NRGExpert
Energy Intelligence

White Paper: # Shale Gas Technology

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An Introduction to Shale Gas Technology

Shale gas is extracted using horizontal drilling and hydraulic fracturing or 'fracking'. None of which are particularly new technologies or shale gas specific

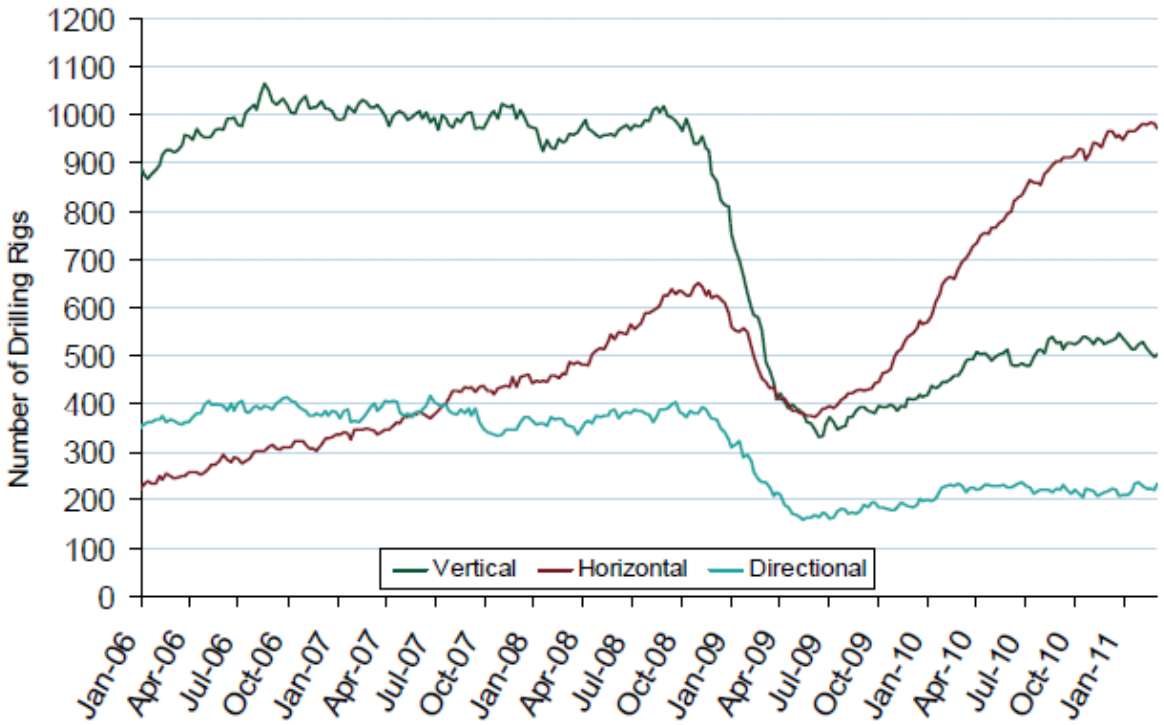
Horizontal drilling

During the process wells are drilled vertically to just above the known shale deposit at a depth of 1,500 to 3,000 metres. Then the drill bit is deviated and drilled horizontally through the shale at an angle to maximise horizontal stress for fractures.

Typically 15 to 16 wells need to be drilled to find a 'sweet spot' which is easily fractured and has sufficient gas saturation to make production economical. Because the gas distribution is uneven, currently reported extraction rates are between 4% and 6%. Therefore, more wells are needed to produce the same volume as would be produced for conventional gas extraction.

Increasingly hydraulic drilling is being used in the United States instead of vertical or directional drilling , despite its higher costs, because it maximises exposure to the reservoir thus the production rate is higher. This makes shale gas extraction economical whereas vertical drilling is not economical for shale gas.

