

**SHALE GAS –
ENVIRONMENTAL IMPACT AND SAFEGUARD**

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The International and National Scenario

Shale Gas is believed to have a huge potential to stabilize Indian energy scenario

✓ Shale Gas is “**The biggest energy innovation of the decade**”
– Daniel Yergin, Chairman, Cambridge Consulting Group

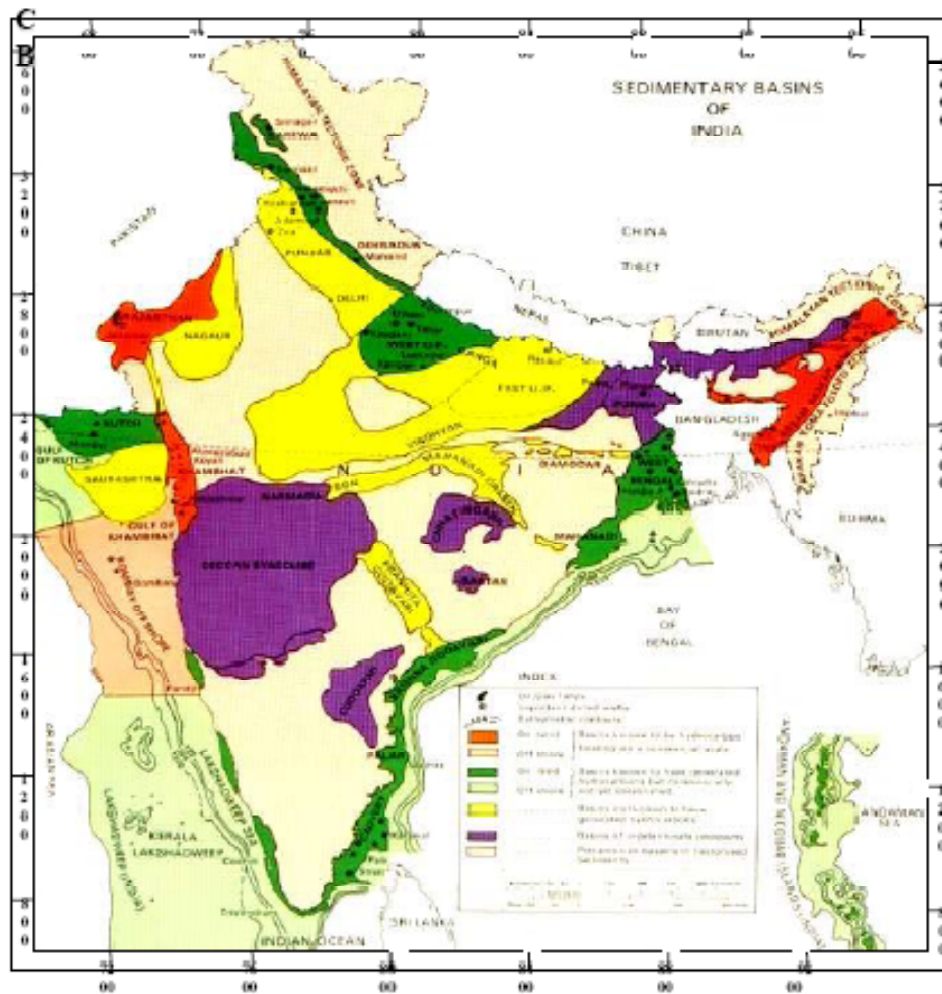
✓ “**Shale Gas: A game changer that India should turn to**”
– B V Shenoy in *The Deccan Herald*, April 13, 2013.

❖ **Identified Shale Gas formation in India: Cambay, Gondwana, Krishna-Godavari and Cauvery Basins**

❖ **India’s first discovery of Shale Gas made in Durgapur in 2011 over an area of about 1300 sq km**

❖ **A recent study by EIA (Energy Information Administration), USA in 2011 reported the potential of Shale Gas in 48 major blocks 32 in countries including India.**

