

ARKANSAS

ENERGY & ENVIRONMENT

GEOLOGICAL SURVEY

Bekki White, Director and State Geologist

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ARKANSAS FOSSIL FUELS ACTIVITY UPDATE FOR 2018

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Little Rock, Arkansas

2019

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South Arkansas Oil and Associated Gas

South Arkansas has seen a decline in oil production for four consecutive years (Figure 1). In 2018, there were 5,003,839 bbls of crude oil produced in this region with 5,963,585 Mcf of corresponding associated gas (Figures 2). Cumulative oil production in south Arkansas as of the end of 2018 was 1,899,531,932 bbls. Approximately 40 drilling permits were issued and 36 wells were completed in 2018, while 66 wells were plugged and abandoned in the same year.

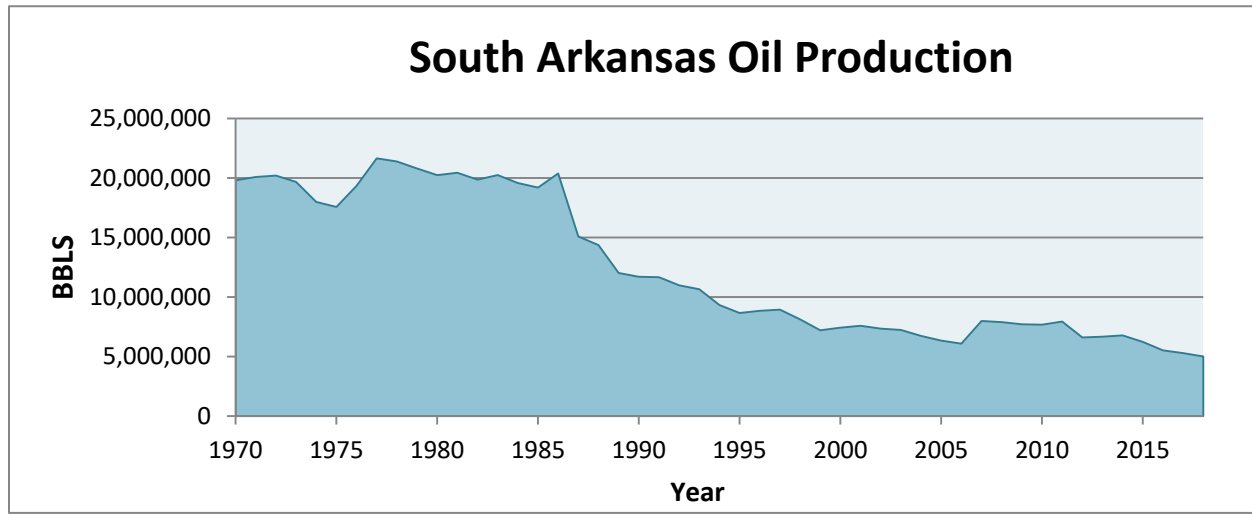


Figure 1. Annual Oil Production of South Arkansas (1970-2018)

North Arkansas Conventional Gas

The western Arkoma Basin of Arkansas has long been a gas producing province with the bulk of the production coming from a stacked succession of Pennsylvanian sandstone reservoirs. Production of conventional gas for 2018 declined by 7.1% to 66,231,919 Mcf. Cumulative production in the Arkoma Basin for all conventional gas wells and tight gas sands of the B-44 gas field producing region is approximately 7.27 Tcf as of the end of 2018. Approximately 8 drilling permits were issued and no gas wells were completed, while 64 gas wells were plugged and abandoned in 2018. Figure 3 illustrates that gas production in north Arkansas has had some modest increases since the mid-1980s, with a sharp increase in production in 2005, which is mostly associated with development of the Fayetteville Shale gas play.

