Gas power and renewables

The key to India's energy future

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Executive Summary

Globally, India is the fifth largest economy (surpassing the UK in 2019), the third largest electricity producer, has the second largest population and the third largest installed power capacity.[1]

Finding the right energy mix will require leveraging the country's existing power plants, addressing inadequacies, adding newer technologies, and using flexible power to increase system efficiencies. Gas-based power plants have a crucial role to play in these efforts and should be a significant part of the country's future energy mix.

Strategic deployment of renewables and gas power can provide a path to make substantive reductions in emissions quickly

This position paper provides a summary of the current initiatives in the country that can help India move forward on the promise of lower CO_2 emissions. In addition, the paper details how flexible power needs could be addressed with the combination of renewables and gas power plants. It will also examine the initiative of the Indian government in providing Round the Clock (RTC) power and how gas and renewables can work together in the power sector.

Based on our extensive analysis and experience across the breadth of the global power industry, GE believes that the accelerated and strategic deployment of renewables and gas power can change the near-term trajectory for climate change. In this proposed pathway, India would make substantive reductions in emissions quickly, while in parallel continuing to advance the technologies for near-zero-carbon power generation, and shifting to electrify and decarbonize other sectors such as transportation and heat.

Viewed separately, renewables and gas generation technologies each have merits and challenges. This position paper helps us look at how these technologies can be complementary and could be utilized efficiently to solve the country's growing power demand.

Creating the right energy mix won't be easy—but with a well thought out strategy, policies to reinforce the strategy, and appropriate application of technology, India can chart a unique path to a cleaner economy with affordable, reliable and sustainable power for all.

Overview

POWER GENERATION TRAJECTORY IN INDIA

Coal is the primary source of electricity generation in India, currently accounting for about 72 percent of the total. This dominant role is expected to continue, despite the massive growth of renewables. According to the International Energy Agency's (IEA) reference Stated Policies scenario, coal's share remains as high as 34 percent by 2040. See Figure 1.[2]

Renewables (hydro, wind, and solar), on the other hand, currently contribute about 21 percent of the Indian electricity generation mix. In their reference scenario, generation from solar and wind grow tremendously by 2040, contributing 31 percent and 13 percent to the generation mix, respectively. Natural gas currently provides about 4 percent of the generation mix and despite more than doubling in absolute terms (71 TWh to 157 TWh), it is expected to remain at about 4 percent of the total in 2040. This uptick in gas generation is expected due to increases in gas imports because of improvements in pipeline infrastructure and policy initiatives.

Coal is expected to retain its dominant position in the electricity generation mix but with the switch to renewables expected to begin with the Indian government's RTC initiative, the transition to renewables might happen sooner.

Coal remains the primary source for power generation but the steep fall of its share shows tremendous renewables focus.

Power Generation Matrix

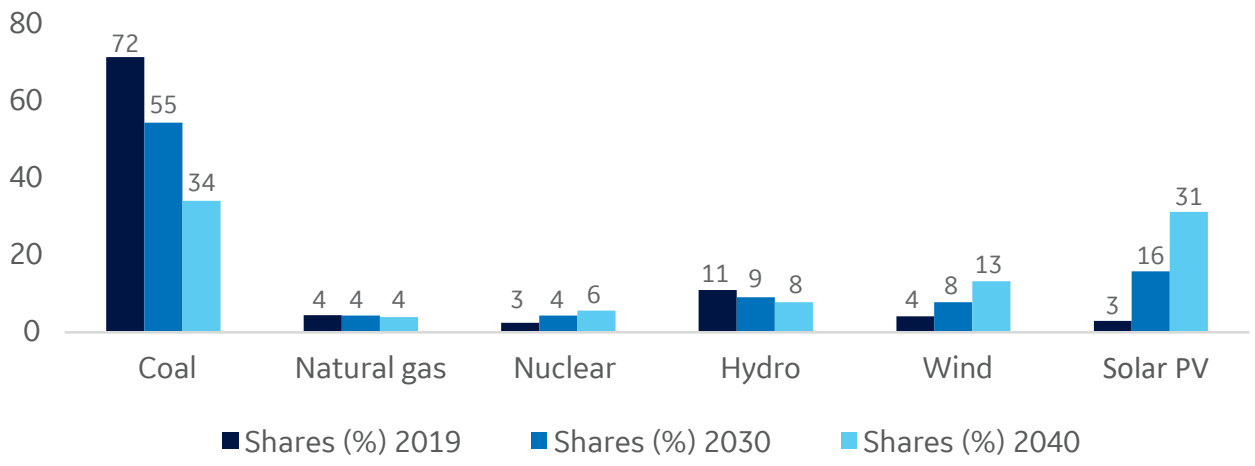


FIGURE 1

Source: IEA India Energy Outlook 2021

Electricity generation demand growth in India is expected to be the highest of any major region in the world, nearly tripling and reaching a Compound Average Annual Growth Rate (CAAGR) of nearly 5 percent (down from 6.5 percent due to Covid-19) for the period from 2018 to 2040.[3]

Despite the shock from Covid-19, India's electricity demand is still projected to grow by almost 5 percent per year to 2040 in the Stated Policies Scenario of IEA 2021, nearly double the rate of overall energy demand.

India is expected to add capacity equivalent to the size of the European Union's installed base over the next two decades with solar PV and wind accounting for more than three quarters of the capacity additions as their costs fall.

This exceptional increase in demand is due to a growing population, an increase in the size of the middle class, and structural trends such as urbanization and industrialization.

More than half of this growth in electricity demand in India is from the buildings sector, which has overtaken industry as the largest consuming sector. The widespread uptake of household appliances means that the share of electricity in total energy demand in buildings is expected to rise from 20 percent today to almost 50 percent by 2040.

Household electrification has been a strong driver of electricity demand growth reflecting a strong policy push; more than half a billion Indian people have gained electricity access since 2000. The push to increase electricity access is expected to continue, and India is on track to deliver universal electricity access well ahead of 2030. This will result in approximately 180 million more people gaining access and adding more than 140 TWh of electricity demand.

