"GAIL's experience on Shale Gas activities in US"

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Outline

- About GAIL
- GAIL's Presence in USA
- Story of Shale Gas Revolution
- Cause & Effect
- Impact on Economy, Environment & Employment
- Key Success Factors
- Challenges
- Conclusion

About GAIL

India's Youngest Maharatna

Pipelines

- **NG Transport Capacity 204 MMSCMD (~10600 Kms.)**
- **LPG Transport Capacity 3.8 MMTPA (~2050 Kms.)**

Gas Sourcing & Trading

- **Gas Marketing - 82 MMSCMD**
- **Imported 16 cargoes (3.6 MMSCMD) in 2011-12**
- **Signed mid / long term contracts**

Petrochemicals

- **Significant Player (~ 20%)**
- **Capacity 410 KTA**
- **2nd plant at Pata – Total capacity 900 KTA**
- **70% stake in BCPL (280 KTA)**
- **15.5% stake in OPaL**

LPG & Liquid Hydrocarbon

- Sizeable contribution
- 7 LPG Plants across India (1.4 MMTPA)

GAIL's Presence in US

- GAIL formed its wholly owned subsidiary GAIL Global USA Inc (GGUI) and opened up an office in Houston.
- GGUI acquired 20% stake in the Oil/condensate rich Eagle Ford Shale play in Sept, 2011 from Carrizo (Eagle Ford) LLC
- Carrizo is the Operator of JV. Four E&P executives on secondment to Carrizo to augment Company's knowhow on shale gas technology
- Net acreage 4,671 acres, 39 wells under production, Average production 1344 Boe/day

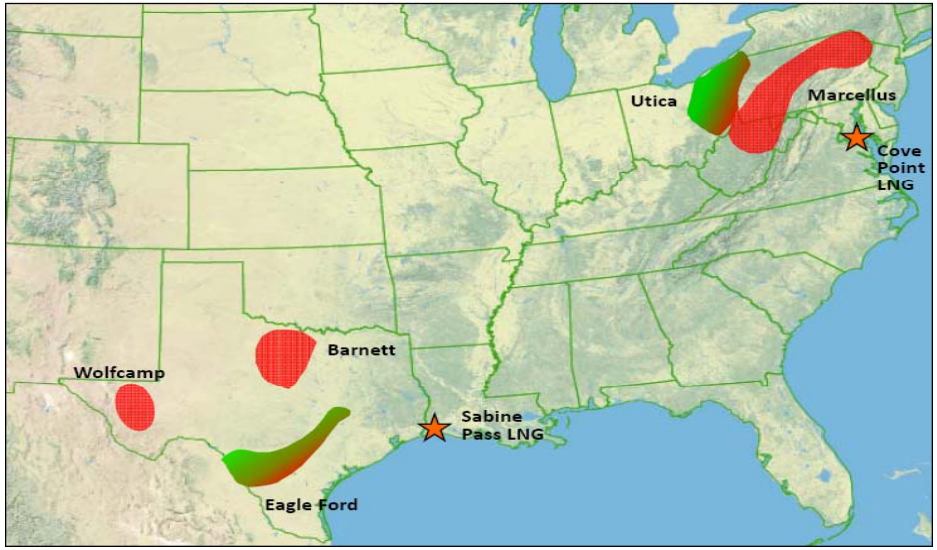
GAIL's Purpose of entering into US Shale gas

- It provides potential gas source. Having access to own source is critical for GAIL.
- Large geographical spread & size of resources
- In US, there are number of established shale gas players looking for infusion of capital to develop the acreages
- Tie up with an established player by participation in US shale gas development and joint participation in the future Indian bidding rounds.
- Technical/ Knowledge+ Skill Build up.

Sourcing LNG from US

- LNG Offtake Agreement with Sabine Pass:
  - Offtake Agreement signed in 2011.
  - Start date expected 2018-19
  - LNG Quantity: 3.5 mtpa

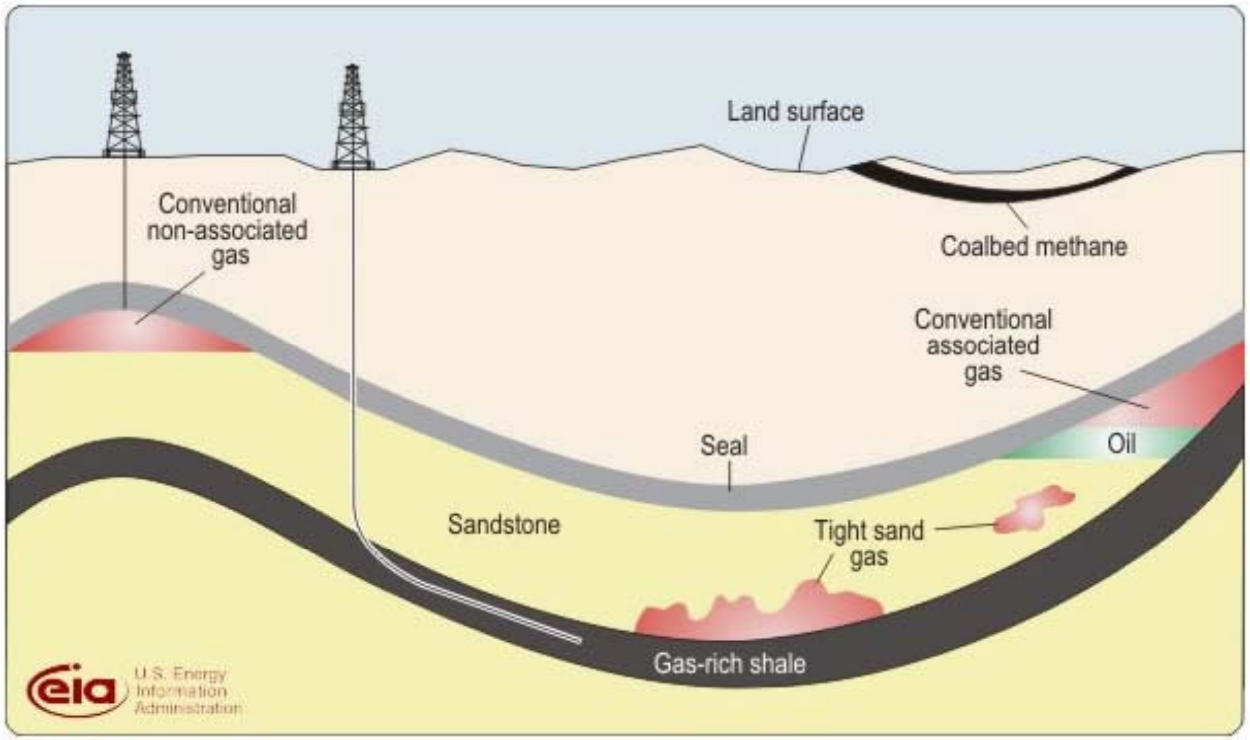
- Capacity Booking in Dominion Cove Point LNG Terminal :
  - Tolling Service Agreement signed in 2013
  - Start Date expected in 2017-18
  - Quantity: 2.3 mtpa



