

Land Use in the Oil and Gas Industry

How is land used? How do technologies and regulations minimize land use?

Introduction

All energy production requires land. Reducing the land-use “footprint” of the energy industry is an important part of limiting environmental impacts while meeting our energy needs. Advanced exploration technologies such as 3D seismic imaging, and drilling technologies such as horizontal and slanted wells, reduce the amount of land disturbed for a given amount of oil or gas produced.

The Size Of Well Sites

Drilling and hydraulically fracturing a well requires several acres around the well for the drilling rig, drill pipe storage, trailers for equipment and staff, pump trucks, data vans, and pits or tanks for water and waste storage. Once drilling is finished and the well is producing oil or gas, much of the drill site can be reclaimed. State and federal regulators require and oversee these reclamation efforts.^{1,2,3,4} The size of a well site, or “pad”, will depend on many factors, including location, land use restrictions, and the type and number of wells being drilled from the site. To take just one example, the total land footprint of a typical well site in Pennsylvania’s portion of the Marcellus Shale is five to eight acres – this includes the land taken up by water impoundments for hydraulic fracturing, access roads, and other equipment.⁵ For more information on how the land footprint of a well site

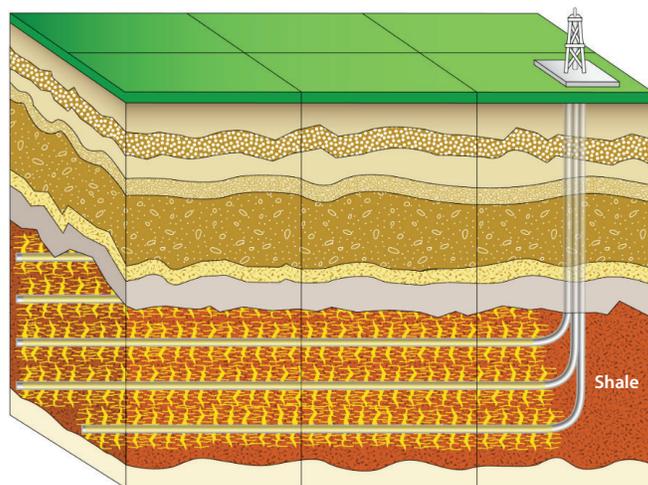
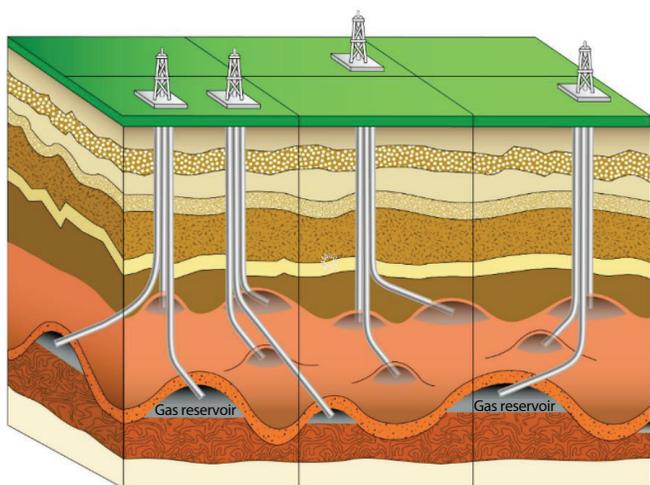


Marcellus Shale Energy and Environment Laboratory drill site near Morgantown, West Virginia. Image credit: Photo courtesy of Northeast Natural Energy.

may change over time, see “The Pinedale Gas Field, Wyoming” in this series.

Advances in Drilling Technology: Fewer, Smaller Well Sites

Modern drilling technology allows a drill to be guided horizontally underground for up to several miles.⁷ This allows operators to avoid sensitive environments and drill multiple wells in different directions from a single site. As drilling technology continues to improve, longer horizontal wells will continue to reduce the number of sites needed.



Schematics showing how multiple wells can be drilled in different angles and directions from a single site, reducing land use. Left: directional drilling to reach multiple lens-like gas reservoirs. Right: horizontal drilling and hydraulic fracturing of shale. Image credit: Government Accountability Office.⁶

Advances in Seismic Imaging: Fewer Unproductive Wells

Exploration for oil and gas requires a detailed image of the rocks below the Earth's surface. Seismic imaging – like an ultrasound for the Earth – helps geoscientists to identify rock layers that are most likely to contain oil and gas, reducing the number of unproductive wells that are drilled. This in turn improves the land-use efficiency of oil and gas production. In the early 1970s, only 60% of wells drilled in the U.S. successfully hit an economically viable oil or gas deposit. By 2005, this had improved to 90%, due largely to improvements in 2-D and then 3-D seismic imaging, as well as other tools for monitoring and analysis.⁸ This improvement has been seen not only in newly explored areas but also in existing oilfields, where a more detailed image helps operators to drill new wells in the most productive parts of the field.

Changes in a Well's Footprint Over Time

The initial development of an oil- or gas-producing area involves acquiring seismic information and drilling wells to identify the total size of the oil or gas reservoir and define the areas likely to be most productive. This process largely uses single-well drilling sites with a high land-use footprint.

Once this initial effort is completed, the relative land disturbance decreases as multiple wells are drilled from each site, unproductive areas are avoided, companies use centralized equipment and fluid handling facilities, and pipelines replace trucks for moving water, oil, and gas.

Once a well starts producing oil and/or gas, the drilling equipment is removed and much of the site is remediated. Supporting infrastructure, such as tanks, pipelines, and access roads, remain in place as long as the well is active, which may be many decades. Automated data collection can reduce the number of trips needed and the resulting land disturbance.

When a well is decommissioned, states require the operator to remove all surface equipment and plug the well with cement. State regulatory agencies maintain plugging records, which are commonly publicly available.⁹

Unproductive wells may sit idle for years, and are sometimes abandoned without being adequately sealed, especially when

companies go out of business. Improperly abandoned wells pose particular environmental risks – see “Abandoned Wells” in this series for more details.

Roads, Plants, and Pipelines

The land footprint of oil and gas extends far beyond the wells:

- New production areas require new access roads, pipelines, and other infrastructure.
- Natural gas must be purified and crude oil must be refined before they are used. As of 2014, there were over 550 gas processing plants¹⁰ and over 140 oil refineries¹¹ in the United States.
- Processed/refined products must be distributed by truck, rail, pipeline, or boat. Each mode of transport has different impacts on land- and energy-use – see “Transportation of Oil, Gas, and Refined Products” in this series for more on this topic.
- Other land uses include facilities for the treatment and disposal of wastewater; natural gas power plants; and gasoline service stations.

The modern energy system is vast. In areas of intense production, land dedicated to oil and gas activity can be very high as a proportion of total land use. Overall, however, the high energy density of oil and gas results in relatively little land disturbance for a large amount of energy production.¹² As the national and global energy sectors evolve over time, minimizing the land footprint of all energy technologies remains a key issue in attempts to balance energy production and environmental protection.

References & More Resources

For a complete listing of references, see the “References” section of the full publication, *Petroleum and the Environment*, or visit the online version at: www.americangeosciences.org/critical-issues/petroleum-environment

Jones, N.F. et al. (2015). The Energy Footprint: How Oil, Natural Gas, and Wind Energy Affect Land for Biodiversity and the Flow of Ecosystem Services. *BioScience*, 65(3), 290-301. <https://academic.oup.com/bioscience/article/65/3/290/236920>