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Director General, FIPI
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Editorial Board

FIPI

Edited, Designed & Published by :
Federation of Indian Petroleum Industry (FIPI)
3rd Floor, PHD House,
4/2, Siri Institutional Area, August Kranti Marg, New Delhi-110016,
Tel. No.: 91-11-40886000, Fax No.: 91-11-40886019
E-mail : dg.sectt@fipi.org.in, tksengupta@fipi.org.in
Website : www.fipi.org.in

From the Desk of the

Director General

Greetings from the Federation of Indian Petroleum Industry (FIPI)!

Dear Members,

At the very outset of this message, I would like to take this opportunity to congratulate and welcome Shri Hardeep Singh Puri ji on his new role as Minister, Petroleum & Natural Gas. I would also like to welcome Shri Rameshwar Teli ji as the Minister of State, Petroleum and Natural Gas. At FIPI, we look forward to working closely with Shri Puri ji and Shri Teli ji towards the growth and development of the oil and gas sector in India.

As I pen this piece, the number of COVID-19 cases in the country have come down significantly and life is fast returning to normal. Experts believe that the Government of India's proactive vaccination drive has helped the country avoid the much dreaded third wave of COVID infection. By the quarter ending September 2021, over 65 percent of the Indian population had already received at least one dose of the COVID-19 vaccine.

The confidence induced by the successful roll out and subsequent fast pacing of the vaccination programme by the Government reflected in the nation's economic performance over the past two quarters. According to the latest data provided by the Ministry of Statistics and Programme Implementation, despite the onslaught of the second wave of COVID-19 infection, India's GDP is displaying a remarkable growth after registering negative growth for the first two quarters of 2020-21. This growth was driven chiefly by the construction and manufacturing industries. As the country approaches the festive season starting in October-November, the economy is expected to further strengthen by the end of the year 2021.

In the Indian oil and gas sector, DGH has now simplified the process to explore and produce oil and gas in the country by limiting the requirement of statutory approvals to only extension of contracts, sale of stake and annual accounts while allowing self-certification and deemed approval for the rest. DGH has pointed out that these interventions will reduce the number of approval and clearances required from 37 to now 18. On 6 August, 2021, the Government launched the OALP Bid Round-VI for International Competitive Bidding. A total of 21 blocks, with an area of approximately 35,346 sq. km. are on offer to the investors.

In a major break-through, Government has now permitted the sale of natural gas through the gas exchanges as an additional mechanism besides the e-auction route already available to gas producers. The contractor may sell a small quantity of gas up to 500 MMSCM or 10 percent of annual production from contract area, whichever is higher, per year through gas exchanges authorized by the Petroleum and Natural Gas Regulatory Board (PNGRB). Going forward, the gas producers such as ONGC, Oil India Ltd, Reliance, Cairn Oil & Gas will be able to participate on the gas exchange platform and the exchange trade of locally produced gas will help in bringing flexibility and better pricing for consumers.

During the past quarter, FIPI has been extremely proactive in voicing industry concerns with relevant stakeholders across various Ministries, State Governments and Regulators. In August 2021, FIPI has sent representations to Secretary, Ministry of Petroleum and Natural Gas (MoPNG) and Revenue Secretary, Ministry of Finance seeking clarification on the methodology for implementation of amendment in section 8 (3) (b) of CST act on inter-state procurement of crude oil and natural gas by petroleum refineries. FIPI has also advocated with MoPNG for review of customs duty exemption notification no. 50/2017. In September, 2021, we approached Joint Secretary – Marketing, MoPNG to apprise him with the key issues faced by the downstream retail segment and requested for earliest resolution.

FIPI organized a one-day workshop on "WINNERS: Women in India's Energy Sector" on September 28, 2021. The workshop was attended by more than 300 delegates (physically and virtually) and was appreciated in terms of content by one and all. At this occasion, Shri Tarun Kapoor ji, Secretary, MoPNG delivered the inaugural address while Shri S M Vaidya, Chairman, IndianOil and Chairman, FIPI delivered the opening address. There were eminent speakers with diverse experience both from within and outside Oil and Gas industry including Ms. Lakshmi Puri, former Assistant Secretary- General, United Nations and former Deputy Executive Director of UN Women; Ms. Esha Srivastava, Director (IC), MOP&G; Ms. Vartika Shukla, CMD, EIL; Ms. Pomila Jaspal, Director (F), MRPL; Ms. Ulrike von Lonski, Chief Operating Officer, World Petroleum Council; Ms. Harjeet Kaur Joshi, CMD, Shipping Corporation of India; Dr. Vibha Dhawan, Director General, TERI; Mr. Ranjan Kumar Mohapatra, Director (HR), IndianOil and Mr. E.S. Ranganathan, Director (Marketing), GAIL. The panelists' insights about advancement of women's engagement in the energy sector received an overwhelming response and will help in carving out a roadmap for increased participation of women in India's energy sector.

In September, 2021, FIPI awarded the study on 'Scope and Role of Natural Gas in Mitigating Industrial Air Pollution' to The Energy and Resources Institute (TERI). The study will be the first of its kind in the country that will assess the impact of industrial pollution on the local environment and showcase the potential benefits of fuel switching in favour of natural gas on the local environment in select clusters. For this purpose, FIPI in consultation with its members, has identified three industrial clusters namely Gurgaon (Haryana), Varanasi (Uttar Pradesh) and Kukatpally (Telangana). The study will be completed in a period of 12 months from its date of initiation. FIPI firmly believes that the findings of this study will not only present a pressing case for switching to natural gas in industrial clusters but will also serve as the single data point for all advocacy efforts in this direction.

In July, FIPI joined hands with Society of Indian Automobile Manufacturers (SIAM) to organize an exclusive Virtual Roundtable on "Expansion of Natural Gas Vehicle (NGV) Ecosystem in India" on 12 July, 2021. The roundtable was aimed at discussions for expanding the Natural Gas ecosystem, exploring opportunities for collaboration, raising concerns/issues, etc. The roundtable saw active participation from CEOs from gas and auto Industries. The speakers from gas industry included Mr Pramod Narang, Director (Technical) – Petronet LNG Ltd and Mr Raman Chadha, CEO – GAIL Gas. The speakers from Auto Industry were Mr Ashish Chutani, Head Govt & Policy Affairs, Maruti Suzuki India Ltd and Mr S Krishnan, Sr Vice President - Product Development, Ashok Leyland. Natural gas vehicles will play a very important role in achieving the target of 15 per cent gas share in the primary energy basket by 2030. In order to achieve such ambitious target, the gas and the auto industries will have to collaborate, cooperate and coordinate with each other.

On 14 July, 2021, FIPI in association with Scottish Development International (SDI) organized an exclusive webinar on 'Energy Transition- CCS & Hydrogen over a virtual platform. The webinar was aimed at understanding the new and emerging clean energy technologies, especially CCS and Hydrogen. The team of experts from Scottish Development International (SDI) included Mr Peter Godfrey, Senior Regional Advisor, Storegga and Dr Edris Joonaki, Fluid Properties Expert/Technical Lead, National Engineering Laboratory TUV SUD. Commencing the day's proceedings, Mr T K Sengupta, Director – Exploration & Production, FIPI highlighted that the oil and gas companies could use these technologies to generate clean energy by capturing carbon, carbon sequestration and carbon storage.

On 12 August, 2021, FIPI in association with Indian Gas Exchange (IGX) organized an exclusive webinar on 'Gas Markets - Best Practices' over a virtual platform. The webinar aimed to give an overview of the Indian Gas exchange and understand some of the best practices prevailing in the European Gas market. The team of speakers included Mr Paolo Maffeis, Executive Manager, PRISMA European Capacity Platform GmbH; Mr Mritunjay Srivastava, Assistant Vice President, IGX and Mr Deepak Mehta, Head Business Development, IGX. Mr. Satpal Garg, Member PNGRB was invited as a keynote speaker for the webinar. The panel discussion on this occasion heightened the interest of the audience, which was reflected in the flurry of questions posted for the panelists. The webinar attracted overwhelming response from the industry and saw participants from across Ministry, industry, experts and think tanks.

The past quarter has proven extremely eventful for the energy sector in India. Some of the policy initiatives taken by the Government during this period will not only accelerate the ongoing energy transition in the country but will also place India as a vanguard for this global shift. The Hon'ble Prime Minister of India announced the National Hydrogen Mission in his Independence Day address from the ramparts of Red Fort. This will not only help India to make new progress in the field of energy self-reliance but will also become a new inspiration for clean energy transition all over the world. Endorsing the policy push from the Government, Mr Mukesh Ambani, Chairman and Managing Director, Reliance Industries Ltd. (RIL) has envisaged that India is well on track to bring down the cost of green hydrogen to $1 per kg by the end of the decade. In September 2021, the cabinet also approved the Production Linked Incentive (PLI) scheme for 13 target sectors in the country with an overall outlay of INR 1.97 Lakh Crores. Under this scheme, INR 57,000 Crores have been allocated for advanced automotive technologies including EVs and Hydrogen Fuel Cell vehicles. Such overwhelming support from the Government will help maturing of these technologies and place India as a global leader in the evolving clean energy & mobility landscape.

The Way Forward

While the COVID infection has not been completely eradicated yet, the country is now well on its way to achieve the envisioned double digit growth. The economic performance of the country has truly been encouraging and forward looking policies introduced by the Government in the recent past will surely usher this country into a new era of growth and prosperity. The Government's policy initiatives to embrace the new technologies such as electric vehicles and hydrogen will enable the country to lead the world in the ongoing energy transition.

On behalf of the Federation of Indian Petroleum Industry, I want to thank all our Members for their continued support, trust and confidence. I take this opportunity to reassure you that FIPI stands strong by the industry and will be at the forefront advocating for a supportive policy ecosystem for the larger good of the nation.

Wishing a very happy and prosperous festive season ahead.

Dr. R. K. Malhotra

Performance and Energy Savings in a FCC Gasoline Hydrotreatment Unit: Have the Cake and Eat it Too

Juan PEREIRA DE LA RIERA
Technologist

Olivier BOISIER
Technology Team Manager

Boris HESSE
Technologist

Catalysts & Adsorbents Global Business Unit
Axens

1. Abstract

Since the first reference was put in operation back in 2001, Axens FCC gasoline hydrotreatment technology, Prime-G+®, has demonstrated the ability to achieve deep desulfurization of the gasoline with minimum octane penalty. This was made possible by the very unique combination of the smartest schemes with the most specific catalysts, capable of very high HDS rates with minimum olefins saturation.

For years, the very high value of octane barrel made it profitable for most refiners to push their FCC gasoline hydrotreatment units towards maximum octane retention "whatever it took" in terms of energy consumption. But the growing importance of environmental stakes and the introduction of CO_2 emissions in the unit economics is progressively shifting the optimum operating point towards better energy efficiency, which inevitably impacts the product properties.

This article describes how the use of Axens' new generation HDS catalyst HR 856 featuring improved selectivity makes it possible to significantly lower CO_2 emissions level of a FCC gasoline hydrotreatment unit through energy savings and without compromising the unit profitability.

2. Important facts about the FCC gasoline hydrotreatment

FCC gasoline hydrotreatment technology is found in the industry with a large variety of lay-outs. The presence of a gasoline splitter, although not systematic, is very frequent. At high HDS level, this piece of equipment allows indeed for significant octane savings thanks to the production of a light gasoline rich in olefins bypassing the HDS section.

The counterpart is that the production of this light gasoline requires bringing a non-negligible amount of energy to the system, generally under the form of HP steam.

On the catalyst side as on the licensing side, Axens offers a wide range of solutions for FCC gasoline hydrotreatment. In the HDS section, HR 806 and HR 846, with over 400 references, are recognized as the industry benchmark products. Used alone or in combination with HR 841 for even better octane retention, they allow for the desulfurization of the most refractory species encountered in the gasoline boiling range while preserving olefins.

During the last decade, IFPEN and Axens focused their catalyst R&D on performance, being selectivity one of the targeted development lines. As a result, new generation HDS catalyst HR 856 has been released, which allows for the same superior HDS activity and resistance to contaminants as HR 806 / HR 846 but with significantly lower olefins saturation. This new generation catalyst, which is a must for refiners seeking to push further octane savings, turns out being also the perfect candidate when it comes to reducing energy consumption.

3. Unit utilities bill

Unit performance would not be achieved without the introduction of a certain amount of energy. In a scenario where global policies target large CO_2 emissions cuts and require from industry to reduce their emissions and eventually to pay for it (carbon tax or buy emission allowances under cap-and-trade systems), assessing the unit performance in a low energy consumption mode is more relevant than ever.

A case study is conducted for a reference FCC gasoline hydrotreatment unit to get a picture of the energy bill inside the unit. The unit treats 20,000 BPSD of a typical full range FCC gasoline from 1,000 wtppm of sulfur down to 10 wppm. The unit has a selective hydrogenation section (SHU), a splitter and a one stage HDS section with two reactors and a heater in between. The HDS section is fitted with a recycle gas loop. The design is representative of the earliest one stage FCC gasoline hydrotreatment units that were commissioned by Axens, which means it does not benefit from the latest design improvements for energy savings. Loaded catalysts are benchmark SHU and HDS catalysts.

For the different case studies presented in the article, the price of utilities is based on averages from Axens projects database. For CO_2, a price of 65 USD/ton is assumed based on the price range considered by the oil industry in investment decision (from 25 USD/ton to 100 USD/ton).

The CO_2 emission factors expressed in tons of CO_2 per unit of utilities produced is summarized in Table 1.

TABLE 1 : CO2 Emissions factors

UTILITY	VALUE	UNIT	INFORMATION
Electricity	0.432	tCO_2eq/MWh	Average US grid mix 2018 (*Source* https://www.epa.gov/egrid)
HP Steam	0.187	tCO_2/t	On-site production from refinery fuel gas, considering a boiler efficiency of 90%
MP Steam	0.151	tCO_2/t	On site production from back pressure turbine exhaust (fed with HP steam)
LP Steam	0.100	tCO_2/t	On site production from back pressure turbine exhaust (fed with HP steam)
Cooling Water	0.00013	tCO_2/m^3	On-site production Pumps P 5 bar; efficiency 80% Cooling : central cooling water tower with T_{return}-T_{supply} = 10 °C
BFW	0.02	tCO_2/t	On-site production Production of BFW (145°C) from LP steam and demineralized water + electricity (pumping)
Fuel Gas	0.0576	tCO_2/GJ fuel (LHV)	Average value given for Refinery Fuel Gas. Source : API, 2009
Fuel Oil	0.0786	tCO_2/GJ fuel (LHV)	Average value given for residual oil #6. Source : API, 2009
Hydrogen	9.7	tCO_2/t	Hydrogen production from Steam Methane Reformer (SMR)

Figure 1: CO_2 emissions breakdown for reference unit

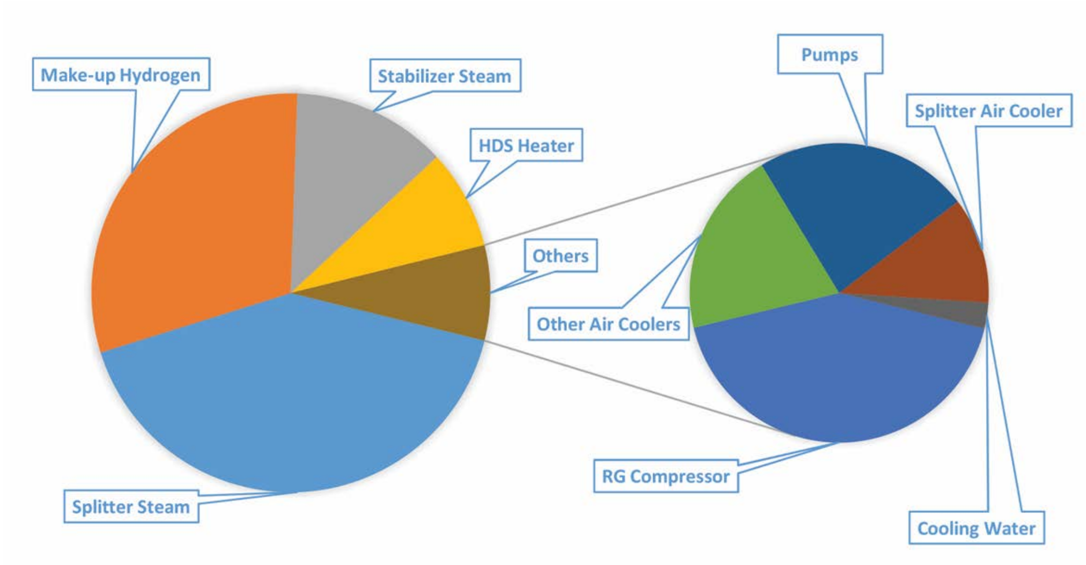
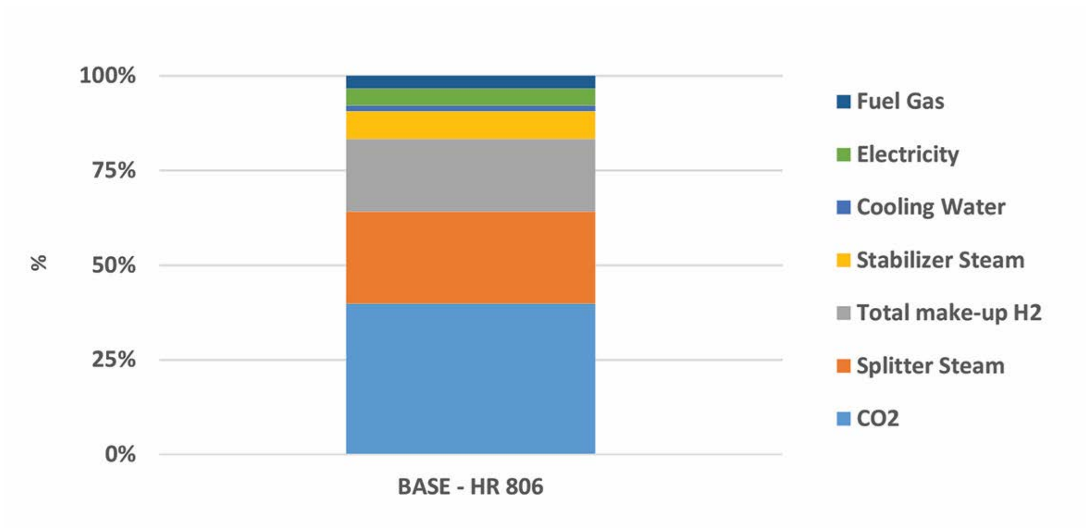


Figure 2: BASE CASE utilities cost breakdown



Looking at the breakdown of CO_2 emissions and utilities for the reference unit on Figures 1 and 2, the following conclusions can be drawn:

- Steam is the biggest contributor to the utilities expenses not including CO_2 and also the biggest contributor to CO_2 emissions. 70% of the total steam consumption is for the splitter.
- Hydrogen consumption is the second biggest contributor to the utilities expenses not including CO_2 and also the second biggest contributor to CO_2 emissions.
- Electricity is not a major contributor to the operating expenses and neither it is to CO_2 emissions. 43% of the total electricity consumption is for the recycle gas compressor.
- CO_2 emissions become critical when considered as an operating expense. Even if CO_2 is not yet considered as an operating expense by all refiners, many Oil and Gas companies tend to apply an internal carbon price when evaluating investment decisions (either static value or a range of values that changes over time). Looking at the mid term (2030), considered carbon prices can be much higher than the one considered in the present case study [1][2].

In an attempt to reduce as much as possible the utilities bill and the CO_2 emissions, acting on both the splitter steam consumption and the make-up hydrogen consumption thus seems inevitable. On the other hand, acting on the power consumption shall probably not be regarded as a priority.

4. The different low energy scenarios

Two ideas come to mind when it comes to reducing the splitter steam consumption, each one having specific undesirable consequences in terms of performance:

- Decreasing the operating pressure. This has an impact on the product yield as some valuable C5 could be lost to the purge and end up in the fuel gas system or at the flare.
- Decreasing the reflux to feed ratio. This has an impact on the LCN recovery and ultimately on the octane retention and the hydrogen consumption as some light olefins are dropped into to the HDS feed with the risk of being hydrogenated.

