

Role of Gas in Cooking and Mobility in the Transition to Cleaner Energy

New Gas Infrastructure Investment Likely to Become Stranded Assets

Executive Summary

The government of India has made strong commitments to increase the share of gas in the Indian energy mix from the current 6% to 15% by 2030, with a particular focus on increasing its share in the cooking and mobility sectors.

Investments have started to flow in to increase the availability of this largely imported fossil fuel. Infrastructure for importation, transportation and distribution is being rapidly rallied up.

An increase in domestic gas production is anticipated on the back of new gas discoveries in the country but the domestic price cap reduces the incentive for domestic producers to take on this risk.

The penetration of piped natural gas (PNG) and natural gas vehicles (NGVs) continues to be low but is expected to take a major leap by 2030 once the planned new gas infrastructure comes on board.

The main reason for the government to push gas aggressively is to meet India's goal of lowering carbon emissions. Though India will need to make a net zero carbon emissions commitment in the longer term, the government for now is viewing gas as a bridging measure, despite it being a high emitting fossil fuel.

The recently published IPCC report warns that the 1.5 degrees Celsius average surface temperature would be breached by 2040 and is a wake-up call for immediate action. If the world is to limit global warming, building new gas infrastructure is a contrary development. That is, gas and LNG cannot be a transition fuel.

So why is the Indian government prioritising new gas infrastructure over the infrastructure cost advantage of distributed clean solar and wind, particularly in rural areas?

India definitely has unmet energy requirements but creating dual connections of gas and electricity can lead to environmental and capital loss for the country. Optimally

**Creating dual connections
of gas and electricity
can lead to environmental
and capital loss.**

using the available gas and investing in greening the electricity grid can reap greater long term results for India. India is already committed to achieve 450GW of renewable energy by 2030 and that should be top priority.

Gas Is a Fossil Fuel - Relying on Imported LNG Exacerbates Emissions

When the entire lifecycle of exploration, transmission and distribution is considered, gas's environmental benefits are seriously diluted. India's high and growing dependence on LNG imports further dampens any benefits.

LNG is a high emitting fuel. To make LNG, 9% of the gas is burnt just in the liquefaction process and a further 2-6% in shipping, adding up to about 13% of the gas being wasted before it reaches the customer. It is estimated that one LNG cargo leads to emissions as high as 270,000 tonnes of CO₂ equivalent.

The oil and gas industry is manoeuvring around this difficult reality by promoting the idea of offsetting emissions, such as through planting trees¹ or encouraging the take-up of so-called "carbon neutral" LNG. Only seven such cargos have been delivered to date (in comparison to 5,500 LNG cargos sold in 2019) and numbers have yet to be shared on how the offsetting is done. Moreover, offsetting does not consider the emissions produced by gas combustion at the destination.²

The Economics of Using Gas Does Not Work for India

The nearly 50% import dependence of LNG not only puts India's energy security at risk but it also sabotages India's current account, currency value and self-reliance goals. Massive government subsidies provided to sectors to either sustain gas price increases or enhance the affordability of gas further disallow a competitive use of the government's limited capital.

Nonetheless, city gas distribution (CGD) infrastructure covering 70% of the population is being planned to generate further demand for gas and increase its share in the energy mix in two key areas identified: cooking and transport.

This strategy of making India a gas-based economy by 2030 is not aligned with the government's view of using gas only as a transition fuel or being self-reliant.

Investing in New 'Bridging' Gas Infrastructure Is a Stranded Asset Risk

A substantial amount of investment is being committed to the gas sector, and especially CGD, from public and private entities alike. These commitments however should be viewed with caution as government policies have made the business case for investing in gas very lucrative but, from a longer-term perspective, government policy may change as global investment accelerates its exit from fossil fuels. The

¹ WoodMackenzie. [What is carbon-neutral LNG?](#). November 18, 2020.

² Bloomberg. [How to Sell 'Carbon Neutral' Fossil Fuel That Doesn't Exist](#). August 11, 2021.

priority allocation of more affordable domestic gas to the CGD sector makes using gas a viable option at present but increasing gas prices could result in a switch to other competitive options by India's price-sensitive consumers. As such, there is a risk of any new gas infrastructure being stranded as technology advancements continue and more competitive options become available for use.

**Government policy
may change as global
investment accelerates
its exit from fossil fuels.**

A different policy paradigm leading to profitability and reliability in a non-fossil resource such as wind or solar would lead to enhanced investment in that fuel and would also make net zero more of a reality for India.

Gas, as a fossil fuel, is a limited resource. While the global resources-to-reserve ratio is 50.9 years, it is 47 years for India.³ Further, ever-higher carbon content gas reserves are becoming more difficult to access due to deep water, ultra-deep water mines or high pressure-high temperature areas. Deeper drilling leads to exponentially inflated production costs⁴, which put the economic feasibility of future gas exploitation into question.

It is therefore important that any transitional use of gas is done in sectors where there are no competitive alternatives or where gas use supports renewable energy uptake. For instance, peaking gas power plants are the best option for balancing the grid in case of increased renewable energy usage until storage options are more widely available and affordable.

A recent IEEFA analysis shows that global capital is moving towards green investments as countries, lenders and companies formulate plans to be carbon neutral. One of the indicators used in the analysis is the Standard & Poor's 500-stock index across sectors in which energy (excluding renewables) contributed 12.27% of the 500-stock index in 2011 but only 2.28% at the end of 2020.⁵ Norway's Sovereign Wealth Fund, the world's largest pension fund, committed to divest US\$13 billion worth of fossil fuel investments in 2019⁶ and the European Investment Bank (EIB) committed to end fossil financing for

**Global capital is
moving towards
green investments.**

³ BP. Statistical Review of World Energy 2019. [Natural Gas](#).

⁴ M. Enamul Hossain. [Drilling Costs Estimation for Hydrocarbon Wells](#). De Gruyter. June 2015.

⁵ IEEFA. [Capital markets are shifting decisively towards cleaner investments](#). February 9, 2021.

⁶ The Guardian. [World's biggest sovereign wealth fund to ditch fossil fuels](#). June 2019.

energy projects by the end of 2021, to name but two. In India, Reliance Industries is aiming for world-leading net-zero emissions by 2035.

So where does that leave India? Even if upfront gas infrastructure investment is made using public funding and investments from big private firms, the viability of this infrastructure would be in question as global capital is fast moving away from fossil fuels. It may result in India's expensive gas infrastructure becoming stranded.

Gas for Cooking and Mobility Is Only Favourable for the Short Term and if the Price Is Regulated

Considering a large proportion of the population is still using harmful solid fuels for their cooking needs, there is an urgency for a switch to cleaner fuels.

The government's option for PNG – reaching 70% coverage by 2029/30 -- could be made accessible to households but it has a minimum ten-year timeline. As connections increase, demand also would increase and incremental supply would most likely have to be provided from expensive imported LNG, affecting affordability. Reflecting what happened in the take-up of LPG -- where penetration rapidly increased but uptake remains low due to affordability -- in this scenario households again would be left with an expensive high emitting fuel source.

Instead of planning a shift for PNG in urban areas and increasing the availability of LPG in rural areas, IEEFA notes it would be more beneficial at this point to encourage a switch to electric cooking in rural areas and to divert existing gas to the power sector for the generation of electricity. Further, the government should encourage and facilitate the use of solar micro-grids which become extremely cost effective with increased electricity use.

Compressed natural gas (CNG) as a transport fuel is currently being used in three-wheelers, buses and taxis. The limited refuelling infrastructure has not yet made CNG a viable option for passenger vehicles. While the government hopes to increase the number of buses and taxis using CNG, it is also aiming at increasing the share of electric vehicles (EVs) in India and has developed policy incentives for the increased electrification of public transport.

One fuel choice cannot be enough for India, yet a more staggered approach would achieve economies of scale and make the cleaner electric sources cost competitive without any support. The government should incentivise the purchase of EV passenger cars to lower emissions, increase acceptability, pique businesses' interest in the sector and encourage investment in EV infrastructure.

Gas via LNG could then be used in long-haul trucking in a transitory role. Further, states such as Gujarat, Maharashtra and Delhi that already have high penetration of gas in mobility could increase CNG penetration, again, in a transitory role. An approach staggered by fuel and location would be an optimal strategy for India to move to cleaner mobility.

Electricity Offers an Affordable Clean Solution for Cooking and Mobility (With Increasing Renewable Energy Induction Into the Grid)

Increasing electricity use provides both economic and environmental benefits while reducing India's dependence on energy imports. Electricity-based options offer the possibility of an accelerated scaling up as there is virtually 100% electric connection coverage in India. Going electric therefore leverages existing infrastructure and avoids locking in a second energy distribution network. Further, various distributed renewable energy options can be deployed for enhancing electricity use.

Going electric leverages existing infrastructure and avoids locking in a second energy distribution network.

Gas on the other hand has failed to reach scale in India over the past two decades, remaining a cooking and mobility option in limited urban areas whilst not really lending a hand in lowering carbon emissions. As global cities start to shun gas and move to zero carbon emissions, investing in this fuel of the past is a strategy that needs to be evaluated with a long-term vision.

IEEFA notes existing domestic gas should be redirected to power plants that have been stranded for the past few years, and to high value peaking power generation and in stabilising the grid.

Cities in advanced nations are starting to shun the strategy of supplying a dual electricity and gas connection. India should take this opportunity to leapfrog new gas in favour of electricity for cooking and mobility, while promoting grid stability and providing appliances at affordable rates.

Table of Contents

Executive Summary	1
Introduction	7
Global Decarbonisation Trends	10
Why is India Pursuing Gas?	11
Domestic Gas Production Trends vs Imports	13
Private Investment Planned In Gas Sector - But Will It Deliver?	15
Proposed Gas Infrastructure Runs the Risk of Becoming Stranded	17
Priority Allocation to City Gas Distribution Sector, But Will the Competitiveness Remain?	18
Viable Alternatives for Cooking in India	20
Decarbonising India's Transport Sector	26
Conclusion	33
About the Author	35

Introduction

The government of India has made strong commitments to increase the share of gas in the country's energy mix from the current 6% to 15% by 2030. This would entail massive investment to increase the availability of this largely imported fossil fuel while also building infrastructure for import and distribution. An increase in domestic gas production is anticipated due to new gas discoveries in the country, though IEEFA notes the domestic price cap reduces the incentive for domestic producers to take on this risk.

