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ENERGY SECURITY & SUSTAINABILITY: ROLE OF NATURAL GAS IN INDIAN CONTEXT

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ABSTRACT: The paper has been developed to analyse the role of natural gas in energy security, sustainability & economic growth of country. Usually, only three aspects of energy considered for energy security i.e. availability, accessibility and affordability. In this paper authors have developed a framework of energy security based on literature review and classroom discussion in PhD coursework and added acceptability and sustainability to above mentioned aspects of energy security. In the proposed framework sustainability occupies the central position and acceptability has been added as a desirable dimension to energy security. The authors apply the proposed framework to assess the role of natural gas in sustainability and energy security of India. Natural gas is billed as the transition fuel between oil and renewable being the cleanest fossil fuel. Currently, natural gas contributes only 6% in the primary energy mix of India vis-a-vis 24% globally. India has an ambitious target to move towards gas based economy by increasing share of natural gas up to 15% by 2030 in the primary energy mix to meet Paris commitment. Further, authors analysed role of government in infrastructure development, policy reforms & recommend actionable measures to improve availability, accessibility, affordability and acceptability of natural gas to achieve energy security & sustainability goal.

KEYWORDS

Energy Security, Sustainability, Gas Based Economy, Transition Fuel, Energy Policy

Introduction

India is second largest country by population with 1.21 billion people (Census, 2011) and 3rd largest economy in the world. India has 18% of world population but it uses only around 6% of world energy consumption (IEA, 2017). Indian economy is growing rapidly with average growth rate of approximately 7% in last two decades. Energy is the key input for economic growth and Indian Energy sector play a vital role in country's Economy. Energy is a key input to the production processes that transform inputs to goods and services (Subhes, Bhattacharyya, 2007) contributing to Gross Domestic Product (GDP). Increase in GDP along with change in structure of the Indian economy resulted in a significant growth in energy consumption in last three decades and will grow in future also (Kaushik, Paul, 2015).

India's energy consumption has surpassed Russia in 2016 and India became the third largest energy consumer in the world after United States and China (BP, 2016). Key drivers for increasing energy demand in India are population growth, industrialization and urbanization.

Energy security and sustainability are interdependent because emissions from energy consumption contributes to climate change in greater extend globally.

Energy Mix play vital role in energy security and India's energy mix(Figure-1) shows dominance of fossil fuels Coal & Oil (82%) with only 6% Natural Gas. Natural gas is the cleanest fossil fuel which emits negligible particulate matters and lowest air pollutants as compare to Coal & Oil. Globally, Natural gas contributes around 24% in World energy mix as shown in Table-1 and Gujarat state in India have 25% natural gas share in energy mix. Hence, Indian government is also committed to increase the share of natural gas in country's energy mix up to 15% by 2030 and Ministry of Petroleum and Natural Gas intervening with policy reforms in natural gas sector.



FIGURE 1. India's Energy Mix (Source: BP Statistics, June 2018)

India's fast economic growth needs more energy consumption that will lead to the increase in emissions causing climate change & concern for public health. Hence to address not only energy demand but also climate change, we need to adapt green and clean energy sources in our energy mix. This will help India to achieve sustainable development & help to fulfil the commitment to Paris Climate Agreement (COP21) ratified on October 2, 2016 (UN, 2016).

Globally, natural gas is considered as transition fuel due to its availability, affordability, environment friendliness and ability to support renewable in pick demand time. For India, International market dynamics and country's energy policies are supporting Natural Gas to become fuel of choice in present scenario and address the energy security & climate change in the future.

Energy Security

Authors have defined the Energy Security by using four-A as "In order to meet energy demand, energy should be **Available** in required quantity, it should be **Accessible** in most economical way, it should be **Affordable** to consumers and last but not the least it should be **Acceptable** by the consumers for **Sustainable** future".

Energy Security is the at most important in line with international security of any country. As India is more depends on energy import (especially petroleum) from international market, hence there is geopolitics involved in international energy relations causing threat to national security. Also, to achieve sustainable economic growth we need to ensure energy security. Hence, authors believe Energy security is vital for National Security & Economics Security. To achieve energy security, India has to address the geopolitical issues and domestic policy reforms.