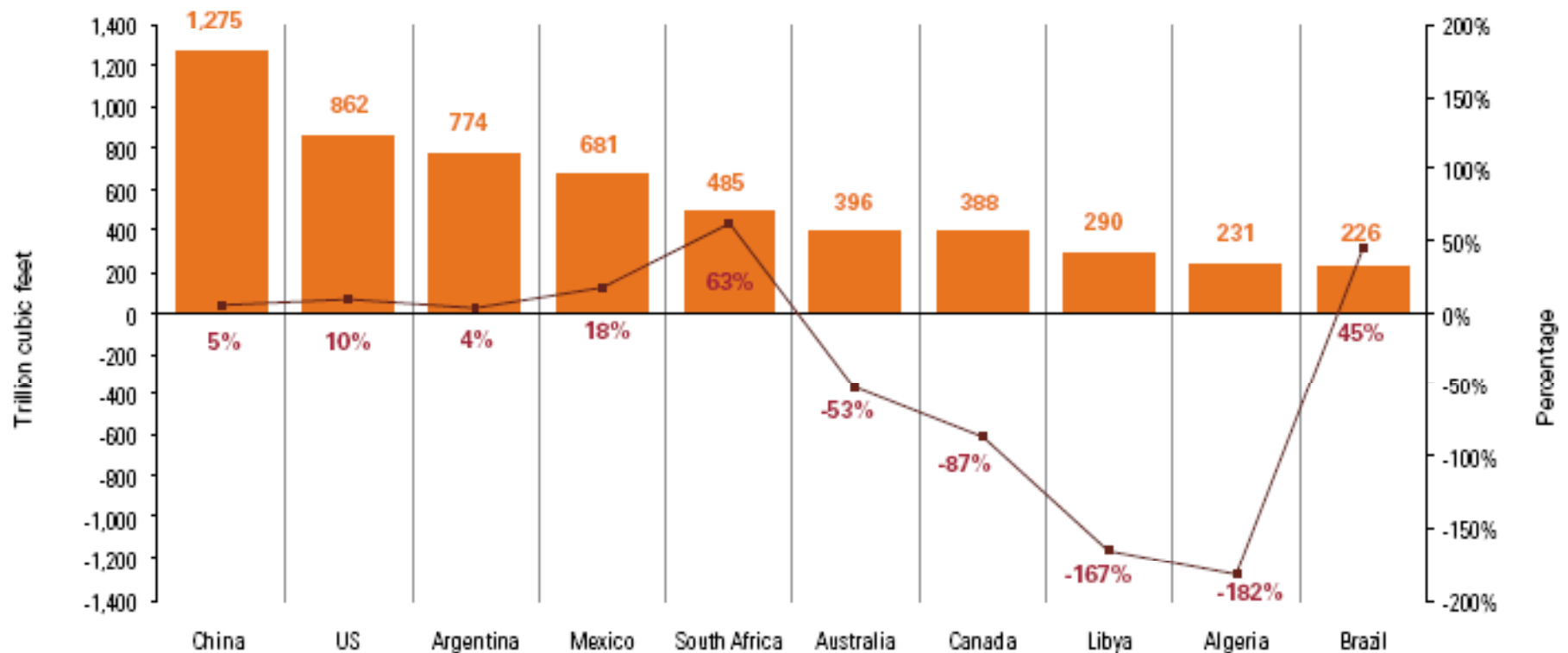
Potential Shale Gas Basins



- **Cambay**
- **Assam-Arakan**
- **Gondwana**
- **Vindhyan**
- **Rajasthan**
- **Bengal**
- **Krishna-Godavari**
- **Cauvery**

The International and National Scenario, contd..

Top 10 regions by estimated shale gas technically recoverable resources and natural gas imports/(exports) percentages



Source: EIA: World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States, April 2011

Estimated Shale Gas reserve in top ten regions of the World

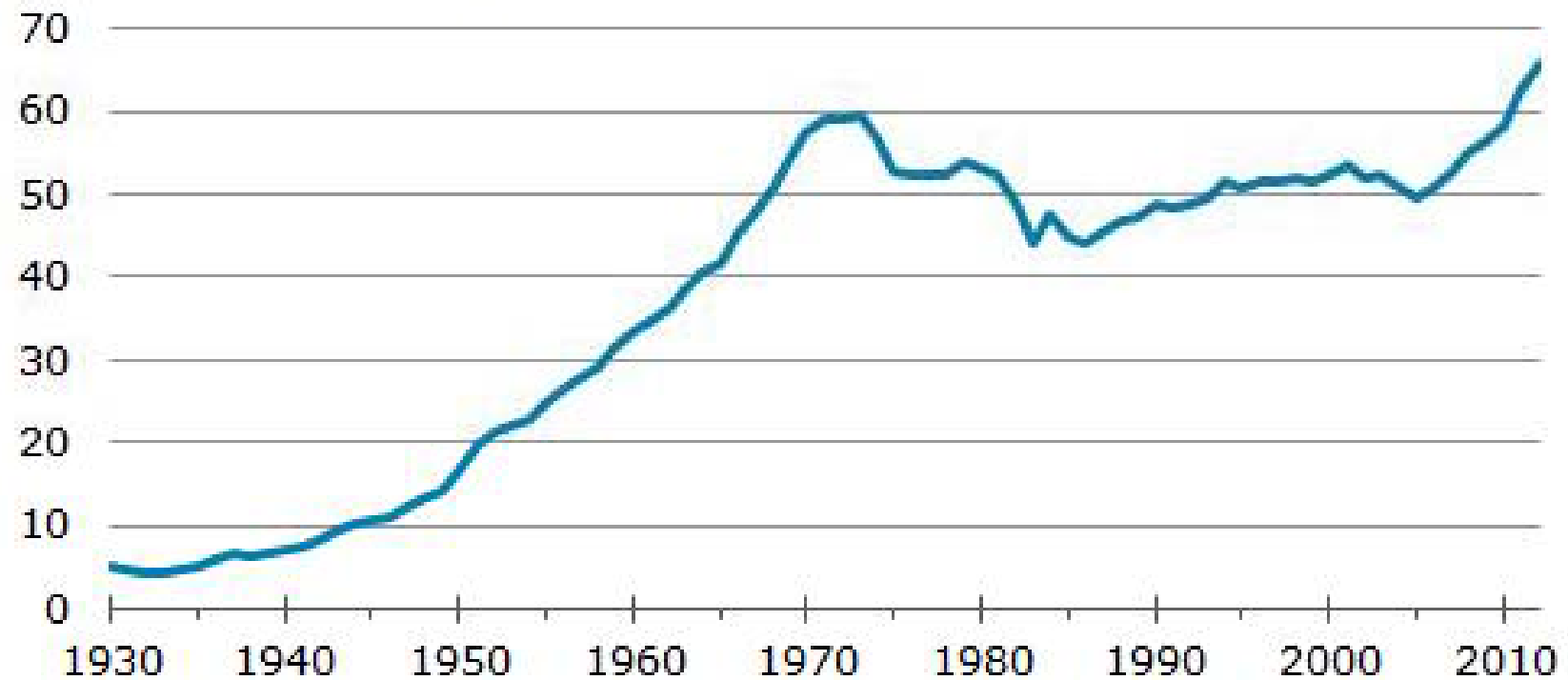
The International and National Scenario, contd..