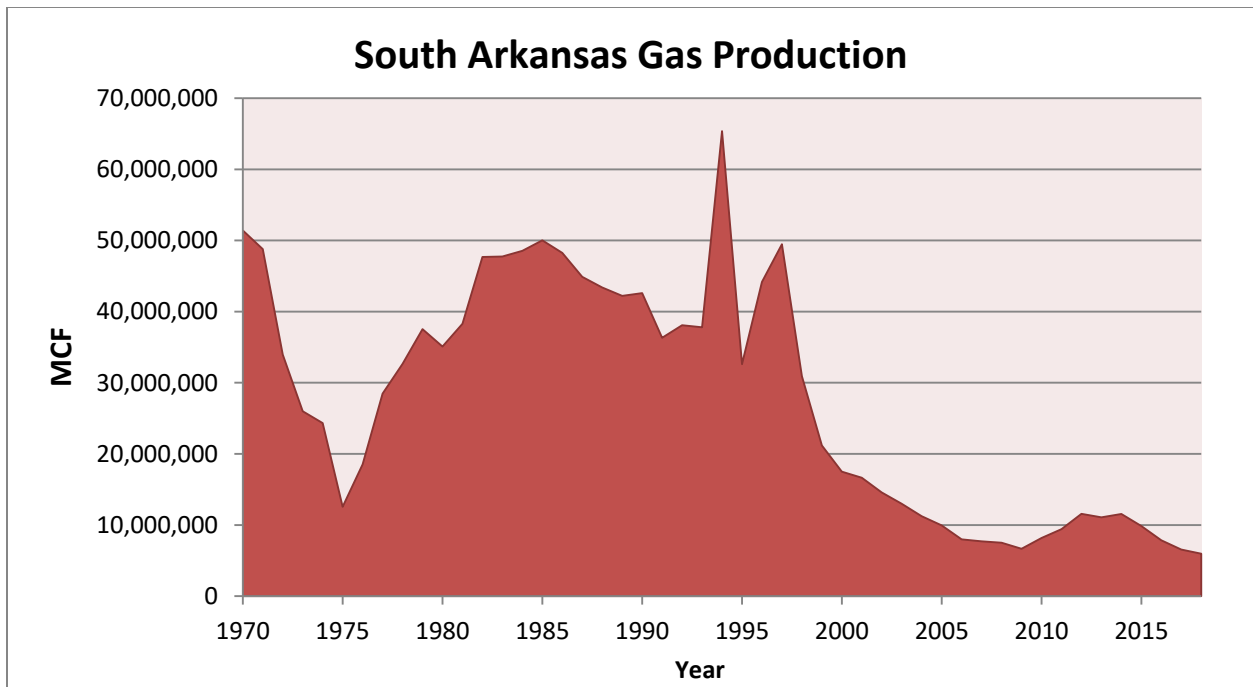


Figure 2. Annual Gas Production of South Arkansas (1970-2018)

