Demand for Natural Gas in the Indian Industrial Sector

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A.T. Kearney Limited

Working Paper #68

October 2007

The Program on Energy and Sustainable Development at Stanford University is an interdisciplinary research program focused on the economic and environmental consequences of global energy consumption. Its studies examine the development of global natural gas markets, reform of electric power markets, international climate policy, and how the availability of modern energy services, such as electricity, can affect the process of economic growth in the world's poorest regions.

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About the PESD Study: Natural Gas in the Energy Futures of China and India

PESD has been studying the emerging global market for natural gas through a series of closely integrated research projects. The topics of these studies range from focusing on the geopolitical implications of a shift to a global gas market, the factors that affect gas pricing and flows as LNG links the U.S. and European markets across the Atlantic basin, and how gas projects fare in privately-owned independent power projects (IPPs) in emerging markets.

One of the open questions in all these studies concerned China and India--both countries use relatively small amounts of gas now but could be very large in the future. The role of natural gas in Chinese and Indian economies is of critical import both domestically and for global energy and environmental issues. The competition between coal and natural gas in these two markets has tremendous implications for local air pollution and for climate change. Rising demand for imported gas in China and India will also shape the LNG market in the Pacific Basin and could lead to the construction of major international pipeline projects to monetize gas supplies in Russia and the Middle East. The present paper is one in a series that looks at the Indian market in detail.

Disclaimer

Demand for Natural Gas in the Indian Industrial Sector

May, 2007

Executive Summary

In the last decade or so, India has emerged as one of the fastest growing economies of the world, recording sustained growth rates well in excess of 7-8% per annum. The unprecedented growth of the Industrial sector, especially during the last five years, has lent greater sustainability to this growth story. A thrust towards achieving global competitiveness, focused government policies and incentives for investments are expected to sustain Industrial growth rates above 10% p.a. levels for the 11th plan period (2007-12).

The growth in the Industrial sector, coupled with rising prices of conventional fuels and increasing environmental concerns, is expected to drive the quest for a more competitively priced and cleaner source of energy. In this regard, Natural Gas is has the potential to emerge as a fuel of choice for many sections of Indian Industry.

While the availability of Natural Gas to Industries in India has traditionally been constrained, the next few years are expected to witness a significant change in the scenario. During this time, while several new gas finds are expected to come on-stream, pipeline infrastructure is expected to be ramped up and a liberalized regulatory environment is expected to be in place, ensuring increasingly unconstrained availability of gas to Industrial consumers.

We expect the total consumption of Natural Gas by Indian Industries - for process heat and feedstock purposes - to rise from the current levels of 6 bcm to about 16 bcm by 2015 and further to 26 bcm by 2025. Moreover, the price affordability of Industries is expected to be higher compared to other sectors, as reflected by the relative inelasticity of Industrial gas demand with prices (beyond $4.5/mmbtu). This is likely to make the Industrial sector a more attractive consumer for gas suppliers.

While Industries in West and North India would continue to be the main markets for Natural Gas going forward, demand in South & East would also grow rapidly. Petroleum Refining & Petrochemicals and Iron & Steel would be the key consuming Industrial sectors with about 50% share of total gas consumption in the Industrial segment.

Further, greater infrastructure penetration and gas availability by 2025 is expected to ensure that a higher portion of the potential gas demand would be realized. We expect that Natural Gas would account for upto 25% of all Industrial fuel consumption in India by 2025 – up from the current level of about 14%.

Contents

1. Introduction to the Study

1.1 About the Report

As India charts an impressive growth story and sets its sights on being amongst the top three economies of the world within the next 25 years, it faces several challenges. The question of energy security is foremost amongst these. Inability of domestic coal and oil supplies to keep pace with increasing energy demands, have forced India to diversify its energy portfolio and explore the potential of other fuels.

In this context, Natural Gas has made rapid in-roads into the overall energy portfolio of the country [1]. Driven predominantly by proliferation of several indigenous and imported supply sources and greater infrastructure penetration, Natural Gas is likely to be the fastest growing fuel in the country.

While Power & Fertilizer sectors have been the early beneficiaries of gas allocation by the government, recent de-regulation of gas markets and increased supplies have spurred growth in gas demand from Industrial consumers. A clean fuel, gas finds application in Industries for process heat requirements, as a feedstock in select industries and also for captive power generation.

This report aims to capture the emerging trends of Natural Gas as a fuel in the Indian Industrial sector addressing several critical questions:

1. What has been the growth trajectory of the Industrial sector in India and the outlook for future?

2. What has been the share of Natural Gas as a fuel in the Industrial sector? How is the share expected to change in the future?

3. What is the expected demand of Natural Gas from the Industrial sector in the short, medium and long term?

4. What are the key enablers required to realize the projected demand potential?

[1] EIA, 2007

Section 1 of the report presents a brief overview of India's growth story and the role of the Industrial sector in the same. It also captures the outlook for Industrial sector growth detailing critical factors expected to impact growth.

Section 2 maps the relative share of various Industrial fuels and the growing importance of Natural Gas. Further, key enablers driving the consumption of Natural Gas in Industries are discussed along with brief case studies illustrating examples where the presence / absence of these enablers led to successful / failed implementation of gas based applications in Industries.

Section 3 details out our projections for the Natural Gas demand in the Industrial sector in India. In addition to base case projections, sensitivity of demand to gas price, supply availability and regulations have also been presented. The section concludes with an assessment of the current regulations and policies specific to Natural Gas.

Section 4 presents the conclusions and key implications.

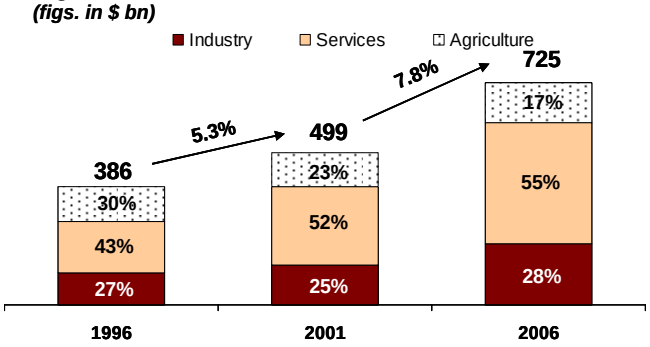
1.2 India's Growth Story & the Role of Industrial Sector

1.2.1 Economic Growth Trends

India is passing through one of its most exciting phases as a young, democratic and independent nation - a phase characterized by sustained economic growth and improvements in several key development indicators. Further, the business confidence is high with stock market indices and investments (domestic & FDI) at record levels. Fig. 1 maps the economic growth of the country over the last 10 years.

