

# Operator reduced drilling and completion time 50 percent while cutting costs by more than half

Continuous improvements helped oil company double production from high-temperature wells



HAL/36294

## OVERVIEW

The Haynesville play stretches across northwest Louisiana and east Texas. Its tight shales have higher porosities – and gas content – than most, making it very attractive to developers. However, its geology also provides extreme technical challenges that demand state-of-the-art horizontal drilling capabilities, and high-temperature tools and technologies.

In 2008, a large oil company partnered with Halliburton to provide integrated drilling and completion services for its new horizontal drilling program in the Haynesville Shale. Through continual process improvements, the operator and Halliburton have brought drilling and completion days down 50 percent – saving millions of dollars per well. The operator recently drilled one of these challenging wells in just 26 days. The operator has also more than doubled the estimated ultimate recovery (EUR) of initial wells. Due to the program’s success, the oil company plans to drill more than 70 wells in 2011, and another 70 in 2012.

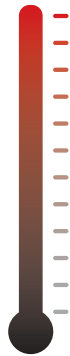
CHALLENGE	SOLUTION
<p><b>Improving cost-efficiency</b></p> <p>Due to the Haynesville Shale’s challenging downhole conditions, initial wells took months to drill and complete. To make this play more economic, the operator needed to improve time and cost savings.</p>	<p><b>Integrated services 24/7</b></p> <p>Integrated services, lessons learned and around-the-clock operations helped the operator cut drilling and completion time by 50 percent. This helped reduce the cost of each well by more than half.</p>
<p><b>Boosting recovery</b></p> <p>Initial well EURs were around 3 billion cubic feet (BCF) of natural gas per well. To meet production targets, the operator needed to optimize drilling and completions operations and, ultimately, improve recovery.</p>	<p><b>Continuous optimization</b></p> <p>Local experience and global best practices helped the operator and Halliburton improve drilling practices, well layout, fracturing designs, perforation spacing and more. Now the operator has EURs as high as 7 BCF.</p>
<p><b>Hostile downhole conditions</b></p> <p>The temperatures and fracturing pressures in Haynesville are much greater than other unconventional shale plays. Wellbore circulating temperatures frequently exceed 340°F (171°C). Average fracturing pressures reach as high as 12,500 psi. These conditions require equipment running near or above the operational limits of conventional tools.</p>	<p><b>Pushing limits of technology</b></p> <p>To meet these wells’ challenges, Halliburton deployed high-temperature tools and doubled hydraulic horsepower for stimulation treatments. Halliburton implemented condition-based maintenance (CBM) to ensure equipment reliability in difficult conditions.</p>

Reduced completion days  
Reduced drilling days



Initial wells in this challenging, horizontal program took months to drill and complete. New efficiencies helped cut drilling and completion days in half.

HAL36289



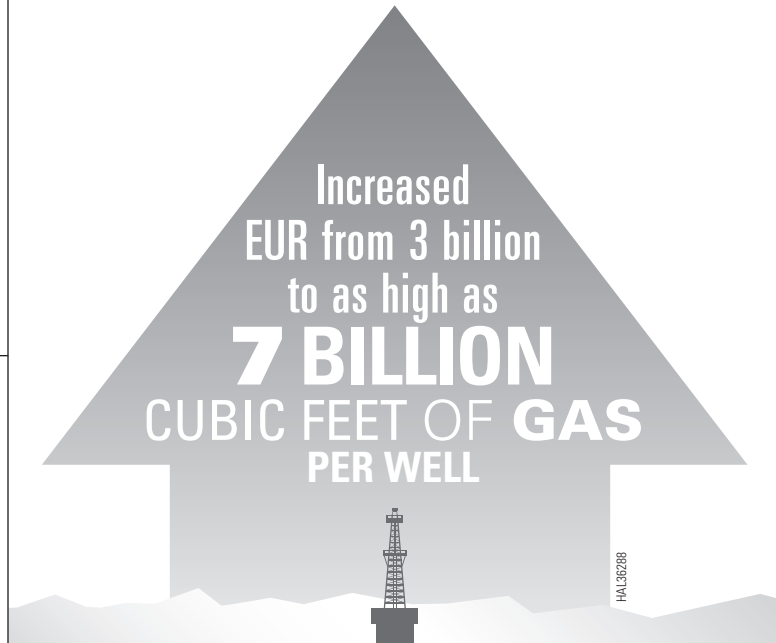
340°F (171°C)

Bottomhole temperatures frequently exceeded 340°F and average wellhead treating pressures during stimulation reached as high as 12,500 psi.



HAL36283

Increased EUR from 3 billion to as high as **7 BILLION** CUBIC FEET OF GAS PER WELL



HAL36288

Continuous improvements in stimulation designs have helped the operator more than double production since the start of the program.