- ❑ Shale Gas production started in the US more than fifty years ago; more than 10% of its gas requirement is met from this source
- ❑ China has a huge reserve; exploration has been done in many areas, production is in the beginning
- ❑ Argentina: Dow signed a MOU for exploration and commercial production (CEN, April 8, 2013)

- ❑ **India is going to adopt a policy on Shale Gas**
 - 32 years contract term may be proposed**
 - Phase 1 - 7 years, for exploration, appraisal, evaluation**
 - Phase 2 – 25 years, for development of well drilling, establishment of field facilities, commercial production and marketing**

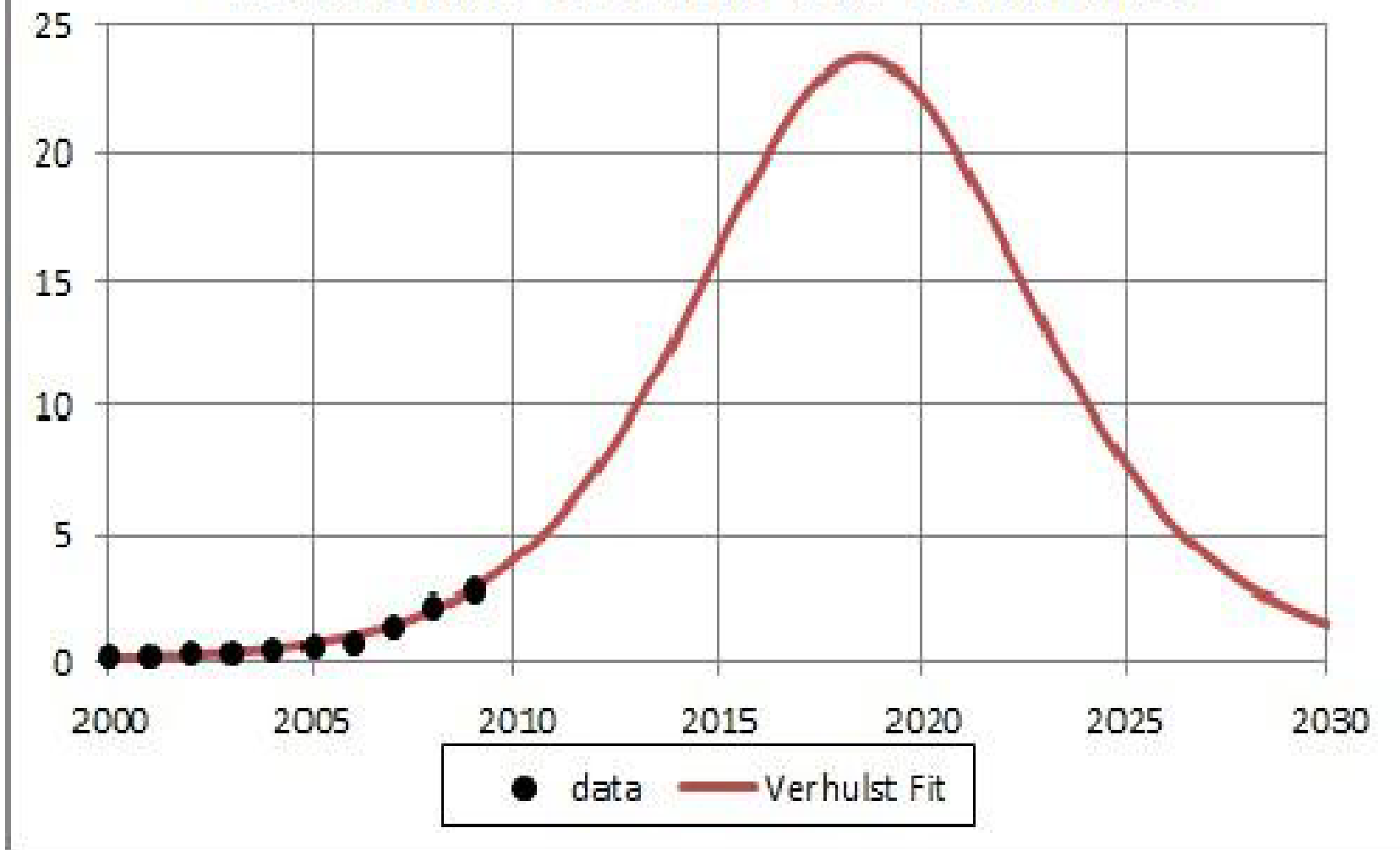
U.S. Annual Dry Natural Gas Production, 1930-2012

Billion Cubic Feet Per Day



Source: U.S. Energy Information Administration, Natural Gas Monthly, February 28, 2013.