The service sector and residential demand have grown more rapidly than industrial demand in recent years. Between 2014 and 2017 electricity consumption for services increased by 28 percent and by 26 percent in the residential sector. The service sector includes agriculture (demand for water pumping) and forestry which account for half of the sector's demand.

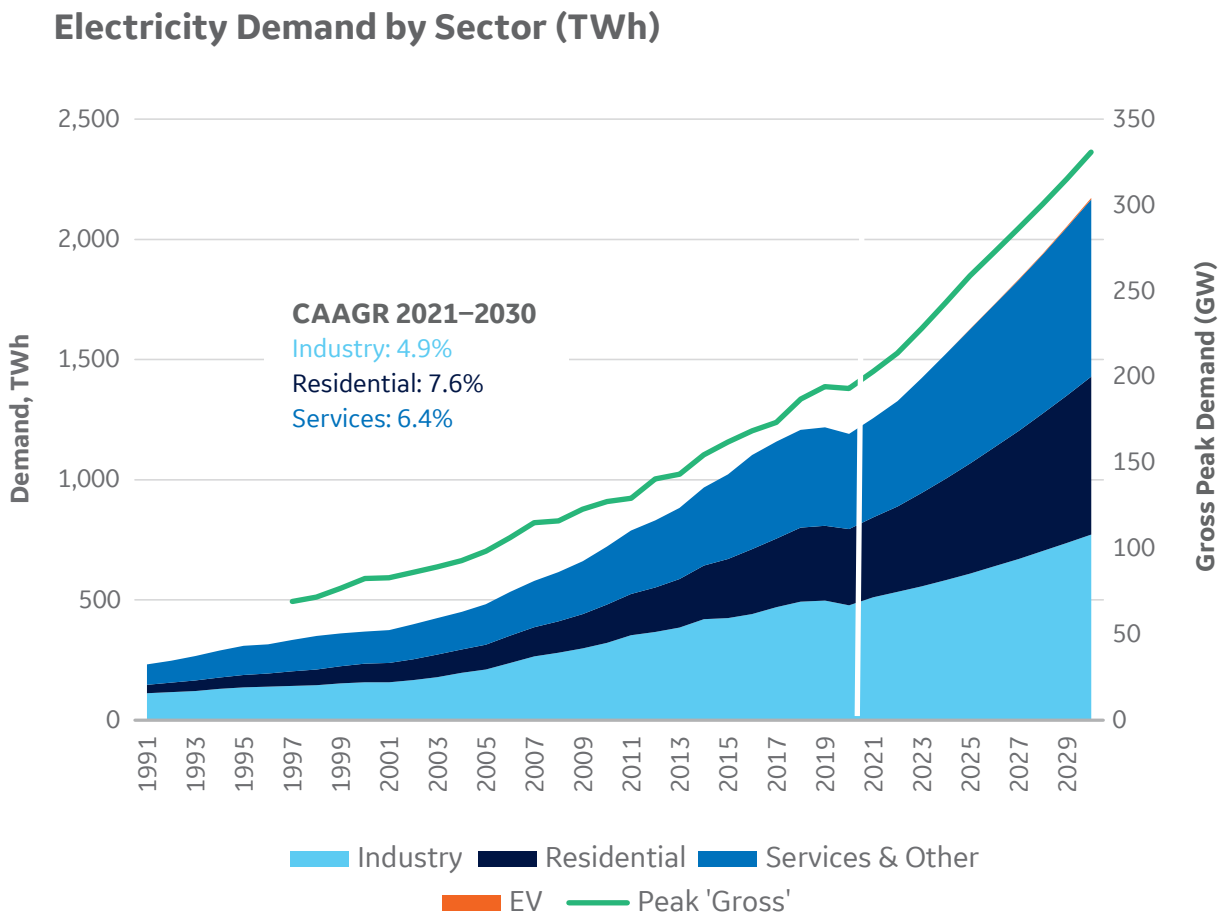


FIGURE 2

Source: GE Gas Power Marketing's Global Power Outlook 2021

India's huge infrastructure needs over the coming decades drive the demand for energy intensive materials, for which India has become an important manufacturing hub.

Industries including chemicals, pharmaceuticals, textiles, food, and transportation equipment are expected to increase production quickly to satisfy the needs of a larger and more prosperous society. The "Make in India" program aims to increase the share of manufacturing in GDP.

India's growing middle class will continue to drive per-capita electricity demand

Per capita electricity consumption delivered to final customers (excluding transmission and distribution losses) is still low in India compared to the world, or even to non-OECD countries as shown in Figure 3. Electricity demand is expected to grow by 5 percent annually during 2018–40 as the population, economy, and the middle class of the country grows.

Future electricity consumption will be driven by growing electricity access, ownership of appliances, and economic growth.

Against this backdrop, the Indian government should look at adding power generation capacity and shifting its generation to more renewables and gas power to help ensure it will meet its National commitment to reduce harmful CO_2 emissions.

