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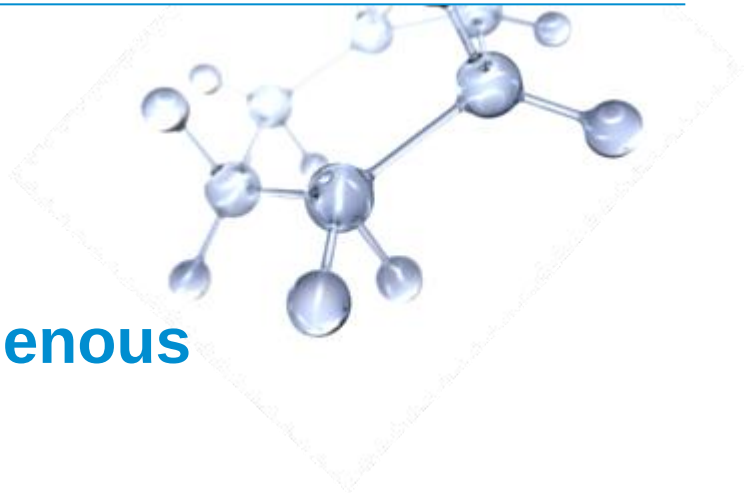


Unconventional Natural Gas:

An Opportunity for a New Indigenous Energy Source for Europe

Tristan Aspray

Exploration Operations Manager, Europe

22 May, 2012

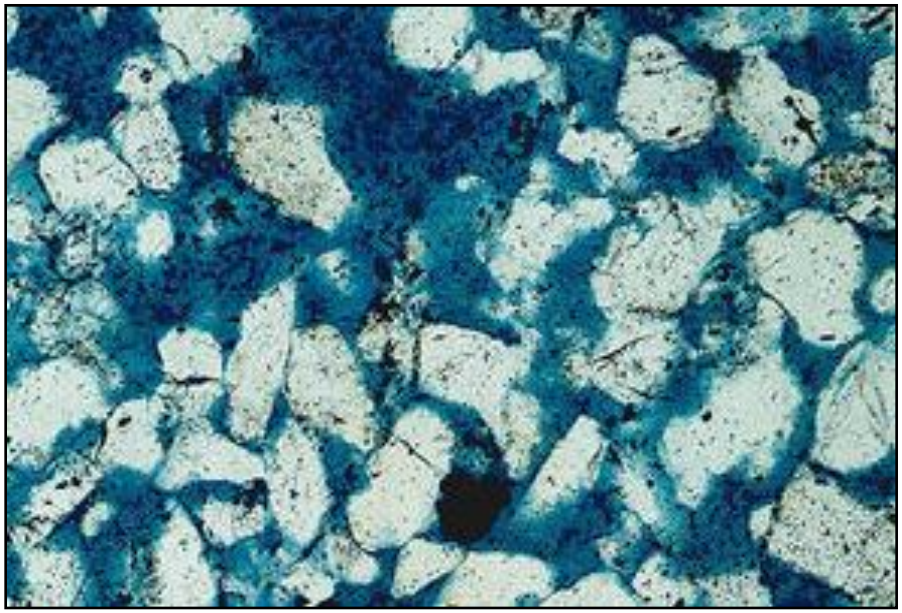
ExxonMobil in Europe

- Present in Europe for 125 years
- 18,400 employees
- Upstream:
  - Largest natural gas producer in Europe
  - Operations in 10 countries
  - Two Liquefied Natural Gas (LNG) import terminals opened in 2009

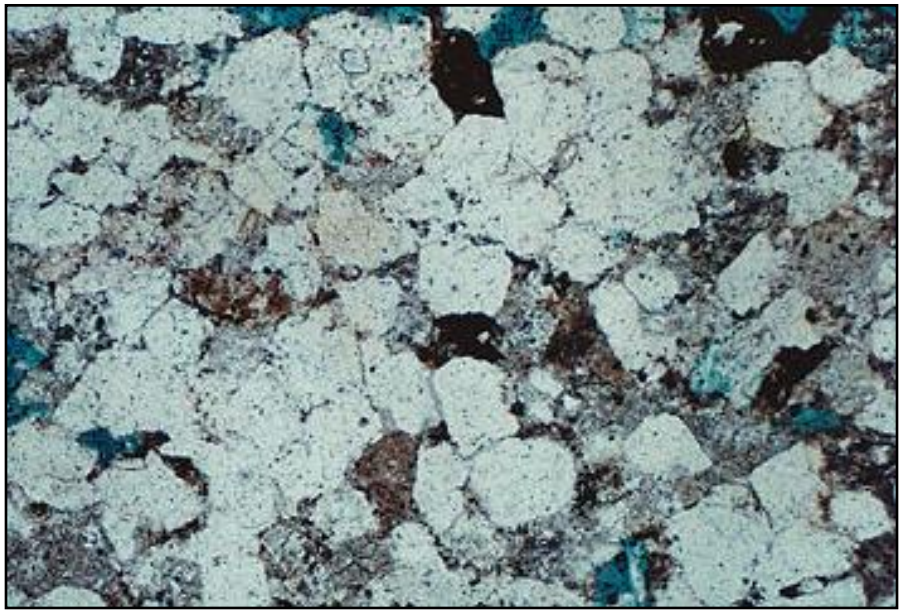
- Downstream:
  - 6,000 service stations
  - 9 major refineries in Europe
  - 125 MW cogeneration plant in Antwerp
- Chemicals:
  - Annual production ~6 million tonnes

Only the Rock is “Unconventional”

Conventional Sandstone gas reservoir



Tight Sandstone gas reservoir



1mm

Conventional gas reservoirs have a lot of pore space…gas can flow more easily to production wells

Tight gas reservoirs still contain a lot of gas, but ability for gas to flow is reduced (lower **permeability**); significant production **today** in Germany and Netherlands

