LOUISIANA STATE GAS PRODUCTION

by

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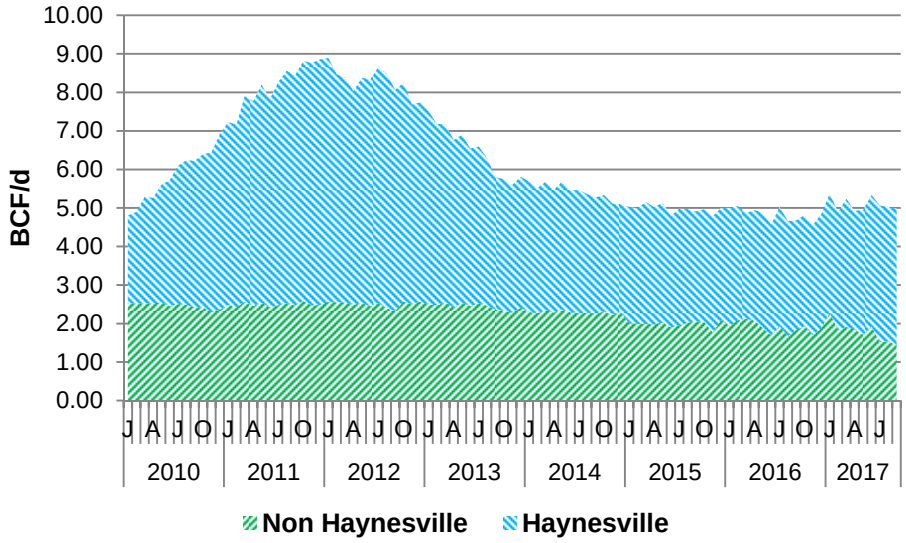
Louisiana has been producing natural gas since the early 1900's. State gas production peaked in 1970 at 15.3 Billion Cubic Feet per day (BCF/d) and declined until 2005, reaching the bottom at 3.3 BCF/d. It then reversed its trend, thanks to production from Haynesville shale play. The Haynesville shale play is a layer of sedimentary rock more than 10,000 feet below ground in northwestern Louisiana, southwestern Arkansas, and eastern Texas, with some of the play stretching well across the northern central portion of Louisiana. Energy companies explored the shale play and drilled for crude oil and natural gas based on the potential of large supplies of oil or gas trapped within some portions of the shale play. Shale plays were once considered too costly, requiring large amounts of ground water to explore, but with improved equipment, less expensive technology in horizontal drilling, 3-D seismic, processes that are more efficient, and the ability to recycle used water have changed that.

Figure 1. Louisiana State Gas Production, Excluding Federal OCS



Louisiana's gas production average daily rate, from 2010 to present, is shown in Figure 1. The Louisiana Haynesville Shale was producing more gas than the rest of the state by March 2010. In December 2011, Louisiana Haynesville production reached a record high of 6.5 BCF/d. In early 2013, as natural gas prices started to decrease, natural gas production in the Haynesville region was surpassed by production in the newly developed Marcellus and Utica Shale plays. These plays are located 6,000 to 6,500 feet below the surface, hence are cheaper to develop than are those in Haynesville. In late 2015, natural gas prices started to decrease to below $2 per MMBTU, while oil prices remained above $30 per barrel. The Louisiana Haynesville gas production was also surpassed by gas production from oil shale wells in the Eagle Ford and the Permian regions in Texas.

