The effect of shale gas revolution on oil industry

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Introduction

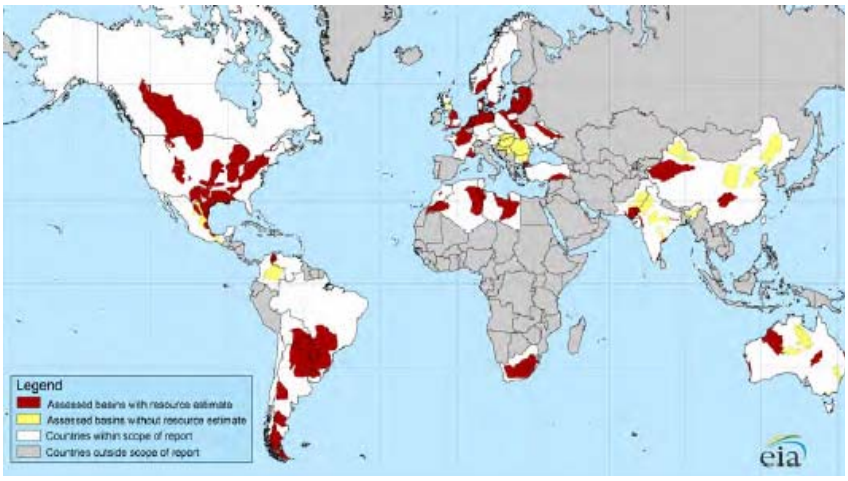
"The Shale Gas Revolution" is one of the most significant issues in the energy industry today. This "revolution" has a potential to affect not only the natural gas market but also the entire energy mix of the world. This report aims to give a brief account of the effect of "Shale Gas Revolution" on the oil market[1]. From this aspect, after a brief overview of the current shale gas development, this report discusses the impact to oil demand in the transportation sector, where oil has been a dominant fuel. The report then examines the influence on the chemical industry and the LPG market, followed by conclusions.

1. Shale gas developments

While it is a well-known fact that shale gas is dispersed in various regions of the world (Fig 1-1), United States, needless to say, is the country where there were the most successful developments. For a long time, the U.S. has been importing large amounts of natural gas from other countries, but now it is expected to become a net exporter of natural gas owing to its expanding shale resource production. According to IEA's forecast, the U.S. gas supply in 2035 is estimated to consist of about 70% unconventional gas (including tight gas and coalbed methane). Moreover, this renaissance of domestic production caused by shale gas developments is predicted to make the U.S. become almost energy self-sufficient by 2035 (Fig. 1-2).

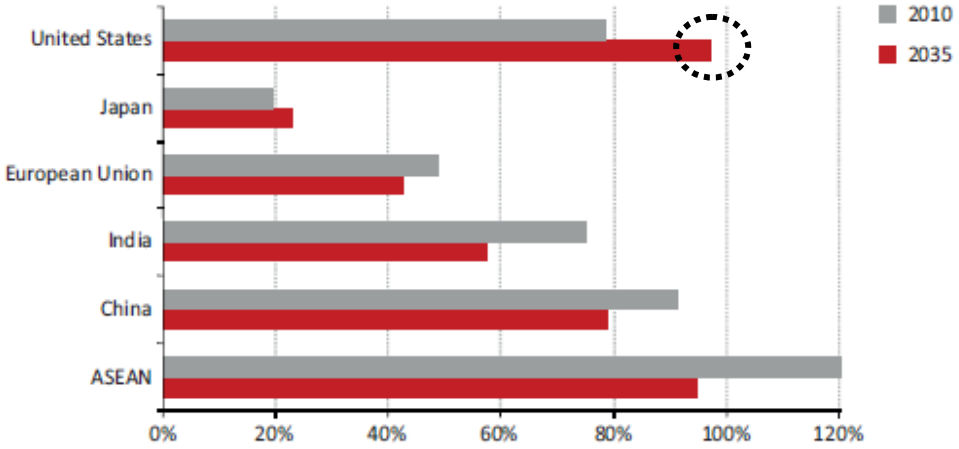
[1] The scope of this report is confined to the impacts on the oil market, and will not discuss recent changes of oil trade and logistics flow in the U.S. resulted from shale oil boom.