There is a major thrust on increasing import capacity to a total of approximately 70 million metric tonnes per annum (MMTPA) by 2024. The transportation pipeline is also being doubled to 34,000km with plans to create a national gas grid. And to enable robust supply, aspirational plans have been put in motion to increase access of the gas distribution network to at least 70% of the population by 2030.

IEEFA questions the merit of this strategy in light of the adverse energy security implications and the locking-in of high carbon emission energy assets at a time when the global market is moving away from fossil fuels.

The International Energy Agency (IEA) in its Gas 2020 report⁷ notes that India's potential for gas consumption is high, noting China and India are expected to account for half of the incremental global figure. However, it also emphasises the importance of favourable policy settings especially post-COVID, noting:

"While the prospects of natural gas remain strong for these two markets, the outlook is highly dependent on China's and India's future policy direction and recovery path in the post-crisis environment."

Following peak production in 2010, ongoing dwindling domestic gas supply led to a decline in India's gas consumption. The current government, in its first term in 2014, sought to change this, bringing in policy changes aimed at increasing the use of domestic gas in India.

Cheaper (price) domestic gas was allocated to the city gas distribution (CGD) segment for residential and commercial cooking, transport and industries. On the basis of this uptake, further policy changes were undertaken including a long-term commitment to invest in expanding gas infrastructure to further enable supply to consumers.

**The Indian government
in 2014 brought in
policy changes aimed
at increasing the use
of domestic gas.**

⁷ IEA. Gas 2020 Report Extract (2021-2025: Rebound and beyond). June 2020.

IEEFA notes that as the proposed investments are policy dependent, they run the risk of policies changing if more competitive fuel options emerge, for example, if electric vehicles become more affordable with battery advancement. This could result in gas infrastructure becoming stranded assets, as previously occurred after changes to the gas utilisation policy in 2014.

Among the risks in building new domestic gas infrastructure and planning to increase the share of gas in the energy mix are:

The massive increase in global gas prices in the spot market during 2021, which has materially undermined affordability. This may result in the government slowing down the policy push for gas, while gas consumers may switch back to carbon intensive fuels such as petrol for cars instead of CNG.

The limited domestic availability of gas (with new discoveries in difficult-to-access fields so there is a chance of those not coming through completely but, even if they do, the supply will not be enough to meet demand at the proposed 15% energy mix), with incremental supply being met by imported gas, which may have a negative impact on policy settings focussed on self-reliance and energy security.

The rapid pace at which global capital is moving away from fossil fuels as the world commits to carbon-free emissions.

Despite government rhetoric and policy in favour of gas, these have not translated into dramatic annual growth rates in the sector. As the IEA points out, any further expansion would be highly dependent on subsidies.

There is an opportunity now for an urgent review of the policy settings and the likely investments required to grow India's gas assets before locking in massive funds.

At the moment, the government's plan is to use gas as a "transitory" fuel until zero-carbon alternatives are available at scale, while also meeting the affordability criteria of a developing country like India.

As with coal, gas is a high emitting fossil fuel, primarily methane, which when released into the atmosphere is worse for the climate than coal in the short term. Emissions are also an issue when much of the gas is imported.

This report aims to answer the following questions:

1. Is the massive investment in building new gas infrastructure, even without considering the disturbance to environment and carbon emissions in construction, the most competitive use of scarce capital?
2. Are energy security concerns alleviated or exacerbated in the plans to increase imported gas use in a country with limited domestic gas availability?

3. Will the government's plan to push gas demand in residential, commercial and industrial sectors by building widespread CGD networks help lower carbon emissions?
4. Will pushing electric cooking and battery-fuelled mobility be a more effective strategy than encouraging more gas usage, both environmentally and economically?

To address these questions, this report deep-dives into the role of gas in cooking and mobility, areas where the government is expecting a fair share of future gas demand to come from. The government is consequently pushing for new infrastructure to ensure a robust supply of piped natural gas (PNG) for cooking and compressed natural gas (CNG) for transport.

As India is fast onboarding renewable energy in the power sector and also has a huge commitment of 450GW of renewable energy by 2030, we will also evaluate alternative uses of electricity in cooking and transport following globally demonstrated trends in these sectors.

Cooking

Close to 35% of the Indian population is dependent on carbon emitting solid fuels for cooking, which are harmful for the environment and lead to major health hazards. Liquefied Petroleum Gas (LPG) cylinders, currently the most prevalent clean cooking option in cities, have had a low uptake with rural and urban poor households due to limited distribution and high prices.

The government intends to increase penetration of clean cooking by shifting ongoing urban LPG consumers to PNG while freeing up distribution of LPG to rural households. This strategy however continues to keep India dependent on imports and fossil fuels while demanding a huge investment in building transportation and distribution networks of gas pipelines. Such a strategy also ignores global trends including the increasing shift to cooking with electricity.

The strategy of building gas pipelines ignores global trends, including the increasing shift to cooking with electricity.

This report reviews clean cooking options available to India – LPG, PNG and electricity -- and determines that with a long-term view, it would be in the country's best interest to promote electric cooking. It is more affordable, even with the ongoing administered (subsidised) prices of gas, as gas prices tend to be inflationary, as shown by the massive increase in spot prices globally over the last year, while renewable energy in India has become cheaper. A shift to electric cooking will also become dramatically cleaner, given progress on India's 2030 renewables target of 450GW.

Mobility

When mobility fuel options in India – petrol or diesel, natural gas or electric – are compared, gas vehicles seem like a plausible clean mobility option with current government support. Petrol and diesel reached historical highs in the past few years, prompting a sudden increase in CNG stations. Electric vehicles (EVs) are expensive and have minimal charging infrastructure.

However, the penetration of gas cars is very low. Huge infrastructure investments would be required to increase the use of gas for mobility, locking in capital for an increasingly dearer fossil fuel – one that is globally under scrutiny for its well-to-wheel emissions. This also gives rise to increasing stranded asset risks.

In contrast, EVs are clean, not solely for the lack of tail-pipe emissions. They are also much cleaner when well-to-wheel or lifecycle emissions are considered, particularly as the grid progressively decarbonises. EVs will become increasingly affordable as battery prices continue to come down. In the past decade, battery prices have dropped by 87% and are expected to further decline by 2023.

Global Decarbonisation Trends

The global race to decarbonisation has begun and the narrative now is far beyond just lowering carbon emissions. The developed world is taking the lead but that offers technological advantages, enabling countries like India to leapfrog from technology that may become redundant in two decades and to invest instead in its development curve with the technology of the future. Global trends indicate that companies, cities and countries are rapidly committing to a carbon neutral future. India, with its scale and size, cannot resist those trends.

**India, with its scale
and size, cannot resist
global trends committing
to a carbon neutral future.**

The massive investment in India planned in exploration, transportation, imports and distribution of gas is locking competitive capital into a fuel of the past, especially when the government clearly states that it is only transitory in nature. These assets can amortise their value only if used for at least three decades. This presents difficulties as countries start to commit to a net-zero future, while also evaluating the carbon emissions of LNG exports across the value chain.

New state-of-the-art satellite-based emission tracking initiatives have observed massive methane streams across the LNG value chain including remote offshore areas. Given more stringent environmental laws and clearer carbon accounting regulations, LNG producers and buyers alike would be under much more scrutiny

than they are today⁸. This poses a risk to all of the players in the LNG market including prospective large-scale buyers such as India.

A recent IEEFA study notes that there is increasing interest from global investors including banks and funds to move away from investing in fossil fuels, owing to climate risks. They are shifting investment to renewable assets with equal enthusiasm⁹.

According to the Energy and Climate Intelligence Unit, 134 countries have initiated a law, legislation, policy document or discussion on target to carbon neutrality by 2050 or earlier¹⁰, except for China, Ukraine and Kazakhstan which are looking at a 2060 target. Bhutan and Suriname are already carbon negative. Bhutan is a small country with large forest cover -- even after fossil dependence it can be carbon negative -- and as it has nearly 100% electrification is it also looking to increase the use of electricity for cooking and vehicles and to lower dependence on expensive imported fossil fuels.

Cities such as Berkeley (U.S.)¹¹ and Canberra (Australia)¹² have rejected the cost and carbon emissions implications of the use of dual gas and electric connection and as a start have banned it any new buildings. They have banned the use of gas in any new buildings and plan to replace gas in household heating with electricity. Also in the US, the Bay Area cities of San Francisco, Oakland and San Jose have passed an electric-only buildings mandate¹³.

Countries are also planning a ban on new fossil fuel production. Spain recently became the fourth EU country after Ireland, France and Denmark to outlaw new gas exploration. New Zealand banned new offshore exploration in 2018.

India on the other hand is committed to increase gas share in the country for residential and commercial cooking and in transport. The global trends to decarbonisation, however, call for a more comprehensive review of the proposed investments and the transitory nature of the proposed infrastructure in the light of the growing stranded asset risks.

Why is India Pursuing Gas?

India is faced with the challenge of meeting the energy needs of a burgeoning population and growing economy. It must also ensure it does not renege on its

⁸ Institute for Energy Economics and Financial Analysis (IEEFA). [Australia's Offshore Industry: A Half-Century Snapshot, Analysis of the Government's Administrative Role, Key Players' Behaviour and the Looming Risks for the Sector](#). September 2021.

⁹ IEEFA. [Global Investors Move Into Renewable Infrastructure](#). July 2021.

¹⁰ ECIU. [Net Zero Tracker 2021 Scorecard](#).