Literature Review & Energy Security Framework

Authors have developed following Energy Security framework on the basis of the discussions and deliberations on "Global Energy Scenario Course" in the classroom of PhD at Rajiv Gandhi Institute of Petroleum Technology, India. Authors have reviewed and discussed the papers focused on energy security, energy policy, energy sustainability, energy poverty and came up with this concept paper to analyse the role of Natural Gas in Energy Security & Sustainability.

Our observations from various literatures are described briefly in this para. There is always a risk in supply of energy and we need to look after sources of insecurity developing over a time along with development of energy system (Andre, Bengt, Lars J., 2014). Long term dependence on energy import make economy vulnerable leading to socio-economic unrest in country and availability of energy at affordable price with desired quality is the key to ensure energy security (Kar.S.K., Sinha. P.K., 2014). To ensure the availability& continuous supply we have to diversify energy sources in our energy mix, Energy policies within energy mix should supplement each other to ensure energy security to the Nation and energy system should be integrated with social & environmental objective for future generation (Benjamin K. Sovacool, Harry Saunders., 2014) which leads to the Sustainability of energy. Energy efficiency plays a vital role in energy security; authors believe that a unit energy saved is more than one unit energy because it reduces consumption by one unit and quantity of energy needed for one unit production. The co-benefits of energy efficiency are reduction in CO2 emissions, local air pollutants SO2 and NOx emissions (Sujeetha, Bundit,2013).

After detailed discussion on Energy Security and Sustainability, authors have concluded that the Sustainability should be taken into consideration while addressing the Four-As of Energy Security (i.e. A-Availability, A-Accessibility, A-Affordability, A-Acceptability). Sustainability should be at the centre of Energy Security Framework; hence, as a result authors have developed following Energy Security Framework (Figure-2).



FIGURE 2. Proposed Energy Security Framework

Role of Natural Gas in Energy Security & Sustainability

To analyse the role of natural gas in India's Energy Security and Sustainability, authors applied the energy security framework (Figure-2). Authors kept sustainability at the centre of a framework and performance of natural gas on key parameters like availability, accessibility, affordability, and acceptability has been carefully evaluated. A brief overview of analysis is presented below:

Availability

Availability of any energy source is at most important in energy security and Natural Gas is not an exceptional. Hence, authors have analysed the worldwide availability of Natural Gas and how it will be available to India. Also, authors examined domestic availability of Natural Gas in Indian context. Though, India unable to meet demand of natural gas from domestic supply, authors found that natural gas is abundantly available globally and it's available to import in India from global market with respect to market dynamics and economics. Currently, India consumes around 50.38% of imported Liquefied Natural Gas (LNG) due to shortage in domestic production. Authors have analysed the same in following section.

Natural Gas Reserves & Supply

Globally, it has observed that, there has been significant increase in natural gas reserve from 119.9 TCM in 1995 to 186.9 TCM (BP, 2017). Also, Global Natural Gas production has been increased significantly from 2876.7 BCM in 2006 to 3551.6 BCM in 2016 (BP, 2017). Also, it has observed that India has 1227.23 BCM of conventional Natural Gas reserves as on 2016 (MoSI, 2017) and around 61% are in offshore basin.

The production of domestic natural gas in India has been stagnant except peak production in 2010 to 2012 due to Reliance's KG production. Gross natural gas production has been decreased from 52200 MMSCM during 2010-11 to 32000 MMSCM during 2018-19 (PPAC, 2019) due to drastic decrease in production level of Reliance's KG basin. The trend has been shown in Figure-3.



FIGURE 3. Trend of Domestic Natural Gas Production in India

(Source: Prepared from PPAC data)

Source/Year	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Dom Supply	127.89	114.36	95.41	80.51	74.39	70.3	69.42	72.03
LNG Imports	35.81	42.81	40.12	49.24	51.49	59.19	68.57	73.14
Total Supply	163.71	157.17	135.53	129.76	125.88	129.49	137.99	145.17
% LNG	21.88	27.24	29.6	37.95	40.9	45.71	49.69	50.38

TABLE 1. Trend of Natural Gas Supply/Consumption in India (MMSCMD)

(Source: Analysed by the authors based on PPAC data)

Total supply and consumption is being supported by imported LNG. Authors have tabulated the historical scenario of consumption and supply of natural gas in the country in Table-1.

