POLICY BRIEF

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The Energy and Resources Institute

Shale Gas in India: Look Before You Leap

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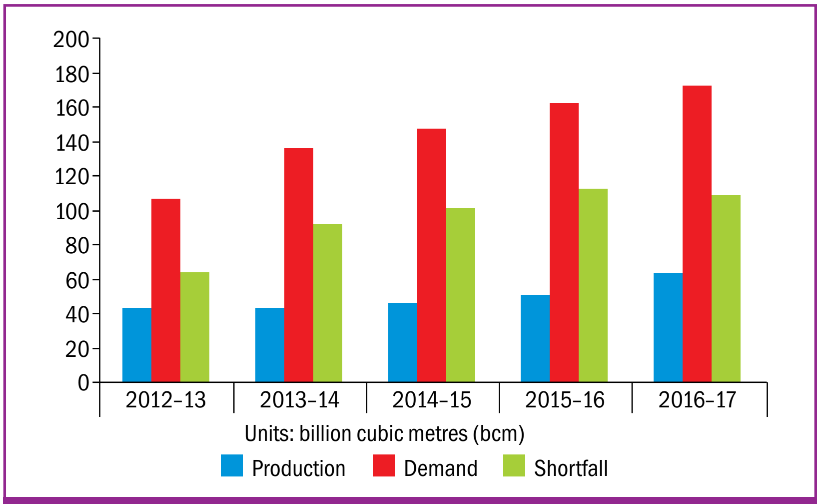
Introduction

Natural gas forms 9 per cent of the total commercial energy mix in India, but demand far exceeds supply, as shown in Figure 1. Part of the demand in 2012–13 was made up by the import of liquefied natural gas (LNG) to the extent of 18 bcm. Several power plants, which were in operation, or ready for commissioning, or in an advanced state of construction, representing about 10,000 MW of generation capacity, were, however, idle for want of gas.

The exploration and production of shale gas in the United States (US) has been a game changer, making the country self-sufficient in natural gas over the last few years. This has created considerable excitement globally, particularly in Europe. India is also looking at exploring shale gas domestically to fill in the supply–demand gap. But will what works for the US also work for Europe and India? This policy brief explores this question in the context of India. It explains the nature of shale gas, the technology for its extraction from underground sources, and its potential for India. It also highlights overseas acquisitions of this resource by Indian companies even before it is sourced domestically, and then examines the viability of the technology in India. **One of the key determinants of the viability of this technology is the availability of large quantities of clean water. This policy brief raises a red flag on this complementary input for exploiting shale gas resources in India, given that India is a water-stressed country, and is fast approaching water scarcity conditions**.



Note: Shortfall as the percentage of demand varies from 60 to 69 per cent

Figure 1: India's estimated natural gas production versus demand

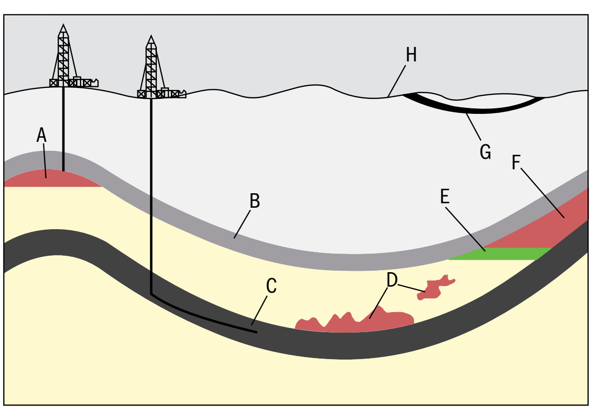
Source: (MoPNG, January 2013)

BOX 1 SHALE GAS

Natural gas (mainly methane) is generally classified under two heads: (a) conventional gas, and (b) unconventional gas. Most of the natural gas that is produced globally comes under the category of conventional gas where, after drilling in a sedimentary basin that is rich in gas, the gas migrates through porous rocks into reservoirs and flows freely to the surface where it is collected, treated, and then piped to various users. Shale gas on the other hand is located in rocks of very low permeability and does not easily flow. Therefore, the technique for recovery of shale gas is quite different from that of conventional gas.