Number of rigs by drilling method in the US, Jan 2006 to Mar 2011



Source; FERC

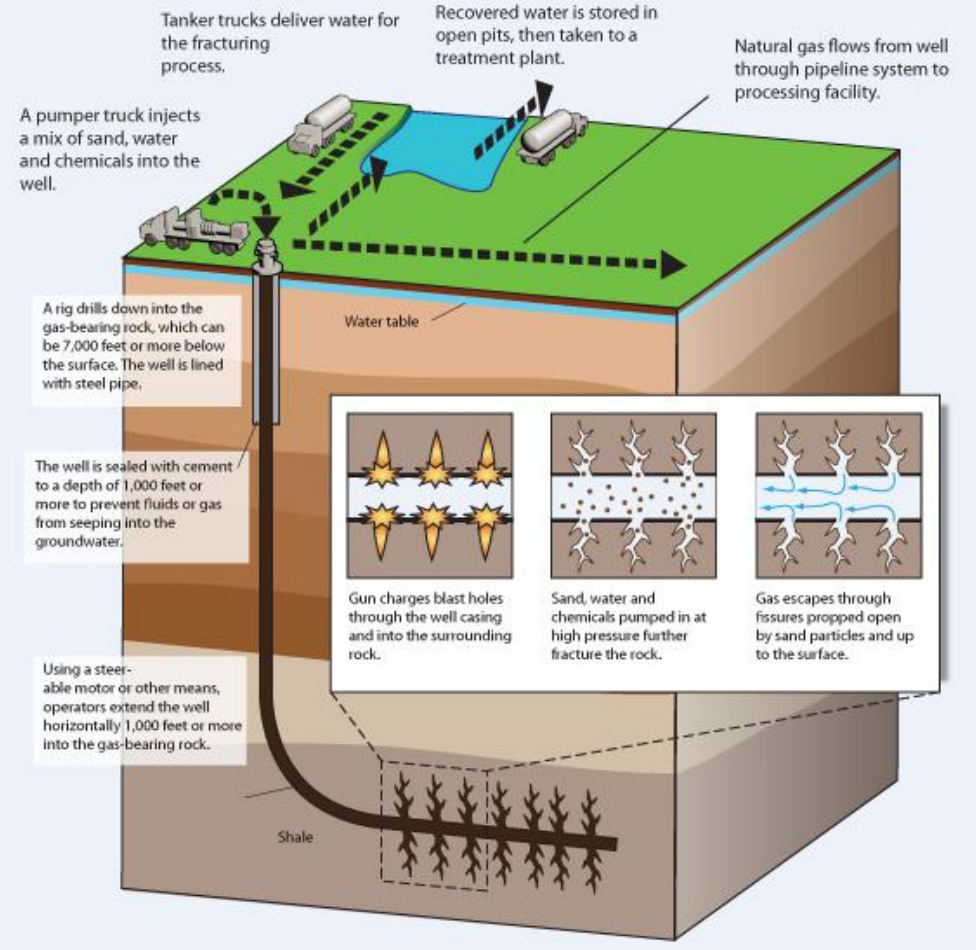
Hydraulic fracturing or ‘fracking’

Productive zones are within the well are then isolated for fracturing where water and chemicals are injected under high pressure into the wells to fracture the rock. ‘Proppants’, usually sand or ceramics, in the injected water solution hold the fracture crack open to prevent their ‘healing’ and allow the continued release of natural gas. This gas is in two forms: ‘free gas’ which is released first and ‘adsorbed gas’ on the surface of organic matter, which is released when the pressure in the well drops.

The solution injected into the well also contains a very small quantity of additives such as gelling agents to cause the rock to crack, biocides to kill contaminating micro-organisms and surfactants to sterilise the well. Additives are also use to increase the efficiency of the process. Typically these additives comprise of around 0.5% of the total injection volume. The composition of additives used depends upon the conditions of the well such as pressure, temperature and also the quantity of proppant used.

Total estimates for its operations an average of 30 ‘fracs’ are performed for each 1,000 metre well and each ‘frac’ uses 300 m^3 of water, 30 tonnes of sand and 0.5% additives in the solution mixture. Therefore, the process is very water intensive, which is a big issue for water-stressed states where gas shale plays are located such as Texas. This water needs to be extracted from aquifers or trucked in to the site on access roads.

