be tilt towards one of the method. This gets decided by the researcher based on the type of study, audience and use of research, research objectives and limitations in research, if any.

Mixing

This is the most important criteria and largely defines the type of mixed method used. Mixing of data is difficult since qualitative data may consist of numbers while qualitative data may consist of texts.

Mixing decides the timing and method of mixing the data collected at the quantitative and qualitative phase. This method involves methods like connected, integrating or embedding.

Connected in mixing means collecting data of one phase and then using that data to collect data of next phase. Integrating as the name suggest is using data from both phases together for analysis post integration. Embedding involves data set of one phase used in other phase to meet further objectives.

Theorizing

Theorizing means the entire design is anchored on a theoretical perspective, which guides the entire process. This can be an existing theory from social sciences or a conceptual lens developed by the researcher. This can be either explicit or implicit in the research.

The shape and design of these four factors, will decide our mixed method study.

6.4   Selection of research method

There are host of factors to be considered while choosing a method in the research. All the factors discussed in previous sections need to be kept in view while deciding either to follow a quantitative, qualitative or mixed method. The following need to be kept in mind while deciding the method for the research

2. Research questions to be answered
3. Research objective
4. World view
5. Strategy of enquiry
6. Audience of research
7. Limitations in area of research

(Creswell J. W., 2009).

Table 10 provides difference that will be helpful in choosing an approach.

Table 10: Qualitative, mixed and Quantitative approach

Tend to or Typically…..	Qualitative Approach	Quantitative Approach	Mixed Methods Approach
• Have these philosophical assumptions	• Constructivist • Advocacy • Participatory	• Post -positivist	• Pragmatic
• Apply these strategies of inquiry	• Phenomenology • Ethnograpies • Grounded theory	• Experimental designs • Surveys	• Sequential • Concurrent • Transformative
• Use these methods	• Open ended question • New approaches • Data in textual or image form	• Closed ended questions • Predetermined approaches • Data in numeric form	• Both open ended and closed ended questions • Both emerging and predetermined approaches • Both quantitative and qualitative data analysis

Developing a framework for creating a gas market in India requires a world view which is pragmatic, and this requires use of all possible approaches to explore and research the problem. As articulated in section 5, the research needs to meet the following objectives

Objective 1 - To identify factors for development of efficient gas market in India

Identification of factors once done through literature survey and semi structured interviews needs to be reduced in numbers, for interpretation and further analysis. This is best done by quantitative methods like factor analysis.

Objective 2: To identify conceptual framework for an efficient gas market based on learning's from developed market like US, UK and EU and factors identified in Objective 1

Objective 3: To develop framework for an efficient gas market in India

Identifying and developing frameworks requires emerging approaches, textual analysis using open ended questions with experts in the field. This can be done only through the qualitative methods like Framework analysis for first identifying a conceptual framework for developed markets and then using grounded theory for creation of the framework for India.

Hence mixed method looks to be the best method for this research as summarized in figure 12. The decision of world view and strategy of inquiry is influenced by research questions and the end objective to be achieved.
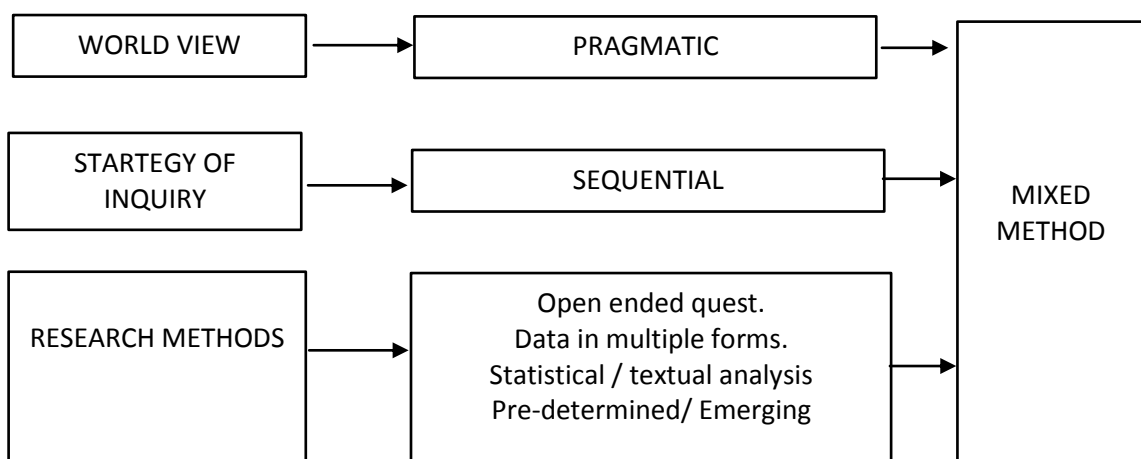
Figure 12: Selection of Research Method

6.5 Advantages of mixed method

The mixed method provides the following advantages over other methods as per various literature

Mixed method is a combination of both quantitative and qualitative methods. It not only involves collecting data using both the approaches but also uses methods which are both textual and analytical in nature. This helps to strengthen the study which is more robust in comparison to either quantitative and qualitative method.

(Clarke, 2007).

The understanding of the research is much wider and deeper using mixed method in comparison to use of only qualitative and quantitative method. The mixed method also helps in building, developing and explaining the results of one method to get a more robust output from the other method.
(Bryman, 2006); (Tashakhori & Teddlie, 1998)

In case the research is complex, the use of quantitative or qualitative approach will not only be inadequate but may not also provide the desired outcomes. Combined use helps to expand the understanding and triangulate the data
(Creswell J. W., 2009).

The creation of a framework for development of gas markets is a complex issue and hence would benefit from usage of mixed method.

In fact, the data obtained by mixed method has more in-depth information. The use of mixed method also helps to help increase the reliability and validity of the findings

(Yin, 2003).

6.6   Procedure for mixed method design

We can choose from six designs while deciding on the research design.
- Sequential Explanatory Design"
- Sequential Exploratary Design
- Sequential Transformative Design
- Concurrent Triangulation Design
- Concurrent Embeded Design
- Concurrent Transformative Design

(Creswell J. W., 2009)

We have chosen the sequential Explanatory design proposed by Creswell since we need to first find out factors and then input those factors in our further study to develop a framework.

Sequential Explanatory Design

The sequential explanatory design consists of dealing with each phase of the design separately. The data is first collected for phase one and then analyzed. The output of phase one is used as an input to phase two data, in addition to its own data collection and then the same is analyzed. In this approach, quantitative phase is followed by the qualitative phase.

6.7   Justification for use of identified research method

The final objective of the research is to develop a framework for creating an efficient gas market in India. Developing a framework not only requires extensive knowledge of Indian gas market but also the knowledge of International gas markets and best practices. The number of experts available in India are limited and hence a qualitative method(s) are best suited for developing this framework.

The development of framework requires three main inputs;

(1) the variables which are required for development of gas markets in India,

(2) the learnings from developed gas markets which can be applied in the Indian market and

(3) the sequencing of the various variables in form of a timeline map for effective implementation.

It can be argued that the above output can be achieved only using the qualitative method. However, since the number of experts who can be interviewed for development of framework are limited this may lead to a large personal bias. Also in using a single methodology, the conceptual lens would have to be developed only with the help of literature survey and personal experience of researcher which again would bring in bias to the research.

Hence, to ensure that a robust framework is developed and to triangulate the data, a larger set of individuals will be used for asking close ended questions on the variables required for development of gas market in India. This would be done first using quantitative methodology. The output from the quantitative phase and the literature survey on the international market will then be used as an input for development of a conceptual lens which would be tested with experts for development of framework for gas markets in India.

Since both phases are equally important, they are given equal weightage in this study. The data has to be collected sequentially for both phases which takes a long time, which is the main weakness of this study. The main strength is that this method is very easy to understand and implement.

The process is shown diagrammatically in figure 13
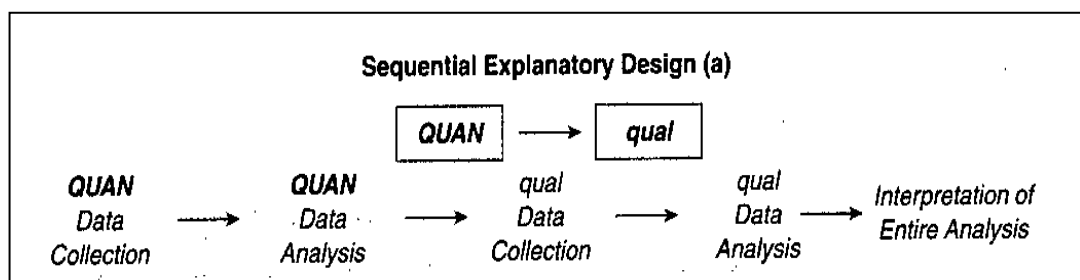
Figure 13: Sequential Explanatory Design

Based on the above discussion the complete Research design includes following steps

a. Use quantitative techniques to help find out factors which would enable development of gas markets

b. The output from the factors analysis and framework analysis (analysis of literature from US, UK and EU) is then used to help develop a conceptual framework for gas market development

c. In the end, the conceptual framework is tested through a grounded theory approach

The various steps of the mixed method design are illustrated through the figure 14
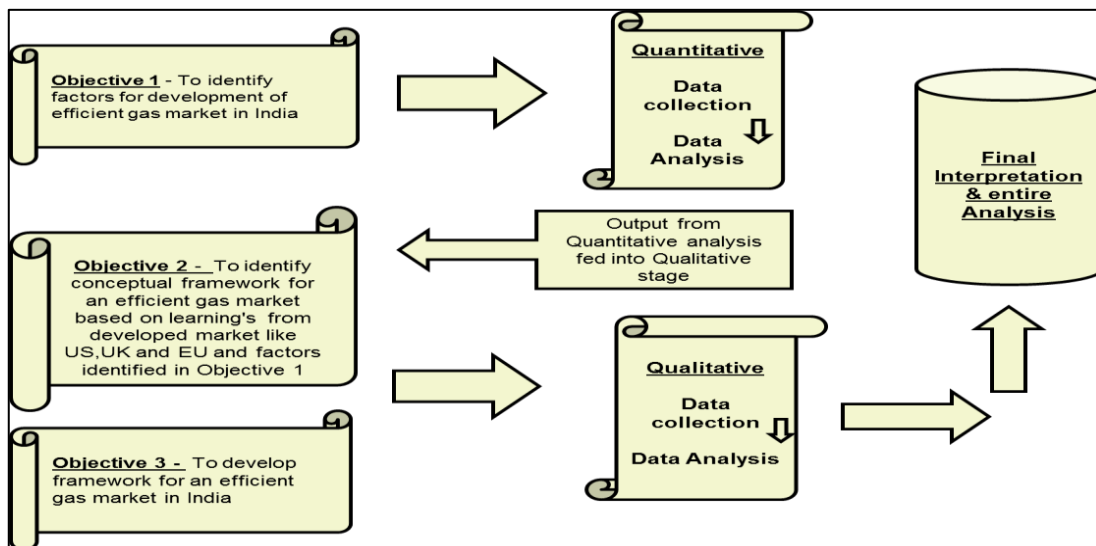
Figure 14: Research Design - Mixed Method

7 RESEARCH METHODOLOGY AND DATA ANALYSIS – OBJECTIVE 1

7.1 Research Methodology

The first objective is to identify factors for development of efficient gas markets in India.

To achieve the first objective, the researcher will be using the, quantitative technique. Factor analysis is one such technique
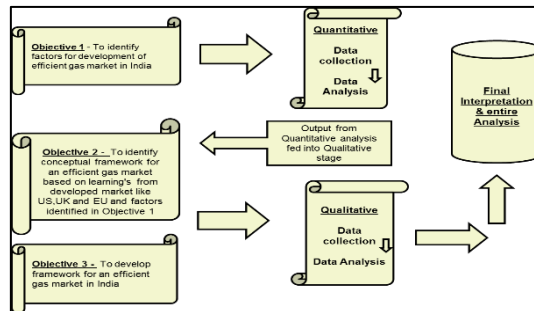
We start the research with multiple variables. We need to make sense out of these variables to help identify factors required for development of efficient gas markets. Factor analysis helps to meet either of the two objectives, i.e. summarize data while identifying structures through summarized data and reduction of data. Data reduction helps in seeing the data in a more meaningful way and help in better analysis. The methodology used includes summarizing the information hidden in large number of
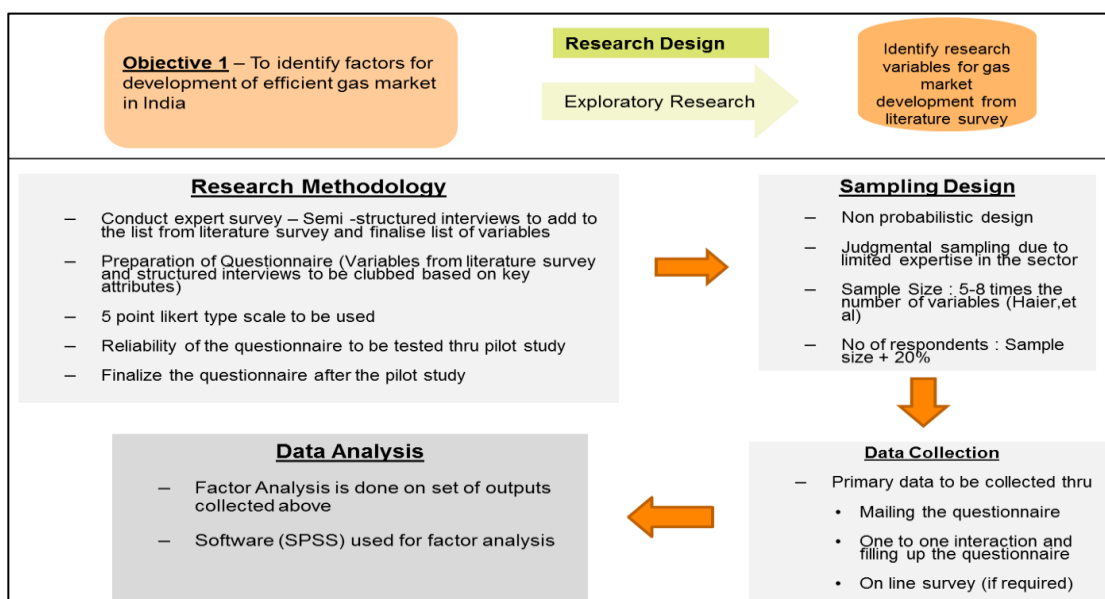
Figure 15: Research Design - Objective 1

initial variables into a smaller set of new composite factors. While doing so the method ensures that the loss of information is negligible.

Thus, we will be using the factor analysis for data reduction. The new set of variables / factors so produced from the factor analysis will be used in subsequent analysis. The new set of factors may partially or totally replace the initial set of variables.

In the beginning, the researcher will be identifying the variables which help in development of an efficient gas market. These initial set of variables would be identified through literature review based on work done in developed countries, which have reached a desired level of market maturity and have lessons to offer to developing countries. In addition, reports from government agencies, world bank and other multinational agencies working in the field of oil and gas would be used for shortlisting the initial set of variables.

The research design for Objective 1 is summarized in figure 15 and detailed in later sections of this chapter. The methodology is as follows

7.1.1   Research Variables

Identify set of key research variables from the literature survey for development of gas markets.

7.1.2   Research Design - Exploratory Design

The List of variables obtained through literature survey is strengthen and finalized after conducting semi-structured Interviews with expert in the field of oil and gas

a. Preparation of questionnaire

A questionnaire on variables responsible for creation of an efficient gas market will be developed based on the variables identified through literature survey and output of semi-structured interview.

Flow of questionnaire will be as follows

Part A – Demographic details of the respondent, profession and the area of expertise

Part B – of the questionnaire will consist of questions based upon the identified variables. The variables would be clubbed based on key attributes. The response from the participants would be recorded on Likert-type scale. We have used a five-point scale which is most suitable for this research.

While responding to Part B of the questionnaire the respondents will be asked to rank their opinion about the impact of variables on the development of efficient gas markets

05 – Strongly Disagree
04 – Disagree
03 - Neither Agree or Disagree
02 – Agree
01 – Strongly Agree

b. Reliability of Questionnaire thru a Pilot study

The weakness if any, of the questionnaire shall be pre-tested through pilot survey. Pilot survey will provide additional ideas and insights on key variables for development of market. Pilot study outputs would be tested by measuring Cornbach's Alpha. Cornbach's Alpha measures consistency, validity and reliability of the questionnaire. The range measured is from 0 to 1. Any value of 0.60 and 0.70 demonstrates lower level of acceptability (Haier, Black, Anderson, & Tatham, 1998).

7.1.3   Sampling Design

As this stage of research is exploratory, the sampling design will be **non-probabilistic** as people have limited expertise and domain knowledge in the area under research. The selection technique of sample will be restrictive and will be done through **judgment sampling.**

The respondents for the questionnaire will be chosen from the following background for carrying out judgmental sampling

a) Management level persons from oil and gas industry
b) Executives at the Ministry of petroleum and natural gas, PNGRB, planning commission, Power and fertilizer ministry
c) Academic researchers / consultants from the oil and gas sector
d) Retired professionals / bureaucrats from the oil and gas background

7.1.4   Sample Size

As the numbers of variables would be finalized based on secondary survey, the below equation would be used for selecting the sample size. The sample size would be at least five times to eight times the number of variables (Haier, Black, Anderson, & Tatham, 1998) and additional 20% persons would be contacted. This will ensure the Haier criteria mentioned above is achieved, since 100% response from the participants is never expected and margins need to be kept, to avoid developing additional list.

a.   No of variables = X
b.   Sample Size = 5X to 8X
c.   No of persons to be contacted = (5X to 8X) + 20%

7.1.5   Data collection

Primary data from the sources would be collected through the following modes;

a.   By mailing the questionnaire to probable respondents
b.   One –to-one interactions and filling up the questionnaire
c.   On-line survey if required

7.1.6   Data Analysis

Factor analysis is done on the set of variables collected through primary survey, to examine the interdependent relationship to define a set of common dimensions called factors. SPSS software was used for factor analysis.