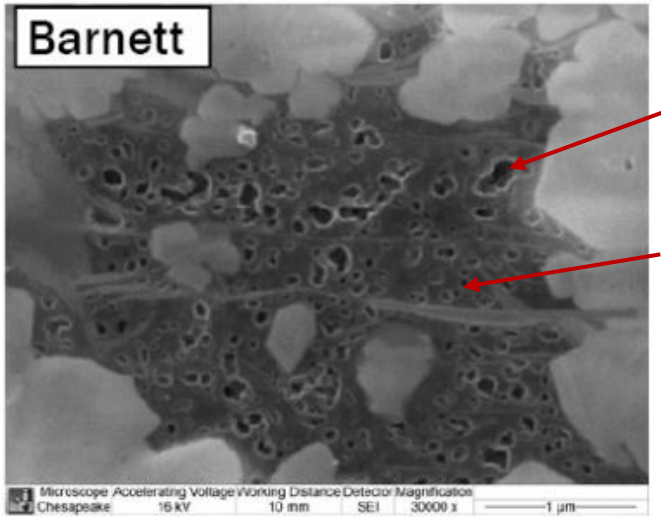
What is Shale Gas?

Typical shale in surface outcrop

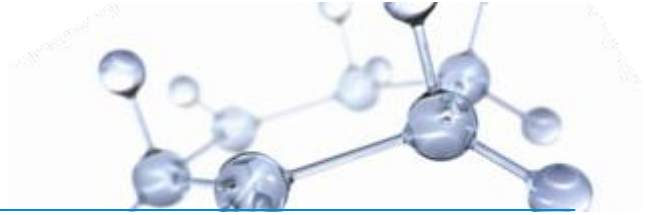
Low permeability requires the use of specific production techniques, to ensure an acceptable level of well productivity

- Muddy sediments rich in organic matter are deposited in seas and lakes
- As these rocks are buried, organic matter is converted to gas, and porosity is generated
- These rock layers are often the **source rocks** for conventional oil and gas fields

Microscope view



Benefits of Natural Gas

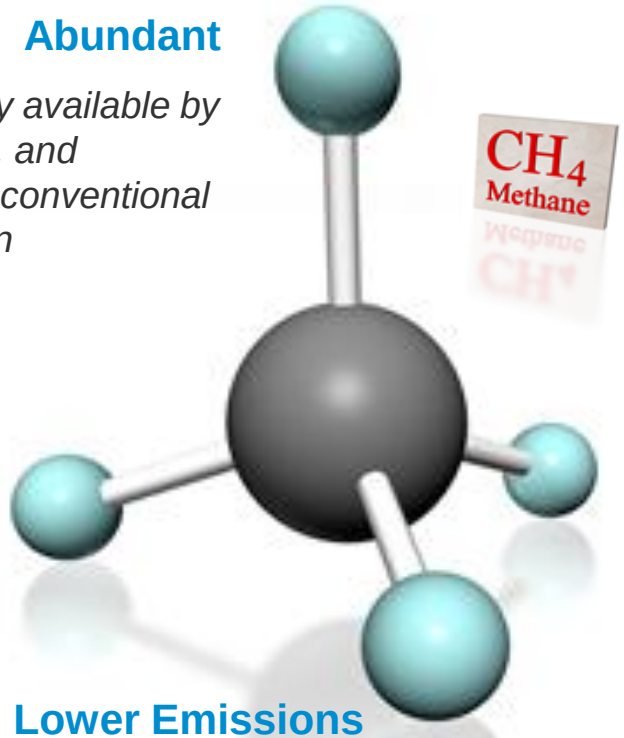


"Gas will be critical for the transformation of the energy system"

- 2050 EU Energy Road Map

Abundant

Diverse supply available by pipeline, LNG, and indigenous unconventional gas production



Cost Competitive

Lower capital costs per MW installed for gas-fired power plants than coal or nuclear

Flexible

Gas-fired power plants act both as flexible baseload and as back-up to renewables

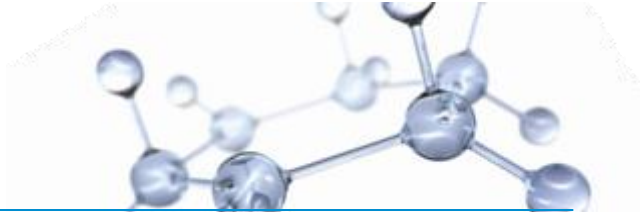
Lower Emissions

Brings immediate reduction in CO_2 emissions through replacing coal in power generation