Figure 2. Louisiana State Gas Drilling Rigs
by Baker Hughes vs. Spot Gas Price

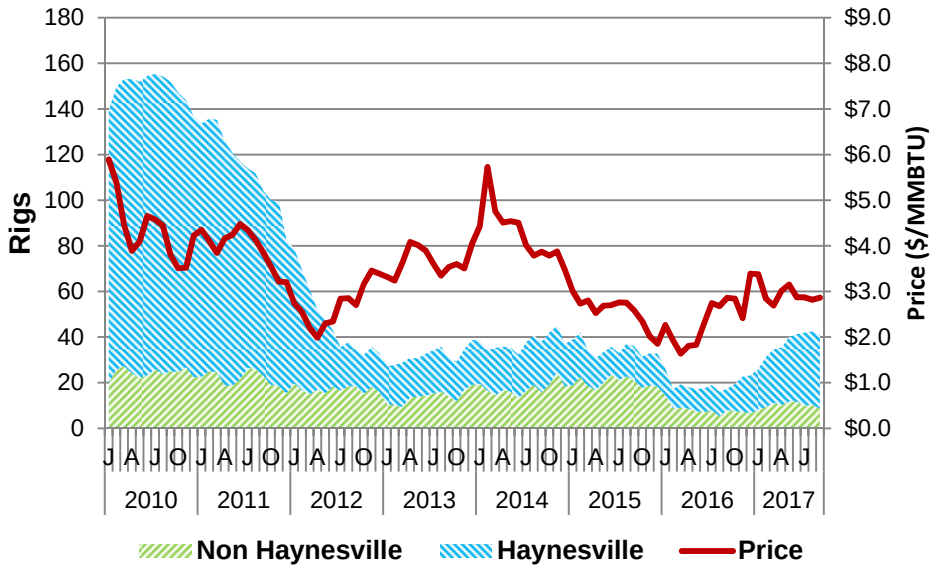


Figure 2 shows the relationship between gas prices and drilling rigs in Louisiana, excluding the federal OCS areas. Historically, the data was highly correlated with a lag around 12 months, but from 2013 thru 2016, this relationship was broken. During those years, production in the Louisiana Haynesville shale remained constant, despite the number of drilling rigs shrinking, due to well production from new wells in the Haynesville increasing since 2013. The production increase can be attributed to some of the following improvements in drilling technology:

- Longer laterals. In the late 1980's, a small diameter 1,000 meters drilled crossing was a considerable achievement, but with the development of bigger and better rigs, improvement in drilling bits and drilled rock strengths, now pushing lengths in excess of 4,000 meters, are being achieved.
- Directional drilling. Usage of geo-steering, a new technology in horizontal directional drilling used to keep a wellbore in a particular section of a reservoir to minimize gas or water breakthrough and maximize economic return, and to reach a larger area from one surface drilling location.
- Increased drilling rates and drilled pipe diameters. A new design in rotary steering systems and mud motors maximize rates of penetration and minimize downtime, and the high torque capability of new rigs let them use larger diameter drill pipe and hole-opening equipment (drills pipe diameters 42", 48", 54" and 60" have become the new norm).

Since late 2016, the correlation between price and drilling rigs are in sync again. The recent increase in drilling activity has increased Louisiana gas production in the Haynesville shale plays. This production increase can be attributed to an increase in demand from new industrial activities, expansion of existent gas plants, increasing gas usage in electric generations, and expectation of LNG exports.

The EIA's October 27, 2017 Today in Energy article, "Haynesville Shale Gas Production Increases to Highest Levels since End of 2013," reported, "Recent increases in drilling activity and well production

rates are raising natural gas production levels in the Haynesville region, according to EIA's Short-Term Energy Outlook (STEO). Marketed natural gas production in Haynesville reached 6.9 billion cubic feet per day (BCF/d) in September after remaining near 6.0 BCF/d for the previous three years. The recent growth in Haynesville natural gas production is attributable to an increase in the number of active drilling rigs (starting late in 2016) and a trend toward higher per-well initial production rates.

"The United States Geological Survey estimates that the Haynesville shale play holds 174.6 trillion cubic feet of technically recoverable shale gas resources, the second-largest level in the United States after the Appalachia region.

"Compared with Appalachian resources, Haynesville natural gas reservoirs are farther underground. Most Haynesville producing wells are in areas where the formations have depths ranging from 10,000 feet to 14,000 feet below sea level. In the Appalachian region, wells are in areas where formations are 2,000 feet to 12,000 feet below sea level. Haynesville shale formation thickness is also slightly narrower, ranging from 100 feet to 350 feet, compared with Appalachia where shale thickness ranges from 50 feet to 400 feet.

"From 2009 to 2012, the Haynesville region was the largest shale gas-producing region in the country. In November 2011, Haynesville regional production reached a record high of 10.4 BCF/d. In early 2013, however, as natural gas prices started to decrease, natural gas production in the Haynesville region was surpassed by production in the Appalachian region, which includes the Marcellus and Utica formations. By late 2015, shale gas production from relatively liquids-rich areas, such as the Eagle Ford region in Texas and the Permian region, which spans parts of western Texas and eastern New Mexico, also started to surpass production from the Haynesville region."

Note: The production volumes in the EIA's article are reported for the whole Haynesville play (Louisiana Haynesville and Texas Haynesville), while the first part of the report refers only to Louisiana Haynesville.