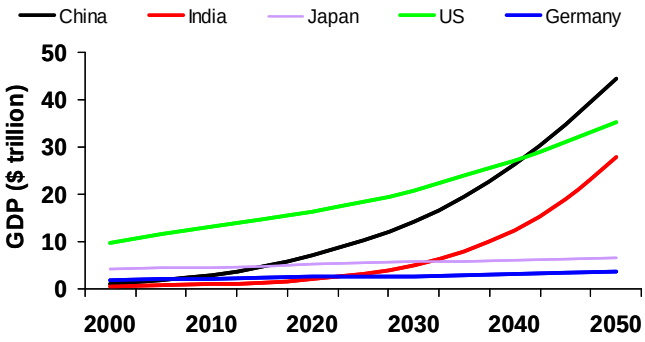
A supportive policy environment, stable leadership, infrastructure improvements and availability of high quality skilled manpower have contributed in no small measure to this current growth momentum. With growth at almost 8% since 2000, India has emerged as one of the fastest growing nations. This momentum

Fig. 1: Economic Growth Trends in India
(figs. in $ bn)



Source: EIU, CSO

Fig. 2: Economic Growth Projections



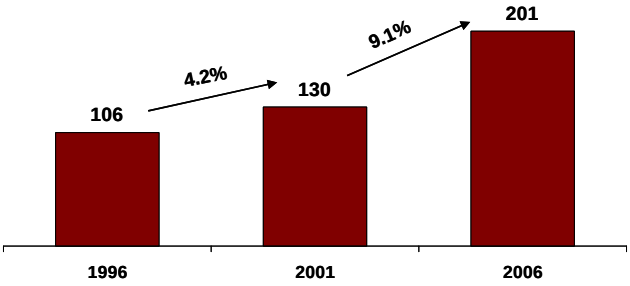
Source: Goldman Sachs Projections

is expected to propel India to be the third largest economy in the world (behind US & China) within the next 25 years[1]. Fig. 2 presents the findings of a recent study projecting the expected growth scenarios for the leading world economies.

1.2.2 Industrial Growth Trends

India's economic performance has been led by rapid growth in the Services sector. Since 1996, the Services sector, growing at 9%, has increased its share in the overall economy from 43% to 55%. On the other hand, the Industrial sector has been a slow-starter. Leading up to 2001, the Industrial sector grew by a modest 4.2% (CAGR). Since then, however, the Industrial sector has emerged as the fastest growing segment of the economy clocking a CAGR of 9.1% over the period. Fig. 3 presents the growth of the Industrial Sector during this period.

Fig. 3: Industrial Sector Growth in India
(figs. in $ bn)



Source: EIU, CSO

This resurgence of the Industrial sector is both significant in the Indian context and also unprecedented. A vibrant Industrial sector provides a balanced development profile for the country and generates employment opportunity especially for farm sector workers. Also, the consistent 7% plus growth rate in industrial output) for the last five years has never been witnessed since 1951 and is a reflection of renewed strength and strong fundamentals in the sector. In the wake of opening up of the economy, this resurgence is also a testimony of the growing competitiveness of Indian industry in the global marketplace.

1.3 Outlook for the Industrial Sector

While the recent surge in the Industrial sector has contributed towards an unprecedented 8-9% growth (CAGR) for the Tenth Plan period (2002-2007), it is still short of the 10% growth target for the period. However, with a combination of several enabling factors, this 10% target is eminently achievable for the next plan period[2]. These enabling factors are detailed in the following sections.

1.3.1 Strong Demand led Growth in all Major Sectors

A critical factor driving the positive outlook for Industries is the strong growth trajectory of most key Industrial sectors as against past periods where only one

[2] Economic Survey of India, 2007

or two sectors would do well. As outlined below, many of the key industrial sectors are currently having significant growth. These include:

– **Petrochemicals & Chemicals**: The Petrochemicals sector is expected to ride a wave of new capacity additions and is expected to see significant growth.

– **Iron & Steel**: Having completed a wave of improvement initiatives in recent years, new capacities are likely to come on-stream in the near future. These include potential expansions by existing players and also entry of new players keen to explore the potential of Indian iron ore.

– **Cement**: Robust demand growth emanating from the Infrastructure & Construction boom and fiscal incentives (a 5-year tax holiday for new capacities is on the anvil)[3] are expected to drive growth in the sector.

– **Automobiles:** Spurred by strong domestic demand and significant export potential, the sector has grown at over 15% in the last 5 years and is poised to continue this momentum going forward.

– **Textiles:** Years of re-structuring, modernization and fiscal concessions is finally expected to translate into brisk growth numbers for the Textile sector

Further, the growth of these sectors is resting on strong economic fundamentals and is led by not only demand growth in the domestic markets but also increasing share in global markets. Similar trends are being witnessed in many other Industrial sectors. While on one hand, more than a decade of strong economic performance has led to rise in income levels and hence sustainable growth in domestic consumption, enhanced competitiveness of domestic industry has made Indian Industry relevant in the global context.

1.3.2 Promising Investment Scenario

The investment scenario for driving growth & capacity additions in the Industrial sector also looks optimistic. Domestic savings and FDI inflows are at an all time high. India surpassed South Korea in the region to become the fourth largest recipient of FDI this fiscal as per the latest UNCTAD report[4]. During April-September 2006, total FDI inflow stood at $4.5 bn. with the electrical equipment sector retaining the top spot. Additionally, significant internal generation of resources is being ploughed back into setting up Industrial capacities.

1.3.3 Governmental Initiatives

In addition, several government initiatives are incentivizing investments in Industries. FDI norms have been relaxed further under the Foreign Direct

[3] Economic Survey of India, 2007

[4] United Nations Conference on Trade and Development, 2007

Investment Policy 2006. Fiscal sops & tax breaks are being offered to select sectors to ensure all-round growth. Governments, both at the Centre & the State level, are focusing on the Infrastructure sector and ensuring availability and quality of basic amenities such as Power & Water.

1.3.4 Creation of Investment Zones

Creation of specially designated investment enclaves - Special Economic Zones (SEZs) & Industrial Parks – is expected to provide a strong impetus to industrial growth. These SEZs are expected to contribute towards rapid economic growth by using tax & business incentives to attract investments – private & foreign – and technology. The Government forecasts that exports from SEZs would reach $15 bn. in 2007-08[5]. Given that majority of the approved SEZs are in the manufacturing space, most of these exports will add to the Industrial export value.

1.3.5 Proliferation of Industrial Growth across the Country

Traditionally, Industrial growth in India has been concentrated in a few geographical areas, with many states lagging behind. However, in recent years and more so going forward, there is a thrust on ensuring Industrial development in these regions. Creation of SEZs all across the country is a step in that direction. Many of the under-developed states have developed industry-friendly policies to attract investments. Tax rebates, administrative support, etc. are being used to facilitate investment in the states. These measures are resulting in proliferation of Industrial growth across the country and we expect these trends to gather momentum in the near future.

[5] Department of Industrial Policy and Promotion, India

2. Role of Natural Gas in the Indian Industrial Sector

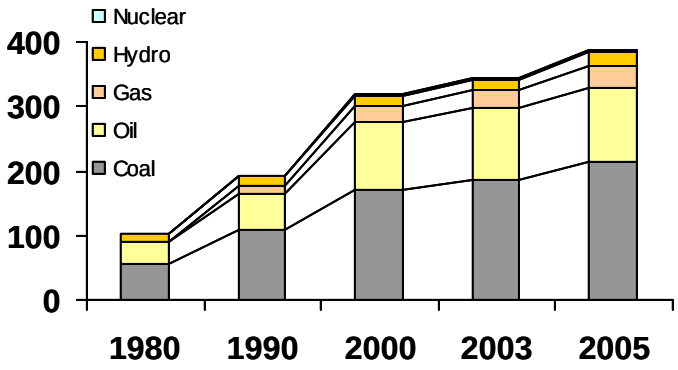
2.1 Emergence of Natural Gas as a Fuel

2.1.1 India's Energy Demand

Over two decades of strong and rapid economic growth is also reflected in the growth of India's energy requirement which has increased at nearly 5.5%[6] over this period. India's energy consumption in 2005 was 387 mtoe and going forward, this is projected to increase to nearly 650-700 mtoe by 2020.

Coal and oil have remained the mainstay of India's energy basket comprising about 85% of total demand over the year[7]. The remaining consumption is accounted for by other sources such as gas, hydro and nuclear. Fig. 4. depicts the evolution of India's energy basket.