These two scenarios will be explored and it can be seen how the use of Axens' new generation HDS catalyst HR 856 can offset any loss in performance arising from a low energy operation. The result for the refiners is a significant increase in profitability and a significant decrease in CO_2 emissions.

A third scenario will also be investigated, which is a decrease of electricity consumption through a decrease of the HDS recycle gas compressor throughput. This should help us definitely rule out this solution as a major path towards energy saving.

The economics will use a product price of 600 USD/tons (gasoline SP 95) and an octane value of 0.9 USD/ OctaneBarrel (AKI based).

a. Splitter steam reduction

The operating parameters of the reference unit have been modified in terms of splitter operating pressure and splitter reflux to feed ratio, first with HR 806 and then with HR 856 (Figures 3 and 4). The BASE case considers standard operation conditions for the Splitter in terms of pressure and reflux ratio. Running case BASE -1 bar means that the unit splitter pressure has been lowered by 1 bar. Concerning the reflux ratio, BASE -10RR means that the reflux ratio has been lowered by 10%.

Figure 3: CO_2 emissions and unit profitability. Comparison Splitter low pressure to BASE CASE

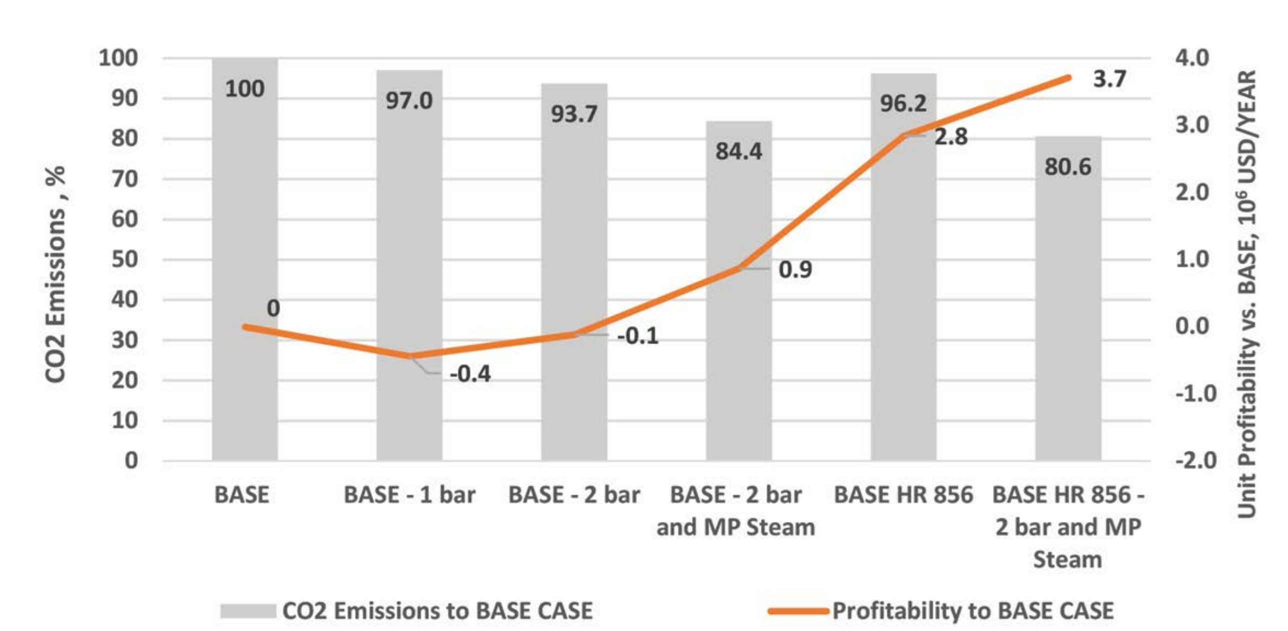
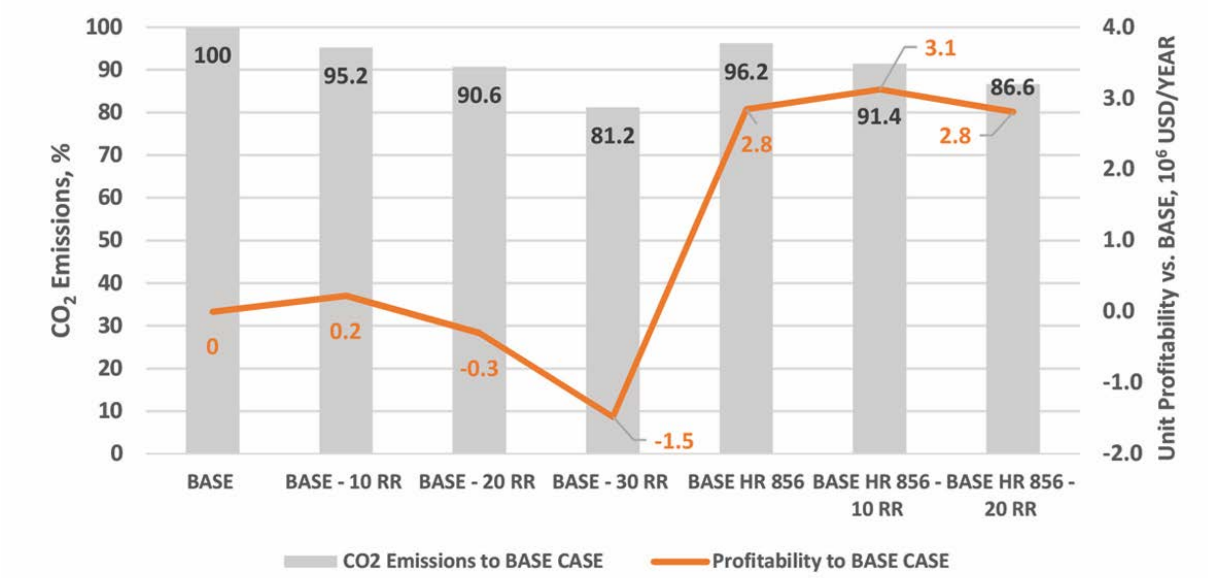


Figure 4: CO_2 emissions and unit profitability: Comparison Splitter low reflux ratio to BASE CASE



As mentioned, operation at lower pressure causes a loss of yield thus degrading the product value. With HR 806 loaded, this operation shows positive net incomes when the switch from HP steam to MP steam is possible.

Low reflux ratio operation causes higher octane losses which degrades the product value. With HR 806, running at BASE - 10 RR is however profitable. For RR below BASE - 20 RR, savings in utilities do not compensate the losses in octane value.

At BASE conditions, a substantial gain of 2.8 MMUSD/year is obtained by switching to HR 856. At the optimum pressure conditions, i.e. BASE - 2 bar, considering that a switch to MP steam is possible, the gain reaches 3.7 MMUSD/year.

In terms of RR, the most profitable option with HR 856 is BASE – 10 RR, leading to a gain of 3.1 MMUSD/year. BASE - 20 RR still shows significantly better profitability than the BASE case with HR 806 and the reduction of CO_2 emissions reaches 13%.

Splitter low energy modes are very profitable when conjugated with a switch to HR 856 and the impact on CO_2 emissions is significant.

b. Power consumption reduction

Operation feedback from the last 20 years show that refiners often challenge the HDS section H_2/HC design value, considered as high especially when compared to conventional naphtha hydrotreaters.

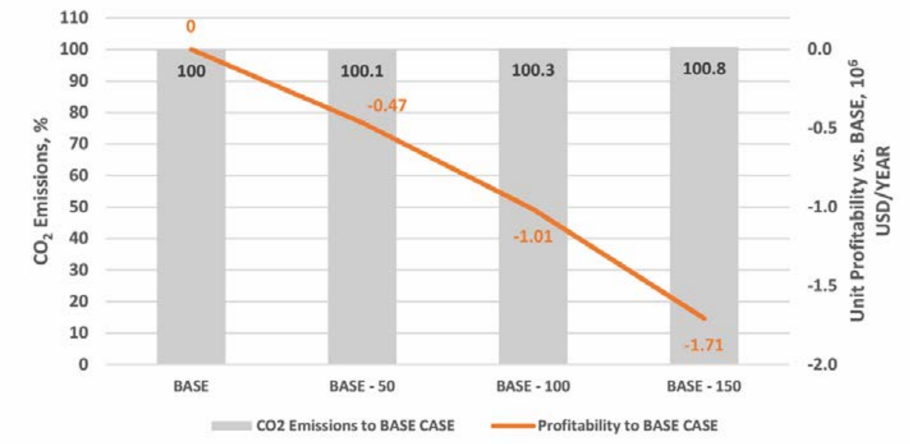
Although the positive impact on electricity consumption from a lower H_2/HC ratio might be appealing, one should keep in mind the negative effects on the catalyst performance:

- The catalyst activity is decreased, which has to be compensated by a higher operating temperature to keep the product on spec.
- The selectivity of the catalyst is decreased, meaning a higher octane loss and a higher make-up H_2 consumption can be expected for the same product spec.

The results from the study (Figure 5) illustrate in fact that the reduction in electricity consumption does not compensate the loss of product value. Besides, the cycle length reduction due to higher WABT in the HDS reactor has not been taken into account, which would tip the balance in favour of other strategies even more.

It is convenient however to indicate that, in the case of a steam-driven compressor, a different assessment would have to be conducted.

Figure 5: Comparison of Compressor low Electricity Consumptions to BASE CASE



5. The digital role on the catalyst performance optimization

In parallel with catalyst R&D, Axens has put significant efforts into the development of digital applications aiming to improve customer experience, maximise profitability and help to control the CO_2 emissions. Connect'In™ is one of them.

Among the numerous functionalities of Connect'In™ ("what-if" projection tool, end of cycle prediction tool, etc.), the Performance Delta Dashboard offers the possibility to model the unit using proprietary models and to compare in real time the actual performance vs. the inferred one. This helps refiners detect any deviation to the optimum operation and identify the parameters that can be tuned with the support of technical services engineers.

It is observed that units often overperform in terms of desulfurization, which has a cost in terms of octane, utilities consumption and CO_2 emissions. The use of an Advanced Process Control (APC) based on licensor's in-house models inferences would automatically avoid these performance issues with fast payback. An APC would also help the refiner set the optimum operating parameters based on both energy consumption and product value.

By using real time fluid properties analysis (Fluid Properties as a Service, FPaaS), the digital experience is enhanced: the use of relevant NIR solutions as real time properties analyzer is providing results as expected in the improvement of inference models.

6. Conclusion

In the context described in this article, limited to operating expenses in early FCC gasoline hydrotreatment designs, it has been shown that an overhaul of the operating parameters might be a good step to take.

The use of the high selectivity catalyst HR 856 allows profitability to the combined with a reduction in CO_2 emissions to get the best of both worlds. This is even more determining when applying a price for CO_2, which will be probably a practice worldwide on the short- or mid-term, significantly modifying investment decisions.

It has also been shown that decreasing the splitter operating pressure and decreasing the splitter reflux to feed ratio are probably the first actions to consider to decrease the utility/CO_2 bill. This is site-dependant and the optimum parameters have to be set case-by-case.

In a case-by-case setting scenario, digitalization becomes a powerful tool to define the optimum parameters, demonstrating that an integrated offer is gaining in importance and that a catalytic solution, only by itself, is no longer in position to respond to refiners interests.

Other scenarios, considering capital expenses, would lead to better optimized schemes. This can be achieved by means of a revamp, in the case of existing units, or by the implementation of latest state of the art design, for grassroot units.

References:

[1] TOTAL, Getting to Net Zero, Report, Sept 2020; [2]https://www.bp.com/en/global/corporate/news-and-insights/press-releases/bp-revises-long-term-price-assumptions.html

Role of Natural Gas in India's Energy Transition and Decarbonization

Soumik Biswas
General Manager
(Corporate Strategy Planning and Advocacy)

Shalini S. Prasad
Senior Manager
(Corporate Strategy Planning and Advocacy)

GAIL (India) Limited

Natural Gas Fueling the Clean Energy Transition

Share of natural gas in India's energy mix is of ~6.7% as against ~24.7% global average. Efforts are being made to increase natural gas production while also creating import infrastructure to meet the growing domestic demand. Increasing the share of gas from 6.7% to 15% means a significant jump to approx. 600 MMSCMD of gas market from current level of 148 MMSCMD assuming an increase of 1.6 times in country's primary energy basket reaching from present 800 mtoe to 1300mtoe by 2030.[1]It is estimated by 2030 domestic gas production is expected to be around 150 to 200 MMSCMD, while the balance is expected to be met through imports.[2]

The gas consumption pattern in India is given below (fig. are in MMSCMD):

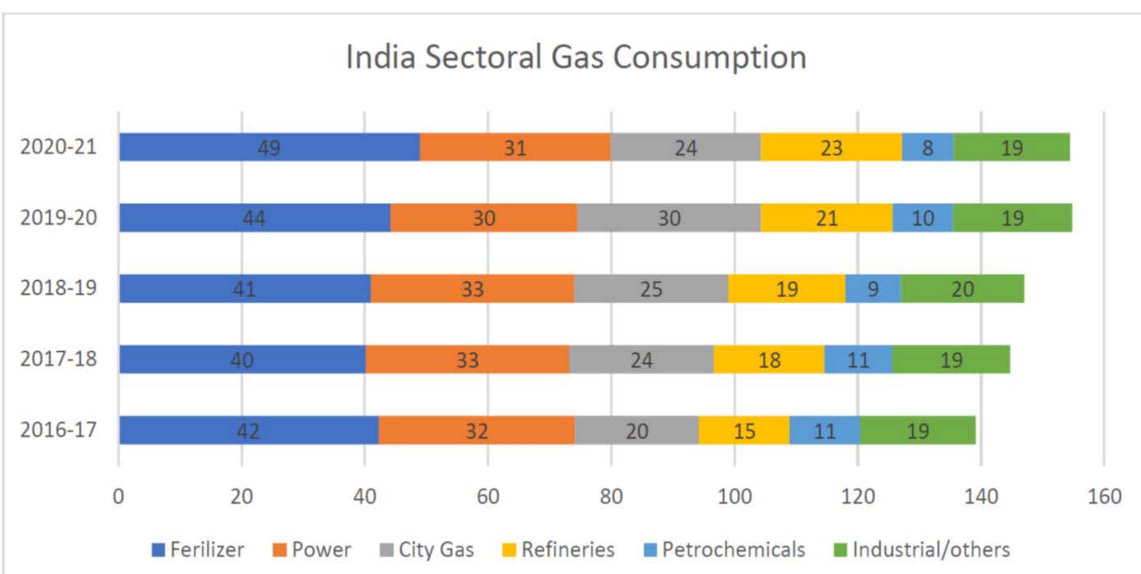


Figure 1: India Sectoral Gas Consumption, PPAC

From the consumption pattern shown above it is observed that the yearly average of growth of gas market is ~4% in last 5 years. Out of total 154 MMSCMD, 45% of the gas comes from domestic sources while rest 54% is imported LNG and majority of growth has come from CGD and refinery segment during last 5 years.[3] Pricing and affordability are the key challenges for India as anchor consumers - Power and Fertilizer, and emerging sectors such as CGD are price-sensitive.

Hon'ble Prime Minister Shri Narendra Modi has clearly envisaged a cleaner, greener and more inclusive future for India by placing "accelerating our efforts to move towards gas-based economy" at top of the seven elements of India's energy sector vision.

India is on the path of achieving most of the COP 21 climate change goals set for 2030 while bringing forth renewable energy as the first pillar of decarbonization. Gas needs to be looked upon as second pillar of decarbonization given the qualities it has in the form of transition fuel and the possibility of infrastructure utilization for transportation of less carbon intensive fuels. Natural Gas is also poised to balance twin objectives of providing energy for growth of the nation and standing tall on climate objectives of the country. According to IGU estimates, in coming decade gas will continue to be critical to the future of energy, joining renewable electricity in form of pillar for decarbonization.

Natural Gas, Emission and its role Decarbonization

Natural gas is the least carbon intensive fossil fuel; unlike other carbon-based fuels, natural gas has a high hydrogen/carbon ratio and therefore emits less carbon dioxide for a given quantity of energy consumed. Natural gas is a cleaner burning fuel than coal or oil. When burned, it releases up to 50 percent less carbon dioxide (CO_2) than coal and 20-30 percent less than oil. Natural Gas is widely recognized as a relatively low-carbon, cost-effective fuel. Use of Natural gas can help to meet CO_2-reduction goals as well as reduce unhealthy emissions such as NOX, SOX and particulates.[4]

The modern economy is powered largely by fossil fuels. Burning fossil fuels produces CO_2. Climate change is an urgent problem requiring global action to reduce emissions of CO_2 and other greenhouse gases (GHGs).

The share in global CO_2 emissions from energy use in 2020 from India (7.2%) standing 3rd globally with 2298MT CO_2 emissions.[5] Climate change is primarily a problem of too much CO_2 in the atmosphere.6Thus, confronting climate change depends, in many ways, on adopting new and sustainable energy strategies that can meet growing global energy needs while allowing for the stabilization of atmospheric CO_2 concentrations at safe levels.

Globally, natural gas currently accounts for approximately 8 Gt of the 37 Gt of CO_2 produced by the energy sector. The reduction of CO_2 emissions per unit of energy, an essential requirement of addressing climate change, is known as de-carbonization. De-carbonization can be achieved by using less polluting fossil-fuel-based energy sources.

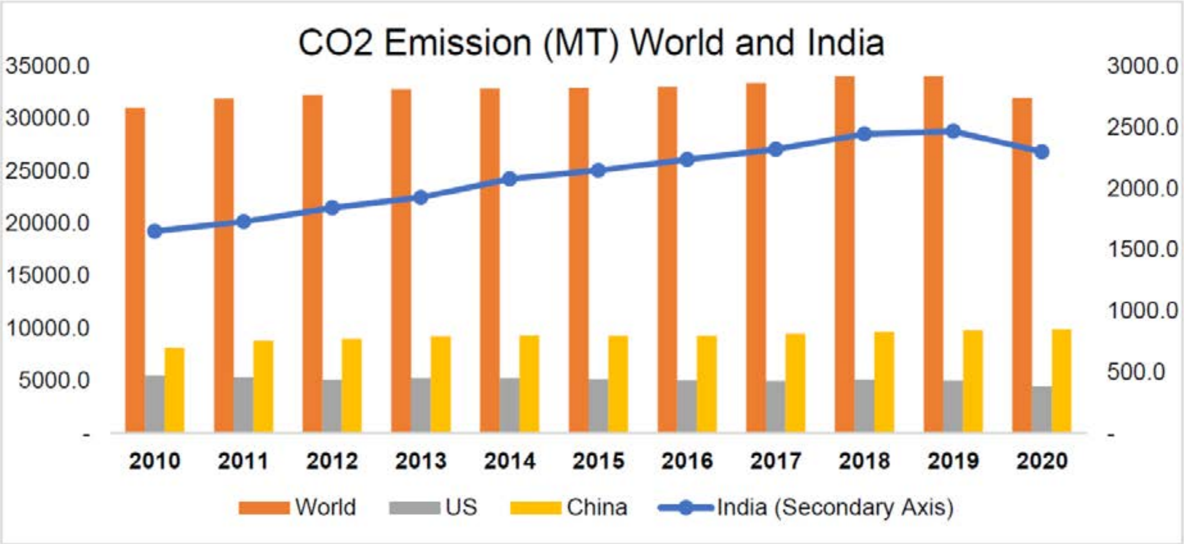


Figure 2: CO_2 Emission Trend, BP Statistical Review 2021

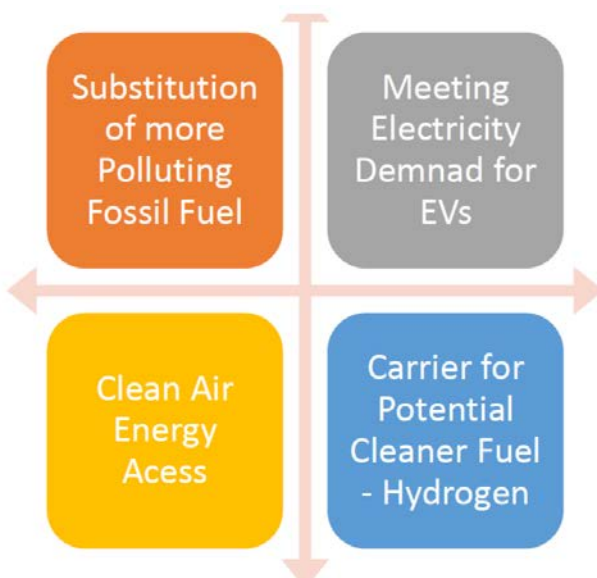
According to the Sixth Assessment Report (AR6) by the Intergovernmental Panel on Climate Change released this year the world can emit approximately 400 billion tonnes more of carbon dioxide before hitting the 1.5°C limit. The world currently emits about 40 $GtCO_2$ annually; the 1.5°C budget is likely to be exhausted in 11.5 years at 50 per cent likelihood and nine years at 67 per cent likelihood.

