# Clean and Green Alternate Energy: India moving towards Secure and Sustainable future

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## Abstract

Basic energy access for a significant part of the population across India is currently a biggest challenge. 18% of world population are residing in India, but per capita energy consumption in India is only 0.62 Tonnes of Oil Equivalent (TOE) which is 1/3rd of world average. Indian economy has emerged as the bright spot in global landscape growing at fastest pace of 6-7% annually. Energy is integral to sustain this accelerated pace of growth of the economy and social progress. India has become the 3rd largest consumer of energy in the world and its energy appetite is growing alongside its population and growing economy. Currently, India's energy profile largely centres around two major sources, namely coal and crude oil which contribute almost 86% of the India's total energy requirement. At a brisk 5% annual growth in energy consumption, India's import dependence remains high to the extend 84% for crude oil. The heavy import dependence on crude and its attendant strain on Indian economic resources and environment make it obligatory to look for a cleaner and greener sustainable energy with a vision to improve self-sufficiency and carbon footprint reduction. Natural gas and Bio-fuel have the potential to significantly contribute towards attaining these goals. Currently, natural gas contributes only 6% in the primary energy mix of India vis-a-vis 24.5% 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 COP 21 Paris commitment. Natural Gas will hold a promising role as a cleaner bridging fuel between oil and renewable. Bio-fuel is an alternative fuel similar to conventional fuel. It can be produced from sugarcane, vegetable oil, animal fats, agriculture waste, Municipality Solid Waste and also from Used Cooking Oil. Bio-fuel can be described as "carbon neutral", which means that the fuel produces no net output of carbon in the form of carbon dioxide (CO2), as the oil seed crop absorbs the same amount of CO2 as is released when the fuel is combusted in a vehicle. The emergence of bio-fuel as an alternate energy source offers opportunities for significant carbon footprint reduction and greater energy independence. Due to these multi-dimensional benefits, India is giving renewed thrust in enhancing the use of bio-fuels and promoting it as a greener and sustainable source of energy with a target of 20% blending of ethanol in petrol & 5% blending of biodiesel in diesel by 2030.

The paper has been developed to analyse the role of environment friendly natural gas and bio-fuel in energy security and sustainability of India. Usually, only three aspects of energy considered for energy security i.e. availability, accessibility and affordability. In this paper author has developed a framework of energy security based on availability, acceptability, affordability and sustainability. In the proposed framework sustainability, availability and affordability occupy the central position and acceptability has been added as a desirable dimension to energy security. The author applies the proposed framework to assess the role of natural gas and Bio-fuel in sustainability and energy security of India.

Further, author has also analysed the measures taken in infrastructure development and policy reforms and also recommend actionable way forward to improve the availability, accessibility, affordability and acceptability of natural gas and bio-fuel for achieving the energy security with sustainability.

## Introduction

India, home to 18% of world's population, uses only 6% of the world's primary energy. India's energy consumption is projected to grow at 4.2 percent per annum up to 2035, faster than all major economies of the world. While India's energy demand increased to 898 Million Tonnes of Oil equivalent (Mtoe) in 2017, but the per capita energy consumption in India is only 0.62 tonnes of oil equivalent which is 1/3rd of world average.

This, however, is rapidly changing and the energy landscape in India is evolving like never before. Energy is a key input to the production processes that transform inputs to goods and services contributing to GDP.

India is now sixth largest economy in the world and will target to become a US $5 trillion economy by 2024. India's share of total global primary energy demand is set to roughly double to about 11% by 2040, driven by strong economic development, increasing aspirant middle class populations, industrialization and urbanization. Energy, today, is considered crucial to achieve India's development ambitions, to support an expanding economy, to bring electricity to rural areas, to fuel the demand for greater mobility and to develop the infrastructure needed to meet the demands of what is soon expected to the world's most populous country. Globally, India is the 3rd largest consumer of energy resources, next only to the US and China and the 3rd largest crude oil importer and 4th largest LNG importer in the world.

Going forward, as per BP Energy Outlook 2019, India is expected to overtake China as the largest growth market for energy by mid 2020s accounting for over a quarter of the growth in global energy demand by 2040.