A more detailed description of hydraulic fracturing is outlined in the diagram below:

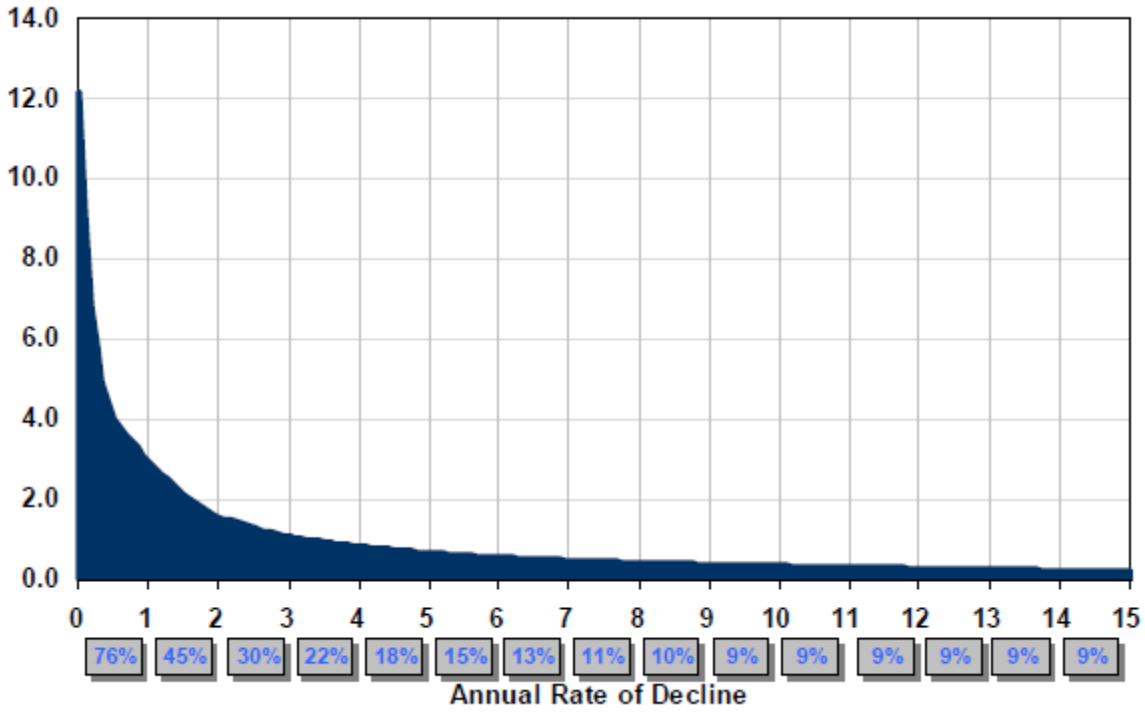


The rate of gas extraction and costs depends upon:

- 'Dryness' of the shale: more production from dry shale;
- Length of the horizontal well: more production from longer wells;
- Operator: some operators are more efficient than others;
- Depth of shale gas: deeper gas is harder to tap but has higher flow rates due to high pressure.

The initial production (IP) from the wells is high but tails off rapidly compared to conventional wells. This rate of decline typically follows a hyperbolic curve, as shown below for the Marcellus shale play. Therefore a larger number of wells and repeated high-pressure fracturing is needed to maintain production compared to a conventional well. The recovery factor for unconventional wells is usually in the 5% to 40% range due to low permeability compared to above 90% for conventional wells.

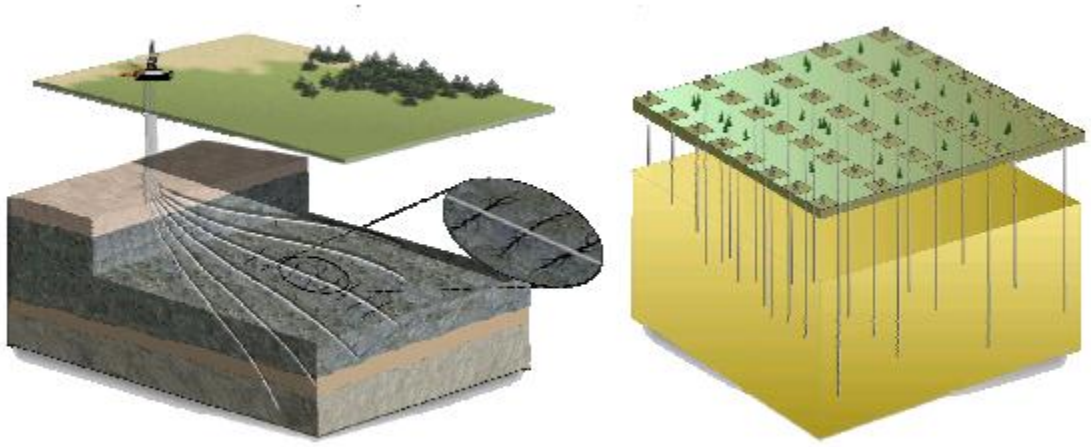
Haynesville shale type curve, mcf per day, 0 to 15 days



