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Role of Natural Gas in India's Energy Strategy

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Gas Today

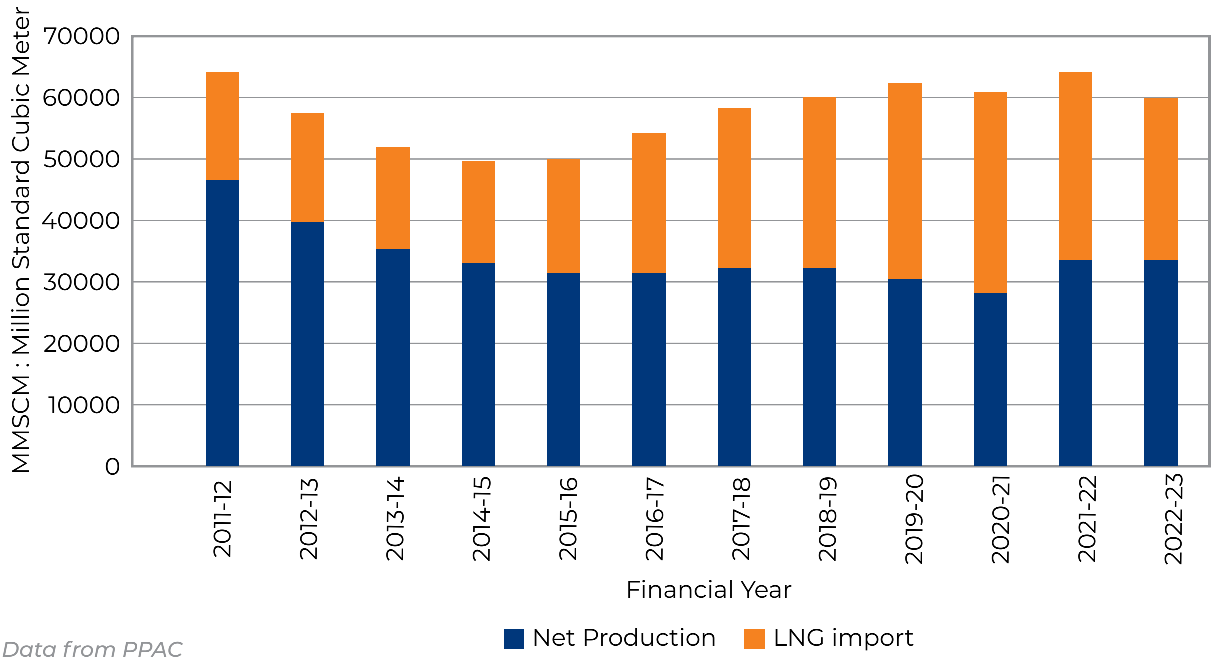
In 2021-22 India's total commercial energy consumption was 800 million tonnes of oil equivalent, mtoe. Natural gas constituted about 7% of the Total energy supply. The government has targeted to increase Natural gas supply to 15% by 2030. the questions that one would raise are how India can reach this target and that is it worth doing so.

Natural gas has some clear advantages. it is cleaner than coal in terms of both local as well as GHG emissions. it is also far more convenient to use than coal. It requires much less handling than cold and can be easily transported through pipelines. On the other hand, its price on the international market is volatile and India depends significantly on imported LNG, liquefied natural gas.

The proportion of imported gas in the local gas supply has been increasing. As seen in Figure 1, India imported around 50% of gas on average over the last 4 years. The price of LNG is quite volatile on the international market. Thus, domestic gas price also varies. Figure 2 shows gas prices in India, set by the Government, over the years. The price

