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. Finding the land-use footprint of the energy industry is an important part of finding appropriate impacts of energy development on the environment. Techniques include the use of land-use maps that show the footprint of oil and gas development. The footprint of oil and gas development can be minimized by using techniques such as horizontal and vertical wells, which reduce the amount of disturbance to the environment.

The Size of Oil Wells Sites

Horizontal drilling techniques allow for a smaller footprint on the land used for extraction. The footprint of a vertical well is much larger than that of a horizontal well. The size of the footprint of a horizontal well depends on the size of the reservoir and the location of the oil and gas. The footprint can be minimized by using techniques such as horizontal and vertical wells, which reduce the amount of disturbance to the environment.

Advances in Drilling Technologies: Fewer, Smaller Wells

Modern drilling technology allows for a smaller footprint on the land used for extraction. The footprint of a vertical well is much larger than that of a horizontal well. The footprint can be minimized by using techniques such as horizontal and vertical wells, which reduce the amount of disturbance to the environment.

For more information on how the footprint of a well is minimized, you may wish to see "The Petroleum Gis Field, Wyoming" by Stites.
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.\textsuperscript{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.\textsuperscript{5} For more information on how the land footprint of a well site 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. 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.

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. 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. 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 plants and over 140 oil refineries 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. As the national and global energy sectors evolve over time, minimizing the land footprint of all energy technologies remains a key topic in attempts to balance energy production and environmental protection.

More Resources


References

2 Kansas Office of Revisor of Statutes – Kansas Statutes Chapter 55: Oil and Gas, Article 1: Oil and Gas Wells; Regulatory Provisions. 55-177: Removal of structures and abutments from lands after abandoning wells; exception.
5 Penn State Public Broadcasting – Explore Shale: How much land in Pennsylvania has been affected by Marcellus Shale drilling? Based on data from FracTracker Alliance and the Pennsylvania Department of Environmental Protection.
9 Railroad Commission of Texas – Oil and Gas Well Records.

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