

Scenario analyses in support of a structure for severance tax for natural gas and natural gas liquids

Introduction

In a July 13, 2013 e-mail, Mining and Energy Commission (MEC) Chairman James Womack tasked Dr. Ray Covington and Dr. Kenneth Taylor to prepare a reasonable baseline estimation of the production volumes of natural gas along with pricing for the shale gas basins in the State. This estimation was needed so that the Funding Levels and Potential Funding Sources Study Group could ensure the funding requirements could be met through the Study Group's recommended funding formulae.

At the September 5, 2013 MEC meeting, Dr. Vikram Rao suggested that rather than preparing an estimate of production volumes, a number of scenarios should be prepared indicating a Low, Medium and High estimate of production using early development in similar shale gas fields in other parts of the country.

A preliminary analysis of the scenarios was presented at the September 12, 2013 meeting of the Funding Levels and Potential Funding Sources Study Group. Following that presentation and with feedback from the MEC Chairman and other members of the study group, a final set of scenarios were prepared. Chairman Womack's assumptions for the estimation were:

- (A) Successful completion of pre-production exploration of the Sanford sub-basin to include 3-D seismic and 2-5 exploratory wells by mid- 2014;
- (B) MEC completion of its rule-set by 1 October 2014, NCGA adoption of the MEC's rule-set, and permit issuance beginning 1 March 2015;
- (C) Confirmation of the presence of wet gas in the Sanford Sub-basin with marketable condensates as reflected in pre-production gas sampling over the past 40 years;
- (D) Reasonable (in-stride) development of gathering lines, field separators and compressor stations to meet mid-stream infrastructure requirements throughout 2015-16; and
- (E) Sufficient market demand to sustain the price points used in the EIA price projections.

Methodology

The (B-43 Field) of the Fayetteville Shale in north Arkansas was selected as the field for these scenarios. Production of natural gas in the nine Fayetteville Shale counties has increased from 100.6 million cubic feet in 2004 to 944 billion cubic feet in 2011.

[Revisiting the Economic Impact of the Natural Gas Activity in the Fayetteville Shale: 2008-2012 – Center for Business and Economic Research, Sam M. Walton College of Business, May 2012] A diagram of the Fayetteville Shale Natural Gas Production is shown in Figure 1.

- **Production of natural gas** in Fayetteville Shale counties increased significantly from 100.6 million cubic feet in 2004 to **almost 943.6 billion cubic feet in 2011**. The highest level of natural gas production in 2011 occurred in Van Buren County, followed by White, Conway, and Cleburne counties.

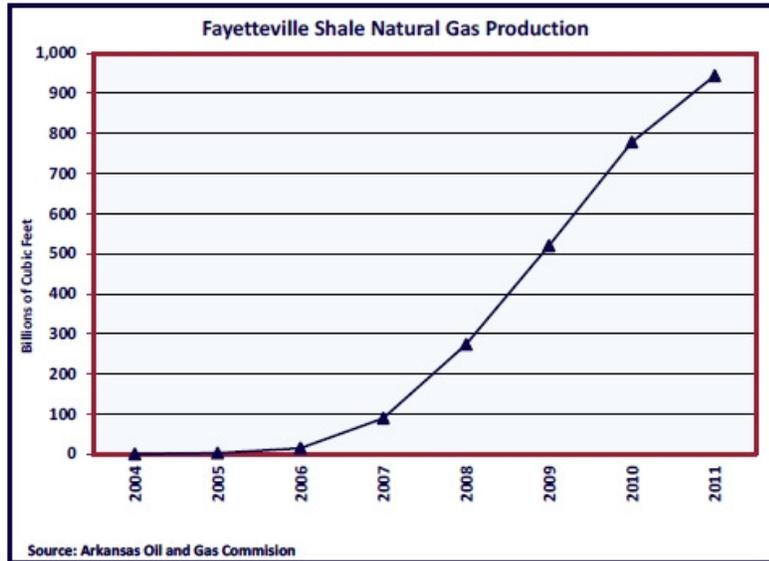


Figure 1

Starting from 2004 with 30 wells completed, the cumulative number of wells increased to 1,080 completed before 2008, and ending in 2011 with 823 completions and 4,878 total wells. A plot of the number of drilling permits issued per year is shown as Figure 70 in the Economic Report and is shown below as Figure 2.