Fig. 1-1 Map of major shale gas basins in the world



(Source) US Energy Information Administration (EIA)、「World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States」(April, 2012)

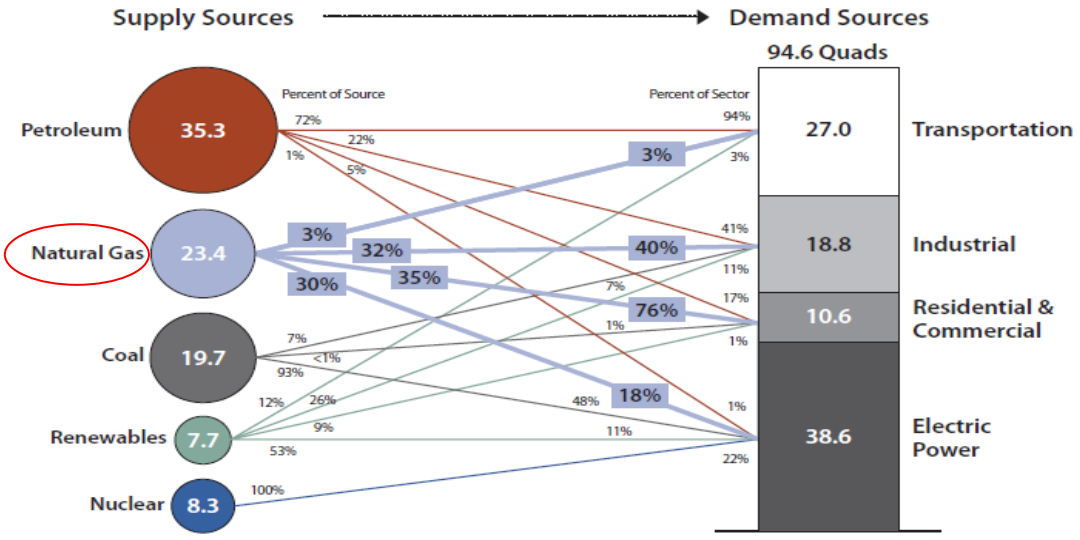
Fig. 1-2 Energy self-sufficiency



(Source) IEA、「World Energy Outlook 2012」

Because the current production of shale gas is concentrated in the U.S., it is better to focus on its impacts in the U.S. market in exploring its influence on the oil demand. If we look at an energy demand pattern, oil is primarily used in the transportation sector, while natural gas is mainly used in the residential/commercial, industrial and power generation sectors (Fig. 1-3). The following sections examine to what extent natural gas can replace oil.

Fig. 1-3 Natural gas demand in the U.S.