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 (86%) 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 & crude oil. Globally, Natural gas contributes around 24% in World energy mix (Figure-1) and Gujarat state in India have 25% natural gas share in energy mix. Hence, Indian is also committed to increase the share of natural gas in country's energy mix up to 15% by 2030 and intervening with reforms in natural gas sector.

The emergence of bio-fuel as a renewable energy source offers opportunities for significant climate change mitigation, greater energy independence, monetising multiple feedstock like agricultural waste, solid urban waste etc and augmenting farm income.

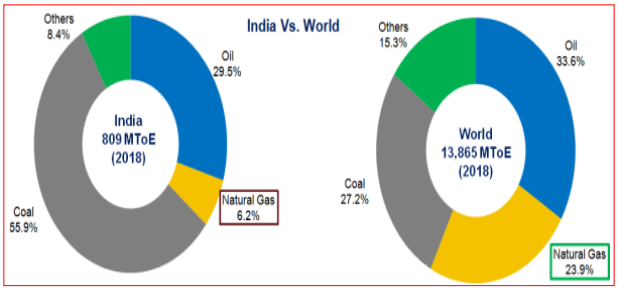



Figure-1: India and world energy mix

In view of these multi-dimensional benefits of bio-fuels, India is giving renewed thrust in enhancing the use of bio-fuels and promoting it as a greener and sustainable source of energy. India is moving towards a sustainable Bio-Economy with a target 20% blending of ethanol in petrol and 5% blending of biodiesel in diesel by 2030.

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, it is required to adapt clean and green energy sources in India's 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. Infrastructure, Technology and innovation can become game changers for India's quest for decarbonising and developing into a gas-based and bio-based economy for a cleaner, greener and sustainable energy 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 and sustainability are the at most important in line with international security of any country. As India is more depends on energy import (especially crude) from international market, hence there is geopolitics involved in international energy relations causing threat to national security. Also, to achieve sustainable economic growth it is required 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.

## Energy Security Framework:

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. 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. 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 & acceptability has been carefully evaluated. A brief overview of analysis is presented below:

### i. 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, natural gas consumption in India is around 150 MMSCMD. This is expected to increase to 215 MMSCMD in next one decade driven by demand from various sectors like Fertilizer, Power, City Gas Distribution and other industries. LNG will account half of this demand 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.

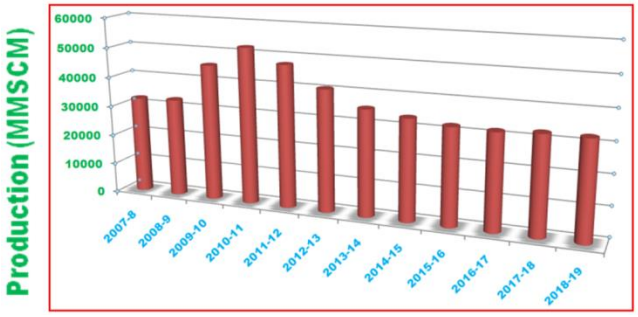



Figure-3: Trend of domestic gas production in India

Total supply and consumption is being supported by imported LNG. Authors have tabulated the historical scenario of domestic supply, import (Liquefied Natural Gas) and total consumption of gas in India (Figure 4).

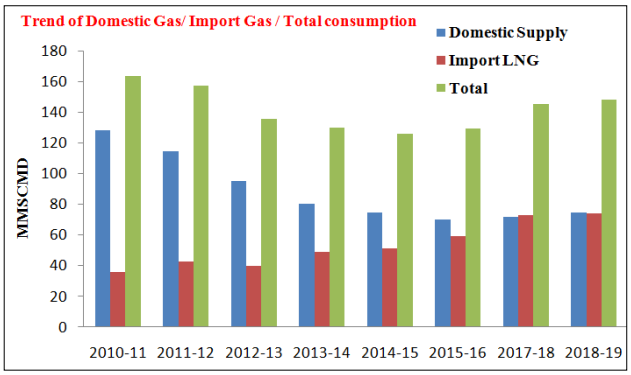



Figure 4: Trend of Domestic gas/ Import gas/ consumption

### Three to Five 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. It is important for gas producers to realize remunerative, market-linked price to encourage domestic gas production. The government brought in a slew of policy

measures to make investment in domestic gas production viable and attractive.