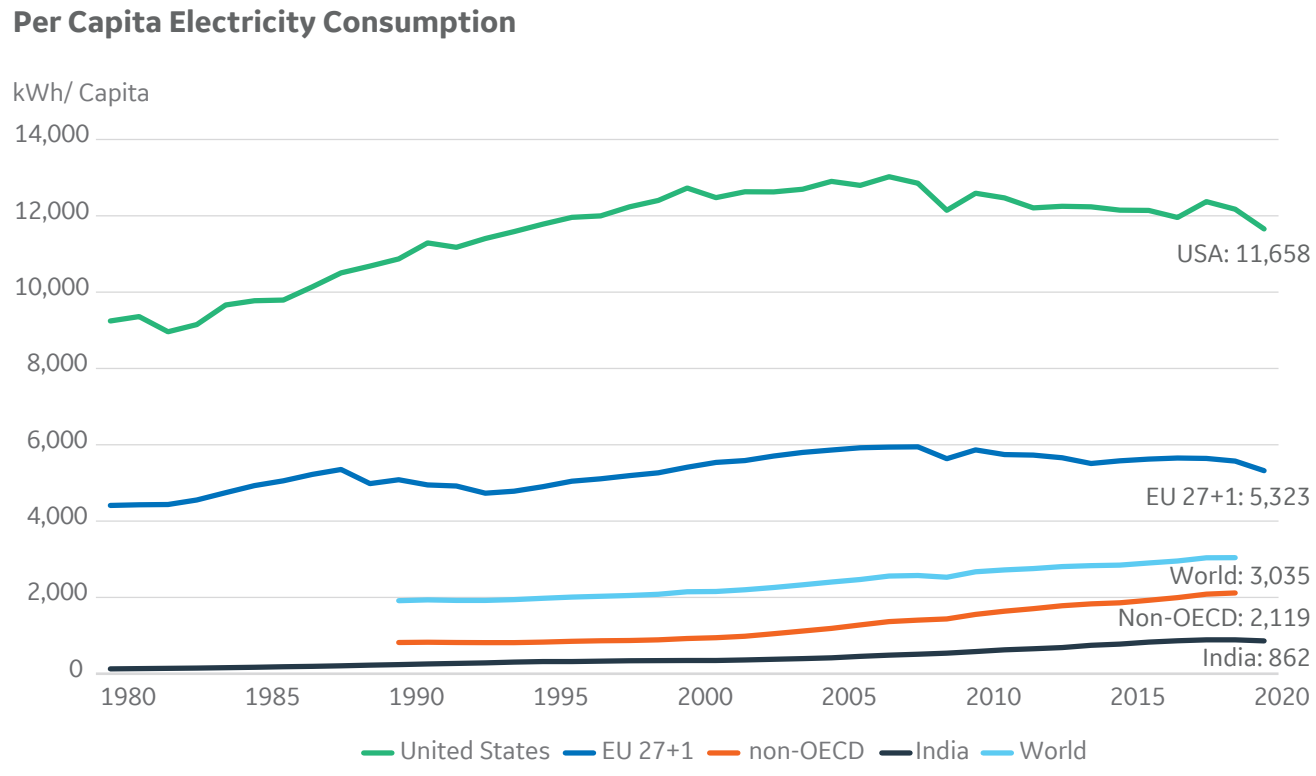


FIGURE 3

Sources: ENERDATA and Oxford Economics

GAS POWER OPPORTUNITIES

Natural gas is one area where international market conditions and India's aspirations are well aligned. India's ambition to become a "gas-based economy" fits well with the interest among many exporting countries and companies in gaining a foothold in India, even though there are uncertainties around the business model for financing new projects.

SOURCE: INDIA ENERGY OUTLOOK 2021 (IEA)

A HISTORICAL PERSPECTIVE

Total natural gas demand in India is steadily approaching the peak levels experienced in 2010–2011. Gas use in power has collapsed since then due to competition from other fuels such as coal and renewables, and the prioritization of domestic gas for other sectors, including city gas and transportation.

Feedstocks, mostly used in the fertilizer sector and the petrochemical sector, accounted for 33 percent of overall gas demand in 2020 as can be seen in Figure 4 below. The central government generally encourages gas use in the fertilizer sector.

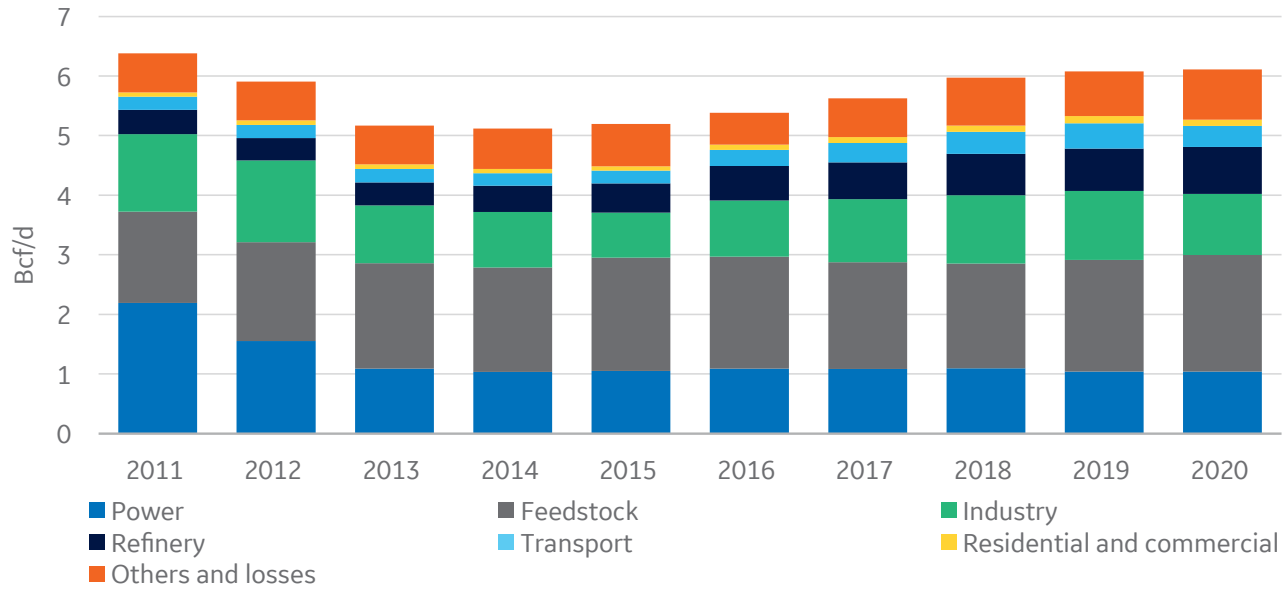
Indian buyers have been major consumers of spot and short-term LNG, taking advantage of times when prices are low to capture unmet demand. Thus far, India's LNG demand is met by relatively low-cost supply from Qatar.

On the other hand, when prices are relatively high, price-sensitivity kicks in and the various gas-consuming sectors face uncertainty.