Early action on emission reductions is vital to meeting the more ambitious decarbonization goals laid out worldwide. In this context, natural gas can play a critical and unique role, particularly in developing economies like ours.

Gas needs to be looked upon as second pillar of decarbonization. The idea of decarbonized world today is dependent on built-in midstream and downstream infrastructure acting as a backbone for the futuristic decarbonization initiatives. Natural Gas plays an important role in short to midterm, using unabated natural gas (fossil gas without CCS), and in the longer term as abated (gas with) CCS gas and other low-carbon gases and technologies scale up. Investments done so far in unabated natural gas supply chain lays the groundwork for a zero-carbon future because the infrastructure can be repurposed.

Natural gas can not only meet growing demand for clean, affordable energy but can also replace coal and oil and their associated higher emissions. This substitution toward natural gas can be done relatively quickly, requires limited deployment of capital, and has a significant impact on emissions.

Drivers for Natural Gas Usage in Decarbonization Era



The main drivers of natural gas use under decarbonization are as follows:

- Substitution more polluting fossil fuel: the opportunity to make immediate deep emission reductions by replacing the higher emitting fuels of coal and oil with natural gas
- Gas Based Power Generation: natural gas to help supply additional demand of electricity for electric vehicles
- Clean Energy Access: PNG penetration in urban areas can help in replacing LPG and making the latter available to rural area, thus leading to clean energy access.
- Clean air: use of natural gas in transportation, notably trucks and ships, to help improve air quality
- Hydrogen: natural gas as a feedstock has potential to cater to new market for producing hydrogen (blue hydrogen) through steam methane reforming in conjunction with carbon capture

According to IHS Markit estimate around 420–550 Bcm per year of additional natural gas—10–15% of current global consumption—would be required to meet a cost-optimal pathway for emission reductions in the Asian power sector alone, generating between 0.9 and 1.2 gigatons (Gt) of annual carbon dioxide (CO_2) reductions.

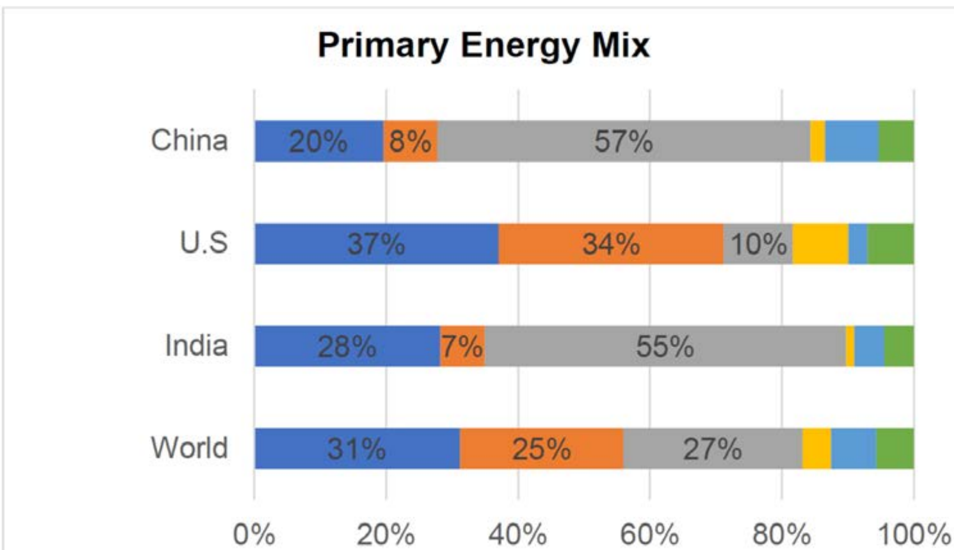
Energy Landscape of India

India is the third largest energy consumer after China and USA consuming around 764 Million tonnes oil equivalent (MTOE). With a share of 5.7 % of world's primary energy consumption – India's energy requirement is fulfilled primarily by coal, crude oil, natural gas and renewable energy.

It is projected by BP Energy Outlook that by mid-2020s India will be world's largest growth market surpassing China and will reach primary energy consumption of roughly 1688 Mtoe by 2040 with a global energy consumption in 2030 of 8% rising from current level of 5.8%.

India's per capita energy consumption 23.2 Gigajoules per capita, which is very low compared to world's 71.4 Gigajoules per capita and of Asia pacific is 59.6 Gigajoules per capita. On a per capita basis, India's energy use and emissions are less than half the world average, as are other key indicators such as vehicle ownership, steel and cement output.

India has so far contributed relatively little to the world's cumulative greenhouse gas emissions, but with growing energy consumption in coming decade, there shall be a relative increase in emission as well. Cleaner forms of energy sources shall play a pivotal role in defining nation's pathways of energy transition.



	World	India	U.S	China
Oil	31%	28%	37%	20%
Natural Gas	25%	7%	34%	8%
Coal	27%	55%	10%	57%
Nuclear energy	4%	1%	8%	2%
Hydro electric	7%	5%	3%	8%
Renew- ables	6%	4%	7%	5%

Figure 3: Primary Energy Mix, BP Statistical review 2021

Gas Networks Supporting Energy Transition

Government of India is supporting the gas industry in a series of investments across the gas value chain to enhance share of natural gas and move towards gas-based economy with long-term investments of over 4 Lakh Crores across various sub sectors of natural gas.7 Gas sector offers a multi-pronged solution to India acting as a catalyst to other industries, driving wider economic growth.

All figures are in Rs. Crores

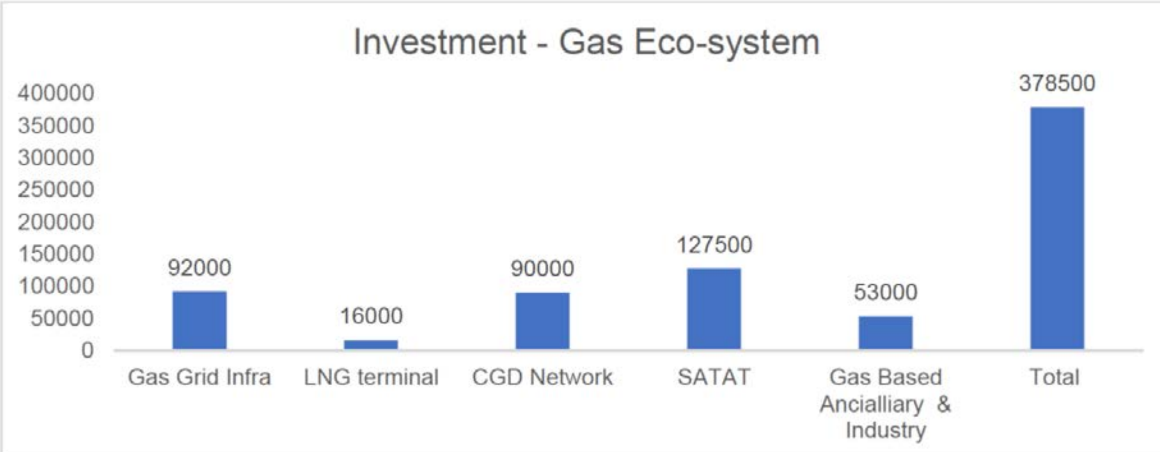


Figure 4: Collated from Inputs of Press Releases of MoPNG at PIB

National Gas Grid (NGG) is the right tool for ensuring the 'Energy Justice', promoting uniform economic growth across India while laying the foundation for downstream industries, ancillary gas-based industries & upcoming CGD networks. The national gas grid (NGG) is expected to expand from the present 18,700 km to 34,500 km in next few years.

Operational Pipelines in India

Entities	Length (KM)	% Share
GAIL	13,700	74%
GSPL	2,765	15%
PIPL	1,460	8%
Others	788	4%
	~18,700	**100.0%**

LNG terminals in India

Existing (40 MTPA)	Dahej, Hazira, Dabhol, Kochi, Ennore, Mundra
Upcoming (22 MTPA)	Dhamra, Dabhol expansion, Chhara, Jaigarh, Jafrabad

In recent years, India has witnessed 33% growth in regasification capacity - commissioning of LNG terminals at Ennore in Tamil Nadu & Mundra in Gujarat.

CGD has been identified by India as an important mechanism to combat pollution while offering affordable energy to masses. It is expected that with already awarded GAs in the 8th, 9th and 10th round- over 53% of geographical area and 70% of population of India will have access to natural gas through CGDs. PNG is helping to divert LPG for rural areas which are still dependent on biomass, wood etc. The 11th city gas distribution (CGD) authorization round has been launched to expand CGD network particularly in Chhattisgarh, Madhya Pradesh, and Vidharba. The developing hydrocarbon infrastructure can also serve as backbone for low carbon energy transition especially for the developing countries.

Gas infrastructure inclusive of pipelines for transmission and distribution, storage facilities, liquefaction plants, and LNG vessels can also be repurposed over time to deliver low-carbon gases. Regulations and performance standards can be developed to incentivize this transition. Owing to above rationale investments in new gas infrastructure should be encouraged and considered a prebuild of energy carriers for a lower-carbon future, enabling the shift to deeper decarbonization.

Conclusion

Natural gas can meet growing demand for clean, affordable energy while also replacing coal and oil along with their associated higher emissions. Natural Gas has a role to play in short to midterm as unabated natural gas (fossil gas without CCS), and in longer term as abated (gas with) CCS gas. Government of India is supporting the gas industry in a series of investments across the gas value chain to enhance share of natural gas and move towards gas-based economy with long-term investments of over 4 Lakh Crores across various sub sectors of natural gas.

Gas sector offers a multi-pronged solution to India acting as a catalyst to other industries, driving wider economic growth. Worldwide midstream and downstream infrastructure is the backbone of the future decarbonized world. Investments done so far in unabated natural gas use lays the groundwork for a zero-carbon future because the infrastructure can be repurposed. Repurposing infrastructure is not an easy task and has challenges while requiring investments. The costs of conversion may be significant but still at a lower cost than new investments. Gas needs to be looked upon as second pillar of decarbonization given the drivers it has in form of transition fuel and its infrastructure utilization options for transportation of less carbon intensive fuels.

1 https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-
2 https://economictimes.indiatimes.com/industry/energy/oil-gas/indias-gas-output-to-jump-52-by-2024-led-by-ongc-reliance-bp-says-new-report/articleshow/82197272.cms?from=mdr
3 Statistics derived from MMSC to MMSCMD from PPAC Ready Reckoner
4 https://www.eia.gov/environment/emissions/co2_vol_mass.php
5 https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-co2-emissions.pdf
6 http://www.ucsusa.org/global_warming/science_and_impacts/science/CO2-and-global-warming-faq.html#.WgkxjFWWbIU
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Gas- Hydrogen Blending: A Decarbonization Solution

Sujay Sarkar
Senior Assistant Director (Gas)
Federation of Indian Petroleum Industry

The world is undergoing an energy transformation, from fossil-based systems to low or zero-carbon based energy systems, to reduce global greenhouse gas emissions and avoid the most severe impacts of a changing climate. Blending zero-carbon hydrogen into the natural gas grid is considered a logical initial step in the energy transition.

Blending Hydrogen into Natural Gas

Blending hydrogen with natural gas has appeal because today's extensive natural gas storage and pipeline infrastructure could allow the development of hydrogen to proceed before incurring the capital costs—and potentially lengthy timeline—of building a dedicated hydrogen network. Therefore, blending with natural gas could enable the scaling up of hydrogen in various new applications before commitments to infrastructure are made for pure hydrogen. Nevertheless, there are limits to the proportion of hydrogen that may be blended with natural gas. In natural gas pipelines, blending limits can result from the lower energy density by volume of hydrogen and the potential for hydrogen to embrittle steel. On average, 10-20% hydrogen by volume is feasible without infrastructure modifications, but infrastructure components may vary widely in their tolerance for hydrogen (IRENA 2019).

Hydrogen produced from renewable, nuclear, or other resources can be injected into natural gas pipelines, and conventional end-users of natural gas can then use the blend to generate heat and power. For both feedstock and fuel, industrial consumers of natural gas may have narrow specifications for the purity of the gas mixture, so hydrogen blending would be less suitable in these processes. Moreover, because the cost of separating hydrogen from a mixture with natural gas is prohibitive (IEA 2019), natural gas blending for the sake of pipeline utilization is not sensible unless the final consumer is amenable to a blend of natural gas and hydrogen. The power sector appears to be more flexible for natural gas blending, with recent gas turbines compatible with a sizable proportion of hydrogen. For example, modern gas turbines from Mitsubishi Hitachi Power System (MHPS) can use 30% hydrogen (MHPS 2019).

Experiments in the France and U.K show that a mixture of 80% methane and 20% hydrogen can be efficiently moved in a natural gas pipeline. As part of a study from mid- 2018 to March 2020, Dunkirk, France, used an 80–20 blend to fuel 100 homes and a hospital boiler without any new equipment along the pipeline or in the buildings. The HyDeploy project is the first programme in UK to supply hydrogen, in the form of a blend, and the first phase of HyDeploy saw 100 homes and around 30 commercial buildings on a closed network at Keele University successfully use the hydrogen blend for 18 months. The second phase of blending up to 20% of hydrogen has started in Aug'21 on a public gas network in Winlaton for 668 homes, a school and some small businesses which will continue for the next 10 months. Customer response has been overwhelmingly positive after the first phase of HyDeploy, mainly since they hardly had to do anything during the changeover. The theory that we can blend hydrogen safely with natural gas is well established, and the first phase has proven that theory works safely in practice, with no impact on the way people use their gas boilers or cookers.

Further, the natural gas infrastructure could be reused with minor modifications for the transportation and storage of hydrogen. Hydrogen can be transported as a gas in high-pressure containers, as a liquid in thermo-insulated containers, in processed form as methanol or ammonia, or in a chemical carrier medium. However, the most economically viable method is via pipeline, where a very high energy transportation capacity can be achieved.

Pathways for Gas- Hydrogen Integration

There are three pathways for the integration of hydrogen in the existing gas infrastructure:

(i) injection of hydrogen and its blending with natural gas in the existing gas infrastructure,
(ii) development of a dedicated hydrogen network through conversion of the existing gas infrastructure or via the construction of new hydrogen infrastructure and
(iii) methanation, consisting of capturing CO_2, combined with hydrogen to produce e-methane, injected in the gas network.

Today the gas infrastructure can accommodate any form of low carbon hydrogen, independently from the technology used for its production, such as electrolysis, gasification of biomass, steam methane reforming combined with capture of CO_2 etc.

"The existing gas infrastructure is of very high value for the EU Hydrogen Strategy for a Climate-Neutral Europe."
Christoph von dem Bussche, CEO, Gascade

Advantages of Gas- Hydrogen Blending

(i) Blending represents an easy entry point into the hydrogen economy, allowing for quick decentralized deployment of renewable and low-carbon hydrogen technologies as well as centralized production scale-up.
(ii) Hydrogen blending can reduce greenhouse gas emissions (GHG) when produced from clean energy sources
(iii) Blending can also be a cost-effective transitional option in those regions without parallel or duplicated networks, or without (potentially) available gas infrastructure capacity, which can be easily repurposed to hydrogen in the short-term.

Limitations on Gas- Hydrogen Blending

Blending may appear to be a solution to (partially) decarbonizing the gas grid, it also presents some specific challenges. Blending is a limited solution as the maximum share of hydrogen would be limited by the capabilities of the existing gas grid to around 20% by volume, before incurring safety issues. Once that is reached, the only solution is to convert the grid to be 100% hydrogen-ready. Across Europe, the permitted levels of hydrogen in the gas supply vary, from 0.1% in the UK to up to 12% in parts of the Netherlands.

Other main challenges can include measurement, energy conversion, process gas chromatographs, and gas metering. Moreover, different levels of blending may pose an obstacle to the interoperability of gas networks. Along a pipeline, the friction causes transported gas to lose pressure. Compressor stations compensate for these losses to boost the system's energy throughput. Hydrogen has a significantly lower molar weight than natural gas, a parameter for the commonly used centrifugal compressors. Therefore, existing compressors are usually not fully optimized for blends, although different compressors models react differently to hydrogen blends. For example, SIEMENS states that, when share below 10 % only leads to minor changes of existing compressors, compressors, when transported a share of above 40 %, requires its replacement. Compressors themselves are usually driv¬en by gas turbines. Many new and recently installed gas turbines show strong resilience towards blends. However, some gas turbines would require modifications, and equipment manufacturers are working to offer adequate solutions in the short term.

In general, possible effects of hydrogen on all relevant materials needs to be assessed.

Pipeline capacity when switching to hydrogen

As the energy density of hydrogen is slightly lower than that of natural gas, the switch from natural gas to hydrogen has little impact on the capacity of a pipeline to transport energy. When comparing the energy flow of two gases through a pipeline, it is not only the volume that is important but also the parameters of density, flow velocity, and pressure. As hydrogen has a density nine times lower and three times the flow rate of natural gas, almost three times the volume of hydrogen can be transported in the pipeline at the same pressure, and during the same time.

Cost estimate for the conversion of the gas infrastructure

The use of existing pipeline routes eliminates lengthy, and time-consuming planning and approval procedures and hence the establishment of a hydrogen infrastructure is possible with little economic effort. The development of new technologies and materials also face fundamental challenges and have already been initiated in many areas. Against this backdrop, the costs for retrofitting the lines – including decommissioning, water pressure tests, replacement of fittings and blowers and dismantling of connections, etc. – can be estimated at around 10-15% of a new construction according to estimates by European gas transmission system operators. Converting the compressor infrastructure to maximize the flow of energy in hydrogen operation requires approximately three times the compression performance compared to natural gas operation. Accordingly, the compression equipment of a hydrogen pipeline, including the drives, would be about three times the cost of a natural gas pipeline.

Technical Considerations related to Gas-Hydrogen Blending

As per Gas for Climate: European Hydrogen Backbone, July 2020 report, the technical state and chemical composition of infrastructure materials need to be considered when assessing if existing pipelines can transport hydrogen. At standard conditions, methane has three times the calorific heating value per cubic meter of hydrogen. The main elements of the conversion process include:

- Technical conditions of gas pipeline
- Integrity management of the steel pipes and fittings: As for natural gas pipelines, it is necessary to inspect the pipeline and identify possible cracks regularly.
- Tightness of the system, including valves: As hydrogen is a much smaller molecule than methane, internal and external tightness of the system needs to be adequately certified; additionally, material used for sealing needs to be chosen as applicable to work with hydrogen.
- Replacement of measuring equipment: Gas chroma¬tographs has to be equipped with an additional column able to measure hydrogen, i.e., in case of pressure transducers, dedicated membranes able to cope with hydrogen needs to be used, gas meters need to be ready to operate with hydrogen properly.
- Upgrade of the software: Software of the flow com¬puters needs to be upgraded, i.e., calculation algorithms have to include hydrogen.

Relevant studies indicate that it is possible to convert the existing steel pipelines from natural gas to hydrogen operation to the extent required for the ramp-up of a hydrogen industry. Nevertheless, further examination is needed on whether the operating parameters must be adjusted for certain types of steel and operating conditions. In fittings and control valves, the suitability for hydrogen of the membranes and seals used must also be determined. In the case of safety shut-off valves and pressure regulators, it must be clarified if the control and regulating functions must be adapted for the flow properties of hydrogen.

Specific conditions of the existing infrastructure would need to be inspected and assessed and the relevant codes and regulations consulted prior to determining if the pipelines are suitable. For example, fittings inside furnaces and stoves, such as burner tips, might need to be altered or replaced or blended with more than 20% hydrogen because, like pure hydrogen, blended gas burns at different temperatures and rates.