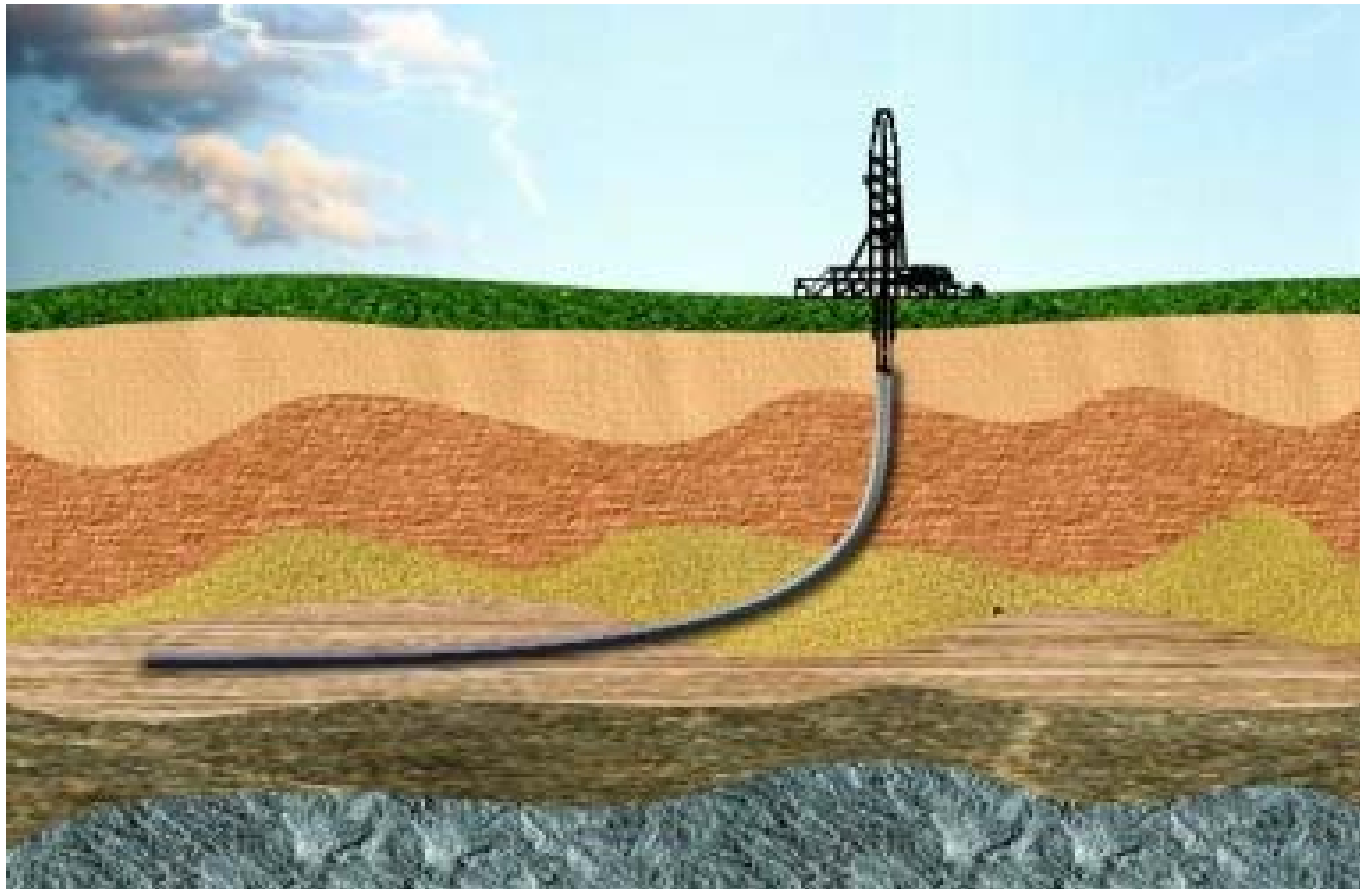
U. S. Shale Natural Gas Extraction



Source: *The Fracked-up USA Shale Gas Bubble*
By [F. William Engdahl](#); *Global Research*, March 13, 2013

Production Technique

Horizontal Drilling; horizontal and multilateral wells; creating fractures in the rock to facilitate passage of the gas (also called “fracking”); huge quantities of water and chemicals are used in the process; heavy machineries, usually diesel powered, are used; substantial leakage of natural gas occurs.



Environmental Concerns

- ✓ **Wastewater**
- ✓ **Air Pollution Issues**
- ✓ **Noise, Congestion, Particulates**
- ✓ **Green House Gas Emission**
- ✓ **Health Effects**

Quite a few reports have been published very recently on related environmental issues. A few are cited below.

- **Impact of Shale Gas and Shale Oil Extraction on the Environment and on Human Health – A report requisitioned by the European Parliament, June 2011**
- **Environmental Issues surrounding Shale Gas Production – IGU, April 2012**
- **Fact-Based Regulation for Environmental Protection in Shale Gas Development – The Energy Institute, U Texas, Feb 2012**
- **Shale Gas – The Facts about the Environmental Concerns – IGU, June 2012**

Surface Water Pollution

Hydraulic Fracturing or Fracking and gas production generates a large quantity of wastewater.