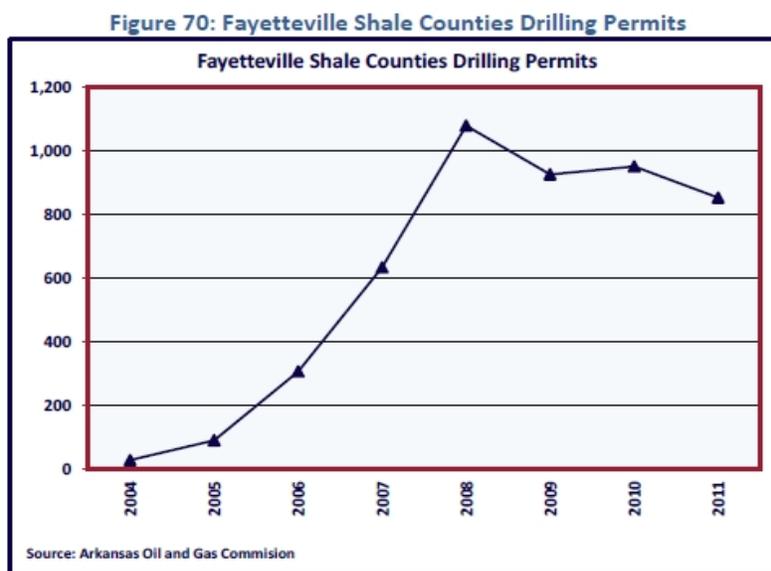


Figure 2

The natural gas production from that field is shown in Table 1. All figures in bold in the table were obtained directly from the Economic Report cited earlier. The other values were calculated from the graphs in Figures 1 & 2.

Year	number of wells completed	total number of wells	Production MCF (thousands of cubic feet gas)	average production per well (MCF)			Severance Tax (1.5%) in MCF
2004	30	30	101,000	3,367	101,000	3,367	1,515
2005	95	125	2,400,000	19,200	2,501,000	20,008	36,000
2006	315	440	14,800,000	33,636	17,301,000	39,320	222,000
2007	640	1080	89,200,000	82,593	106,501,000	98,612	1,338,000
2008	1090	2170	280,000,000	129,032	386,501,000	178,111	4,200,000
2009	930	3100	510,000,000	164,516	896,501,000	289,194	7,650,000
2010	955	4055	790,000,000	194,821	1,686,501,000	415,907	11,850,000
2011	823	4878	944,000,000	193,522	2,630,501,000	539,258	14,160,000

2,630,501,000 Cumulative Production (MCF)

Table 1

There are nine counties which contribute to the Fayetteville Shale production. For 2011, they are in rank order: Van Buren (30.5%), White (24.3%, Conway (21.0%), Cleburne (14.8%), Faulkner (7.5%), Independence (1.3%), Pope (0.3%), Jackson (0.3%) and Franklin (0.01%).

A map of these counties is shown in Figure 3, with the counties classified into three groups by production. The three level of production provides the basis for the direct comparison of the production in these counties compared to an equal area and number of wells to use in the scenarios.

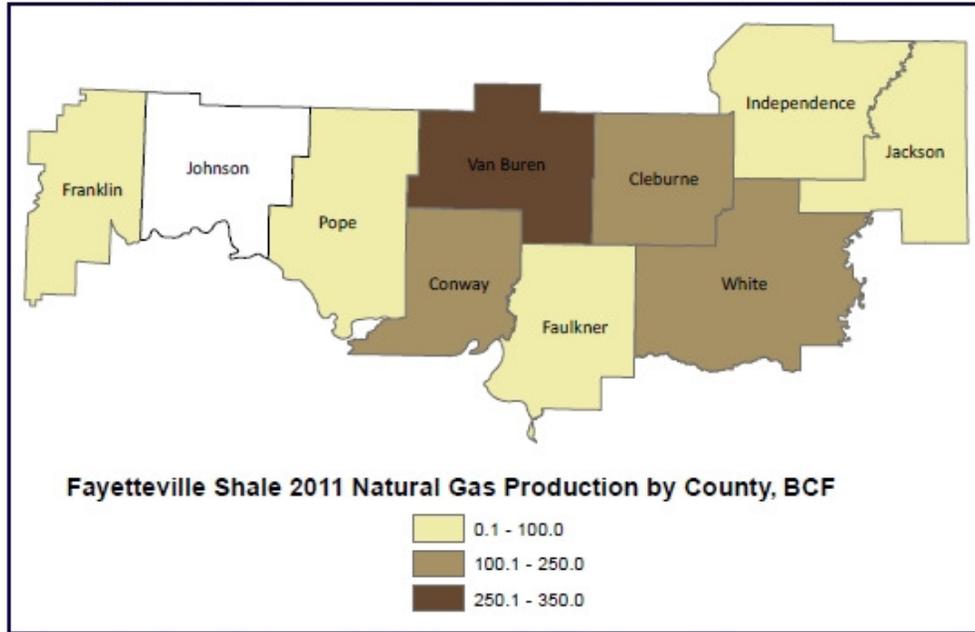
Total production is 944,000,000 MCF and the total number of wells of 4,878. Using the percentages in for each county, the number of well for Group 1-- (Van Buren) is 1,488; Group 2 -- (White) is 1,185, (Conway) is 1024, and (Cleburne) is 722; Group 3 -- (Faulkner) is 366.