Drilling and recovery of shale gas

Figure 2 shows the various underground geographical features for recovery of conventional and unconventional gases. Conventional gas can occur by itself or in association with oil. These are shown on the left and right side of the figure, respectively. Coal bed methane (CBM), which is extracted from coal beds, is also an unconventional gas and, in terms of depth, occurs much closer to the land surface than other similar gases. However, shale rock is sometimes found 3,000 metres below the surface. Therefore, after deep vertical drilling, there are techniques to drill horizontally for considerable distances in various directions to extract the gas-rich shale. A mixture of water, chemicals, and sand is then injected into the well at very high pressures (8,000 psi) to create a number of fissures in the rock to release the gas. The process of using water for breaking up the rock is known as "hydro-fracturing" or "fracking". The chemicals help in water and gas flow and tiny particles of sand enter the fissures to keep them open and allow the gas to flow to the surface. This injection has to be done several times over the life of the well. The number of wells to be drilled for shale gas far exceeds the number of wells required in the case of conventional gas and the land area required is a minimum of 80 to 160 acres.



A- Conventional non-associated gas
B- Seal
C- Gas-rich shale
D- Tight sand gas
E- Oil
F- Conventional associated gas
G- Coalbed methane
H- Land surface

Source: US Energy Information Administration (2011): www.eia.gov

Figure 2: Shale gas extraction
Source: Eucers strategy paper: Strategic perspectives of unconventional gas, Vol. 1, 1 May 2011

Shale gas in the US

There are 34 states in the US, which have vast deposits of rocks rich in shale gas. Production of the gas has added about 20 per cent to domestic gas availability and over 20,000 wells have been drilled. From being an importer of LNG, the country is now self-sufficient and there are plans to export gas from the very terminals that were built for imports.

Estimates of fresh water usage for fracking in the US vary from 2.8 to 3.8 million gallons per well to an average of 4.5 million gallons in the Marcellus field and up to 13.0 million gallons in the Eagle Ford field. These figures need to be multiplied by the number of times fracking has to be done to a well and the number of wells at each location.

Around 80 per cent of the mixture remains underground and the remaining 20 per cent rises to the surface, where it is not always disposed of safely. Environmentalists claim that many different chemical products, some of which are toxic, are injected, along with several million gallons of fresh water, into each of the wells. They further claim that leakage of the toxic chemicals has contaminated aquifers, which are the sources of drinking water. There are also claims that methane can leak through the casing of the well and get released into the atmosphere. These claims are vehemently disputed by the oil and gas companies.

The Environmental Protection Agency (EPA) was charged by the US Congress in 2010 to investigate the potential impacts of fracking on drinking water and groundwater across the country. There has been a considerable delay in releasing its report, which is now due in 2014.

India's participation in the shale gas industry in the US

Reliance Industries Ltd (RIL) has made big investments (US$ 3.5 billion) in the Marcellus and Eagle Ford shales through joint ventures with Chevron, Carrizo, and Pioneer. Marcellus has been described as the largest discovered unconventional gas field in the US and one of the largest worldwide, with estimated net recoverable resources of 318 trillion cubic feet (tcf). (In comparison, the resources in RIL's own D6 fields in the KG Basin were estimated to hold around 3.4 tcf in November 2012, dropping from 10.3 tcf in December 2006.) According to RIL's Annual Report for 2012–13, the break-even cost of shale gas production in the US is as low as US$ 3.50–4.00 per Million British Thermal Units (MMBtu). RIL's revenues from the shale gas business more than doubled to US$ 545 million in 2012 compared to 2011. RIL views its investment as a profitable proposition and not necessarily at gaining technology and experience to explore for shale gas in India. Oil India Limited (OIL), Indian Oil Corporation (IOC), and GAIL India Limited have also made investments in shale gas production in the US.

The other interesting contribution to shale gas development in the US is the export of guar gum from India, which helps in improving the viscosity and flow of water in the fracking process. The gum is extracted from *guar ki phalli*, grown mainly by farmers in arid lands in Rajasthan and Haryana. Earlier, guar gum was used mainly as an additive in ice creams and sauces, but with the serendipitous discovery of its use in shale gas extraction, its production has risen enormously, earning almost US$ 5 billion during the period from April 2012 to January 2013.

