

1971

Natural gas distributors warn of national gas shortages



1973

OPEC imposes an embargo on oil exports

General Electric develops diamond-studded drill bits, which it would improve with the Department of Energy later in the 1970s and 1980s

The Federal Power Commission (FPC) completes the first study of unconventional gas volumes



1974

President Ford and Congress create the Energy Research and Development Administration (ERDA) and the Federal Energy Agency (FEA)

1975

ERDA demonstrates massive hydraulic fracturing (MHF) technique

ERDA and the West Virginia Kentucky Gas Corporation demonstrate "directionally deviated drilling"

1976

ERDA launches the Eastern Gas Shales Program (EGSP) and the Western Gas Sands Program (WSGP) under the Unconventional Gas Research Program (UGRP)

The Gas Research Institute (GRI), the "R&D arm of the gas industry," is founded, initially funded by a FERC-sanctioned surcharge on interstate gas pipelines

Two ERDA engineers patent early directional drilling technique



1977

ERDA merges with FEA to form the US Department of Energy (DOE)



1978

Congress passes the Natural Gas Policy Act, allowing for higher price ceilings on unconventional gas

Mitchell Energy conducts largest contemporary MHF demonstration with DOE assistance

LATE 1970s

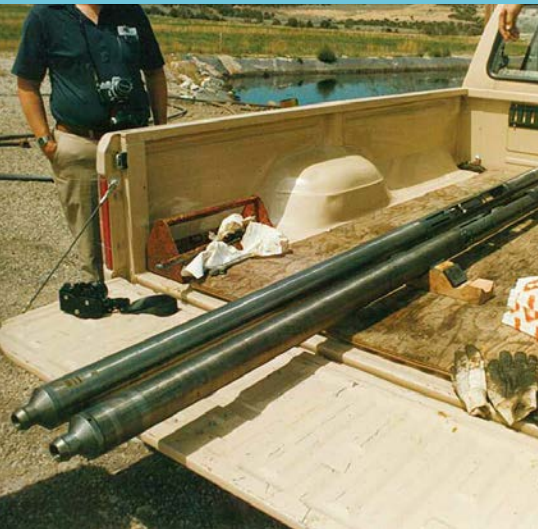
EGSP demonstrates feasibility of foam-based fracking

1980

Congress creates the Section 29 tax credit for unconventional gas, which would last until 2002

Elf Aquitaine, a state-owned French company, drills four experimental horizontal wells in France and Italy

SHALE FRACKING INNOVATION TIMELINE



ABOVE: The first Sandia microseismic receiver, circa 1980. Photo courtesy Norm Warpinski.

1981

Sandia Laboratory initiates the Multiwell Experiment, which would last through 1986; this includes the first-ever published microseismic monitoring of hydraulic fracturing operations

Mitchell Energy drills first well in Texas's Barnett Shale



ABOVE: Photo taken circa 1985, when activities were going on in all three of the close-spaced wells, the key of the Multiwell Experiment. Photo courtesy Dave Northrop.



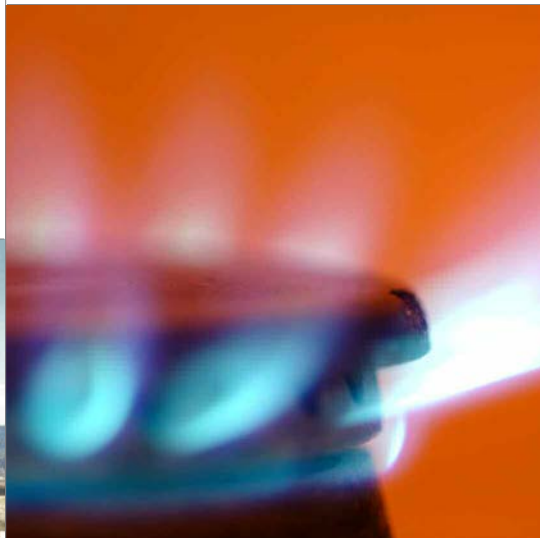
ABOVE: A cored hydraulic fracture from a Multiwell Experiment fracture created in 1983. Core was taken in 1988. The hydraulic fracture has many individual strands. Photo courtesy Norm Warpinski.

1984

Mitchell Energy switches from foam-based to gel-based fracks

1986

First multifracture horizontal well drilled in Wayne County, West Virginia, by DOE-private venture



1989

Congress fully deregulates wellhead natural gas prices

1991

Mitchell Energy experiments with DOE and GRI on mapping and drilling in the Barnett Shale



ABOVE: Installation of the first 5-level receiver array at the M-Site (same location as the Multiwell Experiment), circa 1992. Photo courtesy Norm Warpinski.

