

Addendum: Updates to the gas pipeline paper (Tongia & Arunachalam, 1998)
<http://www.contrib.andrew.cmu.edu/~tongia/pipeline.pdf>

Since the writing of the paper, there have been a number of changes in the environment in which any gas pipeline project for India needs to be considered. Much of these are political, but the technology has also advanced somewhat, and the economic and business case has also shifted somewhat. *Nonetheless, while the exact numbers might have changed somewhat, the underlying thesis has remained the same: for the bulk of Indian consumers, especially in the north and west, an overland gas pipeline from West/Central Asia remains an economically attractive option, with or without sharing the pipeline with Pakistan.*¹

Current Statistics and Growth calculations:

Since the analysis, India (and to some extent, Pakistan) has become more open with sharing numbers regarding its capacity, use of, and planning for natural gas. The use of the Internet as well as domestic Freedom of Information Acts has helped increase transparency in numbers.

Table 1: Indian commercial primary energy (GAIL, 2002):

Nuclear	1 %
Hydro	6 %
Gas	9 %
Oil	17 %
Coal	63 %
Other (including wind)	Balance (with rounding errors)

Note: biomass is a significant energy source, but used non-commercially primarily for cooking (on the order of half the cooking energy).

Current production (all sources) : 66 MMSCM/D or 24.1 BCM/yr.
Shortfall : 52 MMSCM/D or 19.0 BCM/yr.
(No imports yet)

The shortfall is based on allocations by the Petroleum Ministry to various States and other users, based on criteria like economic fuel or feedstock.

Table 2: Current pattern of consumption (66 MMSCM/D):

Power	37 %
Fertilizer	36 %
Sponge Iron	7 %
Other	10 %
Shrinkage and Internal Utilization	10 %

¹ Just recently (October 2002), Reliance Industries Limited (RIL) has discovered very large gas fields in the Godavari Basin, in exploring just the first of blocks, with a find estimated over 7 trillion cubic feet (tcf). This is the largest single find in India, and affects both supply numbers, and becomes a backstop for LNG pricing. There are reports that some of this gas will get piped from the West coast to the East, as well. However, its economics then do not look as attractive. But, for local power plants and other nearby users, this gas could have an estimated cost of on the order of \$3/MMBTU (different newreports quote different numbers – likely to land vs. delivered upstream differences?).

Table 3: Fertilizer Sector Current Feedstock Mix

Natural Gas	51 %
Naptha	28 %
Fuel Oil	13 %
Imported Ammonia	5 %
Coal	3 %

Current urea production: 20 MMT/yr.

Potential demand (2006-7): 35 MMT/yr.

Thus, if we do the math, today, out of 24.1 BCM/yr gas, 4.4 BCM is used for fertilizer production. If we assume that today's naptha is replaced by natural gas, which economics would warrant if supply were there, then that is an additional 2.4 BCM required. If we assume that all the growth comes from natural gas, then that implies an additional 11 BCM natural gas would be required.

If we look at the power sector, natural gas supplies about 7% of the 100,000 MW of power today, with the bulk coal (64%) and hydro (25%). Of course, the generation varies compares to capacity, especially for hydro. Liquid fuels are 1%, and some of this can be substituted by natural gas.

Given the government's ambitious power capacity growth, of 40,000 MW over 5 years, this implies that 8,000 MW per annum is required (a difficult task in the current loss-making utility environment, and where 4,500 MW has been the maximum addition in a given year thus far). If even one third of this is required from natural gas (government documents indicate possibilities up to one half), then that means that some 86.67 billion kWh per year will come from gas (at the end of the capacity growth). This implies 16.7 BCM/year additional gas².

Pakistan

Pakistan has seen a number of changes in its economy since 1998, not least a major slowdown after its nuclear tests as well as due to a worldwide economic downturn. The share of gas has grown somewhat, with some power plants considering switching to gas because of lower costs. But, the absolute consumption has not grown nearly as much as India's has, in part due to macroeconomic reasons (industrial stagnation). Pakistan has also found substantial gas reserves domestically, especially in Sindh. Thus, there are indications that Pakistan's import requirements might be diminished. However, India is likely to be able to pick up the slack in any shared pipeline, and Pakistan can yet benefit from a shared pipeline (as indicated in the main paper).

² This assumes the natural gas is of standard energy content (1,000 scf = 1 MMBTU), and power plant net efficiency of 50% on Lower Heating Value basis, and 68.5% load factor for these plants, which is the nominal load factor. A more realistic load factor (and optimal one given the higher variable costs for gas-based power versus other fuels) would reduce the gas requirements indicated by some 7-10%.