Fig. 4: India's Energy Portfolio
(figs. in mtoe)



Source: BP Statistical Review

Gas consumption started in India in the early 1980s and has grown rapidly since then. It has recorded a CAGR of 15.5% during the last two decades and currently accounts for nearly 9% of energy consumption.

2.1.2 Evolution of Gas Market in India

Traditionally fueled by increasing indigenous production and having passed through several evolutionary phases, India's gas market has now entered a phase of dynamic changes. This evolution of Natural Gas market in India has been mapped in Fig. 5.

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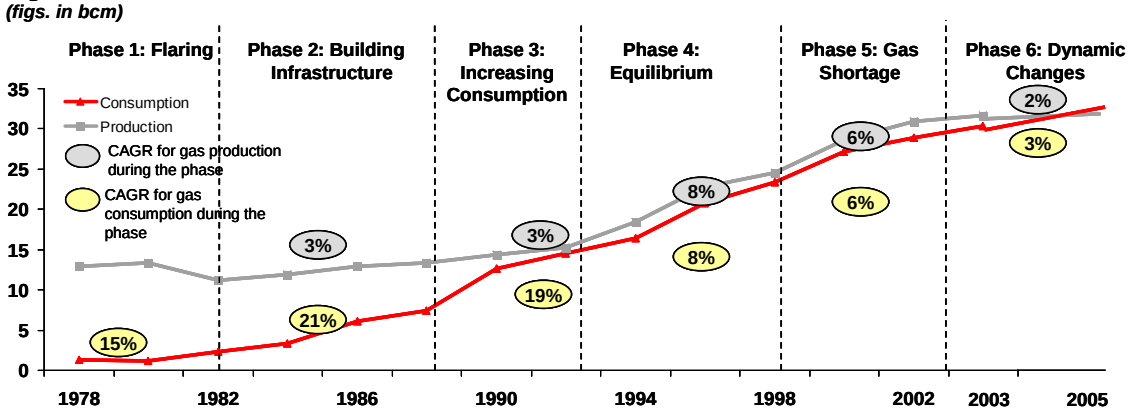
[6] BP Global Statistical Review of World Energy 2006

[7] Considering only commercial fuels excluding bio-mass used for meeting energy requirements

– **Phase 1 - Flaring**: Gas was produced as co-product of oil production. Hardly any gas transportation infrastructure existed till about 1982. There was some

Fig. 5: Evolution of Gas Market in India
(figs. in bcm)



Source: A.T.Kearney Analysis

consumption close to the gas sources but most of the gas was flared. Towards the end of this phase, gas production was rising rapidly due to increased oil production. No formal policy framework existed for gas markets at this time.

– **Phase 2 – Building Infrastructure:** With increased gas availability, this phase saw significant investments towards creating a gas transmission infrastructure. The HBJ pipeline was conceptualized. Some gas transportation infrastructure was also put close to the landfall points. As a result, consumption increased rapidly. A Negotiated Pricing Mechanism was introduced for gas supplies, mainly by ONGC & OIL. Gas prices of about $1.2/mmbtu prevailed during this time.

– **Phase 3 – Increasing Consumption:** This period witnessed consolidation of gas demand along the newly laid HBJ pipeline with consumption growing by a brisk 19%. However, supply was still more than the total demand. In the early parts of this period (1987), the market moved to a cost plus pricing mechanism with the government fixing gas prices at producer level ($0.8/mmbtu), for HBJ transmission ($0.5/mmbtu) and at the consumer level ($1.3/mmbtu).

– **Phase 4 – Equilibrium**: The 1990s saw a phase of demand-supply equilibrium with a wider consumer base ensuring complete off-take of indigenous production. During this period, cost plus pricing mechanism prevailed with minor upward revisions of Producer price to $0.84/mmbtu.

– **Phase 5 – Gas Shortage:** This period witnessed the strong demand growth momentum continuing from previous periods while gas supplies failed to keep pace with this demand. As a result, several gas capable capacities were forced to operate on liquid fuels such as naphtha. During this period (1997-

2002), while the Administered Price Mechanism continued, the wellhead price of gas was linked to a basket of four oil grades, with a floor and a ceiling. Initially the price linkage was set at 55% which was increased to 75% in 1999-2000.

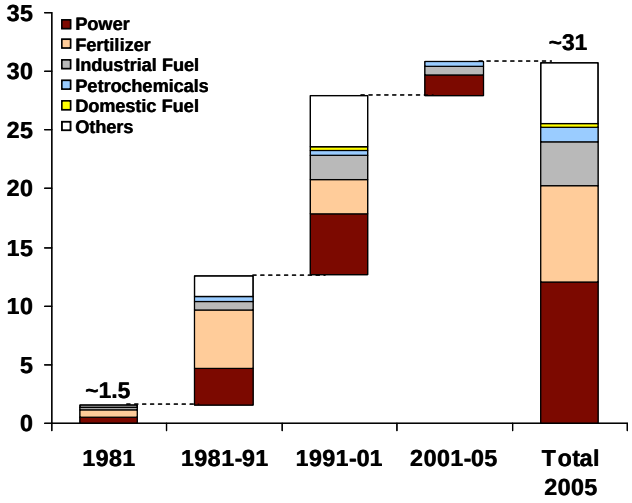
– **Phase 6 – Dynamic Changes:** During the last five years, Natural Gas demand has been constrained by gas availability. However, the supply constraints have forced the market to explore options beyond domestic gas. As a result, imported gas, as LNG, made its first entry into India during this period. Currently there are 2 LNG regasification terminals with a combined capacity of over 7.5 mtpa.

  With increasing share of the imported gas, as also gas from fields developed under joint ventures, different price points have started emerging. The share of APM gas has also decreased. With the advent of LNG terminals, small volumes of gas have been sold on spot prices also. Going forward, price points are expected to increasing move towards "market-determined" pricing.

2.1.3 Key Natural Gas Consuming Sectors

Historically, growth in gas consumption in India has been supply driven, with the supply of gas to any consumer determined by a government appointed Gas Allocation Committee. As a result, Power and Fertilizers emerged as the as the main consumers of gas due to preferential supply. Most of these gas based power and fertilizer units were along the HBJ pipeline or in areas close to the landfall points in Western India.

Fig. 6: Key Natural Gas Consumers
(figs. in bcm)



Source: Ministry of Petroleum & Natural Gas, India

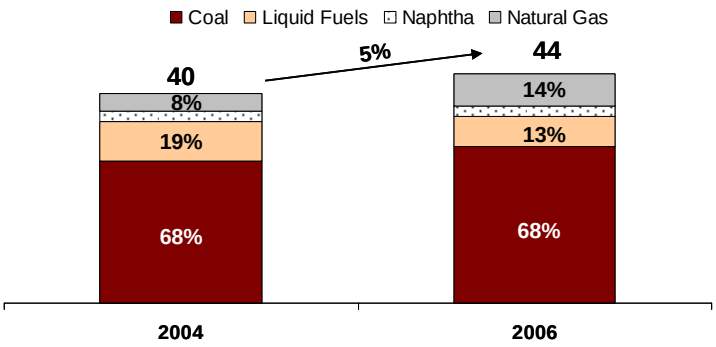
The past few years have seen an increased gas availability for Industrial demand especially from private gas suppliers and LNG. As a result, gas consumption by the Industrial sector is growing and this trend is expected to strengthen as the percentage of non-APM gas increases in the market including from new sources such as CBM. Figure 6 captures the split of gas consumption in India across various consuming sectors.