¹¹ The Guardian. [Berkeley became first US city to ban natural gas. Here's what that may mean for the future](#). July 23, 2019

¹² Reneweconomy. [Canberra households reject gas as ACT moves to end mandatory connections](#). January 17, 2020.

¹³ KQED. [California Cities Are Rushing to Ban Gas in New Homes. But the State Is Moving Slower](#). March 17, 2021.

ambitious carbon emission commitments to the Paris Agreement, nor lock in stranded fossil fuel investments unable to generate a viable return over their commercial life.

As the road to zero carbon emissions is long, the Indian government is looking at gas as a transitory fuel to lower carbon emissions. The gas industry has long touted gas as a bridge or transition fuel to a lower carbon economy. However, the increased use of gas is increasingly globally controversial, as outlined by the recent IEA Roadmap to Net Zero by 2050 report¹⁴, which urges massive investments in renewable energy and a rapid shift away from fossils such as oil and gas.

IEEFA notes while gas was considered a transitory fuel a decade ago, it's unlikely still relevant for India in 2021.

Gas Is a Fossil Fuel

Natural gas is a fossil fuel with some advantages over coal in terms of air pollution but, being primarily methane, it has limited relative carbon emission benefits, particularly when considering the whole supply chain for imported liquefied natural gas (LNG).

Combustion of gas does not result in ash residue or sulphur oxides emissions and releases negligible nitrogen. When sourced locally from a well-managed operator, gas has a lower carbon emission footprint in comparison with the combustion of coal and petroleum products, which are the primary fuels in India for electricity, transport, cooking and industry. However, there is a risk of major fugitive methane emissions from extraction and/or pipeline infrastructure.

The environmental case for gas is drastically weakened when assessed across the entire life cycle of exploration, transport, storage, distribution and consumption. Drilling wells and laying of pipelines disturb soil, wildlife and vegetation, cause deforestation and contaminate water.¹⁵ Storage and transit of gas carries the very high risk of leaks, resulting in high levels of methane emissions. Methane has a shorter life in the atmosphere compared to carbon dioxide but has a much more dramatic greenhouse effect than CO₂. In decades of research considering methane's climatic impact, the scientific community has learned that methane is worse for the climate than previously thought. Methane formerly was regarded as 25 times worse

**The environmental case
for gas is drastically
weakened when assessed
across the entire life cycle.**

¹⁴ IEA. [Net Zero by 2050](#). May 2021.

¹⁵ IEA. [Natural gas explained](#).

than CO₂ based on the Intergovernmental Panel on Climate Change (IPCC) fourth assessment report from 2007.^{16 17} However, the latest research by scientists from the UK's University of Reading and Norway's Center for International Climate and Environmental Research (CICERO)¹⁸ shows the harmful climatic effect of methane is 99 times worse than CO₂.

Additionally for India, the growing dependence on imported LNG undermines India's energy security and global climate targets.

Gas in India's Energy Mix

Gas contributes 6.2% to the Indian energy mix at present and the target is to enhance it to 15% by 2030, although we note the compounded annual average growth rate (CAGR) in total gas demand over the past five years was just 4% pa. Reaching the 15% target would need to more than treble CAGR, which seems an unrealistic ambition.

The current gas allocation trend and infrastructure plans indicate that the government is looking to increase the share of gas by increasing consumption in industrial, transport and residential segments. Massive investments are starting to expand the CGD network, including compressed natural gas (CNG) for transport and piped natural gas (PNG) in domestic, commercial and industrial segments. However, the increasing expense and poor availability of gas supply could mean that these assets run the risk of becoming stranded like gas-based power plants¹⁹.

This report will evaluate the viability of this approach for cooking and transport where the primary fuels currently are liquefied petroleum gas (LPG) and petrol or diesel, respectively.

Domestic Gas Production Trends vs Imports

Domestic gas production has declined in the past decade resulting in an increased dependence on expensive imported LNG. This not only affects the availability and affordability of gas as a fuel but also does not enhance energy security.

The argument in favour of increasing gas usage is that it diversifies India's import basket, which is dominated by oil. It is arguably not a wise strategy to lock in massive investments in building infrastructure for a fuel that is becoming increasingly expensive and limited in domestic supply.

¹⁶ Intergovernmental Panel on Climate Change (IPCC). [Climate change 2007: Impacts, Adaptation and Vulnerability](#). 2007.

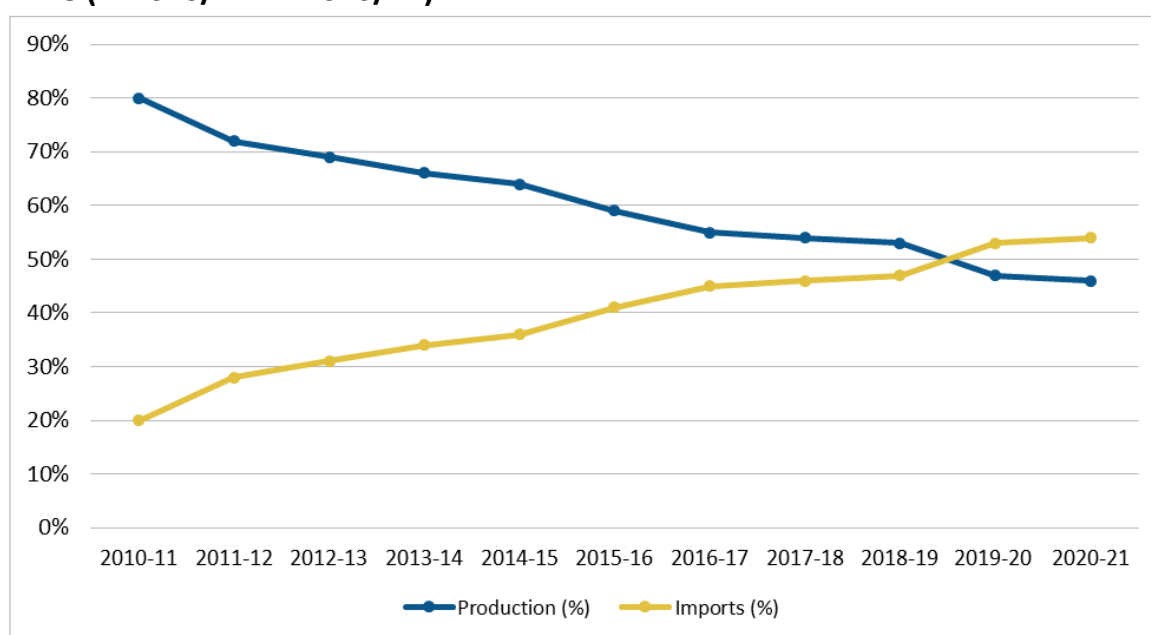
¹⁷ Climate Council. [Passing Gas: Why Renewables Are the Future](#). 2020.

¹⁸ Etminan, M., Myhre, G., Highwood, E. J., & Shine, K. P. Radiative forcing of carbon dioxide, methane, and nitrous oxide: A significant revision of the methane radiative forcing. *Geophysical Research Letters*, 43(24), 12-614. December 2016.

¹⁹ Institute for Energy Economics and Financial Analysis (IEEFA) [Australia's Gas-fired Recovery Under Scrutiny; Inaccurate Assumptions Behind Fossil Fuel Power Plants' Capacity Factor Leads to Financial Overvaluations](#). June 2021.

The 10-year CAGR of gas imports from 2010 to 2020 is an astonishing 18% while the figure for production is negative 5.6%²⁰. In fiscal year (FY) 2010/11, production of domestic gas was at its peak and had reached 51 billion cubic metres (bcm). This resulted in a minimum import requirement of 20%, even though the total consumption was the highest ever at 64 bcm. In FY2020/21, gas availability was close to 60 bcm where 46% came from domestic production and 54% was imported. Figure 1 shows the trend in gas production and imports and clearly indicates that imports are increasingly fulfilling the gas needs of the country putting both affordability and energy security in question.

Figure 1: Share of Production and Import in Fulfilling Gas Demand Over Time (FY2010/11- FY2020/21)



Source: *Energy Statistics India 2021*; *PPAC's Oil & Gas Snapshot April 2021*.

A turnaround in domestic production has long been expected, amid hopes for new gas discoveries in the Krishna-Godavari (KG) basin, which has been underperforming for a decade. From February 2021, there has been a consistent year-on-year increase in gas production on the back of flows from Reliance-BP's new D-34 field of KG-DWN-98/3 and wells from the satellite cluster²¹. There is reasonable policy support for increasing exploration and production. ONGC and the Reliance-BP joint venture are planning to invest nearly US\$10bn (~Rs74000 crore) in their new gas discoveries in the KG-D6 basin and with that, domestic production is expected to peak at 50 bcm by 2024²².

²⁰ National Statistical Office. MoSPI. *Energy Statistics India 2021*. March 30, 2021.

²¹ Business Standard. *India's natural gas production jumps 19.5% in June on back of KG-D6*. 23 July 2021.

²² Hindustan Times. *Govt readies action plan to boost ONGC's production*. April 12, 2021.

With government plans to increase gas's share in the energy mix to 15% by 2030, increased domestic production in India would not be sufficient -- incremental supply would still have to be met by imports. The International Energy Agency (IEA) projection is that India's LNG imports would increase to 48 bcm by 2025.²³

IEEFA notes that dependence on LNG imports in the long term will put India's energy security at risk, burden the current account deficit, not align with India's self-reliance policy and will not lead to any major job creation in the country. Investing in long-term infrastructure with visible imports in mind is a strategy that needs to be evaluated from the perspectives of economic, environmental and commodity/currency volatility risks.

Private Investment Planned In Gas Sector - But Will It Deliver?

The IEA, in its Gas 2020 report, expects India to be a big market for gas in the industrial and CGD sectors during the Covid rebound period 2021-2025, a forecast that is highly dependent on the direction of policy, execution of infrastructure projects and pricing of imported LNG.