The concept map for factor analysis as provided by Malhotra and Dash is provided in figure 16 (Malhotra & Dash, 2010).
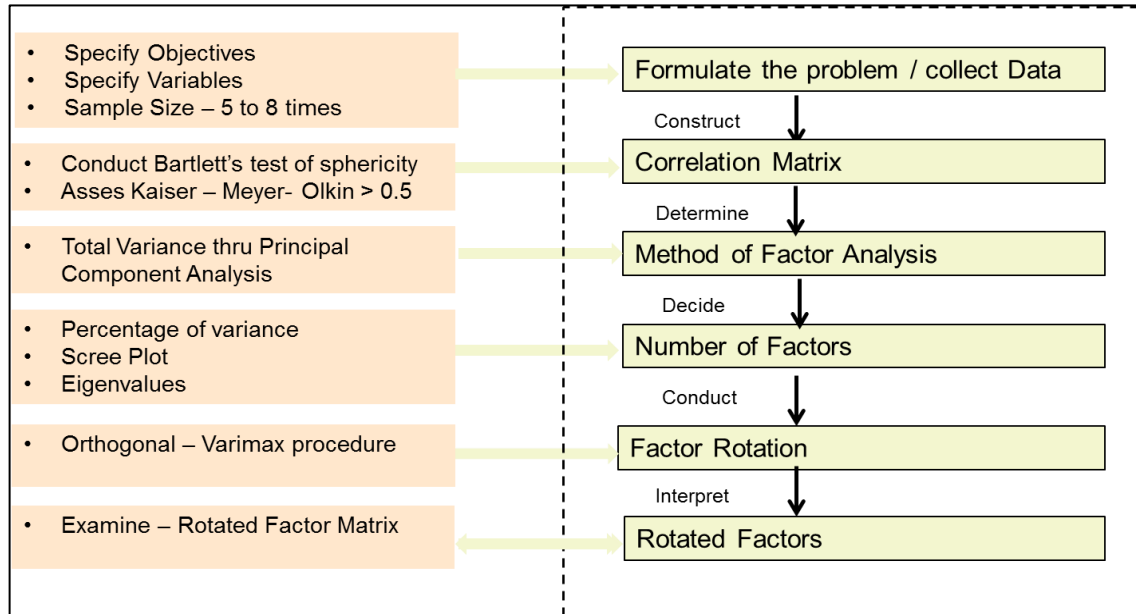
Figure 16: Process Map - Factor Analysis

7.2 Discussion on data output and analysis

Step 1: **Identifying variables through literature survey**

Literature survey was done as explained in Section 3 of this thesis. Literature survey provided a list of 16 variables as outlined below. Textual analysis was used deciding the list of universal variables

1. Existence of cross country gas grid
2. Existence of sufficient number of import terminals
3. An independent upstream regulator
4. Access to infrastructure – robust access code
5. Unbundled transportation and marketing segments of gas sector
6. An independent system operator for pipelines
7. Transparency in regulated businesses

8. Bulletin Board for information sharing

9. Stable long term policy from the government

10. No well head price regulations

11. Entry / exit system for pipeline tariffs

12. Existence of physical hubs and financial markets

13. Secondary trading in pipeline capacity

14. Efficient downstream (power & Fertilizer) markets

15. Presence of unconventional like Shale/CBM

16. Presence of gas imports through pipelines

Step 2: **Semi-structured interview was conducted using judgmental sampling with 10 experts in oil and gas**

Interview protocol included the following brief and questions

Brief to the experts

The experts were briefed that the interview was part of the academic work on finding factors for creation of an efficient gas markets in India. The experts were also informed that by efficient market we mean that the price of gas is determined through forces of demand and supply.

Four key questions were administered in the expert interview

1.0 What factors help /impede creation of an efficient gas market which relate to government policy

2.0 What factors help/impede creation of an efficient gas market which relate to infrastructure and supply

3.0 What factors help/impede creation of an efficient gas market which relate to regulatory interventions

4.0 What factors help/impede creation of an efficient gas market which relate to market mechanism

In addition to the above, intervening questions were asked related on the topic to act as an aid to discussion. The discussion is captured in summary form as key points emerging from the deliberation. Each semi structured interview lasted from 20 -30 minutes. A sample output from a semi structured interview is provided in **Annexure 1**

The factors identified through the literature review (step 1) and that obtained from the semi-structured interview process were combined. Post this the number of variables expanded from 16 to 30. These 30 variables were converted into a questionnaire.

Step 3: **Design of Questionnaire, Pilot Survey for testing reliability of questionnaire**

The questionnaire was designed on a five-point likert scale and was divided into four segments for ease of administering and understanding by participants.

The questionnaire used is provided for Reference in *Annexure 2*

Pilot survey was done to check the reliability of the questionnaire. Pilot survey was done on 30 respondents

Pilot study outputs would be tested by measuring Cornbach's Alpha. Cornbach Alpha was developed by Lee Cronbach in 1951. This measure is used for testing the reliability/ validity and internal consistency. Cornback Alpha is a number between zero and one. Internal consistency checks whether all variables are related to each other so that they measure the same concept.
(Mohsen Tavakol, 2011).

The range of Cornbach Alpha measured is from 0 to 1. Any value of 0.60 and 0.70 demonstrates lower level of acceptability (Haier, Black, Anderson, & Tatham, 1998).

If the value of alpha is high (> 0.90), this may suggest redundancies and demonstrate that the test length should be shortened (Mohsen Tavakol, 2011).

> **Cornback Alpha score for our pilot survey is 0.786, demonstrating that the questionnaire is reliable, valid and have internal consistency.**

After the above results were available, the questionnaire was administered on a large sample size, meeting the Haier criteria.

Step 4: **Sampling Frame & Size**

Since the field of oil and gas does not have many experts judgmental sampling method was used to select the respondents. These respondents included employees of oil and gas companies, consulting organization, government and regulatory bodies at various levels of hierarchy

The questionnaire was administered through various means like mails, face to face meeting and telephonically

The questionnaire was administered to 250 respondents. Out of 250 selected respondent's replies were received from 205 respondents. As per Haier the sample size of 5 to 8 times is adequate. For 30 variables in our questionnaire the size works out to 6.83 times the number of variables. Hence the sample can be termed as adequate.

Step 5: KMO and Bartlett's Test output

It is important to check whether the variables in the population are uncorrelated to each other. This is stated as the null hypothesis i.e. variables are independent or uncorrelated to each other. Bartlett's test output provides this confirmation.

It is equally important to test the adequacy of the sample collected. Kaiser- Meyer-Olkin (KMO) measures the sampling adequacy. If KPO value is between 0.5 and 1.0 (High values) it indicates that it is appropriate to carry out factor analysis on the

collected sample. Values lower than 0.5 indicate factor analysis is not desirable on the collected sample.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.755
Bartlett's Test of Sphericity	Approx. Chi-Square	2.208E3
	df	435
	Sig.	.000

Below is the KMO table

KMO score	Interpretation
0.9+	Perfect
0.8 – 0.89	Great
0.7 – 0.79	Good
0.5 – 0.69	Medicore
< 0.5	Unacceptable

Since the value of KMO is 0.755, i.e greater than 0.5 it is acceptable as per Kaiser.

If the value was below this level than we should go back to the drawing board and either collect more data or think of more variables to be included in the analysis. (Hutcheson and Sofroniou, 1999)

The value of significance level (.000) in the above table demonstrate that there is some relationship between the variables collected.

Step 6: Factor Analysis

Since we have established above that factor analysis is suitable for analyzing the data collected, we need to determine which method of factor analysis needs to be used or which method is most appropriate.

There is two basic approach to factor analysis i.e. principle component analysis and common factor analysis.

Since we are interested in determining the factors (max number) for subsequent analysis, that will account for maximum variance in the data, we select principle component analysis method.

Variables can be extracted using the principle component analysis method. Determination of these factors can be done by various methods. Some of the common methods are listed below

1. A priori determination
2. Determination based on Eigenvalues
3. Determination based on Scree plot
4. Determination based on percentage of variance
5. Determination based on split half reliability
6. Determination based on significance test

We have selected the method based on percentage of variance.

Malhotra and Dash recommend that if we use percentage of variance method, at least 60 percentage of the variance should be accounted by the extracted factors. The percentage of variance is the cumulative percentage of variance.

(Malhotra & Dash, 2010).

As seen in the table 11, 65.4% of the variance is explained by the nine factors

Table 11: Factor Analysis - Total variance explained

Total Variance Explained

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.961	19.871	19.871	2.694	8.979	8.979
2	2.915	9.717	29.588	2.586	8.621	17.600
3	2.249	7.495	37.083	2.378	7.927	25.528
4	2.199	7.330	44.413	2.167	7.225	32.753
5	1.617	5.391	49.804	2.136	7.122	39.874
6	1.374	4.581	54.385	1.961	6.537	46.411
7	1.224	4.079	58.465	1.920	6.401	52.812
8	1.090	3.633	62.097	1.899	6.332	59.143
9	.993	3.311	65.408	1.880	6.265	65.408
10	.892	2.974	68.383			
11	.838	2.795	71.177			
12	.799	2.665	73.842			
13	.713	2.376	76.218			
14	.689	2.297	78.515			
15	.662	2.207	80.722			
16	.647	2.155	82.878			
17	.600	2.000	84.878			
18	.527	1.757	86.635			
19	.506	1.687	88.322			
20	.483	1.611	89.934			
21	.418	1.394	91.327			
22	.400	1.333	92.660			
23	.375	1.249	93.909			
24	.329	1.098	95.007			
25	.318	1.059	96.067			
26	.305	1.017	97.084			
27	.251	.838	97.922			
28	.244	.813	98.735			
29	.203	.678	99.412			
30	.176	.588	100.000			

Extraction Method: Principal Component Analysis.

The initial matrix in Table 11 does not lead to any interpretation or analysis since the factors are correlated with multiple variables. This is the unrotated or initial matrix and the factors need to be rotated so that each factor has significant loading on some of the factors, helping in better interpretation.

Malhotra and Dash recommend using orthogonal rotation method known as Varimax procedure. In this research we have used this method to help interpret and analyse the factors.

(Malhotra & Dash, 2010)

The output from the orthogonal rotation is depicted in Table 12. As see from the output each variable load's significantly only on one of the nine factors of the initial matrix. This method also helps to distribute the variables across all factors.

Nine factors emerge from the analysis. These factors are now labelled and summarised (refer Table 13) to understand their significance and help in further analysis.

Table 12: Factor Analysis - Rotated Component Matrix

Rotated Component Matrix[a]

	1	2	3	4	5	6	7	8	9
Investment by Indian companies in equity oil and gas outside India since Indian prospects are not very encouraging	.807								
Focus on development of resources by government through NELP round every year/moving to OALP (open acreage licensing policy)	.645								
Development of storage / strategic storage facilities (caverns / storage at RLNG tankages)	.627								
Strategic arrangement/tie-up with gas rich neighboring countries to import gas via pipeline	.607								
Development of new technology / spend on R&D to develop resources / skill development									
Government should ensure phased opening of the market /gradual introduction of competition		.743							
Existence of Hub for physical trading of gas		.728							
Existence of financial markets for hedging market risk		.714							
Existence of bulletin boards for information sharing to ensure seamless availability of information		.666							
A dense market place i.e large number of players should be present in the gas chain			-.688						
Excess_to_Pipeline_regas			.586						
Promotion of unconventional resources like shale / CBM (keeping in mind sustainable development)									
Government should provide infrastructure status to the industry for faster development. Incentives to develop infrastructure in unviable areas									
A environment allowing ease of entry and exit of investments from the sector				.739					
Remunerative concession norms (maintaining balance between risk and reward) for attracting investments in the gas chain				.733					
Providing tax concessions to promote green fuels like gas while taxing polluting fuels				.600					
Government should ensure sanctity of commercial contracts and other terms & conditions as at the time of the investments.									
Political will to ensure independence and empowerment of all the regulators									
Existence of uniform tax regime across India for free gas movement					.689				
Existence_Infrstructure_gas					.658				
Introducing transparency in regulated business					.655				
Phasing out of the gas utilization policy i.e the allocation of molecules should be market driven						.778			
Freedom to upstream producers to price gas at well head based on a price discovery mechanism						.711			
Long_Term_stable_policy							.796		
Existence of a single agency (Ministry / Regulator) for the energy sector							.591		
Free markets (market based pricing) in the key consuming sectors like power, fertilizer and transport fuels								.827	
Free markets (market based pricing) in competing energy sectors like coal and Electricity								.804	
unbundling_Capacity_tradinhg_pileline									.797
Transparant_Access_Arrangement									.611
Introduction of entry –exit system for pipeline tariffs									.533

Step 7 - Label the factors:

Once the solution is reached we try and name each of the nine factors. Table 13 attempts to provide name to each of these factors. The naming logic is based on the following principles

Each variable has a loading number on the factor, for example Investment of Indian companies in equity oil and gas outside India has a high loading of 0.807 compared to

other variables. The significance of this factor originates from the fact that Indian acreages are not significant and hence gas from multiple sources will help development of gas markets. Hence the name provided to the factors as – Availability of gas from multiple sources.

Similarly, for the second factor, variables like phased opening of markets by government, existence of physical and financial hub have a loading of 0.71 to 0.74. All of this mean existence of market mechanism hence the name provided to the factor is – Existence of market mechanism.

Table 13: Factor Names

Original Factors	Component									Factor Names
	1	2	3	4	5	6	7	8	9	
Investment by Indian companies in equity oil and gas outside India since Indian prospects are not very encouraging	.807									**Availability of Gas from Multiple sources**
Focus on development of resources by government through NELP round every year/moving to OALP (open acreage licensing policy)	.645									
Development of storage / strategic storage facilities (caverns / storage at RLNG tankages)	.627									
Strategic arrangement/tie-up with gas rich neighboring countries to import gas via pipeline	.607									
Development of new technology / spend on R&D to develop resources / skill development										
Government should ensure phased opening of the market /gradual introduction of competition		.743								**Existence of Market Mechanism**
Existence of Hub for physical trading of gas		.728								
Existence of financial markets for hedging market risk		.714								
Existence of bulletin boards for information sharing to ensure seamless availability of information		.666								
A dense market place i.e large number of players should be present in the gas chain			-.688							**A Dense Market Place /**

Item								Category
Access_to_Pipeline_regas			.586					**Multiple Players**
Promotion of unconventional resources like shale / CBM (keeping in mind sustainable development)								
Government should provide infrastructure status to the industry for faster development. Incentives to develop infrastructure in unviable areas								
A environment allowing ease of entry and exit of investments from the sector			.739					**Incentivizing Investments / Ease of Doing Business**
Remunerative concession norms (maintaining balance between risk and reward) for attracting investments in the gas chain			.733					
Providing tax concessions to promote green fuels like gas while taxing polluting fuels			.600					
Government should ensure sanctity of commercial contracts and other terms & conditions as at the time of the investments.								
Political will to ensure independence and empowerment of all the regulators								
Existence of uniform tax regime across India for free gas movement				.689				**Availability of Infrastructure to move gas**
Existence_Infrstructure_gas				.658				
Introducing transparency in regulated business				.655				

Item	Loading	Theme
Phasing out of the gas utilization policy i.e the allocation of molecules should be market driven	.778	**Freedom to price / sell gas**
Freedom to upstream producers to price gas at well head based on a price discovery mechanism	.711	
Long_Term_stable_policy	.796	**Long Term Stable, Integrated vision & Policy**
Existence of a single agency (Ministry / Regulator) for the energy sector	.591	
Free markets (market based pricing) in the key consuming sectors like power, fertilizer and transport fuels	.827	**Free Energy / Downstream Markets**
Free markets (market based pricing) in competing energy sectors like coal and Electricity	.804	
Unbundling_Capacity_tradinhg_pileline	.797	**Regulatory interventions to break monopoly**
Transparant_Access_Arrangement	.611	
Introduction of entry –exit system for pipeline tariffs	.533	

7.3 Description of Factors which would help development of efficient gas markets

The nine factors named, based on the loadings are discussed in detail on their applicability for creation of efficient gas markets. The factors are also depicted in pictorial form in figure 17

1) Availability of Gas from multiple sources

Gas availability i.e. the availability of commodity is the main factor which is required for development of efficient gas markets. Also, for a dense market there is requirement of commodity from multiple sources. This helps to increase competition and depth in the market. Gas should be available both from domestic and imported sources. Imported gas can come via pipelines or through regas terminals. Based on the principle
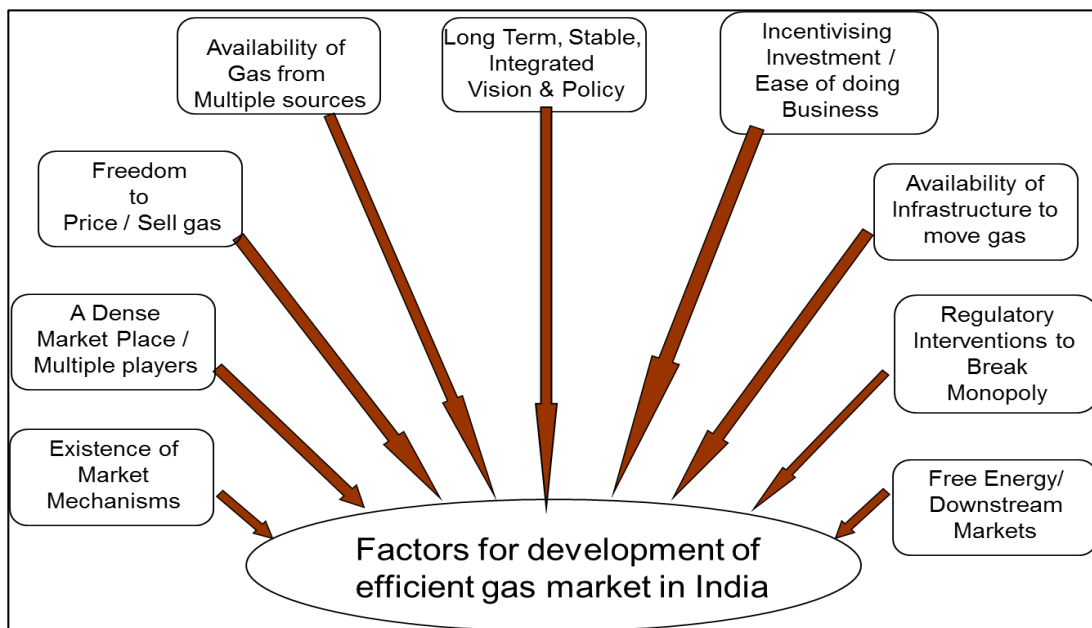
Figure 17: Factors for development of efficient gas market in India

of demand and supply, there should be adequate supply to create some competitive tension between suppliers. Since the domestic supply is not adequate to meet demand, the government of India should bring in policy measures to boost local exploration and production. In addition, they should encourage setting up of new import terminals and cross-country pipelines (from middle east) to import gas.

2) Existence of Market Mechanisms

A market cannot exist without the existence of market intermediaries and mechanisms like trading platforms. Gas hubs for both physical and financial transactions need to be developed. Initially the trading is for the physical commodity but as the market develops, financial trading picks up which helps to provide depth to the market.