Certain initiatives have been taken including Hydrocarbon Exploration Licensing Policy (HELP), Uniform licensing system for all hydrocarbons such as Oil, Gas, CBM coupled with open acreage policy and revenue sharing mechanism. It has already put in place Marketing and Pricing freedom for new gas production from Deepwater, Ultra Deepwater and HP-HT areas with Ceiling price on the basis of landed price of alternate fuels. It is also granted the Marketing and pricing freedom to all new gas discoveries whose field development plan (FDP) had yet to be approved. This is a positive step in terms of encouraging additional activities in the E&P sector and should help accelerate development of discovered resources. 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.

### Diversification of sourcing:

India has diversified the LNG Sources in last three years. India is importing LNG from Qatar (8 MMTPA), USA (5.8 MMTPA), Russia (2.5 MMTPA) Australia (1.44 MMTPA). This would be helpful for India energy security in long run.

## ii. 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. 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. 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, it has been observed that 66.44% of domestic Natural Gas reserves are in offshore and only 33.56% 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:

Gas transportation through pipelines is the most economical means to transport in the country. India has set target of completing 30,000 Km of National Gas Grid (NGG) to enable continuous supply of natural gas across the country (Figure5).

The rationale was simple: if gas is accessible in a new area, demand would follow. It is with this reasoning that the Government decided to invest, for the first time ever, its own money in the construction of an ambitious new gas pipeline that would put five eastern states on the NGG. Currently, India has only 16,250 Km of pipeline and need to develop another approximately 14,000 Km to complete the National Gas Grid. India has extended 40% Viability Gap Funding (VGF) amounting to INR 5,176 Crores to the Jagdishpur-Haldia and Bokaro-Dhamra Pipeline (JHBDPL), more popularly known as Pradhan Mantri Urja Ganga to connect the eastern and north-eastern parts of India with the national gas grid. Efforts are underway to complete the Gas Grid in a time bound manner. The existing, under construction and proposed Natural Gas pipeline are shown in following figure 5.

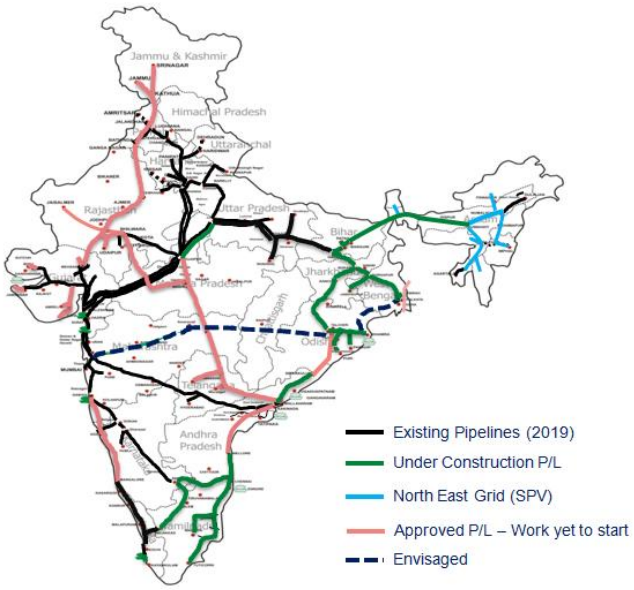



Figure 5: Existing, under construction & proposed gas pipeline

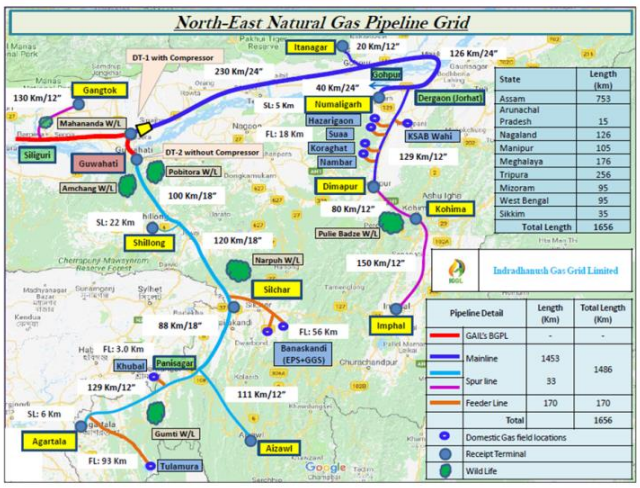



Figure 6: North East Gas Grid Pipeline (IGGL)