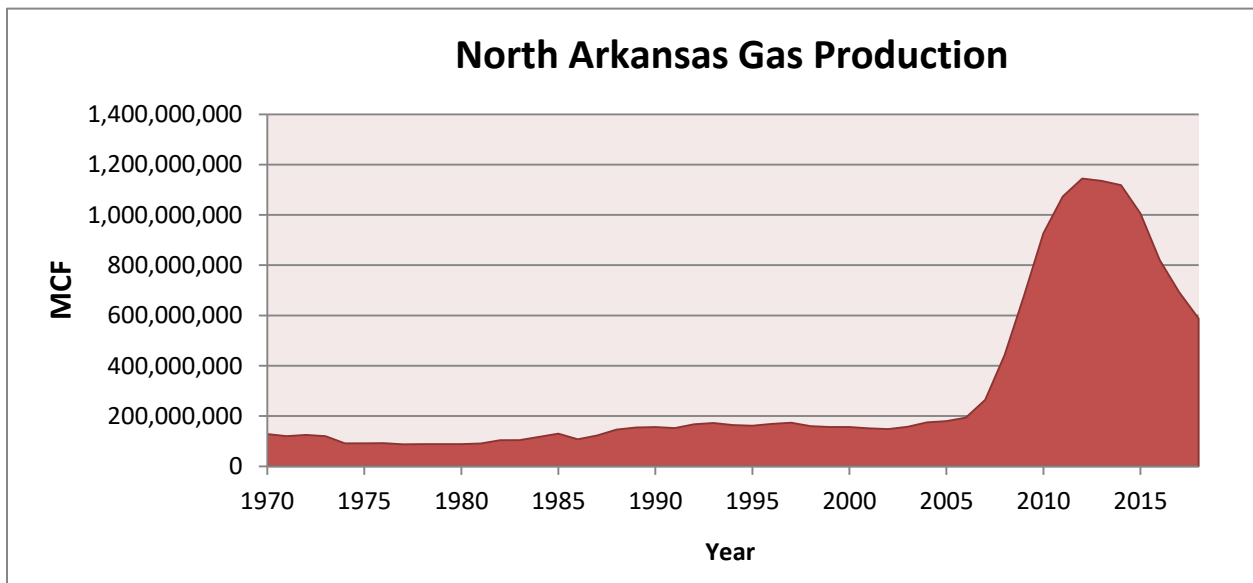


Figure 3. Annual Gas Production of North Arkansas (1970-2018)

Fayetteville Shale Gas Play

The Upper Mississippian Fayetteville Shale play is a regional shale-gas exploration and development program within the central and eastern Arkoma Basin of Arkansas. Approximately 2.5 million acres have been leased in the Fayetteville Shale gas play (Figure 4). Production of thermogenic gas from the Fayetteville began in 2004 and continues to the present.

The U.S. Energy Information Administration (EIA) reported in 2013 that the Fayetteville Shale contained 31.96 Tcf of technically recoverable gas resource, of which 27.32 Tcf was attributable to the core producing area (eastern area) and 4.64 Tcf for the remainder of the producing area (western area). A study by the Bureau of Economic Geology at the University of Texas at Austin found the play holds 38 Tcf in technically recoverable resources, of which a cumulative 18.2 Tcf are economically recoverable reserves by 2050. EIA also reported that the proven gas reserves of the Fayetteville Shale in 2017 were 7.1 Tcf, an increase over the 2016 estimate of 6.3 Tcf.

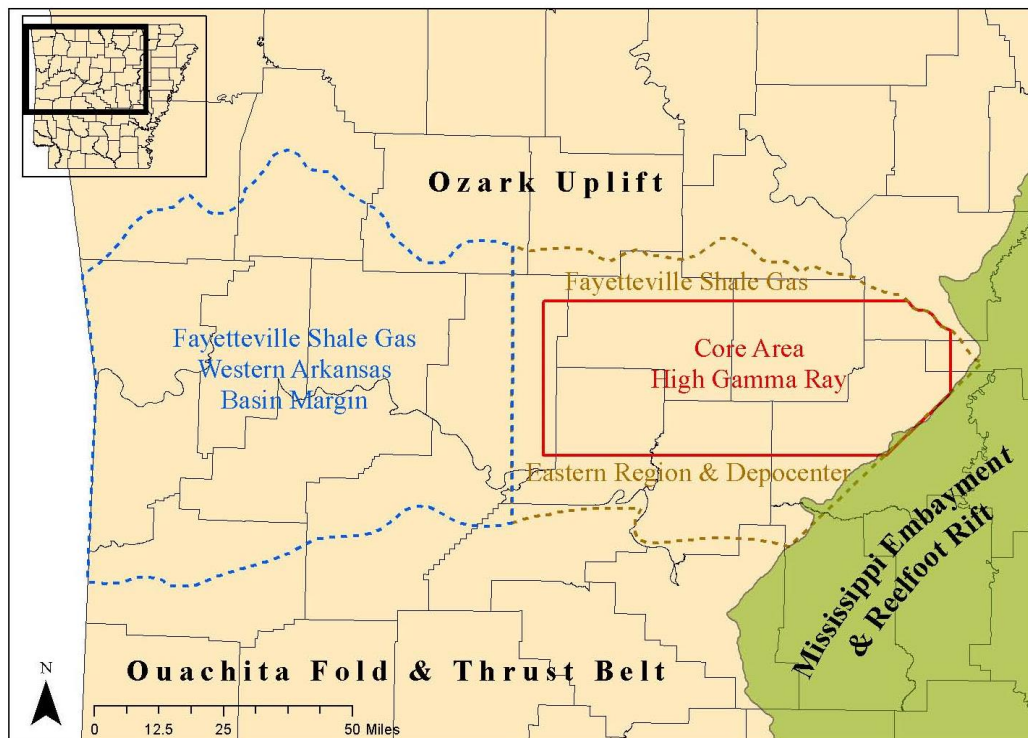


Figure 4. Primary Area of the Fayetteville Shale Exploration and Development in Arkansas