3) A dense market place/ market players

Market cannot exist unless there are multiple players. The market not only needs multiple players, but need them in each segment of the gas sector. The upstream sector needs many producers which will help to increase production and create competitive supply market among them. A market with multiple suppliers, but with a single buyer will not help in development of market. Hence multiple buyers are required, to provide balance to the market. Gas is a commodity which is not fungible, since can't be easily stored, hence the sector would need multiple shippers either enabling access on cross country pipelines or regas terminals. These shippers are necessary to ensure that the product reaches the market.

4) Incentivizing investments / Ease of doing business

The government plays a key role in the initial phase of market development where they should come out with clear policies to attract investments and remove hurdles for starting and running business. This will help in bringing in investment across the gas value chain from upstream to the downstream sector. A single window clearance mechanism would help in ease of doing business.

5) Availability of Infrastructure to move gas

Unlike products which can be stored, gas is not a fungible commodity. Gas needs infrastructure including cross country pipelines, regas terminals and distribution networks to move from source to the sink. This is the most essential element for development of efficient gas markets. The fungibility for gas can be created by liquification which requires large capital and increases cost of supply, hence a large

infrastructure will help move gas across markets and negates requirement of storage (either through liquification or in caverns)

6) Freedom to Price / sell gas

Investments in the upstream gas sector can only be attracted if the investors are allowed the freedom to price the gas production on economic principles and not based on adhoc formulas provided by the government. This would help increase the availability of the commodity and hence help in market development. Freedom to price also means the freedom to sell to any sector without any restriction or allocation policy.

7) Long term stable, integrated vision and policy

The role of the government is to provide a stable and integrated vision and policy for the energy and gas sector. The government needs to bring clarity on the role, of gas in the energy sector and in the economic development of the country. In absence of this clarity it would be difficult to attract investments for development of the sector. The government should also ensure that the policies once declared should be stable and should not be changed which dents the confidence of the investing community.

8) Free energy / downstream markets

Any market distortion would hinder the development of markets. The consumption of gas in bulk is done by the power and fertilizer sectors and hence any factor which impact these sectors also impact the gas sector. In India both these sectors are highly subsidized. The government and the regulators need to remove all subsidies from the energy market including these main gas consuming segments of power and fertilizer for markets to develop.

9) Regulatory Interventions to break monopoly

Regulators need to play an important role for market to develop. It is difficult to assume that the existing monopoly players would allow market to function without

regulators intervening and passing orders for gradual opening the market for competition.

7.4   Summary

The nine factors outlined above would help in development of gas markets in India. However, our research is not confined to just identifying the factors but go ahead and create a framework for development of an efficient gas market in India.

The next step in the research is to identify a conceptual framework for an efficient gas market based on learnings from developed market like US, UK and EU. The next step will use all the nine factors identified as an output in this chapter using quantitative analysis.
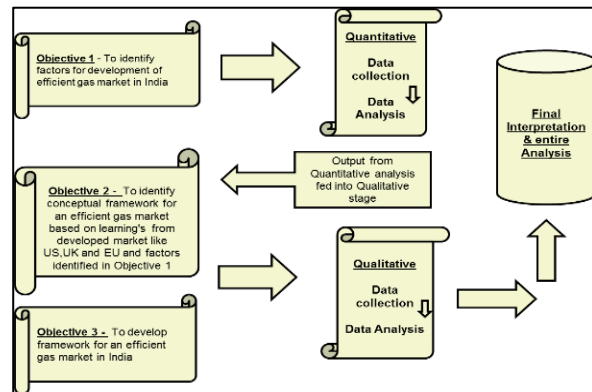
8   RESEARCH METHODOLOGY AND DATA ANALYSIS – OBJECTIVE 2

8.1   Research Methodology

The second objective requires the researcher to identify a conceptual framework for an efficient gas market based on learnings from developed market like US, UK and EU and factors identified in Objective 1. The conceptual lens derived as an output from
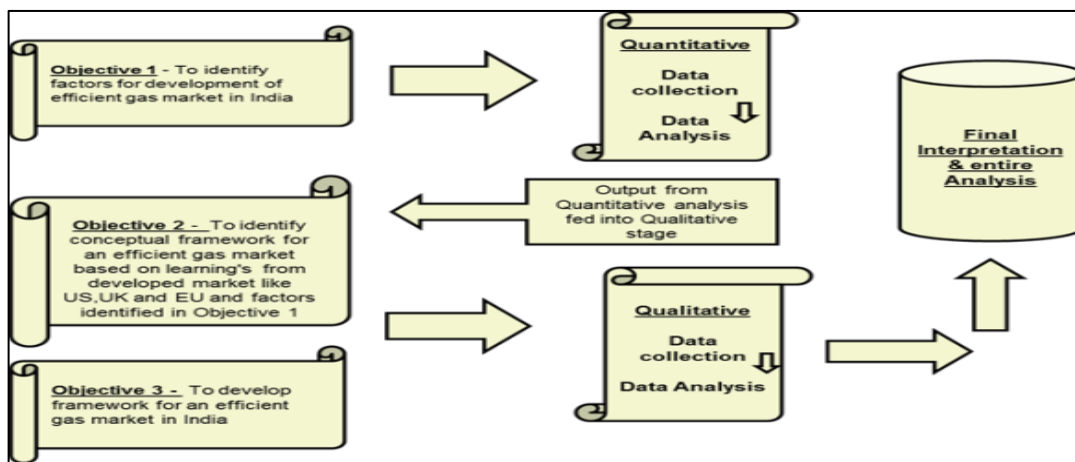
Objective 2 would then form an input into the Grounded theory methodology for Objective 3.

To develop a conceptual framework, the researcher found the methodology of Framework Analysis most suitable. Framework analysis is a kind of textual analysis and is very widely used in research. Framework analysis is particularly useful if we are interested in outcomes or endorsements in very short timescale. Since in developing the conceptual framework we are referring to literatures from developed countries this method is ideal for meeting the requirements of Objective 2. However, to carry out the textual analysis we must choose a method which is well established. Ritchie and Spencer have provided one such method.

Ritchie & Spencer 1994, detail out a 5 step "Framework Analysis" process (figure 18) for analyzing the qualitative data which aligns perfectly to the requirement of the research (Ritchie & Spencer, 1994).

Figure 18: Ritchie & Spenser - Framework Analysis map

STEPS	Process
Familarization	Involves the immersion in the data to identify recurrent themes and list key ideas
Identifying a thematic framework	This is the initial coding framework which is developed both from a priori issues and from emerging issues from the familiraziation stage. Thematic framework should be developed and refined during subsequent stages.
Indexing	Is the approach to labelling data into manageable chunks fro subsequent retrieval and exploration. Data can be labelled in themes emerging above
Charting	Involves building the big picture view from the themes identified and involved abstraction and synthesis of data gathered. Using heading from the thematic framework to create charts
Mapping and Interpretation	Involves pulling together the key components of the data into a whole to define concepts, mapping range of phenomena, finding association and developing strategies etc. that is mapped to the intent of the study

Framework analysis helps to address many questions. Some of these were put forward by Parkinson in the year 2016 and are discussed below

Contextual – using the literature this helps to bring out the facts on what currently exists

Diagnostic – as the name suggest this help to find reasons why certain facts exists

Evaluative – this helps to check the efficacy of the current knowledge

Strategic – this helps to develop and identify new theories/ trends joining chain of events from the existing knowledge

(Parkinson & etal, 2016)

The researcher felt that the question, identifying a conceptual framework for an efficient gas market, fitted with both contextual and strategic category since we are interested in finding out the form and nature in which such conceptual framework exists and help evolve new theories for Indian gas market.

The researchers who follow qualitative techniques are divided on the fact whether using a special software for their analysis is helpful or even the use of generic software's (word, excel) available would be sufficient.

While deciding on the above we kept the following in perspective
8. The complexity of the data being handled
9. The aim of the research
10. The depth of analysis required
11. The work justifying the cost of any specialized software
12. The expertise of the researched in the field being researched
13. The preference of the researcher
14. The value added by using such a software

 (Phelps, Fisher, & Ellis, 2007).

Since the number of literature on gas market framework are limited the researcher has gone ahead with manual method since using any specialized software would not have provided any additional benefit or prespective.

8.2   Discussion on data output and Analysis

Step 1: Familarzation

Familiarization involves understanding the data available and generating whole or partial transcription. Under this, the key research papers were shortlisted as per details below and initial transcripts generated by marking on the papers in soft.

STEPS	Process	Methodology/ Output
1)Familarization	Involves the immersion in the data to identify recurrent themes and list key ideas	15 key research papers were identified from a set of 50 papers to evaluate and finalize key themes like orders passed by governments and regulators.
2) Identifying a thematic framework	This is the initial coding framework which is developed both from a priori issues and from emerging issues from the familiraziation stage. Thematic framework should be developed and refined during subsequent stages.	Protocol was used for culling out key themes form the data. The key themes were analysed across papers for consistency of ideas
3) Indexing	Is the approach to labelling data into manageable chunks fro subsequent retrieval and exploration. Data can be labelled in themes emerging above	Since the desired outcome is a framework II the data collected are then indexed year wise for each country i.e. UK. US and EU
4) Charting	Involves building the big picture view from the themes identified and involved abstraction and synthesis of data gathered. Using heading from the thematic framework to create charts	The key themes and the year wise data is then used to prepare framework for each country
5) Mapping and Interpretation	Involves pulling together the key components of the data into a whole to define concepts, mapping range of phenomena, finding association and developing strategies etc. that is mapped to the intent of the study	The data for each country which were indexed and separated above mapped along with factors identified in Obj1 and themes in a timeline map linking the activities and events

List of authors whose research papers are in area of development of gas market. Shortlisted 15 papers out of circa 50 papers

- Pierce, 2004
- Juris, 1998
- Smead, 2013
- Kim, 2014
- Vany, 1994
- Herbert, 1996
- GAO, 2006
- Energy Charter Secretariat, 2007
- IEA, 2012
- Stern, 1997
- Simmonds, 2004
- Calliope, 2009
- Melling, 2010
- Thuber, 2011
- European federation of energy trade, 2004

Step 2: Identifying a thematic framework

A thematic framework is identified from a priori issues and any issues emerging from the step 1

The nine factors from the quantitative analysis stage, listed below (a priori) form part of the emerging themes in the framework analysis.

1.0   Availability of gas from multiple sources taken as Multiple Supply sources

2.0   Existence of market mechanisms

3.0   A dense market place / market players

4.0   Incentivizing investment / ease of doing business

5.0   Availability of Infrastructure to move gas

6.0   Freedom to price / sell gas or well head price freedom

7.0   Long term stable, integrated vision and policy

8.0   Free energy / downstream markets

9.0   Regulatory interventions to break monopoly

Under this stage a protocol was used to scan through all the literature to draw out themes. The protocol listed below was applied on literature on gas market development in mature countries of US, UK and EU.

- How the developments have panned out starting from when gas was first available in the country until the markets developed
- What are the factors helping these developments (to use a priori knowledge from factor analysis to look for factors helping such developments)?
- Which of these developments / events can be taken as key theme necessary for market development as per available literature on market development in US, UK and EU countries
- What are the dominant and similar themes emerging.
- Can the themes be mapped in a sequence with timeline?
- Can a conceptual framework common to all countries emerge from the dominant theme?

Following themes were identified combining themes emerging from output of Objective 1 (above) and emerging from data of literature survey

1. Long term vison and policy
2. Policy directives
3. Well head pricing freedom
4. Multiple supply sources
5. Independent regulator
6. Incentivising development of infrastructure
7. Gas release program
8. Open access with case to case exemption
9. Phased market opening
10. Distortions removed from power and energy markets
11. Market mechanisms
12. Ease of doing business
13. Breakup of monopoly positions
14. Capacity release programs
15. Transparency
16. Development of hubs
17. Fully liberalized markets
18. Measures for energy security

Step 3: Indexing

Since our objective is to map the history of evolution of gas markets in matured countries, using the emerging themes, we have tabulated and indexed the data based on the year and then mapped the themes to the data

US markets

The Natural Gas Act was passed by US in the year 1938. In more than 70 years since then the US gas markets have seem many major development and key initiatives taken by the government and the regulatory authorities. The evolution (year wise) of US market (Pierce, 2004); (Juris, Andrej, 1998); (Smead, Rick, 2013); (Kim, 2014); (Vany, 1994); (Herbert, 1996); (GAO, 2006); (International Energy Agency, 2013) is presented in Table 14;

Table 14: Indexing of development in US gas market

Year	Key development / Evolution
1938	• Passage of Natural Gas Act to prevent exercise of monopoly power over interstate pipelines. (Pierce, 2004) (Smead 2013) • The companies in business of inter-state commerce came under federal jurisdiction. (Smead 2013) (IEA, 2012) • The Act was passed to regulate the gas industry. The powers were vested with the Federal Power commission (FPC) [later renamed as Federal Energy Regulatory Commission (FERC)] (Juris, 1998), (Energy charter secretariat 2007)
1950's – 1960's	• Post, world war economic boom. No wellhead price regulation. Gas supply was available in abundance. The interstate pipeline network saw major expansion. (Pierce 2004), (IEA 2012) • All gas producers were brought under rate regulations with the Supreme Court ruling of 1954. This ruling provided FERC with powers to regulate prices of gas at the well head. This had a major impact on producer revenues (a retrograde step). However, pipeline expansion accelerated due to low commodity prices (Juris 1998) (Energy Charter Secretariat 2007) • The above order created major problems in creating very high demand for such gas even more than unregulated oil and coal. (IEA, 2013)
1970's -1980's	• The market of gas was divided into Interstate and Intrastate for better control. Interstate market saw shortages of gas due to low gas price at the well head, while excess supply remained in Intrastate market since price were determined by market clearing. (Juris 1998) (IEA, 2013) • Natural Gas Policy Act of 1978 lifted any gas price ceiling on new gas production. This resulted in increase in new exploration and production. Since the interstate pipeline was gas starved the capacity holders had to pay large amount of take or pay liabilities. First US spot gas market created. (Smead 2013) (Energy charter secretariat, 2007)

	• FERC order 380 –a far reaching order helped unhook the utilities from the pipeline companies with respect to any contractual obligations. (FERC Order) (Energy charter secretariat, 2007)
	• FERC order 436 – this was a order with far reaching effects since this enabled open access on pipelines on a voluntary basis. This helped the development of markets by bringing in more shippers, however no trading took place during this time. Producers sold gas to owners of trunk pipeline who were also the aggregators. The aggregators then sold the gas to the city gas distribution companies including large industries. (FERC order)
1990's	• In another regulation of high consequences, the Natural gas wellhead decontrol Act of 1989, removed the price control on gas at the well head. This helped in removing the distortion from the market which was created due to differential price of gas. The impediments on open access on gas pipeline was removed by unbundling transportation and supply for the owners of interstate pipelines. (Juris, Multiple papers)
	• 1992- FERC order 636 – to help improve compliance on open access, the FERC order 636, stipulated unbundling of ownership on the interstate pipelines. Owners were not allowed to hold capacity for themselves. This step encouraged formation of market centers (hubs) on pipeline intersection points. The regulator allowed Capacity release and secondary trading of capacity (FERC order)
Beyond 2000	• FERC order 637 – Removes price ceiling on short term capacity release and allows peak and off peak rates (FERC order)
	• FERC hackberry decision – To promote investments in import terminals FERC allowed LNG terminals to charge market tariff and operate without providing open access. The regulator now believed that the new non open access policy would encourage development of new terminal and hence provide alternate source of supply (FERC order)
	• However, since then due to shale gas boom most LNG terminals are converting into export terminals

	• Order requiring interstate and major intrastate pipelines to post on a daily basis capacity, schedule and actual flow basis (promoting transparency)

The US market is thus a matured marked with few thousand market participants. As outlined above the market has evolved with time. There are more than 6000 producers producing oil and gas from around 480,000 wells (both shallow and deep). The transportation system comprises of 300 000 miles length of pipelines. Numerous marketers supply gas to about 1200 natural gas distribution companies, supplying gas through a network of 2.4 million miles km pipeline. There are around 29 different trading hubs in US and nine in Canada.

UK markets

The markets in United Kingdom have evolved over last 40-50 years. British Gas was the single dominant player in the UK market which required series of measures to develop market as outlined in Table 15 (Stern, 1997); (Simmonds, 2004) ; (Calliope, 2009); (Melling, 2010); (Thuber, 2011); (European federation of energy trade, EFET, 2004) to create a market

Table 15: Indexing of development in UK gas market

Year	Key developments / evolution
1948's	• Until the year 1948, the gas available was synthetic gas which was manufactured from coal gas. The market player were basically the coucils of each county and many small private players. (Stern 1997) • Gas Act was passed in the 1948. This Act nationalized the UK gas industry. Twelve area gas boards were formed and all private companies (around 1046) were merged into these councils (Simmonds, 2004) • This, established the monopoly in the market among these 12 councils for downstream supply of gas (Simmonds, 2004)

	• United Kingdom remained isolated from continental Europe in absence of any interconnector, hence no other market was possible (Juris, multiple) (Simmonds, 2004)
1960's	• UK imported LNG from Algeria in the 1960's helping is supply diversification (Thuber 2011) • 1966 – Post discovery of natural gas in UK continental shelf, UK supply was converted from town gas to natural gas (Simmonds, 2004) • High Pressure transmission pipeline was built as a means to supply natural gas to regional boards (Energy charter Secretariat, 2007)
1970's	• UK facing stagflation; from oil price shocks of 1978 (Thuber 2011) • Gas Act passed in 1972 established British Gas Corporation, effectively merging the twelve councils. • British Gas extended monopsony powers and continued to enjoy monopoly power on supply of gas. (Simmonds, 2004) (IEA, 2012) • Gas prices from domestic production was negotiated at wellhead • Downstream prices were based on cost of gas, transmission & distribution cost and a profit margin
1980's	• 1982 – **Oil & Gas enterprise Act** was passed, to create competition. This Act removed the sole right of BG to purchase gas, however this did not help entities to purchase, transport and sell gas due to practical constraints. (Simmonds, 2004) • 1986 – **Gas Act** passed; first gas regulator (OFGAS) established. British Gas privatised, formation of British Gas Plc. Large customers given open access on pipes (>25,000 therms/annum) (Simmonds, 2004) • 1988 – Monopolies and merger commission (MMC) recommends that BG cannot contract 90% of any new gas and should publish tariff for Industrial and commercial customers. (IEA, 2012)
1990's	• 1990 – First transportation contract signed • 1992 – Office of fair trading (OFT) review reduces thresholds of customers open for competition to 2500 therms/annum. (Stern 2007, Calliope, 2009) • 1992 – **Gas release program** commences (target to reduce share of British Gas to 40% by 1995) (IEA, 2012)

	• 1993 – Gas release program having its impact on share of BG in non-residential market (IEA, 2012) • 1993/94 – BG's trading activity and transportation activity demerged (Simmonds, 2012) • 1994-95 – Green shoots of spot market with higher supply compared to demand. • 1994 – **legal unbundling** - British Gas was re-organised into trading and transmission. Two separate companies emerged as British Gas and Transco. (IEA, 2012) • 1995 – Gas Act 1995 passed to create a fully liberalized gas market. Paved way for competition in residential market. Separate licensing system established for gas transportation, gas shippers and gas suppliers (Simmonds, IEA) • 1996 – Network code passed. Rules and procedures for third part access established including daily balancing (Melling, Stern) • Feb 1997 – British Gas demerged into two separate companies Centrica plc (for trading) and BG plc (for exploration) (Stern, Simmonds) • 1998 – The residential market was opened to competition (Simmonds) • UK – a pipeline interconnecting UK and Belgium was built and made operational allowing two-way trade of gas with Europe. (Stern, Calliope) • In a major step the National Balancing Point (NBP) was established as the main trading hub. (Simmonds)
2000's	• The Utilities Act 2000, the office of the gas and electricity markets (Ofgem) was created by merging gas and electricity regulatory bodies. • Also, it put an end to the exclusivity in transportation licensing which allowed a single license.
2004 – 2008	• Improving security of gas supply – covers emergency situations and actions to be taken by various agencies. In shortage scenarios power stations can be asked to switch to alternative fuels and protected customers get assured supply. (Simmonds) (Stern)

EU markets

The European Union is aggregation of countries working together for common good. These countries allow among themselves free movement / trade of goods and services. Various directives ae passed by European Union, sine 1998 to liberalize and create competitive markets, including an function energy market.