(Source) EIA、「Annual Energy Outlook 2009」

2. Effect to Transportation Sector – Natural Gas Vehicle

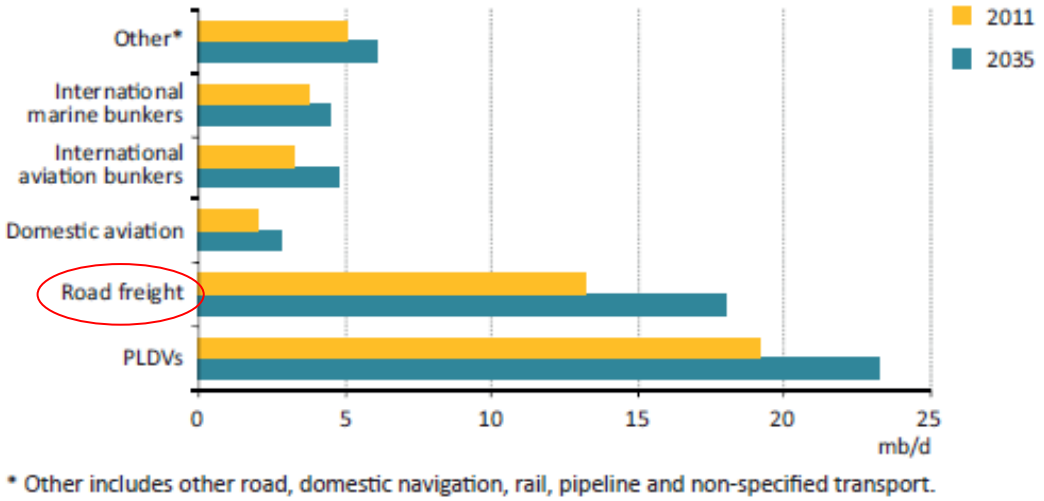
Oil has been the dominant fuel in the transportation sector for a long period of time; however, the low gas price and high oil price may lead to substitution of oil with natural gas in the sector. Natural gas in the transportation sector is used in two ways, compressed natural gas (CNG) vehicle and liquefied natural gas (LNG) vehicle. Presently, CNG vehicle is mainly used in the public transportation sector, the characteristic of which is a short- and medium-range operation and with a regular route such as buses and carrier services. Meanwhile, LNG vehicle has an advantage to hold three times more fuel and thus cover more mileage than CNG vehicle by lessening gas volume according to Korea Gas Corporation's research[2], but a low temperature tank needs high cost and has difficulty in downsizing. It therefore needs more time to be extensively commercialized.

If we look at the future oil demand prospect, according to IEA's forecast, the fuel for road freight sector will see the biggest increase among all transportation modes (Fig. 2-1). Because public transportation and carrier services where CNG vehicles can be extensively used are included in this road freight sector, the growth potential for the

[2] This research was done by a researcher (Han, Jeong Ok) of Korea Gas Corporation in 2007 and was released in the Korea Gas Union journal. – Title: The present condition of technology development and the prospect of supply in NGV industry.

demand may seem substantial.

Fig. 2-1 World Transport oil demand by sub-sector



(Source) IEA、「World Energy Outlook 2012」

In order to promote natural gas vehicle utilization, the most essential factor is certainly the sustained price gap between oil and natural gas and this factor will be a basic premise of a switch to natural gas vehicles in the future. Another important factor is government policy such as car purchase subsidy and support for installing gas stations, because the gradual spread of natural gas vehicles will not be guaranteed only with price competitiveness. The expansion of these vehicles has to be considered not only from the economic viewpoint but also from the standpoint of environmental consideration such as reducing CO_2 emission. Actually, the U.S. government introduced a policy to decrease CO_2 emissions through enhancement of fuel efficiency in 2011[3]. In this policy, the levels of such CO_2 emissions and fuel efficiency are measured on a per-vehicle basis of each automobile manufacturer, and the policy provides an incentive to the manufacturers to produce more natural gas vehicles to meet the required target[4]. The coverage of such preferred vehicle types is not confined to natural gas vehicle but

[3] This regulation includes both a fuel efficiency regulation [CAFE (Corporate Average Fuel Economy) standard proposed by NHTSA (National Highway Traffic Safety Administration)] and CO_2 emissions regulation [GHG (Greenhouse Gas) standard proposed by EPA (US Environmental Protection Agency)].

[4] All automobile companies in the U.S. have to satisfy both CO_2 emissions and fuel efficiency standard according to this regulation. Particularly, when the average CO_2 volume of each company is being calculated, NGV plays a role in reducing its average level. Each NGV is counted as more than one vehicle for calculating CO_2 emissions per vehicle in 2017-2021. [1.6 in 2017-2019, 1.45 in 2020 and 1.3 in 2021]

also include electric vehicles or fuel cell vehicles. This policy will certainly make car manufacturers to pay more attention to gas vehicles.

