Changes in Industry Brought about by the Shale Revolution

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Technological breakthroughs have made it possible to extract oil and gas efficiently from the abundant reserves found in the shale strata (henceforth “shale oil/gas”). The growth in the amount of recoverable oil and gas has led to a shift in the global energy outlook. Known as the shale revolution, this transformation has helped the US to enhance its energy self-sufficiency as well as to supply energy at a lower price. In addition to the energy sector, including power generation, the shale revolution also has a considerable impact on industries that make use of natural gas as a raw material, such as the chemical, fertilizer, and iron/steel industries.

1. Energy Outlook after the Shale Revolution in the US

Technologies to mine oil and gas efficiently from the shale stratum were established in the US around year 2000. They include: (1) horizontal drilling, drilling technology aiming at shale strata distributed horizontally; (2) hydro-fracturing, technology that recovers resources by creating fractures in the shale stratum using high-pressure fracturing water; and (3) microseismic, technology for identifying accurately the position of the fracture in the shale stratum (Figure 1).

According to studies by EIA (Energy Information Administration) of the US Department of Energy, the amount of technically recoverable shale oil (tight oil) reserves is 345 billion barrels, which accounts for 10% of the total technically recoverable oil reserves. Meanwhile, the amount of technically recoverable shale gas reserves is 7,795 trillion cubic feet, which accounts for 33% of the total amount of technically recoverable shale gas reserves.

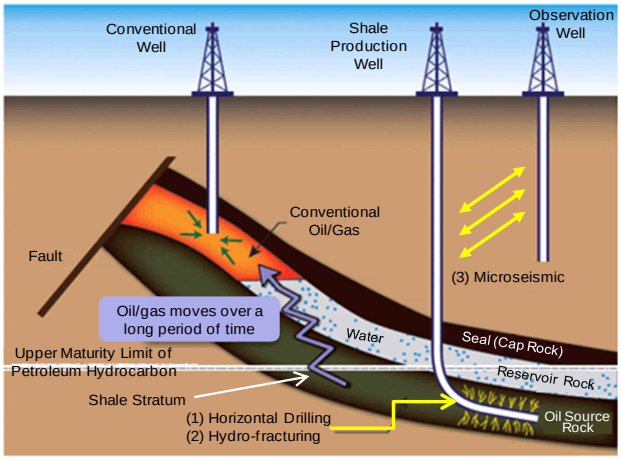

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Figure 1: Conventional & Shale Oil/Gas Drilling Techniques

The US was the first to succeed in the commercial mining of shale oil/gas. In addition to the establishment of the three technologies described above, other contributing factors include utilization of the transport infrastructure, such as the existing pipeline network, and laws that permit the private ownership of underground resources (Homestead Act). In particular, the Homestead Act has offered significant incentives for land owners to develop shale oil/gas resources.

A rise in the production of shale oil/gas is anticipated in the US, particularly in the case of natural gas (Figure 2). This has a considerable effect on the price trends of natural gas. Ever since the production of shale gas began to increase in 2008, the US has maintained an extremely low price level compared to other regions in the world (Figure 3). This drop in the price of raw fuel has helped to boost the competitiveness of US industries.

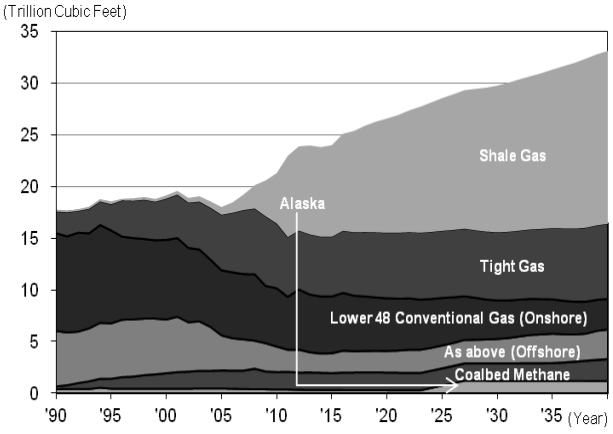

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Figure 2: Changes in the Production of Natural Gas in the US

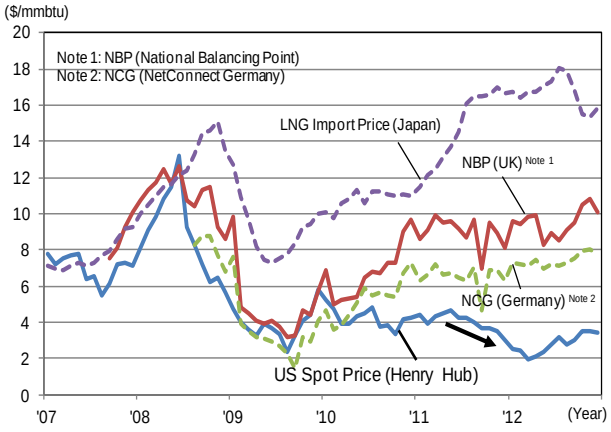

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Figure 3: Changes in the Natural Gas Price Index

2. Impact of the Shale Revolution on US Industries

The economic effects of the shale revolution on the industries of the US spread across three different levels (Figure 4).