Source; Credit Suisse

A more recent technique used is pad drilling where multiple wells are drilled from one location. Usually 16 horizontal wells from one pad covering 57 km^2. This reduces the surface impact of the technique and the need for roads, and allows for high level sophistication in material handling compared to a series of vertical wells. To cover the same area with vertical wells would require the drilling of 320 vertical wells, each with a 10 km^2 pad.

Pad drilling and conventional vertical well drilling



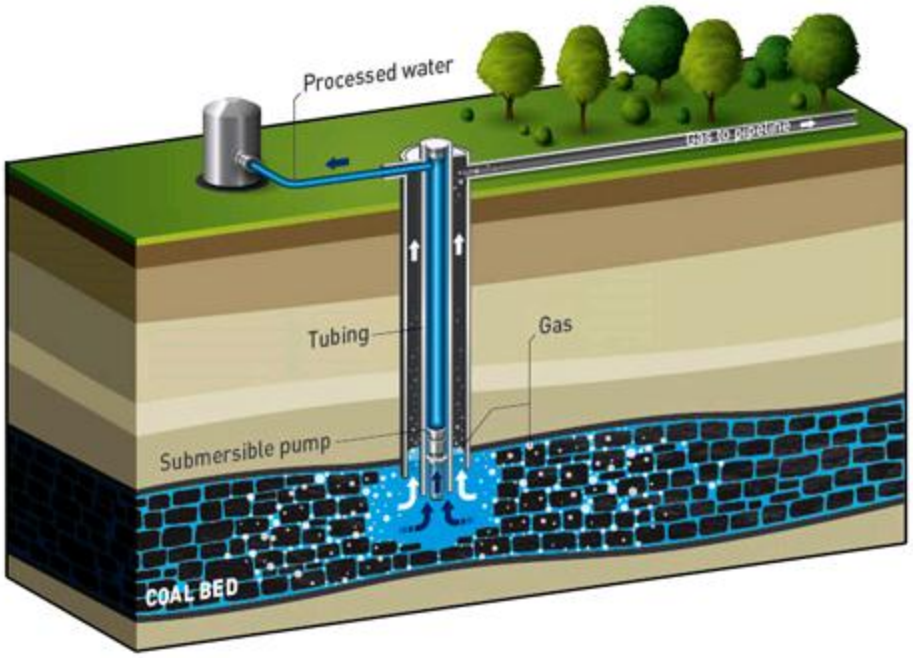
Source; Encana

Other ‘unconventionals’

This process is also used for the production of tight gas, although the initial vertical well may be drilled to deeper depths.

The extraction of coal bed methane can use vertical wells, or in some cases several wells from a single point, similar to multi-pad drilling. Water from the coal bed is pumped out of the coal seam using a bottom hole pump. Initially mainly water is removed and less gas. Peak productivity of gas is not achieved until 1 to 5 years afterwards as the water pressure is reduced further. Localised hydraulic fracturing can be used to increase the wellbore contact with the reservoir to maximise gas recovery.

Production of coal bed methane (CBM)



Source; Total

Costs

Typically it is estimated that drilling accounts for 20% to 35% of the capital expenditure for producers- Which if it does not reserves, these costs are 'wasted'.

Rex Energy Corporation estimates that fracture stimulation accounts for 47% (average of USD 2.2 million); drilling counts for 40% (average of USD 1.9 million); and equipment and facilities accounts for 13% (average of USD 0.6 million) of well allocation costs for at its Marcellus shale projects. The average cost of the well is USD 4.7 million.

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