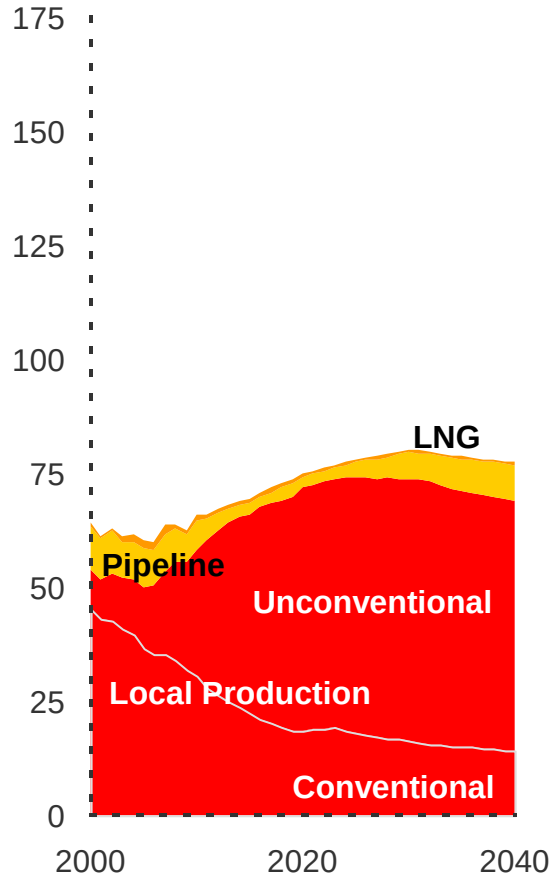
Pillars of EU Energy Policy

- **Supply Security and Diversity**
- **Competitiveness**
- **Decarbonisation**

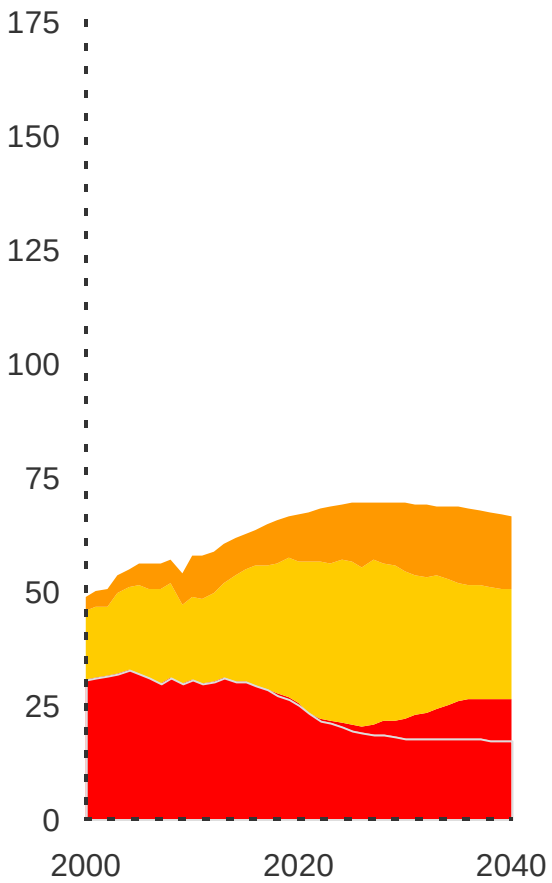
EM View of Gas Market Development



United States
BCFD



Europe
BCFD



Asia Pacific
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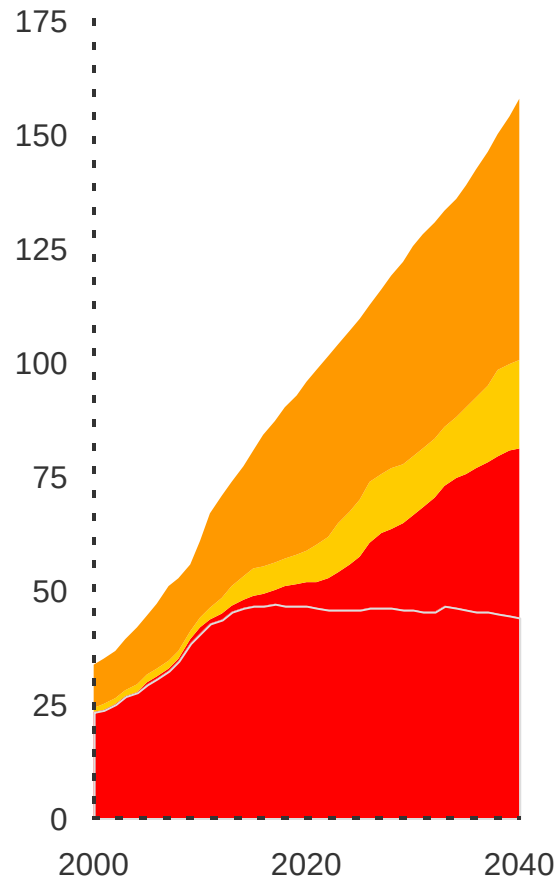
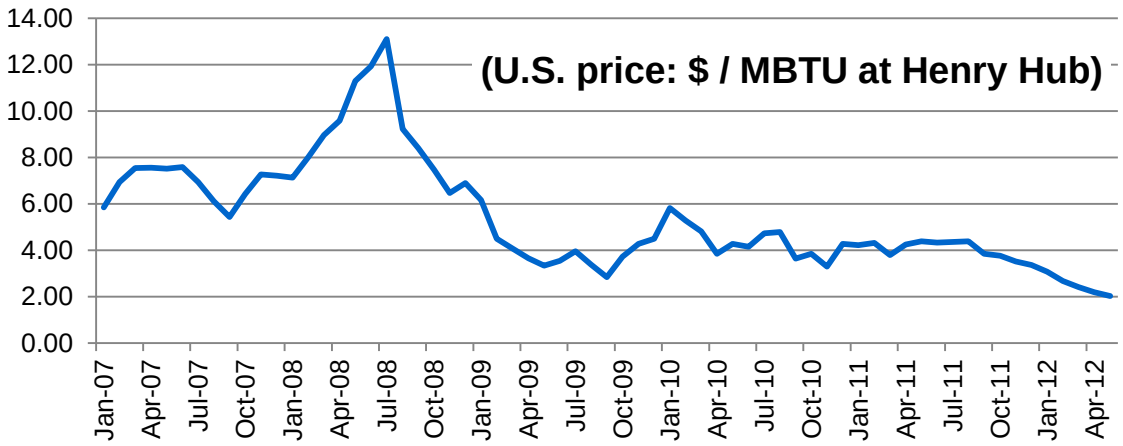


Economic Impacts of Shale Gas

- Reduction in U.S. Natural Gas Price



- Shale development supported **600,000 U.S. jobs** in 2010; 900,000 jobs by 2015[1]
  - Will result in **$1.9 trillion in capital investment** into the economy from 2010 to 2035[1]
  - Will generate nearly **$1 trillion in local, state and federal tax** revenues over the next 25 years
  - Reduced energy prices for residents and small businesses…**$930 more per household per year**[2]
  - **Renaissance in U.S. manufacturing** industry: new plants for steel, chemicals etc.
- **80%** of the value created from indigenous gas production **in Europe** remains in local economy, versus **only 20% if imported**

(1) IHS Global Insight (Dec. 2011), The Economic and Employment Contributions of Shale Gas in the US