Most Fayetteville Shale wells are drilled horizontally and have been fracture stimulated using slickwater or cross-linked gel fluids. Fayetteville Shale gas production generally ranges over a depth between 1,500 to 6,500 feet. The thickness of Fayetteville Shale varies from 50 feet in the western portion of the Arkoma Basin of Arkansas to 550 feet in the central and eastern regions.

Due to a decline in drilling activity driven by lower natural gas prices, Fayetteville Shale gas production has decreased since peaking in 2013. In 2018, there was approximately 521,801,162 Mcf of gas produced in the play, a 16% decline over the last year. Estimated cumulative production of gas as of 2018 has totaled 8.52 Tcf. Initial production rates of horizontal wells in 2017 averaged about 5.3 MMcf/day. For more Fayetteville Shale information, please refer to the Arkansas Oil and Gas Commission's web link at <http://www.aogc.state.ar.us/sales/default.aspx>.

In 2018, only one rig worked for about a month in the Fayetteville Shale gas play (Figure 5). Two wells were drilled in 2018, which demonstrates a rapid decline in well completion since 2015 (Figure 6).

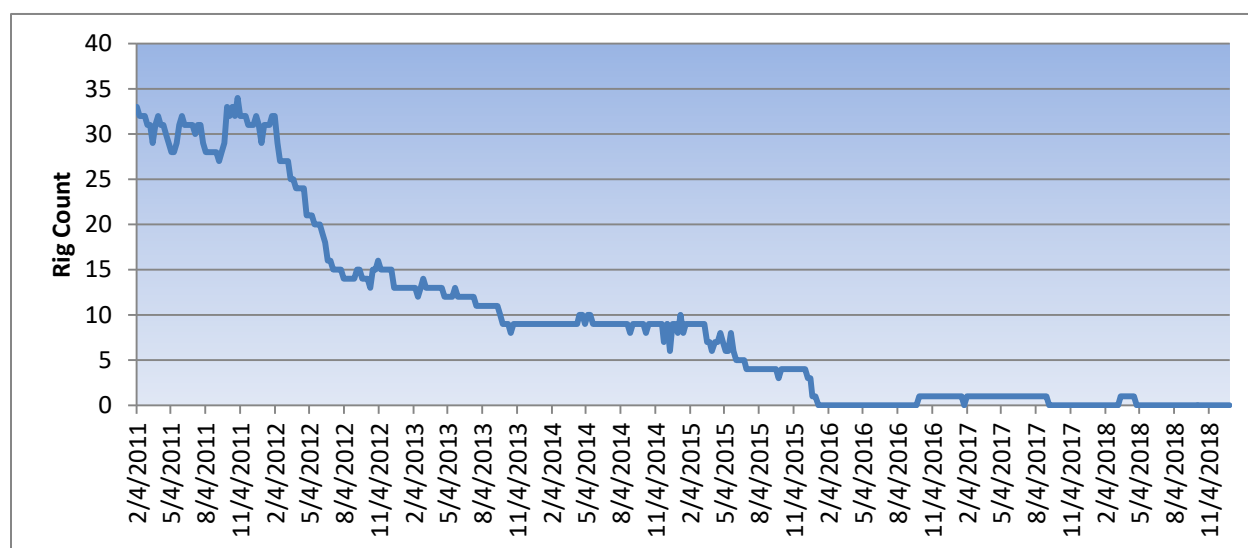


Figure 5. Weekly Drill Rig Numbers in the Fayetteville Shale Gas Play (2011-2018)

Since its inception, the Fayetteville Shale play had been dominated by three operators, Southwestern Energy (SWN), BHP Billiton, and XTO Energy (a subsidiary of ExxonMobil), until the first two exited the play in 2018. In July, BHP Billiton entered into agreement for the sale of its entire interests in the Fayetteville assets to MMGJ Hugoton III, LLC, a company owned by Merit Energy Company, for \$0.3 billion. Two months later, Southwestern Energy announced it was selling its Fayetteville Shale business and related midstream assets to Flywheel Energy for \$1.865 billion.