2.2 Share of Fuels in the Indian Industrial Sector

Traditionally, the Indian industry has been powered by mainly coal and a basket of crude oil based fuels such as Naphtha, Kerosene, etc. Fig. 7 presents the share of these fuels in Industrial consumption basket for 2004.

While, Natural Gas accounts for only 14% of total consumption in Industries, its share in the overall consumption basket has been on a sustained upward trajectory. Since 1990, Industrial consumption of Natural Gas has grown from less than 1 bcm in 1990 to about 6 bcm in 2006. This growth in share has been at the expense of crude based liquid fuels and to a lesser extent, from coal.

Fig. 7: Fuel Consumption in Industry
(figs. in bcm of gas equivalents)
(excluding energy requirement for captive power generation)



Source: A.T.Kearney Research

2.3 Key Enablers of Natural Gas Demand in Industries

Growth of Natural Gas as an Industrial fuel in India has been driven by several key enablers and these, going forward, are also expected to sustain this momentum. These enablers have been detailed in the following sub-sections:

2.3.1 Supply Availability & Reliability

As a non-priority sector, supply of Natural Gas to Industries had traditionally been constrained. Not only was the allocation limited, the infrastructure penetration was negligible. As a result, few industries, in select regions only, found it feasible to convert to Natural Gas.

However, diversification of supply sources, in terms of gas from joint venture fields and LNG through the terminals at Dahej and Hazira in recent years has altered the demand supply scenario making increasing gas available to Industries. Under the NELP program (both on-shore and off-shore) and CBM, exploration activity is underway at an unprecedented level, under public private partnership model. These, together with potential cross country pipelines (from Iran, Myanmar and Turkmenistan) and new LNG terminals will also boost the

supply of Natural Gas to Industrial users. This is expected to facilitate increasing use of Natural Gas by Industrial consumers.

2.3.2 Pricing of Natural Gas

As an Industrial fuel, Natural Gas competes with coal and other liquid fuels. Traditionally, gas was available on government controlled gas prices which were competitive against alternate fuels in many parts of the country. Over the past few years, gas available from alternate sources has been priced higher than APM prices. Going forward, increasing amounts of gas are expected to be priced at market-driven prices. The potential growth of Natural Gas as an Industrial fuel would be contingent on pricing of gas. At low prices, gas has the potential to compete with coal which can result in higher amount of gas usage.

2.3.3 Infrastructure Penetration

Pipeline infrastructure for gas transmission and distribution has been critical in growth of overall gas demand and Industrial demand in particular. Historically, Industrial demand has grown only in regions where gas transmission infrastructure has been built. These include parts of Western India and along the HBJ pipeline.

While the earliest gas infrastructure was built by public sector companies, the government is now encouraging private investments in pipeline infrastructure. Several policy initiatives, which are underway, such as grant of infrastructure status to pipeline projects, 100% FDI through automatic approval route, potential marketing exclusivity for distribution network and competitive transmission pricing are expected to catalyze the growth of gas infrastructure, going forward. The Natural Gas Regulatory Board Act was adopted and passed in 2006. Establishment of a full fledged Regulatory Board is on the anvil and this is expected to provide impetus to development of the transmission and distribution infrastructure. Increased penetration and reliability of supplies would spur greater consumption of gas in Industries.

2.3.4 Regulations & Judicial Intervention

As discussed in previous sections, supply, allocation and pricing of Natural Gas has traditionally been controlled by the government. The advent of free market for gas and with it market based pricing has given a boost to gas availability, and in turn gas consumption, for the Industrial sector. This trend is expected to be more pronounced going forward.

Judicial intervention and environmental concerns have also driven gas consumption by industries in select geographies (e.g. in districts neighboring the Taj Mahal in Agra). Going forward, the judicial & regulatory intervention with respect to environmental impact is expected to only increase. Further, the CDM regime emanating from the Kyoto protocol and the resultant carbon trading

market is also expected to provide large monetary incentive for gas consumption in Industries.

However, excessive regulatory intervention in the sector my also pose a potential risk to the quantum of gas available to the Industrial sector. The risk emanates from the possibility of government intervening to ensure supplies to the Power & Fertilizer sectors as a priority. In such a scenario, gas availability for the Industrial sector may be constrained.

2.4 Natural Gas Supply to MUL – A Case Study

Case Facts

– India's largest automobile company, Maruti Udyog Limited (MUL), has its production facility in Gurgaon, a satellite town of New Delhi. The northern tip of the HBJ pipeline can be accessed for gas supplies to the plant.

– A part of the power generation capacity was designed to ensure a stable, reliable supply to its many ancillary manufacturers

– The MUL management decided to set up a 60 MW gas based captive power generation unit and it entered into an agreement with the Ministry of Petroleum & Natural Gas (MoP&G) for supply of 0.5 mmscmd of Natural Gas from the HBJ pipeline.

Key Issue

– In 1998, the Supreme Court of India drew up a roadmap for mandatory conversion of certain categories of public transport vehicles in Delhi (e.g. taxis and local buses) to Natural Gas and directed the government to ensure availability of gas for this purpose.

– Faced with insufficient supplies, MoP&G partially withdrew supplies to MUL w.e.f. January 2003. After June, 2003 no gas was supplied to MUL.

Impact

– Due to this supply cut, MUL had to switch to diesel to run its captive power plant, resulting in a $18 mn. hit on MUL's bottom-line, annually.

– Considering the higher cost of production, MUL was running the plant at lower loads. It had also cut off power to its ancillaries, forcing them to turn to the erratic supply from the grid

– While the entry of imported LNG (through Petronet LNG) has improved the scenario, reliability of gas supply (even at high prices) remains a big issue

– This example is typical of the scenario faced by many industries with respect to gas supplies. This has resulted in constrained growth of gas consumption in India. Increased availability and reliability of supply can result in more significant gas consumption by the industrial sector.

3. Natural Gas Demand in Industries

This section of report presents the projections for gas demand in the Industrial sector in India. A brief overview of the estimation methodology has been outlined. Parameters governing the realization of potential gas demand have been discussed and corresponding results have been presented. Industry-wise and region-wise gas demand projections have been presented along with future projections for fuel mix in the Industrial sector.

Price elasticity of gas demand and its sensitivity to gas availability have also been discussed with emphasis on future outlook on gas prices and supplies.

3.1 Approach and Methodology

Various fuels are used by the Industry to supplement their energy and non-energy requirements. The choice of fuel depends on the process requirement (energy/non-energy) of the industry, process economics and availability of fuel. Thus, certain fuel requirements can be *alternatively* met through gas, depending on its technical feasibility, economic viability and availability. This potential for substitution is a measure of demand for Natural Gas in the industry. Based on this concept, the following approach was used to estimate the total Industrial gas demand in India:

1. *Estimation of **Total Fuel Demand** by the Industrial sector in India*

   Key Industrial customer segments were identified and their fuel-wise energy and non-energy requirement was determined. The entire gamut of Indian Industries was classified into the following major Industrial segments:

   i. Cement

   ii. Ceramic and Glass

   iii. Chemicals

   iv. Iron and Steel

   v. Heavy Engineering

   vi. Metals and Minerals

   vii. Paper

viii. Petrochemicals and Refining

ix. Textiles

x. Others (such as food processing, rubber, etc.)

All major fuels consumed by the industrial sector (coal, fuel oil, HSD/LDO, Natural Gas, Naphtha, LSHS/HHS, Kerosene/SKO and LPG) were considered for this analysis. Geographical segmentation of demand across North, West, South and East & North-East India was also carried out to map potential demand in various parts of the country.