(2) The Impact of Shale Gas on the U.S. Economy: CERA; March 2012

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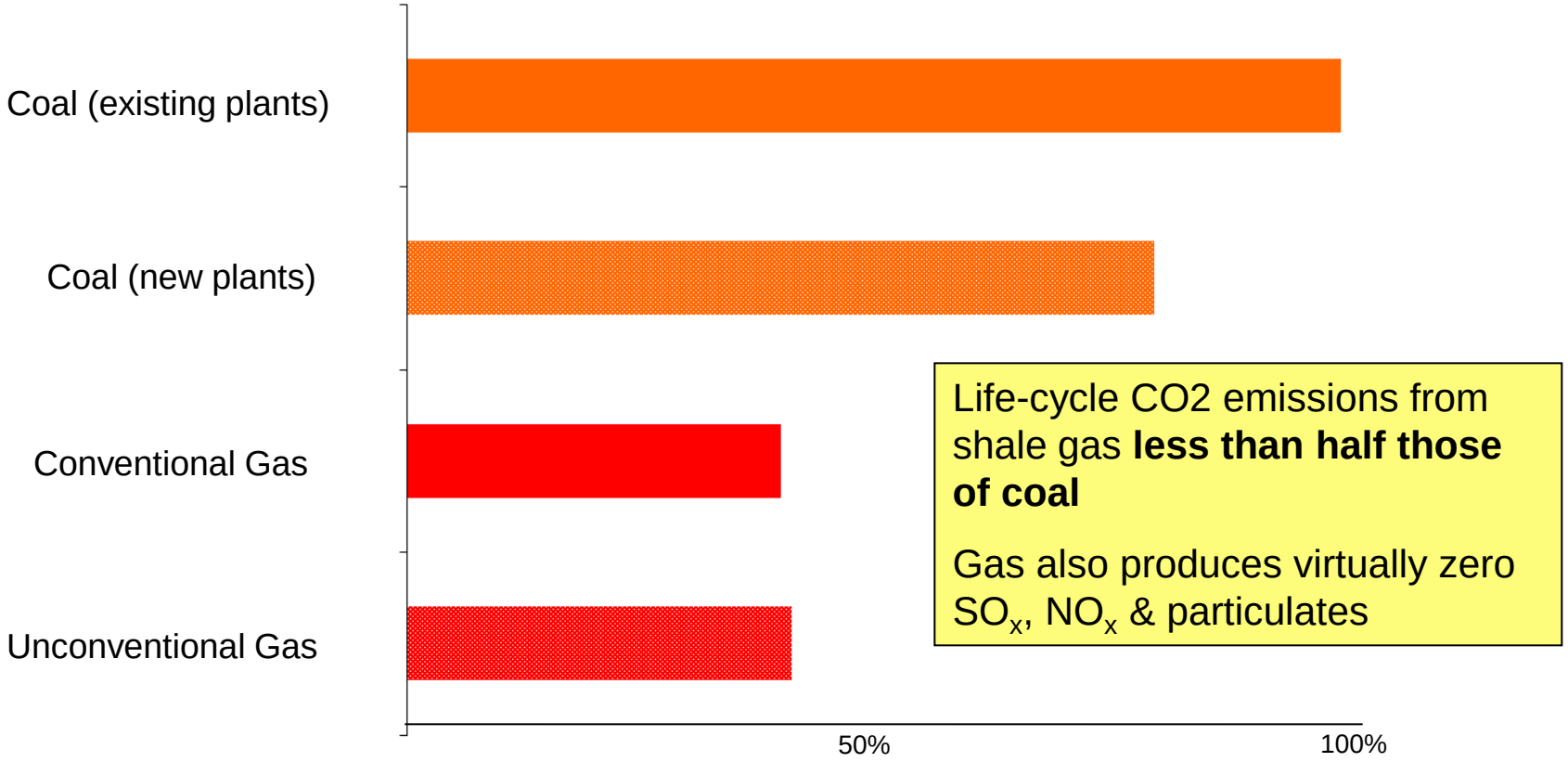
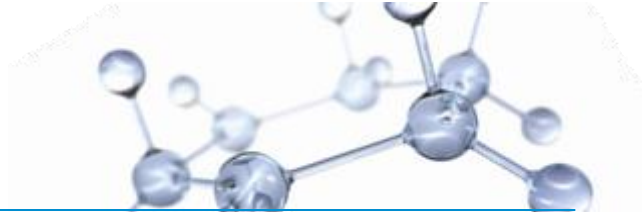
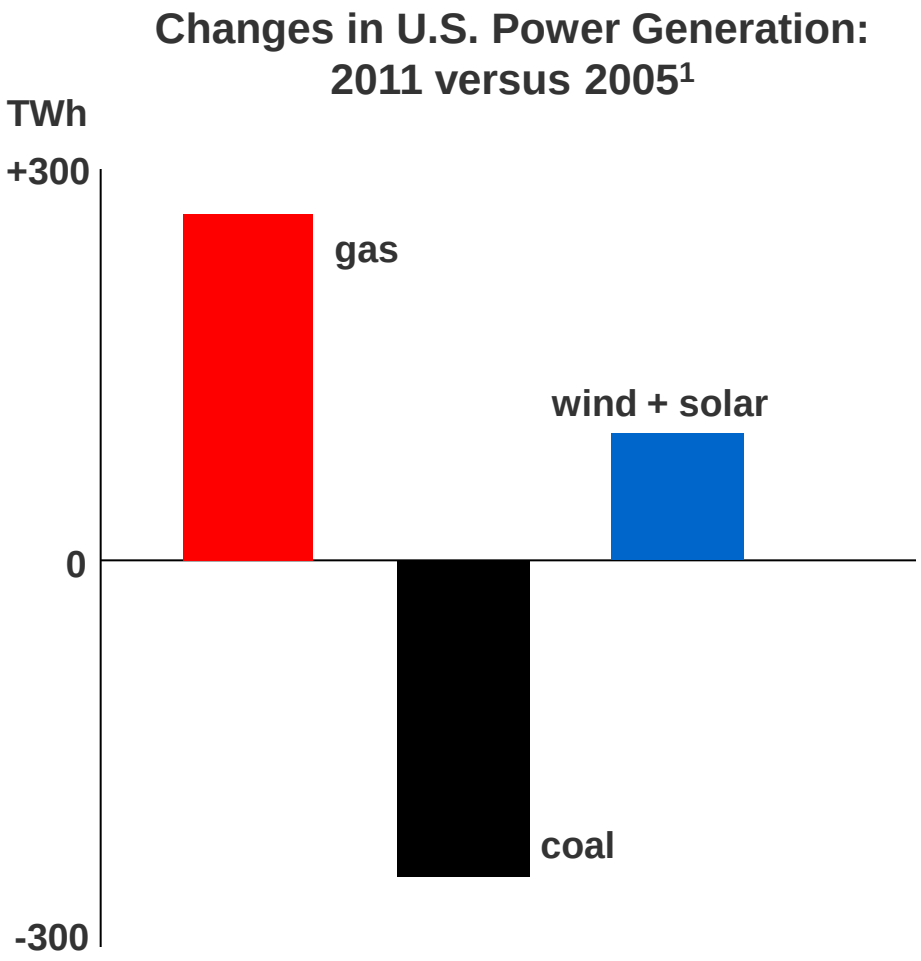
Emission Reduction Benefits of Gas