Figure 1

Domestic Production and LNG Import in Gas Supply

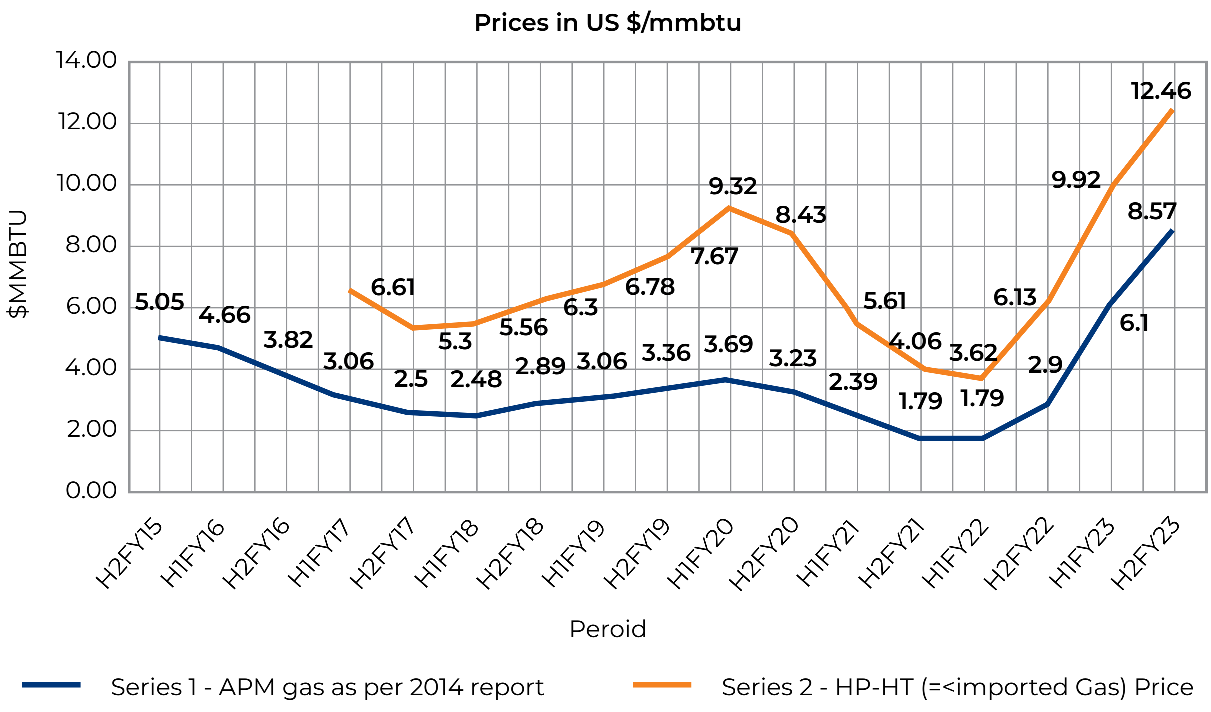


Data from PPAC

of gas from the High-pressure high-temperature (HP-HT) fields is a price set by the GOI as the upper bound on HT-HP gas. The price is set based on the cheapest

Figure 2

Notified Ceiling Prices of APM and HP- HT Gases in India



import price of the competing fuels namely diesel, fuel oil, and LNG. Thus, the actual import cost of LNG could have been higher than shown in Figure 2.

To increase gas supply to 15% of the total energy supply by 2030, India needs to substantially step-up domestic production or else import even more LNG.

The domestic gas production decreased from 2011-12 to 2015-16 and has remained more or less at the same level, as seen in Figure 1. The gas pricing policy still recent years has not attracted many firms to invest in exploration and production (E & P). Till the recent changes in gas prices following the Parikh Committee Report (Parikh Kirit et al, 2022), India had some 14 different prices depending on how the fields were allotted and under what terms. Of these only 7 types of fields produced gas in 2021-22. Table 1 shows the gas produced by these fields and the pricing regime for their output.

Table 1

Gas Production in MMSCM by Different Types of Fields in 2021-22

S. No.	Allotment Basis	Price Regime	Production	Share %
1	Nominated. ONGC +OIL	As per 2014 report	23,500	69%
2-4	Pre-NELP		2453+195+383=3031	9%
5	Coal Bed Methane	Marketing and pricing freedom	682	2%
6	Deep Water (DW), Ultra Deep Water (UDW) and (HP-HT)	Pricing freedom But Under ceiling	6566	19%
7	Miscellaneous		223	1%
	Total		**34000**	**100%**

NELP - New Exploration Licensing Policy

The gas produced by the fields allotted on nomination basis without competitive bidding to ONGC and OIL, contributes the bulk of domestic gas production and is called APM (Administered Price Mechanism) gas. Of the total 34000 MMSCM gas produced in the country in 2021-22, 69% of the gas was APM gas produced by these two public sector firms.