Above trend shows that, LNG has increased its share in total Natural Gas supply/consumption in India and considering current scenario of international market it is going to increase its share in total gas supply in future as well. Due to limited domestic supply, LNG is playing vital role to meet India's demand and it would be playing more important role in future too.

3 to 5 decades of Natural Gas

From above mentioned reserve and production statistics, authors conclude that current Natural Gas reserves shall supply Natural Gas at least for 30 years in India (Domestic reserve) and 52 years (Global Reserve) at current rate of production and consumption.

In the future, increase in demand of natural gas will be compensated by more reserve discovery in world as seen in past trend.

Availability of natural gas in the domestic market in the short run could be a concern. But availability of natural gas in the international market could be helpful to address domestic shortage. In the context accessibility of natural gas in the short run and long run needs to be carefully evaluated.

Accessibility

Infrastructure is the key for accessing the natural gas from domestic and international market. To develop a natural gas market there should be well developed infrastructure throughout the natural gas value chain then only consumption of natural gas can be increased. (PwC, 2016).

Globally, countries with well-developed gas markets

are characterised by the creation of infrastructure such as LNG terminals and gas transmission pipelines first. Infrastructure creation will de-risk gas importers, gas marketers and LNG terminal investors. Over time, the network will provide a push to setting up gas-based industries and promote the development of industrial zones, corridors and clusters.

It has been learnt that, Gujarat state has 25% of natural gas share in their energy mix vis-a-vis 6% in India (PNGRB, 2018). This is due to well established infrastructure by state owned entities and Government's pro-activeness in policy implementation. Authors, understands from Gujarat's state gas grid development scenario that, availability of infrastructure leads to generation of more natural gas demand.

Hence, as Infrastructure is the key for accessing Natural Gas in India, authors have analysed the different perspective of Natural Gas Infrastructure as follow,

Locations of Gas Reserves and Consumptions centres:

Globally, gas reserve and the natural gas consumers are geographically separated. In India, as per the Energy Statistics 2016 by MoSPI, it has been observed that 66.44% (988.89 BCM) of domestic Natural Gas reserve are in offshore and only 33.56% (499.6 BCM) are on onshore. Hence to transport the Natural Gas from offshore to consumption centre requires huge infrastructure development ranging from processing platform, offshore pipeline, cross-country pipeline and distribution pipeline.

Gas Pipeline Infrastructure:

Indian Government has set target of completing 30,000 Km of National Gas Grid (PIB, 2015) to enable continuous supply of natural gas across the country. Currently, India has only 16,250 Km of pipeline and need to develop another approximately14,000 Km to complete the National Gas Grid. The existing, under construction and proposed Natural Gas pipeline are shown in following figure. Also, to enhance Natural Gas supply in country, Government is optimistic to have TAPI and IPI as on land transnational natural gas pipeline. Beside these two pipelines, South Asia Gas Enterprise Pvt. Ltd. (SAGE) is undertaking a path-breaking project, to build the Deepest Underwater Transnational Gas Pipeline. Also known as "Middle East to India Deepwater Pipeline (MEIDP)", this will be a Gas Highway that will connect the Gas Rich Gulf & Middle East regions to India, for the transportation of Natural Gas to secure India's Energy Needs (SAGE).

LNG Infrastructure:

India need huge LNG infrastructure to complement the domestic production and fulfill the rapidly increasing Natural Gas demand in country.

LNG infrastructure scenario in India for Existing and proposed LNG terminals is summarized in Table-2 as follows.

Sr.	Location of Terminal	Owner	Capacity (MMTPA)
1	Dahej, Gujarat	Petronet LNG Ltd.	10
2	Hazira, Gujarat	Hazira LNG Pvt Ltd.	5
3	Kochi, Kerala	Petronet LNG Ltd.	5
4	Dabhol, Maharashtra	GAIL	5
	25		

TABLE 2. Existing Operational LNG Terminal Capacity Source: Ministry of Petroleum and Natural Gas

Around 75% capacity of LNG import terminal is along the West Coast of India with two key terminals in Gujarat State. Existing terminal of Petronet LNG at Dahej and Hazira LNG Ltd at Hazira are under expansion process. GSPC's LNG terminal at Mundara with capacity of 5 MMTPA and Indian Oil's Ennore LNG terminal with capacity of 5 MMTPA have been commissioned in FY 2018-19 and are ready for operation. Besides the existing re-gasification LNG terminals, about 35.5-36.5 MMTPA are being planned and under construction on the eastern and western coasts of India by different entities.