Long term impact on the gas network is not yet fully understood

Several projects worldwide are demonstrating blends with hydrogen concentrations as high as 20%, but the long-term impact of hydrogen on materials and equipment is not well understood, which makes it challenging for utilities and industry to plan around blending at a large scale.

The National Renewable Energy Laboratory (NREL), a national laboratory of the U.S. Department of Energy has started a new collaborative research and development (R&D) project known as HyBlend in 2020 to address the technical barriers to blending hydrogen in natural gas pipelines and is carrying out high-priority research on:

(i) Are pipelines compatible with hydrogen?
(ii) What are the costs and environmental impacts?
(iii) How will hydrogen blends affect appliances and other equipment?

Gas- Hydrogen Blending Targets by some countries

Blending targets have been considered as part of many hydrogen strategies by some of the countries as follows:

US: There are approximately 2,575 kilometres of hydrogen pipelines in operation, and for comparison, there are over 4.83 million kilometres of natural gas pipelines in the US. The fixed cost of expanding the hydrogen pipeline network is a barrier, which has motivated the investigation of the use of natural gas pipelines for transporting hydrogen in the context of the commercial prospects of the various production technologies. Of course, if natural gas is used as a feedstock for blue hydrogen production, which is co-located with end-use applications, then the need for significant expansion of hydrogen pipeline infrastructure is reduced.

UK: The objective of the HyDeploy programme is to demonstrate that a blend of hydrogen, up to 20% by volume, can be safely distributed and utilized within the gas distribution network. By 2030, four of the country's five major industrial clusters could be connected through the phased repurposing of existing gas pipelines to form an initial hydrogen backbone. Currently, only 0.1% of the gas in the UK's network of gas pipelines is allowed to be hydrogen, by law.

Portugal: Portugal is considering a hydrogen blending target that rises from 1-5% by volume by 2025 to 75-80% by 2050 at both the transmission and distribution levels (DGEG, 2020).

Italy: Italy's 2020 "National Hydrogen Strategy Preliminary Guidelines" envisage a blend of 2% hydrogen in the gas grid by 2030, and by 2050, the target goes to 20%, (MISE, 2020).

Australia: The New South Wales government has set an aspirational target of blending up to 10% hydrogen in the gas network by 2030, while the Western Australian government has set a goal that its gas pipelines and networks contain up to 10% renewable hydrogen blend by 2030. Victoria and South Australia are evaluating the possibility of partial conversion or longer-term full conversion to 100% hydrogen into their gas networks.

China: By April 2021, 23 of China's provinces and municipalities had listed hydrogen as a key economic priority or formulated hydrogen development plans. The peninsular province is hoping to become a hydrogen transportation corridor by 2025, blending hydrogen into its gas infrastructure.

Gas- Hydrogen blending overview in India

In India's quest to promote hydrogen as a clean fuel for the mobility sector, the Ministry of Road Transport and Highways (MoRTH) in September 2020 has notified an 18% blend of Hydrogen with CNG (HCNG) as an automotive fuel. A hydrogen enriched-Compressed Natural Gas (HCNG) plant and dispensing station was started by IndianOil (IOCL), Indraprastha Gas (IGL) in collaboration with the Delhi Transport Department (DTC) and 50 buses in Delhi are plying on HCNG on a pilot basis. Based on the outcome of the result, the same shall be scaled up across the country's major cities.

HCNG is predicted to be the first step to a hydrogen economy and can be used in place of gasoline, diesel fuel/LPG. Its combustion produces fewer undesirable gases compared to normal automobile fuel. Efforts are underway in the country to leverage H-CNG as an intermittent technology in a big way for both automotive and domestic cooking applications.

NTPC, under the Ministry of Power in August 2021, has floated a global Expression of Interest (EoI) to set up a Pilot Project on Hydrogen Blending with Natural Gas in City Gas Distribution (CGD) Network in India. This pilot on hydrogen blending with natural gas will be the first of its kind in India and will explore the viability of decarbonizing India's natural gas grid.

Conclusion

The gradual penetration of hydrogen in the gas system, in an orderly manner would permit policy makers and system or pipeline operators to face gradual challenges with time. The conversion of existing gas infrastructures to hydrogen operation can achieve a breakthrough for the hydrogen industry, which will support the future sustainable energy supply with reasonable economic effort and using existing infrastructure for new purposes as well makes sense in the light of a circular economy.

In this way, energy transition and sector integration can be promoted comparatively quickly and inexpensively. Thus, giving gas pipelines the new purpose of transporting hydrogen is a realistic path toward achieving sound energy policy, environmental stewardship, and economic prosperity.

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Is Climate Change Changing Global Finance?

Jessica Singh
Senior Manager (Corporate Planning & Economic Studies)

Indian Oil Corporation Limited

Climate Change is the defining challenge of our times. It is directly affecting multiple sectors and regions already. This article tries to unravel how climate change is affecting the world of finance. Finances and financing have an important role in the global fight against climate change and global action for climate change along with the efforts to manage the impact of global warming are changing and affecting the world of finance in multiple ways. For private players in global finance, climate change is a mixture of risks and opportunities that are largely getting manifested through the overall wave of ESG investing. For the official sector, over and above the mix of risks and opportunities that climate change presents, it is also about commitments and policy evolution.

Climate Change is the defining challenge of our times. It is directly affecting multiple sectors and regions already. The extreme weather events that we have been witnessing in recent months from floods in Europe and China, landslides in India to wildfires in Australia, Turkey and Greece, heat waves in North America, if anything, are stark manifestations of this. And, then there are subtle changes that are taking place, such as changing taste of wine and cultivation of tropical fruits like mangoes and avocados in Sicily.

The quest for limiting global temperature rise has led to action on multiple levels and fronts. Energy sector, which is responsible for four fifths of the carbon emissions is experiencing wide ranging changes under the so-called energy transition. We are witnessing renewable energy forms emerge as the fastest growing energy source, owing to rapidly declining costs. Today, their Levelized Cost of Electricity (LCOE) is lower than that of thermal source electricity. On the other hand, globally, oil, which today is the most dominant source of energy is expected to see its demand peak in a decade or two.

This article attempts to cover how climate change is affecting the world of finance. Finance has an important role in the global fight against climate change and global action for climate change along with the efforts to manage the impact of global warming are changing and affecting the world of finance in multiple ways. In fact, if one talks to insiders of global finance, one finds that sustainability (climate action being a sub-set of that) is one theme that is getting increasingly embedded across the spectrum[1]. It is getting embedded in the public and media relations of the companies, with a surge in the number of financial players producing annual sustainability reports. And, also getting entrenched in their investment decisions, with an all-encompassing urge to make their portfolios greener or at least make them look greener[2].

In the global financial sector, the players can be broadly divided into private players such as banks, financial markets, asset managers, etc. and official sector comprising of central banks, Sovereign Wealth Funds (SWFs) and developmental banks. For private players, climate change is a mixture of risks and opportunities, but also is about commitments and policy evolution.

The article is divided into 2 parts, Part 1 focuses on private players and Part 2 looks into the official sector.

Part 1

The Sustainable Investing Bandwagon

ESG investing or Sustainable investing is a trend that is enveloping the entire global financial sector. ESG investing is an approach to investing that seeks to incorporate environmental, social and governance factors into asset allocation and risk decisions, so as to generate sustainable, long-term financial returns. There is growing evidence that Environmental, Social and Governance (ESG) factors, when integrated into investment analysis and portfolio construction, may offer investors potential long-term performance advantages. Carbon emissions and management and climate change impact are one the biggest considerations under that ESG lens.

Today, the amount of professionally managed portfolios that have integrated key elements of ESG assessments exceeds USD 17.5 trillion globally. The growth of ESG-related traded investment products available to institutional and retail investors exceeds USD 1 trillion and is growing quickly across major financial markets. And since 2020, the rush has further amplified. According to Morningstar, in Q1 2021, global flows to ESG funds stood at $178bn, which is more than 4.5 times the flows received in Q1 2020, which was $38 bn. The exuberance for ESG investing is such that according to The Economist, currently on an average two new ESG funds are getting launched every day. Green bonds are on a rise too, as per Bloomberg in the first half of 2021, these were issued in 29 currencies and 49 countries, which is almost double from 2016 levels, when green bonds were available in 16 currencies and 24 countries.

However, one needs to be cautious in understanding that ESG funds are not synonymous with investing in renewable energy companies or projects, as oil and gas firms are typically not excluded from the major ESG funds. In fact, ESG investing is increasingly being criticised for "greenwashing", i.e. climate and other ESG credentials of ESG investment are being questioned. A recent study by Paris based B-School EDHEC finds that the criteria for stock selection used for building an ESG fund are almost similar to those used by non- ESG funds, with climate data accounting for only on an average 12% of determinants of portfolio stock weights. There are of course exceptions, for instance, European-focused ESG funds already exclude almost all oil and gas investment. And, going forward, IHS Markit expects that top ESG funds (top 10 which account for 50% of ESG assets under management) would move progressively away from oil and gas investment in the future. Mounting criticism for greenwashing along with greater regulatory watch should only make this push stronger.

The Rising Green Stars of Capital Markets

While technology stocks are the favourites of the market, green firms are the emerging stars. S&P Global Clean Energy Index has advanced by 98% since the start of 2020. As per The Economist, since January 2020, value of shares of Tesla and Nio, EV makers, have climbed six-fold and nine-fold, respectively. During the same period, shares of Orsted, a Danish windpower producer, have risen by more than a third and shares of SunRun, a solar firm, have trebled.

Big Banks & Financial Institutions and Climate Risk

An analysis by Bloomberg of 140 leading global banks, finds that, since the Paris Climate Agreement 2015, these banks have given out loans to climate friendly projects and green bonds to the tune of $1.3 trillion. Now, this still pales in comparison to the amount loaned out to fossil fuel industry by this group, which is 3 times more and standing at $3.6 trillion during the same period. However, the data coming in for 2021 (upto mid May 2021) as per analysis by Bloomberg, shows that green bonds and loans to renewable projects and other climate-friendly ventures stood at $203 billion as compared with $189 billion to businesses focused on hydrocarbons.

Attractiveness of renewable energy projects along with their efforts to align the goals of the Paris Climate Agreement are driving this change. As per IEEFA, globally significant financial institutions with assets under management (AUM) or loans outstanding larger than US$10 billion are restricting fossil fuel lending. Over 100 of these, have announced their divestment from coal mining and/or coal-fired power plants. As regards oil and gas, over 75 of these financial institutions have either gone in for general exclusion of funding of oil and gas firms, or have stopped financing oil and gas sector, or have placed selective restrictions to highly climate sensitive segments such as oil sand & arctic drilling.

Pricing of carbon risks in loans in general is also a trend that has emerged. According to a BIS Working Paper[4], carbon risks in the syndicated loan market are priced consistently both across and within industry sectors – after the Paris Agreement. The aforementioned study finds that banks have started to internalise possible risks from the transition to a low-carbon economy – but only for the risks captured by the narrowly defined scope 1 carbon emissions. The overall carbon footprint of firms (including scopes 2 and 3) is not being priced yet.

The rise of Green FinTech

Beyond the world of big banks, in the realm of start-ups, there has been a surge in climate-focused FinTech[6] products and companies. The idea of these of products and services is to innovate financial services with a focus on creating a green world. Stripe, a technology company that provides software to accept payments and manage online businesses has a climate removal tool that lets online businesses redirect some of their proceeds to emerging climate technologies, it also allows companies to highlight their climate credentials to customers. Atmos Financial offers bank savings account that "reverses global warming" by funding "clean energy to fight global warming" from the deposits, it also offers cash backs on money spent on sustainable brands by customers.

Another area where green Fintech has a lot of potential to play is that of **Inclusive Green Finance (IGF)**. Today, global efforts are mostly focused on scaling up green finance through the capital market and large-scale project finance. However, the risks and impacts of climate change tend to disproportionately affect poor and vulnerable population, such as smallholder farmers, fishermen, construction workers. Inclusive Green Finance is a rapidly evolving policy approach that aims to create more financially inclusive and resilient low carbon communities. So, IGF can be seen as an intersection of financial inclusion and green finance to achieve effective adaptation solutions and in many cases contribute to mitigation as well. And, FinTech which is transforming both financial inclusion and green finance in many meaningful ways already, is expected to be a major driving force for IGF too.

The Double (or triple) whammy for Insurance companies

For the insurance sector, climate change represents two main types of risks- physical risk & transition risk. Physical, i.e. the damage caused by extreme weather events, basically affects the underwriting side of the business and is rendering historical models obsolete with regard to their predictions. As per IMF's Global Financial Stability Report 2019, insurance claims from natural losses have already quadrupled since the 1980s. In the first half of 2021, insurers were saddled with $40 billion in losses caused by natural catastrophes, way above the average for pervious ten years at $ 33 billion . The other risk relevant for the insurance sector is the transition risk, which affects the portfolio of investment of insurance companies, which is dominated currently concentrated in the old fossil fuels' economy. Transition risk has begun to get priced in, with insurance industry making inroads in shifting its portfolio away from fossil fuels industry. In addition to this, there is another form of risk that is emerging, that of "insured emissions", i.e. the carbon footprint of the companies for which cover is provided. There is growing pressure from policymakers, investors and campaigners on insurance companies to reduce their "insured emissions".

Part 2

The elusive Climate Finance

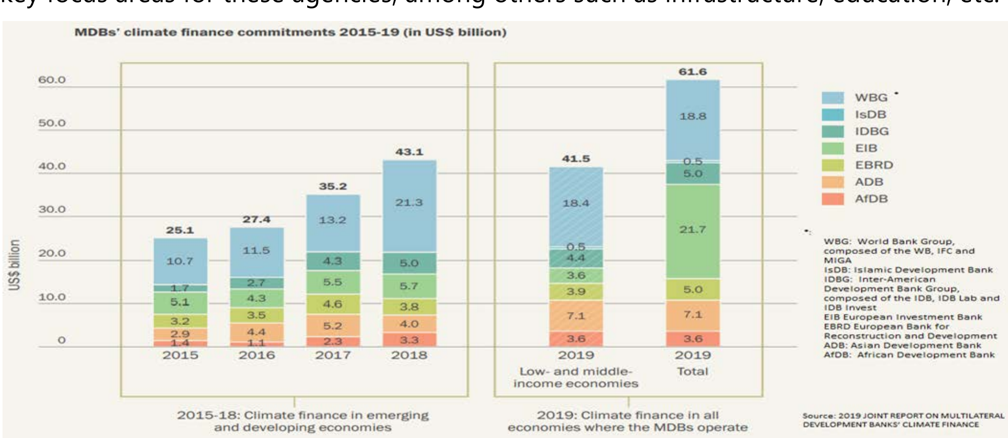
Climate + Finance = "Climate Finance"! In a broad sense, the intersection of climate and finance, the subject of this article, can be called climate finance. However, the context in which the term 'climate finance' is used most often, is more granular and has its linkage with the international climate change negotiation processes. "Climate finance" refers to money flowing from developed countries (both from public and private sources) to developing countries, which is used to help reduce emissions i.e. *climate mitigation* and increase resilience against the negative impacts of climate change, i.e. *climate adaptation*.

Climate finance has been a central element of climate negotiations for almost three decades now. At COP 15 at Copenhagen in 2009, developed countries had promised to provide $100bn a year in climate finance to developing countries by 2020. At COP21 in Paris, France, this goal was extended beyond 2020 through 2025, with increase in the annual amount after 2025. However, on the ground, climate finance is currently falling short of the $100bn goal and there is lack of transparency regarding the flows. In 2018 developed countries provided climate finance to the tune $79bn, 21% below the target. Moreover, as per Carbon Brief, it is not yet clear whether the target for 2020 has been met, because formal reporting is done retrospectively and because there is disagreement over what counts towards the goal. In fact, climate finance target has become a major bone of contention in international climate talks. The recent climate discussions in May-June 2021 to prepare for the upcoming and highly crucial COP 26 at Glasgow were left hanging because of lack of progress on this issue.

Looking deeper into climate finance conundrum one finds beyond the actual number of flows, it is representative of the commitment by developed countries towards developing countries in helping the latter to adapt and mitigate. It is well recognized that $100 bn is way too low in comparison to the amount of climate finance actually required. To get a perspective on this, annual adaptation costs alone (not talking about mitigation costs[9], which at present get most of the climate finance focus) in developing countries are currently estimated to be around US$70 billion, with the expectation of reaching US$140–300 billion in 2030 and US $280–500 billion in 2050 according to UNEP. So, clearly $100 billion is not sufficient and yet even this amount remains elusive. Hence, developing countries are of the view that getting developed countries to firm this up is crucial to building trust[10] in climate negotiation talks and also vital to the success of COP 26[11].

Multilateral Developmental Banks, Climate Finance & Beyond

Multilateral Development Banks (MDBs) such as World Bank, European Investment Bank (EIB), and Asian Development Bank (ADB) work as financing institutions that provide long-term financing for various projects mostly in developing countries. Typically, developed countries are amongst the biggest donors for the funds loaned out by MDBs and particularly so for their concessional lending. Energy and Environmental Sustainability projects are key focus areas for these agencies, among others such as infrastructure, education, etc.



Two major aspects of funding by MDBs are getting redefined by global climate action commitments-

First, of course is the area of climate finance. In 2019, MDBs had committed US $ 61.6 billion, in climate finance, World Bank, which is the leading financer, spent 28% of its total spend on climate finance in 2019. World Bank plans to raise its spend on climate finance to 35% by 2025. And MDBs collectively, plan to raise their commitment to climate finance to at least US$ 65 billion by 2025.

The other is the shift in MDB's energy sector financing away from fossil fuels. In the last decade (2009-2019), for instance, ADB had pumped in $42.5 billion into the energy sector across Asia. In its draft energy policy called "Supporting Low Carbon Transition in Asia and the Pacific," released in May 2021, ADB spelt out its plan to stop financing any coal mining, new oil, and natural gas field exploration as well as drilling or extraction activities. Conditional financing to natural gas infrastructure projects was however kept open, with higher thresholds. Similar is the case with other MDBs, although none of these have stopped fossil fuel financing completely.

Sovereign Wealth Funds-Lagging

Some of the biggest Sovereign Wealth Funds (SWFs) have been built from surplus oil export revenues- Norway Government Pension Fund Global, Abu Dhabi Investment Authority, Kuwait Investment Authority, Public Investment Fund of Saudi Arabia, to name a few. Unlike forex reserves, which are invested in short term foreign government securities, the time horizon of investments by SWF (which are owned and managed investments) is usually medium to long term with the objective of inter-temporal income stabilization. Hence by definition SWFs seem to be equipped to handle the risk of climate change, which is long term in nature. Moreover, with energy transition as a long-term threat to export revenues of their governments, investing in green portfolios could serve as a means of inter-temporal income stabilization. Yet, their very origins in fossil fuel revenues seem to be the reason for their lack-lustre performance in this area. SWFs that control close to $9 trillion in assets, are lagging in their climate focus. As per a study by International Forum of SWFs (IFSWF), only 8 SWFs from a group of 34 have more than 10 % of their portfolios invested in climate-related strategies. While, SWFs have invested US$7.2 billion in renewable energy since 2015, it is less than a third of the funds invested by these in oil and gas.

Central Banks- Expanding their realm

Central Banks or Monetary authorities are increasingly recognizing climate change as an issue that presents both risks and opportunities and which has implications on their policies and can be influenced by their policies. The Bank of England (BOE) has been the pioneer in this, with climate change high on its agenda since 2015. In June 2021 the BoE launched its first green stress tests of top banks and insurers to assess how exposed they are to climate risks. The European Central Bank under the leadership of Christine Lagarde is making headway in this area, with the current President having climate change as one her key priorities. ECB is currently using supervisory powers to force banks to own up to their role in financing polluters, and is planning conduct a climate stress test similar to that of BOE by 2022. It is learnt that ECB is also looking at tailoring monetary policy to favour companies working to reduce their carbon footprint or to punish polluters, through options such as skewing asset purchases[12] to favour companies with low emissions, modifying rules to make it harder for lenders to fund polluting projects.