Main Character of the Story ..

Introducing Shale Gas

- Shale Gas- Natural gas contained in unconventional fine grained sedimentary rocks which is dominated by Shale containing clays (< 20-30%) & other minerals – quartz, calcite.
- Continuous extensive formation.
- Shale has low porosity & very low permeability and thus low natural productivity
- Requires advanced technologies like horizontal drilling and multi-stage hydrofracking for commercial production.



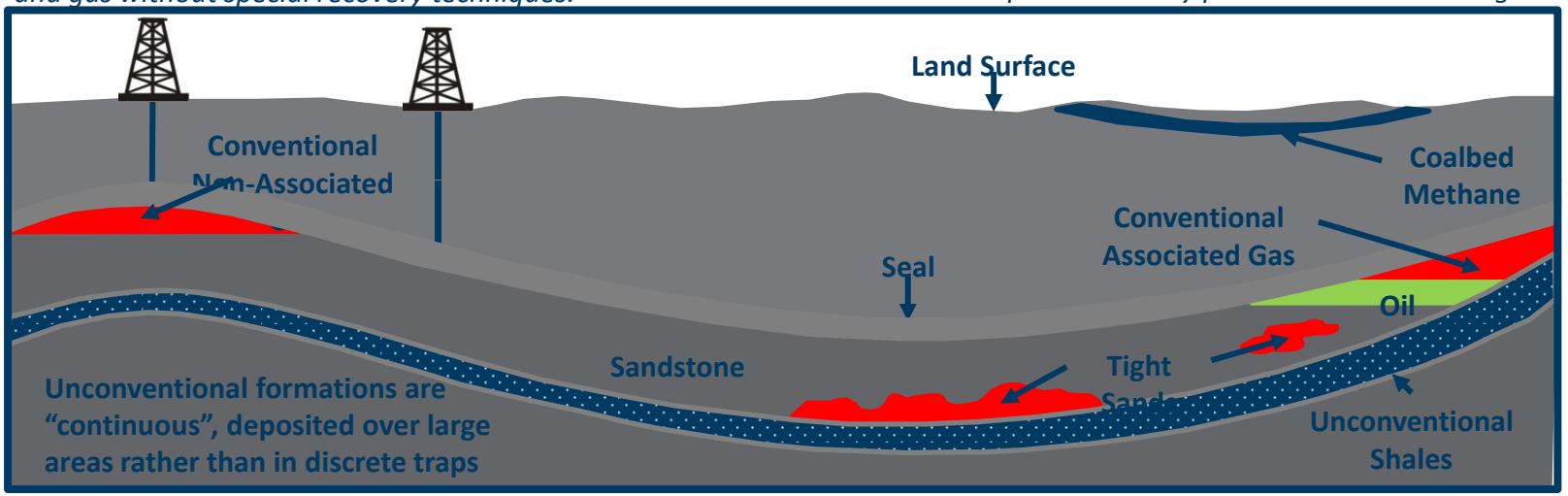
How Shale Gas Play is different from conventional play?

CONVENTIONAL RESERVOIRS

"These are reservoirs that are capable of natural flow and will produce economic volumes of oil and gas without special recovery techniques."

UNCONVENTIONAL RESERVOIRS

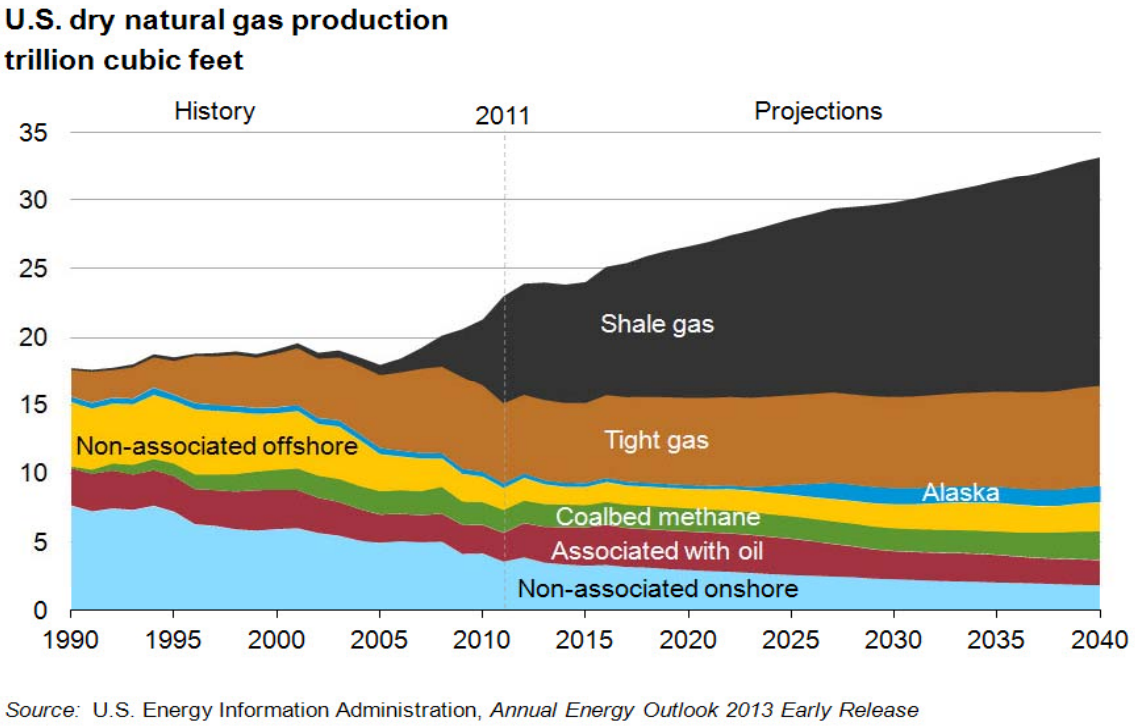
"These are reservoirs that cannot be produced at economic flow rates or that do not produce economic volumes of oil and gas without assistance from stimulation treatments or special recovery processes and technologies."