We note the IEA failed to anticipate the trebling of LNG prices that has emerged since the report was published a year ago.²⁴ Disruption and price volatility are to increase in the LNG market as energy transition gathers pace, specifically considering the new draft of Japan's energy policy as the world's biggest LNG customer. Japan aims to double its renewables' share in the electricity mix by 2030. This jump in renewable energy means LNG and coal will have to surrender market share, with coal dropping by 40% and LNG by about 50% in the power mix in less than 10 years.²⁵ This will shake up the market and lead to major disruptions as we get closer to 2030.

So, India is investing in a sector with highly uncertain dynamics and it would be matter of concern from the energy security perspective. The potential for increasing LNG prices will make gas unaffordable for consumers and adversely affect the profitability of the suppliers. A collapse in demand runs a big risk of gas based assets remaining under-utilised and becoming stressed in the near future.

**Increasing LNG prices will
make gas unaffordable
for consumers and
adversely affect
suppliers' profitability.**

The import infrastructure including LNG regasification terminals and transportation pipelines is being progressively expanded. There are six operational LNG regasification terminals in the country with the total capacity of 42.MMTPA.

²³ IEA. Gas 2020 Report Extract (2021-2025: Rebound and beyond). June 2020.

²⁴ IEA. Gas 2020 Report Extract (2021-2025: Rebound and beyond). June 2020.

²⁵ Bloomberg Green. [Japan Seeks to Aggressively Cut Fossil Fuel, Lift Renewables](#). 21 July 2021.

However, we note that these facilities only had an average capacity utilisation of 52% in FY2020/21²⁶, despite record low LNG prices. In 2019, the utilisation rates were at 67%, following the high utilisation rate of 82% in 2018²⁷. Plans are under way to increase the regasification capacity by 28.565 MMTPA by 2024 with a proposed investment of Rs26,000 crore (US\$3.5bn)²⁸ of which 65% is from the private sector.

There are also plans to double the transmission pipeline network from the current 16,825 km to 33,000 km with 14,000 km already under construction and another 2,300 km under review. While GAIL owns 70% of the existing gas pipeline transmission capacity, there is increased private participation in coming pipeline infrastructure (H-Energy and Gas Transmission Private Limited) and diversification to other public entities such as Gujarat State Petroleum Corporation and Andhra Pradesh Gas Transmission Company²⁹.

CGD network is also being rapidly expanded as evident in the 9th and 10th round of CGD bidding, which combined would cover 50% of the country's population and 42% of the area. The coverage up to the eighth round was 20% of the population and 11% of the area³⁰. Changes to the CGD bid evaluation criteria and amendment to the market exclusivity clause from 5 years to 8 years are aimed at attracting more investors. The onus of pipeline to CGD network connection has also been shifted to the pipeline provider. In addition to this, the government accorded 'public utility' status to CGD in 2017³¹. The total investment for the two rounds is estimated to be Rs1,20,000 crore (US\$16.2bn)³². In evaluating the bids for PNG and CNG, it can be seen that the public sector is making significant investments but there is also a substantial investment by the private sector, whether domestic or international. The key private players are Torrent Group, Adani Group and Megha Engineering & Infrastructures Limited. The prominent international players are Singapore's Think Gas Investments PTE Limited and AG&P Global.

Figure 2 illustrates the massive investment and infrastructure push across the entire value chain of the gas sector with a focus on enhancing end distribution for cooking, transport and industry, even as the imported LNG price has quadrupled in the last year.

²⁶ Calculated from PPAC. [Oil & Gas Snapshot April 2021](#). May 19, 2021.

²⁷ International Gas Union. [2020 World LNG Report](#).

²⁸ Calculated from various sources on information on proposed LNG terminals.

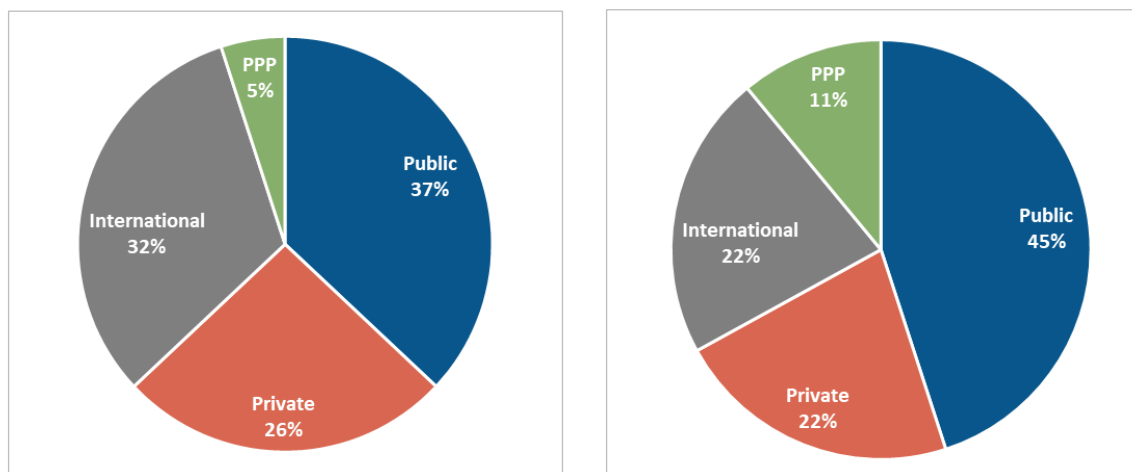
²⁹ PNGRB. [City Gas Distribution in India](#). March 2019.

³⁰ Ibid.

³¹ Lok Sabha [Question No 1126](#). December 17, 2018.

³² The Economic Times. [India to launch 11th city gas licensing round soon: Dharmendra Pradhan](#). September 10, 2020.

Figure 2: Entity-wise Investment Share in 9th & 10th Round of CGD Bidding as per PNG Connections and CNG Stations



Source: IEEFA's calculations from CGD Authorisations for 9th and 10th Round of CGD Bidding.

The key underlining aspect is that private sector investment is due to the favourable policies that are being introduced or amended with the ultimate goal of gas expansion to 15%.

The private sector is committing to invest today for plausible profitability backed by allocation of cheaper domestic gas or higher ceiling price, and government offers of market exclusivity. However, it needs to be seen whether these commitments would be fulfilled and infrastructure executed. Further, the resulting monopoly structures would need to be independently investigated in the context of public interest, particularly in light of dual requirements: the global acceleration in decarbonisation and the critical need for India to improve its self-reliance by reducing dependence on fossil fuel imports.

Proposed Gas Infrastructure Runs the Risk of Becoming Stranded

As mentioned above, there is a massive policy push for increasing gas assets in India. Investments are being committed currently with profitability as a short-term perspective, in the context of skyrocketing gas prices and many global institutions and countries readying to exit from gas.

At the start of the year, President of the European Investment Bank (EIB), Dr Werner Hoyer, said the bank's interests are no longer aligned with unabated use of fossil fuels and its support for gas, under its climate road-map, is limited to well performing power plants emitting less than 250 grams of carbon per kilowatt-hour.³³

³³ Euractiv. 'Gas is over', EU bank chief says. January 21, 2021.

A report by Global Energy Monitor (GEM)³⁴ has noted that India runs the risk of locking in a huge US\$103bn of stranded assets by investing in gas pipeline infrastructure. Decreasing renewable prices and increasing gas prices make investing in fossil fuel pipeline infrastructure economically unsustainable. The report also notes that the lifetime emission of proposed gas pipelines in India is equivalent to that of 61 coal power plants (1000 MW).

Lifetime emission of proposed gas pipelines in India is equivalent to that of 61 coal power plants.

GEM points to the global decrease of pipeline infrastructure additions, down by 13% in 2020, and a slow-down in the past decade. This further illustrates the point that by investing in gas infrastructure, India is locking in scarce capital in a technology that was important a decade or two ago and is missing a golden opportunity to invest in future technologies.

Increasing gas prices also make the existing gas infrastructure uncompetitive and untenable, forcing consumers to cut back on demand. The increase in price of domestic gas is expected to be reflected in the October 2021 revisions -- spot LNG prices are touching US\$16 per million British thermal units (MMBtu) making gas an expensive fuel. There are reports of customers deferring purchase of spot LNG due to high prices³⁵. India's LNG terminals, now under-utilised due to lack of pipeline infrastructure, would further be stranded as LNG prices shoot up. If the inflationary trend remains, companies planning to invest in gas infrastructure may back out as the affordability factor turns consumers to other fuels.

IEEFA notes a long-term analysis needs to be undertaken afresh in light of the growing decarbonisation trends globally, and the extreme LNG price volatility seen in the past two years, which has stepped up markedly relative to last decade.

Priority Allocation to City Gas Distribution Sector, But Will the Competitiveness Remain?

To increase the share of gas in the energy mix, the policy push is being given to spread a massive city gas distribution (CGD) network across the country and also provide the more competitive domestic gas to this sector to further enable investments. The aim is to have a widespread network that can be used to supply gas to households for cooking, to CNG stations for transport and to industries for heating and other activities.