Another use of natural gas in the transportation sector would be in the water transport sector. This new trend has gained more attention in consideration of regulations on sulfur oxide, nitrogen oxide and CO_2 emissions. Due to its sulfur content, fuel oil used in ships usually emits more sulfur oxide than personal light-duty vehicles. IMO (International Maritime Organization) has set a limit on emission from vessels[5], and such a more strict regulation may encourage shipping companies to adopt more natural gas-operated vessels. Besides these environmental considerations, economic benefits (compared with marine oil) based on cheaper natural gas may create a new market to gas-operated vessels. In spite of some barriers like decreased cargo space caused by relatively large fuel (LNG) tank, this new technology is expected to attract more attention in the shipping industry.

Yet several significant barriers for extensive deployment actually exist at present. First of all, the biggest barrier for expanding these gas vehicles is fueling infrastructure that requires massive investments. Almost all of countries where NGV is being operated now have a minimal number of gas fueling stations. In case of the U.S., there are only about 1,000 CNG stations and 50 LNG stations and the stations are not evenly distributed, with 22% of CNG stations and 68% of LNG stations located in California, (the western part of the U.S., Fig. 2-1)[6]. To increase the demand of gas vehicles (especially, the expansion of LDV sector), the extensive gas supply infrastructure has to be preceded. It is however still hard for such gas supply network expansion as it needs a significant amount of investments.

Secondly, relatively high price of natural gas vehicles also hinders the extensive deployment beyond public transportation and carrier services. NGV has basically incremental costs because of a high-pressure fuel regulator in CNG vehicles and an insulation device in LNG vehicles. In this respect, IEA also forecasts that the share of gas in a transport sector still accounts for a minimal portion in spite of above-mentioned some benefits (Fig. 2-2).

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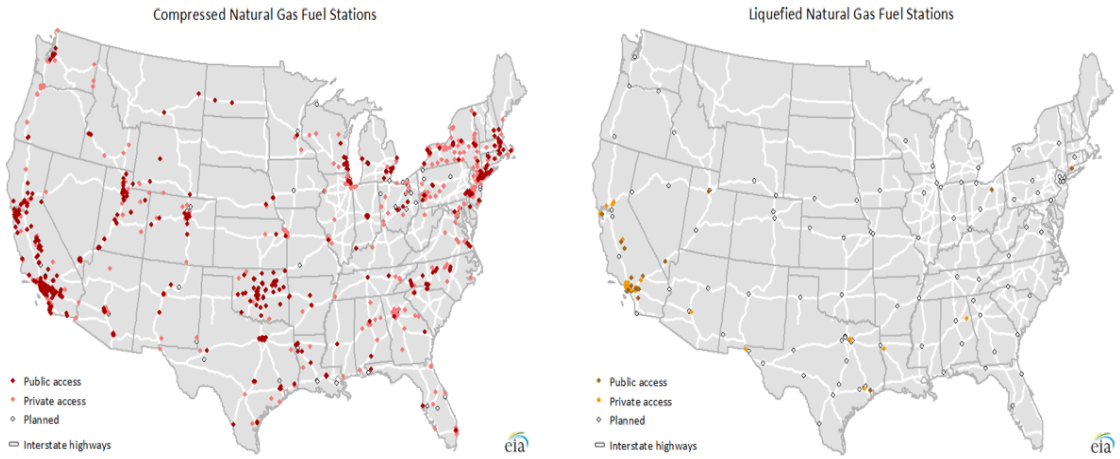
[5] IMO plans to strengthen a standard that all vessels have to follow sulfur oxide emissions limit. Outside ECA (Emission Control Area), emissions have to be limited to 45,000 ppm in 2011,35,000 ppm in 2012-2019, and 5,000 ppm in 2020