Source: Chart:Carnegie Mellon University (Jiang, et al), *Life cycle greenhouse gas emissions of Marcellus shale gas*, Environmental Research Letters (August 5, 2011)

Impact on Power Generation



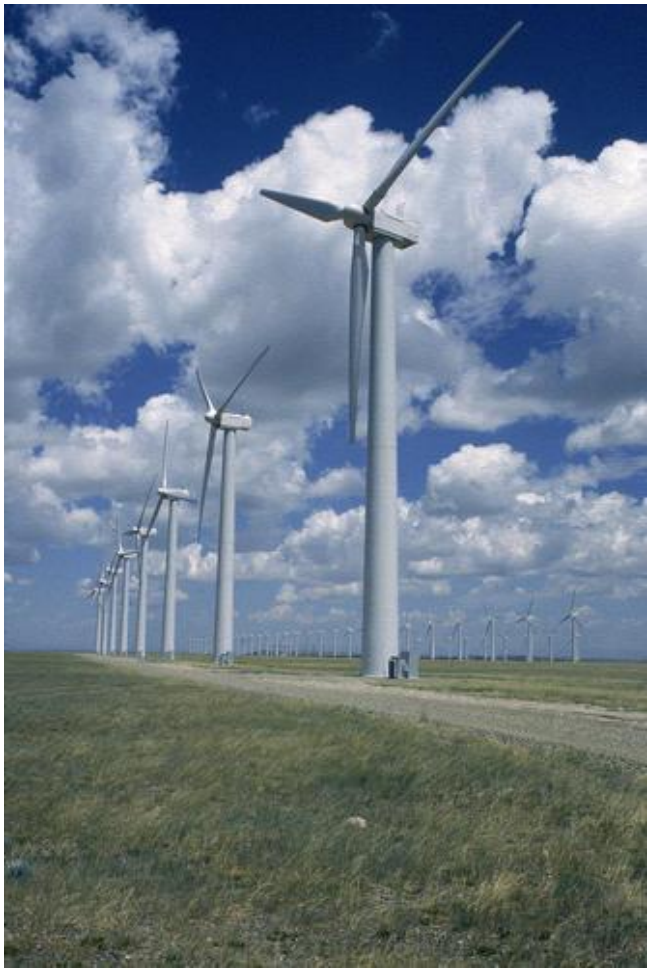


- Power generators switching from coal to gas…annual change versus 2005 equivalent to approx. **total annual UK generation**
  - GHG reduction achieved equivalent to entire removal of annual emissions of Belgium
- U.S. coal demand continues to fall
- Renewables generation has **increased** by 90 TWh in this period, **despite shale gas**
- Annual wind + solar powergen increased by only 7 TWh from 2000 to 2004

Conversion of all EU27 coal- and oil-fired power generation to combined-cycle natural gas would produce a **58% cut in GHG emissions** relative to 1990 levels[2]