India is the world's fourth largest LNG buyer and will be one of the biggest drivers for future LNG demand growth. India was self-sufficient in natural gas until 2004, when it began importing LNG from Qatar. In 2019 India consumed ~7 percent of the global market of LNG.[4]

Alongside wider efforts to stimulate the economy, India instituted important energy market reforms in mid-2020, which have led to the creation of real-time power markets (RTM) including the Green Term-Ahead Market, and the India Gas Exchange (IGX). India is also taking steps to stimulate domestic production as part of a drive to reduce reliance on imports, especially of oil and coal.

Natural gas production, which has seen a significant drop in 2020, is set to rebound relatively quickly as new offshore developments come online, according to IEA's India Energy Outlook 2021.



Note: The gas demand in the power sector has been taken from CEA

FIGURE 4

The effects of the Covid-19 pandemic leave India with an economy that is nearly 20 percent smaller by 2040 than projected in 2019, which means a drop in average annual energy demand growth from 3.2 percent to 2.5 percent compared with 2019. We believe, however, the long-term (2040) growth story is still intact.

The impact of this downward adjustment is not felt equally across fuels. By 2030, natural gas demand is back to the level projected in 2019, and oil demand is only slightly lower. By contrast, there is a significant downward revision for coal, which is one-third lower in 2040 than in pre-crisis projections (per IEA's India Energy Outlook 2021).

Natural gas is poised for significant growth, backed by ambitious government targets to raise its share of the total energy mix to 15 percent by 2030 from its current 6 percent share. Some offshore deep-water developments in the Krishna Godavari basin support near-term production growth, and there is expected to be a slow but steady rise in coalbed methane production beginning in the 2030s.

The level of growth in domestic gas production is, however, insufficient to meet rising demand. LNG imports satisfy nearly 70 percent of demand growth, making India a major importer, and an important presence in global gas markets. See Figure 5.[5] LNG has filled part of the gap, but LNG is too expensive to produce power competitively against coal. **Accordingly, the more likely role for gas-fired power is to balance the grid in an increasingly solar-rich electricity generation mix. This provides a valuable service to the system and enables the wider deployment and integration of renewables.**

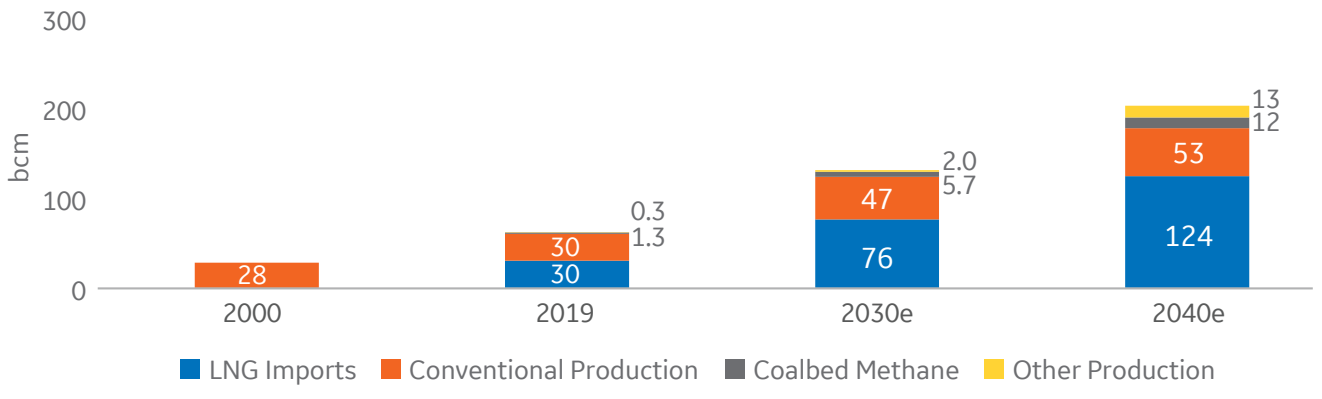


FIGURE 5
Source: IEA India Energy Outlook 2021

HYDROGEN AS A FUEL

Hydrogen is expected to play a central role in India's clean energy transition. Narendra Modi, the Prime Minister of India, has articulated focus areas for its energy economy, including a shift towards emerging fuels including hydrogen.

Given that India has relatively high natural gas prices, can produce low-cost renewable electricity, and faces a high degree of uncertainty about its CO_2 storage potential, water electrolysis is likely to be the favored option for producing green hydrogen. The lowest hydrogen production costs are expected to come from pairing dedicated renewable power plants with electrolysers and local hydrogen storage to smooth the daily supply.

There has been an active interest shown by Indian power generating companies such as NTPC and Reliance Industries to invest in hydrogen projects. NTPC has floated a global Expression of Interest to set up two pilot projects, with hydrogen production using electrolysers at NTPC facilities. Similarly, Reliance Industries is leading a new energy transition coalition called the India H_2 Alliance (IH_2A) to help commercialize hydrogen technologies in Reliance's bid to build net-zero carbon energy pathways in the country. The alliance will work to build the hydrogen economy and supply-chain and also help develop blue and green hydrogen production and storage. Separately, it will encourage development of hydrogen-use industrial clusters and transport use-cases with hydrogen-powered fuel cells.

With these steps, GE expects hydrogen to be a key area of focus in India. With its history of running gas turbines with varying blends of hydrogen (including some in India), GE is well positioned to support the utilization of hydrogen in gas turbine assets.