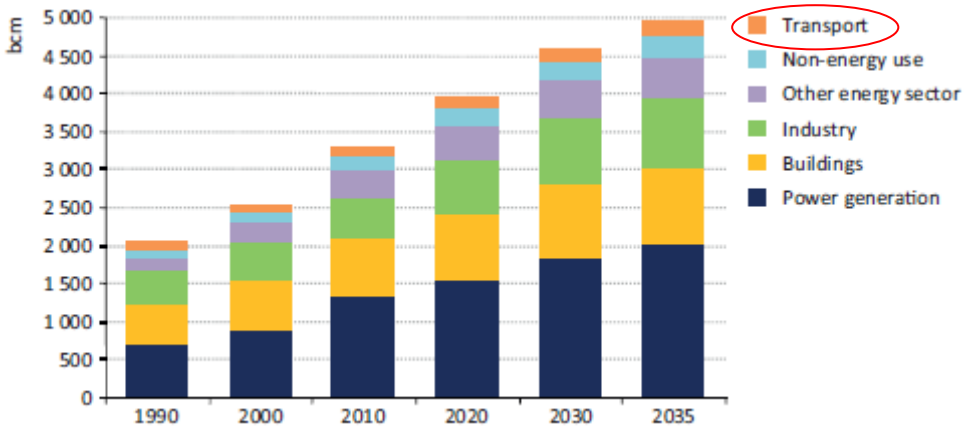
[6] Source – Annual Energy Outlook 2012

Fig. 2-1 CNG/LNG Fuel Stations in the U.S.



(Source) Energy Information Administration

Fig. 2-2 World Natural Gas Demand by Sector



(Source) IEA、「World Energy Outlook 2012」

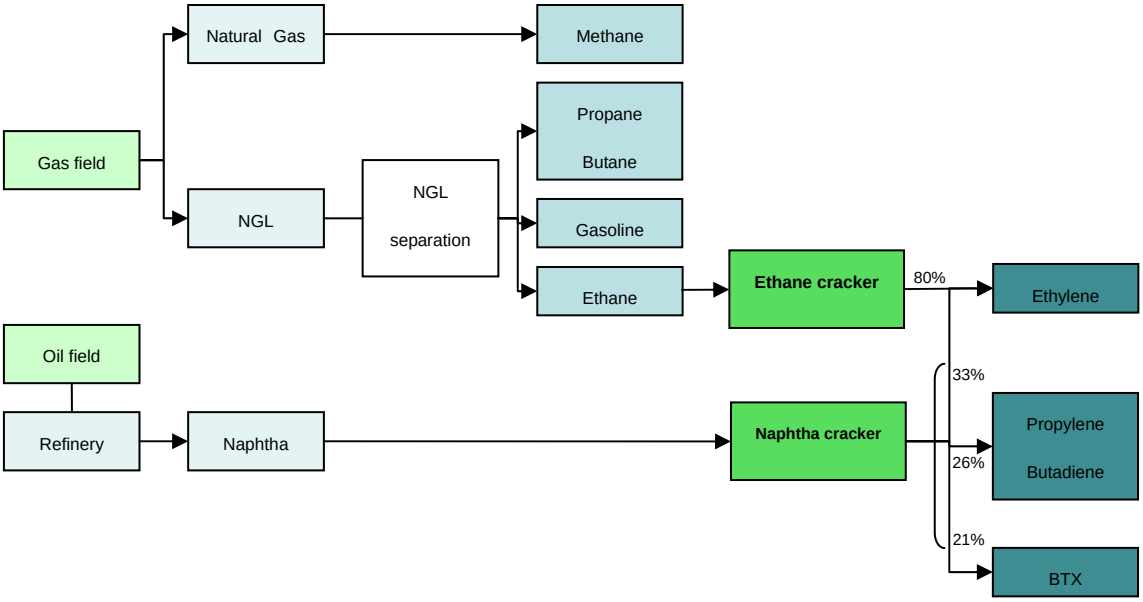
To sum up, the transportation sector will not show a remarkable change due to "Shale Gas Revolution" in the short- to mid-term because natural gas vehicles basically have drawbacks such as lack of infrastructure and relatively high purchase price. The demand switch will happen restrictively to road freight or shipping sector on the assumption that both price competitiveness and proactive support of government are satisfied. Nevertheless, it is undeniable that, in the long-term, natural gas still has a potential to substitute the current oil demand to some degree in light of its social benefits (particularly a low carbon merit).