Earlier in August 2018, India has set up Indradhanush Gas Grid Limited (IGGL), a new Joint Venture of five state-run firms, to construct a 1,500 kms gas pipeline (Figure 6) which will connect all eight states in India's far-flung north-eastern region with the NGG.

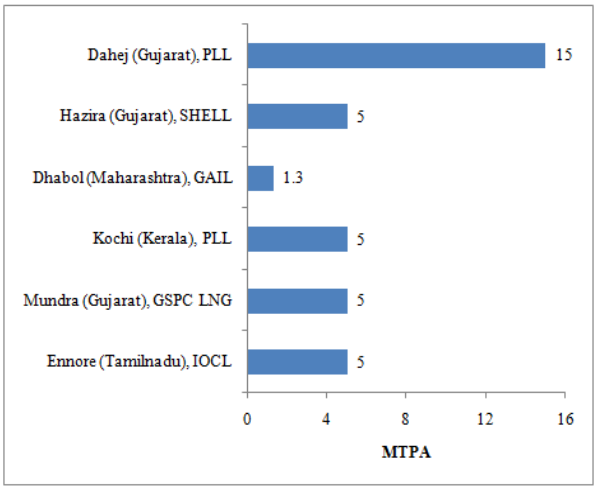
North East Gas Grid Pipeline of 1600+ Km grid will connect all eight North-Eastern States. It will connect several isolated E&P fields of North East. It will enable the industrialisation/ City Gas Distribution in North East India. It has also potential to connect Myanmar gas fields with grid and Bangladesh gas markets.

Also, to enhance Natural Gas supply in country, India is optimistic to have TAPI (Turkmenistan-Afghanistan-Pakistan-India) and IPI (Iran- Pakistan-India) as onland 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, known as "Middle East to India Deepwater Pipeline.

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.

## LNG Infrastructure:

India need huge LNG infrastructure to complement the domestic production and fulfil the rapidly increasing Natural Gas demand in country. Current LNG import and Re-gasification Capacity (Figure-7) is around 36 MTPA (~48 BCM). 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.



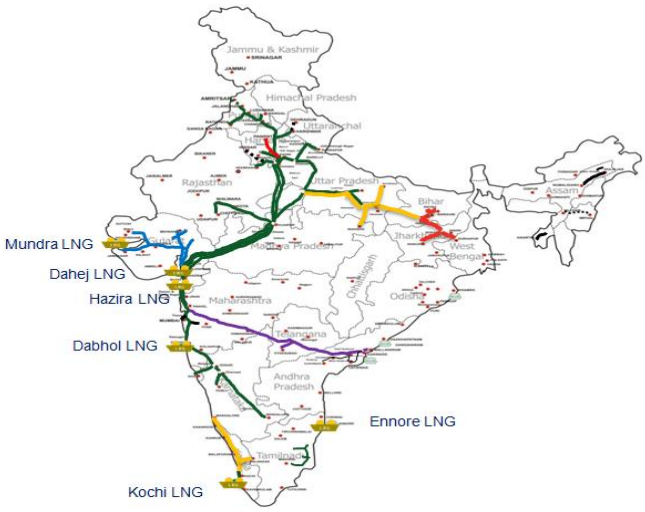




Figure-7: Current LNG import & Re-gasification Capacity

Besides the existing re-gasification LNG terminals, about 26 MTPA are being planned and under construction on the eastern and western coasts of India by different entities (Table 1 & Figure-8).