Pathway to Low or Near-Zero Carbon with Gas Turbines

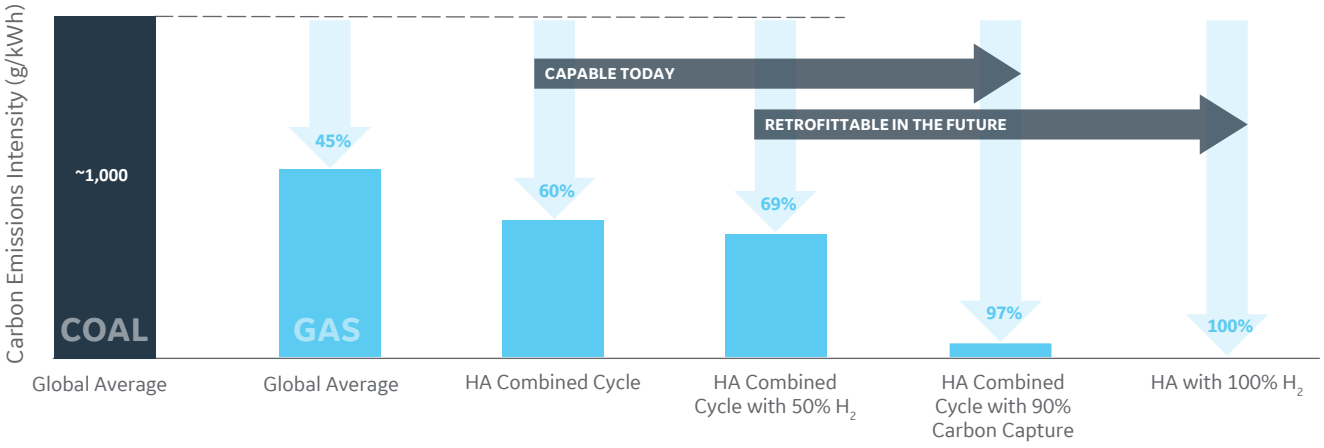


FIGURE 6: Gas turbine decarbonization opportunity

Source: IEA WEO 2020, GE analysis

Renewables in India: Opportunities and Challenges

WIND SECTOR

As the world's fourth-largest onshore wind sector by installations, India had a 38 GW of wind capacity as of 2019. Over the next 20 years, electricity demand is set to more than double. Accordingly, India's government is targeting 175 GW of renewable energy capacity by 2022, of which 60 GW will come from wind energy. The country also has aspirations for a whopping 450 GW of renewable energy capacity by 2030, of which 140 GW will be wind-based generation. The majority of the rest would come from solar, with hydro growing marginally.[6]

In the last decade, this scale of activity attracted multinational utilities, investors, and supply chain players to India's wind market.

An influx of capital and technology initiated a downward slide in prices, with Levelized Cost of Energy (LCOE) of wind in India declining by 40 percent from 2015 to 2019 according to Global Wind Energy Council's 2020 report. As a result, wind at INR 2.81/kWh is now the second most cost-competitive power source on the grid after solar, and priced nearly 35 percent lower than electricity from conventional fuels.

India's ambitious Renewables targets are a catalyst for the transformation of its power sector.

Meanwhile, wind project installations are declining. Only 2.3 GW of wind capacity was installed in 2019—nearly half of the 4.1 GW installed in 2017 according to the same report.[7] While more than 17 GW of capacity has been auctioned across the country by various power purchasing agencies in the last three years, nearly one-third went unsubscribed or was canceled post-award due to various factors, including stringent tender conditions, low tariff caps, off-taker risks, unavailability of grid, and/or land availability. More than 80 percent of awarded projects have been delayed by 6–12 months.

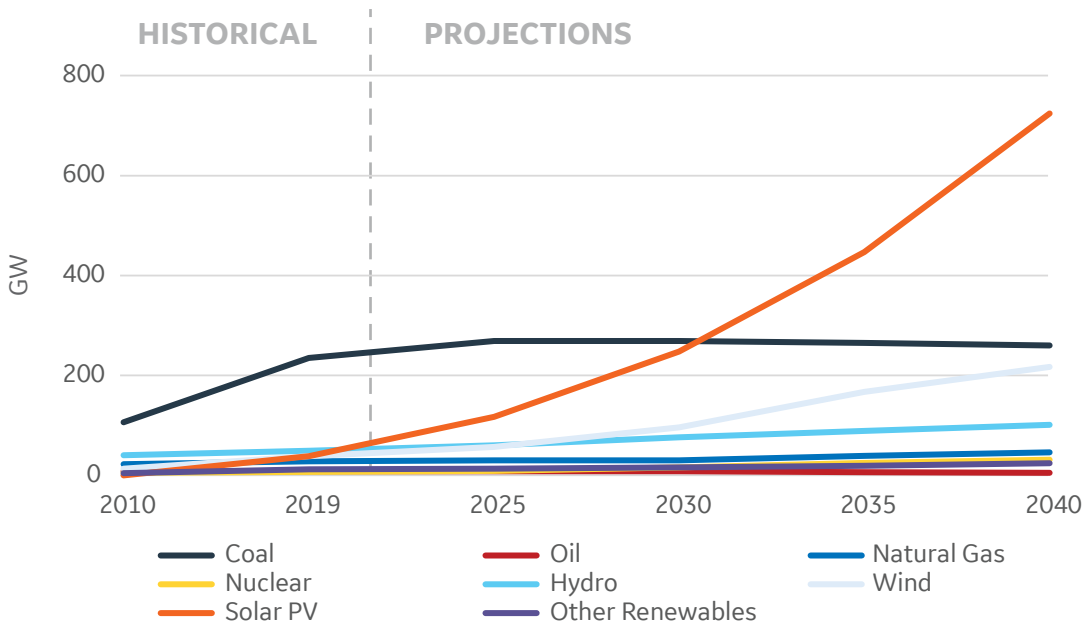


FIGURE 7: India's historical and projected generating capacity. Renewables represent 70 percent of capacity additions to 2040, but new coal capacity is projected in the long term to ensure security. *Source: IEA India Energy Outlook 2021*

SOLAR SECTOR

India's combination of abundant sunshine—about 300 sunny days in a year—and a large energy-hungry population makes it an ideal location for solar. The country's solar capacity reached nearly 37 GW at the end of the first quarter of 2020, with the aim of growing to 100 GW by 2022.[8]

India imports 80 percent of the components required for its solar energy production from China. The introduction of a safeguard duty, in July 2018, on solar panel imports from China created policy uncertainty.

An import duty of 25 percent was implemented for the first year, decreasing to 20 percent for the next six months and to 15 percent for the final six-month period. As the majority of India's solar supply chain depends on imports from China, it meant an increase in the CAPEX for the projects awarded in tenders.