Oil/Gas storage in porous & permeable reservoirs having structural/stratigrahic traps	Gas storage within natural fractures, matrix porosity or adsorbed on kerogene
Higher reservoir porosity & permeability, larger drainage radius	Very low porosity & ultralow permeability in micro to nano darcy, low drainage radius, requires hydrofracing for flow
Vertical wells, lesser number of wells	Large no of wells, extensive use of horizontal drilling & multistage hydofrac
Single well from one location	Multiple horizontal wells from single pad

The Shale revolution ..

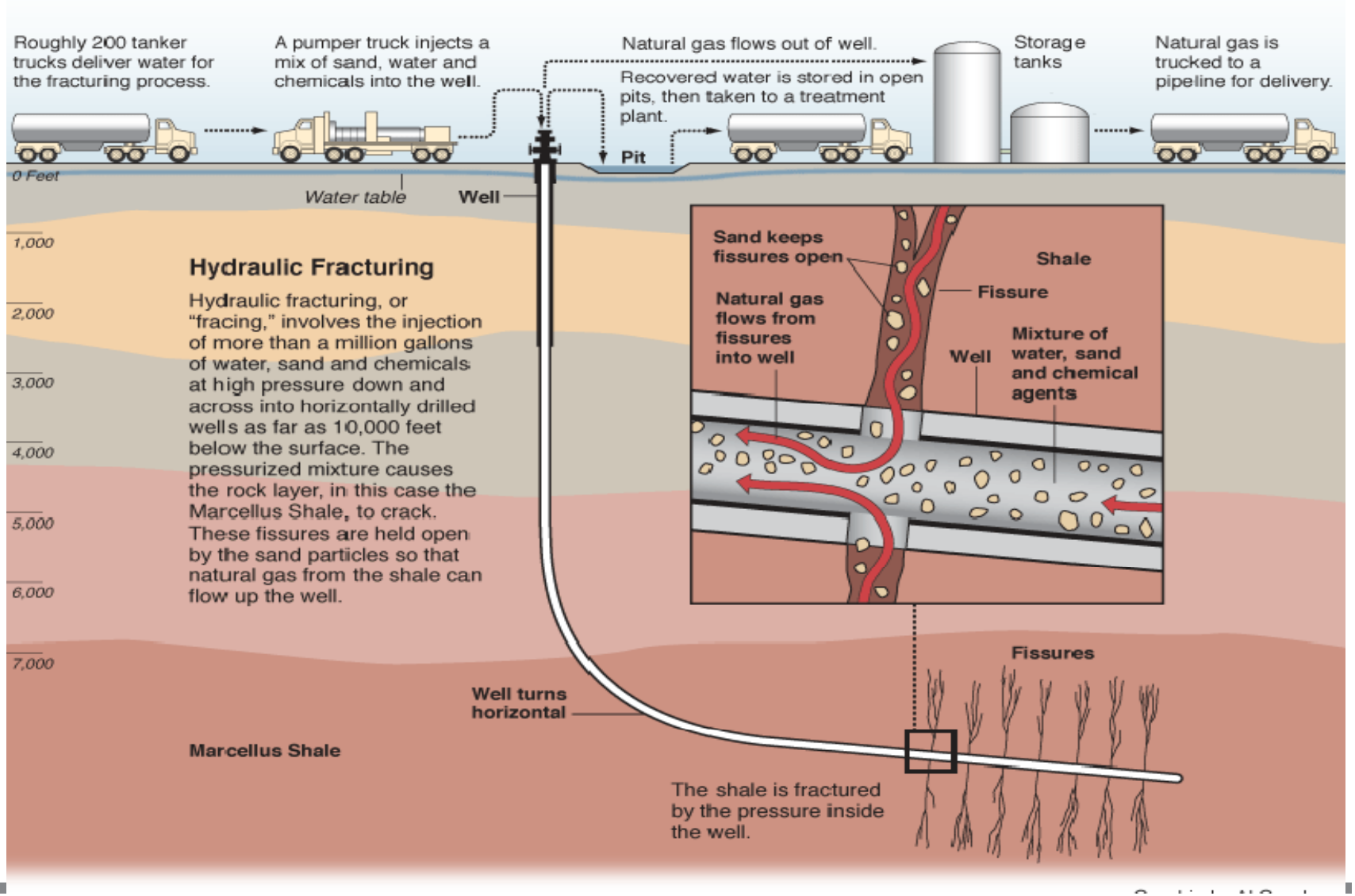
US Shale gas production



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2013 Early Release*

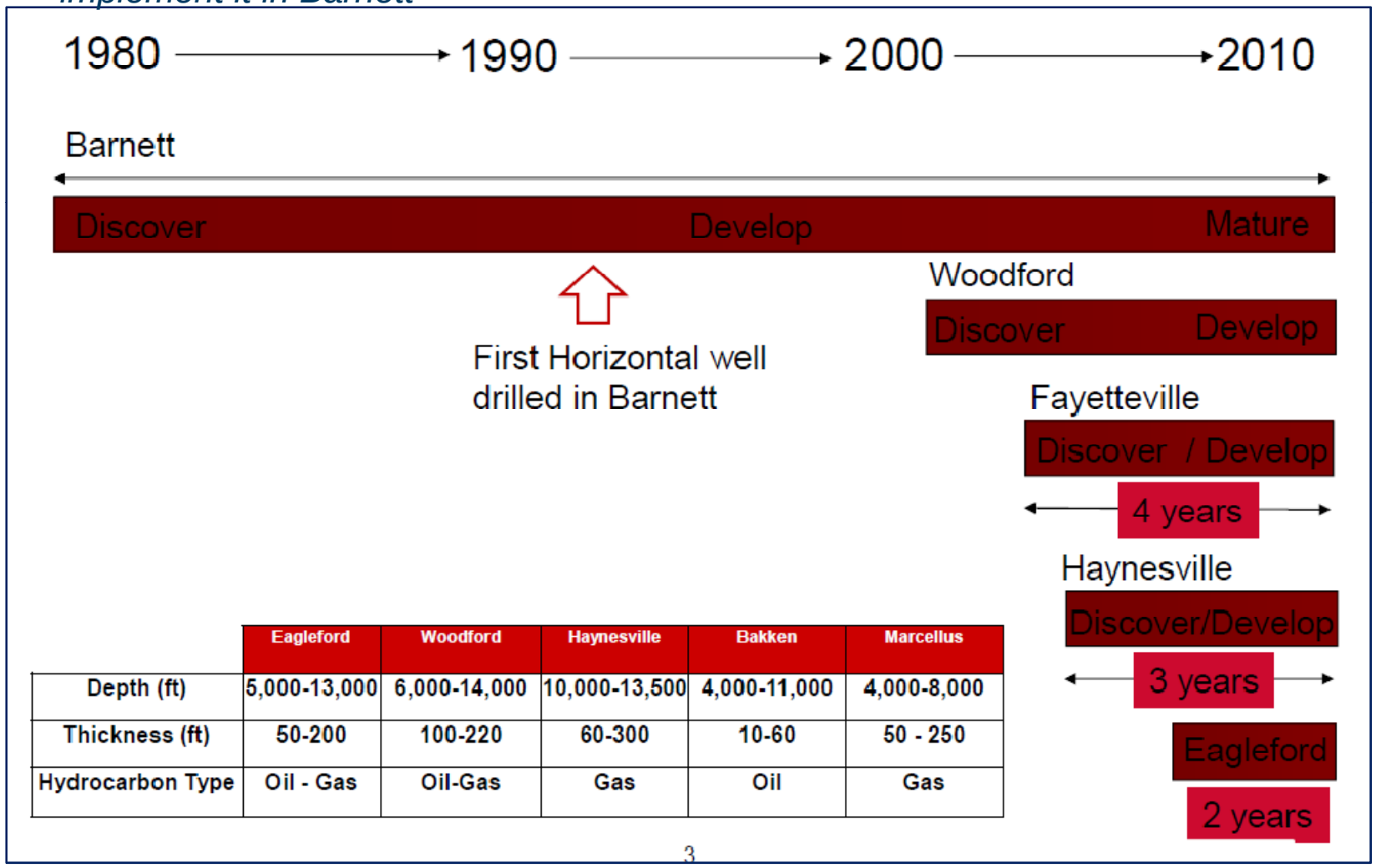
- US gas production from shale increased from 5% in 2000 to ~23% in 2010
- EIA expects that 50% of gas production will come from shale by 2035