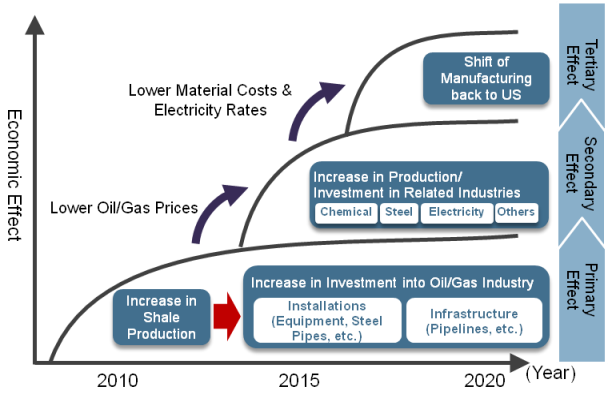

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Figure 4: Impact of the Shale Revolution on US Industries

The primary effect is the growth in capital investment and investments in related infrastructures following an increase in the production in the shale oil/gas industry. Shale oil/gas production is growing rapidly in the US. According to EIA, it is expected to become the world's largest oil-producing country as well as a net exporter of natural gas by 2020. Capital investment is increasing following the growth in production, with the amount of investment in drilling equipment anticipated to exceed a cumulative total of $1 trillion from 2012 to 2020 according to IHS, a US-based research firm. Investments in related infrastructures include, among others, those related to pipelines. The Interstate Natural Gas Association of America estimates the cumulative total amount of investments up to 2020 to be about $100 billion. In areas where the pipeline network is underdeveloped, there is a surge in demand for oil transportation via railway. According to the Association of American Railroads, the transportation volume in 2012 grew by about four times compared to the previous year. In addition to oil transportation, there is also anticipated need for the transportation of sand and water, which are required for shale development and drilling.

The secondary effect is an increase in production and capital investment following stronger cost competitiveness in industries that make use of vast quantities of oil and gas as raw materials. Lower material costs have an impact on chemicals and fertilizers, while lower fuel costs affect sectors such as gas, electricity, iron/steel and automobile (Table 1).

Table 1: Changes in the Industrial Structure Brought about by the Shale Revolution (Secondary Effect)

Direct Cause	Industry	Impact of Shale Revolution
Lower Material Costs	Chemicals	Shift from crude oil (naphtha) to natural gas (ethane) as the raw material for chemical products
	Fertilizers	Lower prices of fertilizers due to increase in the supply of ammonia fertilizers (mid/long term)
Lower Fuel Costs	Gas	Shift from oil as a source of energy for cooling and heating systems to natural gas
	Electric Power	Shift from coal-fired to thermal power generation
	Iron/Steel	Expansion in the production of direct reduced iron (DRI)
	Automobile	Production of natural gas (CNG, LNG) as fuel for large vehicles
	Transportation by Means Other than Automobiles	Production of natural gas (CNG, LNG, DME) as fuel for locomotives, ships, construction machinery, and aircraft

Note: "DRI" stands for "direct reduced iron"; "CNG" stands for "compressed natural gas"; "LNG" stands for "liquefied natural gas"; "DME" stands for "dimethyl ether."

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In the chemical industry, there has been a shift from the use of crude oil to natural gas for the production of ethylene, a raw material for basic chemical products. The lower prices of natural gas have helped to boost the cost competitiveness of ethylene production in the US, which, in turn, is expected to lead to an increase in investments in new plants as well as expansion in production.

In the steel industry, production of direct reduced iron (DRI) used for electric furnaces is expanding. In the past, manufacturers of electric furnace steel products in the US obtained reduced iron mainly through import. As the direct reduction process for manufacturing iron makes use of natural gas as the reducing agent, lower natural gas prices as a result of the shale revolution are expected to increase investments into the steel industry of the US.

For other industries, the shale revolution is expected to lead to an increased supply of ammonia fertilizers in the fertilizer industry, the introduction of gas as an energy source for cooling and heating systems in the gas industry, a shift from coal-fired to thermal power generation in the electric power industry, and the introduction of compressed natural gas (CNG) as well as liquefied natural gas (LNG) as fuel for large vehicles in the automobile industry.

The tertiary effect is the enhancement of cost competitiveness due to lower electricity rates and lower prices of materials used for production in industries such as chemical and steel, which have benefited from the secondary effect. Trends including the return of manufacturers to the US are likely to generate extensive economic effects. For instance, there are cases where companies in electrical machinery, fiber, and metal processing industries are expanding their investment in the country.

3. Future Direction

With the shale revolution contributing to a higher degree of self-sufficiency in oil and gas in the US, dependence on the oil and gas resources in the Middle East has lessened, and there are also moves to export surplus coal from the US to Europe. Exporters of energy resources, such as the Middle East, Russia, and Australia, will need to secure new purchasers in order to rechannel the resources that were planned for consumption in the US. There are also concerns about a drop in the export prices due to the competition. Meanwhile, for importers of energy sources, such as Japan, Korea, and EU nations, lower prices can be expected with the multipolarization of energy suppliers. In sum, the shale revolution has begun to extend considerable influence on the energy strategy of different countries.

Hitachi Research Institute will continue to analyze the impact of the shale revolution on the US as well as the global economy from a medium- and long-term perspective.