Auctions for solar projects are held through the government-owned Solar Energy Corporation of India (SECI) and the National Thermal Power Corporation (NTPC). Their tenders have a clause that insulates a bidder from changes to import tariffs. Power producers can pass on additional costs to their buyers—the Distribution Companies (DISCOMS) owned by various state governments.

ROUND THE CLOCK POWER (RTC)

The Ministry of New and Renewable Energy (MNRE) is aiming to supply RTC Power from Renewable Energy (RE) based (solar, wind or small hydro) power projects, complemented with power from thermal power projects. In the words of the government:[9]

1. The renewable energy sector has its own share of issues in terms of intermittent and unpredictable nature of renewable energy and low capacity utilization of transmission system. The problem gets pronounced with the addition of large-scale renewable capacity. To manage the infirm nature of power, DISCOMs are procuring balancing power to provide grid stability and to meet its requirements in non-RE hours.

2. The developments in renewable energy sector and the necessity to address the issues of intermittency, limited hours of supply and low capacity utilization of transmission infrastructure make case for "reverse bundling," wherein high cost thermal power is allowed to be bundled with cheaper renewable energy, and is provided round-the-clock to the DISCOM.

3. Such bundling of RE power with thermal power can help in:
   a) bringing down the overall cost of power supplied to buying utilities
   b) further penetration of renewable energy
   c) overcome the intermittency issues of RE power
   d) meet the RTC requirement of DISCOMS

SOURCE: MINISTRY OF NEW AND RENEWABLE ENERGY OF INDIA RTC TENDER

POWER SYSTEM FLEXIBILITY

Flexibility requirements are determined by the load shape of demand, the electricity generation mix, and capacity that can meet this demand. The integration of variable renewable energy sources (VRE) into electricity systems can be seen in Figure 8 below. Currently, VRE have no noticeable impact on the power system today. However, by 2040 India needs transformative technologies—such as seasonal power storage—to manage a large-scale surplus or deficit of VRE supply.

According to the IEA, India has a higher requirement for flexibility in its power system operation than almost any other country in the world. The hour-to-hour variation in wind and solar output places increasingly large demands on the rest of the power system to balance supply and demand.

GE believes a two-part tariff based on peak and non-peak demand is key to address the flexibility needs of the system.

Adequate system flexibility will be essential to the security and reliability of electricity supply in India in the coming decades. Flexibility must increase dramatically as the profile of demand becomes more variable, with higher peaks, and as the share of solar PV and wind generation increases from 7 percent in 2019 to 45 percent in 2040.[10] See Figure 8 below to see how flexibility needs are expected to grow.

Given the seasonality of India's wind generation and the steep drop in generation from solar at sundown in all regions, battery storage may need to play an important role in the future electricity market.

Hydropower also contributes to the flexibility in India's power systems, reaching nearly 101 GW of installed capacity by 2040.[11]

India has a higher requirement for flexibility in its power system than almost any other country in the world.

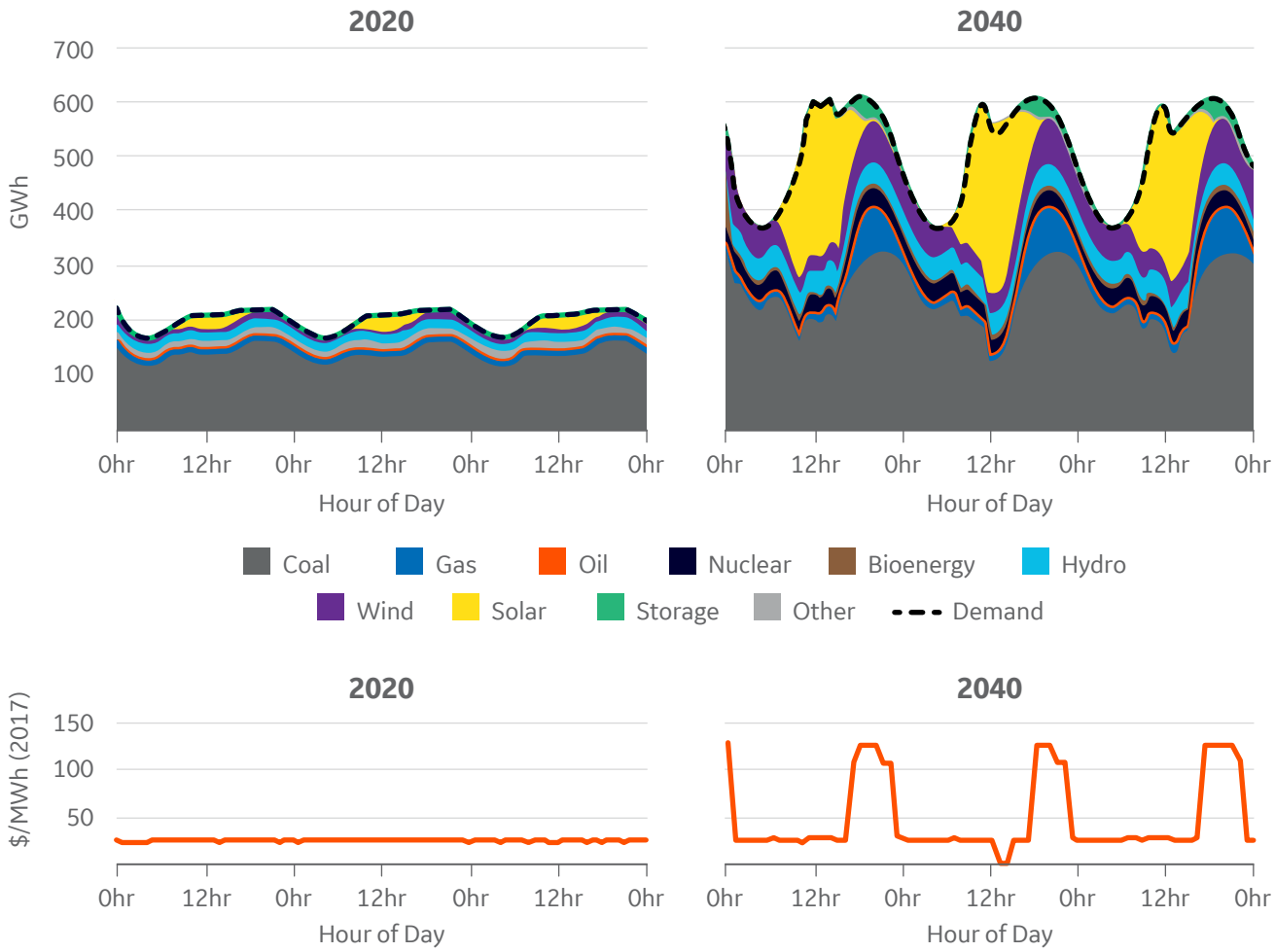


FIGURE 8: India's electricity generation profile and as projected for 2040 (VRE = variable renewable energy sources). The profile of demand becomes more dynamic and VRE account for one-quarter of annual supply, calling for more flexibility in the power system. *Source: IEA WEO 2019*