Shale Gas Driver - Hydrofracking Technology



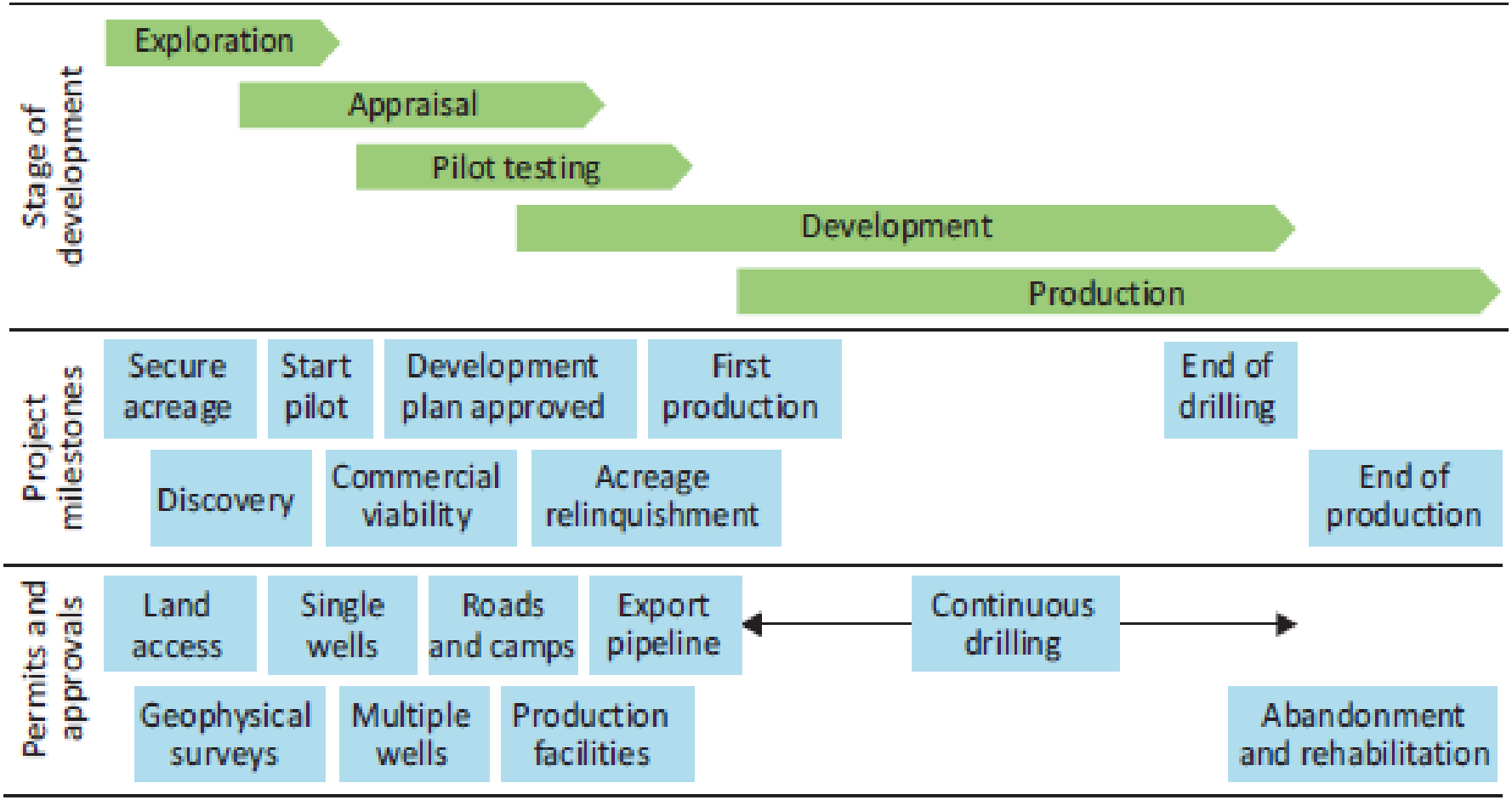
History of Shale Gas Development in US

George Mitchell- Father of shale gas hydrofracking.
It took 18 years from 1981 to develop and successfully implement it in Barnett



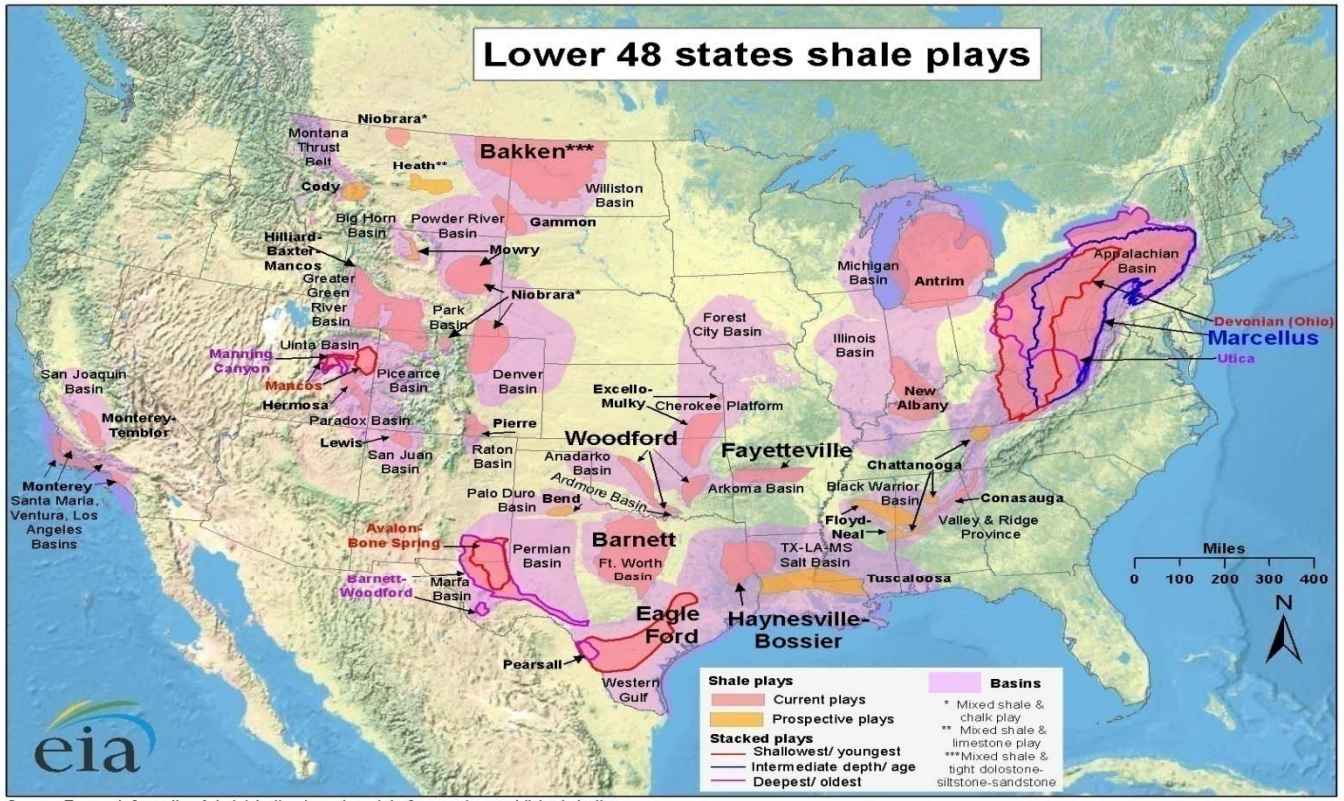
	Eagleford	Woodford	Haynesville	Bakken	Marcellus
Depth (ft)	5,000-13,000	6,000-14,000	10,000-13,500	4,000-11,000	4,000-8,000
Thickness (ft)	50-200	100-220	60-300	10-60	50 - 250
Hydrocarbon Type	Oil - Gas	Oil-Gas	Gas	Oil	Gas

Stages in Shale Gas Development



Note: The stages, milestones and permits shown here are not unique to unconventional developments, but the distinctive element is the overlap between stages of development, as opposed to a more sequential pattern for a typical conventional project.