Shale gas in Europe

Europe has not had the same success in exploiting shale gas as the US for several reasons. In the US, resources under the land belong to the land owner who is happy to allow drilling and get paid by the gas companies, whereas in Europe—as also in India— these resources belong to the government. Also, important tax benefits are given to companies in the US to drill and produce shale gas. In Europe, the geology of shale rock is different from that of the US and it is more likely to be found in places that are more densely populated. The NIMBY effect ("Not in My Back Yard") is much more prevalent in Europe than in the US. The possible contamination of water supply is a serious concern of European governments. France, Bulgaria, Luxembourg, the Czech Republic, and the Netherlands have either banned or put a moratorium on shale gas exploration. However, in the UK, a ban, imposed earlier due to suspected seismic activity, has been lifted. The Tyndale Centre for Climate Change has estimated that around 3,000 wells will need to be drilled in the UK to contribute 10 per cent of annual consumption.

Proposed shale gas exploration policy in India

There is an obvious interest in exploring for shale gas domestically, given the enormous success in the US. The Ministry of Petroleum and Natural Gas (MoPNG) has identified six basins as potentially shale gas bearing. These are Cambay, Assam-Arakan, Gondwana, Krishna-Godavari, Kaveri, and the Indo-Gangetic plain. A map derived from different sources is shown in Figure 3.

In a study conducted by the United States Geological Survey (USGS), recoverable resources of 6.1 tcf have been estimated in 3 out of 26 sedimentary basins. The Government of India