Annual consumption of the CGD sector has doubled from 5,464 million metric standard cubic metres (MMSCM) in FY2015/16 to 10,883 MMSCM FY2019/20. The

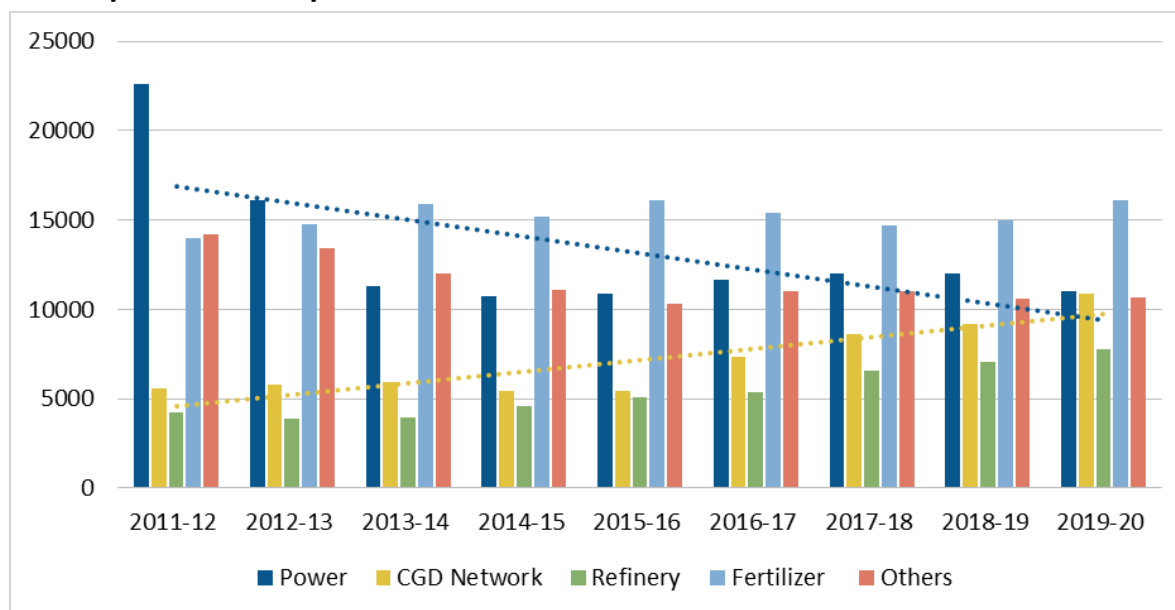
³⁴ Pipeline Bubble 2021. [Global Energy Monitor](#). February 2021.

³⁵ Reuters. [Some Indian buyers cutting imports of costly spot LNG – Petronet](#). August 14, 2021.

share of power in natural gas consumption/allocation has halved from 35% in FY2011/12 to 17% in FY2019/20 while that of CGD has increased from 9% in FY2011/12 to 17% in FY2019/20³⁶. CGD has been accorded priority allocation as it is a cheaper and cleaner option vis-à-vis the available alternatives such as petrol/diesel and EV for transportation and LPG for cooking (which was highly subsidised up to April 2020).

Before 2014, the power sector was the major consumer of domestic gas. As renewable energy started reaching economies of scale and becoming increasingly competitive, gas-based power plants entirely lost their competitiveness and gas as a resource lost its glory. Specifically, the combined-cycle gas turbines (CCGT) have been crowded out by solar and wind in off-peak periods. There remains a small space in the electricity mix for OCGT Gas peakers (Open-cycle Gas Turbines) to compete with other sources in the peak times. This position for Gas peakers is also shaky as large-scale batteries rapidly become more economically viable. By FY2020/21, India's 25GW of gas power plants were operating at just 23% average utilisation rates³⁷, just a third of forecast rate assumed at the time the investments were instigated. This has created a yet-to-be resolved US\$10-20bn stranded asset for India.

Figure 3: Year-wise Sectoral Allocation of Domestic Gas in MMSCM, FY2010/11 to FY2020/21



Source: *Consumption of Energy Resources, MOSPI.*

Note: Others includes Industrial & Manufacturing, Tea Plantation, Internal Consumption for Pipeline System, Miscellaneous for energy purpose and usage in Petrochemical, Sponge Iron and LPG Shrinkage.

³⁶ Calculated from Consumption of Energy Resources, MOSPI.

³⁷ Central Electricity Authority. *Executive Summary Report March 2021.*

The ongoing allocation trend and the infrastructure planning indicate that the priority gas allocation would continue to be given to the CGD sector for residential, transport and industrial. However, as more competitive alternatives to gas emerge in the cooking and mobility segment, the future of gas is likely to be bleak. If the pipelines being built in India are not hydrogen-enabled, India is investing in another set of infrastructure that runs the risk of being stranded in the near future. Electricity for cooking and mobility is emerging as a very strong alternative to fossil fuels globally and countries are fast moving to adoption. This also offers the advantage of being increasingly green as countries are mobilising renewable energy in their grids. A long-term view on the competitiveness of gas in the cooking and mobility sectors is necessary before locking in mammoth investments in gas supplies and perhaps crowding out investments in future technologies such as EVs.

Electricity for cooking and mobility is emerging as a very strong alternative to fossil fuels globally.

Viable Alternatives for Cooking in India

LPG: Uptake Remains Low

In the past decade, there has been a shift in cooking fuels in India with the government's push to increase LPG connections. Under the Pradhan Mantri Ujjwala Yojna (PMUY) scheme itself, 80 million LPG connections have been provided to poor families and another 10 million are to be provided by March 2022 with a support of Rs1600 (US\$21.6) each towards the administrative cost of installation and interest free monthly instalments for stoves and refill cost³⁸.

As on April 1, 2021, there were 289.4 million active LPG customers in the domestic category resulting in LPG coverage of 99.8%³⁹. This however does not translate in LPG being the primary fuel for all households due the high cost of refuelling and inconvenience of transporting the heavy LPG cylinders. This is evident from the data presented in the 76th National Sample Survey (NSS) 2018, which notes that approximately 61.4% of households used LPG as the primary fuel for cooking while 35% of the population continued to depend on firewood, chips, crop residue and

³⁸ Budget 2021-22. Speech Of Nirmala Sitharaman Minister Of Finance. February 1, 2021.

³⁹ PPAC. [LPG Profile as on 1.4.2021](#).

dung cake⁴⁰. Solid fuels for indoor cooking are extremely problematic as they release fine particles that affect lung function and cause many respiratory diseases such as pneumonia and lung cancer, a severe health and wellbeing cost to India⁴¹. The IEA in fact estimates that in 2019 half of the population in India was still dependent on solid fuels⁴², evidence that LPG had not become a reliable primary fuel in India despite all government efforts.

According to the World Health Organisation, approximately 3.8 million people die annually from illnesses attributable to household air pollution caused by inefficient use of solid fuels and kerosene for cooking⁴³. Solid fuels also lead to deforestation, loss of biodiversity and the elimination of carbon sinks.

It is a given that solid fuels are to be completely eliminated but an alternative fuel that can reach the requisite scale for meeting India's clean cooking requirements has yet to emerge. For India's needs and requirements, a one-fuel solution is not possible and until recently the government was simultaneously trying to promote improved biomass cookstoves, family size biogas systems, solar cookers and LPG. But none of these have ensured the use of stoves or encouraged a switch from solid fuels for many poor households.

For India's needs and requirements, a one-fuel solution is not possible.

To counter this, the government's approach at present is to move the urban consumers to PNG to free up LPG and its distribution for rural areas. This prompts the question: will promoting an import dependent fossil resource (PNG) to alleviate the problems not solved by an existing similar resource (LPG) provide a real solution?

LPG cylinders are costly in India and the gas is linked to international crude oil prices. Even after the massive subsidies that were provided until mid-2020, the refilling of LPG cylinders remained expensive and poor households continued to depend on solid fuels for cooking. Prior to 2015, all households were eligible for subsidised LPG cylinders so even when the prices of LPG cylinders reached as high as Rs1241 (US\$20.2)⁴⁴ in January 2014, the subsidised cylinder was about Rs414 (US\$6.7) in Delhi with a cap of nine cylinders per household⁴⁵. A Comptroller and Auditor General (CAG) of India Audit report on the PMUY in 2019 noted that annual

⁴⁰ NSS 76th Round. [Drinking Water, Sanitation, Hygiene and Housing Condition in India](#). July-December 2018.

⁴¹ WHO. [Household air pollution and health](#). May 8, 2018.

⁴² IEA. [Air Quality and Climate Policy Integration in India](#). June 2021.

⁴³ EOS. [Solid-Fuel Use Puts Human Health at Risk](#). March 15, 2018.

⁴⁴ Converted with January 14, 2014 rate (1US\$=Rs61.4)

⁴⁵ India Today. [Cooking gas \(LPG\) price to cost Rs 220 per cylinder](#). January 2014.

average refill consumption of PMUY consumers as on December 31, 2018 remained very low at 3.21 refills per annum⁴⁶. The average refills are pegged at 7-8 cylinders per annum for households using LPG as their primary fuel⁴⁷.

With the direct benefit subsidy transfer scheme for LPG (DBTL) initiated in 2015, all subsidy transfers – one cylinder a month -- are paid directly into consumers' bank accounts after their purchase of the LPG cylinders at market rate. The total amount transferred under DBTL was Rs22,726 crore (US\$3.1bn) for the fiscal year 2019-20⁴⁸. However, the subsequent pay out of the subsidy, while increasing transparency in the subsidy mechanism, has lowered the affordability for consumers. There have also been delays in transfer of subsidy payments, further affecting affordability of LPG and lowering uptake despite high connection coverage.

The prices of subsidised cylinders increased in small amounts in FY2020/21 and with the then-lowered oil prices, the costs of subsidised and non-subsidised cylinders became equal at Rs594 (US\$8) in July 2020⁴⁹. The prices in May and June 2020 were lower than this and hence no subsidies have been provided since May 2020 on LPG cylinders. Oil prices bounced back and LPG cylinders in April 2021 were at Rs809 (US\$11), though the subsidies have not been reinstated for now. This will significantly lower the uptake of LPG cylinders in poor households, for whom there was low affordability even after subsidy.

**Subsidies have been
a major reason behind
the increase in LPG
penetration in India.**

Subsidies have been a major reason behind the increase in LPG penetration in India and it is crucial to take into account the effects of withdrawal. The uptake of LPG cylinders after the subsidy support is completely withdrawn is expected to become lower and a proper independent evaluation should be undertaken now *before* the imported gas infrastructure investment aimed at rural distribution and affordability.

PNG: Requires Massive Infrastructure

PNG is being actively promoted by the government in the urban areas that are already well serviced by LPG. The city gas distribution (CGD) network, which is used for supply of PNG and CNG, is currently available for 20% of the population and is being planned to be expanded to cover 70% of the population by 2030. Additionally,

⁴⁶ Comptroller and Auditor General of India. [Report on PMUY](#). 2019.