Price of APM Gas

The price of their gas is administered by the government and is called the APM (administered price mechanism) gas price. Since 2014 the price of APM gas has been determined as the weighted average producer price over a year three months ago of four foreign markets, one in the USA, one in Canada, one in Europe, and one in the former Soviet Union, excluding Russia. The price was revised every six months.

In a competitive market, it is the consumer price that should be equalised to the cost of imported gas. Linking the producer price in India to that of foreign producers can create problems. The cost of production varies from field to field, and the formula produced an APM gas price of $1.79 per MMBTU for the period 1-10-2020 to 1-10-2021 did not cover even the marginal cost of production of ONGC and OIL. A $4 per MMBTU would cover their cost and provide a reasonable profit margin. Thus, the Parikh Committee on gas pricing recommended a floor price of $4 per MMBTU for APM gas.

There are many different users of gas with options for using alternative fuels. For example, piped natural gas (PNG) is used by households for cooking. They can also use liquefied petroleum gas (LPG) instead. Both are cleaner and more convenient fuels compared to coal or fuelwood. The latter two create a lot of indoor air pollution and damage the health of people, particularly women and children. The government does promote the use of cleaner fuels. India is also importing LPG for household cooking. However, it is preferred that consumers in urban areas use PNG so that LPG can be distributed to rural households.

So that the PNG users continue to use it and not switch to LPG, the price of PNG has to be a bit lower than that of LPG. Similarly, another user of gas is transport vehicles that use compressed natural gas, CNG. Here again, these vehicles can use diesel instead of CNG. However, for containing urban air pollution, CNG vehicles are preferred.

Based on these considerations a ceiling price of APM gas was fixed at US$ 6.5/MMBTU. The average price of import of crude oil over 20 years in India was US$ 65/barrel. The Gas price corresponding to this is US$ 6.5/MMBTU.

The price of gas has to be determined by a competitive market. However international gas and oil markets are not fully competitive and are affected by geopolitical considerations. Thus, intervention by the government is required, which, however, should be minimal.

The price of gas is related to the price of crude oil. For prices of different energy sources to remain competitive, the Parikh committee suggested that the APM gas price should be based on the import price of crude oil in the previous month and should be revised every month. This price is also for APM gas subject to the floor and ceiling prices.

Price of gas from HP-HT, DW and UDW fields

19% of gas was produced by HP-HT, DW & UDW fields and they had pricing freedom within a ceiling price prescribed by the government every six months. 2% of the gas was by coal bed methane and it had full pricing and marketing freedom.

To provide the gas producers incentive to produce more gas, gas prices for all producers should be liberalized including that of APM gas. If certain consumers are to be subsidized it is best to do that through direct benefit transfer (DBT) to their bank accounts. For the APM gas, the Parikh committee had recommended increasing the ceiling price by US$ 0.50 every year eventually removing all price control.

A market-determined price will help optimize domestic production and consumption.

Would this however lead us to a 15% share of gas by 2030? This, when the country aims to reach net zero GHG emissions by 2070 and gas does emit CO_2. Is it even desirable to aim for a 15% share?

Raising Gas Share in the Climate-Constrained World

To explore the potential for gas a projection was made for India. As incomes increase more gas will be used for domestic cooking. Compressed natural gas would be used by the transport sector and we assume that 10 % of vehicles will use CNG by 2050. Since fossil fuel use must be brought down, some 45 % of the vehicles are assumed to be electric. In addition, since India has to expand renewable power, gas-based generation can be used to balance renewable power, which is not available all the time. All these have to be considered in making scenarios for the future. At the same time, the scenario has to be within India's commitments for climate change.