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

| Terminal | Capacity (MTPA) |
|---|---|
| Jafrabad | 5 |
| Chhara | 5 |
| Dabhol Expansion | 3.5 |
| Jaigarh | 4 |
| Kakinada | 3.5 |
| Dhamra | 5 |
| **Total** | **26** |

Table 1: Upcoming LNG import & Re-gasification Terminal

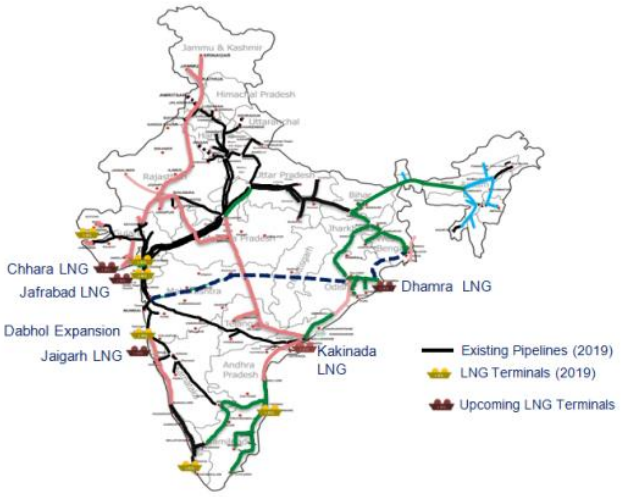



Figure-8: Upcoming LNG import & Re-gasification Terminal

### Distribution Infrastructure and CGD Market:

India is promoting the usage of environment-friendly transportation fuel, i.e. CNG by expanding the coverage of City Gas Distribution (CGD) network in the country. It has been successfully completed the 10th CGD bidding round. Consequently, natural gas would be made available to more than 70% of the country's population, spread across 27 states and Union Territories. Over 4 Crore PNG connections are envisaged to be provided and 8000 CNG stations will be put up. LNG is being promoted as a transport fuel for long-haul trucking along expressways, industrial corridors and inside mining areas. Very soon, India will have LNG refuelling along some of our national highways. These CGD networks and national gas grid will certainly increase the share of natural gas in India's energy mix and also significantly will reduce the carbon footprint.

## iii. 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 at West India is shown in Figure-9 & alternate fuels prices shown in Figure-10.

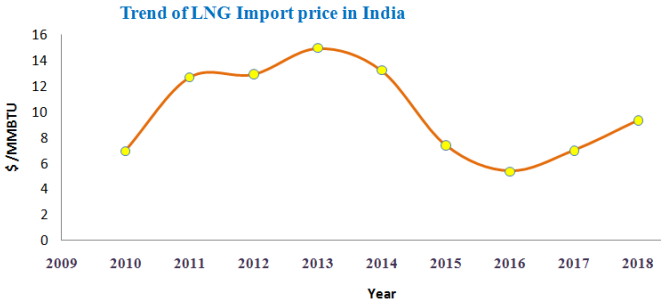



Figure-9: Trend in Indian Spot LNG Prices at West India

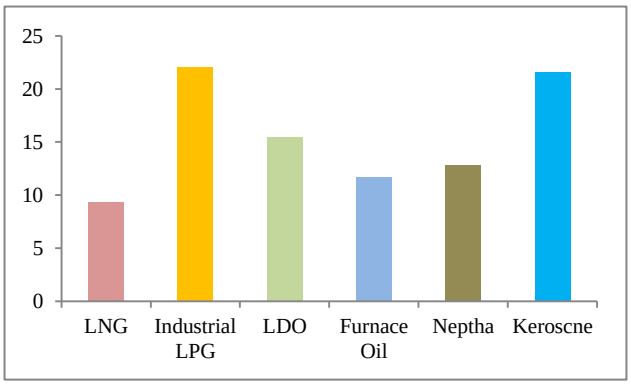



Figure-10: Average Base prices of Fuels in 2018

As represented in above Figure-9 & Figure-10, 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-11 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).