Also, development of planned projects would depend on their techno-commercial feasibility considering natural gas demand supply scenario in the country.

Distribution Infrastructure and CGD Market:

City Gas Distribution (CGD) is emerging as a key driver to

move towards gas based economy in India. Till 9th CGD BID Round, CGD coverage in India is tabulated in Table-3.

As on December 2018, CGD infrastructure in the country supply gas to 4,928163PNG (Domestic) household, 27364 PNG Commercial, 8354PNG Industrial, 1500 CNG Stations & more than 3million CNG Vehicles (PNGRB, 2019).

Total gas consumptions in CGD is 26.04 consist of 15.5 MMSCMD of Domestic Gas (PNG&CNG) & 10.54 MMSCMD of imported RLNG (PPAC, Feb 2019). Under revised, allocation policy of Government of India, Domestic gas has been allocated for Domestic PNG & CNG consumption under no cut category. Government is proactive in supplying PNG & CNG to the citizen across country & has taken strong steps through CGD bidding.

No. of	No. of	% of	% Area	No of
States/UT	GA	Population		Players
18	91	19%	11%	25

TABLE 3. CGD players, demography & geography covered as on 01.04.2018

Source: PNGRB

During FY 2018-19 PNGRB, has taken aggressive step in 9th & 10th Round of CGD bidding offering 86 & 50 Geographical Areas (GA) respectively.

Summary of 9t h& 10th CGD Bid round is tabulated in Table-4, and integrated coverage of CGD in India is tabulated in Table-5.

Bid Round	No. of GA	% of Population	% Area
9	86	26.38	23.82
10	50	24.23	17.92

TABLE 4. 9th & 10th CGD Bidding Round Summary Source: PNGRB

No. of GA	% of Population	% Area
228	70.47	52.73

TABLE 5. Integrated Picture of CGD sector in India after 10th Round

Source: PNGRB

Gujarat is leading the CGD development in India due to availability of State Gas Grid, LNG Terminals and other associated natural gas infrastructure. Now entire state (all districts) has been authorized for CGD development.

Affordability

Natural Gas supplied from domestic sources is affordable to Households &Transport (CNG) and LNG is affordable to industrial and commercial customers in India. Authors have analysed the affordability of Natural Gas as follows:

Natural gas prices in Asia & India

As per the International Energy Outlook-2016 by EIA it has been observed that, in Asian markets, unlike those in the United States, natural gas prices typically reflect contracts that are indexed to prices for crude oil or petroleum products. The declines in crude oil prices between August 2014 and January 2015 and low oil prices since then had a significant effect on Asian natural gas prices and markets. In Asia, major quantity of natural gas is imported as LNG, with LNG prices traditionally indexed to crude oil on a long-term, contractual basis. The average spot price of Asian LNG for the month of May 2016 has been declined to 4.24 \$/MMBTU which was lowest average monthly price since July 2009. This is due to the change in Natural Gas Demand & Supply in international market specially USA & Australian LNG projects. Hence, spot LNG price for India also reduced to 5.4 \$/MMBtu in 2016 and then increased to around 9 \$/ MMBtu in 2018. Currently scenario in international LNG market shows the spot LNG prices reduced below 6 \$/ MMBtu for mid-2019 delivery. Historical trend in Spot LNG Prices (DES) at West India is shown in Figure-4 & alternate fuels prices shown in Figure-5.



FIGURE 4. Trend in Indian Spot LNG Prices (DES) at West India

Source: Platts LNG Daily



FIGURE 5. Base prices of Fuels in May 2018

*Annual average of 2018 DES West India LNG price is considered

Source: BPCL, Platts & Authors Analysis

As represented in above Figure-4 & Figure-5, it is clear that LNG is competitive over all liquid fuels used in industries. This economic benefit encourages industrial units to use natural gas as fuel instead of other polluting liquid fossil fuels. Hence, natural gas is affordable to all industries using liquid fuels.