➤ **Water requirement (as stated in the Indian policy document): 11,000 to 15,000 m³ for one well (the estimate is of the same order of 7-19 million liters per well according to a field data from a US gas field). Many chemicals and additives are used in the fracking water; many of them are toxic.**

Disposal of Wastewater:

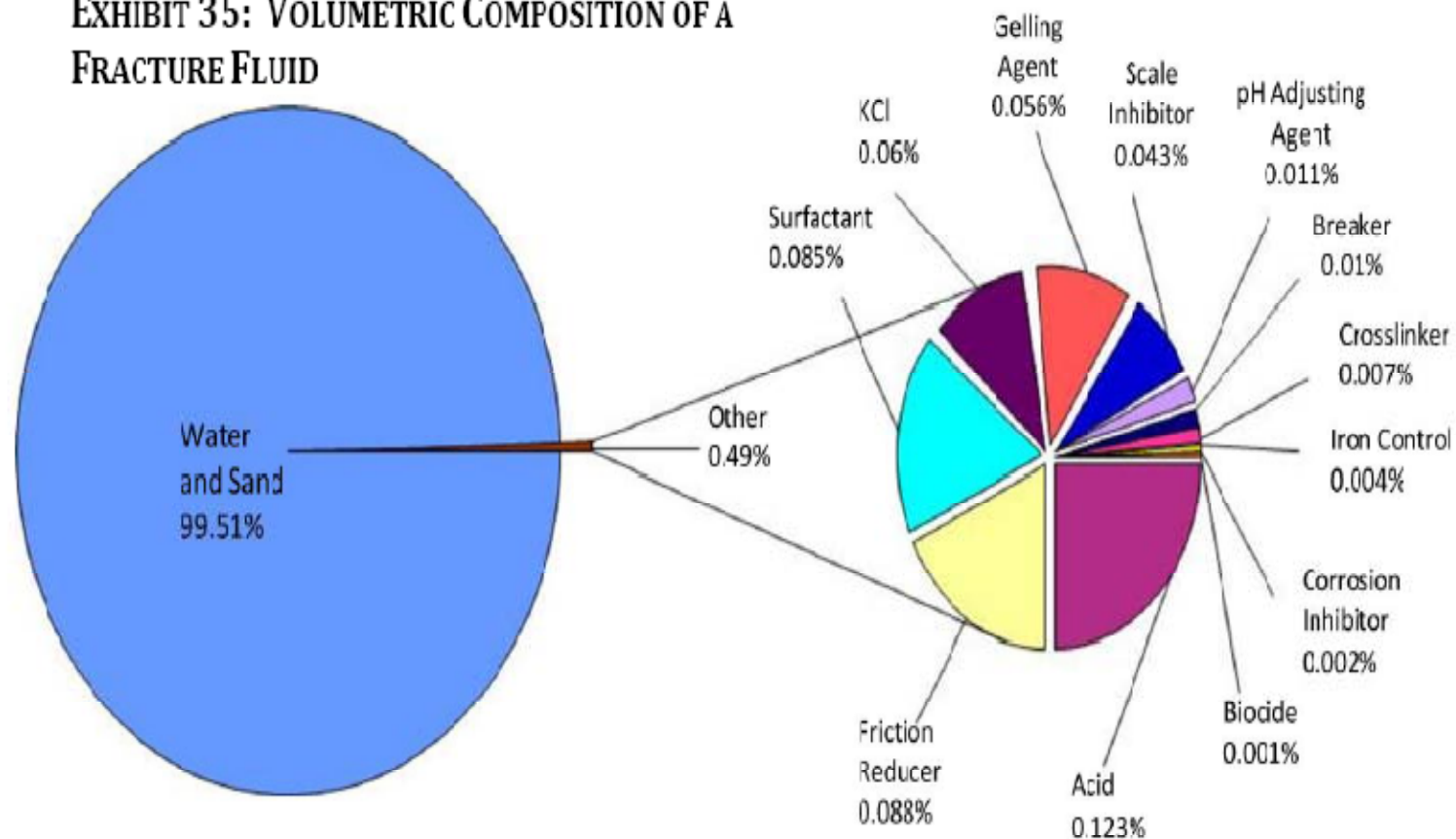
- **May be transported to a local wastewater treatment facility – it is difficult to remove and dispose of the chemicals used for fracking**
- **Injected into deep geological formation – risk of contamination of groundwater in the long run**
- **Recycled and reinjected after addition of chemicals**
- **Used for irrigation or dust suppression of local roads**

Each technique has one or more associated problems. It is very difficult to isolate the toxic chemicals from the fracking wastewater.

