Hydraulic Fracturing

Hydraulic fracturing is one of the many steps in the process of drilling and completing most oil and natural gas wells. It is a well-stimulation method used to complete 90 percent of the oil and natural gas wells drilled in the United States. Although the injection process for each well typically lasts only two to three days, the well may produce for 20 years or more.

Commonly known as "fracking," the stimulation process involves injecting a mixture of water, sand, and a small amount of chemical additives at high pressure into rock formations many thousands of feet below the surface of the earth. The mixture travels inside cement-lined steel casing until it reaches the targeted hydrocarbon-bearing formations, where it creates small fractures that provide a path for trapped oil and natural gas to flow into the wellbore. Hydraulic fracturing makes it possible to recover previously inaccessible oil and natural gas. It extends the life of existing wells and increases the productivity of new wells. This has the effect of reducing the overall number of wells drilled to produce oil and gas. Hydraulic fracturing is often combined with horizontal drilling techniques that enable greater reach within an oil- and/or natural gas-bearing formation from a single well site.

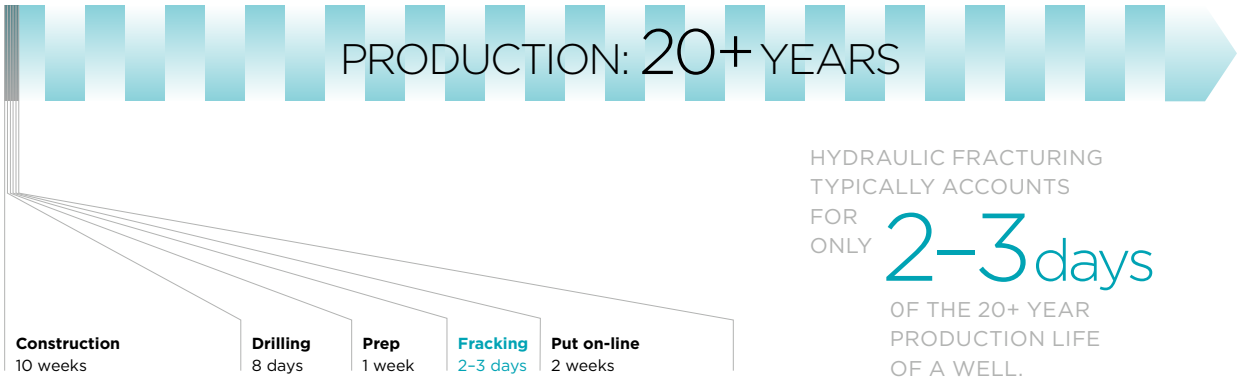
RESPONDING TO QUESTIONS ABOUT HYDRAULIC FRACTURING

We know there is concern about the impacts of hydraulic fracturing, and of onshore oil and natural gas drilling in general, on the environment. These concerns about oil and natural gas development and related questions are addressed in this section and in the "Standing for Our Environment" section beginning on page 25.

We also recognize that communication at the local level – especially listening to our communities – is essential. We have launched several new initiatives to ensure we understand the concerns and address them directly. One example is our Noble Neighbors program, which we launched in 2013.

At these town hall-style meetings, we describe what our operations will look like, and what to expect regarding impacts on communities and the environment. In turn, we listen and respond to the questions and concerns that people raise and provide a point of contact for future communication.

Exploration and Development Stages



HYDRAULIC FRACTURING TYPICALLY ACCOUNTS FOR ONLY **2–3 days** OF THE 20+ YEAR PRODUCTION LIFE OF A WELL.

INNOVATION REDUCES OUR FOOTPRINT

Noble Energy continues to implement new technologies and improved methodologies that reduce our surface and environmental footprint. Some of the techniques and methods we introduced in 2013 include:

- **Expanded use of water recycling – reusing water to reduce water disposal**
- **Incinerator technology that provides minimal-emission flowbacks**
- **Shortened completion flowback periods to reduce emissions**

We also partner with businesses and universities to develop new fracturing fluids and treatment processes, and serve as a founding member of Colorado Water Watch. This is an initiative to measure water quality in real time before and after oil and natural gas wells are drilled, and to make the data publicly available.

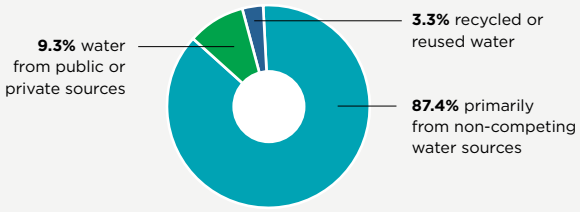
We also introduced an employee ambassador program in 2013 to help employees understand the challenges and opportunities facing the onshore oil and natural gas industry. With this information, employees are better able to answer questions from neighbors and participate in civic engagements to discuss our operations, technology, and safety and environmental practices.

PROTECTING FRESH WATER SUPPLIES

We are committed to safe and responsible operations. Each well is engineered with multiple barriers in place to keep the oil or natural gas in the well and isolate it from the surrounding environment, including fresh water aquifers. Before a well is drilled, we assess the area, including the rock formations in the proposed drilling path down to the target oil- or natural gas-containing formation. We also assess any nearby earlier-vintage vertical wells that may need to be isolated or plugged before drilling new horizontal wells.

During well construction, we install multiple layers of steel pipe and cement in the wellbore. These protective layers ensure that hydraulic fracturing is directed into the hydrocarbon-bearing zone and that the produced oil or natural gas stays securely enclosed. We monitor the integrity of the casing and cement throughout the operation.

2013 U.S. ONSHORE WATER CONSUMPTION BY SOURCE



Note that fresh water aquifers used for drinking water are typically shallow, less than a thousand feet below the surface. In contrast, the average depth of Noble Energy's hydraulic fracturing operations in the Marcellus Shale and DJ Basin is between 6,500 and 8,500 feet. This means that most hydraulic fracturing operations take place more than a mile – and through many layers of rock formations – below the level of potable fresh water aquifers.

We have also listened to stakeholder concerns that hydraulic fracturing may increase competition for fresh water supplies. In 2013 87 percent of the water used in our U.S. onshore operations came from "non-fresh" sources such as brine aquifers. We are working on ways to increase that percentage. We are also working hard to increase the amount of flowback and produced water that we recycle and reuse. See page 25 of our Environment section for a more extensive discussion of the ways in which we are reducing our use of fresh water.

HYDRAULIC FRACTURING AND SEISMIC ACTIVITY

The National Academies of Science and the U.S. Geological Survey have both determined that the process of hydraulic fracturing does not pose a significant risk of inducing earthquakes. Evidence suggests that deep-well fluid injection, a completely separate process for waste water disposal, can cause seismic activity. Our initiatives aimed at recycling and reusing produced water from our operations provide an alternative to disposing of it through deep well injection.

HYDRAULIC FRACTURING FLUID TRANSPARENCY

Noble Energy is an active participant in FracFocus, a national hydraulic fracturing chemical registry website, and discloses the chemical additives used in all its onshore wells. To find out about the composition of hydraulic fracturing fluids Noble Energy uses, please go to fracfocus.org.

We will continue our efforts to listen to our stakeholders and address their concerns, and to improve our processes to achieve our common goal: the energy we need, the economy we want and the environment we deserve.