Gas Price trend for Domestic Gas

Domestic gas is being priced as per Domestic new Natural Gas Pricing Guidelines, 2014, by Ministry of Petroleum and Natural Gas.

Yearly average for April 2017 to March 2018 was 2.68 (\$/MMBtu) & 3.21 for April 2018 to March 2019 is 3.21 (\$/MMBtu). Below Figure-6 shows the decreasing trend of domestic gas price up to mid-2017 since 2014 & then increased to 3.69 \$/MMBtu. As per new policy initiatives in last couple of years by Government of India, 100% allocation of domestic gas is done for domestic PNG and CNG segments for faster roll out of PNG connections and CNG stations in given City/Geographical Areas. This makes natural gas more affordable vis-a-vis domestic LPG & liquid fuels (petrol & diesel) in transport.

From decreasing trend of Natural Gas price of Domestic and imported LNG in India, it could be conclude that, Natural Gas is becoming more affordable vis-a-vis other expensive liquid fuels like LPG, Naphtha, LSHS, FO, LDO and Petrol in respective segment of customers (Household PNG, Transport (CNG), Commercial and Industrial).

Acceptability

In current state of Indian economy, natural gas is acceptable across all customer segments such as industrial, transport, commercial, domestic/households due to various benefits it offers like cleanest fossil fuel, convenience of use, less technological up gradation needed in industrial use and its affordability vis-a-vis other liquid fuels.

Sustainability

Sustainability of natural gas an energy source can be defined as, "It can fulfil the energy need of present generation at present scenario with less effect on environment & society". Authorsbelieve that, Natural Gas is sustainable and cleaner alternative to coal and liquid fossil fuels because it emits substantially negligible particulate matters, mercury, NOx, SOx visa-vis liquid fossil fuels and releases up to 50% less CO2 than coal & 20-30% less than oil (IGU, 2009). It results into both immediate and long-term benefits for public health, the environment and society at large. Methane leakage throughout gas supply chain has considered hazardous but it can be manage.Also, use of natural gas in Transportation offers a significant contribution to improve local air quality and address the public health issue.

Further, authors have analysed the role of natural gas as a sustainable energy source for India in different consumer segments



FIGURE 6. Trend in Domestic Gas Price in India

Source: Prepared from PPAC notification

Indian power sector with total installed capacity of 330260 MW (CEA, 2017) has dominance of coal based plants (59% of total capacity) which is causing damage to the environment and society at large. Hydro and other renewables are most favoured energy sources as per environmental benefits are concerned. But these sources have their own constraints like weather conditions, geographic disadvantages, unable to meet pick demands and cost of productions. Hence to address the pick demand load and reduced environmental hazard, natural gas play vital role and act as transition fuel supporting renewables.

Gas based power plants can be set up with less cost, quicker and produces 50% less CO2 & 90% less air pollutants as compared to coal based power plants (Shell, 2015). India has total gas based installed capacity of 25185.38 MW (7.6% of total capacity) and due to supply shortage of domestic natural gas & un-viable LNG price some plants are idle and others are running on low Plant Load Factor (PLF).

Considering the benefit of gas fired power plant, Indian government is focusing on supporting gas based power plants in country and came up with Power Sector Development Fund (PSDF) to revive the sector. PSDF has help power players to source LNG through open bidding on pooled price. Even after PSDF support gas based power sector could not perform well and were operating at an average PLF of 24.46% in November 2017 producing 4452 MW electricity (CEA, 2017).

Annual average PLF(April 2018-March 2019) is 21.51%, the monthly capacity utilization trend of natural gas based power generation capacity is as showed in Figure-7.

Utilization of available power capacity is vital to secure the uninterrupted electricity supply in peak load demand. Hence, to revive & enhance the utilization of stagnant power plants, India needs to work on gas sourcing strategy and build the LNG import capacity to meet the demand with competitive LNG price to reduce the cost of electricity production.

Recently, Japan's Tokyo Gas has set precedent with an unusual move for pricing long term LNG for gas based power by signing a deal with Royal Dutch Shell for the long-term supply of LNG using a coal-linked pricing formula (Bloomberg, 2019). India being predominantly coal based power generation economy, may try for this type of deal which would definitely help to improve capacity utilization in power sector.