Source: 1: International Energy Agency; 2: *IHS CERA 2011 pg. II-2&II-3*

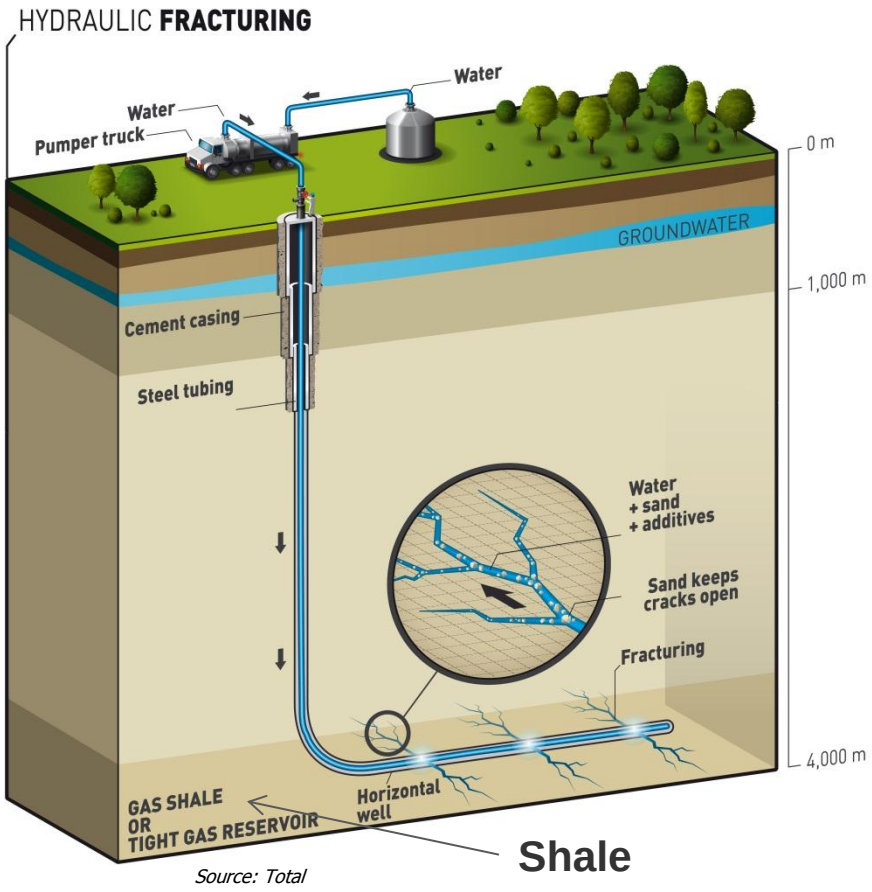
Complimenting Renewables in Europe



- Wind and solar power are **intermittent sources** of energy
  - From 2002 and 2009, German wind turbines provided power to the grid between **16% and 21%** of the time[1]
  - Offshore wind turbines contribute **34% to 43%** of the time[1]
- Another source of power is required to **back up renewables**, and **provide grid stability**
- **As renewables grow, so does this requirement for back up and stability**
- Natural gas provides the most suitable complimentary power source
  - Low capital cost, lowest GHG emissions of fossil fuels, fast plant start up times

Source: 1: The Impact of Wind Power on European Gas Markets, IEA, January 2012

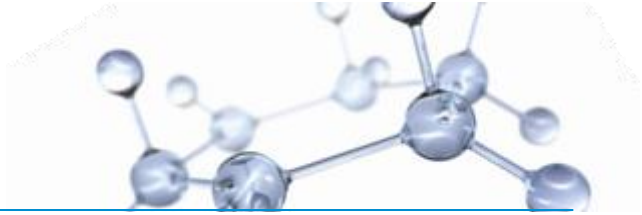
Shale Gas Production Process

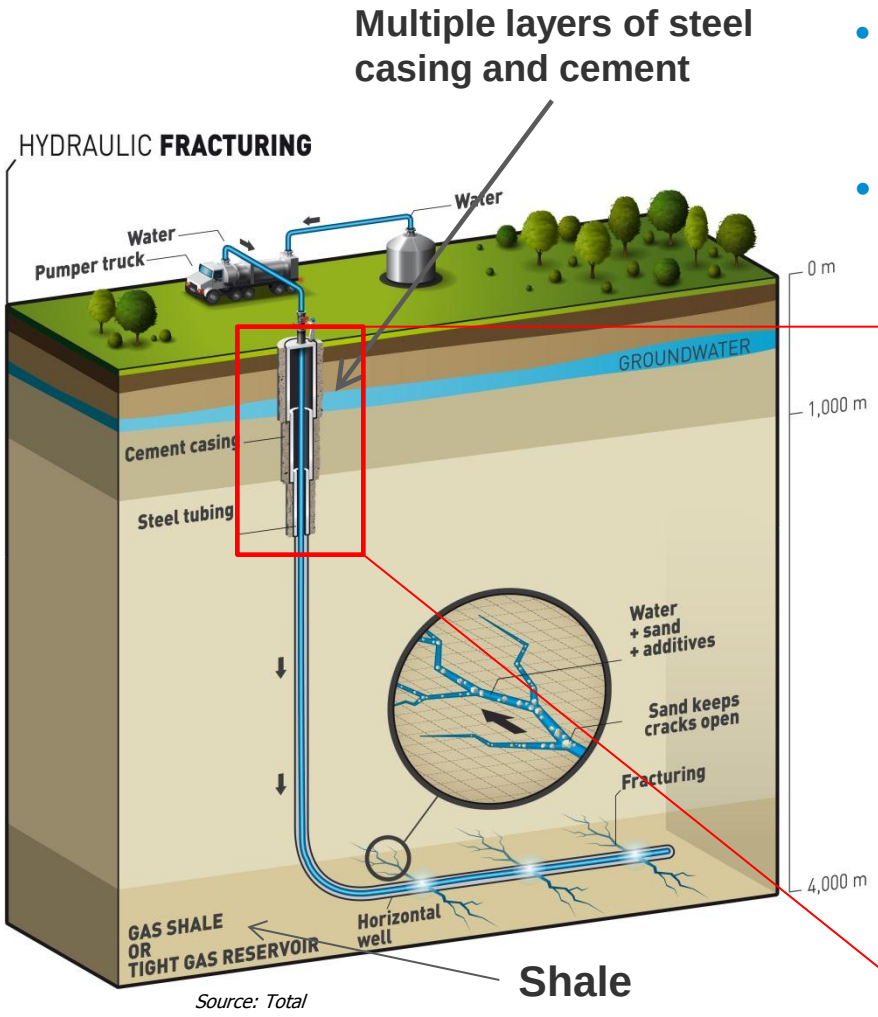


Source: Total

- Uses two **established technologies**: **horizontal drilling** (1960s+) and **hydraulic fracturing** (1950s+)
- Shale reservoirs are generally 2,000m to 4,000m below surface
- Water, sand and additives are pumped at pressure into the shale, opening up hairline fractures that allow gas to flow
- Thousands of meters of impermeable rock separate fractures from drinking water aquifers
- **Fractures cannot propagate to the surface**

Shale Gas: Aquifer Protection





- Aquifers protected by several layers of steel and impermeable cement
- No different from a conventional oil or gas well, or geothermal well