⁴⁷ DownToEarth. [Overcoming India's clean cooking challenge](#). December 26, 2019.

⁴⁸ PPAC. [Oil & Gas Snapshot April 2021](#). May 19, 2021.

⁴⁹ ET Energy World. [No DBT on subsidised LPG for 3 months due to favourable oil market](#). July 28, 2020

the current 17% share of natural gas allocated to the CGD sector is also set for rapid expansion.

A key problem with PNG as a primary fuel for India at present is its limited penetration and access. Total number of PNG connections across the country is 7.82 million as on March 31, 2021, translating to just 2.7% of the total estimated households in India. PNG offers the convenience of on demand availability and takes away from consumers the burden of refilling cylinders but it requires creation of large, efficient distribution networks with particular challenges and necessarily massive investment. Further, the monopoly licence allocations mean consumers will be exposed to potentially significant progressive price increases, particularly in times of high LNG prices. In the absence of subsidies for LPG cylinders, there would be high demand for PNG. The government should play a prominent regulatory role in this ambitious plan.

Reliance on PNG also brings a high dependence on imports, not only affecting energy security but also contributing to massive carbon emissions in transportation, exploration and even infrastructure development -- perhaps negating the benefits of a switch to or addition of PNG. It is not an optimum strategy to complement LPG, which is also highly import dependent. In FY2020/21, out of the total LPG consumption of 27.6 million metric tonnes (mmt), only 12.1 mmt (44%) was produced in India⁵⁰. This strategy does not seem to align with Indian government's policy of self-reliance policy or lowering carbon emissions.

Electric Cooking: Can Offer an Alternative

Electricity is barely utilised as a cooking fuel in India whereas the developed world is now aggressively shifting to electric cooking. In the United States, 63% of the households use electricity for cooking⁵¹. The World Bank also finds merit in electric cooking especially for meeting the Sustainable Development Goal 7 (Ensure access to affordable, reliable, sustainable and modern energy for all).

India's advantage in switching to electric cooking is that preliminary infrastructure for providing connections is far ahead of that for PNG or LPG distribution. With India's close to 100% electrification, the idea is increasingly plausible. However, the hindrance is the lack of reliable supply, which in turn reduces willingness to pay for electricity. Before any proposed major switch to electric cooking, a stable connected load has to be established. This is a long-term goal that has to be achieved regardless of using electricity as a cooking fuel or no. Also, with ambitious renewable

Before any proposed major switch to electric cooking, a stable connected load has to be established.

⁵⁰ PPAC. *Oil and Gas Snapshot May 2021*. June 18, 2021.

⁵¹ DailyEnergyInsider. *Electricity is the most used power source for cooking in the US*.

energy targets being set, electricity can in the near-term be the cleanest modern cooking fuel available to India.

It is estimated that for an annual consumption equivalent of LPG (7-8 cylinders per annum), 4 kWh per day of electricity would be required. For an urban household in Delhi, consuming a monthly average of 260 kWh of electricity⁵², an additional requirement of electric cooking at 4 kWh per day (or 120 kWh per month) would translate to a bill of ~Rs2010 (US\$27) for a month including the cost of running lighting and other appliances. If the incremental cost of 120 kWh is taken at a tariff of Rs4.5/kWh (US\$0.06), then the additional cost of electricity for cooking would be Rs 540 (US\$7.3) per month which is comparable to the cost of LPG.

Shifting to electric cooking can also spur demand for electricity and in turn enable an enhanced domestic supply. Even solar mini-grids, which have a high upfront cost, can be utilised. The World Bank's report on *Cooking with Electricity: A Cost Perspective*⁵³ notes that utilising solar hybrid mini-grids for cooking can stimulate demand and bring the grid above the break-even tariff of US\$0.40/kWh (Rs29.7/kWh). The tariff at present is almost US\$3/kWh (Rs222.7/kWh) as the grid is being utilised for 2-5 kWh per household per month for LED lights and to charge phones only. The report takes an additional consumption of 30-60 kWh per month per household for cooking after assuming 20-30 kWh for more basic lighting, phone charging, small TV and refrigerator and notes that it can be economical to use microgrids for lighting and cooking.

The Ministry of Power is getting ready to make electric cooking a reality in India and has plans to set up a Power Foundation. One of the objectives in enabling the switch to electric cooking is to set the Indian economy for self-reliance and independence from imports. This appears to be a more relevant strategy for India in terms of energy security, self-reliance, affordability and carbon emissions.

A comparison of these modern cooking fuels across various parameters is presented below.

Modern Cooking Fuels – A Comparison

The chart below shows a comparison of the three key modern cooking fuel options for India to evaluate the role of natural gas in clean cooking in India. The key factors evaluated below are the most important aspects of a good fuel for cooking. Low, medium and high indicate the scale of contribution to the good fuel indicator with low meaning that the value as a good fuel is low per that indicator.

⁵² CSE. [CSE releases new analysis of electricity consumption in Delhi during the lockdown and un-lockdown](#) phases. Aug 13, 2020.

⁵³ World Bank. [Cooking with Electricity: A Cost Perspective](#). September 21, 2020.

Table 1: Good Fuel Matrix for Clean Cooking

Key Factors	PNG	LPG	Electricity
Penetration as a cooking fuel	low	medium	low
Affordability	medium	low	medium
Reduction in fossil factor (enabling reduction in fossil fuel consumption)	low	low	low*
Convenience in usage	high	medium	high
Availability	low	medium	medium**
Elimination of stacking requirement	high	low	low**
Safety in using	medium	-low	high
Infrastructure availability for distribution	low	medium***	high
Reduced carbon emissions of distribution	low	low	medium
Ease of conversion from existing cooking system	high	high	medium
Energy security	medium	low	high
Scalability	medium	high	high
Sustainability	medium	medium	high
Speed of enhancing supply penetration	low	high	medium
Thermal efficiency	medium	medium	high
Ranking amongst available clean alternatives	medium	low	high
Score^ (low=1, medium=2, high=3)	29	28	36

* Whilst coal dependent generation is high.

** 100% electrification but supply stability and load factor is low.

*** As already in place but if demand increases then improving distribution channels and increasing bottling plants may lead to increased cost.

^ Subject to change with change in technologies, fuel pricing and policy implementation

Source: IEEFA estimates.

The above comparison shows that there are not many factors in favour of gas as a primary fuel. Setting up the infrastructure for supply of PNG would take high levels of investment and a long time – five to 10 years. By then the global commitment on emissions might become more stringent due to technological advancements in developed countries. If a numeric value of 1,2 or 3 is assigned to the ratings low, medium and high then we would see that the highest score is for electric cooking, which is not only futuristic but also the most cost effective in the long term. PNG is accorded a low score due to the high upfront cost, expensive inflationary fuel utilisation and limited environmental benefits.

More developed countries have already moved to electric cooking and would advocate that in the move towards net zero carbon commitments. PNG's high upfront infrastructure cost runs the risk of becoming stranded, owing to inflationary LNG prices and expensive domestic exploration, but also does not offer a strong environmental case when observed across the entire supply chain.

Electric cooking, on the other hand, offers a more competitive option to LPG and solid fuels, with the promise of energy security and being the cleanest fuel for cooking in India given the rapidly increasing renewable energy penetration. The basic infrastructure is available and until the load is stabilised the government can invest in distributed renewable energy (DRE) alternatives such as solar mini-grids to increase penetration. There would be more merit for India to invest in this as a means of meeting renewable energy and clean cooking. Government should invest in stabilising the electricity load in the country and also offer a subsidy to people to buy the relevant appliances and utensils for electric cooking as the best use of limited capital resources. A NITI Aayog paper recommends that India should focus on promoting electric cooking in urban areas with adequate supply of electricity and free up LPG for rural households. This is definitely a more cost-effective approach than shifting urban households to PNG to free up rural LPG. A step ahead would be to slowly shift rural households to electric cooking with the use of DRE or to further promote the use of biofuels. According to IEA India Energy Outlook 2021⁵⁴, India has 5 million biogas units in operation and many programs are in place to support household-scale bio-digesters as a clean cooking solution in rural areas.

Saul Griffith, an Australian-American inventor in the energy conservation field, notes that a policy commitment to cleaning the electricity grid and to push use of electricity for residential, transport and industrial uses could solve 70% of the climate change problem for a country such as the United States without requiring any sacrifices in the living standards of the people⁵⁵. India has a golden opportunity in such a scenario as it still has a large population that needs access to clean cooking. Instead of planning a fossil fuel-based expansion it can promote use of electricity while working on greening the grid, so that in a much shorter timeline both accessibility and zero carbon emissions can be achieved. Leapfrogging a technology would prove to be inexpensive in the long term and will help avoid the risk of stranded assets on a massive scale.

Decarbonising India's Transport Sector

Decarbonising the transport sector is a globally accepted strategy to lower the greenhouse gas (GHG) emissions and an important step to keep the increase of global average temperature within a safety threshold of 1.5°C. The transport sector accounts for 24% of the global CO₂ emissions from fuel combustion. Of this, 75% of emissions are from road transport (cars, trucks, buses and two- and three-wheelers). Aviation, shipping, rail and indirect emissions from electricity generation are the other sources of emissions from the sector⁵⁶.

In India, the transport sector is a major contributor to the carbon emissions. According to the IEA's World Energy Outlook 2021⁵⁷, as per the stated policy scenarios, India's massive upward pull in carbon emissions is going to be attributed to the transport sector. The report also notes that with the majority of vehicles

⁵⁴ IEA. [India's Energy Outlook 2021](#).

⁵⁵ Vox. [How to drive fossil fuels out of the US economy, quickly](#). August 6, 2020.

⁵⁶ IEA. [Transport: Improving the sustainability of passenger and freight transport](#).

⁵⁷ IEA. [India's Energy Outlook 2021](#).

being two-wheelers/three-wheelers in India, the maximum opportunity to lower CO₂ emissions comes from passenger cars and freight transport. With the aggressive policy plans to shift two- and three-wheelers in India to EV versions, a huge opportunity is there for India to build self-reliance and investment and employment gains in manufacturing for the huge domestic market.

