PLANNING STORY

Analyzing Whether a College/University Should Drill for Natural Gas on its Property

by Kenneth L. Kutina and Ana B. Locci

Institutions deciding whether to drill for natural gas on their property need to consider non-financial factors in addition to economic considerations.

INTRODUCTION

PRACTICALLY EVERYONE IN THE UNITED STATES TODAY is aware of the surge of interest in drilling for and producing natural gas. It is a regular news item in the popular press. In 2010, the *Chronicle of Higher Education* published a frontpage article, "Colleges Atop Gas-Rich Shale Weigh Offers from Drillers" (Carlson 2010), that described the decision facing many colleges and universities as to whether to authorize drilling for gas on their property. At that time, the authors of this article were engaged in research and analysis regarding whether drilling for gas should be initiated on a 400-acre property in a suburb of Cleveland (the "Biological Field Station") owned by Case Western Reserve University (CWRU) and located about 10 miles from the main campus. This article describes the process and methodology that were used.

DYNAMICS OF A GAS WELL

The rate of gas production from a well over time is a function of the amount of gas trapped in the reservoir being tapped, which directly influences the pressure in the gas reserve. As gas is released from the well, the volume decreases, causing the pressure in the pocket of remaining gas to decline until there is insufficient pressure to push recoverable amounts to the surface. This phenomenon produces a negative exponential pattern of gas production over time. Figure 1 shows a system dynamics diagram representing this phenomenon. The rectangular boxes represent "stock" or levels of inventory. The double-lined arrow represents the actual flow of materials or goods, and the valve-like symbol represents a controller of this flow. The single-lined arrows represent information flow, or signals, that actuate the valve and thereby the rate of flow of the material.

Figure 1 Gas Well Extraction System Dynamics



Note: This figure was created by the authors using techniques and nomenclature found in Richardson and Peterson (2000).

In our gas well example, the double line represents gas flow. The information arrow going from the reservoir of gas to the valve represents the pressure in the well based on the amount of gas still in the reservoir. The information arrow labeled "Extraction Rate" represents any external influence on the rate at which gas is extracted. For example, a well operator could keep the gas flow below what is possible in the case where the gas is only being used locally and the total available flow cannot be used. Similarly, if the gas is being pumped into



a main commercial gas line, the capacity of the line could be exceeded at some point in time, thereby constricting the flow out of the well. These situations are rare in the region where data for this study were collected. There is normally a strong economic incentive to get all of the gas out of a well as rapidly as possible, especially when it is being operated by a for-profit company.

DATA ACQUISITION

Based on their previous investigations, geologists from the CWRU Department of Earth, Environmental, and Planetary Sciences felt that natural gas on the CWRU Biological Field Station property, if it existed, would be found in the "Clinton Sandstone Formation," which is located 3,500 to 5,500 feet below the surface. Anecdotal information indicated that wells drilled in the immediate area of the Biological Field Station ranged from being very successful and productive to dry holes. Data on all gas wells drilled in the State of Ohio are recorded and available to the public in an Ohio Department of Natural Resources database (Ohio Department of Natural Resources n.d.). This database contains the original data from all applications for drilling in the state and is kept up-to-date as the wells are drilled and production numbers reported. For purposes of this study, data were collected on wells drilled in an area approximately 10 miles in radius centered on the **Biological Field Station.**

For the period studied (through 2010), 347 permits for gas wells were issued in the region of focus. Of those, 224 were productive and 123, or approximately 35 percent, were unproductive. There were 43 wells that showed active production for at least 10 years, and these 43 were selected as the sample to be used to calculate the likely gas produced from a productive well for this study. For the productive wells, average cumulative output over a 10-year period was about 90,000 MCF (MCF = thousand cubic feet).

DATA ANALYSIS

Figure 2 shows the pattern of gas production based on data aggregated from the 43 wells for which 10 years of production data were obtained. The data points show the mean production totals at each age of the wells in years. Since there is random variation in the raw data and only the data means are used in the remainder of this article, it is important to understand the degree to which the means could vary statistically. Therefore, the figure shows the 95 percent confidence interval for each of the means (indicated by the dotted lines), which ranged from \pm 7,700 MCF in the first year to \pm 1,200 MCF in year 10.