(IEA, 2012).

Table 16 outlines the evolution of markets in EU.

Table 16: Indexing of development in EU gas market

Year	Key Developments / Evolution
1980's	**Policy Target** - Directive of 1988 – Any directive passed by the European community or European Union must be passed as a law by all the member countries. The directive of 1998 was for creation of a single market without any boundaries or frontiers, to allow free movement of capital, goods and services among member states.
1990's	**Upstream Competition** - Directive 94/22/EEC The directive provided non-discriminatory access to exploration and production activities. The opening of the upstream sector through this directive was aimed to help development of competition and augment security of supply. Authorization was granted in transparent manner including the parameters for prospecting, exploring and producing the acreage (geographical area)
1998	**Regulated or negotiated Third Party Access (TPA) -** Directive 98/30/EC – Open access proposed for natural monopoly owners of transmission network, storage and LNG facilities.

	Accounting separation was mandated for vertically integrated companies Member states were given freedom to choose between regulated or negotiated access.
	The directive also allowed choice to customers consuming more than 25 mmscm per year i.e. they can chose their suppliers. Thus the directive provided suppliers not only access to networks but also to the customers. The directive set initial target of 20% and later 28% and 33% market opening in 5 and 20 years respectively
2003	**Set up regulators / Network Tariffs** - EC 2003/55/EC & Reg. 1775/2005 Establishment of independent regulatory bodies was provided in the directive, to be followed by all member states. TPA based on network tariff calculated actual cost and building efficiencies, appropriate rate of investment and incentives to construct new infrastructure. This directive also allowed regulators to grant exemption to infrastructure developers on case by case basis
2004	**Market opening & Security of supply** - Directive 2004/67/EC - Market opened up for all non-residential users and security of supply
2009	**Ownership unbundling & Network planning -** Directive 2009/73/EC – The mandate was passed to ensure fair and transparent access to infrastructure which was only possible through ownership unbundling. Ownership unbundling the directive stated would also help bring in investments. The directive also mandated the formation of an independent system operator (ISO) or a independent transmission operator (ITO) This directive allowed that certain risky investments can be exempted (partly or fully) from TPA, tariff setting, congestion rents and

	unbundling. The directive also enabled better coordination among EU states for planning
2010	**Security of supply Directive** - Reg 994/2010 – Planning for security of supply under exceptional emergency condition, providing for clear roles for all agencies. Infrastructure to be developed keeping in view certain extreme conditions

Step 4: Charting

Since we are interested to know the evolution of gas markets in developed countries like UK, US and EU, using the themes and indexing above, charts for each country was drawn as per figures 19-21.
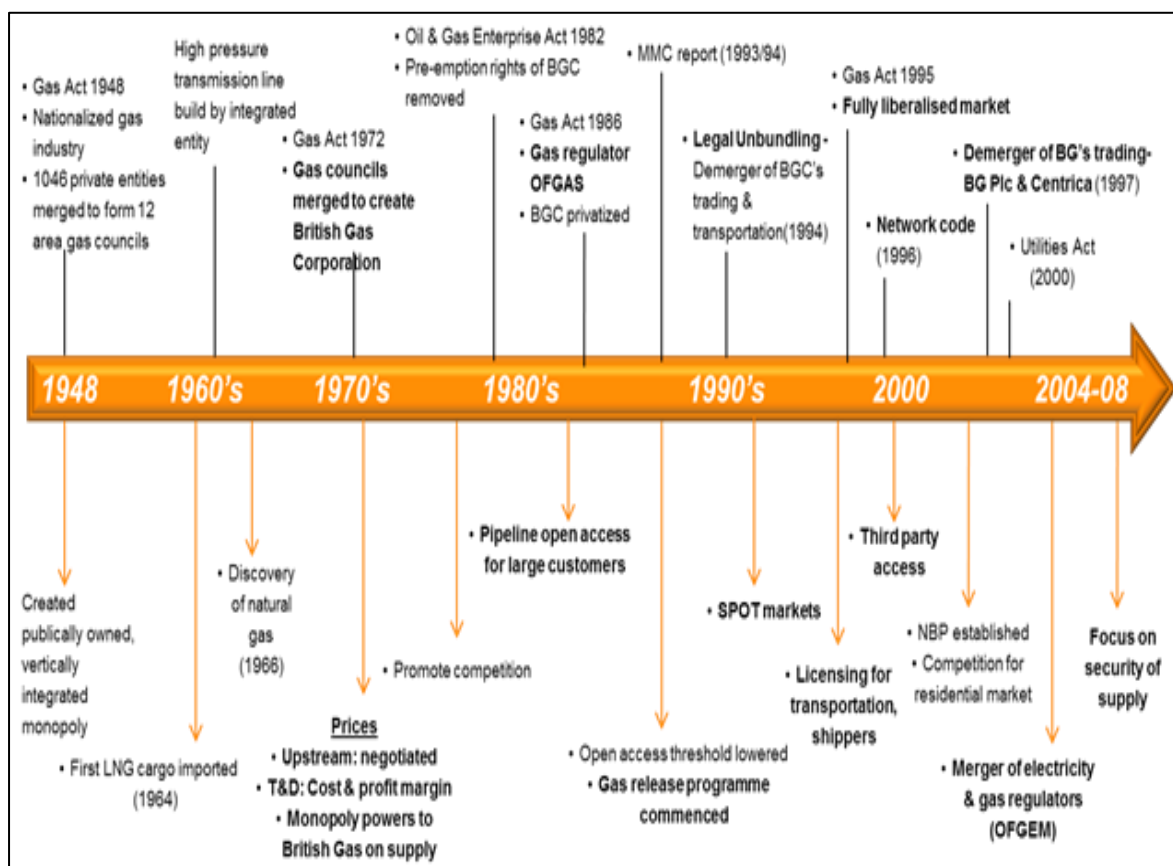
Figure 19: Chart for evolution of gas market in UK

Each country is different when it comes to developing its gas market and deciding on the trajectory of its reforms. However, important points of learning can be drawn from the evolution of gas markets in the developed countries of US, UK and EU.
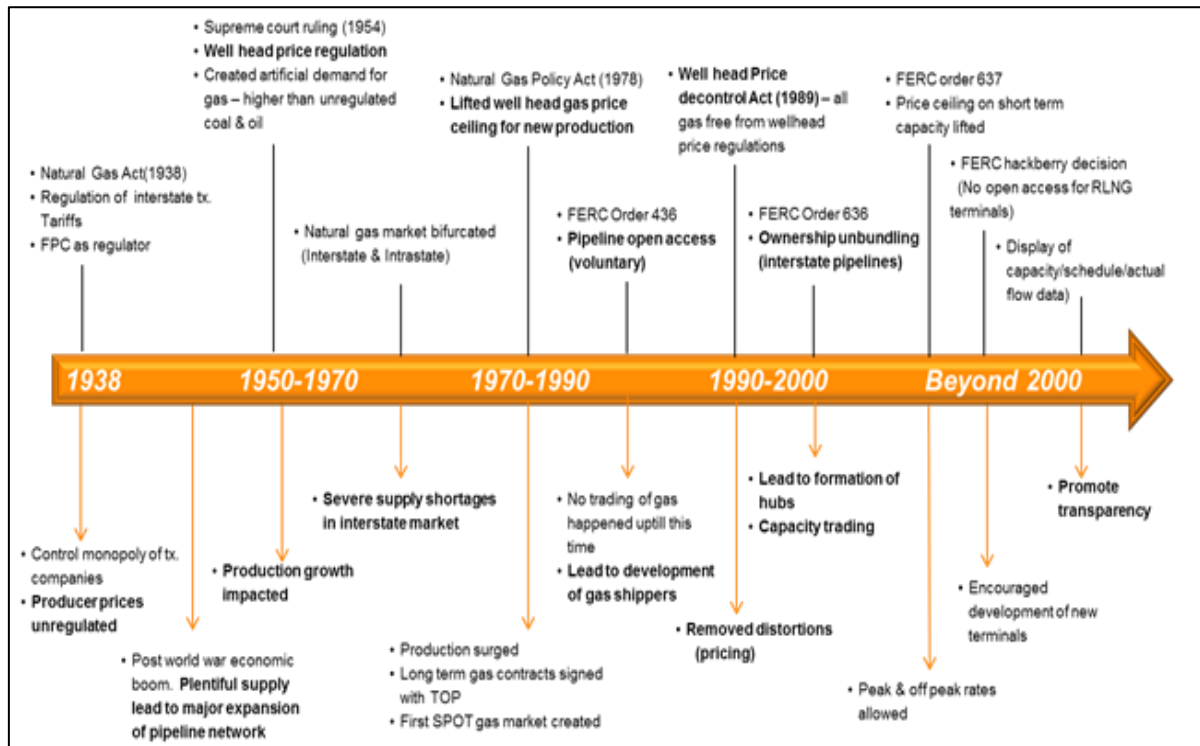
Figure 20: Chart for Evolution of Gas market in US

1. Most, EU countries and US, already had a fully developed infrastructure before before they started liberalisation. Indian gas infrastructure is still underdeveloped.

2. In US, gas market was already few decades old before start of liberlisation.

3. India is a large country like US but does not have abundant resources in place like US. In comparison EU had similar resource issues and had to develop cross country pipeline and import terminals to meet their energy needs.

4. UK seems to be the nearest comparable to the Indian market in terms of
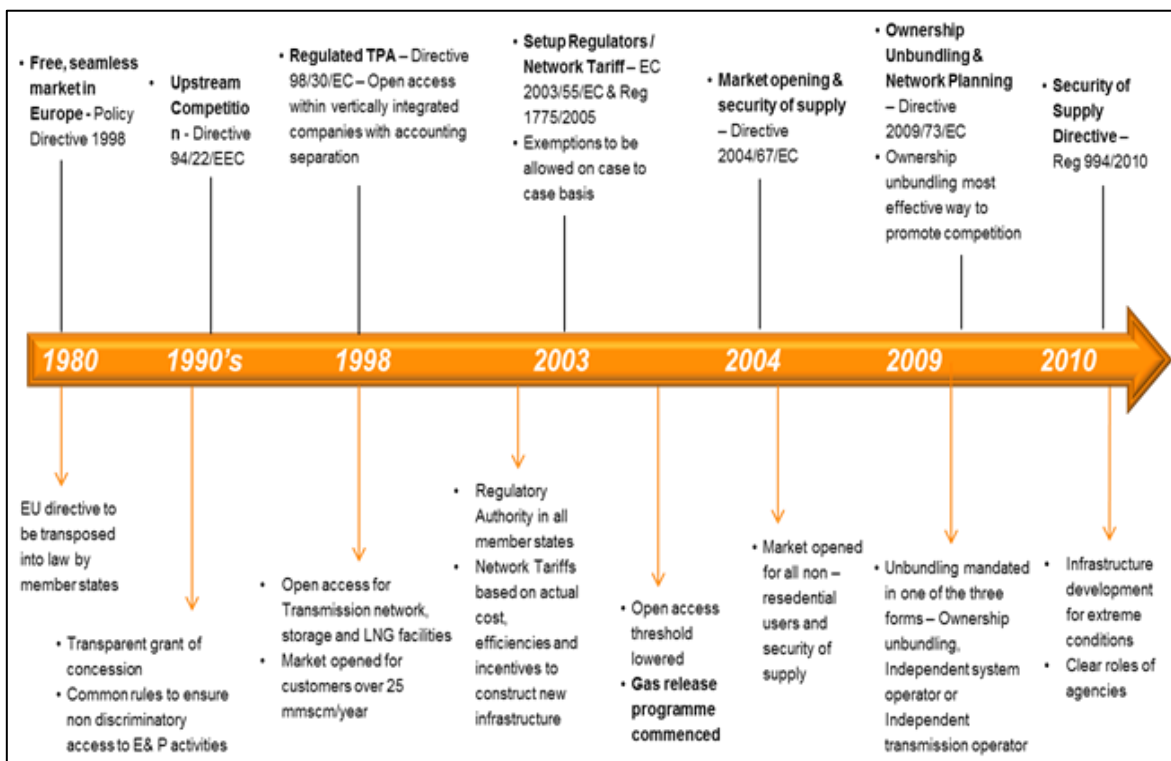
Figure 21: Chart for Gas market evolution in EU

demographics and other parameters.

5. Liberalization of gas market along with power market is vital. While in EU the liberalization of gas market was ahead of the gas market while is US it has taken place at different times in different states. In India the two large consumers of gas power and Fertilizer remains only partly liberalized.

(Mehrotra A. , Factors affecting development of Indian Natural Gas market - Learning from Mature market, 2016)

Even if the basics of each market are dissimilar, there are few factors which are relevant to any gas market and hence can be safely adopted by any market.

1. Policy directives from government key for developments of markets

2. A strong and independent regulator is the important pillar for any vibrant market; US and UK regulators have made mistakes but have made course corrections as their markets evolved.

3. Promoting infrastructure development key for any market to develop. US, have 300,000 miles of wide diameter, high pressure pipelines and 29 major market hubs including Henry Hub in Louisiana.

4. Prices and rates at source of supply need to be deregulated for attracting investments (wellhead for producers and LNG terminals for imported gas). The success of US market is evident from the fact that after undergoing numerous policy changes, they have today more than 20 major gas producers (in addition to 6800 independent producers).

5. Granting exemption from regulatory obligations on risky infrastructure like re-gas terminals helps higher investment

6. Remunerative tariffs for transmission pipeline required to incentivize investment

7. Open and transparent access to cross country pipelines necessary for competition.

8. Unbundling of ownership of pipeline with shipping activity prerequisite to remove hurdles on open access. Unbundling can be through TSO or ISO also

9. Promoting transparency (no information asymmetry in the market) important for helping develop markets which are efficient.

10. Reforms in Electricity market precedes gas market reforms

Step 5: Mapping and interpretation

Mapping helps in creating a visual display of data, providing insights into any patterns, concepts and elucidations.
(Lacey & Luff, 2007).

Ritchie and Spencer (1994) also provide similar explanation on mapping and interpretation. As per them at this stage the researcher is aiming to find associations between data sets, defining concepts and mapping the nature of the phenomenon he is trying to explain or understand.

Based on the above the main aim of mapping is to help researcher to display visually ideas and concepts emerging from the data which would help in further analysis, testing or interpretations.

The concepts, themes and charts developed above were linked at this stage to create a conceptual framework which would be used as an input for the objective 3. The conceptual lens links various themes depending upon its occurrence in the developed markets.

At the initial stage, the conceptual lens provides for Policy directives. It means that it is important for governments to provide the policy directions for the gas as a fuel in the energy mix. It is also imperative to understand that along the reform path there will be more policy interventions by the regulators but they may also be called policy directives as in case of FERC. In the conceptual lens the policy directive refer to the following action

- Clear long-term policy and direction
- Integrated approach by government agencies

As a next step, the government needs to ensure that there is well head price freedom

Figure 22: Conceptual lens for creation of gas market
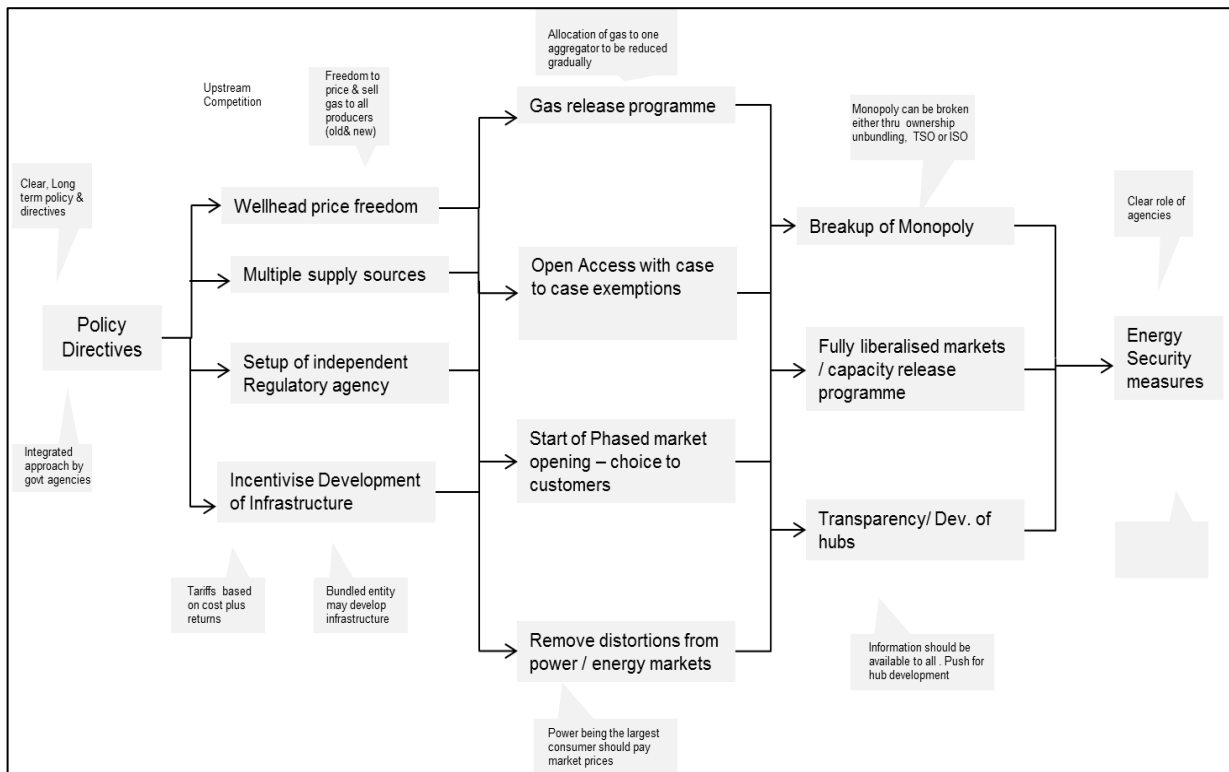
i.e. freedom to price & sell gas to all producers and there is upstream competition. There needs to be multiple supply sources and incentive to develop infrastructure. Independ regulator also needs to be setup at this stage. Entities are bundled at this stage to enable infrastructure development. Tariffs are based on cost plus system.

