Executive summary

Gas scenario in India is changing at a rapid pace. Government has started giving thrust to city gas distribution with an aim to improve deteriorating environmental conditions and to reduce subsidy burden by providing Piped Natural Gas (PNG) for domestic use and Compressed Natural Gas (CNG) for vehicles which is a safe and clean fuel. It has been declared by the government of India that in next 5 years at least 1 crore of new PNG domestic connections will be provided to households across major cities of India which are already connected or likely to be connected with natural gas pipelines in near future.

City gas distribution companies provides natural gas for the following purposes-

- Compressed Natural Gas (CNG) as a clean fuel for vehicles
- Piped Natural Gas (PNG) for domestic purposes as a safe fuel to replace LPG
- Piped gas for commercial purposes like hotels etc.
- Piped gas to industries

Earlier city gas distribution sector was given fourth priority in gas allocation after Fertilizer, Power, LPG and Petrochemical. Now gas allocation priority has been revised and city gas distribution has been given top priority among all sectors. In this direction natural gas has been diverted from non-priority sector to city gas distribution sector. Government has decided to provide 100% requirement of natural gas for CNG vehicles and domestic household use through cheaper indigenous gas. Further, government has also decided to provide 10% extra gas to meet growth requirement and fluctuating demand of city gas distribution companies. There are presently 70 Geographical Area (GAs) which are connected to city gas distribution. Government is making all round efforts to connect around

300 cities with gas grid by laying another 15000 kms of Natural Gas pipelines in next five years.

Considering the case of India, where many City Gas Distribution (CGD) companies are operating in various geographical areas, CGD companies are mostly connected with single source pipeline and presently not a single CGD company has any kind of strategic natural gas storage. This may lead to disruption in gas supply to city due to various factors in case of any exigency. Densely populated cities like Delhi and Mumbai, where around 15 lacs house dependent on piped natural gas and more than 16 lacs vehicles running on compressed natural gas, may starve because of non-availability of natural gas due any disruption in gas supply. Presently there is a significant demand and supply gap in India, and with low level of indigenous gas, India is relying on imported LNG. This scenario will continue to grow in future as the demand increases. Any interruption in supply of indigenous or imported gas due to any reason may lead to customer dissatisfaction and huge loss to CGD industry. Understanding the intricacies of this sector and considering the growing demand of CGD in India and thrust provided by Government of India, it is prudent to have some arrangement to ensure un-interrupted gas supply to City Gas Distribution sector in India. In majority of the countries around the world, CGD companies takes services of already established gas storage facilities connected to national gas grid. In India, Gas Grid is not yet fully developed. Thus due to non-availability of strategic gas storages in India, CGD companies depends upon available line pack in gas pipeline only in case of any emergency or disruption in gas supply.

Notably no research has been done till now which specifically focus on storage for CGD companies. Thus no literature is available regarding its feasibility in Indian scenario. After the literature review, the business problem can be summarized as follows:

There are an ample number of gas storage facilities in the world which are responsible for meeting base load and peak load demand of natural gas consumers

and also provides the security in case of any future disruption in supply. As India doesn't have any storage facility thus the future is not properly secured and thus *"In the event of any disruption in consistent gas supply due to non–existence of Gas Storages will lead to actual and opportunity loss in CGD industry in India"*

The above business problem motivated the researcher to perform this study. Detailed literature survey was carried out in the area of gas storages to find out the methods of gas storages and the variables which affect the establishment of gas storages specifically for CGD industry. No literature is available on this topic as no gas storage has been setup for CGD industry in India so far. Based on literature study following gaps were observed:-

➢ To the best of researcher knowledge, variable and factors which are specifically related to Natural gas storage for CGD companies in India are not known

➢ No literature is available which defines framework for establishment of Natural Gas Storage for City Gas Distribution in India

Business problem is further narrowed down to following business problem statement:-

"Identification of variables and factors influencing establishment of natural gas storage for CGD industry in India"

Based on above business problem, research questions and research objectives formulated for this research study are as given under:-

Research Question 1:-

What are the various variables/factors that will influence the establishment of natural gas storage for CGD industry in India?