This would ensure clean and affordable electricity generation to meet peak load demand and address the energy security in sustainable way.



FIGURE 7. Trend of Monthly Gas Based Power Generation Capacity Utilization

Source: CEA, 2019

Industrial Fuel

LNG is used as replacement fuel for liquid fuels in industries and from current market scenario and authors observed that LNG is competitive against all liquid fuels used in India. Currently, in India around 8354 small & medium industrial units are using natural gas through CGD (PNGRB, 2019). These industries are contributing to reduce the emissions and address the climate change issue with business sustainability.

Transportation

CNG in Car, Buses & Light commercial vehicles:

Use of Compressed Natural Gas (CNG) is economical and the cleanest alternate fuel for transportation. Currently 3045268 vehicles are running on CNG in India. The geographical presence of CNG vehicles across country are as shown in Figure-8 as below.



No. of CNG Vehicles in India

FIGURE 8. No. of CNG vehicles in India Source: PPAC, CGD Report, April 2018

Gujarat is leading state having around 29% of CNG vehicles in India because of well developed local natural gas infrastructure across the state & Government policy in vehicle conversion.

LNG in Heavy Transport:

LNG should be use as preferred fuel in Heavy Vehicles and Railways because LNG is an environmentally friendly fuel with less number of Nox, Sox and particulate matters, as compared to any other automotive fuel. CO2 emission from LNG is also lesser than diesel. Ministry of Petroleum and Natural Gas has taken bold steps in this regard and launched pilot project of running Bus on LNG in Kerala on 8th November 2016 with the support of Tata Motors, Indian Oil, Petronet LNG & Kerala State Government.

Petronet LNG limited is setting up 20 LNG stations at existing petrol pumps along the highways en-route of west coast. This LNG highway would connect National Capital Delhi with Thiruvananthapuram covering a total distance of 4,500 km via Mumbai and Bengaluru (Times of India, 2017).

Government should bring policy for infrastructure development to enable use of LNG in Transport and Railways. The introduction of LNG in the transport sector will definitely help India to meet its commitment towards COP21 by reducing emissions from heavy vehicles which are currently being run on diesel.

CNG in Two Wheeler:

On 1st January, 2017 in presence of Hon'ble Minister for State, Ministry of Petroleum & Natural Gas, Mahanagar Gas Limited Mumbai in association with M/s Eco Fuel has launched CNG fuelled two-wheelers at Mumbai (NEWS18, 2017). Also in one more step towards curbing pollution caused by vehicles, the regional transport office and the Automotive Research Association of India (ARAI), Pune has approved compressed natural gas kits for scooters in the Pune City. The CNG kit has a maximum capacity to hold two Kg of CNG fuel and expected mileage of around 60 km per Kg.

This new horizon of green fuel in transportation is long way to go but it will definitely help India to curb the pollution level caused by vehicles in cities once commercialized.

Households:

Piped Natural Gas (PNG) is most reliable, safe and affordable source of energy for cooking by households in India. Currently around 4928163 households have PNG connections across the country (PNGRB,2019). The geographical distribution of PNG connections are as shown in Figure-9. Gujarat is leading state with 43% of PNG connections in India because of proactive state government policy in building local natural gas infrastructure across the state through state PSU.



Domestic PNG Connections in India



Summing-up the role of natural gas in all consumer segments

After detailed analysis it has been observed that, natural gas is not only affordable but also plays a vital role in providing clean energy to all consumer segments across country. Natural gas is convenient for cooking, economical and environmental friendly for industrial segment, reduces urban pollution through use of CNG/ LNG as a fuel in vehicles. Hence, authors believe, natural gas being clean fossil fuel is definitely going to play sustainable role in Electricity, Household, Transport & Industries and act as transit fuel. It has been proven from historical trend in natural gas industry around the globe that, infrastructure is key backbone for development of natural gas market and it is capital intensive affairs. So we believe that, government should take a proactive steps in supporting infrastructure development in India.