Based on a study of the Indian power sector and GE's global experience, GE makes the following recommendations with respect to the RTC power plan.

GAS-BASED PLANTS

More widespread deployment of gas turbine technology for the purposes of grid balancing and achieving an economical tariff.

Flexibility benefits of gas power include fast start up times (30 to 45 minutes), and faster power ramp rates (varying between 5–10 percent per minute). Gas turbine technology can complement the variability of wind and solar by providing the required output into the grid, and is optimal for smoothing out spikes and dips caused by the mismatch between variable renewable generation and fluctuating demand. In addition, gas plants are also ideal for spinning reserve and for meeting peaking power and frequency control requirements, providing the inertia required to counter changes in frequency caused by a sudden change in electricity consumption or production. Flexible gas-based power generation, with its quick start up, deeper turn down levels and faster ramp rates is a key enabler to integrate more renewables into the National Grid and meet seasonal and peak power demand.

NEUTRAL TECHNOLOGY FOR GRID BALANCING

The Ministry of New and Renewable Energy and Solar Energy Corporation of India, in the Round-the-clock tenders have provided bidders the flexibility to choose grid balancing sources. These sources could be coal or gas-based plants, or battery storage. The bids are currently evaluated based on the tariffs, and the lowest bidder (L1) is awarded the project irrespective of the technology solution being adopted to provide RTC power to the distribution companies. However RE-RTC bid evaluation does not give any weight to 'clean', 'firm', or 'sustainable' attributes. The 'RE + Gas Power' solution is superior to other technologies when important criteria such as emissions, ramp rates, land use intensity, financial viability, etc., are considered. These are important characteristics that improve RE integration. Provided below are important recommendations that would make the RTC more amenable to developers:

- **SECI must allow new-build gas power assets to be used for the RE-RTC tender.** It will ensure highly efficient and fit-for-purpose technology ideal to deliver cleaner and firmer power. The existing gas plants are one to two generations older in technology and were primarily built to address base-load applications, and as such, are not ideally positioned to cater to firming applications like the RE RTC).

- **Align RE-RTC PPA terms with the gas (fuel) supply agreement.** The tender stipulates that the dispatch of non-RE power plants is subject to merit order principles, which makes it impossible for the bidders to ascertain annual gas power generation (and gas fuel consumption). However, gas suppliers require a minimum quantity of gas to be committed on a take-or-pay basis in the gas (fuel) supply agreement.

- **Incorporate provisions to reset the gas price terms (slope, constant, taxes etc.) two to three times during the 25-year PPA tenor.** The RE-RTC PPA is for 25 years, whereas typically, gas supply agreements are typically only available for a maximum 10–12 years. This provision would allow bidders to secure the most competitive gas supply terms and align the PPA and gas supply agreements.

In addition to the prior recommendations, the following important issues pertaining to gas supply terms need to be addressed.

"The Centre should prioritize gas power as an option in 'renewable energy plus thermal' tenders to promote the growth of renewable energy."

DEEPESH NANDA
CHIEF EXECUTIVE OFFICER
GE GAS POWER, SOUTH ASIA

GAS PRICE INDEXATION

Allow for changes on gas price indexation and the frequency used for payment and evaluation purposes.

CERC has recently accepted aligning the escalation rate for imported natural gas to the JKM index instead of the previously used JCC index. This is significant because most global imports (~48 percent) use JKM. It is a widely used index even for LNG contracts by Indian entities (the Reliance R3 cluster gas auction in early 2021 was linked to JKM).

GAS SUPPLY

Enable contractual gas supply agreements for flexible pricing and volume optionality. This is important to accommodate diurnal and season variation in gas offtake.

GE's Policy Recommendations

The Indian government has put in place ambitious renewable energy targets to meet growing electricity demand, which is set to double in the next 20 years.

The biggest challenge for the state electricity markets is the inability of the distribution companies (DISCOMs) to make timely payments. To enhance liquidity in the sector, in May 2020, the Indian government announced an INR 900 billion ($13 billion) stimulus for the power distribution sector to minimize the economic impact of the COVID-19 pandemic. This was clearly a step in the right direction as the power sector was under pressure even before the pandemic hit the country. GE applauds the step and provides the following additional recommendations:

1. The government should consider reinstating the subsidy scheme for stranded gas assets. The current installed gas-based capacity in the country is approximately 25 GW. Policy intervention for sustainable revival of these assets is required.
2. The country should put in place a clearly defined gas pricing policy to support natural gas-fired plants supplying peak power at market rates.
3. A combined evaluation considering environmental impacts and efficiency gains should be conducted on new and existing projects to address the economic viability of gas for power generation.
4. The merit order should incorporate efficiency and a cost on green house gas emissions. In the merit order, renewables which are causing least harm to the environment are to be run, followed by fossil units which are stacked by respective variable costs (priority of dispatch lowest to highest).
5. The government should ensure that power producers comply with new emission standards by 2022 for India to meet its emission targets.
6. Gas should be included in India's new Goods and Sales Tax (GST) regime to increase gas' competitiveness. The GST should simplify the country's tax code and eliminate duplicative taxes at the state and federal levels. As many liquid fuels competing with gas have already been included in the GST, LNG demand could be reduced in sectors that consume liquid fuels, including industry, refineries, and city gas. Despite the efforts of energy consumers, natural gas has not yet been included in the tax code.
7. Steps should be taken to fast track development of the natural gas pipeline infrastructure and optimize contact to increase utilization of the gas pipeline infrastructure.
8. Encourage capex investments through subsidies and incentives for the retrofit of combined cycle plants to meet the fast startup and ramping requirements needed with higher RE penetration.