Shale Gas Play in US

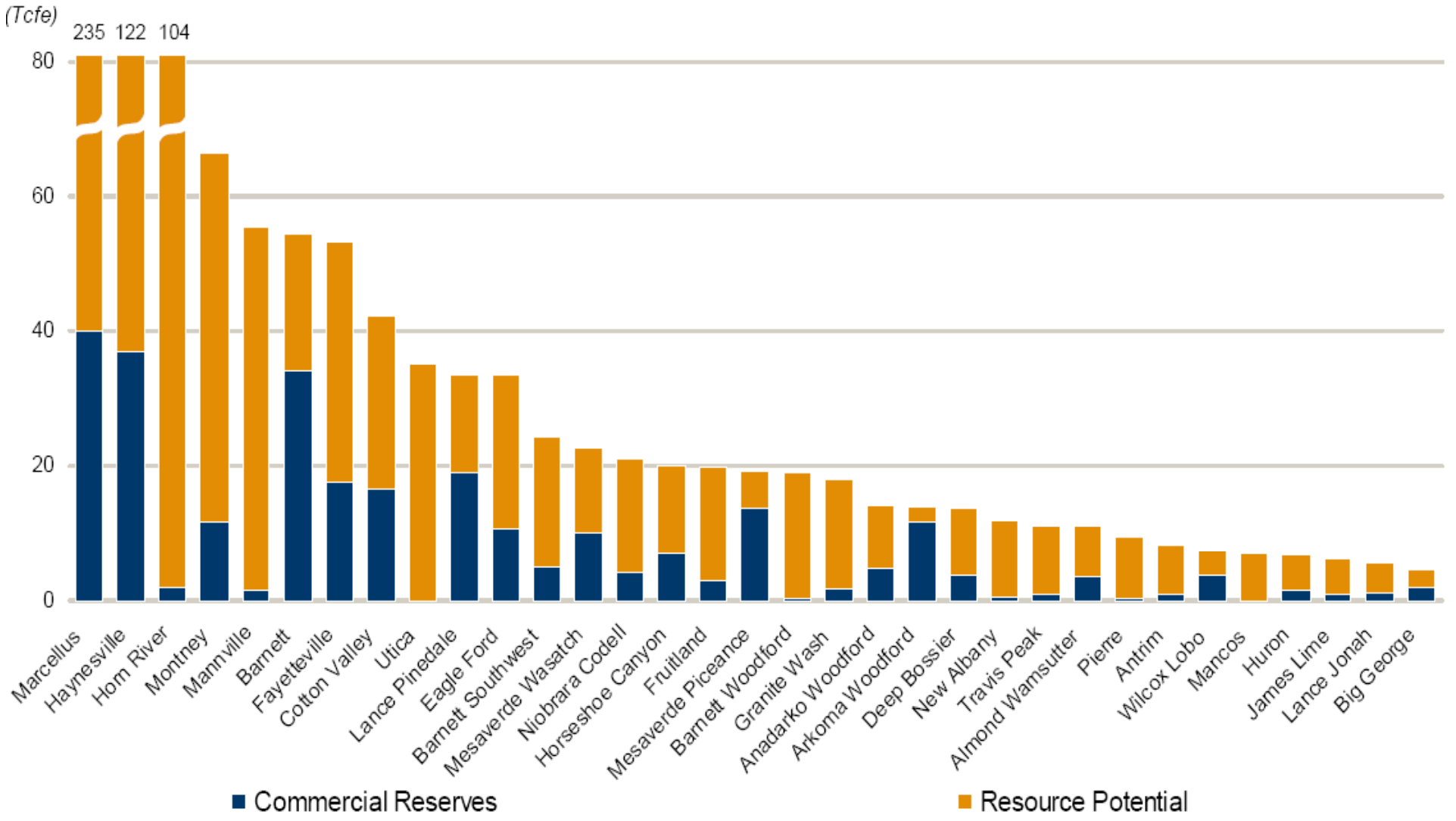


Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

	Basin area (km^2)	Depth (metres)	Thickness (metres)	Gas in place (bcm/km^2)	Gas in place (Tcm)
Barnett	13,000	2,000–2,800	50–200	0.5–3.0	7–39
Fayetteville	23,000	300–2,100	15–100	0.5–3.0	12–69
Haynesville	23,000	3,200–4,100	60–90	1.6–2.7	37–62
Horn River	39,000	2,000–3,000	150–175	1.4–2.5	55–98
Marcellus	250,000	1,000–2,600	15–75	0.2–1.1	50–275
Montney	11,000	900–3,000	150–300	1.0–3.2	11–35
Woodford	28,000	1,800–3,300	15–70	0.4–1.3	11–36

North American Unconventional Gas Reserves Overview

Shale Play Reserves / Resources



Other Factors that aided the change..