LNG projects

LNG is moving ahead in India, in a manner that doesn't sidestep a pipeline, but rather would be complementary to it. Realistically, India will see LNG based natural gas imports before pipeline based gas. There are a number of projects underway in India, including:

Table 4: Proposed LNG facilities (GAIL, 2002)

Company	Capacity (MMTPA)	Location(s)
Petronet (GAIL Joint Venture)	7.5	2 Terminals: Dahej, Cochin
Indian Private Joint Ventures	25	6 Terminals: Kakinada, Jamnagar, Hazira, Trombay, Mangalore
Foreign Companies	16	5 Terminals: Pipavav, Hazira, Kakinada
State Govt. (TIDCO)	2.5	1 Terminal: Ennore

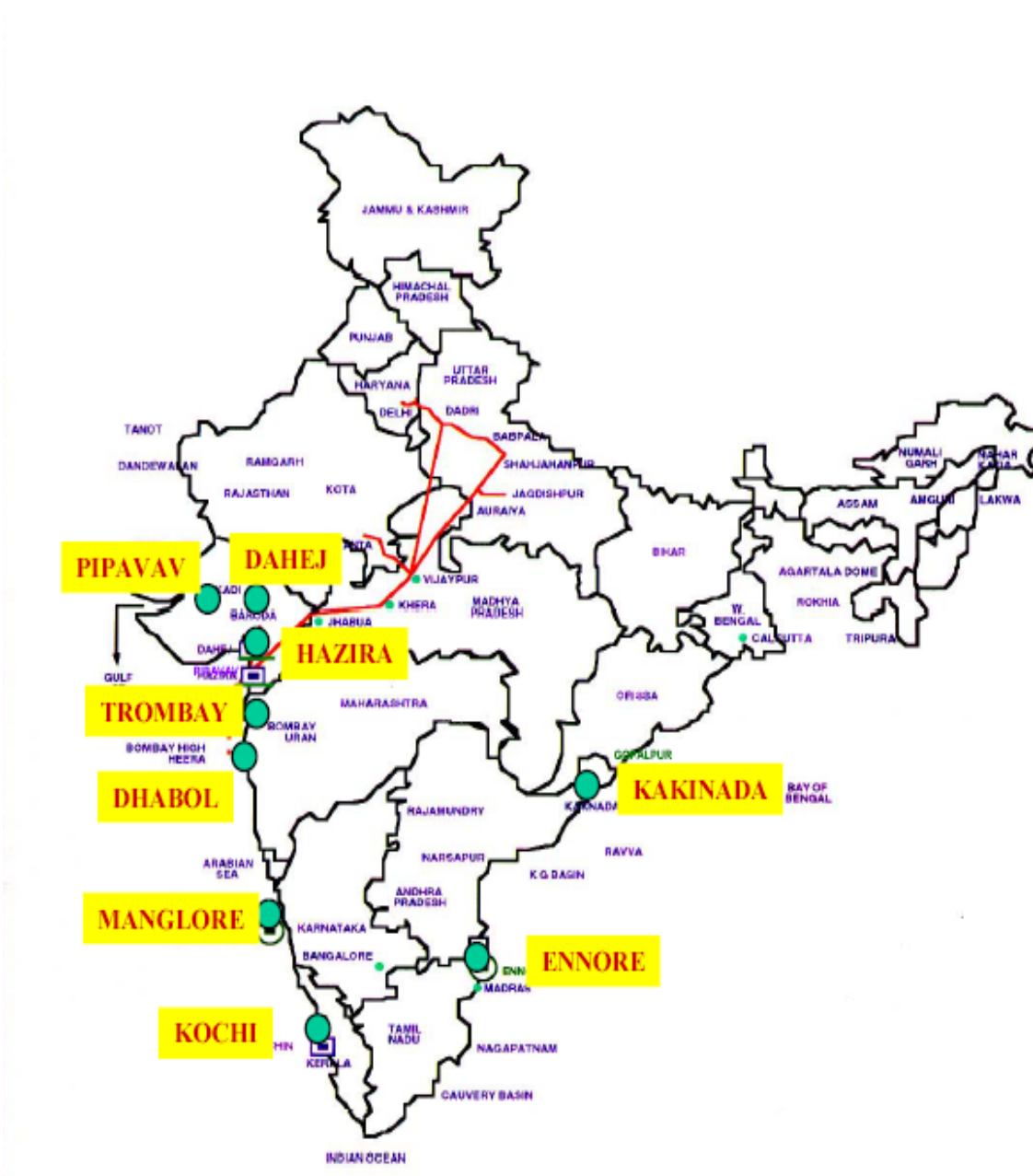


Figure 1: Proposed LNG Terminals (GAIL 2002)

The first one under construction was the ill-fated Dabhol project (linked to Phase-II), but this has stalled. Further along in the process include Dahej in Gujarat (Petronet), and Shell's venture at Hazira. Shell's venture is interesting since the company is moving ahead without firm buyers or special financing, a new idea in this area. This might be partially driven by competitive concerns vis-à-vis the public sector Petronet, which is also building a plant in Gujarat.