Once the Infrastructure is developed and basic regulations in place, the regulators start acting to provide open access on pipeline. Provide choice to customers and remove distortions from the energy markets. Any gas allocated to aggregators are released to create a level playing field. Once market is sufficiently developed, the regulators start breaking up monopoly positions, bring in higher transparency and development of trading hubs. Once gas gains sufficient percentage in the energy mix of the country the government and regulators work on measures to bring in energy security

The conceptual framework is as shown in figure 22 which will be used as a conceptual lens to develop framework for creating an efficient gas market in India.

9   RESEARCH METHODOLOGY AND DATA ANALYSIS – OBJECTIVE 3

9.1   Research Methodology

Qualitative research includes ethanography, phenomenology, biography, case study and Grounded theory. Ethanography comprises of studying cultural groups which are unbroken. This study is done in their natural setting and over long periods. Phenomenology comprises identifying core human experiences. This is normally captured as described by the participants. Biography as the name suggests allows the individuals to describe the stories of their life. Thus in essence it studies the life of people. Case study explores the unique characteristics of one or many individuals relating to a program or an activity.

In contrast, the grounded theory takes views of participants to develop a theory, constantly update and revise the theory as the views of participants evolve and converge. Thus, any theory so derived is grounded in view of the participating individuals.

(Creswell J. , 1998) .

We found that the grounded theory was the most appropriate for the research since:

- The purpose of this study is to generate a conceptual framework than can explain a process. Since experts in the area are limited, grounded theory was best suited for this research (Patton Q. M., 2002).
- It aids the deduction and explanation of phenomenon by answering socially purposeful questions of what is happening here and why (Douglas, 2004)
- Gas market is an area where the knowledge is restricted to few individual and not much is known. Grounded theory will help bring a new perspective to this area of developing gas markets (Goulding, 1999)

The grounded theory methodology is built by (Corbin & Strauss, 1998), and (Charmaz K. , 2006), after its two original authors Barney Glaser and Anselm Strauss split post disagreement on the way to implement this theory. However, originally the theory was built on the premise that the theories which existed in research were often inappropriate for research where interactions with people was important and data should be continusly collected and vetted in the field.

As per Strauss and Corbin (1998), the researcher, normally follows a methodical analytical process to develop theory. In their later work, Corbin and Strauss to an extent and Charmaz sought to reclaim Grounded theory from its 'positivist underpinning' to interpretive.

As per Strauss and Corbin (1998), Grounded theory is just not a methodology for analyzing data, but has its own heart and understanding i.e. – it is a way of thinking about data and how it and its analysis are influenced by the environment in which it is generated.

Grounded theory centers on an area of study, collects and analyzes data using systematic processes like theoretical sampling and coding (Glaser & Strauss, The discovery of grounded theory, 1967); (Corbin & Strauss, 1998); (Charmaz K. , 2006); (Creswell, J W, 2007). Data gathered is continued until saturation occurs i.e. no new information about topic is found. Data are examined using a constant comparison method that involves initial coding.

Figure 23, provides a schematic represents of the process of Grounded Theory as devised by Bitsch, 2005. This includes deciding on a problem. This is also the stage where the conceptual lens is identified to answer the question of developing a framework for development of efficient gas markets in India. This is followed by data collection and theoretical sampling, followed by coding and analysis. Once theoretical saturation is reached the theory development concludes. The researcher has adopted this method along with Grounded theory method and concepts proposed by Charmaz, Corbin & Strauss and Creswell.

Figure 23: Concept Map - Process of Grounded Theory
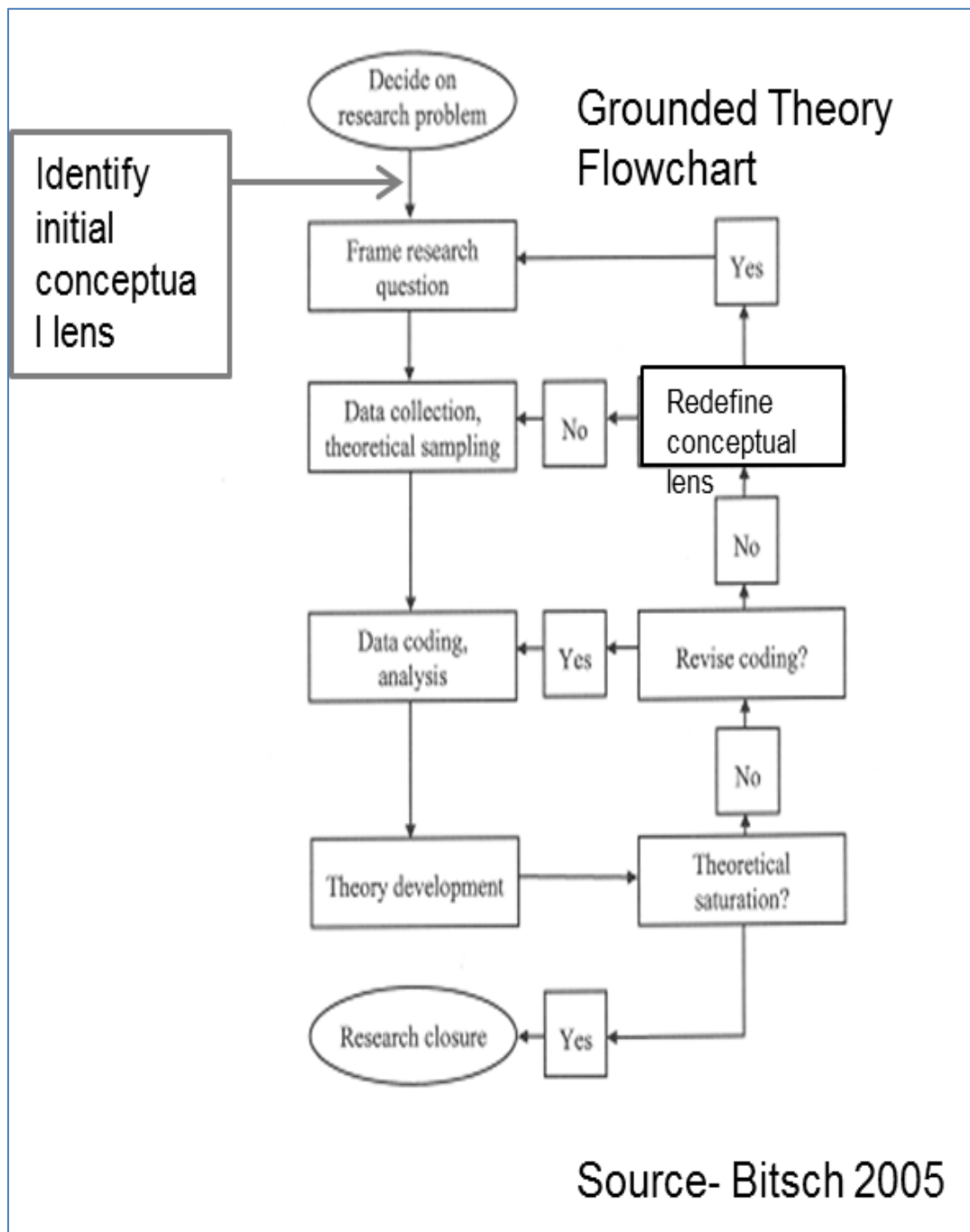
9.1.1 Sampling

The participants were chosen by way of initial sampling followed by theoretical sampling. Initial sampling is done based on existing knowledge on experts in the field being researched and the objective set to be achieved. Initial sapling is done before the first interview is started.

(Charmaz K. , 2006)

Theoretical sampling is decided based on emerging concepts once the initial set of interviews are done. Often the person being interviewed, himself suggest names of other experts to help uncover ideas in certain new dimensions. Theoretical sampling gets decided also based o emerging themes, ideas or concepts which will help maximize the chances of developing the required theory.
(Corbin & Strauss, 2008).

In her book, constructing grounded theory Charmaz (2006, p.189) defined theoretical sampling as a method where the researcher aims to further develop/ clarify the emerging categories. This is done by seeking fresh information from people or events.

As per Corbin and Strauss (1998), the participants in the study should have experienced the process. Since development of gas markets is a very specialized subject, therefore the sample of this study consisted of top officials from oil and gas Industry, senior government functionaries, big consultants working in the area, and regulators. As the study progressed the participants were theoretically sampled based as per the question/ concepts that arose from the data.

Sampling procedures of qualitative research differ from those of quantitative research – they are based on concept of theoretical sampling rather than statistical sampling (Corbin & Strauss, 2008). Expressing their views on sample size, Corbin and Strauss (2008) explained that while using qualitative research the issue is not whether the sample is representative of a large population. If effect the researcher looks for variation in ideas and concepts and not similarities. Once the variations stop emerging the saturation is supposed to have been reached.

Therefore, in Grounded theory, size of sample is determined through theoretical sampling, achieved through constant comparison of emerging categories. Grounded theory approach suggests saturation as the criteria to apply to the emerging categories. Glaser (1992, 1998), argued that the only criteria for sampling is checking for saturation. Even if the sample is very small and saturation is reached, the researcher needs to stop new sampling.

As per Charmaz (2006), when after gathering new data and or interviewing new people do not throw fresh insights into categories being developed, saturation is assumed to be reached in gathering data.

In the study on the creating the framework for an efficient gas market nothing new appeared in the eight interview (with the head of a consulting organization), from the content prospective, indicating a theoretical saturation (Glaser and Strauss, 1967). However saturation (theoretical) is a notion that fits with positivist ontology based on one reality. From the prospective of constructive ontology, the possibility of another researcher arriving at a different conclusion cannot be ruled out.

Although the saturation of data was reached at the eight interviews, one more interview was conducted to triangulate the data with an expert in an oil & gas company working at the CEO position. Now new ideas or concepts emerged at this stage indicating that saturation is reached and data triangulated.

9.1.2   Data Collection Method

In grounded theory, analysis of data continues along with the collection of data. (Glaser & Strauss, The discovery of grounded theory, 1967). This indicates an iterative process with constant comparison between data collection based on theoretical sampling, rather than a linear process where data analysis begins when data collection is complete. However, for proving clarity to the readers, this research follows a positivist paradigm and present literature upfront followed by methods and then findings.

(Corbin & Strauss, 2008) have provided in grounded theory the researcher should be using unstructured interview which help in collecting maximum data, therefore unstructured interviews were used to collect data form the participants. If a researcher enters the field with a structured questionnaire, participants will answer only that which is asked, and often without elaboration. The participants might have other information to offer, which they don't share fearing that they might disturb the research process (Corbin, J; Morse, J, 2003).

A pre-decided protocol was kept ready to help navigate the interview; it included the interview style, procedure and general rules to be followed. As per Patton (1990), the objective of such studies is best met using open ended questions and keeping the topics/areas flexible. Though a few initial questions are asked, the wording of the question is not predetermined & the focus of the enquiry gets evolved with the interviews (Patton M. , 1990).

9.1.3   Interview Protocol

The initial set of questions were drawn from the conceptual lens. The list is provided below

- Which factors will help in development of efficient gas market?
- Which factors are more important than others?
- Among these factors how do you rate factors which are more important for market development?
- You are talking of [X, Y or Z] as key pillars. What follows this, i.e once this is in place what needs to be done.
- How does the factor contribute to development of gas market?
- What should be the priorities of GoI / Regulator
- How is India different from US, UK and EU markets.
- At what stage the regulator should start unbundling of transportation and marketing activities?
- How government should go about incentivizing pipeline in absence of demand?
- Do you think land and labour reforms are important for the market development?
- How many years it will take for development of gas markets in India

Probing questions were asked to have detailed insight into the subject being probed. Some key probing questions are provided below

Could you elaborate…?, What contributed to ?, How...?, Tell me more...?, Could you throw more light on...?, Is this also the factor….   ?, Is this also important ……

There is a set procedure which was followed for each interview. The main steps are outlined below

- Introduction
- Giving background Information- narrating the study and the purpose of it.
- Promising confidentiality
- Asking for concern and permission
- Putting the first mandatory question.
- Putting probing questions
- Asking further leading and probing questions
- Asking for something they wish to tell or know more.
- Asking for lead, and checking whether the participant is comfortable letting his name used.
- Thanking for the support

In any interview, there are some key rules which were followed as provided below
- Informing the participant about the topic and process
- Ensuring that the place of interview be comfortable enough for the participant to share information.
- Making a point to paraphrase the responses for capturing the thoughts of the participant correctly and checking your understanding.
- Transcribing the interviews immediately after the interviews are done.
- Checking for saturation levels

9.1.4   Data Analysis

Data analysis helps researchers get a handle to massive data, reduce its volume, capture emerging patters and generating framework for communicating what data the tells. The process of analysis in Grounded theory may begin while the data are being gathered, and immediately after the interviews are transcribed.

The study used constant comparison method at each stage of the analysis, at first compared data with data to identify similarities – it compared concepts, categories and ideas within the same interview and then compares them in different interviews. The statement and incidents that seemed conceptually similar were given the same code.

The analysis of the data was supported using qualitative analysis software Atlas.ti. Atlas.ti helped in coding, linking codes and text segments, creating memos, searching, revising and reorganizing. It also helped in visual display of data and findings (Creswell, J W, 2007).

9.1.5 Coding

Coding, an essential element to the formation of grounded theory. The concept of coding uses raw data to draw out concepts and theories (Corbin & Strauss, 2008). Coding consist of providing short labels to each set of data which helps in summarizing and analyzing the data (Charmaz K. , 2006).

Grounded theory coding occurs in the following stages

1. Initial code / Open code
2. Focused / Selective code
3. Axial code
4. Theoretical code

(Charmaz K. , 2006)

In Initial coding as many ideas are generated inductively from the transcripts as possible. In focused coding, the initial codes which are important and contribute more to the analysis are selected and elevated to the level of categories. In axial coding, relationship among categories with its subcategories is specified. In theoretical coding, possible relationship among the final concepts is specified.

In this study, the first two stages, helped to identify factors for development of gas markets and the final two stages helped in linking these factors in a sequence to help

provide a step by step framework for development of gas markets. This framework was then compared with the conceptual lens.

Initial / Open Coding

Initial coding also known as open coding had been described by Corbin & Strauss (2006) as breaking each sentence or part of sentence of data, which are then provided names/codes signifying an idea or concept.

This study resulted in 380 initial codes, adopting the guidelines of Charmaz (2006) as mentioned below

- Line by line initial coding was done.
- The attempt was made to stick close to the data.
- The words and actions of the participants were used in the codes to preserve the fluidity of their experience.
- Actions were seen in each data segment, which was unique to itself.
- Endeavor was made to code words that reflect action, hence coding was done with gerunds (Glaser, Theoretical sensitivity, 1978)
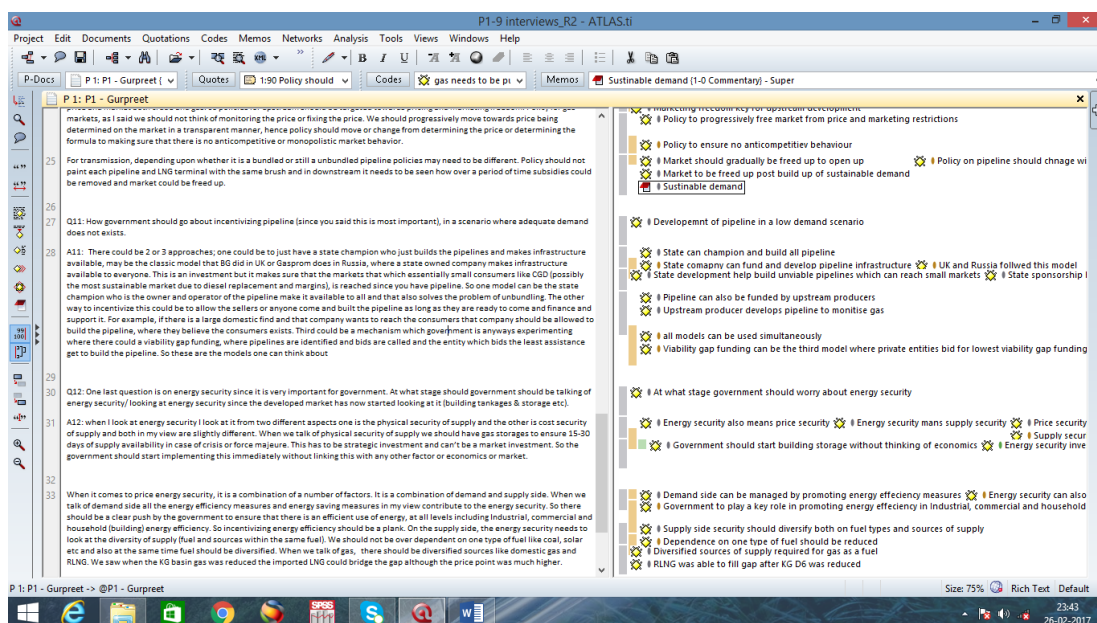
Figure 24: Initial coding sample

Figure 24 depicts application of all the above concepts in forming initial codes. This is one of the sample initial code output from Atlas Ti

Focused / Selective Coding

Focused coding

Focused or selective coding is done post the open codes are in place. While in initial codes data is segregated, focused coding is a stage when codes with certain conceptual basis are developed. (Glaser, Theoretical sensitivity, 1978). It requires identification of the initial codes and classifying them into categories. (Charmaz K. , 2006).

The study merged together the codes with common features to create conceptual categories (Strauss & Corbin, 1990). The consolidation made it possible to reduce the 380 initial codes into 25 focused codes. To achieve this researcher, sift through the data, moved across the interviews and compared the categories. The example of focused codes are, supply side factors, Demand side factors, Infrastructure factors etc.

The early categories were kept provisional in line with the Grounded Theory to remain open to ensuing analytic possibilities. The constant comparison method resulted into many initial categories revised and re-revised.