Figure 2 Mean Historical Gas Well Production by Age of Well with 95 Percent Confidence Intervals Shown by the Dotted Lines

Average Gas Well Production



Using the data described above, a negative exponential bestfit curve was derived. Figure 3 shows the fitted line versus the original data means. As shown in the figure, the R² is 0.9519, meaning that the equation for the curve explains 95 percent of the variation in the original data. Given the precision of this fit, the exponential equation was used to predict the likely annual production of gas for a possible new well and as the basis for the financial analysis that follows.



Figure 3 Fitted Gas Production Curve with Actual Data Means Shown by the Dots



Average Gas Well Production

FINANCIAL ANALYSIS

A spreadsheet-based financial model was created to calculate the net present value of a proposed future well. The model uses the exponential equation shown in figure 3 for predicting gas production. This model allows the user to easily change any of the assumptions to suit institutional characteristics or to analyze sensitivity to any variable's variation. Figure 4 lists the key variables that can be easily changed and the assumed values used in the examples in this article.

Figure 4 Assumptions for Financial Model

Price/MCF – \$3.25	Annual Operating Cost/Well – \$6,000
Property Tax – \$0	Probability of Drilling a Productive Well – 65%
Income Tax Rate – 30%	Royalty to the University with a Driller-Owned Well – 15%
Discount Rate – 5%	
Capital Cost/Well – \$300,000	

A spreadsheet-based financial model was created to calculate the net present value of a proposed future well.

CWRU, like most universities, is a nonprofit corporation. However, since drilling for gas on university property could be considered "Unrelated Business" by Internal Revenue Service rules, the university may have to pay both property taxes to the local community and state and federal corporate income taxes should it choose to drill. The example here assumes no property tax, but does assume that income tax will have to be paid on the net income to the university.

The gas price of \$3.25 per MCF used here is an approximation of the current wholesale gas price at the time this article was written. The estimates of drilling and well maintenance costs were provided by local drillers. The probability of drilling a well that produces recoverable quantities of gas (65 percent) is derived from the data described earlier. Should the institution decide to contract with a private company (normally for-profit) to drill, own, and operate the well, the typical arrangement is that the driller pays the land owner (the university in this case) a percentage of gross receipts, if any. The assumption used here is that the company pays the university 15 percent of gross receipts-a fairly generous, but possible, arrangement based on conversations with local drillers. The "discount rate" is the cost or value of capital to the institution; in this case, what the university could earn if the capital used to drill and operate a gas well were deployed in some other manner (such as invested in its endowment or used to pay down debt). For the examples in this article, a middle-of-the-road value of money of 5 percent was used.

A 10-year planning horizon was chosen for the financial analyses that follow. Figure 5 shows the financial spreadsheet model for a scenario in which the university owns the well and provides all the funding necessary to drill and operate the well.



Figure 5 Financial Re	esults for a University-Owned Well
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Year	1	2	3	4	5	6	7	8	9	10
Gas Production in MCF	24680	14,155	10,226	8,119	6,788	5,865	5,183	4,657	4,237	3,894
Total MCF	87,804									
Revenue	\$46,004	\$33,235	\$26,387	\$22,061	\$19,061	\$16,845	\$15,135	\$13,770	\$12,656	\$0
Expense	\$300,000	\$6,000	\$6,000	\$6,000	\$6,000	\$6,000	\$6,000	\$6,000	\$6,000	\$6,000
Property Tax	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Income Tax	\$0	\$8,170	\$6,116	\$4,818	\$3,918	\$3,253	\$2,741	\$2,331	\$1,997	\$0
Net Cash Flows	-\$253,996	\$19,064	\$14,271	\$11,243	\$9,143	\$7,591	\$6,395	\$5,439	\$4,659	-\$6,000
Discounted Cash Flows	-\$241,296	\$17,205	\$12,235	\$9,157	\$7,075	\$5,580	\$4,466	\$3,608	\$2,936	-\$3,592
Total Present Value of Net Income	-\$182,626									
Adjusted for Productive Well Probability	-\$118,707									

As figure 5 shows, the net present value of this investment, adjusting for the probability of an unproductive well, is about -\$119,000. Therefore, using the assumptions listed above, the scenario in which the university invests its own money to drill and operate the well is a poor investment financially.