Any discussion about Central Banking is incomplete without talking about US Federal Reserve (Fed). US Fed has joined the Network for Greening the Financial System (NGFS), an international group exploring ways to build climate risk into bank management, supervision and regulation. Fed has begun conducting more research on the economic implications of climate change. However, it has been reluctant to go as far as other central banks such as ECB and BOE on climate change, with policies to tackle climate change seen largely as an area to be addressed by elected officials.

Talking about India, RBI joined the NGFS in April 2021, however, has refrained from explicitly expressing a desire to re-examine its own monetary policy framework or indicating whether it is moving to incorporate climate change policies.

Besides regulations, voices asking central banks to internalize climate change in their monetary policy and inflation targeting frameworks are emerging. Former Reserve Bank of India, Governor, Urjit Patel opines13 that since emissions are linked with economic activity and climate change poses a risk to output in the short term and over the long term "ignoring climate risks will complicate macroeconomic management, just as overlooking financial risks eventually led to the GFC (Global Financial Crisis)".

Epilogue

Despite the financial sector getting on the climate bandwagon, climate finance still falls short of the promised amount. Further, "climate risk is systematically under-priced in financial markets" , with financing of fossil fuels by world's biggest 60 banks rising . Criticism for greenwashing in ESG investment points to that fact that there is much talk and less work for greening financial portfolios. Moreover, even with best intentions, given the fact that greening of asset portfolios continues to be work in progress, a lot of work in terms of development of standards and best practices remains to be done.

In India too, ESG funds, ESG indices and sustainability reporting by financial players are flourishing, as is financing of green projects. However, despite this, India is facing financial challenges to meet its 175 GW RE target. A recent report by a Parliamentary Panel has asked the Indian government to address the issues of non-performing assets in the sector and focus on attracting international funds to boost growth to raise the Rs. 2.6 trillion required for installing the balance of 175 GW target.

1. And, of course digitalization is the other driver-be it through digital currencies like Bitcoin or through FinTech; 2. Many big financial sector players have even taken up net zero targets.; 3. A green bond is a fixed-income instrument designed specifically to support specific climate-related or environmental projects.; 4. The pricing of carbon risk in syndicated loans: which risks are priced and why? by Torsten Ehlers, Frank Packer and Kathrin de Greiff Monetary and BIS Economic Department, June 2021; 5. A syndicated loan, is a loan offered by a group of lenders—referred to as a syndicate—who work together to provide funds for a single borrower. The borrower can be a corporation, a large project, or a sovereign government.; 6. Digital Financial Technology; 7. Financial inclusion means that individuals and businesses have access to useful and affordable financial products and services that meet their needs – transactions, payments, savings, credit and insurance.; 8. As per Swiss Re AG's Report; 9. Out of the annual flow of climate finance mitigation gets 76% allocation, while adaptation gets the remaining 24; 10. According to Saleemul Huq, director of the International Centre for Climate Change and Development in Bangladesh, "It isn't that $100 billion is going to solve everything, but $100 billion promised and not delivered is going to create distrust." Source: WRI; 11. COP26 President Alok Sharma has said that the delivery of the "totemic 100 billion US Dollar" in climate finance from developed countries to developing ones to tackle climate change is crucial to the success of COP26; 12. ECB's current asset purchase programme is to the tune of 80 billion euros per month; 13. "Central banks must stop pussyfooting on climate", Urjit Patel, Business Standard Opinion; 14. Andrew Bailey, governor of the Bank of England, has said that there is increasingly persuasive evidence that climate risk is systematically underpriced in financial markets (Source: FT.com); 15. Fossil fuel financing rose from $700 bn in 2016 to $800 bn in 2019. "Although overall fossil fuel financing dropped in 2020, bank financing from January to June was the highest of any half year since the adoption of the Paris Agreement." Source: Banking on Climate Chaos Report 2021

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India's Green Shift for Cleaner Future



Hiten Sutar
Director

Neetu Vinayek
Partner

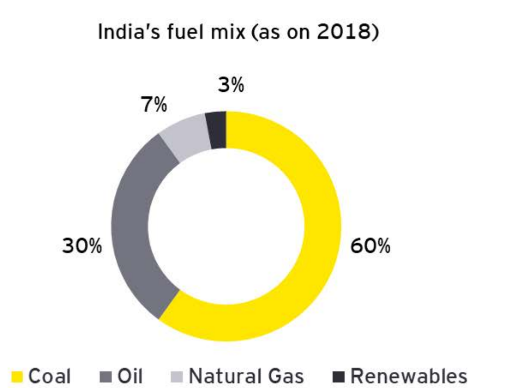
Ramanpreet Oberoi
Manager

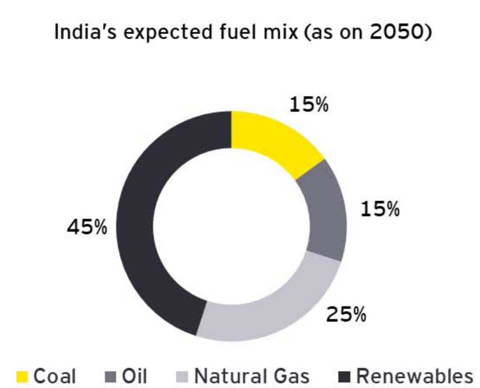
Ernst & Young LLP

The world has been blitzed by climate change calamities. Floods, blazing forests, heatwaves, cloudbursts, etc. in various parts have broken new records, re-emphasising the urgency of controlling carbon emissions. Fossil fuels are the worst nemesis of carbon emissions and climate change. Countries must monitor and curtail their fossil fuel consumption - this may help retard global warming effects, thought inevitable, to the extent possible and controllable by human intervention.

India is labelled as the world's third largest crude oil importer and has historically accorded preferential status to fossil fuels to satiate its energy hunger. India's energy demands are growing rapidly as its population moves from low income groups to middle/ high income groups. Mindful of the global atmosphere, India is painting a different picture this time - it is gradually shifting its focus from high emission to low emission fuels such as natural gas and renewable energy for its energy needs. This is also in line with India's commitment at the Climate Change Summit (Paris 2015) of reducing greenhouse gas (GHG) emissions by 35 percent over 2005 levels.

If clean energy is not on the pedestal of India's energy needs in the coming future, it may be among some of the largest emitters of GHGs in the world. To address this, India has been consciously implementing a range of energy market reforms to integrate high share of renewable energy sources into its grid. Indian Government is determined to rejig its energy mix to increase natural gas component from current levels of 6.5 - 7% to 15% by 2030 and by 2050 it is likely that renewable energy sources would dominate India's energy matrix. A broad overview of India's current vis-à-vis expected energy basket is given below:[1]





Needless to say, India's move towards clean fuels will not only brace its commitment to the Paris Accord but will also ameliorate the fiscal pressure cast by import of fossil fuels on India's national budget.

Sustainable Alternative Towards Affordable Transportation (SATAT) scheme

One of the avant-garde initiatives that embodies Indian Government's intentions and ambitions is the SATAT scheme which envisages setting up 5,000 Compressed BioGas (CBG) units across the country to produce 15 million tonnes of CBG by 2023. This initiative can attract investments worth Rs 2 trillion as per former Oil Minister Mr. Dharmendra Pradhan.

What is CBG

CBG consists of mainly methane (more than 90%) and other gases like carbon dioxide (less than 4%), etc. and is produced by anaerobic digestion of biomass and waste sources like agricultural residue, cattle dung, sugarcane press mud, municipal solid waste, etc. Once biogas is purified (process of removing of hydrogen sulphide, carbon dioxide, water vapor), its methane content crosses the 90% mark. Purified biogas is compressed and filled in high pressure cylindrical vessels which is called CBG.

CBG is like CNG which means CBG has potential to easily replace CNG as an alternative renewable transport, industrial and commercial fuel. In fact, Ministry of Road Transport and Highways has already permitted usage of CBG for motor vehicles as an alternate to CNG – ie vehicles running on CNG can be straightway be filled with CBG without any modifications.

Composition and calorific value akin to CNG makes CBG a lucrative clean fuel not only for manufacturers but also consumers. CBG can be seamlessly integrated in various sectors with little or no structural change to existing infrastructure and technologies.

Scheme modus operandi

PSU Oil Marketing Companies (OMCs) act as one of the cornerstones in the SATAT scheme. OMCs invite expression of interest (EOI) from desirous entrepreneurs to set up CBG plants and supply CBG for sale as automotive & industrial fuel to OMCs. OMCs also play a crucial role in the marketing and sale of CBG produced by the entrepreneurs.

The country has a strong network of 1,500 CNG stations which currently serves about 32 lakh gas-based vehicles2 – this is a huge leverage point for the OMCs to market the green transport fuel alternative.

CBG plants are proposed to be set up mainly through independent entrepreneurs. As the daunting task of marketing and sale of CBG is addressed by OMCs, the Plant owners can concentrate on the planning, preparation, engineering and executing of the project, including storage of raw material, operation and maintenance of the plant, maintaining final product output quantity and quality and managing the by-products & wastes from the plant.

Some key scheme enablers are

- In addition to offtake and marketing of CBG, OMCs offer assured long-term pricing to plant owners under contracts
- Central financial assistance of up to Rs 10 crore per project has been notified by Ministry of New and Renewable Energy (MNRE)
- CBG plants have been accorded "priority sector lending" categorisation by Reserve Bank of India
- Government is working towards synchronization of CGB with City Gas Distribution (CGD) pipelines for seamless evacuation and sale / distribution of CBG. Integration of CBG with CGD will address structural / infrastructural issues associated with sale of CBG
- Banks like State Bank of India and Bank of Baroda have dedicated financing for CBG plants to be set up under SATAT
- CBG plant owners are required to offer nominal bank guarantee
- Invoices raised by plant owners are required to be cleared fortnightly
- Plant owners have the liberty to sell excess CBG to consumers other than OMCs, if they so desire

Tax incentives for CBG Plant Owners:

Impact of the above scheme enablers is amplified by various incentive available to CBG plant owners under the Indian tax regimes.

Direct Tax incentives and exemptions for CBG Plant Owners includes:

1. 100% profit linked deductions for 5 years – this incentive provides that the profits earned by the entrepreneur is not subject to tax for the initial five years. While the profits are exempt from taxation, the entrepreneur is still subject to Minimum Alternate Tax (MAT),

2. Concessional corporate tax rate of 17.16% would be eligible for companies owning biogas plant, if they are incorporated after 1 October 2019 and begins manufacturing on or before 31 March 2023, subject to fulfilment of certain conditions.,

3. special incentives for eligible start-ups which also includes full deduction on profits for 3 years, subject to meeting certain conditions.

On indirect tax front, CBG Plant Owners in addition to input tax credit optimization can explore benefits under Manufacturing and other Operations Warehouse Regulations, 2019 for deferment of custom duty on capital goods imported.

To promote the CBG initiative, the state and central governments offer investment subsidy (net SGST reimbursement), interest subsidy, stamp & electricity duty exemptions, etc. Further, MSMEs can explore added incentives such as interest subvention, collateral free loans.

Recommendations

Exemplar as the scheme may be, it appears there is substantial work due in making CBG a preferred substitute of CNG. There is growing discourse in the industry about CBG, but full-scale production and usage is yet to be witnessed.

The scheme was introduced in October 2018 but as of May 2021, efforts seem to have translated into only 1550 issued LOIs, little over 10 commissioned CBG plants and 1369 tonnes of sold CBG.

These numbers don't even compare of the aspirational targets of the government. It is incontrovertible that CBG still requires emphasised and energetic actions from the authorities before it becomes one of the mainstream fuels.

One of the fundamental adjustments that can be considered is assured off-take from CBG Plant Owners to a certain extent – this may be in the form of tailored take-or pay arrangement. Currently the OMCs do not guarantee off-take of CBG produced – they will only "endeavour" to offtake.

While there are incentives for CBG plant owners under the scheme and tax regimes, entrepreneurs still have to cough-up substantial upfront investment which is marred by long gestation period required in setting up the plant on a sizable land. Inflation and interest rates haven't been at their best for entrepreneurs. Considering the current market situation and the need to promote the scheme, the government may consider providing assured interest subsidies at least in the initial years.

Entrepreneurs already operating anywhere in the CBG value chain may consider collaboration with other Indian or Foreign companies to share financial commitments and gain technological edge.

Biomass is available in abundance in the country. If harnessed consciously, this renewable energy could take centre stage in India's growth story providing lasting prosperity, greater energy security and realising Prime Minister's vision of enhancing farmers' income, rural employment, and entrepreneurship.

What is considered waste today can truly transform India's energy landscape.

1 Source: BP Energy Outlook 2020 edition
2 https://iocl.com/pages/satat-overview

KGD6 Project R & S Cluster Development

Project Overview

McDermott's scope of work for Reliance Industries Limited KG-D6 Project, off the east coast of India, was to plan, engineer, design, procure non-company-furnished materials, fabricate, transport, install and hook-up, pre-commission and provide commissioning support for the subsea facilities, including pipelines and umbilical and modifications on the Control and Riser Platform (CRP).

The Project included:

- **230 km** of rigid flowlines (14 no.) ranging from 4" to 18" diameter, to be installed in water depth of up to **2,150m**
- **29 Ixn-line structures** (PLETs & ILTs) and **31 jumpers**;
- **1 SSIV** and **4 subsea manifold** structures including their foundations with maximum weight of **~520MT**.
- **154 km** (16 no.) of umbilicals with diameter range from 95 mm to 235 mm were installed in similar water depth.
- Major brownfield modification work was carried out on the existing CRP platform to accommodate production from R and S Cluster wells and connect to the export trunkline GTL2 and GTL1.
- Topside scope included associated modifications to electrical systems, control systems including HIPPS, flare and vent system, fuel gas system, HVAC package, chemical injection skid etc.

The R Cluster subsea facilities installation was completed during second quarter of 2020 and CRP modification work was completed during fourth quarter 2020. The S Cluster marine campaign was carried out during December 2020 to April 2021.

HIGHLIGHTS
ULTRA-DEEP WATER DEPTH – 1,560M TO 2,150M
1,200+ VESSEL DAYS.
12 MAJOR ASSETS
2,000+ CREW OFFSHORE
3 MARINE CAMPAIGNS / SEASONS

230 KM OF PIPELINE (14 NOS)
31 JUMPERS
4 SUBSEA STRUCTURES

154KM UMBILICAL (16 NO) 29 SUBSEA IN-LINE STRUCTURES
2 CRP RISERS

Challenges

- One of the deepest pipeline installations in Asia
- First ever J mode installation of 29 PLET structures for installation vessel DLV2000
- A first-of-its-kind piggyback pipeline and dual PLET (18" + 4") installation at 1,965m water depth
- Installation of 4" pipeline (often termed as "spaghetti" in this water depth)
- Installation of longest dual riser (18" / 4") in Indian waters - 110m long
- Large-diameter composite umbilical transpooling/loadout and offshore installation
- Subsea pre-commissioning activities of pipelines and umbilical using ROV operable equipment & test set ups
- Maintained progress through two severe cyclones and monsoon season during execution of marine activities/CRP modification works
- Notorious Bay of Bengal weather conditions. High surface current and subsea currents and cyclone area poses challenge to work within limited workability window
- Navigated challenges of COVID-19 and ensured business continuity
- Impact on supply chain and logistics due to COVID-19 pandemic

Execution Excellence

- Maintained excellent safety records by implementing various HSES initiatives; TRAs; communication cards, mock drills etc. overall, 5.2 million LTI free work hours were recorded.
- 1,000+ TRAs were conducted; 178 HSE initiatives were implemented; 2,900+ personnel attended HSES induction; 262 mock drills were performed during 1,279 days of Work.
- Maintained best-in-class quality record resulting in exceeding target weld repair rate of <1% (actual achieved 0.6%) for ~ 19,000 weld joints performed offshore during subsea pipeline installation.
- Upheld the Indian Government's 'Make in India' initiative by maximizing the work scope executed in India:
- Overall, 1.4 million work hours were executed in the fabrication yard set up in Kakinada.
- Number of local man-power trained and developed skills to carry out specialized activities such as Subsea structural design capabilities, ROV tooling technicians, dimensional control experts, Automatic UT.
- Cadet program was implemented in compliance with requirement of Government of India
- Implemented a piggy-back firing line system onboard DLV2000 to improve efficiency during 18" / 4" piggy-back pipelines

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- Bespoke piggyback block design (PP-20 Glass fibre reinforced PU Material selected to avoid compression at ultra-deepwater depths) and rigorous testing regime implemented to ensure integrity
- Automatic Ultrasonic Testing (AUT) used for testing of welded pipeline joints offshore and McDermott's in-house automatic welding system (AWS) used for welding of linepipe
- Jumper fabrication at Kakinada was supported with post installation 3D metrology. FIT / SIT performed prior to loadout of jumpers
- First jumper trial fitting carried out using mock ROV and structures to eliminate any mismatch during offshore installation
- Coil tubing equipment was introduced to carry out pipeline pre-commissioning. This innovative step provided a highly reliable and efficient method to perform these operations in deep water
- MEG slug with Nitrogen was used for 4" pipeline dewatering to avoid risk of stuck pig

- Due to limitation of MBR; 3 of the umbilical were transported on reels from Newcastle UK to Kakinada India.
- Transpooling from reels on HLV to umbilical installation vessel (NO102) carousel was carried out at quayside in Kakinada
- Existing CRP Platform design, built and installed by McDermott in 2007-08, required modifications to accommodate additional gas
- 300+ Vessel days offshore from Jan to Dec 2020 to carry out brown-field modification works on CRP
- Brownfield engineering was carried out from Chennai office involving multiple site visits, 3D Model reviews, constructability reviews
- Expert workforce with brownfield execution experience from Dubai office was deployed
- Pressurized habitats were used during initial working on live operating platform
- To operate during monsoon, heave compensated gangway was deployed to improve workability

Covid-19 Management

- New digital experience, remote working.
- Maximised remote audits, vendor assistance and diagnostics to mitigate challenge posed by restricted travel.
- Vessel clearances and personnel mobility including visa arrangements with minimum to no downtime achieved with the proactive logistics team (1,300+ crew with 30 nationalities were mobilized during pandemic period).
- Chartered international flights to mobilize 230 personnel from various international locations.
- Dedicated COVID-19 management team deployed to address logistical challenges resulting from COVID-19 pandemic. Implemented onboard
- COVID testing facilities on McDermott's main assets.
- Stringent Bio-bubble - Dedicated hotels and / or dedicated floors in hotels for quarantining crew. Security management by McDermott.
- No major outbreak on any marine vessels, marine base or fabrication yard.

Digital Initiatives

Deployed digital initiatives to deliver schedule advantage and cost efficiencies

- For the Brownfield execution scope, all aspects were modeled in a 3D environment and clash checks performed including ROV simulation checks to mitigate risks offshore; this involved staged model reviews with multiple stakeholders attending virtually across the world.
- Remote document reviews and paperless approval of documents.
- Digital presence for pre-comm support from Vendor tech.
- 3D metrology was performed for all subsea jumpers tie in – this resulted in flawless execution without the need for any rework
- Due to the pandemic induced work from home mode of operation, major activities such as constructability reviews / site testing / vendor support during start-up etc. which typically occur in person were performed remotely.
- FIT testing between the Subsea Master Control System (supplied by SPS contractor One SubSea) and the Topside DCS (supplied by ICSS vendor) typically happens at one of the facilities by shipping the panels and connecting them with the other side and demonstrating all functionalities. However, due to the pandemic induced restrictions, the team created a remote testing protocol for the S Cluster scope by having a series of virtual servers at either ends, to simulate the physical interface and complete the entire testing. The actual integration between the MCS and DCS offshore was flawless.

