

## Worldwide shale resource plays and potential

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The United States is now energy independent in natural gas resources perhaps for the next 30 to 100 years due to the development of unconventional shale-gas reservoirs. Despite this success the development of similar tight reservoirs in other parts of the world has been slow to follow suite despite the need for natural gas especially in Europe and China. While the reservoirs are uniquely recalcitrant due to their nanodarcy permeability and low porosity, they contain vast amounts of hydrocarbons. Despite the success of independent petroleum companies in developing shale-gas, natural gas is generally underutilized despite its abundance and being the lowest carbon dioxide emitting carbon-based energy source.

Unconventional shale resource plays include both shale-gas and shale-oil resource plays. Shale-gas plays include both biogenic and thermogenic systems, but thermogenic systems are by far the most productive. Thermogenic shale-gas plays range from low thermal maturity with modest flow rates (e.g., New Albany Shale, Illinois Basin) to gas window maturity with much higher rates (e.g., Barnett, Woodford, Fayetteville, and Muskwa shales). The highest flow rate systems are hybrid systems where mudstone is intermittently mixed with siliceous, carbonate, or silty lithofacies. Examples of this system type are the Haynesville, Bossier, Marcellus, Lewis, and Montney shales.

Shale-oil plays are mudstone systems containing producible oil (not oil shale systems requiring heating of organic matter). These are subdivided into three system types consisting of highly fractured, hybrid, or mudstone shale-oil plays (e.g., Monterey, Bakken, and Barnett shales, respectively). Bakken tight oil producible reserves are estimated to amount to 5 billion barrels given present day technologies for development.

As need for hydrocarbon resources has escalated, efforts are now underway worldwide to develop shale-gas. Exploration efforts are underway in Europe, Africa, South America, Asia, and Australia-New Zealand.

The purpose of this paper is to provide general characteristics of the existing and potential shale resource plays in North America as well as globally.