Source: OGP

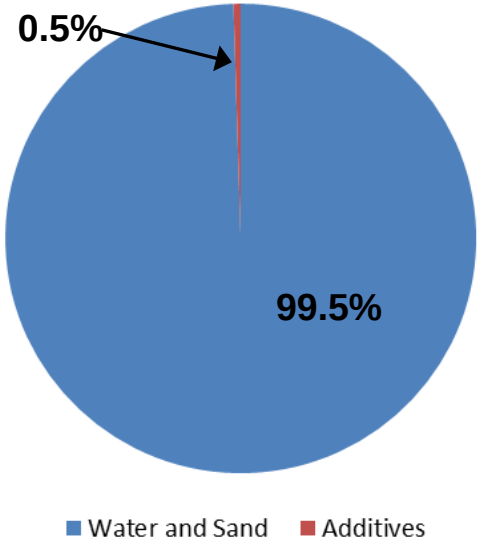
Hydraulic Fracturing Fluids

Additives are minimal and commonplace, but still require careful handling

Typical Chemical Additives Used in Frac Water

Compound	Purpose	Common application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Sodium Chloride	Allows a delayed breakdown of the gel polymer chains	Table salt
Polyacrylamide	Minimizes the friction between fluid and pipe	Water treatment, soil conditioner
Ethylene Glycol	Prevents scale deposits in the pipe	Automotive anti-freeze, deicing agent, household cleaners
Borate Salts	Maintains fluid viscosity as temperature increases	Laundry detergent, hand soap, cosmetics
Sodium/Potassium Carbonate	Maintains effectiveness of other components, such as crosslinkers	Washing soda, detergent, soap, water softener, glass, ceramics
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant, sterilization of medical and dental equipment
Guar Gum	Thickens the water to suspend the sand	Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces
Citric Acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, hair coloring

Source: DOE, GWPC: Modern Gas Shale Development in the United States: A Primer (2009).

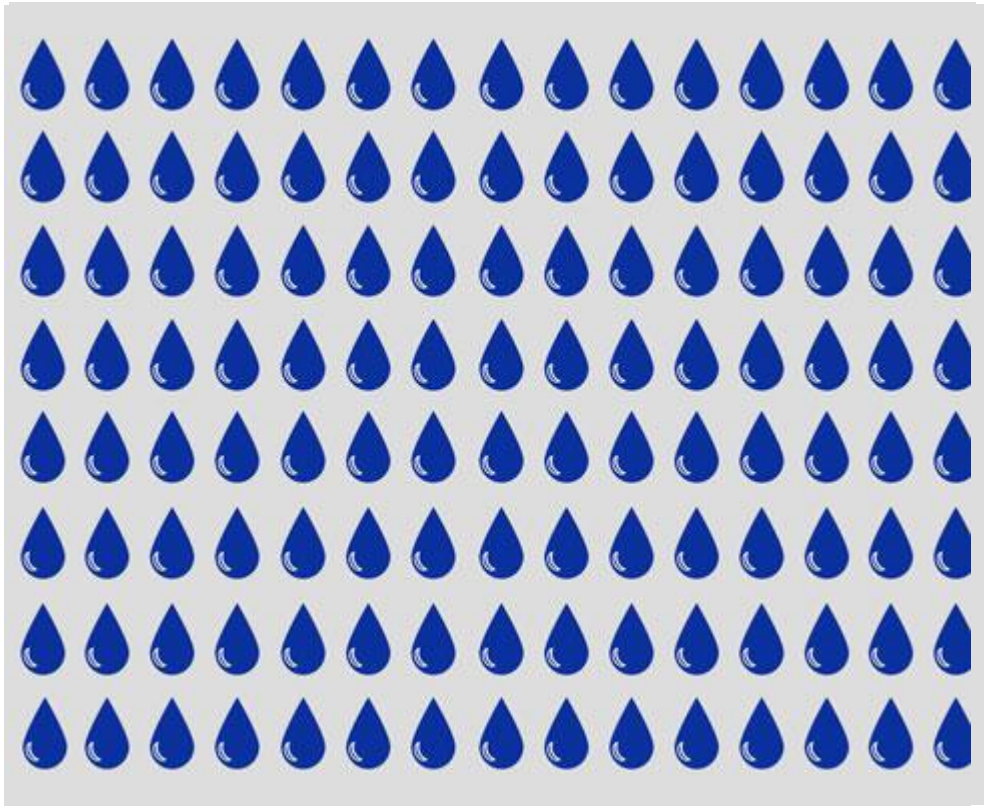


"ExxonMobil believes that a comprehensive disclosure program allows citizens and communities to consider this technology with a strong factual foundation. We believe that will lead to open discussion about environmental protection and risk management, and the potential benefits of shale development in Europe"

Rex Tillerson, CEO ExxonMobil, March 2012

Shale Gas Water Use

- Typical shale gas well requires 10,000 to 20,000 cubic meters of water (once: at start of operation)
- Coal mining requires 2 to 4 times more water per unit of energy
- Certain agriculture products, such as corn, require **80 to 12,000 times** more water per unit of energy
- In Texas, entire natural gas industry (including multiple shale gas plays) uses **less than 1%** of society water demand
- U.S. industry recycling more and more water: **75% in Marcellus**



Surface Impact

Old Gas Development from Western US

Source: ENVI Committee Report "Impacts of Shale Gas and Shale Oil Extraction on the Environment and on Human Health", June 2011

- Shows **decades-old tight gas** operation in Texas using only **vertical wells**
  - Not representative of modern horizontal drilling technology
- Unconventional gas development in Europe would not resemble this picture

Modern Marcellus Shale Gas Development

Source: OGP

- Modern horizontal drilling technology enables a **single surface pad** location to develop 5 to 10 km^2

Public Perception is Shaped by Images

Image from *GasLand* film

"Gasland incorrectly attributes several cases of water well contamination in Colorado to oil and gas development when our investigations determined that the wells in question contained biogenic methane that is not attributable to such development."