Axial Coding

In focused coding, data generated is divided into categories. Out of these categories certain categories will be subcategories of a category. Axial coding helps in linking categories to its sub-categories so that the data is available for interpretation in a more meaningful way.

(Strauss A. , 1987), sees axial coding as a method to build relationships between categories. Howver, t**his research uses Charmaz way of developing sub categories of a category to show a link between them** and not the paradigm model consisting of conditions, actions, inactions and consequences as advocated by Strauss and corbin.

The study used axial coding to integrate categories with sub categories like supply side factor as a category to its subcategories which help the supply side factors like many suppliers, many sources of supply and competitive supply to name a few. Figure 25 depicts one such axial coding. Similarly factors like policy directive, demand side factors, regulatory interventions and market forces were used to link to their subcategories.

Figure 25: Axial coding output from Atlas Ti
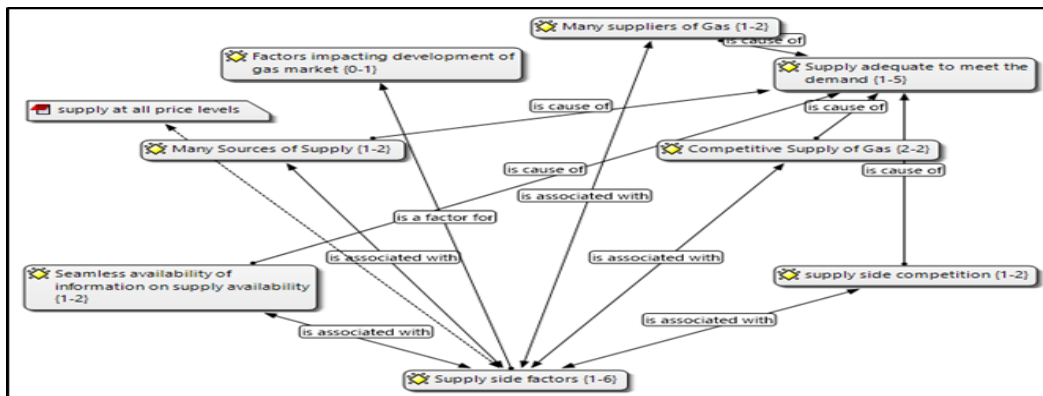
Theoretical Coding

Theoretical coding uses the codes generated during focused coding and linked them in axial coding. Glaser (1978: 72) introduce the word conceptualizing while working on theoretical codes. This means that at this stage the researcher works to link all the substantive codes into a theory. Thus this stage provides relationship between broad categories that have been developed in the previous stages (Charmaz K. , 2006).

Theoretical code is like an umbrella that covers and accounts for codes and categories before the stage of theoretical coding (Saldana, 2010).

In this study the focused codes are integrated and organized into a logical emerging framework to help creating and efficient gas market in India. Timelines are also integrated while linking these categories. Figure 26 depicts a theoretical coding

Figure 26: Theoretical coding output from Atlas Ti
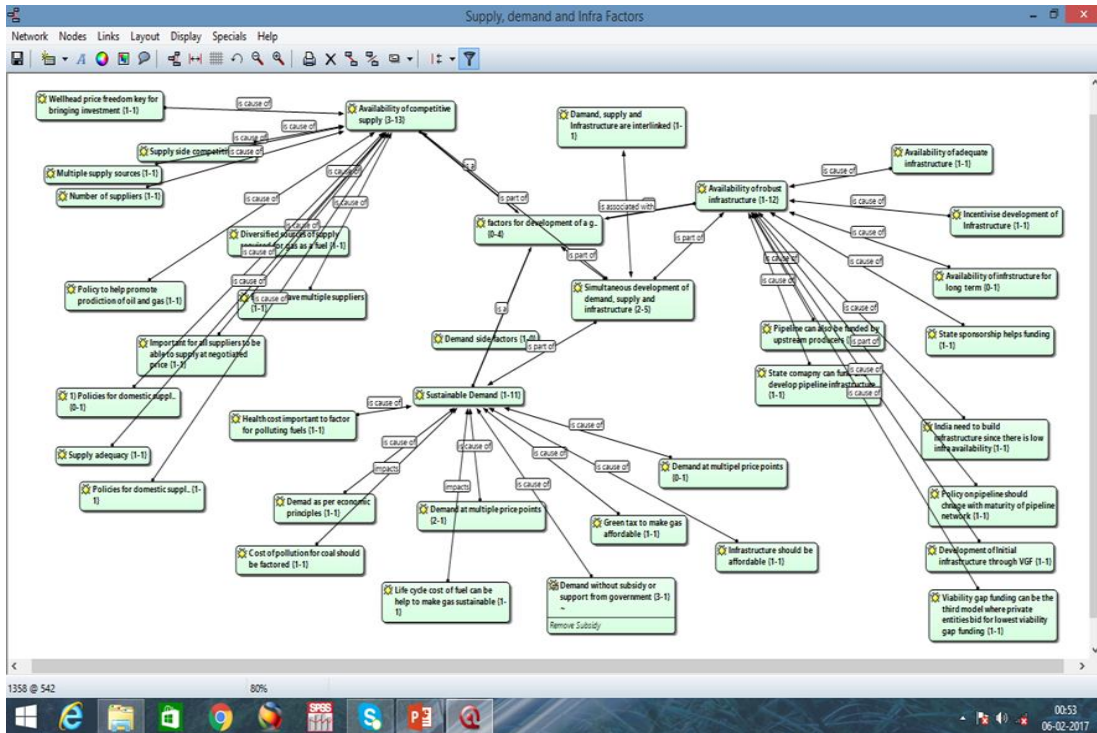
Outputs of coding can be viewed in Annexure 3

10 DISCUSSON ON FINDINGS, CONTRIBUTION TO LITERATURE & PRACTICE, RESEARCH LIMITATIONS AND FUTURE WORK

10.1 Discussion on findings

Figure 27: Modified Conceptual Lens
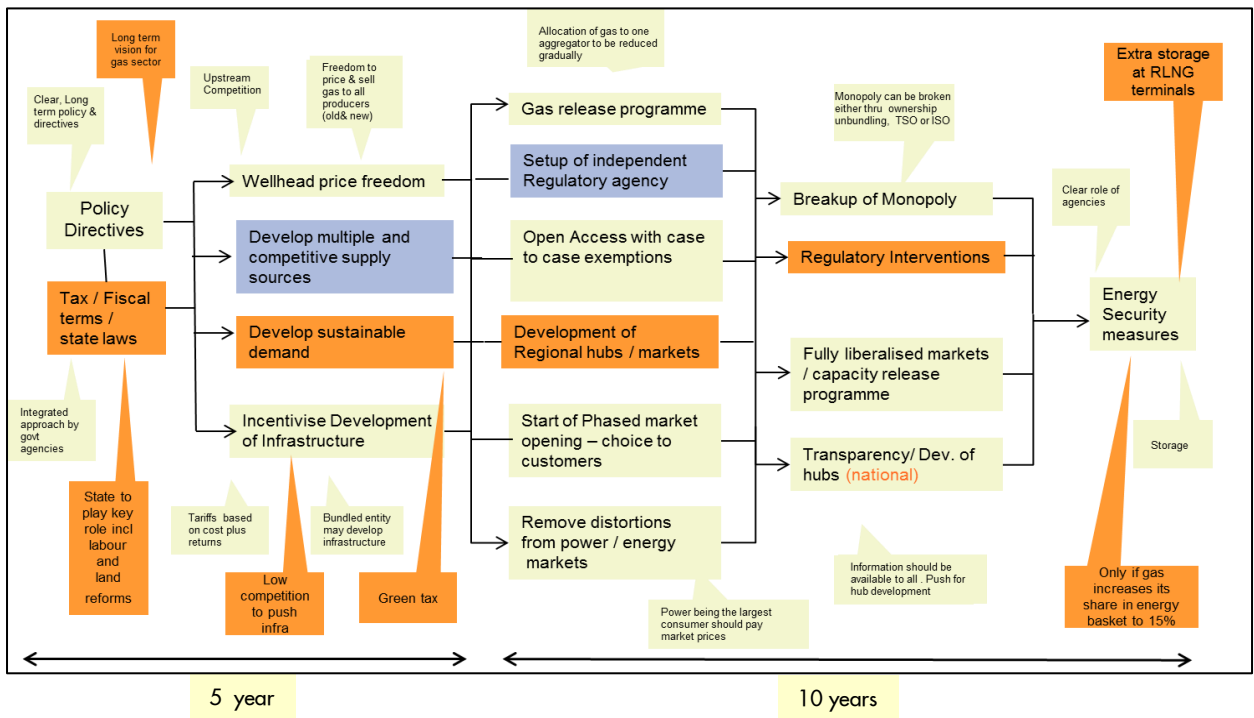
A new modified conceptual lens emerged from the outcomes of the grounded theory.

The categories emerged were compared with the conceptual lens.

It was found that many of the categories matched that of the conceptual lens

Policy Directives, Wellhead price freedom, Incentivize development of infrastructure, Open access, phased market opening, remove distortions form power and energy markets, breakup of monopoly, gas release program, capacity release program, transparency and development of hubs and energy security measures.

Some new got created

Fiscal and tax incentives, state laws, labour and land reforms, sustainable demand, low competition to push infrastructure, development of regional hubs, regulatory interventions, storage at RLNG terminals and energy security if gas assumes a good double-digit share in energy basket.

Some did not appear in the same form

Multiple supply came with a rider of competitive supply sources, real requirement of regulatory body was felt only after development of infrastructure. While international gas markets took decades to develop, it was envisaged that the Indian gas market can take shape on 15 years based on learning from international markets

Table 17 provides the summary of all categories when compared with the conceptual lens

Table 17: Comparison of Categories between conceptual lens and final framework

Matched categories	New categories	Modified categories
• Policy directives • Wellhead price freedom • Incentivise infrastructure development • Open access • Phased market opening • Remove energy market and end user market distortions • Break monopoly postions	• Fiscal and tax incentives • State laws • Labour and land reforms • Sustainable demand • Low competition in infrastructure • Development of regional hubs • Regulatory interventions	• Competitive supply source (along with multiple supply) • Delay in requirement of regulator

• Gas release program • Capacity release program • Transparency • Development of trading hubs • Energy security measures	• Storage at RLNG terminals for energy security	

10.2   Framework for creating efficient gas market

Based on the modified conceptual lens, and taking into considerations the new categories brought forward by qualitative analysis using grounded theory, the framework for creating an efficient as market in India is represented in figure 28.

As discussed above the framework is unique for India since many categories got added which has a unique relationship with the Indian conditions. The Framework for development of efficient gas market is discussed in detail below. For simplicity and ease of understanding the framework has been divided into broad five phases depending upon the time horizon

- 0-3 years – Planning / Monopoly phase
- 3-10 years – Build / Growth phase
- 11-12 years – consolidation phase
- 13-15 years – Market development phase

Each of these phases are discussed below to understand the framework for creating an efficient gas market in India

1) Planning / Monopoly Phase (0-3 years):

This is a phase when government should come out with a clear and integrated energy policy for the gas and energy sector. The policy should provide a directional statement of what role the government of India wants gas to play in the energy mix. This is the

first basic requirement for gas economy to kick start. In absence of such directive the investors don't get the signals for making the desired investments. Coupled with the policy statement, the government should also bring out clear policy directives for various segments of the oil and gas chain from upstream to downstream. The policy framework needs to be stable in the medium term including fiscal and tax structure so that market has absolute clarity of returns on their investment. This is important unlike other countries since very often we have witnessed structural changes without grandfathering which hurts the investor sentiment, since he cannot project his returns. In addition to the role of centre, the states in India need to play an important role in the policy formation with respect to land and labour (being state subjects) and ensure that it is easy to do business. A potential solution is single window clearance and ease in laws to enter and exit business.

2) **Build / Growth Phase: Partial Monopoly and start of market opening (3-10 years)**

The next phase requires absolute focus on four core elements for gas industry to build and grow

   a) Creating and promoting multiple and competitive supply sources
   b) Creating a demand which is sustainable and can absorb gas at reasonable market prices.
   c) Create infrastructure to connect this demand and supply
   d) Ensure ease of doing business
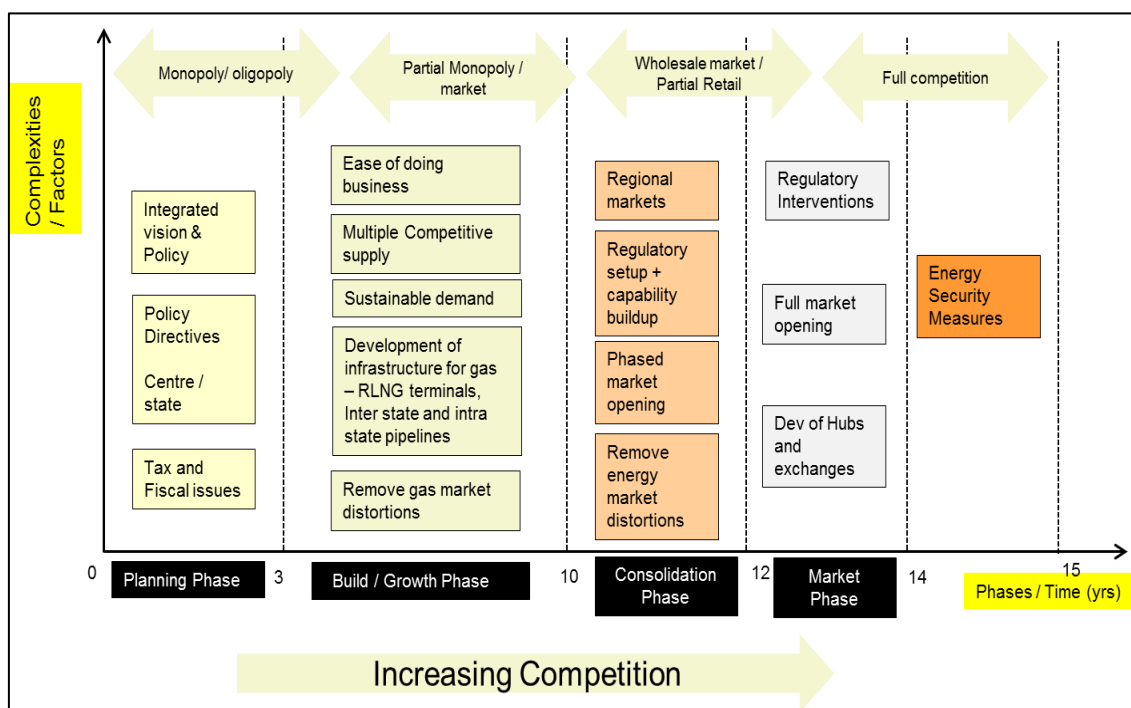
Figure 28: Framework for Creating efficient gas market in India

The difference between gas and any other commodity market is that gas requires huge investment both in connecting with the market and for storage. Storage can be in the pipelines or in the cryogenic tanks of regas terminals. Natural cavers if they exist can be an additional source of storage. All these investments are large with high gestation periods before returns can be made. This may require the government to invest heavily in the sector since returns are not lucrative for private investors in part of the gas chain. Also, in the pipeline sector, the government needs to provide monopoly status to the sector to protect returns.

Any opening up of the sector at this stage when infrastructure is marginally developed will lead to erosion of returns which in turn will turn away risk capital.

In addition, during this stage the government should remove any price or allocation distortions from the gas market i.e. allow freedom to price gas at the wellhead and have single price of gas in the market both from new and old fields. All this will yield little results unless the state and central government work on ease of doing business, which includes reforming land and labour laws and fast track clearance for setting up business.

3) Consolidation Phase: Wholesale Market development / Partial retail market (11-12 yrs)

During this phase, regulatory capacities need to be built for the regulator to start intervening in the market. This requires recruiting right resources and acquiring right capabilities. Regulations would be required to set tariffs for monopoly business and later breaking up of the monopoly positions if required. The role of regulator is to create Pseudo competition in absence of market.

In addition to this the market should be opened in phased manner with the following actions

a) Open access should be provided on gas infrastructure with option of case to case exemption

b) Choice to customers should be provided for large volumes – wholesale competition

c) Gas allocation provided to bulk supplier should be release with contractual liability taken over by government. This will open up supply side competition.

d) Energy market distortions from power and fertilizer (the main gas consuming sectors) need to be removed for competition

In addition to the above this is the stage when some part of markets like western markets in India would be matured enough to start development of regional trading hubs. This also helps advance the learning curve for a pan India hub. A potential regional hub could be the western market of Gujarat and Maharashtra which are more mature than the other regions of India in terms of gas infrastructure, supply and demand.

4) Market Development Phase: Full Retail Competition (13-14 years)

During this phase the regulator pushes for full market opening, where in, many regulatory interventions are required

a) Unbundling of supply and marketing

b) Network codes required at this stage to deal with open access as well as capacity release and trading in pipelines

c) Merchant RLNG terminals need to be encouraged

d) Transparency in declaration of capacity, availability and demand of gas becomes key since information asymmetry has been the bane for any market.

e) Independent transmission system operators can be appointed at this stage

Open access norms and access code helps in increasing competition, but the bundled entities, work to ensure there are operational hurdles, thus frustrating the attempt to create competition. If this were to happen, which has been the experience in most markets, the regulator need to unbundle supply and marketing to push for competition. This measure works since if a owner of pipeline has tariffs as its only earning they tend to attract more players to utilize their capacity to increase utilisation.

National trading hubs should be developed starting with physical trading and followed by financial trading.

5) Fully developed market phase (15th Year)

Once full competition is established in the market it is expected that the share of gas in the energy basket would be in the range of 10-15%. Since India is not endowed with excellent upstream acreages, a large part of gas would be imported. This brings with it the additional risk of energy security, in case of any geo-political unrest. To deal with this countries having high percentage of gas in the energy mix resort to 30-60 day's storage to deal with disruptions. However India needs to embark on this path only if gas attains a significant (at least 15%) share in the energy mix. During this phase the role of regulator is to monitor the market for any monopoly behaviors.

However, in the interim, to take care of energy security, India should develop low cost storage, which can be line pack in the large pipeline network as well as building additional storage tanks at the RLNG terminals.

While India has followed few elements from each stage, the regulators and governments have failed to follow a systematic approach, which is provided in the framework.

10.3   Contribution to Literature and Practice

Contribution to Literature

This research provides a step by step framework for development of efficient gas market in India. The current available literature is either for countries which have developed gas markets or provide solutions for a segment of gas sector in India. However, no researcher has provided a comprehensive step by step framework for addressing all the issues for development of gas markets, including the timeline in which to implement the same. This research attempts to fill this gap

The framework provides two outcomes: one, it provides issues to be resolved or addressed to develop the market and two, the timelines and sequence in which to address / resolve the same. This is a major addition to literature in this sector.