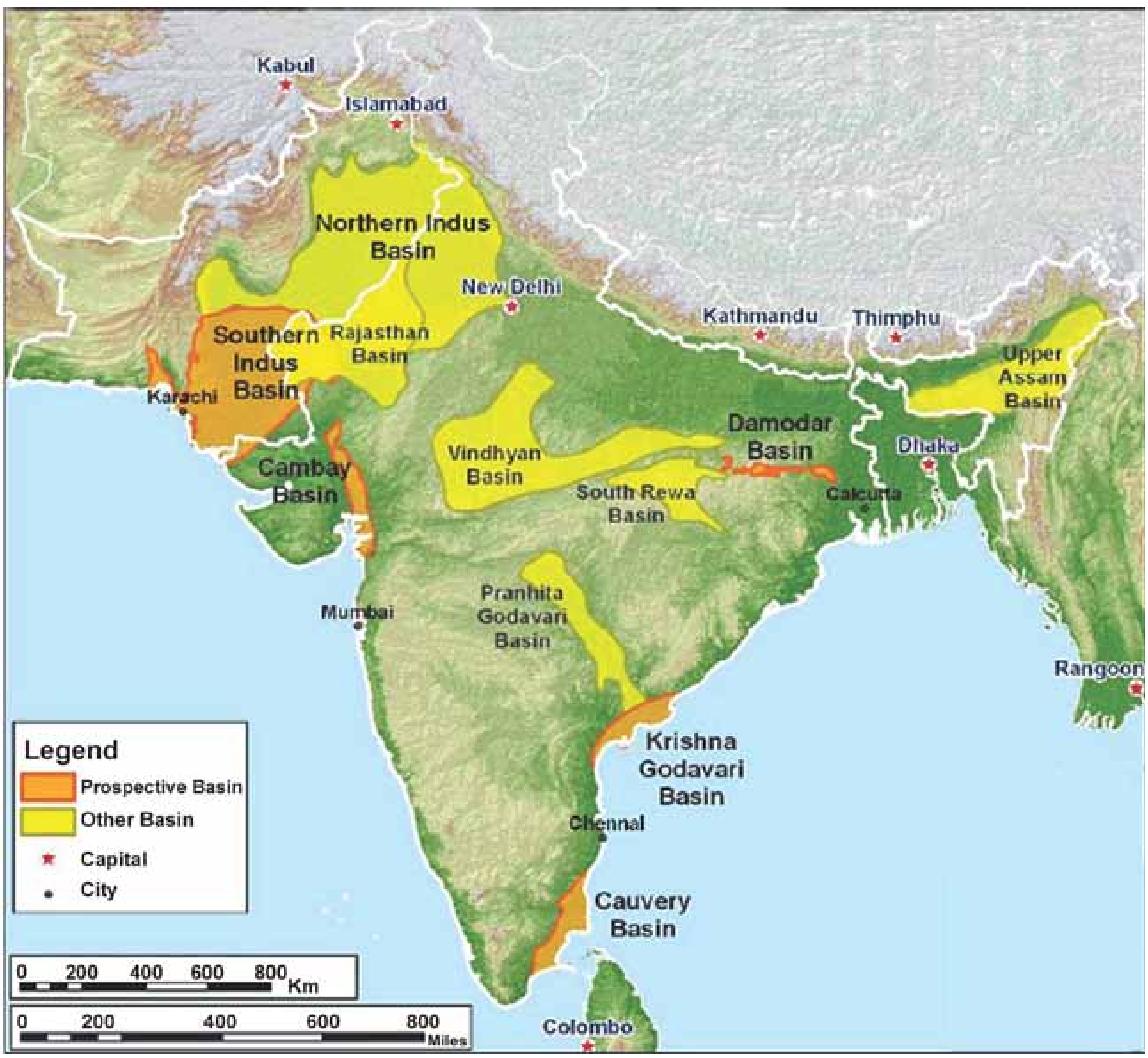


Figure 3: Shale gas sedimentary basins in the Indian sub-continent
Source: Adapted from http://suvratk.blogspot.in/2011/05/india-basin-wise-shale-gas-estimates.html (Mr Suvrat Kher, Sedimentary Geologist)

had also put out in 2012, a draft policy for the exploration and exploitation of shale gas, inviting suggestions from the general public, stakeholders, environmentalists, etc. Salient features of the policy draft are given in Box 2.

BOX 2: SALIENT FEATURES OF THE PROPOSED SHALE GAS POLICY

1. The identified blocks will be advertised for international competitive bidding. Participation of the state will not be mandatory.
2. All areas, which are already allotted and where operations have entered the development/production phase shall be excluded from the area to be offered for shale gas exploration.
3. If an offer for shale gas overlaps or falls within an existing oil and gas/CBM block, right of first refusal will be offered to the existing contractor to match the offer of the selected bidder.
4. Fiscal regime proposed for exploration to be based on royalty and production linked payments, similar to the regime adopted for CBM operations. Ad valorem royalty at the prevailing rate for natural gas would be applicable and accrue to the state governments. Production-linked payment on ad valorem basis will be made to the central government on different production slabs, which will be biddable items. Cost recovery will not be admissible.
5. The contract duration will be of 32 years and will be divided into two phases. Phase I will be for a period of 7 years and will be for exploration, appraisal, evaluation of the prospect, and feasibility. Phase II will be the development and production phase for the remaining duration of 25 years.
6. There will be freedom to market shale gas within India on an arm's length basis within the framework of the government policies in marketing and pricing of the gas.

As we write this brief, this policy is being considered by a group of ministers. The draft policy has identified some of the water issues in the exploitation of shale gas and these are reproduced verbatim hereunder:

- Optimal exploitation of shale gas/oil requires Horizontal and Multilateral wells and Multistage Hydraulic fracturing treatments of stimulate oil and gas production from shale.
- This may require large volume of water ~3-4 million gallons per well (11,000 to 15,000 cubic metres of water required for drilling/hydro fracturing depending upon the well type and Shale characteristics).
- The water after Hydraulic fracturing is flowed back to the surface and may have high content of Total Dissolved Solids (TDS) and other contaminants (typically contains proppant (sand), chemical residue occur in many geologic formation, mainly in shale). Therefore, the treatment of this water before discharge to surface/subsurface water needs to be in line with the Central/State Ground Water Authority regulations.
- Possibility of contamination of Aquifier (both surface and subsurface) from hydro-fracturing and fracturing fluid disposal and the need for safeguarding the Aquifer. Multiple casing programme (at least 2 casings) will be a mandatory requirement across all sub-surface fresh water aquifers.

The government's draft policy further suggests that there should be a mandatory rainwater harvesting provision in the exploration area, which trivializes the extent to which water will be required. It states, "as far as possible", river, rain or non-potable groundwater only should be utilized for fracking — and re-use/recycling of water should be the preferred method for water management. The environmental concerns in using water for fracking (see Figure 4) have been considerably downplayed and their significance underestimated. Further, enforcing legislation on environmental and water issues is a problem in India, and such legislation has been more in breach than in observance.