The Paris Agreement set a goal to keep global warming to within 1.50 C. To work out India's obligation for this target, we considered a fair share of the remaining carbon space in the global atmosphere based on equal per capita share for all persons in the world. The IPCC scenarios suggest a range of emissions between 2012 and 2050 that can keep warming within 1.50 C. Based on the lower limit India's share would be 133 GT cumulated emissions over 2012 to 2050. If we consider the median value of the range, it would be 166 GT of CO_2 emissions.

We use a multi-sectoral inter-temporal optimizing model with 25 sectors and some 42 activities to produce the 25 goods and services (Parikh K, Parikh J and Ghosh P, 2018). The model solution maximises the present discounted sum of private consumption over the period. The model has 20 different consuming classes, 10 rural and 10 urban, whose demand systems are econometrically estimated. The available total national income is distributed to these classes using log-normal distribution functions. The demand and supply of each sector is balanced every year as also the balance of payment constraint. Production of each activity in each year is within its production capacity, which can be increased by investment in the preceding period.

The Scenarios

We generate three scenarios.

DAU: Dynamics as Usual - These captures current policies.

AMBA: Ambitious Actions - This includes policies under consideration and modest technical progress.

TC1.5: Technical Change and Policies to Stay within 1.50 C Emissions Limit - This shows higher energy efficiency and technical change.

The specification of TC1.5 involves many assumptions.

Since global technology is changing rapidly, we have also assumed a fall in cost of renewable power plants and batteries. Compared to projections made by some international studies we have taken conservative reductions in these costs. Thus, the installed cost of Solar Photo-Voltaic (PV) plants is assumed to fall by 50% compared to that of 2015. The cost of battery storage will fall by 75% over the same period to US$ 50 / kWh by 2050. Since renewable electricity from solar or wind is not available around the clock, they have to be balanced and here natural gas can play an important role.

The efficiency of electricity use will also increase. Electricity consumption in households in 2012 (NITI Aayog, 2015) was for 22% ACs, 21 % lighting, 17 % ceiling fans, 16 % water heating, 12 % refrigerator, and 12 % TV. The use of LED bulbs reduces electricity required by 60% to 80% compared to incandescent bulbs. Energy-efficient appliances are now widely available and bought by consumers. Parikh and Parikh (2018) have shown that the electricity needed for household appliances can come down by 50% or more. Thus, it is assumed that household demand for electricity for each consumer class will fall by 2% per year from 2010.

The use of piped natural gas for cooking in households will cover 90% of the urban population by 2030, which is expected to be 600 million. At around 12 standard cubic meters of gas per month per household with a size of 5 persons, this will require 0.9*600*144/5 million cubic meters per year, which is around 12 million tonnes of natural gas per year or around 13 BCM.

The expert group report for “Low carbon strategy for Inclusive growth” (LCSIG) (Planning Commission, 2014) observed that energy savings from commercial buildings by 2030 could be as much as 10 % over 2010 just from better design and management of buildings, not counting what can be gained from efficient appliances and lighting. When the gains from improved efficiency of appliances are accounted for, new commercial buildings can have electricity requirement that is 50 % lower. However, this may increase investment costs by 10%. We introduced a new technical option for commercial buildings. The level of the selection of this option will be determined by the model solution.

India is pushing electric mobility and the government's target is to have all vehicles sold in 2030 to be electric. There are, however, vehicles that might prefer to use CNG at least for the next two decades or so till the battery costs and weights come down. We have assumed that by 2030, 10 to 15 million cars and 30 to 50 million two-wheelers will run on electricity and some 25 million 4W equivalents (a bus or a truck can be considered as equivalent to five 4Ws) will run on compressed natural gas. This will consume in 2030 around 11 BCM of gas.

The Scenario Results

Are the emissions in the scenario TC1.5 remain within India's share of global carbon space? Table 2 shows the emissions in the different scenarios.

Table 2

Cumulative emissions

Cumulative Emissions	GT CO2		
	DAU	AMBA	TC15
2012-2030	50	44	31
2012-2040	121	99	65
2012-2050	242	178	119

It is seen that in TC1.5 the cumulative emissions from 2012 to 2050 are less than the lower limit of 133 GT of India's share of carbon space. Thus, the scenario is consistent with India's commitments. We now look at natural gas use in these scenarios. The generation of electricity from different sources is shown in Table 3.