GE's Policy Recommendations

9. When determining the optimal generation mix, attributes of the generating system such as emissions and ramp rates should be considered in the evaluation along with capacity payments and tariffs.
10. Industrial RTC policy and frameworks should be laid out for customers wanting to use RE for Renewable Purchase Obligations, while enabling conventional firm power to meet requirements of high reliability.
11. Fast track development of an ancillary services market should be pursued to help meet the reserve and regulation services requirements of the system. This will mitigate the variability caused by higher RE penetration. Gas based plants can provide these services required for grid operations.
12. Identify and set up more 'islanding systems' (like Mumbai and Kolkata) to power industrial and commercial clusters. An optimal generation mix consisting of RE and gas power can be used to ensure continuity of generation is maintained, thereby strengthening existing systems and protecting these zones from any sudden grid loss events. Accord 'must run' status to units generating power to support these islanding systems. Gas is well suited due to its high energy density (requiring less land which is a concern in big metros), and lower environmental effect.
13. Promote the usage of hydrogen (both green, and blue) in power generation via a pilot project and identify the opportunities to scale and commercialize the solution. Encourage competition in this space to enable institutions, organizations, and manufacturers to come up with advanced solutions to produce hydrogen and contribute to the National Hydrogen Mission.
14. Promote and incentivize coal gasification and allied technologies to convert coal into cleaner syngas which can be used for power generation in gas turbines. This can be explored as a pathway to decarbonize the power sector and use India's coal reserves.

Gas-based power plants can help decarbonize the power sector and enable India's energy transition by providing needed flexibility and reliability in operation. These would also increase gas-based power offtake and drive natural gas consumption. Ultimately this will contribute to the vision of gas power's share in the energy mix increasing to 15 percent vs. 6 percent currently. It would also ensure that an optimally diverse set of generation technology options is available to any electricity provider planning to procure power through the competitive bidding route.

The power industry has a responsibility, and the technical capability, to take significant steps to quickly reduce greenhouse gas emissions. The solution for the power sector is not an either/or, renewables or natural gas, proposition. It requires a multi-pronged approach to decarbonization with renewables and natural gas power at its core.

Complementary nature of renewables and gas power

TABLE 1: The complementary attributes of renewables and gas power.

	WIND, SOLAR & STORAGE	GAS POWER
FUEL	Limitless, free fuel that is variable	Flexible, dispatchable power whenever needed, utilizing abundant & affordable natural gas or LNG
CO_2	Carbon-free	Less than half the CO_2 of coal with a pathway to future conversion to near-zero carbon with H_2 and Carbon Capture and Sequestration (CCS)
COST	Competitive Levelized Cost of Electricity (LCOE) when available, with no lifecycle uncertainty (mostly CAPEX)	Competitive LCOE with lowest CAPEX, providing affordable, dependable capacity
DISPATCH	Dispatches first in merit order... extremely low variable cost	Most affordable dispatchable technology... fills supply/demand gap
PEAKING	Battery storage economical for short duration peaking needs (<8 hour, intraday shifting)	Gas economical for longer-duration peaking needs (day-to-day and weather-related extended periods)
CAPACITY FACTORS	25%–55% capacity factors based on resources (wind and solar often complementary)	Capable of >90% capacity factors when needed
LAND	Utilizes abundant land with good renewable resources (multi-purpose land use)	Very small physical footprint for dense urban areas with space constraints
HYBRID SOLUTIONS	Extends renewable energy to align with peak demand	Carbon-free spinning reserve peaking plants

There is a tremendous opportunity for India to develop and successfully meet the aspirations of its citizens without following the high-carbon pathway that other economies have pursued in the past. Seizing this opportunity is critically important for India, and critically important for the world.

SOURCE: INDIA ENERGY OUTLOOK 2021 (IEA)

Conclusion

India is at the crossroads of a critical energy junction. The Prime Minister of India has articulated focus areas for its energy economy, including a move towards a 'gas-based economy,' cleaner use of fossil fuels, rapidly scaling renewables, a shift towards emerging fuels including hydrogen, and digital innovation across energy systems.

PRIME MINISTER N. MODI, 4TH INDIA ENERGY FORUM, CERAWEEK

In this context, the current RE-RTC bid evaluation should give greater weight to 'clean', 'firm', and 'sustainable' attributes. The 'RE + Gas Power' solution is superior to other forms of power generation when important criteria such as emissions, ramp rates, land use intensity, financial viability, etc., are considered. These are important characteristics which improve RE integration. Gas power has an additional advantage—in the words of Deepesh Nanda, CEO of GE Gas Power, South Asia *"We are in a long-cycle for inexpensive natural gas. The government should take advantage of this."*

India will chart its path towards explosive growth in renewables with heavy deployment of solar and wind in the coming decades. This is simultaneously exciting and challenging for the overall power system. Wind and solar used in tandem yield zero carbon emissions and clearly are beneficial for the country. At the same time the hour-to-hour variation in wind and solar output places increasingly large demands on the rest of the power system to balance supply and demand. To address flexibility in the system, GE recommends a two-part tariff to address peak and non-peak demand.

Finding the right energy mix to address the growth needs of the country and reduce carbon emissions while embracing the 'gas-based' economy will require government, public and private partnerships. GE as a company is uniquely positioned to play a key role through its scale, breadth, and technological depth.

We have been a key player in the power industry since its inception more than a century ago. We have a suite of complementary technology including gas-fired power, onshore and offshore wind, hydro, small modular reactors, battery storage, hybrids, and grid solutions needed for the energy transition. More importantly, we believe it is our responsibility to support this transition through our relationships with customers, policymakers, and consumers, collaborating to build an energy system that works for everyone.

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