This research will enrich the International understanding on development of gas market in developing economies, bringing in special Indian context including factors like

- ✓ Regulatory competence
- ✓ Development of sustainable demand
- ✓ Tax and fiscal incentives
- ✓ Competitive supply
- ✓ Land and labour reforms
- ✓ Ease of doing business
- ✓ Development of regional hubs to expedite market opening

These factors as outlined in the research were not existent or not relevant for the mature markets even when they were in developing phase.

Each country is unique and India is no exception, hence the international best practices cannot be applied to India as it exists. There must be unique features to the Indian

market, which this research is attempting to address. Sustainable demand means demand at a price point which the Indian consumer can afford and use in a long run. Similarly, tax incentives play a large role in India since India does not have large natural resources and has to depend on expensive imports. Tax and fiscal incentives help develop sustainable markets. Similarly ease of doing business is unique to Indian market

Energy sector and therefore the gas sector is unique in terms of how to liberalize. As seen in the proposed framework for creating the gas market any liberalization has to be preceded by proper pre-liberlaization process to develop and stabilize the sector before opening up. The current issue is that the Indian government and the regulators in a hurry to open the market have missed the pre-liberalization phase which has impacted infrastructure creation in the last 4-5 years.

Gradualist approach would be best suited for gas sector due to political compulsions. Globalisation should be restricted based on the availability of the key resource for the country's population

Contribution to Practice and Business:

Governments, regulators and business can use this framework getting additional insights to develop markets so that more gas is available as a clean and affordable fuel. Initially the government needs to play a key role in providing a basis on which the regulators can build the structure which is sustainable and workable for the Indian conditions.

Since the framework provides guidance on step by step approach along with indicative timelines, the, framework would guide decision makers to approach phase wise development of market and move to next phase only when key steps of last phase are achieved

Increased availability of clean and cheap energy which would help India to supply energy to its 1.3 billion population at affordable prices as well as meet its emission targets during the economic growth phase.

10.4 Quality of Research and Validity

Quality and Validity of research is important and needs to be addressed for users of the research to be comfortable with the outputs.

Researchers have traditionally called for objectivity / reliability and generalizability / validity to judge the quality of quantitative research, but criteria for grounded theory may vary ………. Charmaz, (2006, p.101)

Corbin and Strauss have stressed that the term validity and reliability are terms which are used more for qualitative inferences. These are not very important when carrying out qualitative research …….. Corbin & Strauss (2008, p.301)

There are many strategies suggested by Silverman (2005) to help increase the validity of the findings. These include constant comparison method where data collected is tested in next interview, treating data comprehensively and tabulating. Grounded theory method uses constant comparison thus validating the research.

However, Charmaz (2006, pp182-183) offers a list of criteria for evaluating constructionist grounded theory. Corbin and Strauss find these criteria's to be the best and covering all aspects required for qualitative research …….. Corbin & Strauss (2008, p.299)

The four criteria which we will use to test the quality and validity of this research are
1. Credibility
2. Originality
3. Resonance
4. Usefulness

Let's discuss each of the criteria in detail and test how this research stacks against these parameters. The table 18 provides the indicators for evaluation, and provides

assessment summary on criteria's of Credibility, Originality, Resonance and Usefulness

Credibility

It is important to check how credible the research is so that it can be referred with confidence. As per charmaz, the following points need to be addressed to test the credibility

- The gathered data and analysis should be linked logically
- The data collected should be sufficient to back the results
- The categories should be based on large size and array of empirical observations

This research used the mixed method to deduce its result. The use of mixed method has helped to triangulate the data. Also, the grounded theory method used for qualitative analysis uses constant comparison method which lends its credence to the validity of the results. This research has also used all types of data collection methods like

- Primary sources like questionnaire survey
- Secondary sources like key literature on the subject
- Interviews of key oil and gas professionals

The above has provided enough empirical evidence to support this research. Also the data is comprehensive and very detailed, which required few years to collect.

Table 18: Evaluation - Quality and validity of Research

Sr. No	Criteria	Indicators	Assesment
1	Credibility	Do the categories cover a wide range of empirical observations Are the data sufficient to merit your claimed. Are there strong logical links between the gathered data and analysis	The researcher has used multiple modes of data collection like literature, govt. reports and experts. Also experts interviewed were from varied institutions to provide a holistic views. Constant comparison method also lends credibility thru validity of data at each stage. Mixed method has added has helped to triangulation of key data
2	Originality	Are your categories fresh. Do they offer new insights What is the social and theoretical significance of the work How does the grounded theory challenge, extend, or refine current ideas, concepts and practices	Research has offered a new integrated conceptual framework for development of gas markets in India. Also new categories were added like sustainable demand, tax incentives , competitive supply and regional gas hubs .
3	Resonance	Do the categories portray fullness of the studied experience Does your grounded theory make sense to your participants or people who share their circumstances	Constant comparison method in grounded theory helps in validating emerging categories . The last two interview not only validated all the concepts thrown by previous interviews but also did not provide any new category.
4	Usefulness	Does your analysis offer interpretations that people can use in their every day worlds How does your work contribute to knowledge. How does it contribute to make world better. Can the analysis spark further research in other substantive areas	The framework provided by the research would be useful for the government and decision makers to help develop gas markets which in turn would help in development of the countries economy.

Originality

The main points to consider for testing whether the research has got originality is

- The categories generated by the research should be fresh

- The categories generated should offer some new insights

- The output of the research should have social, practical and theoretical significance

- The method of grounded theory should have helped to refine current ideas, provided challenge to existing concepts and developed new ideas, practices or concepts.

The research offers a new insight, since this provides a framework for creating efficient gas market in India, which did not exist. As discussed in detail in section 10.1 of this chapter there were many fresh categories which got added to the conceptual lens and few categories got modified. Hence the grounded theory has helped challenge and extend/refine the current understanding.

India, as discussed earlier is a country of 1.3 billion people who need energy which is affordable. Development of gas markets will not only help achieve this objective in part (since other forms of energy also need to contribute) but also help India meet its emission targets (COP21)

Resonance

The key issues to be tested for resonance as per Charmaz is

- When the people are interviewed understand what has been asked and why and grounded theory resonate with their circumstances
- The categories which are built as per the research process should demonstrate completeness

The framework was created using the grounded theory. Constant comparison method in grounded theory help validate the emerging categories. The last two interviews with experts in the field not only validated the previous interviews / categories, but also did no through up any new category

The study did resonate with people interviewed and hence can be stated that it portrays fullness of the study.

Usefulness

The main areas if addressed demonstrates the usefulness of the research as per Charmaz

- The output and analysis offer ideas and solution which is useful for everyday work
- The research work should contribute to the existing knowledge and should help to make the world a better place to live.
- The research work and output should help stimulate further research in important areas.

The developed framework can potentially be used by the government, the regulators and the consultants to help develop a vibrant and functioning gas market which can be

termed efficient. This has also been discussed in the last section, hence need not be elaborated again.

In addition, this research throws open window for many multiple research in each category of the areas highlighted in the framework, since the objective was to create a framework and not go into details of the each and every element of the framework. Each element being a complex issue in itself can be picked up by future researchers.

Hence it can be stated with confidence that this research meets the criteria of credibility, originality, resonance and usefulness. Therefore, the research can be termed as potentially as valid and of high quality.

10.5   Research Limitation

No research can be done which can be termed as perfect. Each research has its own limitations. The main limitation of this research is discussed below so that this can be factored in by the users of this research in their understanding

- Most of the interviews were recorded, however being sensitive issue, three of the interviews with government / regulator could not be recorded. However, the researcher has used the following technique to ensure data is captured correctly and completely
  - Paraphrasing
  - Questioning
  - Checking
  - Working on data immediately post interview

- The output being a substantive conceptual framework, for gas sector, it cannot be generalized for other sectors

- This research does not claim that this is the only possible way to develop gas markets, but one of the ways to develop. There can be other ways to meet the same objective.

- Any research like this takes few years to complete, there can be bias in respondents based on in which year they were interviewed and /or responded.

10.6   Future work

A good research is the one that raises more question than it answers. This research to help develop efficient gas market has thrown up a framework to achieve this objective. Each category /variable in the framework is a complex piece of area and will require dedicated work. Also. each phase of the gas market framework can be taken up for further research to expand understanding of each element in the that phase or the whole framework.

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Annexure 1

Mr [X]
Country Head – Gas / LNG
New Business development
Shell India Markets Private Limited
9th Floor, building 9A, DLF cyber city, Phase 3,
Gurgaon – 122 022, Haryana
Date of interview: 25th Feb 2014 (Thru telephone)

Key points from the discussion

1.0 Policy on taxation should be uniform for gas and other fuels. Coal attracts zero tax while gas sales attract various levels of VAT based on state. Gas being environmental friendly fuel should attract zero tax

2.0 There should be consistency in policy direction of center and state. States in India have found to be moving with more short term objectives than long term plan to promote and develop gas as a fuel

3.0 A single energy regulator is preferable (at least common gas and power regulator is required since power consumes 60% of gas)

4.0 Government should change its outlook towards regulators and empower them.

5.0 Clarity from government on it long term vision visible from its policy directives which are not consistent

6.0 Development of pan India pipeline and RLNG terminals. Storage facility should be encouraged either in caverns or at RLNG terminals

7.0 Infrastructure should be developed to lead supply. In such an scenario, government should work on providing project financing to such infrastructure

8.0 Bidding for development of infrastructure should be more rationalized to reduce regressive bidding which does not result in actual buildup of the infrastructure

9.0 Faster environmental clearance for building the infrastructure is required

10.0 Development of clear norms on 3rd party access

11.0 Government should not intervene in pricing of gas and power

12.0 Direct subsidy should be provided in case government needs to provide grant to weaker sections of the society

13.0 Encourage more shippers to take part in the market

14.0 Development of trading platform

Annexure 2

Research Survey - Factors impeding development of gas markets in India

Dear Sir/Madam,
Warm greetings,
At the outset I would like to introduce myself, I am Akhil Mehrotra, working with BG India as Director – Downstream Business. I am currently pursuing my PhD from University of Petroleum studies (UPES), Dehradun in gas sector. The purpose of my research is to find the variables/factors which help create an efficient/developed gas market in India. Efficient gas market is defined as where the invisible hand of market leads buyers and sellers to allocate resource efficiently, information on market at all stages of the supply chain is publicly available and price is determined through forces of demand and supply. I shall be grateful to you for valuable response on the suggested questionnaire.
I assure you that your response (in your personal capacity) will be used for academic purpose only and will be confidential. Your inputs will help in validating the gaps and will be useful in completing the research effectively.

Kindly provide your personal details:

Name: _____

Designation: _____

Organisation: _____

Loaction: _____

Email id: _____

Phone number: _____

Date: _____

Please read each question given below & indicate your response by marking against the preferred option [✔] . Rating scale is explained in the footer of each page

SECTION 1

This section covers the factors relating to government policy required for development of an efficient gas markets

1. Requirement of a long term/integrated vision and policy for the energy / gas sector + stability in policy and fiscal regime and legal framework.

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5 -

2. Existence of a single agency (Ministry / Regulator) for the energy sector

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5

3. Phasing out of the gas utilization policy i.e the allocation of molecules should be market driven

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5

4. Free markets (market based pricing) in competing energy sectors like coal and Electricity

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5

5. Free markets (market based pricing) in the key consuming sectors like power, fertilizer and transport fuels

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5

6. Freedom to upstream producers to price gas at well head based on a price discovery mechanism

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5

7. Political will to ensure independence and empowerment of all the regulators

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5

8. Remunerative concession norms (maintaining balance between risk and reward) for attracting investments in the gas chain

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5

9. Providing tax concessions to promote green fuels like gas while taxing polluting fuels

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5

10. A environment allowing ease of entry and exit of investments from the sector

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5

11. Government should ensure sanctity of commercial contracts and other terms & conditions as at the time of the investments.

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5

Section 2

This section covers the factors relating to infrastructure and supply, impeding the development of gas market in India or factors required for development of efficient gas markets

12. Existence of country wide gas grid for transportation of gas + regas terminals

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5

13. Availability of sufficient spare capacity in regas terminals for importing gas and in the trunk pipelines for shippers to buy/sell gas + introducing UIOLI provisions.

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5

14. Strategic arrangement/tie-up with gas rich neighboring countries to import gas via pipeline

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5

15. Promotion of unconventional resources like shale / CBM (keeping in mind sustainable development)

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5

16. Government should provide infrastructure status to the industry for faster development. Incentives to develop infrastructure in unviable areas

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5

17. Focus on development of resources by government through NELP round every year/moving to OALP (open acreage licensing policy)

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5

18. Investment by Indian companies in equity oil and gas outside India since Indian prospects are not very encouraging

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5

19. Development of storage / strategic storage facilities (caverns / storage at RLNG tankages)

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5

20. Development of new technology / spend on R&D to develop resources / skill development

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5

Section 3

This section covers the factors relating to regulatory interventions impeding development of gas markets in India or factors required for development/ creation of gas markets in India

21. A robust access code for gas transmission pipelines + Independent system operator

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5

22. Legal unbundling of gas transportation and marketing segments of natural gas + allowing secondary capacity trading

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5

23. Introduction of entry –exit system for pipeline tariffs

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5

24. Introducing transparency in regulated business

◯ 1   ◯ 2   ◯ 3   ◯ 4   ◯ 5

Section 4

This section covers the market related factors impeding the development of gas markets in India or required for development / creation of an efficient gas market

25. A dense market place i.e large number of players should be present in the gas chain

◯ 1   ◯ 2   ◯ 3   ④ 4   ◯ 5

26. Existence of bulletin boards for information sharing to ensure seamless availability of information

◯ 1   ◯ 2   ◯ 3   ④ 4   ◯ 5

27. Existence of Hub for physical trading of gas

◯ 1   ◯ 2   ◯ 3   ④ 4   ◯ 5

28. Existence of financial markets for hedging market risk

◯ 1   ◯ 2   ◯ 3   ④ 4   ◯ 5

29. Government should ensure phased opening of the market /gradual introduction of competition

◯ 1   ◯ 2   ◯ 3   ④ 4   ◯ 5

30. Existence of uniform tax regime across India for free gas movement

◯ 1   ◯ 2   ◯ 3   ④ 4   ◯ 5

Your valuable suggestions:

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Kindly rate the factors to the degree of agreement on a five point likert scale, which are represented as follows; 1 – strongly disagree, 2 –Disagree, 3 –Neither agree or disagree, 4- Agree, 5 – Strongly agree

Annexure 3

Initial / open Coding

Initial / Open Coding

P 4: P4

15 Since, the gas is not a must use fuel in India and has alternates, while we all know this is among the cleanest fuel govt needs to decide its strategy and policy of pushing gas.

16 Q5: In comparison to the US and UK markets which are the most developed, and from where we can draw learning, what do you think needs to be done differently in India.

17 A5: I think, in comparison with UK and other developed market countries (except US), India has a federal structure and hence every element around the market development has impact from both the center as well as the state. So whether it is infrastructure development, whether fiscal issues or partly regulatory elements in midstream and downstream value chain, states bring in the additional complexity compared to Europe. Even the US has gone through the entire cycle for the entire 60-80 years to go thru the complete cycle, hence it does take time.

18 This is one aspect; the second aspect is the availability of the commodity itself, which in the other economies, the government and in some cases the market, has ensured that the commodity has always remained available, and hence the market has been willing to take whatever price has been offered. But in India this is a question mark since we have gone thru a phase when commodity has not been available.

19 Q6: Hence are you saying that the above is the key difference.

20 A6: Yes, like in cold countries, the gas is must buy/use and hence government has to make it available, including LNG buying countries like Korea and Japan. India it is not clear why we are promoting gas. In India, the moot point is that what is the policy of government on gas i.e does it want to promote for environment reason which it should thru taxes and carbon taxes

21 Q7: What are the timelines when you see the above happening?

22 A7: Infrastructure development itself would take 3-5 years and post that CGD networks would be developed. Another key is the intra-state pipeline and all of these would take at least 10 years which is the desired state. Regional markets like Western India can be developed in the interim where there are structural elements in place.

23 Q8: what do you think state specific issues like those related to land, labour and skill.

24

25 A8: As long as some key issues related to the market which are in the concurrent lists remains these will have there impact on market development. GST is an example but we have to worry about all issues in the concurrent list.

26 Q9: Do India need to do something on energy security keeping gas in mind.

27 A9: energy security is more of an ideological issue. India can meet this through robust contractual arrangement to ensure energy is delivered at its door steps. Also storage is available at the RLNG terminals which can act as low cost storage.