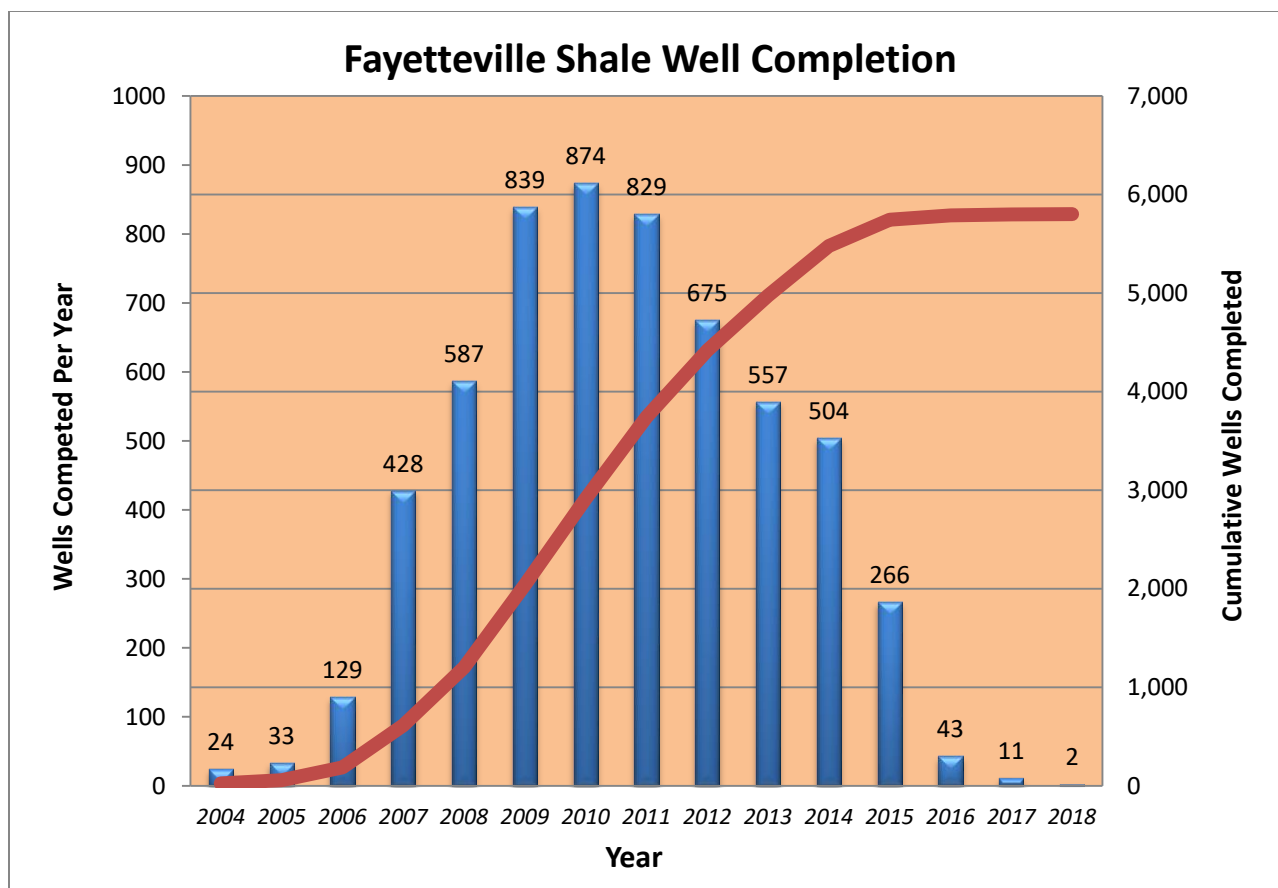


Figure 6. Fayetteville Shale Well Completion Numbers

The Arkansas Geological Survey (AGS) has completed two extensive geochemical research projects on the Fayetteville Shale and has provided this information to the oil and gas industry and the public to assist with exploration and development projects. The results of these studies were published by the AGS as Information Circular 37 (Ratchford et al., 2006) and Information Circular 40 (Li et al., 2010), which integrated surface and subsurface geologic information with organic geochemistry and thermal maturity data.

Lithium From Smackover Formation

The abundance of lithium in southern Arkansas has been studied for decades (Collins, 1974, 1976). Lithium concentrations of 370–424 mg/L are found in Smackover Formation brines (Moldovanyi and Walter, 1992). The demand for lithium has skyrocketed in recent years as lithium is a key component in hybrid and electric vehicles and energy storage systems. In January 2018, **Standard Lithium Ltd., headquartered in Vancouver, Canada**, signed an option agreement with TETRA Technologies Inc. to acquire the rights to conduct exploration, production and lithium extraction activities on up to 33,000 acres of brine leases located in an area where the Smackover Formation is known to be highly productive in southern Arkansas (Figure 7). In May 2018, **Standard Lithium** has signed up with Lanxess Corporation and its US affiliate Great Lakes Chemical Corporation, with the purpose of testing and proving the commercial viability of extraction of lithium from processed brine (“tail brine”) produced from the Smackover Formation underlying over 150,000 acres of lands in Union County. In November 2018, the Arkansas Oil and Gas Commission (AOGC) approved a joint application from Great Lakes Chemical Corporation and Arkansas Lithium Corporation, a new subsidiary of Standard Lithium, to operate a pilot plant in El Dorado, Arkansas. The pilot plant will process 50 gallons of tail brine a minute, or approximately 1,700 barrels a day, for an 18-month testing period. Arkansas Lithium expects to have its full-scale pilot plant in operation in early 2019. The goal of the plant is to produce battery-grade lithium carbonate. Lithium batteries are used in practically all battery-powered electronic devices, from cell phones to electric vehicles.