2. *Estimation of **Total Potential Gas Demand** by the Industrial sector*

   Certain non-energy fuel requirements (including feedstock such as coking coal in the Iron and Steel Industry) are fuel-specific and hence *cannot be technically converted* to gas. The potential for gas demand was estimated only for the remainder of the fuel requirements which *can be technically converted* to gas. Based on economic and Industrial growth rates, growth in potential gas demand was estimated for each Industry segment.

3. *Estimation of **Total Addressable Gas Demand***

   The economic viability for converting to gas was assessed for each Industrial segment depending on the projected price of gas vis-à-vis other fuels. For each industry segment, the *propensity to convert* to gas was estimated as a function of the fuel prices, capital expenditure required for the conversion, the expected payback period and affordability.

4. *Estimation of **Total Realizable Gas Demand***

   The total realizable gas demand was assessed based on the impact of regional supply constraints and infrastructure penetration on the addressable gas demand in the Industry.

Interviews with Industry experts and secondary research were used to validate inputs for gas demand estimation for the Indian Industrial sector. Current gas consumption and future outlook towards conversion to gas for each Industrial segment were also validated through industry interviews.

3.2 Industrial Gas Demand Projections

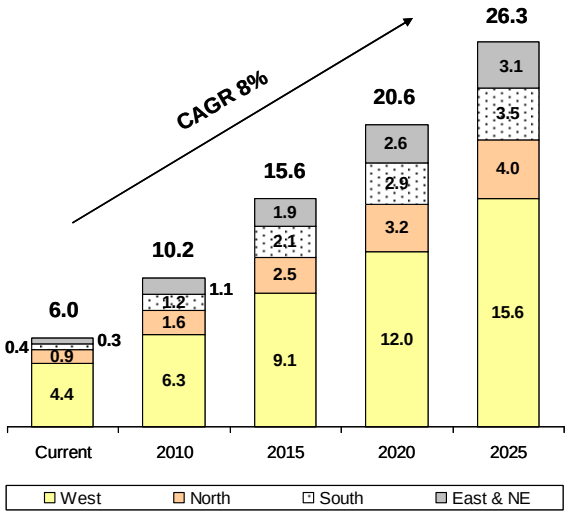
The Industrial sector currently accounts for ~17% (6 bcm) of the total gas consumption in India. Driven by strong GDP and Industrial growth, Industrial demand for gas is projected expected to grow at ~8% p.a. over the next 20

years. Total Industrial gas demand is expected to reach ~16 bcm by 2015 and 26 bcm by 2025.

However, regional disparities in gas consumption are expected to continue. Gas supply sources in India have been concentrated in Western India, thus driving gas consumption in the region. Western India currently accounts for ~73% (4.4 bcm) of the total Industrial gas consumption. Sustained growth in the petrochemical sector in the region is expected to continue driving Industrial gas demand in the West at ~7% p.a to reach 15.6 bcm by 2025. However, with the expected growth in gas consumption from industries in other regions, the share of Western Region is expected to decline about 60% in 2025.

Historically, South India has been a supply constrained region and hence gas consumption has been low. However, recent gas discoveries in the KG Basin are expected to spur Industrial gas consumption in the region in the future. The share of South India in total Industrial gas consumption is expected to increase from the current 7% to 13% in 2025.

Fig. 8: Industrial Gas Demand (bcm)



Source: A.T Kearney Analysis

Recent gas finds in the CBM blocks in the Eastern states and development of cross-country pipeline infrastructure is expected to fuel gas consumption in the East. Gas demand from the Industrial sector in the region is expected to grow at over 12% p.a. and its share in the country's Industrial gas consumption is expected to increase from the current 6% to 12% by 2025.

3.2.1 Industry-wise gas demand

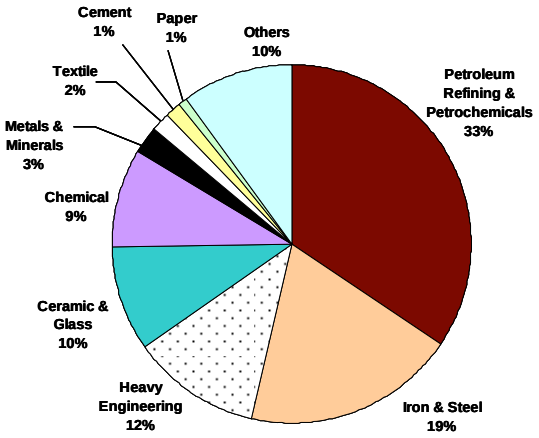
Within the key Industrial segments, the Petrochemicals and Petroleum Refining Industry is the largest gas consumer, accounting for almost one-third of the current Industrial gas consumption. The Iron and Steel industry is the second largest Industrial user of Natural Gas, with increasing use of gas in the reduction process in this industry.

However, the industry outlook towards Natural Gas as a fuel is improving due to its high efficiency coupled with its properties of a clean fuel. Regional concentration of certain industry segments coupled with regional disparities in gas availability are expected to persist, and hence only marginal changes in the Industrial mix of gas consumers is expected in the future.

The petrochemical sector is expected to remain the largest gas consuming Industrial segment, accounting for over ~40% of the total Industrial gas consumption in 2025. The share of Iron and Steel Industry in total Industrial gas consumption is expected to decline from the current 19% to ~10% in 2025. This is primarily on account of the dominance of coal in this industry due to its proximity to the eastern coal reserves. However, market leaders believe that by increasing the use of Natural Gas in the steel industry in India, the entire outlook of this industry could be transformed in the years ahead since the utilization of Natural Gas could encourage a shift in the mix of technology from large capacity Blast Furnace - Basic Oxygen Furnace (BF-BOF) based units to relatively smaller Electric Arc Furnace (EAF) based plants that are superior in terms of environmental sustainability.

Fig. 9: Industry-wise Gas Demand (2006)

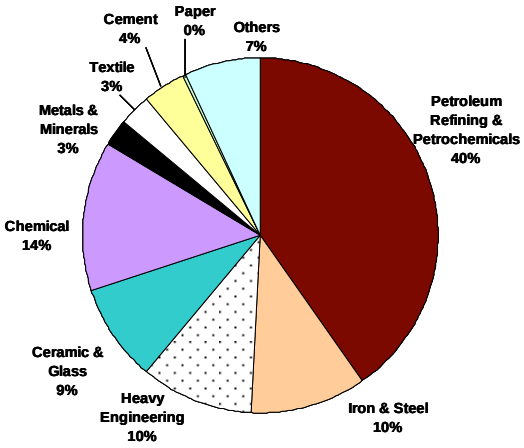
Total Demand = 6.0 bcm



Source: Ministry of Petroleum and Natural Gas

Fig. 10: Industry-wise Gas Demand (2025)

Total Demand = 26.3 bcm



Source: A.T Kearney Analysis

The share of the Chemical Industry in gas demand is expected to increase from the current 9% to ~14% in 2025, primarily driven by conversion of liquid fuel based applications.

Many other Industrial sectors e.g. Heavy Engineering, Ceramic and Glass, etc. are expected to contribute to the increased consumption of gas in the Industrial sector. As outlined earlier in the document, many of these sectors are witnessing significant growth in their output currently and expect these trends to continue over the next few years.