Currently, 90% of the road transport is fuelled by oil, leading to massive pollution and carbon emissions. Efforts by the government are under way to lower carbon emissions from the transport sector and the key strategies to that effect include improving efficiency in internal combustion engine (ICE) vehicles, promoting natural gas vehicles (NGVs), enhancing electric vehicles (EVs) and including biofuels. As India imports ~85% of its oil, a failure to shift to EVs means a massive growing energy security risk for the nation, with strong economic growth likely to lead to continued widening of the current account deficit.

**Currently, 90% of
road transport is fuelled
by oil, leading to
massive pollution and
carbon emissions.**

There is a strong environmental case for use of gas in transport if only the direct emissions and tailpipe emissions are considered. There is no soot, dust or fumes emitted from natural gas combustion, making it one of the cleanest fossil fuels, albeit an EV is 100% cleaner! It is also necessary, however, to consider the well-to-wheel emissions, which may not give a very high comparative advantage depending on the method of transmission and distribution of gas.

In India, it is estimated that a total of 11% of gas is used in the transport sector⁵⁸. CNG vehicles were introduced in the early 2000s in India and have an extensive presence in major cities including New Delhi and Mumbai. The policy focus was on converting public transport plying on-road, such as buses, three-wheelers and taxis, to CNG. In volume terms, India is one of the world's biggest CNG markets, with nearly 3 million CNG vehicles and 500,000 CNG buses⁵⁹.

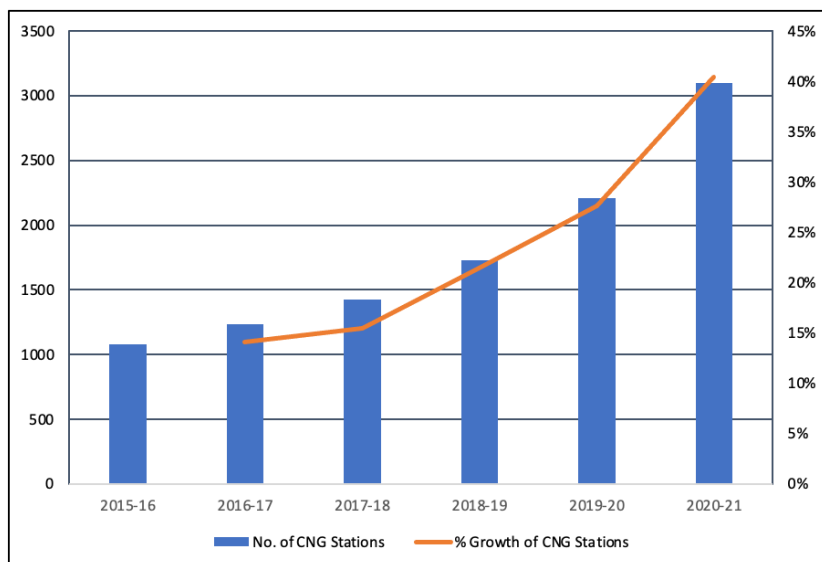
The ambition for gas to contribute to a larger percentage of transport in India will have to be concomitant with a major push to gas infrastructure such as pipeline, CGD network, CNG stations and LNG stations. The government is investing heavily in increasing the pipeline and CGD network and has allocated minimum work programs for establishing an additional 8000 CNG stations by 2030 under the 9th and 10th round of CGD bidding. In recent years, there has been a tremendous increase in the CNG infrastructure with a whopping 40% year-on-year growth from FY2019/20 to FY2020/21. It is interesting to note that the increase in CNG stations

⁵⁸ NGV Global News. [India's Natural Gas Fuelled Transport Sector Poised for Growth in 2018](#). February 2018.

⁵⁹ IEA. [India's Energy Outlook 2021](#).

has been a recent phenomenon with more than 1500 CNG stations added in the past three years. Many cities inaugurated their first CNG station in 2020.

Figure 4: Number of CNG Stations from FY2015/16 to FY2020/21



Source: IEEFA analysis based on *Year-wise Indian PNG Statistics* released by MoPNG, PPAC *Oil & Gas Snapshot April 2020*.

While there is a recent push on the CNG infrastructure, it is still to translate to people preferring to buy CNG vehicles. The sales numbers of CNG vehicles for FY2020/21 are being reconciled and are not yet available with PPAC. FY2019/20 data show only an 8% increase in the sale of CNG vehicles. The recent increase in petrol and diesel prices, combined with increased access to CNG, is expected to lead to higher sales of CNG vehicles. Two major car makers, Maruti Suzuki and Hyundai, are increasing CNG car production in anticipation of increased sales. The key concern with CNG vehicle uptake is that in smaller vehicle category there is already a competitive entry being made by electric vehicles. For long-haul vehicles it is not a sustainable option. In the passenger segment, CNG sales are most prevalent in the entry to mid-level cars. These will be an affordable option only until gas prices are not market determined in India (versus petrol and diesel prices, which are

EVs are becoming increasingly affordable, especially with advances in battery technologies.

deregulated and not administered by the government). Yet again, it is necessary to take a long-term view of the competitiveness of gas in the mobility sector as gas prices are inflationary and EVs are becoming increasingly affordable, especially with advances in battery technologies.

Electric Vehicles Are a Clean Mobility Alternative

EVs have been centre-stage in clean mobility discussions in India. There are varying but ambitious targets (30% by 2030 or 100% for two-wheelers by 2024) which are well supported by policy initiatives such as the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme. The investment influx has been in tandem with these ambitions and the EV market in India is expected to rise to US\$2bn pa by 2023⁶⁰.

The environmental concerns of EVs are few as studies have proven that lifecycle emissions for EVs continue to be much lower than ICE vehicles for high renewable energy countries and, even when the electricity is not coming from clean sources, the emissions are comparable or lower and will reduce with accelerated decarbonisation⁶¹.

As India progresses to clean its electricity production and add its ambitious 450MW of renewable energy by 2030, with all incremental electricity demand being met by new zero carbon generation, these environmental concerns could be completely mitigated.

The economic case of EVs grows stronger by the day, with battery costs coming down faster than expected, though for now the extremely costly batteries make a same segment EV far dearer than an ICE vehicle. Also, while the upfront cost of EVs is higher, the total cost of ownership is lower or close to break-even in most cases except for four-wheel passenger vehicles at the current battery price levels⁶². However, the upfront cost will become comparable in the near term with declining battery costs. Bloomberg New Energy Finance (BNEF) predicts that the battery price will come down to US\$101/kWh (Rs7,490/kWh) by 2023 from US\$137/kWh (Rs10,160/kWh) in 2020⁶³. The battery price was US\$1,100/kWh (US\$50303/kWh)⁶⁴ in 2010. Figure 5 below shows the relative cost of batteries is plunging much faster than other renewable technologies. This trend would translate to much higher level of affordability for batteries in the near future.

⁶⁰ Invest India. [Electric Mobility](#).

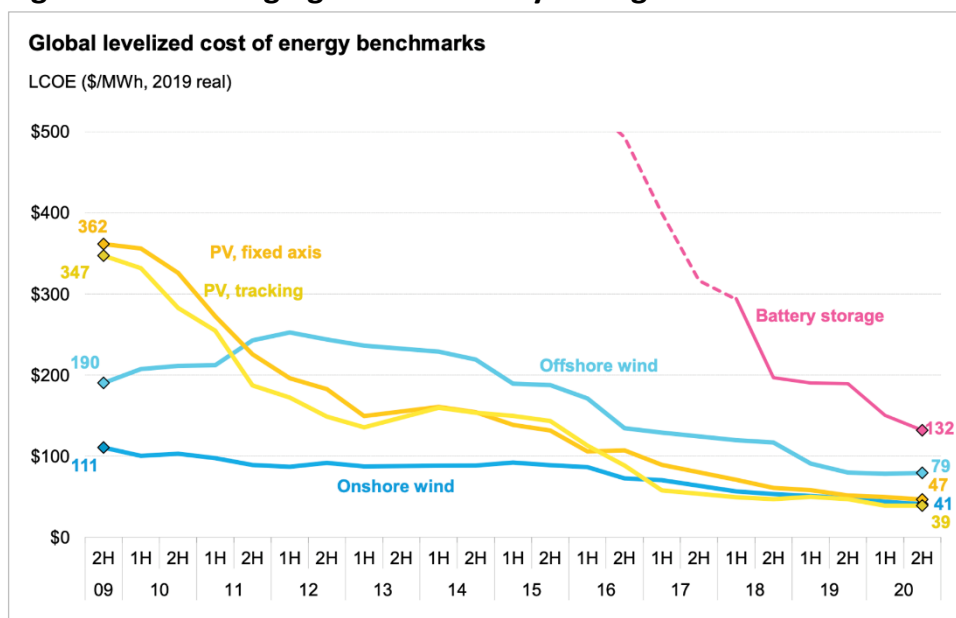
⁶¹ CarbonBrief. [Factcheck: How electric vehicles help to tackle climate change](#). May 13, 2019.

⁶² Aventus. [The Economics of Electric Vehicles in India](#). July 2020.

⁶³ BNEF. [Battery Pack Prices Cited Below \\$100/kWh for the First Time in 2020, While Market Average Sits at \\$137/kWh](#). December 16, 2020.

⁶⁴ Converted with 2010 rate (1US\$=Rs45.73)

Figure 5: The Plunging Cost of Battery Storage



Source: BloombergNEF.

Increased demand and advances in technology have led to the decline in prices. BNEF also notes that with high utilisation rate of manufacturing plants (as high as 85%), the leading battery manufacturers are now operating at a gross margin of 20%.

Investment in EVs in India is expected to reach US\$50bn by 2030.⁶⁵ Investments from private entities in the sector are rising at a fast pace, backed by government incentives and schemes such as the Production Linked Incentive (PLI) Scheme for advanced cell chemistry (ACC) battery storage. States are also providing clear policy directives with their individual EV policies and incentives including land availability. EV has become a solution for the last mile connectivity in India, which public transport was not providing until now. Other advantages of EVs are easier maintenance (they have fewer moving parts) and greater longevity (3.5 times the lifecycle) than ICE vehicles⁶⁶.