Unique facilitators

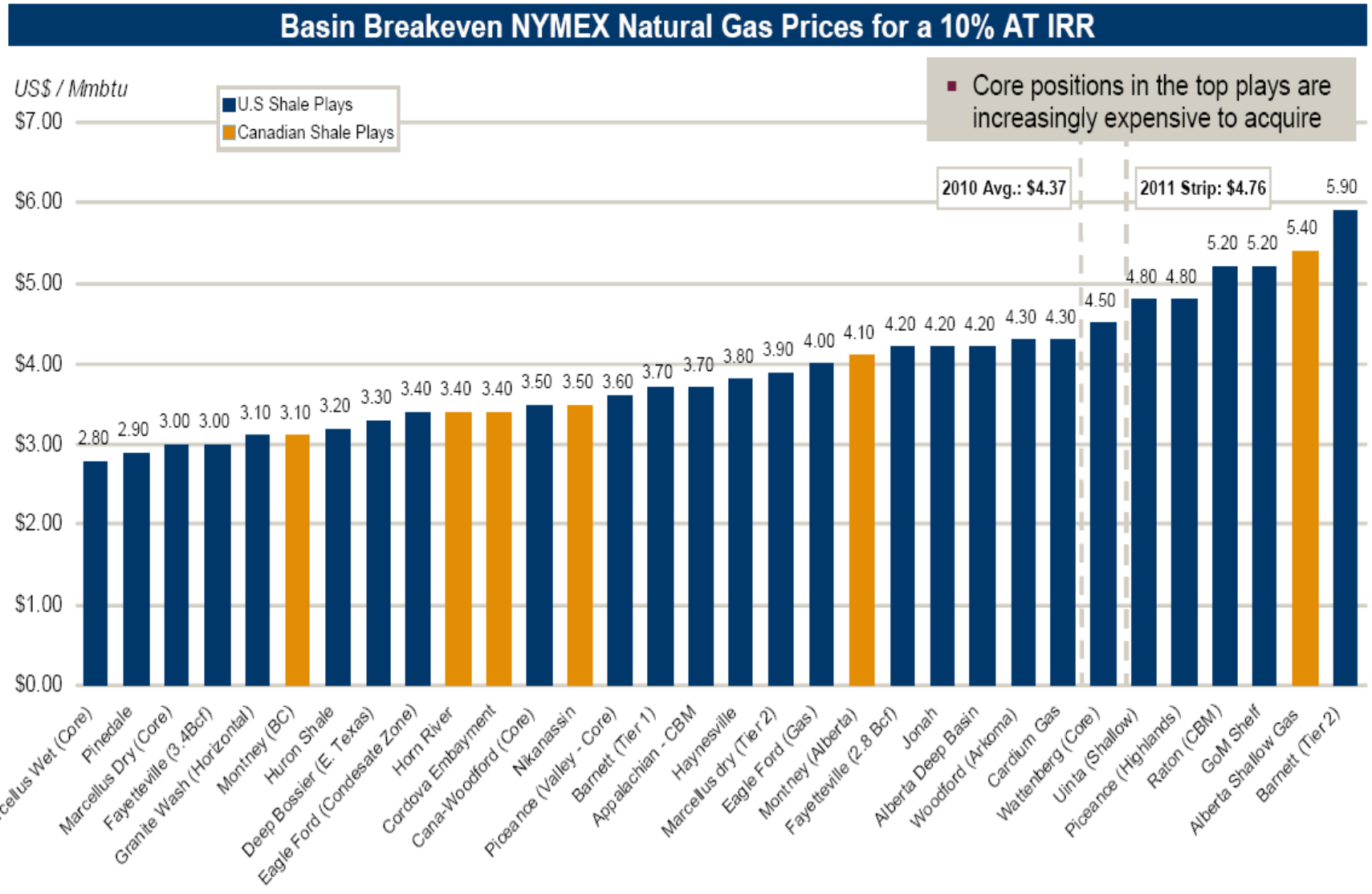
- **Natural Gas Policy Act (NGPA) of 1978** – well-head sale prices of natural gas took first steps towards deregulation
- **Natural Gas Well-head Decontrol Act of 1989** – fully deregulated gas prices
- **Section 29 of the Crude Oil Windfall Tax Act of 1980** provided with about $0.50/MMBtu tax credits to reduce the burden of initial infrastructure
- **Mineral rights in USA** – land owners having rights to sub-surface minerals; producing companies can directly negotiate with the owners rather than a Govt, greatly reducing barriers & time to receive access to mineral rights
- **Favorable North American Geology –** 24.4 Tcm of estimated technically recoverable shale gas in USA
- **Significant build-out of natural gas infrastructure** - allowing gas to flow and helping to create liquid regional markets for physical gas trading

Effects ..

On Producers

- Gas price was soaring as high as $13/MMBtu in 2008
- With higher domestic reserves and surge in production, natural gas prices hit new 20 year low, $1.88/MMBtu in 2012 late winter on the Henry Hub
- Weaker producers blamed poor market conditions and lack of profitability and many went bankrupt
- Many Gas heavy E&P players had negative cash flows
- Most players shifted towards oil and liquid-rich drilling
- Gas directed rig count hit 18 year low
- Shale acreage M&A activities increased significantly

Basin Breakeven Price



Effect on LNG Terminals

- 4 years ago industry was applying permits to put up LNG import terminals because of scarcity of domestic gas
- In the current surplus situation, LNG importing terminals are being converted to export terminals
- Around 30 Bcf/d export application has been filed with DoE for export to FTA / non-FTA countries
- EIA study conducted to assess how much LNG will the US really allow to be exported
- DoE study cites economic benefits of US LNG exports

Environmental concerns

- Large-scale use of water in hydraulic fracturing
- Hydraulic fluids that contain hazardous chemicals can be released by leaks in faulty construction, etc.
- Wastewater contains dissolved chemicals and other contaminants that need treatment before disposal or re-use
- French Govt has placed a moratorium on fracking

Impact on Economy & Employment

- Nearly $1.9 trillion in shale gas capital investments are expected between 2010 and 2035.
- The shale gas contribution to US GDP was more than $76 billion in 2010. This will increase to $118 billion by 2015 and will triple to $231 billion in 2035.
- In 2010 shale gas production contributed $18.6 billion in federal, state and local government tax and federal royalty revenues. By 2035, these receipts will more than triple to just over $57 billion.
- In 2010, the shale gas industry supported 600,000 jobs; this will grow to nearly 870,000 in 2015 and to over 1.6 million by 2035.

Source: IHS Global Insight

Industry impact

- The lower natural gas prices achieved with shale gas production will result in an average reduction of 10% in electricity costs across US
- By 2017, lower prices will result in an initial impact of 2.9% higher industrial production. By 2035, industrial production will be 4.7% higher.
- Chemicals production in particular stands to benefit from an extended period of low natural gas prices, as it uses natural gas as a fuel source and feedstock. Chemicals producers have already signaled their intentions to increase US capacity.
- Savings from lower gas prices will add an annual average of $926 per year in disposable household income between 2012 and 2015. In 2035, this would increase to just over $2,000 per household

Source: IHS Global Insight

Key Success Factors ..

Key Success Factors to Shale Gas Development

- **Identification and selection of areas**, Identification of target shale formation to drill horizontal wells, optimum frac interval, potential barrier for frac containment etc. *Understanding of geologic/petro-physical properties of reservoir, enhanced well architecture, improvements in drilling, multi well pads and customized frac treatment, developments in fluid and proppant technologies are key enablers in shale plays development.*

- **Pick the right section** by Petrophysical, geochemical, geomechanical evaluation of target objectives.