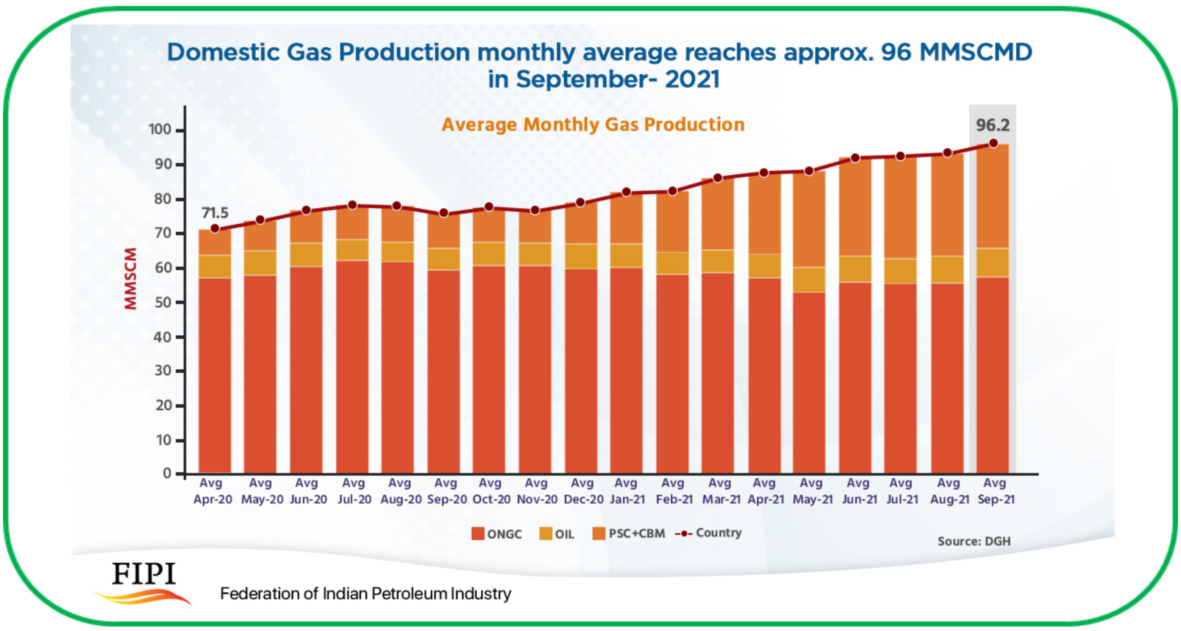
Benefit of Digital Initiatives

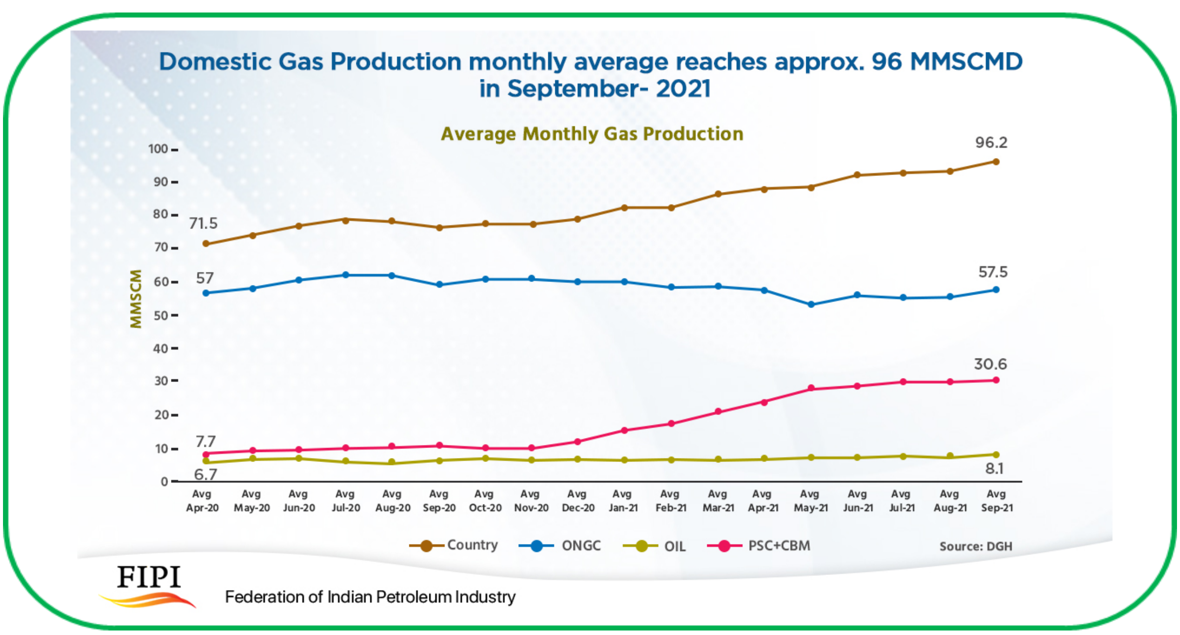
- As a result of detailed review of 3D model and constructability reviews, the offshore installation was flawless and avoided any clashes or re-work. This is typically a huge risk in brownfield modification works on an operating manned platform.
- Accurate metrology data was gathered after installation of flowlines, fabrication of jumpers was carried out exactly per post-metrology measurements, thereby avoiding any risk of subsea misalignment of jumpers during installation.
- Avoiding clashes and misalignment offshore benefited the project by achieving schedule certainty.
- COVID-19 pandemic schedule risks were mitigated by virtual meetings including conducting reviews, obtaining vendor support remotely, including factory integration test; assisted in achieving schedule benefits and not causing insurmountable project delays.

MITIGATED COVID-19 PANDEMIC RISKS TO DELIVER PROJECT EXECUTION EXCELLENCE

ACHIEVED FIRST GAS ON R CLUSTER IN DECEMBER 2020 AND ON S CLUSTER IN APRIL 2021

DOMESTIC GAS PRODUCTION IN INCREASING TREND





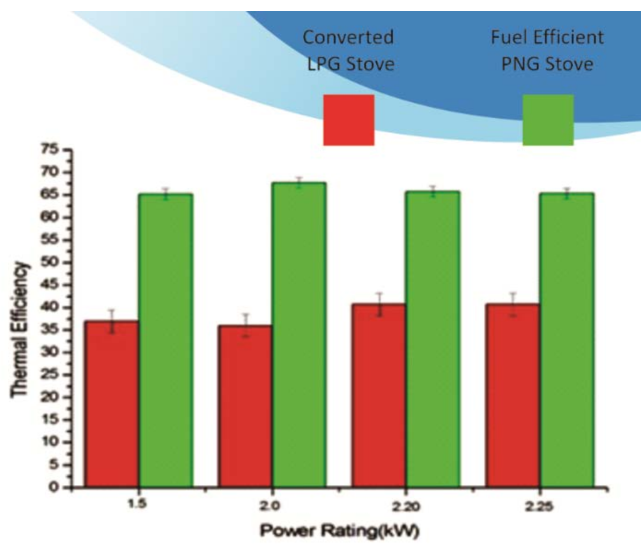
PNG Stoves– The Next Generation Cooking Stove for Domestic Kitchen

Manoj Kumar Acharya
Additional Director (S&L)

Petroleum Conservation Research Association (PCRA)

Piped Natural Gas (PNG) is being seen as the alternate to LPG for domestic cooking. At present, there are more than 70 Lakhs of PNG consumers in India and the numbers are rising progressively with new connections being made every day. By completion of work under PNGRB's 10th Bidding round in next 08 years, the total number of domestic PNG customers is estimated to reach more than 400 Lakhs[1], i.e more than 50% of Indian households.

Hitherto, domestic PNG consumers are using a LPG stove by modifying the gas injector. With this modification, the modified LPG stove when used on PNG service has a Thermal Efficiency of approximately 40%. This act of modification is a huge compromise when viewed in perspective of energy efficiency and conservation of a perishable resource. Moreover, the act of tampering with a standard LPG Stove results in its non-compliance of relevant BIS standards. To mitigate this anomaly, a novel fuel efficient domestic cooking burner dedicated to PNG service has been developed and commercialized by PCRA and CSIR-Indian Institute of Petroleum, Dehradun.



LPG & PNG are two different fuels with different physical & chemical properties. Theoretical study on the interchangeability of LPG and PNG indicates that interchangeability of fuels directionally depends on the Wobbe No. of the gasses and the Wobbe No. of gas depends on the composition and physicochemical properties. Since there is significant difference in the Wobbe Number of LPG and PNG are different, PNG cannot be directly used in the LPG stove. Also, changing supply pressure in atmospheric burners (by modifying the injector) affects the flame characteristics as the different burning velocity of gases may cause "Flame Lift" or "Flash Back" during application.

The newly developed PNG burner comprises a gas injector with a diameter suitable for injecting PNG in a range of flow rates at a fixed supply pressure of 21 mbar. The injector is in alignment with mixing tube and mixing tube throat has been designed for the required primary aeration to allow entrainment of air thus leading to adequate air-fuel mixing. The mixing tube is designed to prevent frictional pressure losses. The top portion of the burner head has ports with defined diameter to support high flow rate flames.

The holes are on the defined tapered faces of the head to spread the flame in a larger circular area. The burner head and gas manifold have a circular body with a central hole to support secondary air entrainment. The loading height has been optimized for improved heat transfer from flames to the cooking vessel using Computational Fluid Dynamics (CFD) models. The newly developed PNG burner has a thermal efficiency of around 55% which is approximately 25-30% more in comparison to the modified burners used with PNG. Further PNG stoves using these fuel efficient dedicated PNG burners also meet the specifications of BIS 17153:2019, promulgated for PNG Stoves.

Features of the Dedicated PNG Stove

1. A product 100% conceptualized and made in India.
2. The only PNG burner meeting the BIS standard for domestic PNG burner IS 17153:2019.
3. An improvement of 25-30% in thermal efficiency over the existing converted LPG stove and consequent reduction in gas consumption.
4. Ensures safety by eliminating the flame lift and flashback.
5. Provides optimized temperature profile for efficient cooking.

These newly developed PNG stoves have a similar look as that of commercially available LPG stove and are available in various options – Steel base / Glass Top with 2-to-4 burner configuration. As of now, IIP-Dehradun has made the technology transfer to 40 gas stove manufacturers in India for commercialization of the technology and 10 manufacturers have commenced commercial production. To ensure authenticity of the product, every genuine PNG stove manufactured under the license of CSIR-IIP will have a unique Logo in Body of stove and holograms on the Mixing tube. The Logo can be scanned by the distributor and customer for its authenticity verification

AVAILABILITY

- ☆ Available in various option – Steel Base / Glass Top / 2-to-4 burner configuration
- ☆ Major LPG Gas stove Manufacturers are into PNG Stove Manufacture
- ☆ Can be made available through CGD companies.
- ☆ Cost is almost same to LPG Stove of similar model

Adoption of this newly developed energy efficient PNG stove will benefit domestic households as well as nation as a whole. As per an estimate, the nation will be benefitted by savings of more than 150 crores over a period of two years with 10 lakh customers adopting this new stove.

The major challenge in adoption of this new technology is lack of mass awareness. PCRA has been striving on promoting this newly developed PNG stove through its social media campaign, website and Mygov platform. PCRA has also conducted seminars / workshops for stakeholders in major cities of India, involved CGD companies to promote the stove among their customers as well as through public display at Exhibitions and various locations in NCR. To carry forward, schemes similar to "Ujala" or "Ujjwala" may be the harbinger of change. Further, regulatory guidelines for use of only BIS approved domestic PNG stove would also help us as a nation in saving of natural gas and also reducing the carbon footprint of domestic sector.

1 – PNGRB Annual Report 18-19

Oil & Gas in Media

Shri Hardeep Singh Puri takes charge of the Ministry of Petroleum and Natural Gas as the Cabinet Minister
Shri Rameswar Teli took charge as the Minister of State in the Ministry

Shri Hardeep Singh Puri took over the charge of the Ministry of Petroleum and Natural Gas as the Cabinet Minister on 8th July 2021. Shri Rameswar Teli took charge as the minister of state in the ministry. Shri Dharmendra Pradhan, who was holding the charge before the cabinet reshuffle, was also present on the occasion.

Shri Puri on the occasion made the following statement:

"Today, I feel honoured by the trust reposed by the Hon'ble Prime Minister, Shri Narendra Modi Jee who has made me the Cabinet Minister of this important ministry. Shri Dharmendra Pradhan Jee's are big shoes to fill.

The work of this Ministry touches each and every citizen in the country directly or indirectly. The energy issues in this Ministry have immense potential and several challenges. The need to adapt to changing times, adopt new technologies and to be in consonance with the energy transition taking place across the world, provides a fascinating opportunity.

As we transform towards a 5-Trillion economy, energy availability and consumption will be of paramount importance. My focus will be on increasing domestic production of crude and natural gas, in line with the Prime Minister's vision of Aatamnirbhar Bharat.

I will also work towards development of a natural gas-based economy in the country and increase the share of natural gas in primary energy mix of the country to 15% by 2030 as announced by Hon'ble PM.

In the last seven years, under the able guidance of my predecessor Shri Dharmendra Pradhan Jee, a number of path-breaking reforms and initiatives have been ushered in the sector. I would strive to take them forward, and fulfil the expectations of the Prime Minister, our people and the country."

Source: PIB

Conference on Oil and Gas opportunities in North Eastern Region

Ministry of Petroleum and Natural Gas, Government of India organized an event in Guwahati to showcase Upstream Oil & Gas opportunities in North East Region (NER) on 24th September 2021. The plenary session of the event was chaired by Union Minister of Petroleum and Natural Gas, Shri Hardeep Singh Puri. Assam Chief Minister Dr. Himanta Biswa Sarma, Minister of state for Petroleum and Natural Gas Shri Rameswar Teli and Ministers from Sikkim, Arunachal Pradesh, Nagaland, Manipur and Mizoram took part in the event. Secretary MoPNG, senior officials of the Central and State Governments, DGH and various stakeholders took part in the meeting.

Speaking on the occasion, Shri Puri said that NER, with its abundant natural resources, rich cultural heritage and huge opportunities for growth is central to our country's development agenda. The North-Eastern States of India are perceived to be highly prospective based on available geo-scientific information and hence ample opportunities for potential oil and gas finds through accelerated exploration exists in the region.

Shri Puri said that the NER is of strategic importance for India. In line with its intent of rapidly transforming the region, the Government of India has undertaken many key initiatives to augment Infrastructure and pace economic development. He mentioned about following key Oil and Gas initiatives in the NER:

1. Oil and Gas Projects worth Rs 1 lakh Crore are approved and are expected to be completed by 2025 [Major Projects: Upstream (27,000 Crore), NRL (30,000 Crore), IGGL (10,000 Crore), CGD & Others (33,000 Crore)]
2. Special Bidding Round under OALP for NER with acreages being carved out by Government and offered with Additional Incentives for attracting Investments
3. Doubling the exploration acreage in NER from existing 30,000 Sq. Kms to 60,000 Sq. Kms by 2025 (Approx. 20,000 Sq. Kms of area already awarded under OALP over last 3 years in NER)
4. Plans to Double the Oil and Gas production from current 9 MMTOE to 18 MMTOE by 2025
5. Plans to set up a dedicated service provider hub in NER to support the requirement of Oil and Gas Industry in collaboration with State Governments
6. Implementation of North East Gas Grid (NEGG) to provide access of natural gas to end-user in north-eastern region
7. Six Geographical Area (GAs) comprising of 18 Districts in the State of Assam and Tripura are on offer under the 11th Round of CGD Bid Round for developing the City Gas Distribution (CGD) network.

Shri Puri announced that Digboi refinery in Assam will be expanded. He also assured that the issue of blending ethanol with petrol at the refinery level will also be explored.

Shri Puri said that the outlook of E&P business in North East Region is indeed promising. There is a huge hydrocarbon potential waiting to be tapped; of the estimated 7600 MMTOE in the North-East, only 2000 MMTOE has been discovered so far. With concerted efforts by industry and governments, oil production is expected to increase by 67% from 4.11 MMT in 2020-21 to 6.85 MMT in next 4 years. Gas production is forecasted to more than double from 5.05 BCM in 2020-21 to 10.87 BCM in next 4 years.

Calling upon the investors to actively participate in upcoming rounds and become part of the national E&P enterprise which is set to gather momentum in the days ahead, Union Minister said that much impetus has been given to NER in recent past, which will act as catalyst for the envisaged future growth in the region.

The objective of the conference was to highlight the portfolio of high-volume Oil and Gas assets of Indian Sedimentary basins, and to promote the Bidding Rounds of Hydrocarbon Exploration and Licensing policy and Discovered Small Field Policy. The event saw enthusiastic participation from Central and State Government, leaders of National oil companies, private E&P companies, Service Providers and Academic Institutions.

Theme of event was aligned to Hydrocarbon Vision 2030 for north-east India, which is a paradigm shift in production and utilization of hydrocarbons to catalyze growth in the North East region and to improving standard of living for the people, generating opportunities for the youth and creating a sustainable energy secure future.

This was one of biggest E&P sector event of recent time in the region which was exhaustively planned with a comprehensive set of presentations and panel discussions touching a gamut of topics pertaining to E&P sector.

E&P opportunities showcased at the event:

1. OALP Bid Round VI- 21 Blocks on offer across 11 sedimentary basins covering ~35,346 Sq. Km of area. Out of 21 Blocks, 15 Blocks are Onland type, 4 Blocks are Shallow Water type and 2 Blocks are Ultra Deep-Water type.
2. DSF Bid Round- III- 32 Contract areas (with 75 discoveries) on offer covering ~13685 Sq. Km of area with an estimated in place resource of 232 Million Metric tonne of oil equivalent.

Source: PIB

PM announces National Hydrogen Mission

Prime Minister Shri Narendra Modi formally announced the launch of a National Hydrogen Mission to accelerate plans to generate the carbon-free fuel from renewables as he set a target of 2047 for India to achieve self-reliance in energy. Delivering his Independence Day address from the ramparts of the Red Fort, he said India can achieve self-reliance in energy through a mix of a gas-based economy, doping sugarcane extracted ethanol in petrol and electric mobility. India, he said, spends over Rs 12 lakh crore on energy imports every year. While India is 85 per cent dependent on imports for meeting its oil needs, overseas supplies make up for roughly half of the local requirement for natural gas. "For India to progress, for Atmanirbhar Bharat, energy independence is necessary," he said. "India has to take a pledge that it will be energy independent by the year we celebrate 100th year of Independence." The roadmap for that is to increase usage of natural gas in the economy, setting up a network for supply of CNG and piped natural gas across the country, blending 20 per cent ethanol in petrol and electric mobility, he said. The country has achieved the target of 100 gigawatts of renewable energy capacity ahead of the target, Modi added. "I announce National Hydrogen Mission," he said. The target is to make India a global hub for production as well as export of green hydrogen. "Green hydrogen will give India a quantum jump in achieving its targets," he asserted. The National Hydrogen Mission was first announced in the Union Budget for 2021-22 in February this year. Hydrogen is produced predominantly through Steam Methane Reforming, or SMR, which utilises fossils fuels, such as natural gas or coal, and through Proton Exchange Membrane Electrolysis, which splits water into hydrogen and oxygen using a current of electricity. Currently, all hydrogen consumed in India comes from fossil fuels. By 2050, three-fourth of all hydrogen is projected to be green -- produced by renewable electricity and electrolysis. Speaking at the 'Urja Sangam' conference in March 2015, Prime Minister Modi had set a target of cutting India's oil import dependence from 77 per cent in 2013-14, to 67 per cent by 2022. Import dependence has, however, only increased. The government is now looking at substituting some oil by one that is produced from sugarcane and other bio-materials. It is looking to supply petrol mixed with 20 per cent ethanol by 2023-24, up from the current 8 per cent.

PNGRB Includes 50 CGD Areas Under Common Carrier List

The Petroleum and Natural Gas Regulatory Board (PNGRB) is seeking to declare more than 50 city gas distribution licensed areas, including Delhi, Mumbai and large parts of Gujarat, as common carriers. All the city gas areas identified for the purpose have already exceeded their exclusivity period. For cities like Delhi and Mumbai, the exclusivity period expired in 2012, while for many others it ended in the years up to 2021.

The downstream regulator's move is likely to affect city gas distributors like Indraprastha Gas in Delhi, Mahanagar Gas in Mumbai and Gujarat Gas in several cities. Other distributors that will be affected by this include Gail Gas, Indian Oil-Adani Gas, Bhagyanagar Gas, Maharashtra Gas, Sabarmati Gas, Central UP Gas, Megha Engineering and Infra, Tripura Natural Gas Company, and Rajasthan State Gas. In notices published on its website, the regulator has sought comments from stakeholders on the proposed move, which falls under Section 20 of the PNGRB Act. The notices carry details of the number of piped gas connections, length of pipeline, and CNG compression capacity in each city gas area. After the regulator declares a city gas area as a common carrier, the original licensee has to permit about 20% or more of its network capacity for use by other suppliers. Declaring city gas areas as common carrier, however, has not been easy for the regulator with licensees fiercely contesting past attempts in court. Indraprastha Gas has previously fought PNGRB in court over the exclusivity period.