Role of Government in Natural Gas Infrastructure Development

As infrastructure development being highly capital intensive subject to market dynamics, many players are unable to perform as per their commitment across entire natural gas value chain, hence there is need of hours where government should support these infrastructure development through various schemes, Some of the initiatives we have noted and recommended as follow,

Capital Grants:

Capital grant should be provided to the critical infrastructures like cross country pipeline to complete National Gas Grid. (recently, the Cabinet Committee on Economic Affairs, chaired by Hon'ble Prime Minister Shri Narendra Modi has approved viability gap funding / partial capital grant (PIB, 2016) at 40 percent (Rs. 5,176 crore) of the estimated capital cost of Rs. 12,940 crore to GAIL for development of 2539 km long Jagdishpur-Haidia and Bokaro-Dhamra-Gas-Pipeline).Such Capital Grant support should be provided to other Pipeline projects which are facing viability problem due to current market scenario.

This will definitely help government to fulfill its goal of completing 30,000 Km National Gas Grid in India and increased natural Gas Share up to 15% in Energy Mix of country.

Sovereign Guarantee Funding from Multilateral Agencies

The Multilateral Organizations like World Bank, ADB, Asian Infrastructure Investment Bank, JICA which provides Sovereign Guarantee Funding to develop energy infrastructure in all developing countries at discounted rates as compare to commercial banks. As India is the member in most of these Multilateral Agencies and has good sovereign rating so Government of India should provide Sovereign Guarantee for getting funds from Multilateral Agencies at discounted rates which may lead to natural gas infrastructure projects become viable and sustainable.

Industrialization Policy initiatives

Government of India may take an initiative to set up new Urea Fertilizers Plants along the planned cross-country pipeline which will reduce Urea import dependency reducing subsidy and also help the natural gas pipeline to be viable due to increase in capacity utilization.

Also, current Natural Gas price in international market favours the Indian power sector and expected to be stable or decrease in future. Hence Government may continue its scheme of PSDF to run the idle gas based power plant and also may plan more gas base power capacity in country to ensure the 24*7 electricity to its citizens.

CGD in Smart Cities

Government of India has accorded highest priority & placed under No-cut category for domestic gas allocation to PNG(Domestic) and CNG(Transport) segments of CGD networks. This policy reforms opens the opportunity for Smart Cities to get Natural Gas as a clean fuel to make the smart cities cleaner. Hence, Ministry of Petroleum and Natural Gas has taken the initiatives to rollout CGD bidding for proposed Smart Cities(MoPNG, 2017). Under stage-1 of Smart City Mission98 cities has been announced, 38 Cities amongst these 98 had existing CGD network and most of the other cities has been covered under 9th& 10thround of CGD bidding by PNGRB.

All smart cities should be covered under CGD network which would reduce vehicular emissions in urban areas and will help Government of India to fulfill the commitment towards Climate Change Agreement (COP21).

Conclusions

Natural Gas is Available globally in sufficient quantity to cater at least for 3-5 decades, Accessible via infrastructure, Affordable vis-a-vis other liquid fuels and Acceptable by Society. Hence, for meeting rapidly increasing energy demand in immediate future, it is not feasible to switch over to renewable sources like Solar, Wind which has its own challenges but at least for coming two-three decades there is a need of hours to adapt natural gas as a Transit Fuel for reducing carbon emission and contribute to Sustainable Development Goals while addressing energy security of the country.

Considering the current scenario of infrastructure development in natural gas value chain and policy initiatives & regulatory intervention being taken in India, authors believe that uses of natural gas will definitely increase in coming decades. This would definitely help in increasing the share of natural gas upto 15% in India's energy mix by 2030. It is observed that in the next two to three decades, natural gas would play a vital role in energy mix of India subject to development of natural gas infrastructure across the country. Current, international scenario of natural gas supply & pricing supports development of natural gas market in India.

For time being researcher are interested to see that how Indian Government would play its role in framing and implementing energy policies for making India a gas based economy by 2022 with 15% share of natural gas in energy mix. To achieve this target, lessons from Gujarat state needs to be learn in development of natural gas infrastructure and proactive involvement of the Government to boost the natural gas sector. Also, natural gas infrastructure developments should be supported through capital grants and sovereign guarantee funding from multilateral agencies to the entities.

In Indian context natural gas poised to be a game changer; further it would play an important role in driving towards gas based economy in the near future. Gas based economy is going to address energy security in the country and help India to fulfill its INDC commitment towards Paris Climate Agreement by reducing emissions.

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