Operator reduced cost per well by more than half



HAL36291

2008 >>> WELL COST >>> 2011

Since 2010, the operator has increased production intervals (curve and lateral sections) drilled with one bottom-hole assembly (BHA) by 20 percent.

HAL36293



PRODUCTION INTERVALS DRILLED WITH ONE BHA **UP 20%** IN 2011

## Operator reduced drilling and completion time 50 percent while cutting costs by more than half



### High-temperature gas play presented complex challenges

The Haynesville Shale is one of the largest onshore natural gas resources in the United States. Conservative estimates show 168 trillion cubic feet of natural gas, making it the fourth-largest gas field in the world. However, the area's geophysical properties present operators with a host of unique challenges. The play is deeper and hotter than comparable North American unconventional gas plays. As a result, wells in the Haynesville Shale take longer to drill and require more advanced technology.

### Integrated services helped reduce rig days, increase production

This oil company entered into the Haynesville play in 2008. Halliburton provided integrated drilling and completion services, including:

- Bits
- Cased hole logging
- Cement
- Coiled-tubing
- Directional drilling
- Drilling fluids
- Frac plugs
- Logging-while-drilling (LWD)
- Measurement-while-drilling (MWD)
- Open hole logging
- Project coordination
- Service tools
- Stimulation
- Tubing-conveyed perforating



As knowledge and experience increased, the integrated services helped the operator improve drilling and completion time, cost-efficiency and production. Today's wells are drilled and completed 50 percent faster than initial wells. EUR from most wells has increased from approximately 3 billion cubic feet of gas to as high as 7 billion cubic feet. And, the cost per well has decreased by more than half.



### Industry-leading MWD/LWD tools

Many wells in the program reached 18,000 feet total depth, including laterals up to 4,600 feet. Circulating temperatures frequently exceeded 340°F and have reached as high as 370°F.

To overcome this extreme environment, the operator deployed Halliburton's industry-leading SOLAR 175™ suite of MWD and LWD services. The tools have directional, gamma, resistivity, density and porosity sensors rated to circulating temperatures of 347°F (175°). To provide even more reliability, Halliburton upgraded electronics packages and made improvements to mud pulse telemetry. Halliburton's ability to provide timely, accurate formation data despite hostile downhole conditions helped the operator stay in the pay zone.

## Operator reduced drilling and completion time 50 percent while cutting costs by more than half



HAL36285



HAL36280



HAL36284

### Upgraded motors withstood fluctuating temperatures

The rubber in most mud motors can withstand temperature variations of +/-50 degrees from the optimal operating temperature. The rubber in these motors had to endure temperature ranges up to 100 degrees. The operator and Halliburton worked with vendors to optimize rubber products and improve motor reliability.

### CBM increased reliability while minimizing risk

Because all of the tools were pushing their operating limits, Halliburton implemented condition-based maintenance. CBM increased reliability and availability by allowing Halliburton to service equipment based on recorded vibration, temperature and pressure data. This helped enhance drilling efficiency by preventing costly, time-consuming breakdowns.

For example, Halliburton helped the operator increase production intervals (curve and lateral section) drilled with one BHA by 20 percent since 2010. Each production interval drilled with one BHA in one run helps the operator save approximately three drilling days.

### Doubled hydraulic horsepower for high-pressure fracturing

During completion operations, Haynesville's deep, high-temperature wells created difficult pumping conditions. Wellhead treating pressures during stimulation commonly exceeded 12,500 psi. These wells required almost twice the amount of hydraulic horsepower than other shale plays – putting significant strain on equipment. The unique designs of Halliburton's pumping equipment consistently met the challenge.

### Local experience helped double production

Through extensive experience, Halliburton's technology teams helped the operator optimize completion designs and double EUR. This involved tweaking proppant concentrations, fracturing fluids, perforation design and more.

### 24-hour completions improved collaboration and efficiency

Halliburton moved completions operations from a day schedule to a 24-hour schedule. This enabled Halliburton to improve transitions between services and minimize downtime. Previously, teams would complete one-and-a-half frac stages per day. Now the operator and Halliburton can complete more than four stages per day. Because of this, completion days have dropped from more than 10 days to five or less.

### Pad operations helped drill a well in just 26 days

Due to the success of the program, the operator plans to drill more than 70 wells in 2011, and another 70 in 2012. To drill and complete wells even faster, the operator and Halliburton are transitioning to pad operations. Pad operations enable Halliburton to provide services for multiple wells at the same time. This approach enabled Halliburton to drill one of the first pad wells in just 26 days. It also enabled Halliburton to perform the best stimulation to date – six fracturing treatments in one day.