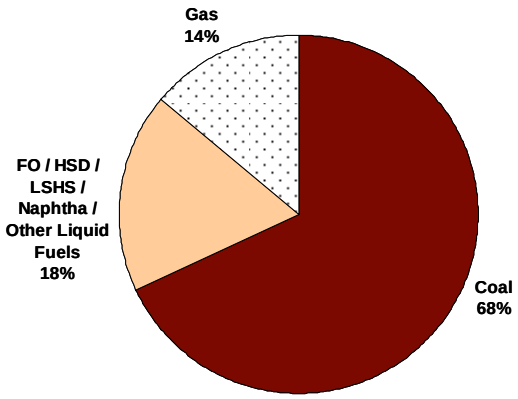
3.2.2 Industrial Fuel Mix

Historically, coal has been the predominant source of energy in the Indian Industrial sector, primarily due to its abundance and cost-effectiveness. Currently, coal based energy and non-energy applications account for ~68% of the total Industrial fuel consumption. It is expected that coal would continue to be a fuel of choice, especially in the Eastern part of the country due to its cost-effectiveness.

Although the share of gas in the Industrial fuel portfolio has been increasing rapidly in the recent past, it currently accounts for only 14% of the total Industrial fuel consumption. As discussed earlier, under the allocation processes followed, preferential allotment of APM (Administered Price Mechanism) gas to the Power and Fertilizer sectors was usually carried out. This resulted in lower gas availability for the Industrial consumers. However, with increasing amounts (and percentage of total gas supplies) available outside of APM regime, a shift towards market determined gas prices is expected. This is likely to increase the future gas availability for the Industrial sector. Potentially higher price realizations from the gas sector are expected to make this sector attractive to many gas suppliers. .

Fig. 11: Industrial Fuel Mix (2006)

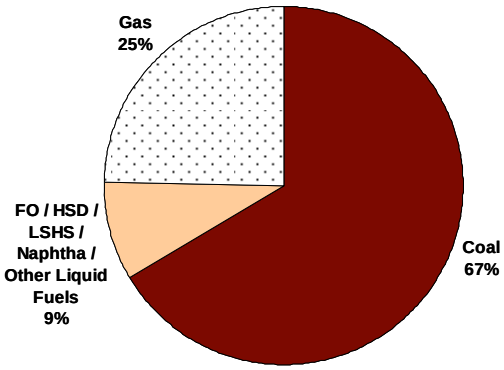
Total fuel consumption = 44 bcm (gas eq.)



Source: Ministry of Petroleum and Natural Gas, Ministry of Coal

Fig. 12: Industrial Fuel Mix (2025)

Total fuel consumption = 106 bcm (gas eq.)



Source: A.T. Kearney Analysis

About 18% of Industrial fuel consumption is accounted for by liquid fuels such as fuel oil, HSD (High Speed Diesel), LDO (Light Diesel Oil), LSHS (Low Sulfur Heavy Stock), Naphtha and Kerosene. However, the economic viability of using these fuels has come under pressure due to sharp increases in crude prices in the recent past. With relatively high crude prices expected to prevail in the future, industrial applications based on these liquid fuels are expected to migrate to gas. However, since the economics of this conversion are governed by the returns on the investment required and the availability of gas, the propensity to convert will vary with regions, industrial segments and scale of operations.

Growth in gas availability coupled with conversion of liquid fuel based applications is expected to drive Industrial demand for gas over the next 20 years. The share of gas in the Industrial fuel portfolio is expected to increase to 25% by 2025, with conversion of liquid fuel applications causing their share to decline to 9% during the same period.

3.2.3 Realization of Potential Gas Demand

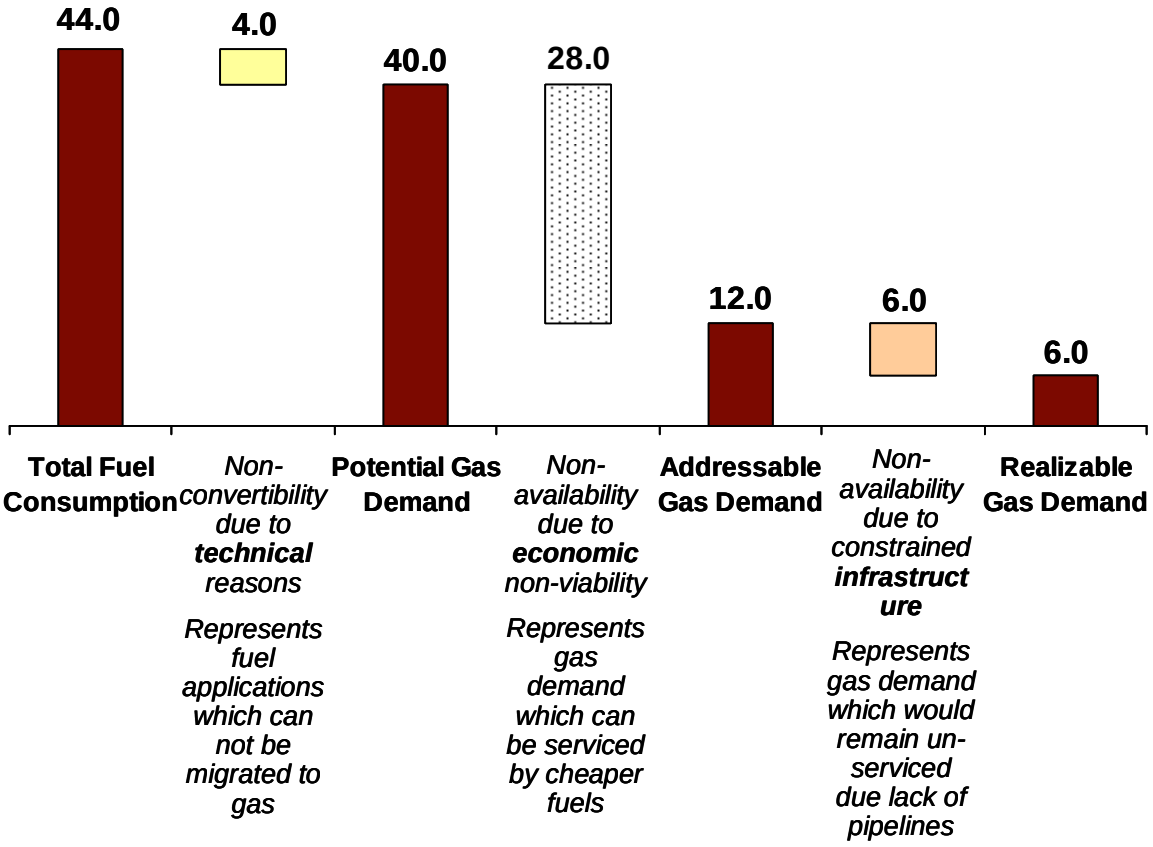
The total Industrial fuel consumption is currently 44 bcm of gas equivalents. However certain non-energy fuel applications, such as coking coal in the Iron and

Steel Industry cannot be migrated to gas, reducing the potential for gas demand to 40 bcm.

At current fuel prices, coal is the most economically viable industrial fuel. This is reflected through the addressable gas demand which is 70% lower than the total potential for Industrial gas demand.

Fig. 13: Realization of industrial gas demand (2006)

(bcm)



Source: A.T. Kearney Analysis

Despite being economically viable, only 50% of this demand is realized due to infrastructure constraints. Thus, the current gas consumption in the Indian Industrial sector is to the tune of 6 bcm.