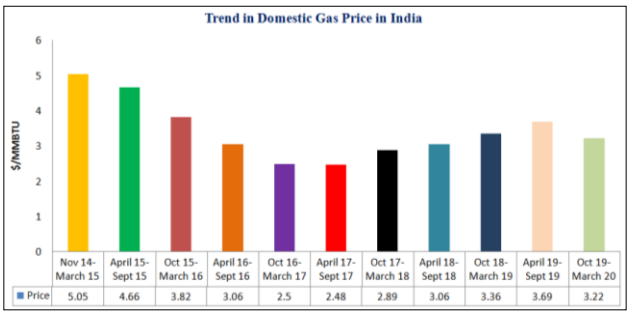



Figure-11: Trend of domestic gas price

### iv. 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".

Authors believe 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 almost 50% less CO2 than oil. Table-2.

| Parameter | BS-IV | BS-VI | CNG/LNG | Difference (BS VI & CNG) |
|---|---|---|---|---|
| CO | 0.50 | 0.50 | 0.22 | 56% Down |
| PM | 0.025 | 0.005 | 0.0029 | 42 % Down |

Table 2 : Level of CO 2 emission by Oil & Gas

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

### Green Source for alternate energy:

Promoting bio-fuels and its enhanced use is an important pillar and a key priority of India to achieve the objectives of energy security and promoting environment friendly clean fuel choices. Alternative fuels that have superior environment benefits and economically competitive with fossil fuel. This envisages a strategic role of biofuels in the Indian Energy basket.

India has been promoting ethanol blending in Petrol and Biodiesel blending in diesel to shift towards a sustainable biofuels based economy which is primarily being sourced from sources such as sugarcane based molasses, palm stearin oil, non-edible oil seeds etc.

Since the sources for conventional biofuels (1G) are limited, wastes such as biomass, Municipal Solid Waste (MSW), Industrial waste, sewage water etc. are being explored as a potential source (2G) for biofuel generation.

National biofuel Policy 2018 has set an indicative target to achieve 20% blending of ethanol in petrol and 5% blending of biodiesel in diesel by 2030 besides to develop of new feedstock for biofuels and new technologies for conversion to biofuels.

India have witnessed perceptible progress in creation of bio-fuel adopting several path breaking steps. Authors have analysed the same as follows:

### i. Ethanol Blended Petrol (EBP):

It is launched in 2003 and Prime Raw Materials are Heavy /Partial Sugar cane Juice, 100% Sugar Cane Juice, Damage Food Grains. Table 3 is showing the quantity of ethanol has been procured in the current sugar year achieving average percentage of blending.

| Ethanol Supply Year (Dec- Nov) | Ethanol Qty (Crore litre) Procured | % Blending |
|---|---|---|
| 2014-15 | 67.4 | 2.37 |
| 2015-16 | 111.4 | 3.54 |
| 2016-17 | 66.5 | 2.01 |
| 2017-18 | 150.5 | 4.24 |
| 2018-19(till July 19) | 150.1 | 6.03 |

Table 3 : Quantity of Ethanol blending

### ii. Second Generation (2G) Ethanol:

Subsequent to opening of alternate route i.e. Second Generation (2G) route for Ethanol production, India is in process of setting up twelve 2G Ethanol Bio-Refineries in 11 States with an overall capacity of 1100 Kilo Litre per Day (KLPD) with an overall investment of Rs. 14,000 crore.

### iii. Biodiesel Program:

It is launched in January, 2015 and direct sale of Bio-diesel (B100) to all consumers was allowed. The Blending has been started since 2015

| Biodiesel Procured for Blending | | | |
|---|---|---|---|
| **Year (April-March)** | **Qty (Cr Litre)** | **% blending Achieved** | **Remarks** |
| 2015-16 | 1.19 | 0.012 | Started in Aug 15 |
| 2016-17 | 3.59 | 0.046 | |
| 2017-18 | 4.36 | 0.050 | |
| 2018-19 | 8.21 | 0.133 | |
| 2019-20 | 4.41 | 0.145 | Till July 19 |

Table 4 : Quantity of Biodiesel procured for blending

### iv. Used Cooking (UCO) Oil Based Biodiesel:

In India, 2,700 crore litres of cooking oil is used, out which 140 crore UCO can be collected from bulk consumer such as hotels, restaurants and canteens for conversion, which will give around 110 crore litres of biodiesel every year. What is considered today as unhealthy Used Cooking Oil entering our food chain and causing various health problems across the country shall be converted to useful fuel for the Nation creating a revolution of "Randhan se Indhan"