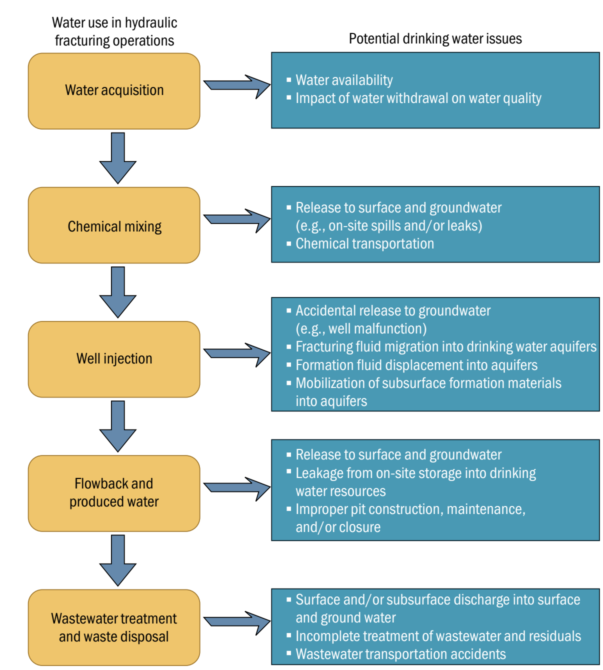


Figure 4: Water use in hydraulic fracturing operations
Source: US EPA (http://www.waterworld.com/articles/wwi/print/volume-27/issue-2/regional-spotlight-europe/shale-gas-fracking.html)

Fresh water availability in India

Figure 5 shows that India suffers from physical and economic water scarcity whereas the US and Europe do not have the same water worries.

The website 'Indiawaterportal' points out that in the next 12–15 years, while the consumption of water will increase by over 50 per cent, the supply will increase by only 5 to 10 per cent, leading to a water scarcity situation.

This year, seven drought-affected states— Maharashtra, Andhra Pradesh, Himachal Pradesh, Sikkim, Gujarat, Kerala, and Uttarakhand—have been provided a relief package of Rs 2,892 crore by the Centre under the National Disaster Relief Fund with retrospective effect from 1 March 2013.

TERI's own study in 2010, *Looking Back to Think Ahead*, demonstrates that India is already a water-stressed country and is fast approaching the scarcity benchmark of 1,000 m^3 per capita with unabated growth in the irrigation sector and