Pricing for LNG

As indicated in the main paper, LNG appears somewhat more expensive than compared to piped gas, and much more so when transported long distances inland. In a move to help spur imported LNG usage, the Indian Ministry of Petroleum has promulgated a draft policy that would pool imported gas (LNG) with domestic gas for pricing purposes. Domestic gas has traditionally been quite inexpensive (but limited in supply), with fuel oil parities a little more than half. Today, GAIL (Gas Authority of India Ltd.) gets cheap gas from the fellow govt. company ONGC (Oil and Natural Gas Corp.), and resells it for about \$2.50/MMBTU. By pooling the domestic gas with imported, it could sell gas for \$3.00-3.500/MMBTU (depending on volumes), instead of the \$4.5+ that LNG might go for³. However, there are difficulties with this, with different end-user Ministries asking for exemptions from the increase in domestic gas price (power vs. fertilizer).

LNG economics improving

New LNG facilities are being built at lower cost than previously thought, due to both issues of scale and technology (Jensen, 2002). There are indications that new developments could deliver gas at about \$2.50/MMBTU to coastal regions in India, including regassification (assuming \$0.80 supplier costs). This is highly desirable, but looking more deeply at the numbers presented by Jensen, the Capex varies significantly on how much field development is required. Even assuming it is not required (a big if), and being optimistic on the other counts, reworking the numbers says that LNG would cost \$3/MMBTU after regassification. Even this depends on a number of assumptions. Adding inland delivery costs would push up the price by anywhere from \$0.75-1.50/MMBTU. Nonetheless, it is clear that modern LNG economics are improving significantly, and it is no longer as expensive as it once was. Here, users can bargain for better deals, thereby incorporating or giving away the risk associated with oil price fluctuations or supplier nation charges.

Bargaining power of purchasers

LNG suppliers would like firm contracts for their gas, which is important for their own negotiations with suppliers. Here, Indian users are gaining sophistication and asking for collars (limits) to prices when considering these against an oil index. More interestingly, NTPC (National Thermal Power Corporation) wants landed prices of LNG between 2.5 – 3\$/MMBTU, which is reasonably aggressive, and it is bypassing the LNG ventures coming up in India by inviting its own bids. This is to fuel their power plants, which they expect to grow by 20,000 MW in less than ten years (substantial portion gas, but coal majority estimated). This is because fuel prices have been seen as a reason for Dabhol's failure and unviability.

NTPC is unique for demanding a fixed price for LNG. It has directly sought bids for 5 million TPA of LNG for power plants in Gujarat State and Cochin. Interest has been shown by Petronas, BG's Pipavav LNG, Shell, Total Fina Elf, Yemen LNG, British

³ The Petroleum Secretary, Mr. Chaturvedi, has stated that the present cap price of natural gas comes to \$2.5/MMBTU delivered, 100 per cent fuel oil parity would mean into \$3-3.5/MMBTU. Against this, regassified LNG would cost between \$4 to 5.3/MMBTU.

Petroleum, Unocal, BHP Billiton, and L&T (Asia in Focus, 2002). NTPC claims that a number of suppliers are willing to provide fixed price LNG. This will be an interesting and important development, since fuel costs are the largest component of gas-based electricity.

Suppliers

While the natural gas suppliers listed in the paper remain willing to export, Turkmenistan is unique in having almost no ability to ship LNG. Iran has limited capacity today, but is considering it actively. Oman and Qatar already have capacity for LNG, as does Abu Dhabi in the region.

When Enron's LNG venture imploded, Oman and Adgas (Abu Dhabi) were left without a consumer in the short term. However, they have found other buyers since then (Petroleum Intelligence Weekly, 2002). Today, many of these groups are looking for firm contracts before expanding capacity.

RasGas has agreed to give Petronet 5 MTPA LNG based on a collared index price. This would be linked to a basket of crude oil with floor and ceilings of 16 and 24 dollars per barrel. Based on this, users would expect to pay about \$3.0-3.5/MBBTU as a base price (*More details on the exact numbers are forthcoming...*)

Politics – India & Pakistan

India and Pakistan have had numerous political differences since 1998. Both nations exploded nuclear devices in May 1998, and the effect of the ensuing economic sanctions was more pronounced on Pakistan than on India. There was a brief thawing of relations indicated by Prime Minister Vajpayee's Lahore Bus trip, but this was lost when militants, ostensibly with Pakistani backing, entered the Kargil region of India, leading to a mini-war. After this period, hostilities over Kashmir increased, and today both nations have some one million troops along the border, but there are indications that this tension is decreasing. During this period, the Pakistani PM Nawaz Sharif was overthrown in a coup, and General Musharraf has since taken control. It appeared that Pakistan was becoming an international pariah, until the attack on Sept. 11, 2001 shifted political alliances somewhat back towards Pakistan, a US ally in the War on Terrorism. The current expectation would be that Indian-Pakistani relations will remain strained, and a pipeline could only be considered in the future under economic and multi-national grounds as opposed to a Confidence Building Measure between the two neighbors.

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