- **Accurate well placement** in target reservoir by directional well design and geosteering the well within the target

- **Drilling efficiency improvement-** Pad drilling, optimizing rig move/ILM, rig skid to next pad, logistics and contract management

- **Completion/hydrofracking Optimization**: Fracking design based on Geomechnical properties of rock, determination of perforation, treatment size, proppants, fluid selection, logistics, execution of the job, Batch completion/hydrofracking, micro seismic post frac evaluation and optimizing .

- **Flow back water treatment/disposal**

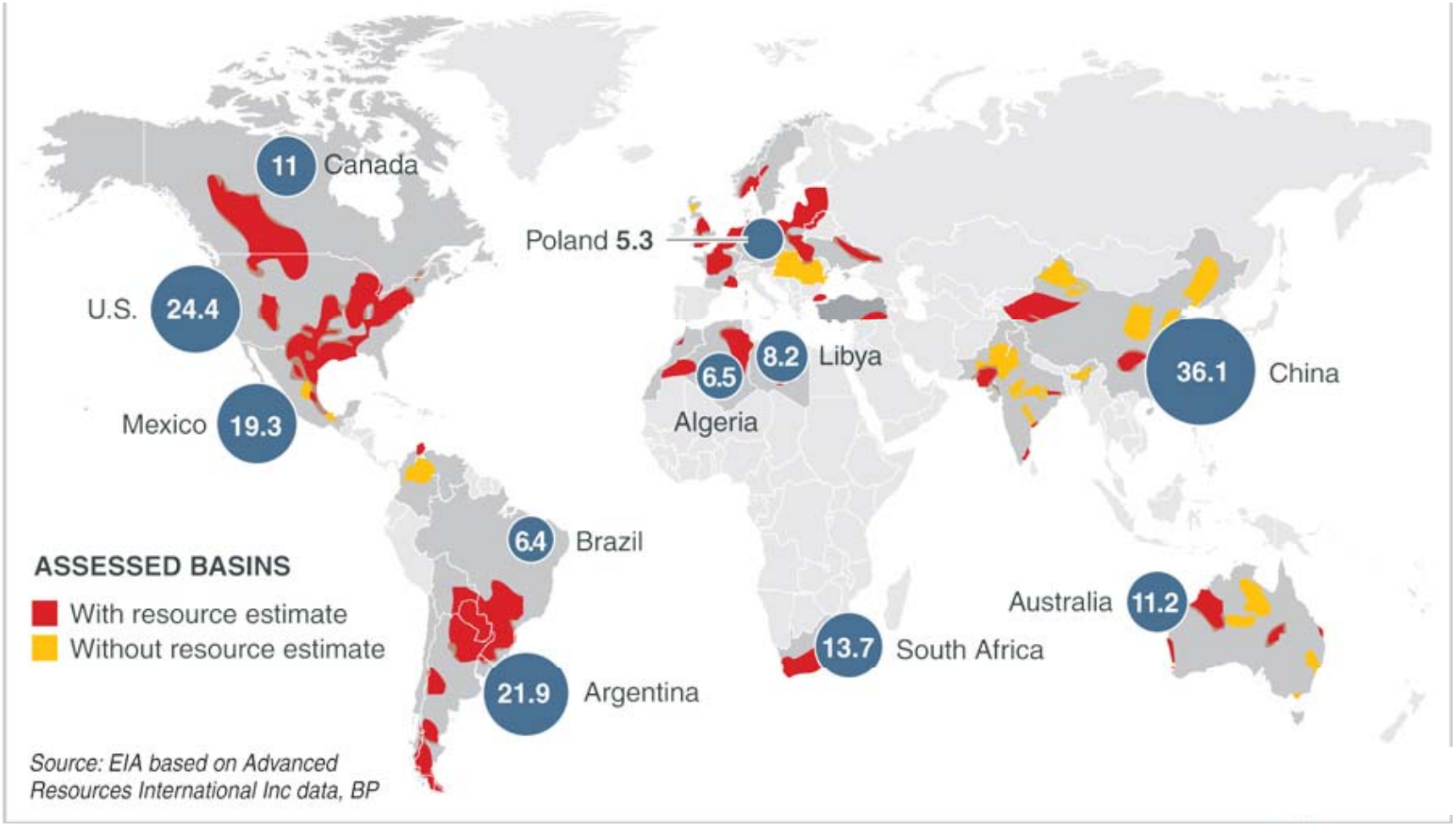
Challenges ..

Challenges of Shale Gas Development

- **Geological Risks**-Confirming the presence, extent and favorable characteristics of shale gas in specific area, location.
- **Technological and viability risks-** Determining whether a specific deposit can be developed on an economically viable basis at the prevailing market price by the application of technology.
- **Regulatory and public acceptance risks-** Whether the regulatory structure is conducing to unconventional gas exploitation and whether related environmental impact is acceptable to local population.
- **Availability of water** among competing demand in the region to meet the large scale hydrofracking
- **Operator and service sector capacity** to support intensive factory approach of shale gas deveoplement
- **Natural gas pricing environment**

Global Shale Gas Resource Potential

- *Uncertainties & challenges of converting resource into economically producible volume exists in other parts of world.*



Conclusion

- US shale gas success is widely recognized as alternative source of hydrocarbon from unconventional reservoir. Global shale gas resources potential estimates are huge and reassuring. Advances in horizontal drilling and hydrofracking technology and its wide successful in shale gas has made exploitation of hydrocarbons from shale gas commercially recoverable which was earlier considered uneconomic .
- Each gas shale basins is different and each has a unique set of operational, logistic, environmental, availability of water, infrastructure and service industry to support development. Because of these differences, the development of shale gas resources in each of these areas faces potentially unique opportunities and challenges.
- There is no unique solution that fits for each shale basin evaluation, drilling, completion and stimulation design and execution. Technology and efficient industry practices in each shale gas play development evolves over a period of time.
- The recovery of shale gas at competitive price to make economic sense is still a long way to go!

THANK YOU