28 To setup up specific infrastructure to store bulk energy, the developed markets have done once they know that the market is completely fungible i.e at fully developed market stage and hence India can look at this option at that stage. Anyways this is only required if the percentage of gas in energy mix reaches to 20-25%.
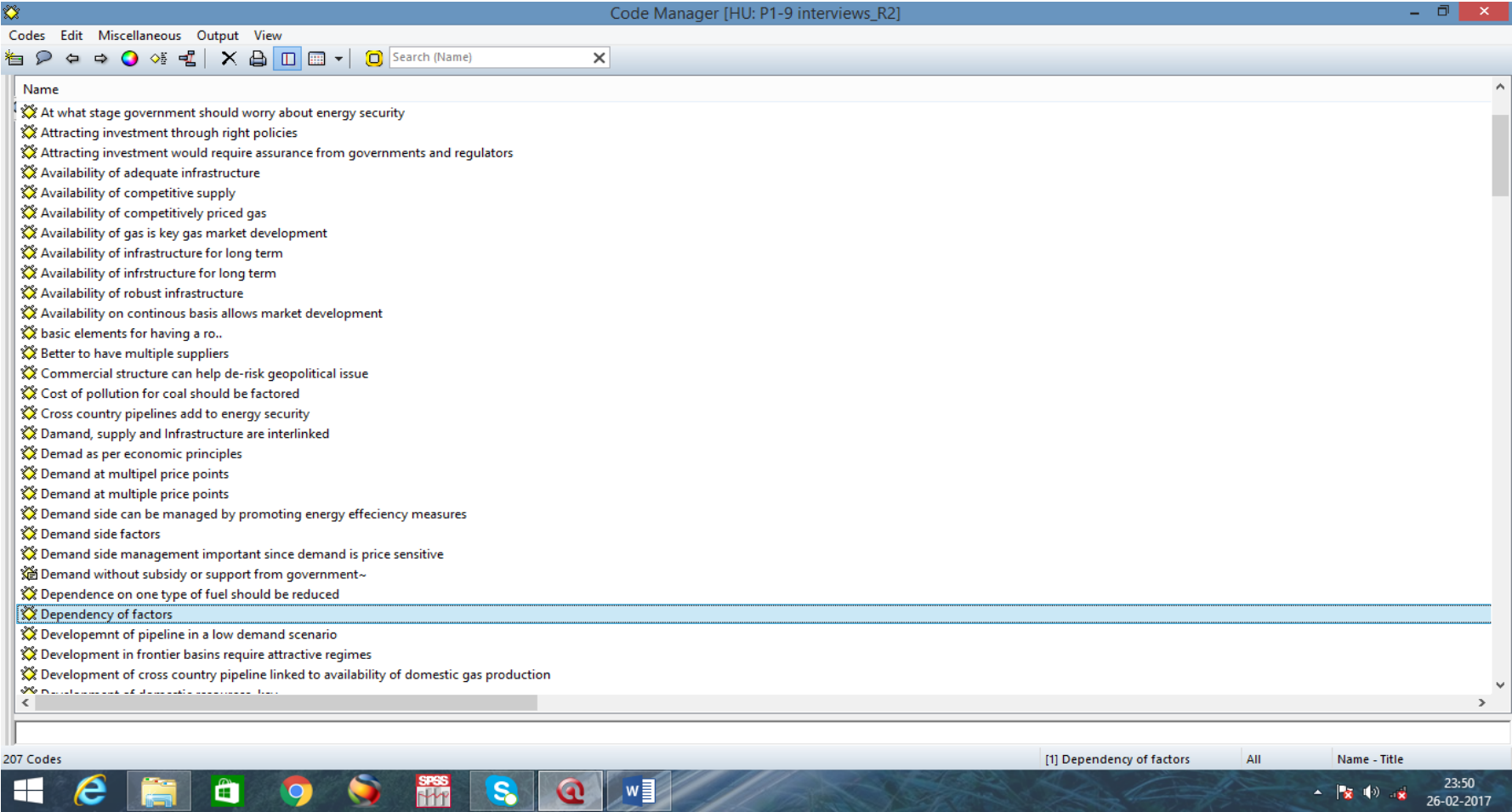
29 Q10 Any, thing else you would like to highlight which I have missed

30 A10: No all are covered

Government should clarify its stand on it policy towards gas a sa fuel

Fedreral structure has an impact on market development
In Federal strcuture role of state is also important on elevan policy measures   States in India bring
even US took 60-80 years   India can take learning and develop faster   It takes time to develop r
Availability of gas is key gas market development
Availability on continous basis allows market development

In India is not a must buy commoity additing to complexities
Japan and Korea the key LNG buying countries have to make gas available at any cost   Gas to be p
Governmer

Infarstructure post policy is key
Infartsructure development can be achievd in 10 years time frame   Regional markets can be develo
Structural elements of markets

State matters like land, taxes and labour important for reforms

RLNG storage tanks can act as low cost measure for storing energy and hence energy security
Robust contractual arrangement can help energy security
Energy security measures require only if percentage of gas in energy mix reach a resonable percentage
energy security post market development
Government should look after energy security post gas achieves 15% in the energy mix

P 4: P4 -> @P4   Size: 75%   Rich Text   Default

Codes

Codes

Code Manager [HU: P1-9 interviews_R2]

Codes   Edit   Miscellaneous   Output   View

Search (Name)

Name

Independent Exchange
Independent Operator for pipelines
Independent regulator required to monitor market and not price
Independent regulator should be setup at this stage
India can take learning and develop faster
India is different due to political situation and macroeconomic environment
India need to build infrastructure since there is low infra availability
Infarstructure post policy is key
Infartsruction development can be achievd in 10 years time frame
Infartsructure should be the key priority
Infartsructure, gas production and demand generation ahs to happen simultaneously
Information to help working of economics for market participants
Infrastructure should be affordable
Infrstrastructure comes on back of domestic gas
Investment in the sector key for developing the entire gas market chain
Issue of affordabilility due to weaker sections consuming power and fertilizer
It takes time to develop markets
Japan and Korea the key LNG buying countries have to make gas available at any cost
key for development of market in India
Life cycle cost of fuel can be help to make gas sustainable
Long term contracts required for making pipelines sustainable
Market development difficult on LNG
Market development difficult only on LNG
Market mechnaism once market is mature is also importnat
Market not sustainable with subsidy
market opening post build up of infrastructure
Market should gradually be freed up to open up
Market to be freed up post build up of sustainable demand
Marketing freedom key for upstream development
Multiple supply sources

207 Codes   [1] Dependency of factors   All   Name - Title

23:52
26-02-2017

Code Manager [HU: P1-9 interviews_R2]

Codes   Edit   Miscellaneous   Output   View

Search (Name)

Name

Structural elements of markets like policy and infra key for market development
Subsidy should be direct and targeted
Supply adequacy
Supply at multiple price points
Supply security should ensure 15-30 datys of supply
Supply side competition
Supply side Factors
Supply side security should diversify both on fuel types and sources of supply
Supportive Policy directives
Sustainable Demand
sustainable demand key for market development
Sustainable market through subsidy
Taxation to be used for buiding sustainable demand
Three development planks need to progress simultaneously
UK and Russia follwed this model
Unbundling cannot be done when India is struggling for development of infrastructure
unbundling impacts returns
Unbundling may be done for old pipelines
Unviable development need to be funded through viability gap funding
Upstream policy should be to develop acreages
Upstream producer develops pipeline to monitise gas
Viability gap funding can be the third model where private entities bid for lowest viability gap funding
Wellhead price freedom
Wellhead price freedom key for bringing investment
what more can be done to make gas sustainable in long term
what needs to be done post policy, demand , supply and infra issues are handled
What policy measures are required to promote markets
When should regulator break mopolistic behaviou i.e unbundle entities
When should unbundling be done for marketing and transportation function

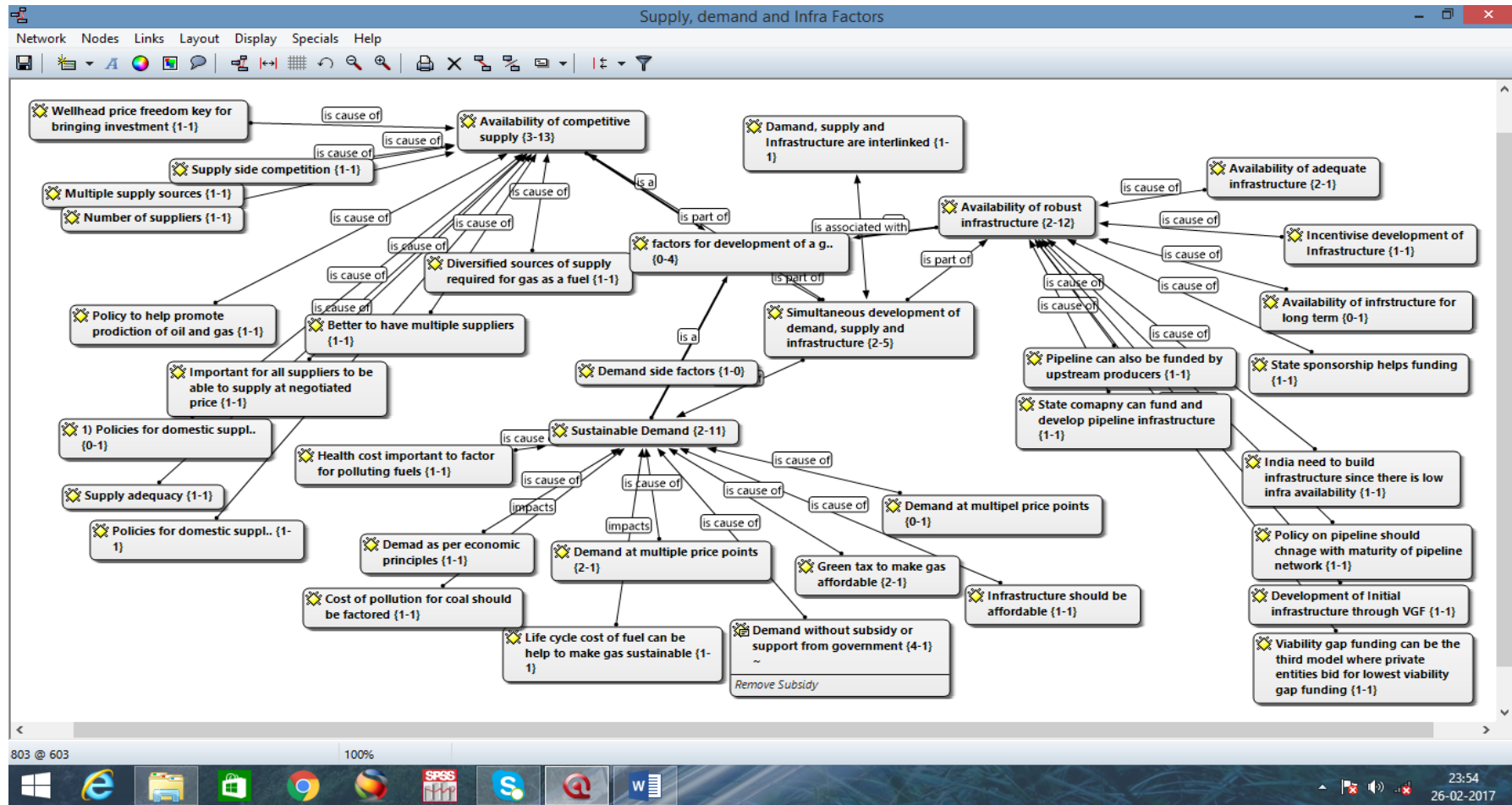207 Codes   [1] Dependency of factors   All   Name - Title
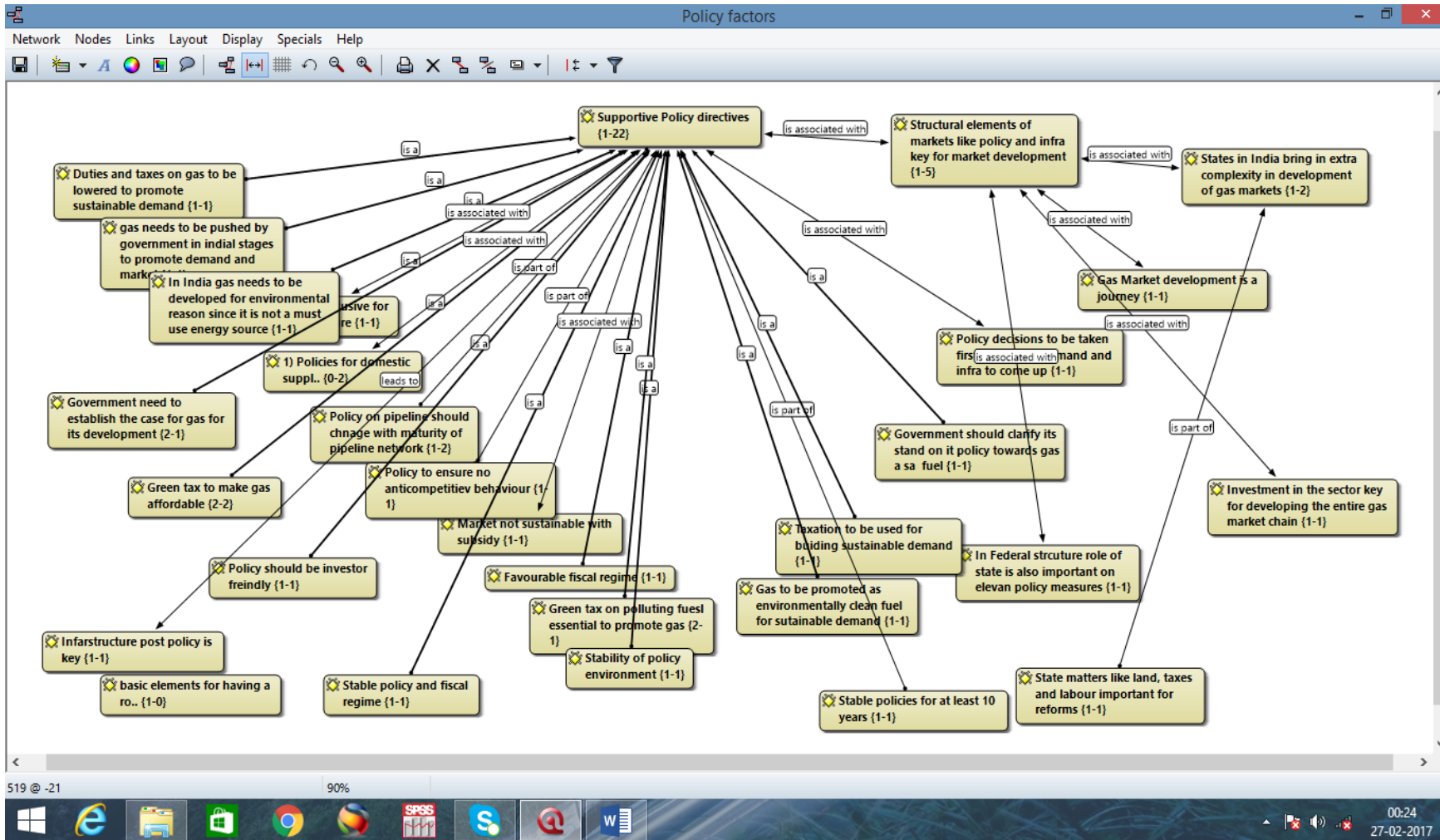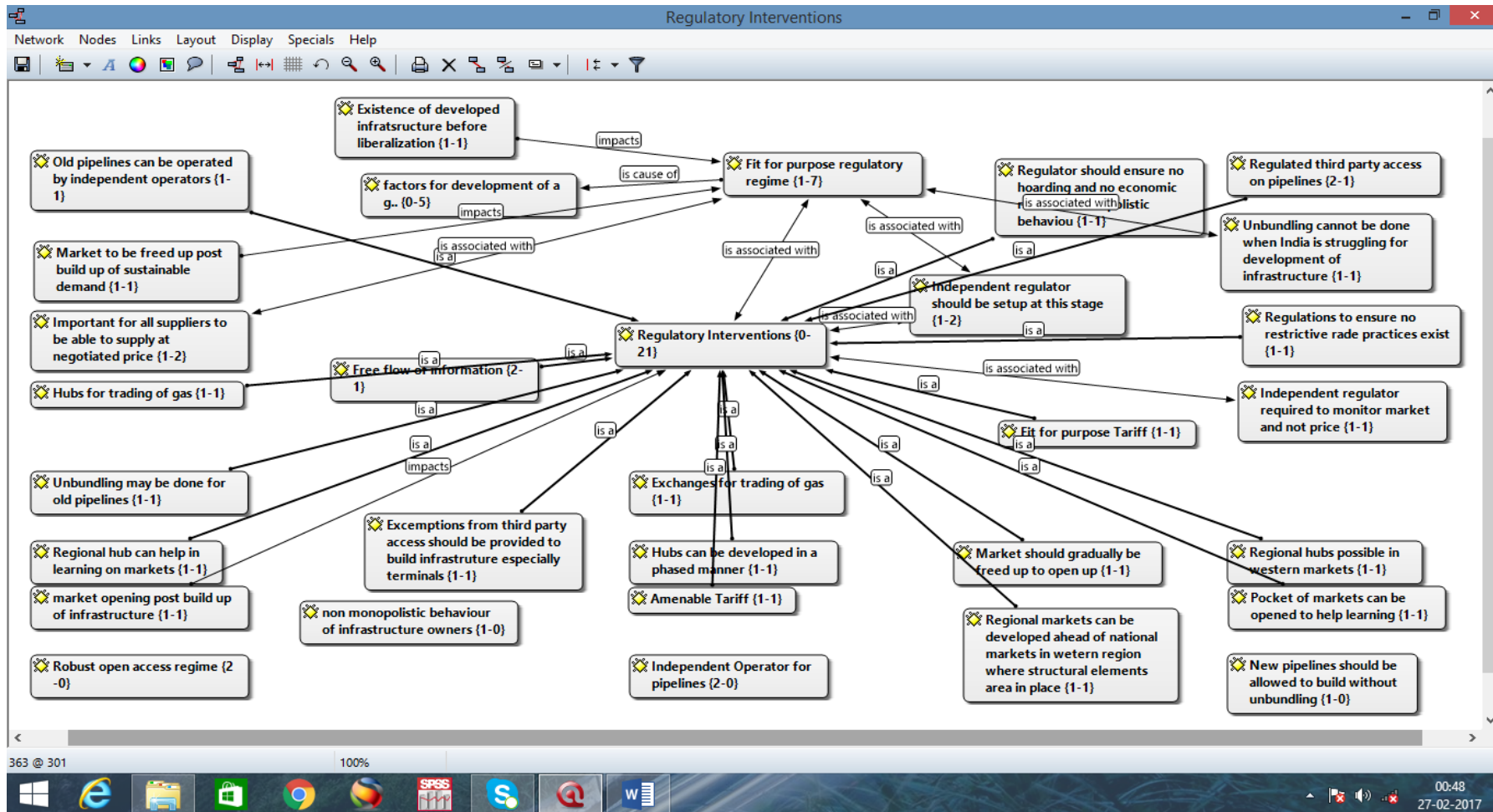
Axial coding

Theoretical Coding

Brief Resume of the Scholar – Akhil Mehrotra

Akhil Mehrotra is currently working as GM – IG ventures with Shell plc in India at their Mumbai office. He is also currently the Chairman of Mahanagar Gas Limited, a downstream utility in Mumbai.

Akhil is an energy sector professional with more than 25 years in the sector working with large energy companies – Shell, BG and Reliance. He has worked extensively in oil & gas, power and telecom sector. His area of expertise includes managing P&L of business, risk, strategy, business development, projects and policy & regulations.

Akhil has worked extensively with govt of India and PNGRB on the policy landscape of India. He worked on the development of the PNGRB Act 2006 and electricity Act 2003 and was part of most of the PNGRB committees which drafted the midstream & downstream regulations for oil & Gas sector in India. In 2012-13, Akhil chaired and finalised the "Vision 2030 – Natural Gas Infrastructure in India", an Industry report commissioned by PNGRB. The report has since been used by most of additional work on done on gas sector in India.

Akhil has spoken in various conferences in India as well as internationally on power, city gas development and policy & regulatory issues. He has advised government/regulators of Kazakhstan and Tanzania on development of Gas laws in their countries. Akhil is a mechanical engineer and a MBA in Finance. In addition to this he has done courses with some of the top B -schools like IIM Bangalore, Harvard, London & Kellog's Business School. Akhil has a passion for travelling and reading.

In academics, Akhil has published many papers and authored an edited book on Natural gas by Springer. Some of his publications include; 1) Paper on State of Natural gas sector in India; 2) Paper on Factors affecting development of Indian Natural gas market- Learnings from mature market; 3) Paper on Indian Exploration and production sector at Cross roads – NELP to HELP; and 4) Springer book – Natural Gas markets in India
Chapter – Issues & Challenges in development of efficient gas markets

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