STATE OF COLORADO
OIL & GAS CONSERVATION COMMISSION

Government Commission found incidents were naturally occurring

- May 11, 2012: U.S. Environmental Protection Agency (EPA) completed study of 61 water wells in Dimock, Pennsylvania – also featured in *GasLand*
- **EPA ruled water was safe, and there were no grounds for any further action**

Dialogue with Communities

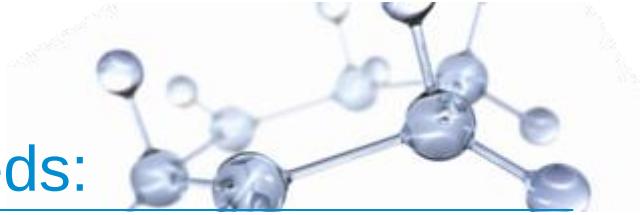
- Community acceptability is a key priority
- EM has held numerous community meetings in Germany and Poland to address concerns and answer questions

ExxonMobil Germany: Community “Info Markt”

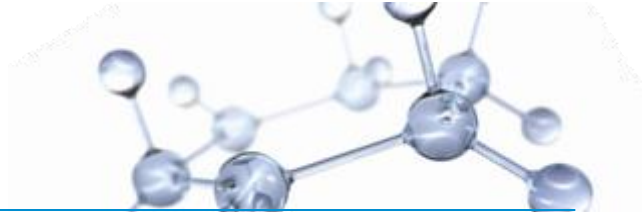
Town Hall Meeting

TV ads

Unconventional Gas Meets Many Needs:



Diversity in natural gas supplies...	Unconventional gas provides an indigenous source of supply **within Europe**
Cost competitive energy...	Gas-fired power plants have **lower capital costs** per MW installed than coal or nuclear
Lower GHG emissions and better air quality…	Gas gas emits up to **60% less GHG** than coal and ~zero NO_x, SO_x and particulates
Reduction in GHG emissions **now**…	European gas-fired power plants only run about **35%** of the time today
More **renewables**…	Natural gas is best-suited generation fuel to **complement intermittent** wind and solar
Efficient water use...	**Shale gas uses less water** than coal and nuclear per unit of energy produced
Limited surface impact...	One shale gas well pad can develop **5-10 km²**
Safe shale gas development...	Rigorous integrity standards, disclosure, baseline monitoring, best practices

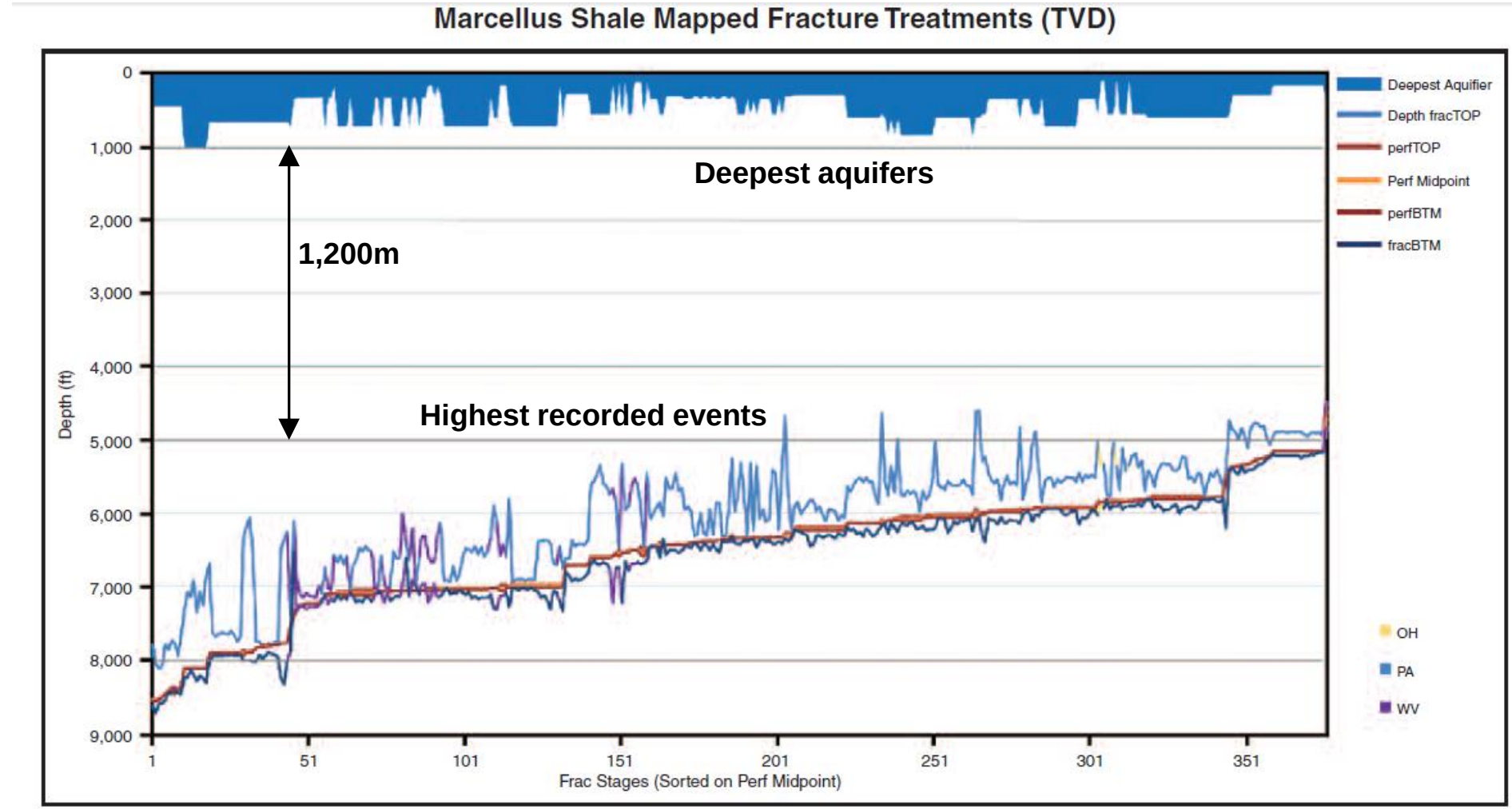


For further information on shale gas in Europe:

http://www.europeunconventionalgas.org

Thank you for your attention

Marcellus Shale Fracture Heights



Source: Pinnacle, compiled in American Oil and Gas Reporter, July 2010