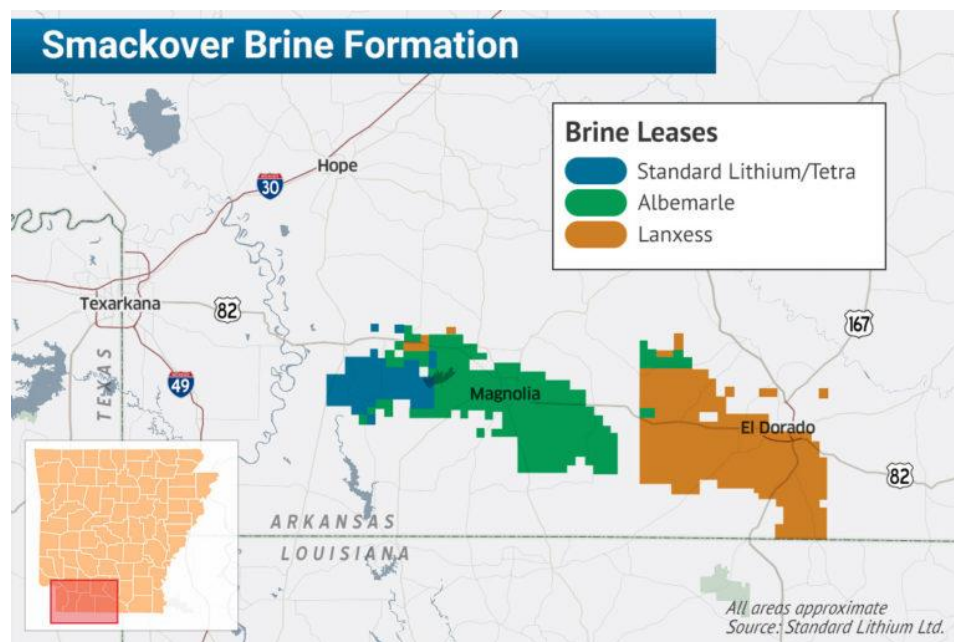


Figure 7. South Arkansas Brine Leases

Coalbed Methane

The development of Arkansas coalbed methane (CBM) resources began in 2001 and has yielded an approximate cumulative production of 31,512,221 Mcf as of year-end 2018. Since the production peak in 2007, the sales of CBM have continually declined. Fifty (50) wells contributed 930,823 Mcf to the total sales of 2018. Figure 8 shows the CBM production trend since 2001. EnerVest Operating LLC acquired all CBM wells in 2009 from CDX Gas LLC, who was previously the only producer of this resource in Arkansas until it filed bankruptcy in late 2008. Another active operator, Ross Exploration Inc., commenced CBM production in Arkansas in 2009 and possesses 3 producing wells to date. Most of the producing wells are Z-pinnate horizontal wells. The wells are completed in the Pennsylvanian Lower Hartshorne Coal and over 560,000 feet of horizontal lateral has been drilled in Arkansas. On average, approximately 15,000 feet of horizontal lateral is drilled for each of CDX's Z-pinnate wells in the Lower Hartshorne Coal. The AGS routinely updates a map which reflects producing and permitted horizontal and vertical coalbed natural gas wells and can be downloaded from the AGS website: https://www.geology.arkansas.gov/docs/pdf/maps-and-data/fossilfuel_maps/csng-lower-hartshorne-coal.pdf.