Environmental Concerns Associated with Shale Gas Production

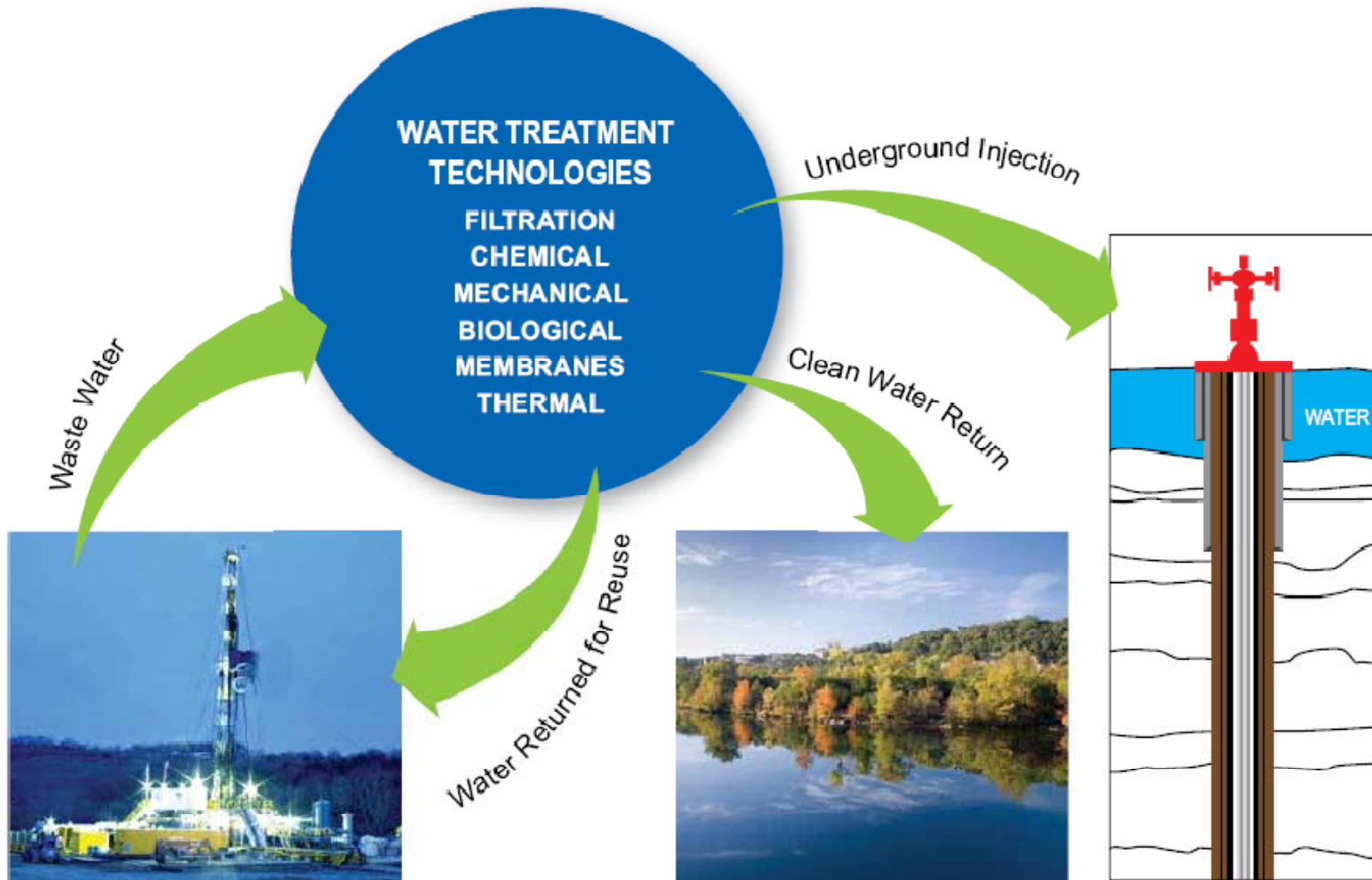
Water Pollution Issues – Chemicals and Additives

EXHIBIT 35: VOLUMETRIC COMPOSITION OF A FRACTURE FLUID



It is necessary to treat the wastewater separately, separate the chemicals and additives and dispose them of scientifically as hazardous materials.