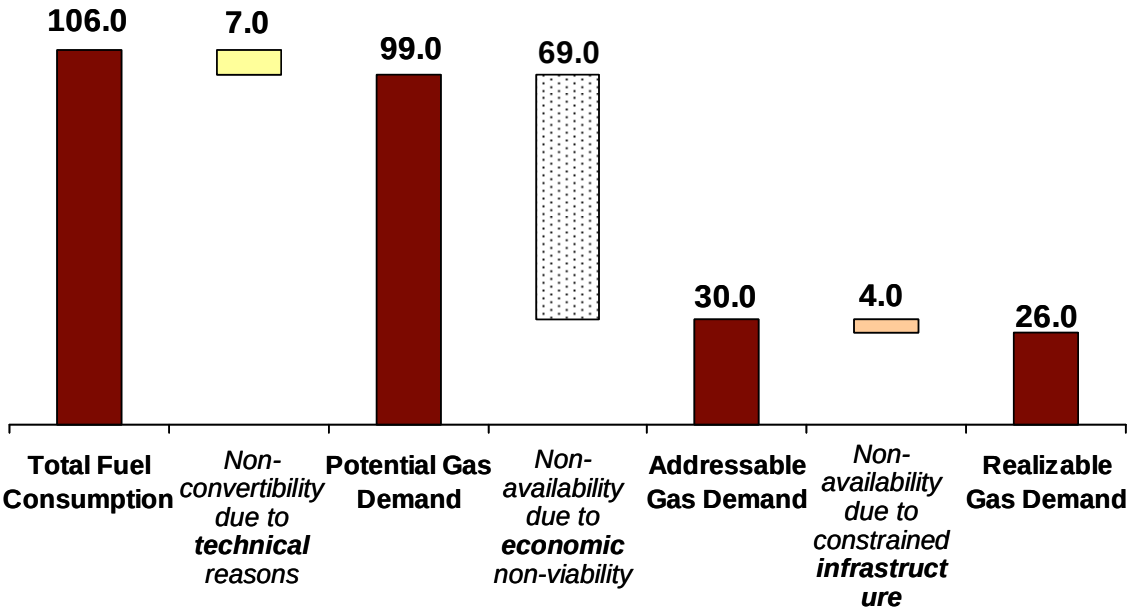
India's GDP is poised to continue growing at a steady pace in the future. In our assumptions, we have assumed a CAGR of 7% p.a. upto 2012 and more mature growth rates of 6% and 5% in successive plan periods. This is expected to propel strong Industrial growth and a corresponding spurt in Industrial fuel consumption. India's Industrial fuel consumption is expected to increase at ~4.7% p.a. to reach

106 bcm of gas equivalents by 2025. Correspondingly, addressable gas demand is expected to grow to ~100 bcm during the same period.

At potential gas prices of $4.55/mmbtu - $5.15/mmbtu, conversion from solid fuels such as coal would be economically unviable. However, economic advantages of converting liquid fuel based applications will continue to gas drive Industrial gas demand to ~30 bcm by 2025.

Fig. 14: Realization of industrial gas demand (2025)

(bcm)



Source: A.T. Kearney Analysis

Moreover, rapid development of gas transmission and distribution network is expected to bridge the gap between addressable and realizable gas demand in the next 20 years. As a result, nearly 87% (26 bcm) of the addressable gas demand in the Industrial sector is expected to be realized by 2025.

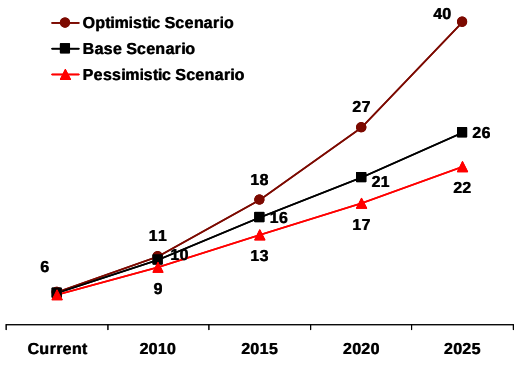
3.3 Sensitivity Analysis

This section discusses the variation in gas demand under different economic and Industrial growth scenarios. Price elasticity of demand has also been discussed in order to assess the impact of gas price volatility on future demand.

3.3.1 Impact of Industrial Growth on Gas Demand

In recent years, India has witnessed a boom in the Industrial and Services sectors, driving strong GDP growth. The future outlook for GDP and Industrial growth rates remains positive, with India's GDP poised to continue growing at a steady pace. However, government estimates are optimistic and higher than our base case assumptions, pegging GDP growth at ~8% p.a. till 2025. Under such a scenario, Industrial gas demand in 2025 could be around 40 bcm – around 50% higher than the base case estimates.

Fig. 15: Impact of GDP growth on industrial gas demand (bcm)



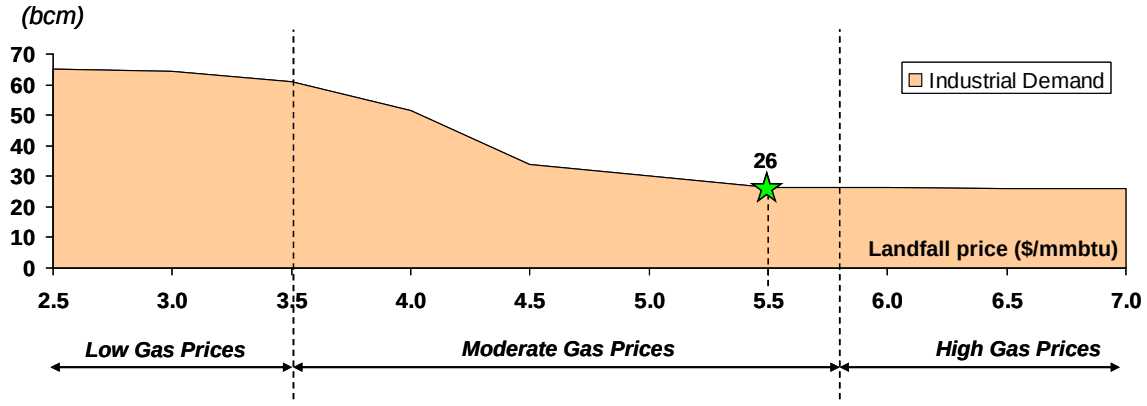
Source: A.T. Kearney Analysis

Under a pessimistic GDP growth scenario (5% p.a. till 2025), demand growth for Natural Gas in the Industry is lower with the expected demand being around 22 bcm by 2025 – 16% lower than the base case estimates.

3.3.2 Price Elasticity of Industrial Gas Demand

Historically, gas pricing has been regulated by the government under the Administered Pricing Mechanism. However, with recent private gas discoveries in the NELP (New Exploration Licensing Policy) blocks, gas prices are expected to be determined by market demand-supply forces. Market dynamics coupled with unclear government policies on gas pricing have created an atmosphere of uncertainty in the market. Thus, it is critical to assess the impact of price on gas demand.

Fig. 16: Price elasticity of industrial gas demand (2025)



Source: A.T. Kearney Analysis

At low gas prices (< $3.5/mmbtu), gas becomes more attractive than all other industrial fuels (including coal). Thus, gas demand remains high (> 60 bcm) at these prices since it is economically viable to convert even coal based applications to gas.

Industrial gas demand is fairly elastic at low to moderate prices (upto $5.5/mmbtu). At these gas prices, gas becomes uncompetitive for conversion of coal based capacities. However, gas prices remain attractive for conversion of liquid fuel based applications. Moreover, gas provides an attractive option for incremental capacities. However, as prices increase, the viability of conversion to gas reduces. Thus, gas demand drops to ~26 bcm at a landfall gas price of $5.5/mmbtu.