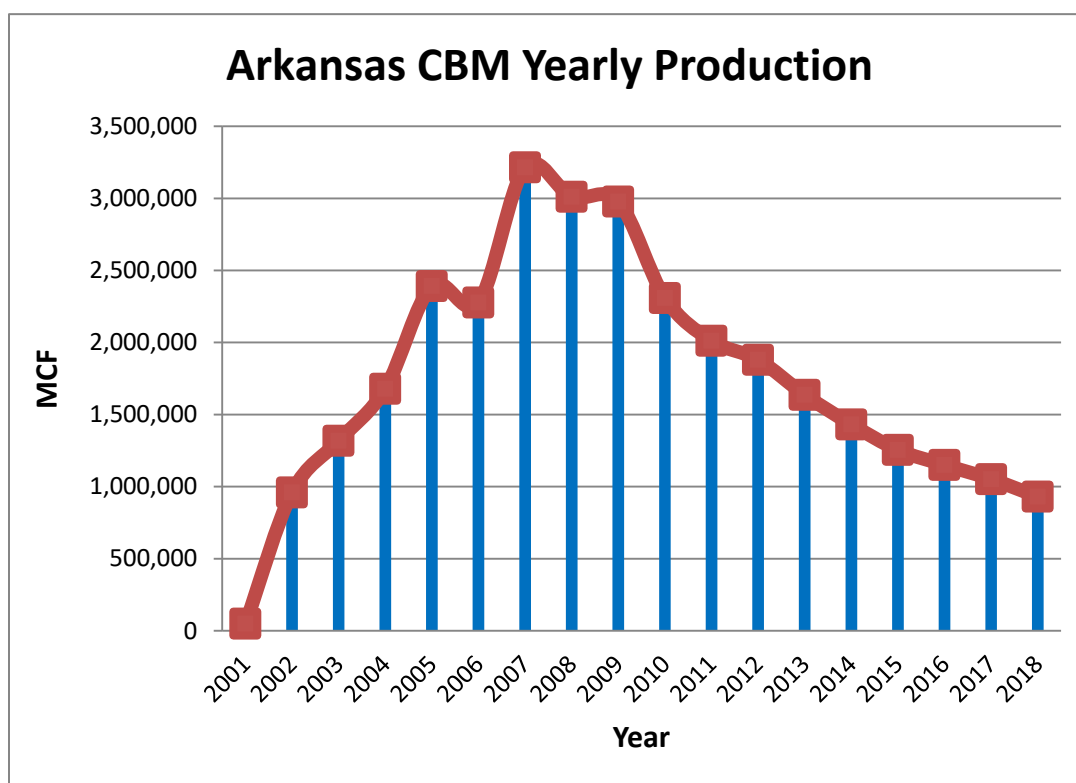


Figure 8. Annual Production of Coalbed Methane in Arkansas

Coal

Arkansas did not have any coal production in 2018. The Comer Coal Mine stopped surface coal production in 2018 and currently only leases to a sandstone quarrying operation. The underground mine operated by Sebastian Mining in southern Sebastian County discontinued mining in 2017 and has filed for bankruptcy. The