Wastewater Treatment and Disposal Options

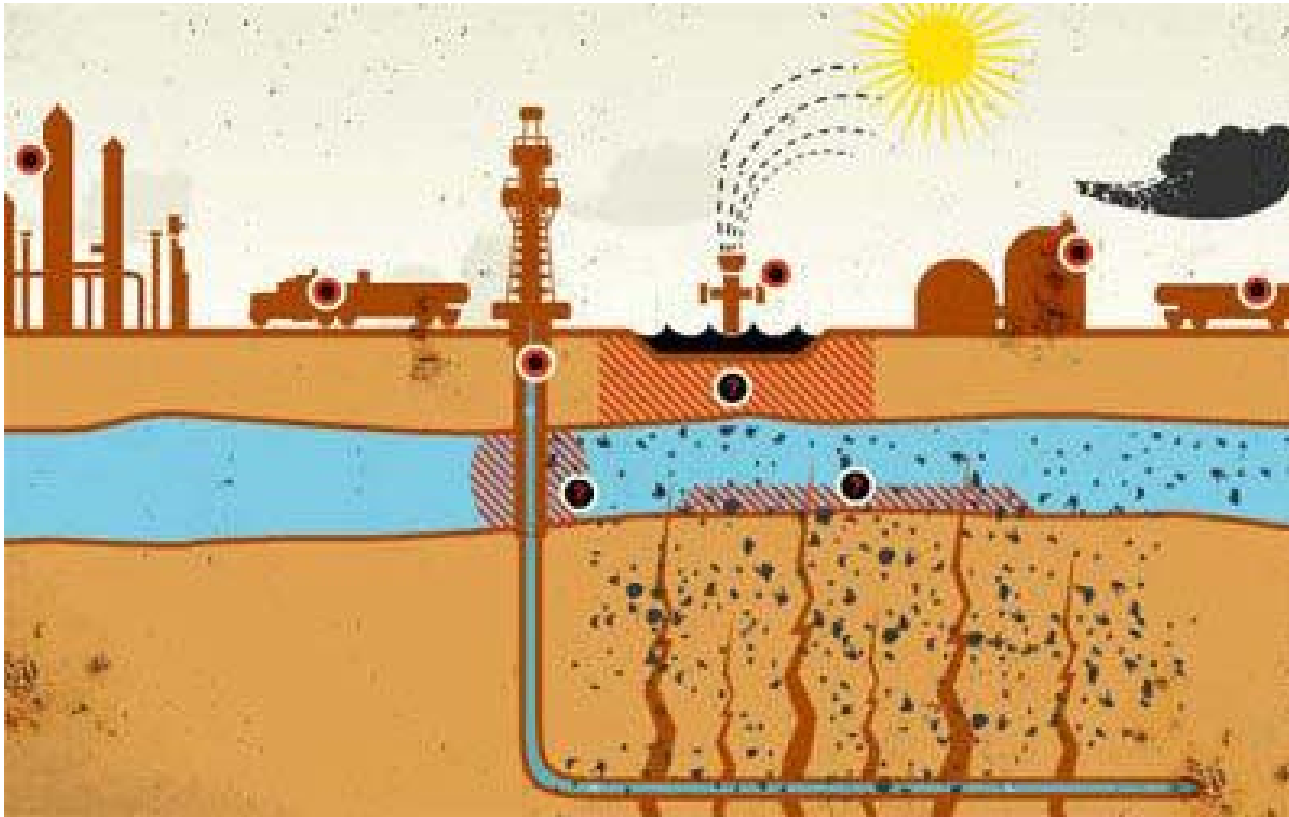


It is not easy to remove the toxic chemicals during wastewater treatment!!

For illustrative purposes only.

Ground Water Pollution Issues

Since the wells are horizontal and multilateral, there is high possibility of ground water contamination



Fracking toxic waste. This diagram depicts methane gas and toxic water contaminating the drinking water as the fracturing cracks penetrate the water table.

Most likely candidates as sources of possible water contamination

Contamination propagate through the fractures by advection

Improper well design, inadequate surface casing and substandard or improper cementing,

Improper handling of surface chemicals, improper design/performance of holding ponds, and improper storage and disposal of wastes and produced water.

More stringent design standards are being adopted, and more active regulatory oversight will reduce the incidence of such problems.

In many cases the fracturing water requirement may have to be met by extracting ground water. This will have long-term devastating impact on water table.

Impact on Air Quality

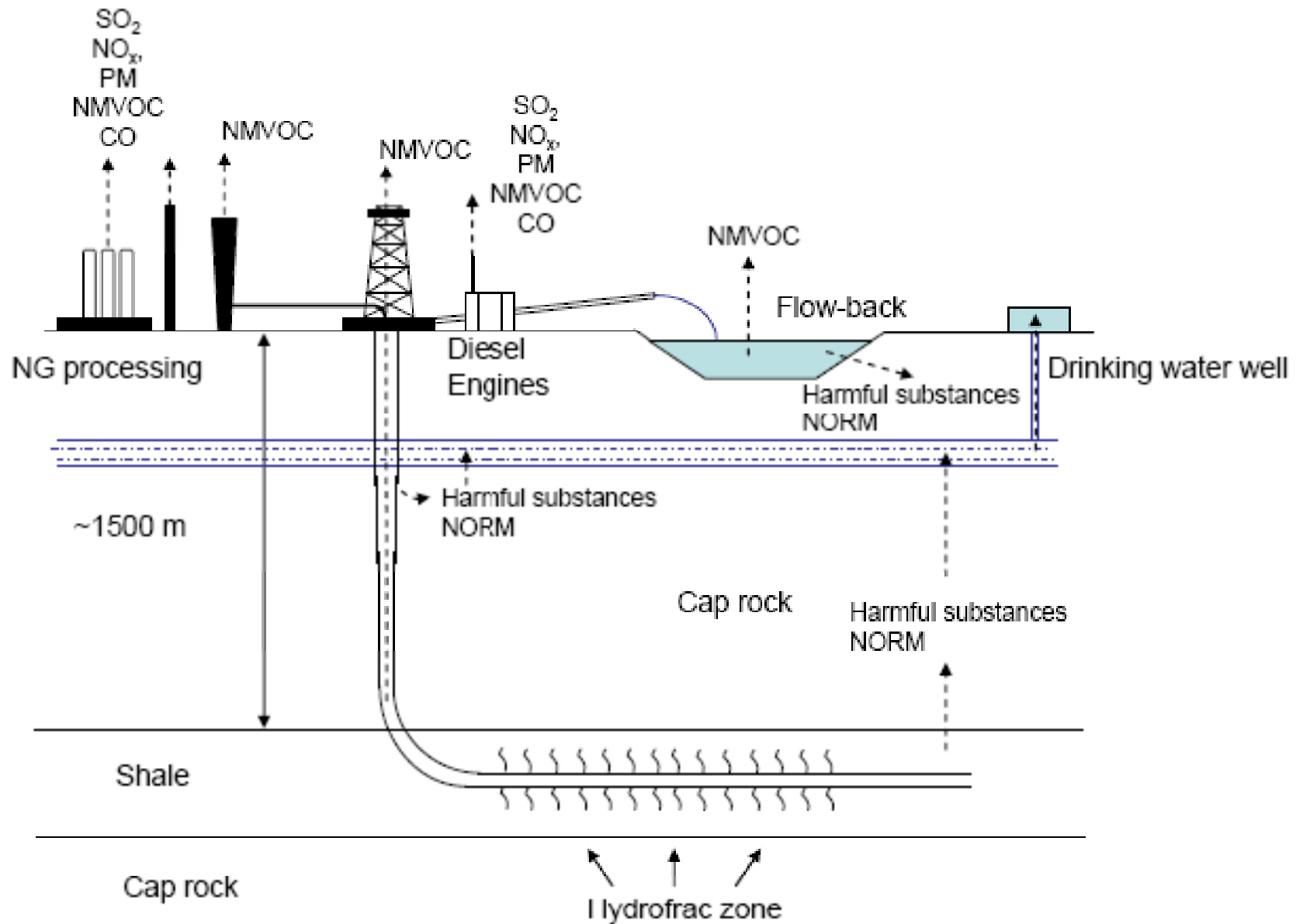
- ❖ Increased NO_x, H₂S, Particulates,
- ❖ Emissions from engines of drilling rigs
- ❖ Emission from diesel-powered pumps
- ❖ Venting or flaring of natural gas
- ❖ Heavy vehicular traffic with engine exhaust
- ❖ Dust from unpaved roads
- ❖ Fugitives emission from pipelines