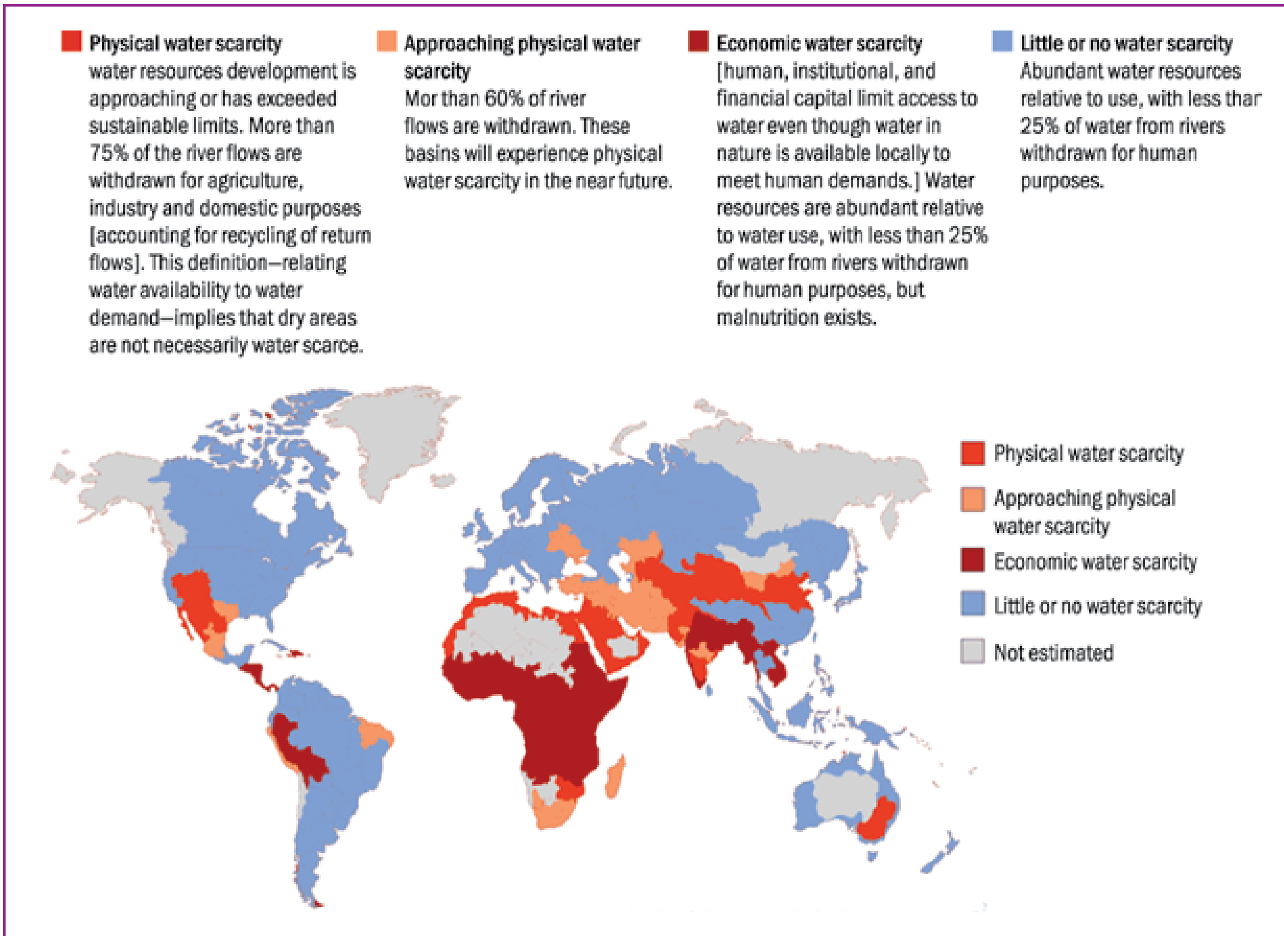


Figure 5: Areas of physical and economic water scarcity
Source: http://www.fao.org/nr/water/issues/scarcity.html

even more rapid growth in industrial and domestic water demand. Another detailed study released in January 2013 by UNICEF and FAO, *Water in India: Situation and Prospects*, points in the same direction. A map of India showing various river basins and their projected status by 2030 in another study by the Water Resources Group in 2010 is provided in Figure 6. This group consists of the consultancy firm McKinsey, the World Bank, and a consortium of business partners.

It is evident that potential shale gas bearing areas, such as Cambay, Gondwana, Krishna-Godavari, and the Indo-Gangetic plains are also areas that will experience severe water stress by 2030.

Land acquisition is not covered in the shale gas policy, but will be a serious issue because of the large area required for fracking and the consequent displacement of people.

When the government invites bids, they are expected to cover three major basins, i.e., Cambay, Krishna-Godavari, and Raniganj (Damodar basin). According to the Oil and Natural Gas Corporation (ONGC), there are about 34 tcf of shale gas in the Damodar basin alone (compared to India's total conventional gas reserves of 47 tcf) of which 8 tcf are recoverable. However, in an address to the Bengal Chamber of Commerce and Industry in May 2013, the Chairman and Managing Director (C&MD) of ONGC, while highlighting the potential of shale gas in the Damodar basin, also mentioned "land use for drilling operations may face severe resistance from the locals", and "availability of huge water resources for its shale gas operation is also apprehended to be a great challenge for us".