new surface coal mine, Stryton Mine No. 1, has discontinued its production due to quality control problems since 2017. All of the mines in Arkansas sold their coal to the AES Shady Point coal-fired power plant in eastern Oklahoma. Figure 9 shows the coal production trend since 2000.

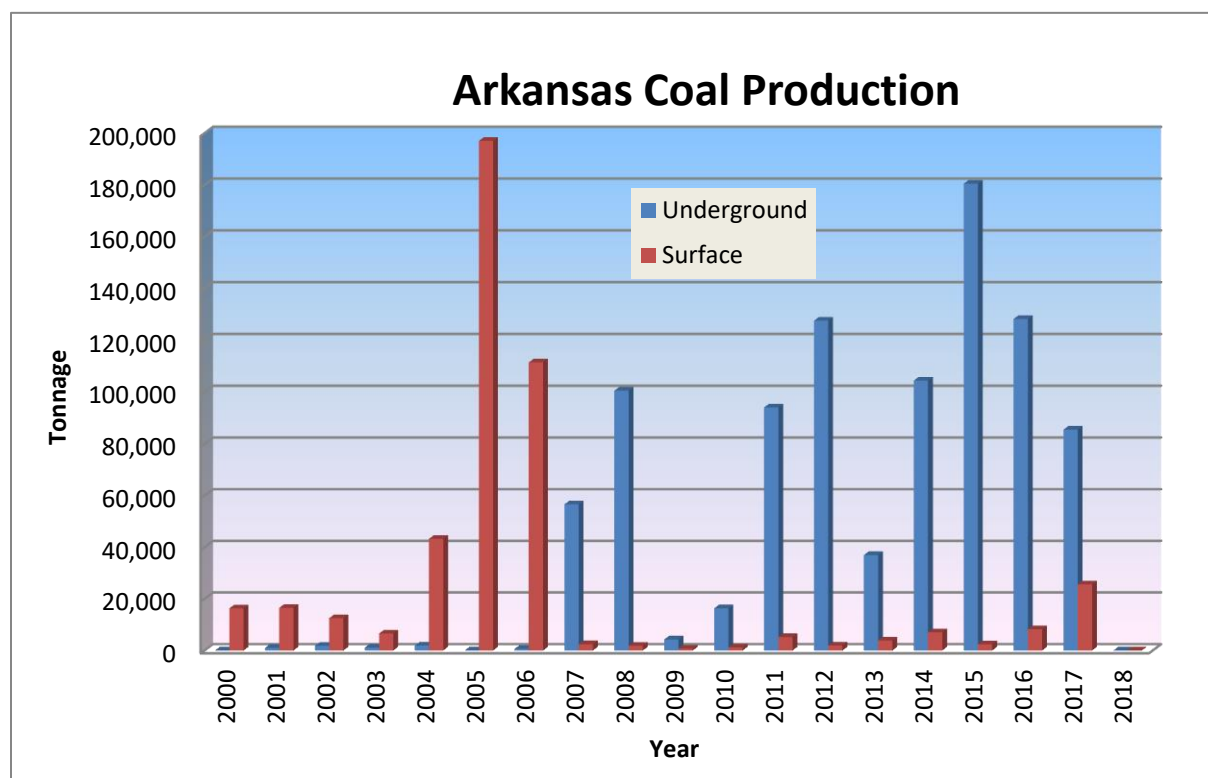


Figure 9. Annual Coal Production of Arkansas

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