



Marcellus Center for Outreach & Research

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How Much Natural Gas Can The Marcellus Shale Produce?

The U.S. Energy Information Agency (EIA) released its 2012 Annual Energy Outlook on January 23, with the claim that the Marcellus shale contains 141 trillion cubic feet (TCF) of *unproved technically recoverable* natural gas. That estimate reignited the debate begun in spring 2011 about whether the amount of natural gas in the Marcellus Shale has been overestimated. The key to comprehending the wide-ranging estimates of the Marcellus shale's natural gas reserves lies in understanding the nuances of the terms applied to oil and gas reserve estimates—namely *proved*, *unproved*, *undiscovered* and *technically recoverable*.

Some of the most recent estimates of Marcellus shale reserve volumes are summarized below to allow a better understanding of their significance.

- In 2009, the U.S. Department of Energy's National Energy Technology Laboratory estimated the Marcellus shale's *original gas-in-place* is approximately 1,500 TCF.
- In 2009, Penn State geologist Dr. Terry Engelder estimated the Marcellus shale has a 50% probability of ultimately yielding 489 TCF of natural gas, which is considered to be *technically recoverable reserves*.
- In April 2011, the EIA reported *technically recoverable reserves* of approximately 400 TCF of natural gas in the Marcellus shale in its 2011 Annual Energy Outlook report.
- In August 2011, the United States Geological Survey (USGS) reported that the Marcellus shale contained an estimated mean value of 84.2 TCF of *undiscovered technically recoverable reserves*. The USGS estimate was widely reported by media outlets to be a nearly 80% reduction in reserve estimates when compared to the EIA's April report.
- In January 2012, the EIA stated Marcellus contains 141 TCF of natural gas that is classified as *unproved technically recoverable reserves* in its 2012 Annual Energy Outlook (early release version dated January 23, 2012), again widely reported as a significant decrease in the Marcellus shale's natural gas reserves.

Note that each estimate above contains a unique term (in *italics*) describing the volume of gas being quantified. Understanding these different terms is necessary to fully comprehend the meaning of each estimate and helps explain why the estimates vary so widely.

The following is a compilation of accepted and relevant definitions used to describe the volume of fossil fuels in geologic reservoirs.

Original gas-in-place. The entire volume of gas contained in the reservoir, regardless of the ability to produce it. An important element to understand is that the amount of gas ultimately produced from unconventional reservoirs, such as the Marcellus, is typically a relatively small fraction of the original gas-in-place since much of the gas remains bound in the relatively impermeable shale. Currently it is estimated that approximately 10% to perhaps as much as 30% of the original gas-in-place is able to be produced from shale formations over the several decade lifespan of a well. The majority of the 1,500 TCF of original gas-in-place estimated to be in the Marcellus shale will not be extractable with current technologies, however more gas may be recoverable in the future as technologies improve.

Technically recoverable reserves. Those quantities of hydrocarbons which are estimated to be producible from accumulations, either discovered or undiscovered. This quantity would be considered to be consistent with Dr. Engelder's estimate of 489 TCF and the EIA's initial estimate of 400 TCF of technically recoverable natural gas from the Marcellus shale.

Undiscovered technically recoverable reserves (UTRR). Oil and gas that may be produced as a consequence of natural pressure, artificial lift, pressure maintenance, or other secondary recovery methods, but without any consideration of economic viability. These are primarily located outside of known fields. This quantity would be equivalent to the USGS's estimate of 84.2 TCF of natural gas in the Marcellus shale.

Proved reserves. Proved reserves are those quantities of oil and gas which, by analysis of geological and engineering data, can be estimated with reasonable certainty (typically 90% certainty) to be commercially recoverable, from a given date forward, from known reservoirs and under current economic conditions, operating methods, and government regulations. (Note: these quantities are required to be reported from publicly-traded companies to both EIA and U.S. Securities and Exchange Commission using specific guidelines as they are considered to be capital assets).

Unproved technically recoverable reserves. Those quantities of oil and gas which, by analysis of geological and engineering data, can be estimated with reasonable certainty to be commercially recoverable, from a given date forward, from known reservoirs and under current economic conditions, operating methods, and government regulations but have not been proven to exist based on accepted geologic information, such as drilling or other accepted practices per SEC guidelines. This volume is consistent with the EIA's 2012 estimate of 141 TCF of natural gas in the Marcellus shale.

The EIA will be publishing the *proved reserves* of the Marcellus and other shale plays in the first half of 2012, based on the requirement that publicly-traded companies report this information to the EIA and SEC. In theory, these reported *proved reserves* could be added to the *unproved technically recoverable reserves* to estimate the total *technically recoverable reserves* in the Marcellus. Another way to consider this is that once more reserves become *proven* by additional drilling and geologic data, then the *unproved* reserve estimates would decrease commensurately (since they have become *proven*), but the *technically recoverable reserves* value would remain the same.

The EIA compared its most recent estimate of 141 TCF of *unproved technically recoverable resources* to its previous estimate of 410 TCF of *undeveloped technically recoverable resources*, and considered this a reduction in the total Marcellus natural gas reserves. This appears to be a direct comparison of different terms used for distinct metrics of gas reserves. However, further explanation by EIA is expected in the full version of its 2012 Annual Energy Outlook, which is due out this spring.

Interpreting the various reported estimates of energy reserves requires an understanding of an intricate set of specific definitions. In addition, scientists and government agencies use different models with variable input factors, assumptions, and uncertainties, and as a result may derive a relatively wide range of values for a defined reserve volume. The ability of a shale formation to produce natural gas depends largely on geologic factors such as permeability, porosity, and gas pressure in the reservoir, which drives the gas out of the shale. As more wells are drilled in relatively unexplored areas of the Marcellus reservoir, more consistent estimates of the volumes of the recoverable natural gas should become available with better data. In addition, the estimated recoverable volumes of gas will most likely increase in the future as economics change and recovery efficiencies improve with new technologies.

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