1992

The DOE/GRI/industry "M-Site" Experiment, which would run through 1996, successfully demonstrates the accuracy of microseismic monitoring



ABOVE: Senior management of Mitchell Energy. This photo was taken after Bill Stevens took over as president of the company in the mid-1990s. Photo courtesy Dan Steward.

2002

Devon Energy buys Mitchell Energy for \$3.5 billion

For the first time, Devon Energy successfully combines its horizontal drilling techniques with Mitchell Energy's microseismic mapping and slickwater fracking in the Barnett Shale

2012

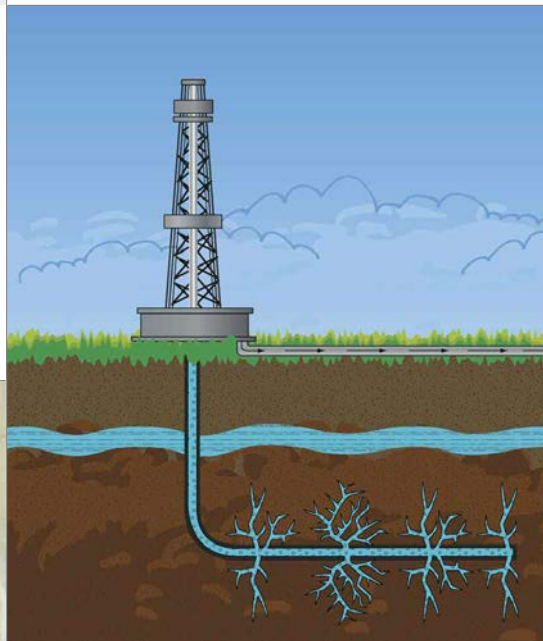
Natural gas prices drop to below \$2/mmBTU; natural gas reaches a record 30 percent of total US power generation

2013

Shale gas reaches 40 percent of US natural gas production, up from less than 2 percent in 2001

1998

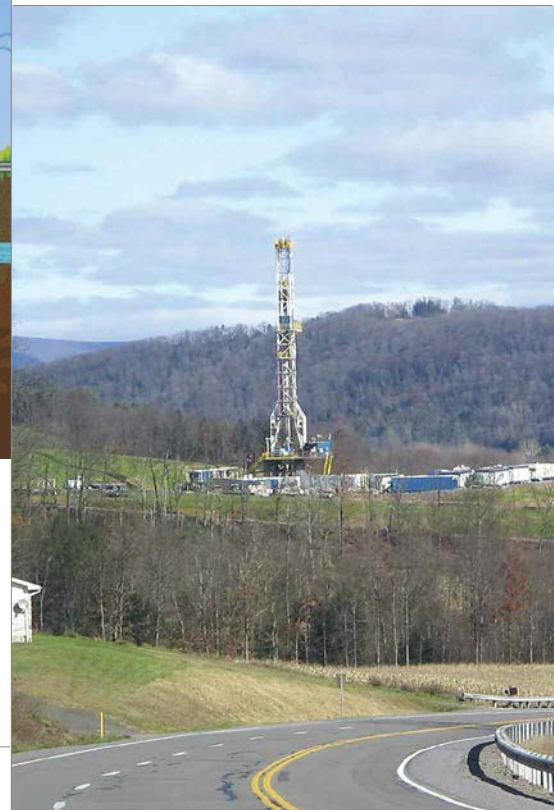
Mitchell Energy, adapting a technique from Union Pacific Resources, successfully demonstrates slickwater fracking in the Barnett Shale



ABOVE: (Left to right): George Mitchell, Doug Mitchell (no relation), and Dan Steward at celebration commemorating 700th Barnett Shale well in Decatur, Texas, in the early 2000s. Photo courtesy Dan Steward.

2003

Southwestern Energy uses Mitchell's slickwater fracking techniques to extract oil



Mid-2000s

Shale gas production grows steadily, initially led by Chesapeake Energy

Several companies including Continental, EOG, and Brigham begin applying fracking techniques to oil deposits in the Bakken Shale

2000

Mitchell contractor Pinnacle and GRI-funded researchers successfully map the Barnett Shale using microseismic imaging

2014

Global oil prices crash by nearly 60 percent over 8 months, largely because of the boom in US shale oil production