Table 3

Total Generation and Shares of Different Types of Plants

	2010	2030			2050		
	DAU	DAU	AMBA	TC1.5	DAU	AMBA	TC1.5
Coal sub & supercritical	67	80	61	28	80	41	17
Natural Gas	12	5	7	9	7	3	12
Nuclear	3	1	10	39	0	6	19
Hydro	13	5	6	6	2	7	6
Solar with and w/o storage	0	1	8	7	2	33	34
Wind with and w/o storage	3	5	8	9	8	10	12
Total (bkWh)	982	3172	3011	3074	10608	8421	8656

Table 3 shows that despite assuming a large share of nuclear power, generation by natural gas is substantial in the TC1.5 scenario. In 2030 a 9% share of 3074 bkWh is 376 bkWh generated using natural gas. The model scenario balances power supply and demand on an annual basis. The gas plants are largely combined cycle ones and so the gas consumption per unit generated is less. 31 BCM of gas is required to generate 376 bkWh.

The sector-wise consumption of natural gas is shown in table 4.

Table 4

Natural Gas Flow across Selected Sectors in BCM

2030	Production	Import	Road Transport	Fertilizer	Power	Household	Government
TC1.5	123	94	11	18	31	13	9

The share of natural gas in total energy consumption is shown in table 5.

Table 5

TC1.5 Total Energy Supply in 2030 MTOE

Coal	Crude oil	Natural Gas	Hydro	Wind	Nuclear	Solar	Wood	Other Renew.	Total	Share of Gas
346	322	195	15	25	314	19	3	47	1287	0.15

It is seen that in MTOE terms natural gas is 15% of total energy in 2030. Thus, the target of 15% by 2030 is met while the CO2 emissions are kept within India's share of global space for a 1.50 C world.

This affects the macroeconomic outcome. The GDP and private consumption are affected. Table 6 shows the GDP and per capita consumption in 2030 and 2050.

Table 6

Macroeconomic Impact in 2007-08 Prices

	DAU	AMBA	TC1.5
GDP in Billion Rs.			
2030	231677	227941	228725
2050	946257	905904	910898
Consumption per capita Rs/year			
2030	60075	62410	63656
2050	326648	328213	329684

It can be seen that compared to the DAU scenario in TC1.5, GDP will go down by 1.2% in 2030 and by 3.7% in 2050. However, consumption goes up by 6% in 2030 and by 1% in 2050. The various efficiency gains and technical progress reduce the need for investment which lowers GDP but, at the same time, increases human well-being.

Concluding comment

To reach the 15% target of natural gas share in total energy, domestic production has to increase to more than 120 BCM from around 35 BCM in 2023, and the share of import will remain at around 45% in 2030, increasing to 95 BCM from around 30 BCM in 2023. At the same time, pushing gas use in households, road transport, power sector, and fertilizer to provide the needed market. If energy efficiency and technical progress assumed in the TC1.5 scenario materialize, and our assumptions in these are conservative compared to many international projections, then we can live within a 1.50 C limit without strain on human well-being.

References

Planning Commission, 2014. Expert Group Report on Low Carbon Strategy for Inclusive Growth. Planning Commission, Government of India

NITI Aayog, 2015. http://www.indiaenergy.gov.in/iess/Demand_overview.php

Parikh, Kirit S., Parikh, Jyoti, 2016. 'Realizing potential savings of energy and emissions. from efficient household appliances in India.' Energy Policy 97, 102–111. http://dx.doi.org/10.1016/j.enpol.2016.07.005

Parikh, Kirit S., Parikh, Jyoti, and Probal P. Ghosh, 2018. 'Can India grow and live within a 1.5-degree CO2 emissions budget?'. Energy Policy, 120 (2018) 24–37. https://doi.org/10.1016/j.enpol.2018.05.014

Parikh Kirit et al, 2022. Report of the Parikh Committee for Natural Gas Pricing Reforms. Ministry of Petroleum & Natural Gas, Government of India