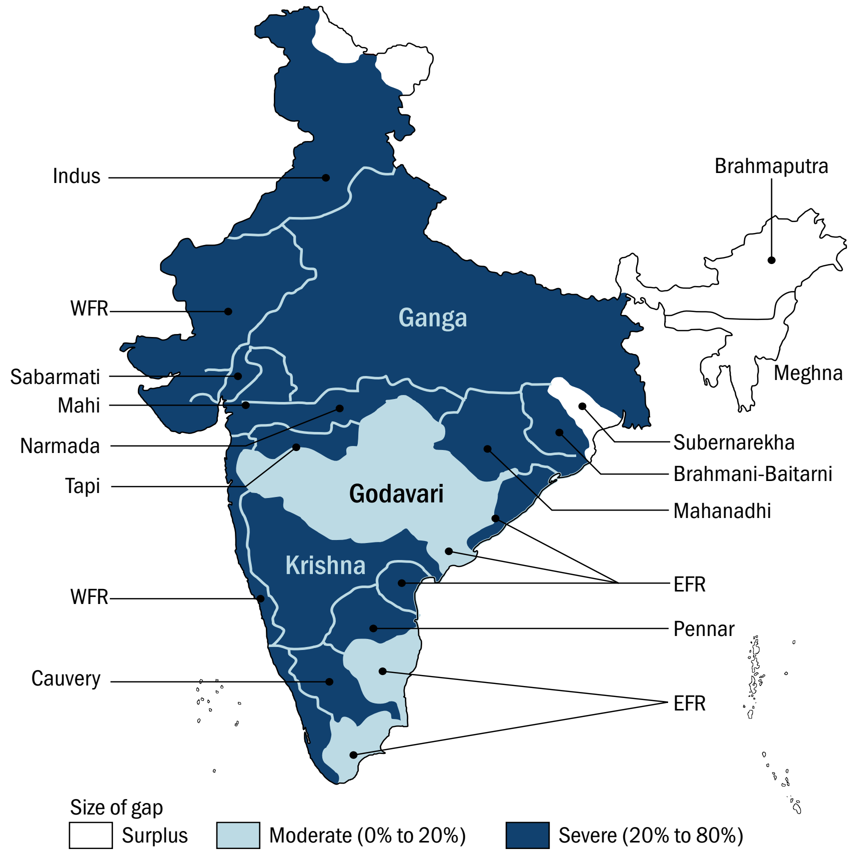


Figure 6: Water basin projections for 2030. The unconstrained projection of water requirements under a static policy regime and at existing levels of productivity and efficiency.
Source: 2030 Water Resources Group, 2010
WFR = western-flowing coastal rivers; EFR = eastern-flowing coastal rivers

Conclusion

While the potential shale gas reserves overshadow those of conventional gas, we have a long way to go in identifying shale gas rich basins and acquiring the necessary technology and experience to extract shale gas. Meanwhile, the water situation will only get worse due to the reducing availability of fresh drinking water year by year, dropping groundwater levels, and the increasingly polluted rivers and other water bodies. Unless, there is some revolutionary technological breakthrough, which does not need the use of fresh water and chemicals, it is vital that we seriously ask ourselves this question: **Should we further endanger a rapidly depleting resource on which all life depends?**

The answer should be a resounding "NO", and instead the focus must be on the following:

- **Removing the bottlenecks in CBM exploration and production while safeguarding the environment:** This gas is formed in association with coal at shallow depths. Its extraction does not entail horizontal drilling and requires a much smaller degree of fracturing compared to shale gas. However, a considerable amount of water associated with the gas needs to be removed to allow the gas to flow. This water can contain dissolved solids and pollutants, which will need to be treated or disposed of safely. Although 33 blocks have been awarded since 2001, mainly in east India, production is currently around just 3 bcm per annum. Delays have been due to obtaining environmental clearances, acquisition of land, and governmental approval on pricing.
- **Establishing a national research and development (R&D) Centre for gas hydrates, as requested by DGH Hydrocarbons:** These are methane and water molecules in seabed sediments that get frozen into ice due to low temperatures and high pressures. India's offshore reserves have been tentatively estimated at around 66,000 tcf or 1,500 times more than the known conventional gas reserves. Though the government formulated a National Gas Hydrate Programme in 1997 and under an Indo-US initiative a drilling ship explored four seabed areas in 2006, nothing much has happened since. So far no commercial production has started globally, though Japan has announced it may do so by 2016.
- **Expanding our exploration of conventional gas through investor friendly policies by reducing their risks and allowing market driven prices**
- **Acquiring gas equity abroad:** The success of BPCL and Videocon in Mozambique is a case in point.

- **Continuing to import LNG from the Middle East and expanding our sourcing to the US, Australia, etc.**
- **Giving a big push to renewable energy**
- **Last, but not the least, taking urgent steps to protect, augment, and conserve our water resources for other critical uses.**

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This is part of a series of policy briefs by TERI based on its research work in specific areas. These briefs are made available to members of parliament, policy-makers, regulators, sectoral experts, civil society, and the media. The briefs are also accessible at http://www.teriin.org/policybrief/. The purpose is to focus on key issues and list our policy recommendations to encourage wider discussion and debate. We would very much value your comments and suggestions.

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