3. Effect to Petrochemical sector

The U.S. chemical industry has become globally competitive with the current low and stable natural gas price, as this industry is basically sensitive to feedstock's price. It also has been shifting to its feedstock from naphtha to ethane because of the ethane-rich natural gas discoveries in the U.S. and greater supplies of shale gas have widened the gap between ethane and naphtha prices.

The ethane price advantage makes ethylene an apparent beneficiary. Many petrochemical companies in the U.S. announced investment plans to take advantage of a favorably low natural gas price. These plans normally include restart of an existing ethylene production unit and expansion of new ethylene crackers. On the contrary, other petrochemical products including propylene and butadiene will face a more difficult situation. These changes of feedstock to natural gas have reduced propylene production and it also has tightened supplies of butadiene, which influences price. Production of aromatics such as benzene is also affected by the shift of cracker's feedstock from naphtha to ethane (Fig. 3-1).

Fig. 3-1 Process for producing petrochemical products

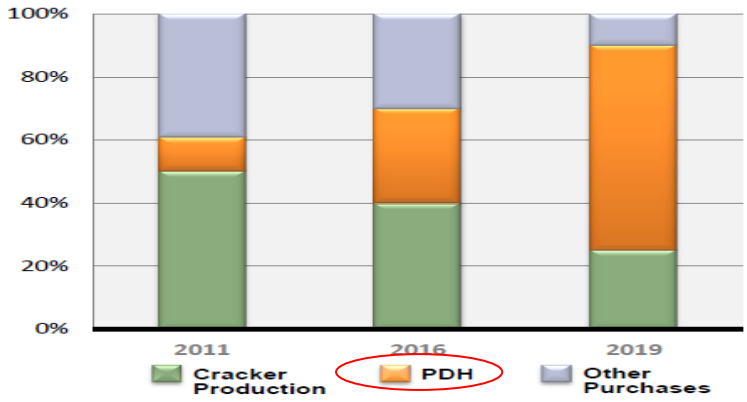


(*) Petrochemicals can be made from oil derivatives or from natural gas liquids.
(Source) Based on the materials presented by Dr. Yonghun Jung, IEEJ Seminar held in Oct. 3rd, 2012

As shale gas makes both propylene supplies tight and propane prices cheap, some companies in the U.S. such as Dow Chemical are planning to build on-purpose

production (particularly a propane dehydrogenation (PDH) plant), which takes propane as feedstock and converts it into propylene (Fig. 3-2). In the past, this process had not been seriously considered as a means to produce propylene because it was uneconomical compared with other methods like naphtha cracking or other refinery process. Now a growing number of companies which plan to expand their ethane crackers are paying attention to this process.

Fig. 3-2 Dow Chemical's plan for propylene



(Source) Presentation material released in Dow Chemical home page dated 6 December 2011

This abundant shale gas supply, however, has caused rather pessimistic prospect for naphtha crackers, particularly for those in Asia. Basically, ethane crackers are superior to naphtha crackers in terms of price competitiveness due to the difference of feedstock costs between ethane and naphtha. Nevertheless, naphtha crackers will maintain a certain portion over the total ethylene production capacity for many years to come. As noted before, the trend of expanding ethane crackers has brought about a decline of some by-products such as propylene and butadiene. Compared with ethane crackers, naphtha crackers clearly have a disadvantage of high-priced raw material, but they also have an opportunity to diversify kinds of by-products such as propylene, butadiene and BTX (benzene, toluene and xylene). From this aspect, many petrochemical producers especially naphtha-oriented producers in Asia have to focus on these products and try to sustain their total operational margins. In addition, if the global demand growth for gasoline slows down, it will lead to create a surplus of naphtha supply in the future, and then help to maintain naphtha crackers' competiveness.

