How much water is used in deep shale gas development?

Water is an essential component of Chesapeake Energy's (Chesapeake) deep shale gas development. Chesapeake uses water for drilling, where a mixture of clay and water is used to carry rock cuttings to the surface, as well as to cool and lubricate the drillbit. Drilling a typical Chesapeake deep shale gas well requires between 65,000 and 600,000 gallons of water.

Water is also used in hydraulic fracturing, where a mixture of water and sand is injected into the deep shale at a high pressure to create small cracks in the rock and allows gas to freely flow to the surface. Hydraulically fracturing a typical Chesapeake horizontal deep shale gas well requires an average of 4.5 million gallons per well.

How does deep shale gas water use compare to regional uses?

The volume of water necessary to drill and fracture deep shale gas wells represents a very small percentage of the total water resources used in each geographic region in which the shale gas is found. The natural gas industry is expected to increase the amount used by less than 1.5% in each shale gas area, and is well within available resources in the region. The largest water users are municipalities (public water supply), power generation, industrial users and agriculture. However, the magnitude of these uses varies widely from region to region. For example, in the Barnett Shale area of Texas, municipal uses account for more than 80% of water use, with

> ### How much is 5 million gallons?
>
> The 5 million gallons of water needed to drill and fracture a typical deep shale gas well is equivalent to the amount of water consumed by:
> - **New York City** in approximately **seven minutes**
> - A 1,000 megawatt coal-fired **power plant** in **12 hours**
> - A **golf course** in **25 days**
> - **7.5 acres of corn** in a season
>
> ### While these represent continuing consumption, the water used for a gas well is a one-time use.

KEY POINTS
- Water resources are protected through stringent federal, state and local permitting processes.
- Natural gas production uses significantly less water per BTU of energy produced than other fuel sources such as coal, oil or ethanol.
- Water is essential for deep shale gas development.
- Deep shale gas drilling and hydraulic fracturing uses a small amount of water compared to other uses, and does not represent a long-term commitment of the resource.

agriculture accounting for about 8%. In the Marcellus Shale area of the Appalachian Basin, power generation accounts for more than 70% of the water consumption, while agriculture accounts for approximately one tenth of one percent (0.10%). Water used in Chesapeake deep shale gas differs most notably from all other uses because it is temporary, occurring only once during the drilling and completion phases of each well. Use of this water does not represent a long-term commitment of the resource which are typically years, decades or even longer for other water users.

How much water is used in deep shale gas development compared with other energy sources?

Water and energy are interdependent. Water is essential to energy resource development. Conversely, energy resources are needed for producing, processing, distributing and using water resources. A typical Chesapeake deep shale gas well will produce between 2 and 6.5 Bcf (billion cubic feet) over its lifetime, the amount of water used to produce the gas equates to about 0.8 to 1.7 gallons for every million British thermal unit (MMBTU - one MMBTU equals about a thousand cubic feet of gas). To put this in perspective, this is less than 20% of the water needed to produce one MMBTU of coal that is ready to burn in a power plant, or less than 0.1% of the water needed to produce the same energy equivalent of ethanol for fuel. The following table compares water use per unit of energy for several energy sources.

Water requirements for various energy resources

Energy Resource	Range of Gallons of Water Used per MMBTU of Energy Produced
Deep Shale Natural Gas[1]	0.84 – 3.70[2]
Coal (no slurry transport) Coal (with slurry transport)	2 – 8 13 – 32
Nuclear (uranium ready to use in a power plant)	8 – 14
Conventional Oil	8 – 20
Synfuel - Coal Gasification	11 – 26
Oil Shale	22 – 56
Tar Sands	27 – 68
Synfuel - Fisher Tropsch (from coal)	41 – 60
Enhanced Oil Recovery (EOR)	21 – 2,500
Biofuels (Irrigated Corn Ethanol, Irrigated Soy Biodiesel)	> 2,500

[1]Source: GWPC Report
[2]The transport of natural gas can add between zero and two gallons per MMBTU.
Other Sources: DOE

Where does the water come from?

Chesapeake utilizes several sources of water in deep shale gas exploration including rivers, creeks, lakes, discharge water from industrial or city wastewater treatment plants, groundwater and the reuse of fracturing water. Chesapeake often works directly with local officials to arrange water purchases from a municipality when drilling inside city limits. This water is typically transported via temporary pipelines or trucked to drilling locations for storage prior to use in tanks or impoundments. The overall mix of water sources used depends on the region and the availability of sources near drilling sites.

Are water resources protected and regulated?

Regardless of the source, water used in the drilling and fracturing process by Chesapeake is purchased and, if necessary, properly permitted. This permitting ensures that water used for drilling and hydraulic fracturing does not interfere with the available supply for other users. It also assures that its use does not adversely affect stream flows, aquatic life, recreational resources or sensitive environments. Chesapeake works collaboratively with

federal, state and local agencies to ensure that water use for deep shale gas development is consistent with water use plans and does not adversely affect other users.

In some areas, regional river authorities have jurisdiction in multiple states. The federally established river authorities have been created to protect the water quality of the entire river basin and to regulate uses of the water. Additional approvals and permits may be required for operations in these river basins. For example, the Delaware River Basin Commission (DRBC) covers parts of New York, Pennsylvania, New Jersey and Delaware. Natural gas operators seeking to withdraw water for consumptive use in this basin must first receive a permit from the DRBC.

Chesapeake's deep shale gas development, with its comparatively small water use per unit of energy, is consistent with the nation's energy/water strategy by making a positive energy and economic contribution at a relatively low cost to the overall water supply. Chesapeake's deep shale gas has the potential to supply decades of natural gas for the U.S., while using less water than other currently available viable energy sources.

Information Sources

- ➢ Argonne National Laboratory
- ➢ Arkansas Department of Environmental Quality
- ➢ Delaware River Basin Commission (DRBC)
- ➢ Ground Water Protection Council (GWPC)
- ➢ Louisiana Department of Natural Resources
- ➢ Oklahoma Water Resources Board
- ➢ Sandia National Laboratory
- ➢ Susquehanna River Basin Commission
- ➢ Texas Commission on Environmental Quality
- ➢ U.S. Department of Energy (DOE)
- ➢ U.S. Geological Survey

About Chesapeake

Chesapeake Energy Corporation is one of the largest producers of natural gas and the most active driller of new wells in the U.S. Headquartered in Oklahoma City, the company's operations are focused on discovering and developing unconventional natural gas and oil fields onshore in the U.S. Chesapeake owns leading positions in the Barnett, Fayetteville, Haynesville, Marcellus and Bossier natural gas shale plays and in the Eagle Ford, Granite Wash and various other unconventional oil plays. The company has also vertically integrated its operations and owns substantial midstream, compression, drilling and oilfield service assets. Further information is available at www.chk.com.