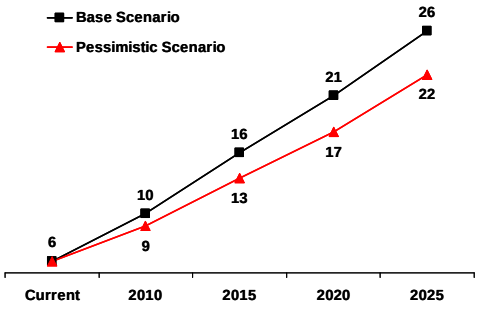
However, at gas prices beyond $6/mmbtu, Industrial demand for gas remains inelastic. This demand is driven by existing gas based capacities and conversion of existing liquid fuel based applications due to superior economics. However, the prospects of attracting new capacities on gas reduce at such high gas prices.

3.4 Supply Sensitivity

Under an unconstrained supply scenario *(base case)*, industrial gas demand is expected to grow at ~8% p.a. to over 26 bcm by 2025. However, supply deficit coupled with infrastructure constraints may reduce availability of Natural Gas for the Industrial sector.

Since the Industrial sector offers higher price realization than the Power and Fertilizer sectors, lower supplies from proposed domestic gas fields are unlikely to affect gas availability for the Industrial sector. However, slower growth in pipeline infrastructure and lower infrastructure penetration may constrain Industrial gas supply. Moreover, this constraint may get magnified for the Southern and Eastern regions which may become unattractive due to lower potential gas demand in these markets.

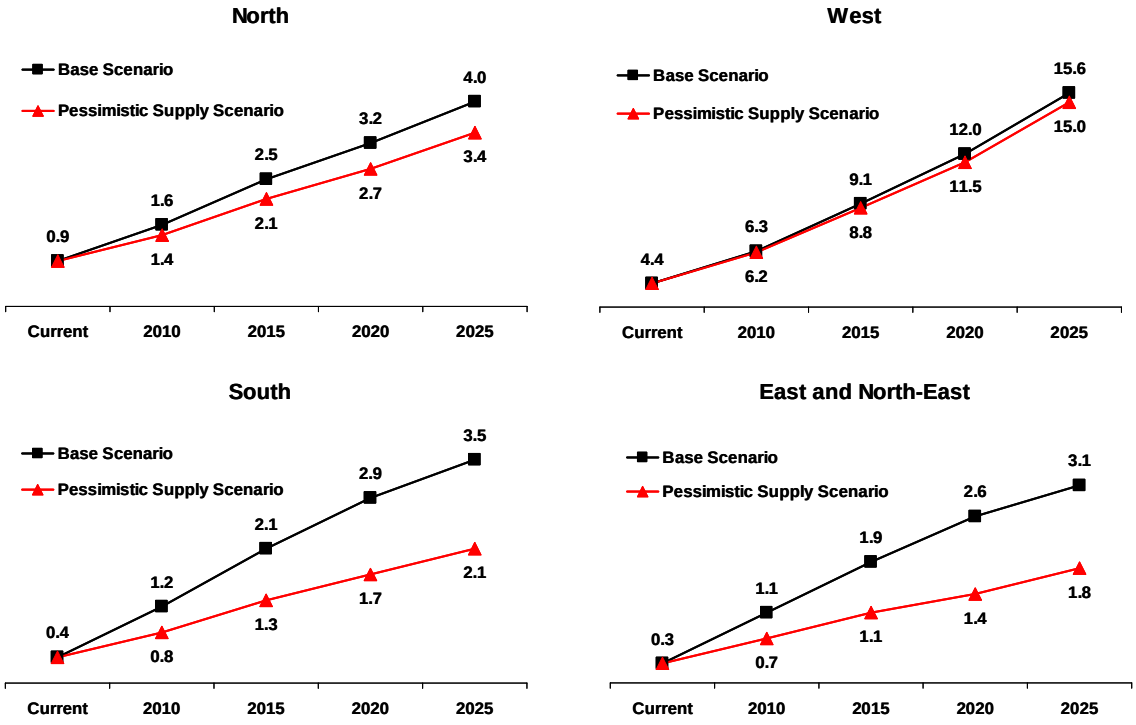
Fig. 17: Impact of supply constraint on industrial gas demand (bcm)



Source: A.T. Kearney Analysis

Under such a scenario, growth in gas demand from Industrial sector might be lower than in the base case scenarios. However, the negative impact on demand in the South and East could be more severe, with demand realization declining by over 40% as compared to the base case in 2025. The Western region already has a high infrastructure penetration and the highest gas demand and thus, the impact of such supply constrains is expected to be minimal in this region.

Fig. 18: Regional impact of supply constraint on industrial gas demand (bcm)

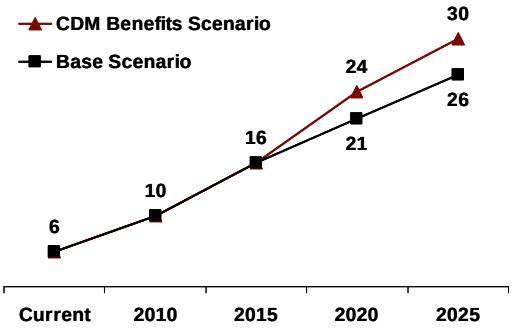


Source: A.T. Kearney Analysis

3.5 Potential Impact of Carbon Trading

Under the CDM (Clean Development Mechanism) regime, the Industrial sector may derive economic benefits of gas usage. This is expected to increase the gas demand. However, under the assumed price scenario, the true impact of this benefit is expected to be significant only beyond 2015 when the benefit from carbon trading is able to offset the price advantage of alternate fuels (coal, liquid fuels etc.) over Natural Gas.

Fig. 19: Impact of Carbon Trading on Industrial gas demand (bcm)



Source: A.T Kearney Analysis

As a result, beyond 2015, industry may be able to absorb a higher gas price due to additional carbon benefits. With a 5-10% cost benefit due to carbon credits, gas demand in 2025 may be higher by 14-15% as compared to the base case.

4. Conclusion

India is, therefore, poised to witness a strong growth in Industrial gas consumption over the next two decades. Gas demand is expected to be highly sensitive to GDP growth and with firm indications of sustained economic and Industrial growth, the projected demand growth is already shaping into a reality.

In addition, the imperatives of the fast evolving Industrial scenario, where cost competitiveness is the key to success, are also expected to drive the increasing importance of gas within the Industrial fuel mix. With production economics stacked against liquid fuels due to high global crude prices, the Industry is expected to witness increasing conversions to gas based applications.

Moreover, with new gas discoveries in the KG and Mahanadi Basins and growth in pipeline infrastructure, supply is expected to match pace with demand growth. Over the medium-long term, infrastructure does not appear to be an obstacle to growth of the sector.

With a shift towards free market dynamics, market forces are expected to drive gas pricing and flow. Thus, potentially higher realization from Industrial consumers is expected to favor gas supply to industries. While gas demand remains highly elastic at low gas prices due to competitiveness with coal, at medium-high prices the demand becomes relatively inelastic (upto ~$8/mmbtu).

Further, environmental regulations and judicial intervention could accelerate both demand and supply growth of Natural Gas in Industries. Carbon trading under the new CDM regime could potentially drive discretionary conversion to Natural Gas in industries.

Overall, both demand and supply factors indicate a strong growth potential for Natural Gas as an Industrial fuel. Realization of this potential could ensure that Natural Gas accounts for 25% of energy requirements of the Industrial sector by 2025.