The areas of the counties in square miles are Van Buren, 712; White, 1234; Conway, 556; Cleburne, 553; and Faulkner, 647. For the three scenarios, the production is calculated in terms of the number of wells at an average annual production of 130,000 MCF is compared to the equivalent area of the Deep River Basin.

For Scenario 1 – the area of Deep River Basin = 1,184 square miles. The area of Van Buren County = 712 square miles. The ratio of the areas is $1,184/712 = 1.66$. The number of wells in Van Buren County = 1488. Because the area of Deep River Basin is

larger than Van Buren County, the number of wells must be increased to make a direct comparison of the production two areas with the same density of wells; $1,488 * 1.66 = 2,470$ wells.

Figure 77: Fayetteville Shale Natural Gas Production by County, 2011



Source: Arkansas Oil and Gas Commission, Center for Business and Economic Research estimates

Figure 3

For Scenario 2 – Again the area of Deep River Basin = 1,184 square miles. The area of Cleburne County and Conway County and White County = 2,143 square miles. The ratio of the areas is $1,184/2,143 = 0.55$. Note that in this scenario, the number of wells in Cleburne, Conway and White is 2,931 which must be reduced since the area of the Deep River Basin is smaller than the area of those three counties. $2,931 * 0.55 = 1,612$ wells.

For Scenario 3 -- Again the area of Deep River Basin = 1,184 square miles. The area of Faulkner County = 647 square miles. The ratio of areas is $1,184/647 = 1.83$; Number of wells in Faulkner County = 366. The number of wells in the scenario must be increased to account for the larger area of the Deep River Basin; $366 * 1.83 = 615$ wells.

Scenario 1, Scenario 2, and Scenario 3 are shown in the attached PDF document “Scenarios_for_estimating_severance_taxes.pdf”.

Each scenario starts with the number of well (Scenario 1 – 2,470; Scenario 2 – 1,612; and Scenario 3 – 615) and back calculates the cumulative number of wells by year using the Fayetteville Shale cumulative production curve (Figure 1 and Table 1). The number of wells completed per year is then calculated by subtracting the previous year’s cumulative number from the current year number.

The number of wells is multiplied by the average production per well (130,000 MCF) to produce the production MCF. The annual production is summed into the cumulative production. The cumulative production is used to calculate the number of barrels of natural gas liquids which could be expected from such production based on the USGS Resource Assessment [“Assessment of Undiscovered Oil and Gas Resources of the East Coast Mesozoic Basins of the Piedmont, Blue Ridge Thrust Belt, Atlantic Coastal Plain, and New England Provinces, 2011”, U.S. Geological Survey Fact Sheet 2012-3075, June 2012].

In the USGS assessment, the mean total undiscovered resource of gas is 1,660 billion cubic feet of gas (BCFG) and the mean volume of natural gas liquids is 83 million barrels of natural gas liquids (MMBNGL). In order to calculate the number of gallons of natural gas liquids per thousand cubic feet of gas (MCF), one multiplies the number of barrels of natural gas liquids by 42 gallons/barrel and divide that number by the number of MCF gas.

$83 \text{ MMBNGL} = 83 \times 10^6 \text{ BNGL}$, which is multiplied by 42 gallons/barrel which equals 3.486×10^9 gallons. 1,660 BCFG equals 1.66 billion MCF (1.66×10^9 MCF). Divide the two numbers and one obtains the value of 2.1 gallons/MCF. This is the same number Dr. Rao gave at the September 12th meeting.

Discussion

An examination of the three spreadsheets shows that for Scenario 3 – 615 wells, the severance tax of 1.5 percent does not generate the required \$3.0 million annual funding need. However, when the severance tax of 5% (which is already set by statute) on liquid petroleum, sufficient revenue is generated to sustain the proposed funding needs.

For Scenario 2 – 1,612 wells, the severance tax of 1.5% on natural gas provides two-thirds of the need and when combined with a portion of the severance tax of 5% on liquid petroleum, there is more than sufficient funds.

For Scenario 1 – 2,470 wells, the severance tax of 1.5% could provide the necessary funding with only a small portion of the natural gas liquids severance tax.

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September 19, 2013