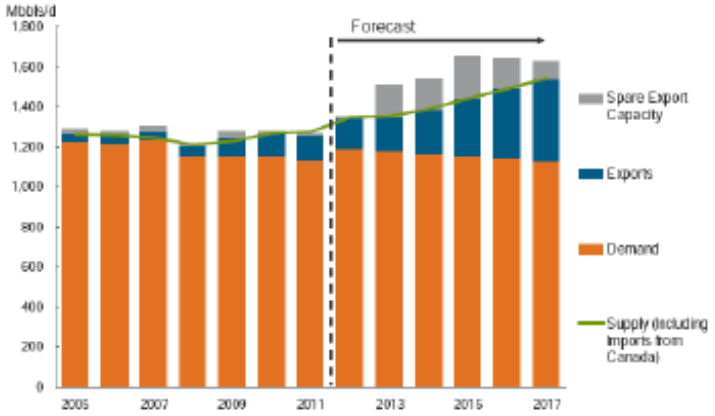
In short, expansion of ethylene production in the U.S., thanks to cheap and

abundant supply of natural gas, is sure to be a favorable factor for the U.S. chemical companies and this situation will be a threat to the naphtha crackers notably in Asia. The continuous expansion plans of ethane crackers in the U.S. have a significant effect on a trade flow of overall chemical products. Many ethane crackers benefited by low priced gas in the U.S. can eventually affect the Asian market. This trend is likely to become a threat to naphtha crackers and they have to make the best use of various types of by-products and focus on developing high value products.

4. Effect to LPG market

The shale gas is increasingly boosting the production of LPG, which is one of by-products from natural gas liquids (NGL). A projection for NGL production in the U.S. has been increasing continuously since 2008. Along with a slide of domestic price, the U.S. has become an LPG exporting country and the volume of export is expected to continue to increase gradually. Overall, LPG import and export in the U.S. was nearly balanced in 2010, but the total volume of LPG exports is now higher than imports (Fig. 4-1).

Fig. 4-1 LPG Balance in the U.S.



(Source) Energy Information Administration

The LPG export from the Gulf of Mexico has been directed to Latin America and Europe so far, but the targeted countries for exports are expanding to even Asia. In fact, Eneos Globe Corporation, a Japanese LPG distributor, recently agreed to buy 200,000 tonnes of LPG per year with Enterprise Products Operating LLC, a subsidiary of US gas

firm Enterprise Products Partners[7]. What is notable in this agreement is that its contract price is linked with the U.S. domestic price, not to Middle Eastern price (originally notified by Saudi Aramco)[8]. Also, E1 Corporation, which is the second largest LPG importer in Korea, recently announced that it would import 180,000 tonnes of LPG from the same company mentioned above.

These LPG procurement activities enable both diversification of supply sources and potential changes in pricing. In particular, the influence of LPG export countries in the Middle East can be lessened gradually if more American LPG supply is exported directly to Asian countries. Asian importing countries are able to strengthen a bargaining power towards their traditional suppliers. More export to Asia will become possible after the expansion of Panama Canal, which is scheduled to be completed in 2014. After all, the abundant LPG in the U.S. has enough potential to bring about downward trend on an international price.

Conclusion

The Shale Gas Revolution is expected to bring various positive effects through the advent of the low-priced energy supply. In respect to substituting oil, however, the shale gas development has not realized a significant size of substitution so far. Yet, there is a sign that it can contribute to slowing down oil demand growth to a certain degree. As already mentioned, impacts on petrochemical industry and LPG market has become a reality. Likewise, if the current price disparity between oil and natural gas continues, attention to NGV will remain in accordance with government policy. It is therefore essential that we have to pay attention to a profound examination of changes caused by "shale gas revolution," and understand various impacts on related industries.

Please direct inquiries to: report@tky.ieej.or.jp

[7] Eneos Globe Corporation announced this press release on its homepage in July 6th, 2012

[8] In US, there is a restriction on exporting LNG (in principle, export of LNG is permitted only in FTA agreement countries); meanwhile there is no limitation for exporting of LPG from US as LPG is regarded as petroleum product.