The key challenges for EVs are the lack of charging infrastructure, limited distance per charge and associated range anxiety, and dependence on imports. Considerable advancement in battery storage, the investment pipeline for infrastructure enhancement and increased familiarity of people with EVs will together help overcome these challenges. In India, another beneficial factor for the EV market is that it is driven by businesses and start-ups and is supported by government policies of minimum barriers to entry. Investors have put more than US\$7million

⁶⁵ The Third Pole. [Electric vehicle financing in India to touch USD 50 billion by 2030](#). March 17, 2021.

⁶⁶ Avendus. [Electric Vehicles - Charging Towards a Bright Future](#). July 2020.

into five start-ups and there is the reported US\$300 million funding in Ola Electric⁶⁷. Ola is planning a hyper-charger network covering 400 cities with 100,000-plus charging points. According to the company’s fuel cost calculations, EVs make more economic sense than ICE vehicles – driven 30km daily, the annual fuel cost of ICE vehicles is almost Rs20,000 (US\$270) versus Rs4100 (US\$55) for EVs⁶⁸.

ICE, NGV and EV – The Best Option?

A comparison of transport options across various parameters is presented below. The key factors evaluated below are the most important aspects of a mobility option that can be adopted in India. Low, medium and high indicate the scale of contribution to the mobility matrix with low meaning that the value as a good option is limited per that indicator.

Table 2: Mobility Matrix - Comparison of ICE, NGV and EV

Key Factors	ICE	NGV	EV
Penetration as a transport fuel	high	low	low
Affordability (entry range vehicle)	high	high	low*
Reduction in Well-to-wheel / Lifecycle emissions	low	low	medium**
Availability - vehicle options	high	medium	low
Energy security	low	medium	high
Accessibility of refuelling infrastructure	high***	medium	low
Fuel price	high	low	medium
Proposed technological innovations	low	low	high
Convenience in usage	high	medium	low****
Vehicle longevity	medium	medium	high
Ease of entry across value chain	low	low	high
Ease of maintenance	low	low	high
Score^ (low=1, medium=2 and high=3)	25	19	24

* Battery leads to high cost, expected to go down by 2023.

** Till coal dependent generation is high.

*** As already in place but if demand increases then improving distribution channels may lead to increased cost.

**** Convenience in usage high in terms of efficiency and charge speed but low due to range anxiety and lack of sufficient infrastructure.

^ Subject to change with change in technologies, fuel pricing and policy implementation.

If a numeric value of 1,2 and 3 is assigned to the ratings low, medium and high then we would see that the highest score is achieved by ICE, which have been prevalent for decades and have enjoyed massive government support. Despite this, electric

⁶⁷ Business Insider. [India’s electric vehicle startups charge up with funding as everyone from the government to Mukesh Ambani and Elon Musk have their eyes on the sector.](#) March 23, 2021.

⁶⁸ Ola Electric. [Ola Hypercharger.](#)

vehicles are behind by only one point and are bound to go much further ahead with the lowering of battery costs, increased renewable energy generation and building of just enough charging infrastructure. NGVs as can be seen perform poorly on most parameters and do not appear as an optimum alternative for mobility in India.

India needs to take a leaf from the EU book, which proposes to ban all ICE vehicles by 2035⁶⁹. Canada is also mulling a ban on any new ICE by 2035, UK by 2030 and France will phase out all ICE by 2040⁷⁰. The US in August 2021 committed to a 50% EV share of new vehicles by 2030.⁷¹ The share of EVs is also increasing rapidly in the developed world. The EV stock in EU almost doubled from 1.9 million in 2019 to 3.3 million in 2020 and that in China increased by 30% in one year⁷². BNEF's Electric Vehicles Outlook 2021 notes that global investment is flowing into electrified transport with China in the lead. By 2030⁷³, EVs will account for 28% of global car sales.

**Global investment
is flowing into
electrified transport.**

India, with its increasing middle-income population with unfulfilled aspirations to own a vehicle, has this massive opportunity to move parallel to the developed world in decarbonising the transport sector by promoting EVs while cleaning the electricity grid. This would again require India to leapfrog a technology instead of working with a lag of 20 years from the developed world.

The infrastructure cost of setting up CGD network, coupled with the cost of LNG imports, weakens the long-term economic case for natural gas as an optimum fuel for transport. It lowers energy security and does not offer very high environmental benefits when well-to-wheel emissions are considered. There are massive subsidies for any new technology and India provides direct and indirect subsidies for fossil fuel-based technologies. It would be efficient to provide these subsidies for EVs including passenger vehicles, which have a high up-front cost.

EVs use the fuel of the future and offer many investment and business opportunities to start-ups and big companies across the value chain, in comparison to CGD infrastructure which requires massive upfront investment in a fossil based fuel that may not remain competitive in the near future. The EV infrastructure is being

⁶⁹ The Verge. [EU proposes phasing out new internal combustion cars by 2035](#). July 14, 2021.

⁷⁰ HT Auto. [With parts hotter than Delhi, Canada targets end to sale of ICE vehicles by 2035](#). June 30, 2021.

⁷¹ The White House. [FACT SHEET: President Biden Announces Steps to Drive American Leadership Forward on Clean Cars and Trucks](#). August 5, 2021.

⁷² IEA. [Global electric vehicle stock by region, 2010-2020](#). April 28, 2021.

⁷³ ETAuto: [A Deep-dive Into World EV Market: In India, only 8% of new car sales will be electric by 2030 against 28% globally, says Report](#). July 2, 2021.

planned and is expected to arrive much faster than the spread of CNG stations.

In addition, there is a promising potential for EVs to interact with distributed energy systems in homes with batteries and solar panels. EVs could offer convenience of charging in case of blackouts or in the peak times and they could be charged by excess solar electricity produced during the times of peak solar radiation. These synergies are the by-product of increasing the share of EVs in the transportation fleet, which is completely in-line with the world and India's movement towards net-zero economies.

Conclusion

The government of India has made strong commitments to increase the share of gas in the country's energy mix as a bridging measure to meet the goal of lowering carbon emissions on the way to net zero.

To do so, the government is prioritising new gas infrastructure over the infrastructure cost advantage of renewables. Creating dual connections of gas and electricity to meet energy needs can lead to environmental and capital loss. Using the available gas and investing in greening the electricity grid can reap greater long-term results. India is already committed to achieve 450GW of renewable energy by 2030 and that should be top priority.

Meanwhile, the nearly 50% import dependence of LNG not only puts India's energy security at risk but it also sabotages its current account, currency value and self-reliance goals. Massive subsidies for gas further disallow a competitive use of the government's limited capital. Further, CGD infrastructure to cover 70% of the population will increase demand for gas in cooking and transport.

This strategy of making India a gas-based economy by 2030 is not aligned with the government's view of only using gas as a transition fuel or being self-reliant, while there is a risk of any new gas infrastructure being stranded as technology advances and more competitive options become available.

A policy change to boost profitability and reliability in wind or solar would enhance investment in non-fossil fuel and make net zero more of a reality for India.

**There is a risk of any
new gas infrastructure
being stranded as
technology advances.**

IEEFA analysis shows that global capital is moving towards green investments as countries, lenders and companies formulate plans to be carbon neutral.

A large proportion of India's population is still using harmful solid fuels for cooking so there is an urgency for a switch to cleaner fuels. IEEFA notes the benefits of

switching to electric cooking in rural areas and to divert existing gas to the power sector for the generation of electricity.

The government hopes to increase the number of buses and taxis using CNG and, to increase the share of EVs, has developed policy incentives for the increased electrification of public transport. The next step is to incentivise the purchase of EV passenger cars to lower emissions, increase acceptability, pique businesses' interest in the sector and encourage investment in EV infrastructure. Gas via LNG could then be used in long-haul trucking in a transitory role.

Increasing electricity use provides economic and environmental benefits and reduces India's dependence on energy imports. Going electric leverages existing infrastructure -- there is virtually 100% electric connection coverage -- and avoids locking in a second energy distribution network. Gas should continue to be an alternative only where a robust supply chain is already established.

Gas, having failed to reach scale in India over the past two decades, remains a cooking and mobility option in limited urban areas while not really assisting in lowering carbon emissions. As global cities start to shun gas and move to zero carbon emissions, investing in this fuel of the past needs to be re-evaluated.

About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

About the Author

Purva Jain

Purva Jain is an independent consultant with over eight years of experience in policy advocacy and research in the energy and development sectors. Her areas of policy interest include renewable energy, climate change, energy subsidies, electric vehicles and sustainable development. She has previously engaged as a policy consultant with G20 Sherpa team in the International Economic Relations Division at the Indian Ministry of Finance and the Global Subsidies Initiative of the International Institute of Sustainable Development (IISD). She has also worked with various think tanks and organisations such as UNDP, ADB and ORF.

This report is for information and educational purposes only. The Institute for Energy Economics and Financial Analysis ("IEEFA") does not provide tax, legal, investment, financial product or accounting advice. This report is not intended to provide, and should not be relied on for, tax, legal, investment, financial product or accounting advice. Nothing in this report is intended as investment or financial product advice, as an offer or solicitation of an offer to buy or sell, or as a recommendation, opinion, endorsement, or sponsorship of any financial product, class of financial products, security, company, or fund. IEEFA is not responsible for any investment or other decision made by you. You are responsible for your own investment research and investment decisions. This report is not meant as a general guide to investing, nor as a source of any specific or general recommendation or opinion in relation to any financial products. Unless attributed to others, any opinions expressed are our current opinions only. Certain information presented may have been provided by third-parties. IEEFA believes that such third-party information is reliable, and has checked public records to verify it where possible, but does not guarantee its accuracy, timeliness or completeness; and it is subject to change without notice.