The next calculation uses the same assumptions and planning horizon but assumes that a for-profit drilling company drills, operates, and owns the well. Figure 6 shows the financial model results for this scenario.

Figure 6 Financial Results for a Driller-Owned Well

Year	1	2	3	4	5	6	7	8	9	10
Gas Production in MCF	24,680	14,155	10,226	8,119	6,788	5,865	5,183	4,657	4,237	3,894
Total MCF	87,804									
Revenue	\$80,210	\$46,004	\$33,235	\$26,387	\$22,061	\$19,061	\$16,845	\$15,135	\$13,770	\$12,656
Royalty Income	\$12,032	\$6,901	\$4,985	\$3,958	\$3,309	\$2,859	\$2,527	\$2,270	\$2,066	\$1,898
Property Tax	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Income Tax	\$3,609	\$2,070	\$1,496	\$1,187	\$993	\$858	\$758	\$681	\$620	\$569
Netincome	\$8,422	\$4,830	\$3,490	\$2,771	\$2,316	\$2,001	\$1,769	\$1,589	\$1,446	\$1,329
Discounted Cash Flows	\$8,001	\$4,359	\$2,992	\$2,257	\$1,792	\$1,471	\$1,235	\$1,054	\$911	\$796
Total Present Value of Net Income	\$24,869									
Adjusted for Productive Well Probability	\$16,165									

In this scenario, the forecast yields an expected net present value of just over \$16,000—a positive return, but not overwhelmingly so, considering it is a 10-year commitment and especially when one takes into account some of the qualitative factors discussed later in this article.

As one would expect, the economics of drilling for gas are directly related to the wholesale price of gas on the open market. To better understand this relationship, economic models were run for the two ownership scenarios at varying prices for natural gas, and the results are plotted as shown in figure 7.

Figure 7 Projected Net Income as a Function of Gas Price





It is interesting to note that the determination of which ownership model to choose shifts from a driller-owned well to institutional ownership when the wholesale price of natural gas passes about \$9.75 per MCF. The figure also shows that the economics of an institution-owned well change from a negative present value of net income to a positive value as the price approaches \$8 per MCF.

QUALITATIVE FACTORS AFFECTING FINAL DECISION

Institutions deciding whether to drill for natural gas on their property need to consider non-financial factors in addition to the economic considerations discussed above. These include

- Environmental and nuisance impact of the 24/7 drilling operation;
- » Environmental impact of the high-volume hydraulic fracturing ("fracking") process if it is used;
- » Safety of students, employees, and visitors;
- Reactions of institutional constituencies as well as neighbors;
- » Ethical, donor, and tax-related issues of using college/ university property for non-academic-related business ventures;
- » Long-term aesthetics of the well site; and
- » Impact of providing for truck access to the well site over the long term.

The drilling operation, even in the case of the relatively shallow wells considered by CWRU, requires about a threeacre site for equipment, a containment pond, trailers, etc. Long term, the site needs to have truck access and will include storage tanks, a gas-liquid separator, and the well head itself. The site is normally fenced to keep people safely away from the equipment. Recent research (Howarth, Santoro, and Ingraffea 2011) indicates that methane gas released during the fracking process has a greater global warming potential than carbon dioxide, and there has been much in the popular press recently about the hazards and possible side effects related to the disposal of the chemically treated fracking water.

CONCLUSION

This article does not attempt to provide a "one-size-fits-all" conclusion regarding whether to drill for natural gas on a college/university's property, but rather offers guidance on how to gather relevant data on existing wells in the area, how to analyze that data to help predict the potential production from a new well, and how to evaluate the likely economics of a decision to drill. Institutional decision makers must also consider the many non-economic factors that should influence their decision whether to drill.

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