City gas areas that the PNGRB has identified for common carrier include Bareilly, Kanpur, Dewas, Kota, Pune, Mathura, Kakinada, Sonipat, Meerut, Vijayawada, Thane, Indore, Firozabad, Hyderabad, Agra, Gandhinagar, Gwalior, Agartala, Anand, Surat, Ahmedabad, Hazira, Moradabad, Chandigarh, Allahabad, Jhansi, Bengaluru, Panipat, Daman, Haridwar, and Belgaum.

RIL to invest 75,000 Cr in Green Initiatives Over Next 3 years

Mukesh Ambani, chairman, Reliance Industries Ltd (RIL) has reiterated his commitment to invest Rs 75,000 crore over the next three years in green energy initiatives, including the Dhirubhai Ambani Green Energy Giga Complex in Jamnagar, as the global energy behemoth shifts its focus from hydrocarbons to renewable power. Ambani had first made the Rs75,000 crore investment announcement on 24 June at RIL's annual general meeting. Addressing the International Climate Summit 2021, Ambani said work was underway at a brisk pace to develop the 5,000-acre giga complex, which would be one of the world's largest green energy facilities, and that RIL was on track to become a net-zero carbon company by 2035. "Although the cost of green hydrogen energy is currently high, they are expected to fall significantly. New technologies are emerging for storage and transportation of green hydrogen which will lead to a further reduction in costs," Ambani said. The government is planning to create an enabling green hydrogen ecosystem which will attract investments," he added.

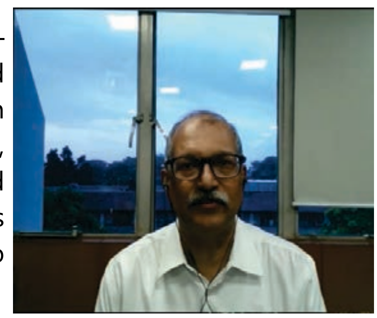
India has targeted 450GW of renewable energy capacity by 2030, of which RIL plans to establish and enable at least 100GW of solar energy. A significant part of this will come from rooftop solar and decentralised solar installations in villages. "This will create a pan-India network of kilowatt and megawatt scale solar energy producers who can produce Green Hydrogen for local consumption," said Ambani, adding that efforts are on globally to make green hydrogen the most affordable fuel option by bringing down its cost to initially under $2 per kg. "Am sure that India can set even more aggressive target of achieving under $1 per kg within a decade. This will make India the first country globally to achieve $1 per 1 kilogram in a decade-- the 1-1-1 target for Green Hydrogen," Ambani said. RIL has been focusing on a shift from oil and gas to new energy at a time when global consensus has been building for action against climate change. Energy majors including Royal Dutch Shell, Chevron Corp, and Exxon Mobil Corp are being pushed by environmentally concerned investors to cut emissions. As part of RIL's green energy investment, the oil-to-telecom conglomerate, at a cost of Rs 60,000 crore, will build an integrated solar photovoltaic module factory, an advanced energy storage giga factory and an electrolyser giga factory to manufacture modular electrolysers used for captive production of green hydrogen for domestic use as well as for global sale. RIL's fourth initiative will be the fuel cell giga factory. A fuel cell uses oxygen from the air and hydrogen, to generate electricity.

EVENTS

Energy Transition - CCS & Hydrogen

he Federation of Indian Petroleum Industry (FIPI) in association with Scottish Development International (SDI) organized an exclusive webinar on 'Energy Transition- CCS & Hydrogen on 14 July, 2021 over virtual platform. The webinar was aimed at understanding the new and emerging clean energy technologies especially CCS and Hydrogen. The team of experts joined from Scottish Development International (SDI) included Mr Peter Godfrey, Senior Regional Advisor, Storegga and Dr Edris Joonaki, Fluid Properties Expert/ Technical Lead, National Engineering Laboratory TUV SUD.

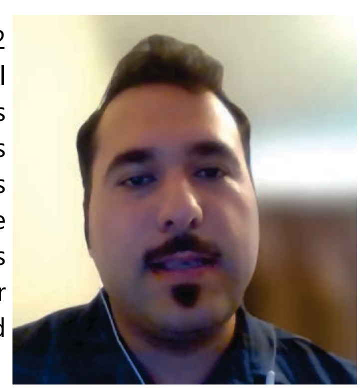
Mr Peter Godfrey represents Storegga, a company that exists to champion and deliver carbon capture and storage (CCS), hydrogen, and other subsurface renewable projects in the UK and internationally to accelerate carbon emission reductions. Dr. Edris Joonaki is Fluid Properties Expert/Technical Lead at TÜV SÜD UK National Engineering Laboratory. His research works have won several research funds as well as numerous UK and international awards.



Commencing the proceedings of the day, Mr T K Sengupta, Director – Exploration & Production, FIPI extended a warm welcome to the speakers and participants at the session. He highlighted that the oil and gas companies can use these technologies to generate clean energy by capturing the carbon, carbon sequestration and carbon storage. He further highlighted that Scotland being connected to North Sea is bringing a lot of technological advancements and FIPI will make its endeavour to connect the industries between these two countries for any potential collaboration in the energy transition space.

Mr Kevin Liu, Head of APAC Energy, SDI highlighted in his opening address that SDI is the Scottish Government's International Economic Agency with a core mission to develop, build and maintain effective global trade and investment partnerships and also to build a collaborative partnership with FIPI. He further highlighted that given the strengths and depths of the India and Scotland's petroleum industries, there is a lot to work through collective energy transition initiatives and CCS and hydrogen will be a key part of that collaboration.

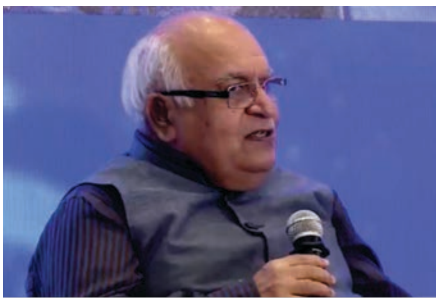
Mr Peter Godfrey in his presentation on the "ACORN CCS/ Hydrogen Cluster Project" highlighted the major macro factors driving CCS deployment. Those are : (i) Political (Climate neutrality, Net Zero, Carbon budgets, etc.) (ii) Economic (Carbon border taxes, Emissions trading schemes, etc) (iii) Social (Climate change movements, creating political will, etc) (iv) Technology (CCS is proven technology, only solution for heat and industry, etc.). He mentioned that Acorn is a low-cost, low-risk carbon capture and storage (CCS) project, designed to be built quickly, taking advantage of existing oil and gas infrastructure and a well understood offshore CO2 storage site. The project is located in north-east Scotland at the St Fergus Gas Terminal – an active industrial site, where around 35% of all the natural gas used in the UK comes onshore.



The next speaker Dr. Edris Joonaki talked about the "Technical aspects of CO2 Process Streams and Sequestration in Reservoirs". He pointed out that the oil and gas infrastructure such as subsurface reservoirs and transportation pipelines which have suitable capacity and ability, can be used for the CCS processes as well, however, there are some significant challenges associated with this strategy. These are: (i) Accurate CCS flow measurement: When we capture CO2, some impurities such as hydrogen, methane and other components present may give significant errors in the performance of the flowmeters for accurately measurement of CO2 (ii) Such impurities may cause CO2 induced Corrosion problems and CO2 rock dissolution & associated leakage challenges.

While briefing about the potential CO2 leakages from these storage infrastructures into the environment, he mentioned that again use of a thermodynamic model could successfully predict all such behaviours. Also, before doing any CO2 storage and projects, we need to carefully consider all below factors to avoid any challenges of CO2 leakage into this atmosphere: (i) Depth of the injection point pressure (ii) Temperature of the reservoir (iii) Salinity of the formation of water or aquifer (iv) Predicting the pH changes when we inject CO2 (v) Study the potential fluid flow reactive transport of the CO2 streams.

The next segment of the session was audience Q&A. For this session, an overwhelming number of questions were received from the audience, which also stood testimony to the audience interest on the subject. The one and a half hour long session witnessed an overwhelming participation by over 100 participants across the oil and gas value chain in the country.



Dr. R K Malhotra, DG FIPI in his closing remarks thanked speakers from SDI for collaborating with FIPI for energy transition topic on CCS and hydrogen. He further added that based on the presentation and discussion on CCS; some of our upstream companies attending the webinar can also focus to find the opportunity of capturing and storing CO2 from the industrial belt along the Bombay high and FIPI and SDI can jointly work and collaborate in this direction.

Strengthening NGV Ecosystem in India

Federation of Indian Petroleum Industry (FIPI) and Society of Indian Automobile Manufacturers (SIAM) jointly organized an exclusive Virtual Roundtable on “Expansion of Natural Gas Vehicle (NGV) Ecosystem in India” on 12 July, 2021. The roundtable was aimed at discussions regarding expanding the Natural Gas ecosystem, exploring opportunities for collaboration, raising concerns/issues, etc. The roundtable saw active participation from Top-level executives from Gas & Auto Industries.

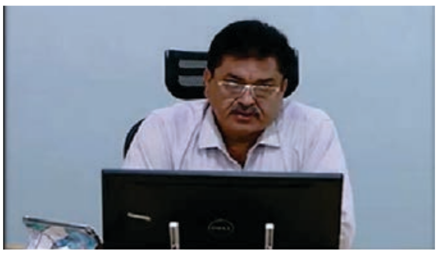
The speakers from Gas Industry included Mr Pramod Narang, Director (Technical) – Petronet LNG Ltd and Mr Raman Chadha, CEO – GAIL The speakers from Auto Industry were Mr Ashish Chutani; Head Govt & Policy Affairs, Maruti Suzuki India Ltd and Mr S Krishnan, Sr Vice President - Product Development, Ashok Leyland.

Commencing the day's proceedings, Mr Prashant K Banerjee, Executive Director, SIAM extended a warm welcome to the speakers and participants. He highlighted that the Government of India has laid out an ambitious plan of expending the CNG & LNG infrastructure across the country and this is possible only with the cooperation between the Gas and Automobile industry leadership.

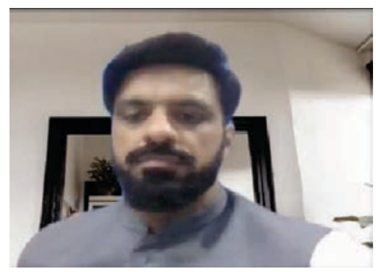
Dr. R K Malhotra, Director General, FIPI in his opening remarks highlighted that Natural gas has been identified as a fuel for reducing pollution and with the start of CNG vehicles in 90’s has helped a lot in reducing the pollution in cities like Delhi and Mumbai. He further added that Natural gas vehicles will be going to play a very important role in achieving the target of 15% gas share in the primary energy basket by 2030. In order to achieve such ambitious target, the gas industry and the Auto Industry has to Collaborate, Cooperate and Coordinate with each other.

Mr. Pramod Narang, Director (Technical), PLL in his presentation on the "LNG Infrastructure roadmap across India" emphasised that to increase share of natural gas from 6.3% to 15% in the Energy basket by 2030, a massive infrastructure development spanning RLNG Terminals, Natural Gas Transmission pipelines and City Gas Distribution is required and also a need to enhance India's LNG re-gas infrastructure to around 150 MMTPA (considering 80 % utilization).

He highlighted that apart from traditional sectors, new segments like LNG as an automotive fuel in M & HCV Segment of Vehicles, its usage in non-Road segments like Mining Sector and railways could take centre stage in growth story of gas sector in the coming few years.



Mr Raman Chadha, CEO – GAIL Gas in his presentation on the "CNG Infrastructure roadmap across India" highlighted 7% Growth in number of CNG vehicles from Mar'16 to Mar'20, 24% Growth in number of CNG Stations from Mar'16 to Mar'21, improved cost of ownership for CNG vehicles with increase in price of Petrol & Diesel and OEMs coming forward and promoting CNG in NGV Space.



The next session's speakers were from Auto Industry. Mr Ashish Chutani; Head Govt & Policy Affairs, Maruti Suzuki India Ltd informed that SIAM has created a group to collaborate with all stakeholders, including Government, Gas companies, component makers to facilitate higher adoption of natural gas vehicles (CNG and LNG) in India. The group represents all vehicle segments (Cars, Three Wheelers, Buses, Heavy Commercial Vehicles).

He further informed that there is a huge customer acceptance of CNG vehicles in the country and wherever CNG stations have critical mass, customers have adopted OEM CNG vehicles. There is huge untapped potential for exponential growth of CNG vehicles in the country.

Mr S Krishnan, Sr Vice President - Product Development, Ashok Leyland emphasised that the need of the hour is to have cleaner IC engines- that is having Clean & Renewable fuels, Clean combustion and Lower Emissions and in that direction Ashok Leyland is working to enable Multi Fuel adaptability. By introducing a spark plug provision, Multi fuel capability has been introduced thereby bringing innovation and addressing sustainability.

The next segment of the session was the discussion and interaction between the Gas Industry & Auto Industry. The 2 hour-long session witnessed overwhelming participation across the country's gas and auto industries. Several key issues were taken up for discussion by the participates with the panel of experts.

Lastly, Dr. Sandeep Garg, SIAM thanked speakers from the Gas and the Auto industries and FIPI for collaborating with SIAM for the Virtual Roundtable. The session was brought to an end, wishing all speakers and participants the best of health and happiness during the ongoing battle against COVID-19.

NEW APPOINTMENTS

Vartika Shukla assumes charge as Chairperson & Managing Director of EIL


Vartika Shukla

Smt. Vartika Shukla has assumed charge as Chairperson & Managing Director of Engineers India Limited (EIL) w.e.f. September 1, 2021. Smt. Vartika Shukla has the distinction of being the first-ever woman C&MD of the Company.

A graduate in Chemical Engineering from the prestigious Indian Institute of Technology, Kanpur, Smt. Shukla joined EIL in 1988 and possesses extensive consulting experience comprising Design, Engineering and Implementation of complexes in Refining, Gas Processing, Petrochemicals, Fertilizers etc. She has led to the successful completion of many prestigious projects for clients in Oil & Gas and Petrochemical Industry both in India and Overseas.

In line with Government of India's emphasis on deploying alternative fuel sources to supplement the energy requirements of the country, Smt. Shukla has also been spearheading the Company's initiatives in new energy areas like Bio Fuels, Coal Gasification, Waste to Fuel, Hydrogen Energy etc. These initiatives will not only strengthen the energy infrastructure of the country but will also promote the sustainability mission.

Smt. Vartika Shukla's distinguished career is adorned with several prestigious accolades namely, first PETROFED Woman Executive Award, SCOPE Excellence Award and MoP&NG Innovation Award with her team.

Arun Kumar Singh takes over as Chairman and Managing Director of BPCL


Arun Kumar Singh

Mr. Arun Kumar Singh took charge as the Chairman and Managing Director of BPCL on September 7, 2021.

A Mechanical Engineer by qualification, Mr. Arun Kumar Singh was earlier Director (Marketing) on the Board of the company, holding additional charge of Director (Refineries) and Director (Finance).

In his more than 36 years of experience in Oil & Gas industry, he has headed Business Units and Entities in BPCL such as Retail, LPG, Pipelines, Supply Chain Optimization, etc. He also held the position of President (Africa & Australasia) in Bharat PetroResources Ltd., a wholly owned Subsidiary of BPCL, engaged in exploration of Oil & Gas, largely overseas.

He is also Chairman of Indraprastha Gas Ltd. a Joint Venture CGD Company, listed on Indian bourses. He is also a Director on the Board of Bharat Gas Resources Ltd, a wholly owned subsidiary of BPCL, engaged in Natural Gas business; on the Board of Bharat Oman Refineries Limited, a subsidiary of BPCL engaged in Refining business; and he represents BPCL on the board of Petronet LNG Ltd (PLL), a Joint Venture Company, listed on Indian bourses.

NEW APPOINTMENTS

Arvind Kumar assumes charge as Managing Director of CPCL

Arvind Kumar

Mr. Arvind Kumar has assumed charge as the Managing Director of Chennai Petroleum Corporation Ltd (CPCL) on August 27, 2021.

Mr. Arvind Kumar holds a Bachelor's Degree in Mechanical Engineering. He also holds a Master's Degree in Business Administration with specialization in Operations Management. He joined IOCL on 3rd October 1990. He has got more than three decades of experience in the areas of Engineering, Project Management, Material & Contract Management and in Plant Operations & Maintenance.

Mr. Kumar was Executive Director and Unit Head of Mathura Refinery in 2020-21 and worked as Executive Director (Projects) at Refineries Headquarters, New Delhi for Refineries Division of IOCL handling mega projects in Refineries and Petrochemicals before assuming charge of MD, CPCL on 27th August 2021 at Chennai.

Pankaj Kumar takes over as Director (Offshore) of ONGC

Mr. Pankaj Kumar has taken over charge of Director (Offshore) of Oil and Natural Gas Corporation (ONGC) on 4th September, 2021. As Director (Offshore), he is responsible for the entire gamut of Offshore Fields contributing around 70% of Oil and 78% of Natural Gas production of ONGC.

Pankaj Kumar

Mr. Kumar is a thorough Oil & Gas industry professional with more than 34 years of experience across ONGC's business functions varying from Operations Management of Offshore and Onshore fields, Well Engineering, Joint Venture Management, Corporate Strategic Management and Asset Management.

He holds a Bachelor's degree in Chemical Engineering from University of Roorkee (now IIT Roorkee) and Master's degree in Process Engineering from IIT Delhi. He completed Advance Management Program at IIM, Bengaluru and Leadership Development Program at IIM, Calcutta.

Vetsa Ramakrishna Gupta takes over as Director Finance of BPCL

Mr. Vetsa Ramakrishna Gupta took charge as the Director (Finance) of BPCL on September 7, 2021.

Vetsa Ramakrishna Gupta

Prior to his elevation to the board, he was the CFO of the company. He has handled various functions of finances at BPCL since more than two decades now. He has a rich experience in the field of Corporate Accounts, Risk Management, Budgeting, Business Plan, Treasury Operations etc. and has played critical role in strategy formulation & implementation to ensure corporate governance compliance and monitoring key internal controls.

He is also a Director on the board of Fino Paytech Limited, Fino Finance Ltd, Mumbai Aviation Fuel & Farm Facility Limited, Matrix Bharat Pte Ltd. and Bharat Oman Refinery Ltd., which is wholly owned subsidiary of BPCL.