Green House Gas Emission: Large quantity of METHANE may be released during “flowback phase” of fracturing when the fracturing liquid returns back to the surface.

A joint study by NOAA and University of Colorado reveals that 4% of the methane produced at a field near Denver is leaking to the atmosphere.

(*Nature News*, vol 493, jan 3, 2013)

Emission of Air Pollutants AND OTHER HARMFUL SUBSTANCES



Other Major Concerns

Health Effects:

Field studies in several shale blocks in the US revealed causes of concern.

In aquifers overlying the Marcellus and Utica formations of Northeastern Pennsylvania and upstate New York methane contamination of drinking water has been established.

It is established that residents living within ½ mile from wells are at greater health risk. Subchronic exposure to air pollutants (trimethylbenzene, xylenes, and other pollutants) during well completion activities poses greatest potential for health effects.

Induced Seismicity: Stress applied to rocks by hydraulic fracturing interacts with pre-existing stress fields underground - **Result: Microseismicity**

Radioactivity: The returning fracturing fluid may have radioactive substances in it originating from rocks.

Fracking, shale gas and health effects: Research roundup

A few recent articles expressing concerns and giving data on environmental Impact of Shale Gas exploration and production (published in the last two years)

[“Methane Contamination of Drinking Water Accompanying Gas-Well Drilling and Hydraulic Fracturing”](#) Osborn, S G.; Vengosh, A; Warner, N R.; Jackson, R B. *Proceedings of the National Academy of Sciences*, May 2011

[“Blind Rush? Shale Gas Boom Proceeds Amid Human Health Questions”](#) Schmidt, C W. *Env Health Perspectives*, August 2011; 119(8): a348-a353..

[“Human Health Risk Assessment of Air Emissions from Development of Unconventional Natural Gas Resources”](#), McKenzie, L M.; Witter, R Z.; Newman, L S.; Adgate, J L.; *Science of the Total Environment*, May 2012, Vol. 424, 79-87.

[“Natural Gas Operations from a Public Health Perspective”](#), Colborn, T; Kwiatkowski, C; *Human and Ecological Risk Assessment*, Sept 2011, 1039-1056

[“Geochemical Evidence for Possible Natural Migration of Marcellus Formation Brine to Shallow Aquifers In Pennsylvania”](#), Warner, Nathaniel R.; et al. *Proceedings of the National Academy of Sciences*, May 2012

[“Potential Contaminant Pathways from Hydraulically Fractured Shale to Aquifers”](#), Myers, T. *Ground Water*, 2012. doi: 10.1111/j.1745-6584.2012

Shale Gas - Despite the proven potential, skepticism exists

The Effect of Shale Gas Revolution on Oil Industry – Choi Dooho,
Institute of Energy and Environment Journal, Jan 2013, pp 1-10

Plenty of Shale, Plenty of Problems

Worldwatch Institute, Vision for a Sustainable World, 13 April 2013

Shale gas cannot be environmentally responsible,

Conservation Council New Brunswick March 12, 2013

Sustainable shale gas: real possibility or illusion?

03-04-2013 | Insight | Sylvia van Waveren, Thomas Guennegues

Shale gas in the EU - to regulate or not to regulate?

United Kingdom | Energy and Natural Resources, EVERSHEDES, 15-05-2012

European Scenario: Lots of reservation about the practical exploitation of Shale Gas exist. France stopped exploration at several places because of public protest.

Greenpeace Document, April 24, 2012 – It expresses grave concern about all the non-conventional methane sources in Europe (Shale Gas, Shale Oil, CBM) for potential of pollution and health effects and safety.

Incidentally, WBPCB received many complaints against fields producing coal-bed methane.



Europe's resistance to shale gas could boost renewables
Euro Active Published 24 August 2012

The concerns need to be evaluated and properly addressed and suitable regulatory framework should be developed.

CONCLUSIONS

- **Shale Gas is not an unmixed blessing. It needs enough care to exploit the potential.**
- **Besides environmental concerns, there are lots of social concerns, especially in a country like ours. Shale gas wells require huge land areas that may give rise to big local issues.**
- **India does not come among the top countries in respect of Shale Gas reserve. We have to proceed with care.**
- **Standards should be prescribed for all major activities related to exploration and production**

Thank You!!