Research Question 2:-

What conceptual framework needs to be developed for establishment of natural gas storage for CGD industry in India?

Research Objective 1:-

To determine various factors influencing the establishment of natural gas storage for CGD industry in India

Research Objective 2:-

To develop a conceptual framework for establishment of natural gas storage for CGD industry in India

So as to go forward with the research and to answer the research questions, an appropriate research model is framed out and appropriate research methodology has been followed.

For research objective 1, exploratory research has been used. Variables were identified with the help of literature review, expert review and secondary information. In this process 29 variable were identified. Then a questionnaire was prepared in alignment with the variables identified. A "**7 point Likert Scale**" was used in questionnaire for better accuracy. Pilot testing was conducted on 30 people to check the internal consistency of the questionnaire for which **"Cronbach's Alpha test"** was used. The Cronbach's Alpha test value came out to be 0.82 which is close to 1. The higher is the internal consistency better is the reliability of the questionnaire. *Cronbach's Alpha coefficient of 0.822 signifies a high level of consistency.*

After the successful Cronbach's Alpha test, developed questionnaire was administered on industry executives related to upstream, midstream, downstream sector including consultants and academic institutes. Sample size was calculated based on Yamane formula considering target population of 3000 which was decided based on judgmental sampling due to limited expertise in this sector. Finally 395 responses were received.

For factor analysis, the **Principle Component Analysis (PCA)** method has been used. PCA method is considered to be most accurate for factor determination. Before using the PCA method, sampling adequacy checked through **Kaiser-**

Meyer-Olkin (KMO) and Bartlett's test. By using KMO and Bartlett's test, sampling adequacy calculated as 0.910. This signifies that the variables are dependent on each other and correlated. This is a necessary condition to proceed with PCA factor analysis. By using KMO test, sampling adequacy calculated 0.910. The sampling adequacy of more than 0.90 is excellent while below 0.50 it is unacceptable. Considering result PCA method of factor analysis can be applied. In PCA method, Eigen value method is used to determine the factors. Using PCA, Six factors were determined whose cumulative percentage of total variance is explained by 60.045%. In simple words it implies that the 60.045% of variance is explained by the 6 factors. Scree Plot method is also used. A scree plot displays the Eigen values associated with a component or factor in descending order verses the number of component or factor. It visually shows that which component or factor explain most of the variability in the data. Though this method, six number of factors extracted are also six.

Rotated component matrix is generated by using Varimax with Kaiser Normalization which is orthogonal method of factor rotation. By using Factor Analysis six major factors emerged from the analysis. These factors are:

1. Economic Factors
2. Legal & Techno Operational
3. Geographic &Political Concerns
4. Awareness & Importance
5. Technical & Labor Skills
6. Environmental concerns

For research objective no.2-Qualitative Research methodology is used for the purpose of development of conceptual framework. In-depth semi structured interview with experts conducted using the Focus Group technique. The interview was recorded, transcribed and fed into **Atlas TI** software that provided a suggestive framework based on the output of transcribed conversation. The steps followed are given as follows:-

1. Expert Group setup based on Judgment Sample consisting of
    a. Natural Gas Transmission Experts
    b. CGD Marketing & Technical Experts
    c. Regulatory Expert
    d. Safety Expert
2. Semi Structured Interview conducted with the expert group
3. Transcribe the recorded interview
4. Coding with Atlas TI software
5. Suggestive Framework developed based on Atlas TI software output

Theoretical Premises like Stakeholder theory, Theory of Constraint (TOC), Resource value based theory (RVBT) etc. were studied to deliberate the theoretical premise for this study. After due deliberation, it is observed that **Stakeholder's theory** is the most relevant for this study. Stakeholder theory suggests that the purpose of a business is to create as much value as possible for stakeholders. The various stakeholders and their roles are deliberated.

This research study shall be very useful for Government, Regulator, Planning commission or any CGD company. This study can be used by Government of India while formulating the natural gas storage policy. Planning Commission can also make use of this study for planning the establishment of gas storage in India. Existing or new CGD companies can use this study for the establishment of gas storage for their use directly or through major gas suppliers or any gas aggregator.