### v. Compressed Bio Gas (CBG) & Bio CNG:

SATAT – Sustainable Alternative Towards Affordable Transportation an initiative to set up Compressed Bio Gas (CBG) production plants and make it available in the market for use in automotive fuels. CBG is produced from raw materials such as agricultural waste, animal dung, municipal waste, sewage, green waste or food waste or press mud. As per available estimates, there is total potential of 62 MTPA CBG and 370 MTPA bio manure in the country from various feed stock. An important aspect of the scheme is that the entrepreneurs are free to choose any technology as per their preference and can use any feed stock for producing CBG. With this initiative, India has targeted to set up 5000 CBG plants across the Country by March 2023 for producing 15 MTPA CBG and 50 MTPA bi-manure which shall reduce import of chemical fertilizers and natural gas.

## Sustainability:

Net GHG Emissions (kg CO2 equivalent/liter) from some typical Biofuels based on Unites States Environment Protecon Agency's (EPA) lifecycle analysis for the Renewable Fuel Standard (RFS) is given as figure 12:

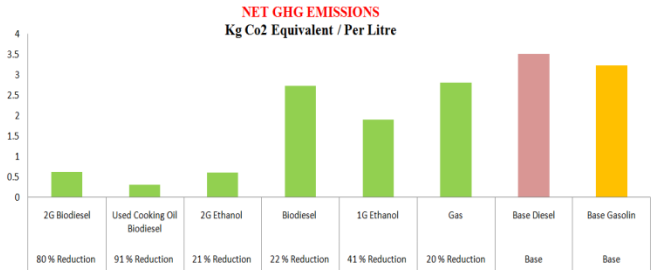



Figure-12: Emission rate

The values in brackets indicate percent reduction in GHG Emissions when compared with Fossil Fuels.

## Recommended actionable measures for way forward:

### i. Natural Gas:

- More electricity from Gas based Power plants.
- Short terms incentivized policy from Govt for Gas Based Power Plant.
- Instead only recommendation, Govt can enforce the transport sectors (at least in metro cities ) to switch into Gas based mode
- Long distance haul can be incentivized like EV
- **Gas Trade Hub:** Local gas price discovery , not the global gas price
- Natural Gas should be under GST
- Infrastructure sharing
- Uniform tariff of transportation across the country
- Not to be considered just as transition fuel, has to pay attention more like renewable energy

### ii. Biofuel:

- Creation of supply chain of biomass to delivery at steady price viable for the Plants.
- Action plan for deployment of high ethanol blend logistics and infrastructure
- Policies/incentives to support aggregation at scale of sugarcane
- Policies/incentives to support collection and aggregation of agricultural residues and MSW

- Liberalisation of ethanol and sugarcane pricing (profit sharing)
- Enforcement of policies to stop Unused Cooking Oil (UCO) entering the food chain; making it only available for production of Bio-diesel
- Compressed Bio Gas (CBG) Plants to included under 'White Category' Under 'White' category, it will not require environmental clearance
- Inclusion of Biofuel Projects in Priority sector lending
- More focus on technology for optimizing the cost
- Can be focused on 3G Bio-diesel (Algae)
- Robust framework to enable access to competitive finance

## Conclusion:

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.

India needs to curtail emission of greenhouse gases (GHG) while meeting the growth targets. In this context, it is worthwhile to note that burning of agricultural waste, along with intensive use of fossil fuels, plays major role in GHG emissions. Therefore, to mitigate the aforementioned challenges, it is utmost essential to develop alternate fuel/energy options. Biofuel in India is of strategic importance for ensuring India's energy security and sustainbility. In this context, India is promoting biofuels viz. bio-Ethanol. The National Biofuel Policy 2018 also envisages a target of 20% blending of Ethanol (~635 Crores Liters) in petrol by 2030. If all efforts are made to substitute petrol and diesel fuel, India could replace over 40% of the projected demand for diesel by 2020. The energy generated from biofuels is equivalent to 340 million barrels of oil or over $22 billion.

In Indian context natural gas and biofuel are poised to be a game changer; further it would play an important role in driving towards gas based and bio based economy in the near future.

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***Views expressed in this paper are that of the author(s) only and may not necessarily be of ONGC.***

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