STATISTICS

INDIA: OIL & GAS

DOMESTIC OIL PRODUCTION (MILLION MT)

		2015-16	2016-17	2017-18	2018-19	2019-20	2020-21 (P)	April - June 2021 (P)	% of Total
Onshore	ONGC	5.8	5.9	6.0	6.1	6.1	5.9	1.5	38.3
	OIL	3.2	3.3	3.4	3.3	3.1	2.9	0.7	19.5
	Pvt./ JV (PSC)	8.8	8.4	8.2	8.0	7.0	6.2	1.6	42.3
	Sub Total	**17.8**	**17.6**	**17.5**	**17.3**	**16.2**	**15.1**	**3.8**	**100**
Offshore	ONGC	16.5	16.3	16.2	15.0	14.5	14.2	3.4	93.2
	OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Pvt./ JV (PSC)	2.5	2.1	1.9	1.9	1.5	1.1	0.2	6.8
	Sub Total	**19.1**	**18.4**	**18.1**	**16.9**	**16.0**	**15.4**	**3.6**	**100.0**
Total Domestic Production		36.9	36.0	35.7	34.2	32.2	30.5	7.4	100.0
	ONGC	22.4	22.2	22.2	21.0	20.6	20.2	4.8	64.9
	OIL	3.2	3.3	3.4	3.3	3.1	2.9	0.7	10.0
	Pvt./ JV (PSC)	11.3	10.5	10.1	9.9	8.4	7.4	1.9	25.1
Total Domestic Production		**36.9**	**36.0**	**35.7**	**34.2**	**32.2**	**30.5**	**7.4**	**100.0**

Source : PIB/PPAC

REFINING

Refining Capacity (Million MT on 1st August 2021)

Indian Oil Corporation Ltd.	
Digboi	0.65
Guwahati	1.00
Koyali	13.70
Barauni	6.00
Haldia	8.00
Mathura	8.00
Panipat	15.00
Bongaigoan	2.35
Paradip	15.00
Total	**69.70**

Chennai Petroleum Corp. Ltd.	
Chennai	10.50
Narimanam	1.00
Total	**11.50**

JV Refineries	
DBPC, BORL-Bina	7.80
HMEL,GGSR	11.30
JV Total	**19.10**

Bharat Petroleum Corp. Ltd.	
Mumbai	12.00
Kochi	15.50
Total	**27.50**

Hindustan Petroleum Corp. Ltd.	
Mumbai	7.50
Visakhapattnam	8.30
Total	**15.80**
Other PSU Refineries	
NRL, Numaligarh	**3.00**
MRPL	**15.00**
ONGC, Tatipaka	**0.07**
Total PSU Refineries Capacity	**142.57**

Private Refineries	
RIL, (DTA) Jamnagar	33.00
RIL , (SEZ), Jamnagar	35.20
Nayara Energy Ltd. , Jamnagar #	20.00
Pvt. Total	**88.20**

Total Refining Capacity of India 249.9 (5.00 million barrels per day)

Nayara Energy Limited (formerly Essar Oil Limited)

Source : PPAC

CRUDE PROCESSING (MILLION MT)

PSU Refineries	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21 (P)	April - June 2021 (P)
IOCL	58.01	65.19	69.00	71.81	69.42	62.35	16.72
BPCL	24.10	25.30	28.20	30.90	31.53	26.22	6.72
HPCL	17.20	17.80	18.20	18.44	17.18	16.42	2.51
CPCL	9.60	10.30	10.80	10.69	10.16	8.24	2.03
MRPL	15.53	15.97	16.13	16.23	13.95	11.47	3.07
ONGC (Tatipaka)	0.07	0.09	0.08	0.07	0.09	0.08	0.02
NRL	2.52	2.68	2.81	2.90	2.38	2.71	0.64
SUB TOTAL	**127.03**	**137.33**	**145.22**	**151.04**	**144.71**	**127.50**	**31.71**

JV Refineries	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21 (P)	April - June 2021 (P)
HMEL	10.71	10.52	8.83	12.47	12.24	10.07	3.22
BORL	6.40	6.36	6.71	5.71	7.91	6.19	1.59
SUB TOTAL	**17.11**	**16.88**	**15.54**	**18.18**	**20.15**	**16.26**	**4.82**

Pvt. Refineries	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21 (P)	April - June 2021 (P)
NEL	19.11	20.92	20.69	18.89	20.62	17.07	4.98
RIL	69.50	70.20	70.50	69.14	68.89	60.94	15.76
SUB TOTAL	**88.61**	**91.12**	**91.19**	**88.03**	**89.51**	**78.01**	**20.73**

	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21 (P)	April - June 2021 (P)
All India Crude Processing	**232.90**	**245.40**	**251.90**	**257.25**	**254.38**	**221.77**	**57.25**

Source : PIB Release/PPAC

CRUDE CAPACITY VS. PROCESSING

	Capacity On 01/08/2021 Million MT	% Share	Crude Processing April-June 2021 (P)	% Share
PSU Ref	142.6	57.1	31.7	55.4
JV. Ref	19.1	7.6	4.8	8.4
Pvt. Ref	88.2	35.3	20.7	36.2
Total	**249.9**	**100**	**57.3**	**100**

Source: PIB/PPAC

POL PRODUCTION (Million MT)

	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	April-June 2021 (P)
From Refineries	227.9	239.2	249.8	257.4	258.2	229.2	59.0
From Fractionators	3.4	3.5	4.6	4.9	4.8	4.2	1.0
Total	**231.2**	**242.7**	**254.4**	**262.4**	**262.9**	**233.4**	**60.0**

DISTILLATE PRODUCTION (Million MT)

	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	April-June 2021 (P)
Light Distillates, MMT	67.1	71.0	74.7	75.4	76.8	71.4	18.0
Middle Distillates , MMT	118.3	122.5	127.5	130.8	130.2	110.5	28.3
Total Distillates, MMT	185.4	193.5	202.2	206.1	206.9	182.0	46.3
% Distillates Production on Crude Processing	**78.5**	**77.8**	**78.8**	**78.6**	**79.9**	**80.5**	**79.4**

Source: PIB/PPAC

PETROLEUM PRICING

OIL IMPORT - VOLUME AND VALUE

	2015-16	2016-17	2017-18	2018-19	2019-20 (P)	2020-21 (P)	April-June 2021 (P)
Quantity, Million Mt	202.9	213.9	220.4	226.6	227.0	198.1	51.4
Value, INR ₹000 cr.	416.6	470.2	565.5	783.4	716.6	463.0	185.2
Value, USD Billion	64.0	70.2	87.8	112.0	101.4	62.7	25.1
Average conversion Rate, INR per USD (Calculated)	65.1	67.0	64.4	70.0	70.7	73.8	73.8

OIL IMPORT - PRICE USD / BARREL

	2015-16	2016-17	2017-18	2018-19	2019-20 (P)	2020-21 (P)	April-June 2021 (P)
Brent (Low Sulphur - LS-marker) (a)	47.5	48.7	57.5	70.0	61.0	44.3	68.6
Dubai (b)	45.6	47.0	55.8	69.3	60.3	44.6	66.9
Low sulphur-High sulphur differential (a-b)	1.8	1.7	1.6	0.7	0.6	-0.3	1.7
Indian Crude Basket (ICB)	46.17	47.56	56.43	69.88	60.47	44.82	67.44
ICB High Sulphur share %	72.28	71.03	72.38	74.77	75.50	75.62	75.62
ICB Low Sulphur share %	27.72	28.97	27.62	25.23	24.50	24.38	24.38

INTERNATIONAL PETROLEUM PRODUCTS PRICES EX SINGAPORE, ($/bbl.)

	2015-16	2016-17	2017-18	2018-19	2019-20 (P)	2020-21 (P)	April-June 2021 (P)
Gasoline	61.7	58.1	67.8	75.3	67.0	47.5	75.0
Naphtha	48.5	47.1	56.3	65.4	55.1	43.9	66.3
Kero / Jet	58.2	58.4	69.2	83.9	70.4	45.8	71.5
Gas Oil (0.05% S)	57.6	58.9	69.8	84.1	74.1	50.0	73.6
Dubai crude	45.6	47.0	55.8	69.3	60.3	44.6	66.9
Indian crude basket	46.2	47.6	56.4	69.9	60.5	44.8	67.4

CRACKS SPREADS ($/ BBL.)

	2015-16	2016-17	2017-18	2018-19	2019-20 (P)	2020-21 (P)	April-June 2021 (P)
Gasoline crack							
Dubai crude based	16.1	11.1	12.0	5.9	6.7	2.9	8.0
Indian crude basket	15.6	10.6	11.4	5.4	6.5	2.6	7.5
Diesel crack							
Dubai crude based	12.0	12.0	13.9	14.8	13.8	5.5	6.7
Indian crude basket	11.5	11.4	13.4	14.2	13.6	5.2	6.2

DOMESTIC GAS PRICE ($/MMBTU)

Period	Domestic Gas Price (GCV Basis)	Price Cap for Deepwater, High temp Hingh Pressure Areas
October 15 - March 16	3.82	-
April 16 - September 16	3.06	6.61
October 16 - March 17	2.50	5.30
April 17- September 17	2.48	5.56
October 17 - March 18	2.89	6.30
April 18 - September 18	3.06	6.78
October 18 - March 19	3.36	7.67
April 19 - September 19	3.69	9.32
October 19 - March 20	3.23	8.43
April 20 - September 20	2.39	5.61
October 20 - March 21	1.79	4.06
April 21 - September 21	1.79	3.62
October 21 - March 22	2.90	6.13

Source: PIB/PPAC/OPEC

GAS PRODUCTION

Qty in MMSCM

	2017-18	2018-19	2019-20	2020-21 (P)	April-June 2021 (P)
ONGC	23429	24667	23746	21872	5052
Oil India	2881	2722	2668	2480	675
Private/ Joint Ventures	6338	5477	4770	4319	2441
Total	**32648**	**32875**	**31184**	**28671**	**8169**

		2017-18	2018-19	2019-20	2020-21 (P)	April-June 2021 (P)
Onshore	Natural Gas	9904	10046	9893	9601	2439
	CBM	735	710	655	477	172
	Sub Total	**10639**	**10756**	**10549**	**10078**	**2611**
Offshore		22011	22117	20635	18428	5532
	Sub Total	**22011**	**22117**	**20635**	**18428**	**5532**
	Total	**32649**	**32873**	**31184**	**28506**	**8143**
	(-) Flare loss	918	815	927	721	186
	Net Production	31731	32058	30257	27785	7957

	2017-18	2018-19	2019-20	2020-21 (P)	April-June 2021 (P)
Net Production	31731	32058	30257	27785	7957
Own Consumption	5806	6019	6053	5736	1427
Availabilty	25925	26039	24204	22049	6530

AVAILABILTY FOR SALE

	2017-18	2018-19	2019-20	2020-21(P)	April-June 2021 (P)
ONGC	18553	19597	18532	16972	3888
Oil India	2365	2207	2123	1930	535
Private/ Joint Ventures	5007	4235	3549	3147	2107
Total	**25925**	**26039**	**24204**	**22049**	**6530**

CONSUMPTION (EXCLUDING OWN CONSUMPTION

	2017-18	2018-19	2019-20	2020-21 (P)	April-June 2021 (P)
Total Consumption	53364	54779	58091	54910	14088
Availabilty for sale	25925	26039	24204	22049	6530
LNG Import	27439	28740	33887	32861	7558

GAS - IMPORT DEPENDENCY

	2017-18	2018-19	2019-20	2020-21 (P)	April-June 2021 (P)
Net Gas Production	31731	32058	30257	27785	7957
LNG Imports	27439	28740	33887	32861	7558
Import Dependency (%)	46.4	47.3	52.8	54.2	48.7
Total Gas Consumption*	**59170**	**60798**	**64144**	**60646**	**15515**

* Includes Own Consumption

Source:PIB/PPAC

SECTOR WISE DEMAND AND COMSUMPTION OF NATURAL GAS

Qty in MMSCM

		2018-19	2019-20	2020-21 (P)	April-June 2021 (P)			
					April	May	June	Total
Fertilizer	R-LNG	8711	9556	11336	877	893	964	2734
	Domestic Gas	6258	6559	6331	539	521	538	1598
Power	R-LNG	2869	3554	3630	286	263	281	830
	Domestic Gas	9194	7526	7289	560	584	554	1698
City Gas	R-LNG	3981	5146	4169	431	409	351	1191
	Domestic Gas	5240	5737	4899	455	404	517	1376
Refinery Petrochemical	R-LNG	12650	13130	12505	1030	904	928	2862
Others	Domestic Gas	5225	5285	5920	682	797	845	2324

Source:PPAC

1. CGD INFRASTRUCTURE

		As on 31st March 2018	As on 31st March 2019	As on 31st March 2020	As on 31st July 2021 (P)
PNG	Domestic	42,80,054	50,43,188	60,68,415	79,47,882
	Commercial	26,131	28,046	30,622	32,919
	Industrial	7,601	8,823	10,258	12,343
CNG	CNG Stations	1,424	1,730	2,207	3,323
	CNG Vehicles	30.90 lakhs	33.47 lakhs	37.10 lakhs	40.50 lakhs

Source: PPAC/Vahan

2. MAJOR NATURAL GAS PIPELINE NETWORK As on 31.03.2021

Nature of pipeline		GAIL	GSPL	PIL	IOCL	AGCL	RGPL
Operational	Length	8,242	2,265	1,459	132	105	312
	Capacity	167.2	43.0	85.0	20.0	2.4	3.5
Partially commissioned#	Length	8,071			1,431		
	Capacity	121.0					
Total operational length		**16,313**	**2,265**	**1,459**	**1,563**	**105**	**312**
Under construction	Length	2,445					
	Capacity	23.2					
Total length		**18,758**	**2,265**	**1,459**	**1,563**	**105**	**312**

Nature of pipeline		GGL	DFPCL	ONGC	GIGL	GITL	Others*	Total
Operational	Length	73	42	24				**12,653**
	Capacity	5.1	0.7	6.0				**337.3**
Partially commissioned#	Length				2,590	365		**12,457**
	Capacity				O			**-**
Total operational length		**73**	**42**	**24**	**2,590**	**365**	**0**	**25,110**
Under construction	Length				90	1,446	3,550	**7,531**
	Capacity						149.0	**-**
Total length		**73**	**42**	**24**	**2,680**	**1,811**	**3,550**	**32,641**

*Includes AGCL, DFPCL, ONGC and excludes CGD pipeline network
Source: PPAC/PNGRB

3. EXISTING LNG TERMINALS

Location	Companies	Capacity (MMTPA) As on 01st Sep'21	Capacity Utilisation (%) April- July 2021
Dahej	Petronet LNG Ltd	17.5	90.1
Hazira	Shell Energy India Pvt Ltd	5	72.0
Dabhol*	Konkan LNG Ltd	5	52.4
Kochi	Petronet LNG Ltd	5	22.5
Ennore	Indian Oil LNG Pvt Ltd	5	16.0
Mundra	GSPC LNG Ltd	5	21.9
Total Capacity		**42.5 MMTPA**	

*To increase to 5 MMTPA with breakwater. Only HP stream of capacity of 2.9 MMTPA is commissioned
Source: PPAC

Member Organizations

S No	Organization	Name	Designation
1	Antelopus Energy Pvt Ltd	Mr. Suniti Bhat	Chief Executive Officer
2	Axens India (P) Ltd.	Mr. Philippe Bergault	Managing Director
3	Baker Hughes, A GE Company	Mr. Neeraj Sethi	Country Leader
4	Bharat Oman Refineries Ltd.	Mr. Abhairaj Singh Bhandari	Chief Executive Officer
5	Bharat Petroleum Corporation Ltd.	Mr. Arun Kumar Singh	Chairman & Managing Director
6	BP Group	Mr. Sashi Mukundan	President, bp India & Senior Vice President, bp group
7	Cairn Oil & Gas, Vedanta Limited	Mr. Sunil Duggal	Group CEO, Vedanta Ltd.
8	Chandigarh University	Mr. Satnam Singh Sandhu	Chancellor
9	Chennai Petroleum Corporation Ltd.	Mr. Arvind Kumar	Managing Director
10	Chi Energie Pvt. Ltd	Mr. Ajay Khandelwal	Director
11	CSIR-Indian Institut e of Petroleum	Dr. Anjan Ray	Director
12	Decom North Sea	Mr. Will Rowley	Interim Managing Director
13	Deepwater Drilling & Industries Ltd.	Mr. Naresh Kumar	Chairman & Managing Director
14	Dynamic Drilling & Services Pvt. Ltd.	Mr. S. M. Malhotra	President
15	Engineers India Ltd.	Ms. Vartika Shukla	Chairman & Managing
16	Ernst & Young LLP	Mr. Rajiv Memani	Country Manager & Partner
17	ExxonMobil Gas (India) Pvt. Ltd.	Mr. Bill Davis	Chief Executive Officer
18	GAIL (India) Ltd.	Mr. Manoj Jain	Chairman & Managing Director
19	GSPC LNG Ltd.	Mr. Anil K. Joshi	President
20	h2e Power Systems Pvt. Ltd.	Mr. Siddharth R Mayur	Managing Director & CEO
21	Haldor Topsoe India Pvt. Ltd.	Mr. Alok Verma	Managing Director
22	Hindustan Petroleum Corp. Ltd.	Mr. M.K. Surana	Chairman & Managing Director
23	HPCL Mittal Energy Ltd.	Mr. Prabh Das	Managing Director & CEO
24	HPOIL Gas Private Ltd.	Mr. Arun Kumar Mishra	Chief Executive Officer
25	IHS Markit	Mr. James Burkhard Mr.	Managing Director
26	International Gas Union	Luis Bertran	Secretary General
27	IIT (ISM) Dhanbad	Prof. Rajiv Shekhar	Director
28	IMC Ltd.	Mr. A. Mallesh Rao	Managing Director
29	Indian Gas Exchange Ltd.	Mr. Rajesh Kumar Mediratta	Director
30	Indian Oil Corporation Ltd.	Mr. S.M. Vaidya	Chairman
31	Indian Strategic Petroleum Reserves Reserves Ltd	Mr. H.P.S. Ahuja	Chief Executive Officer & MD
32	Indraprastha Gas Ltd.	Mr. A.K. Jana	Managing Director
33	Indian Oiltanking Ltd.	Mr. Rajesh Ganesh	Managing Director
34	IPIECA	Mr. Brian Sullivan	Executive Director

S No	Organization	Name	Designation
35	Invenire Petrodyne Ltd.	Mr. Mannish Maheshwari	Chairman & Managing Director
36	IRM Energy Pvt. Ltd.	Mr. Karan Kaushal	Chief Executive Officer
37	Jindal Drilling & Industries Pvt. Ltd.	Mr. Raghav Jindal	Managing Director
38	LanzaTech	Dr. Jennifer Holmgren	Chief Executive Officer
39	Larsen & Toubro Ltd	Mr. S.N. Subrahmanyan	CEO & Managing Director
40	Maharashtra Institute of Technology (MIT) Pune	Dr. L.K. Kshirsagar	Principal
41	Mangalore Refinery & Petrochemicals Ltd.	Mr. M. Venkatesh	Managing Director
42	Megha Engineering & Infrastructures Ltd.	Mr. P. Doraiah	Director
43	Nayara Energy Ltd.	Mr. Tony Fountain	Chairman
44	Numaligarh Refinery Ltd.	Mr. S.K. Barua	Managing Director
45	Oil and Natural Gas Corporation Ltd	Mr. Subhash Kumar	Director (F) & CMD (Addl. Charge)
46	Oil India Ltd.	Mr. Sushil Chandra Mishra	Chairman & Managing Director
47	Petrofac International Ltd.	Mr. Paolo Bonucci	Head of Business Development & Senior Vice President
48	Petronet LNG Ltd.	Mr. Akshay Kumar Singh	Managing Director & CEO
49	Pipeline Infrastructure Ltd.	Mr. Akhil Mehrotra	Chief Executive Officer
50	Rajiv Gandhi Institute of Petroleum Technology	Prof. A.S.K Sinha	Director
51	Reliance BP Mobility Ltd.	Mr. Harish C. Mehta	Chief Executive Officer
52	Reliance Industries Ltd.,	Mr. Mukesh Ambani	Chairman & Managing Director
53	SAS Institute (India) Pvt Ltd.	Mr. Noshin Kagalwalla	CEO & Managing Director-India
54	Schlumberger Asia Services Ltd	Mr. Vinay Malhotra	Managing Director
55	Scottish Development International	Mr. Kevin Liu	Head of Energy Trade, Asia Pacific
56	Secure Meters Ltd.	Mr. Sunil Singhvi	CEO - Energy
57	Shell Companies in India	Mr. Nitin Prasad	Country Chair
58	SNF Flopam India Pvt. Ltd	Mr. Shital Khot	Managing Director
59	South Asia Gas Enterprise Pvt. Ltd.	Mr. Subodh Kumar Jain	Director
60	Tecnimont Private Limited	Mr. Sathiamoorthy Gopalsamy	Managing Director
61	THINK Gas Distribution Pvt. Ltd.	Mr. Hardip Singh Rai	Chief Executive Officer
62	Total Oil India Pvt. Ltd.	Mr. Alexis Thelemaque	Chairman & Managing Director
63	University of Petroleum & Energy Studies	Dr. S.J. Chopra	Chancellor
64	UOP India Pvt. Ltd.	Mr. Mike Banach	Managing Director
65	VCS Quality Services Private Ltd.	Mr. Shaker Vayuvegula	Director
66	World LPG Association	Mr. James Rockall	CEO and Managing Director

FIPI

Federation of Indian Petroleum Industry

3rd Floor, PHD House, 4/2, Siri Institutional Area,
August Kranti Marg, New Delhi-110016

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