MARITIME TRANSPORT FOR LNG, POWER GENERATION, AND ELECTRIC TRANSMISSION

Ryuta Takashima,Tokyo University of Science, Phone +81 4 7122 1372, E-mail: takashima@rs.tus.ac.jp
Shigeki Toriumi, Chuo University, Phone +81 3 3817 1691, E-mail: toriumi@ise.chuo-u.ac.jp
Keisuke Inada, Chuo University, Phone +81 3 3817 1681, E-mail: a09.g57c@g.chuo-u.ac.jp

Overview

In Japan, all of the 50 nuclear units have been gradually shut down as a result of the accident at the Fukushima Daiichi plant. The use of fossil-fueled generation, especially natural gas has increased due to the influence. For example, in 2010, natural gas accounts 29.3% of total electricity generation, while in 2012, it increases to 42.5%. Therefore it becomes more important to select exporting countries for LNG in terms not only of geopolitics but also of economic efficiency. On the other hand, in Japan there exist no power transmission grids, which can transmit electricity power multilaterally, as in the EU. If the power grid is installed in Japan and the neighboring countries or in East Asia, it would strengthen energy security of each country. However when the economic efficiency is relatively important factor for the girds installation, by means of comparing the cost of the maritime transportation for LNG with that of electricity transmission it is necessary to evaluate economic efficiencies for two methods of energy transportation. In previous works on economic analysis for LNG transportation (Maxwell and Zhu, 2011; Messner and Babies, 2012), Messner and Babies (2012) compare a cost of LNG transport with that of natural gas via pipeline, and show a break-even point for two methods.

In this work we consider economic efficiencies for two policies of energy transport such as electric transmission and maritime transport for LNG. We calculate the costs for power generation by means of LNG transport and electricity purchase via transmission. A break-even point of the economic efficiency for both policies is derived by comparing each cost.

Methods

In this work we consider a discounted value of total cost, which is composed of fuel, operating and maintenance, and investment costs, with a lifetime of 40 years. We use cost data for natural gas-fired power in OECD/NEA (2010) in the calculation. The data is approximately the same value as in Japan EEC/CVC (2011). In order to consider maritime transport for LNG, we use a relational expression of CIF price for LNG and fuel cost for natural gas power. We calculate the distance from exporting country to importing one by means of a commercial maritime data (Lloyd's List Intelligence) and a sea lanes network data (Fig. 1). Routes of maritime transport for LNG which are used in this analysis are shown in Fig. 2. This route data provide us with a relational expression of distances from exporting countries and CIF prices, that is, fuel costs for LNG. In the calculation for the policy of electric transmission we assume that the cost of electricity purchase include transmission cost.

Results

Fig.3 shows a relationship between a distance from each exporting country to Japan and each CIF price for LNG. Each data with respect to the transportation distance and the CIF price for different exporting countries is plotted on Fig. 3. As the transport distance increase, the CIF price becomes large due to increase in transport cost. An intercept of the regression line in Fig. 3 is 30,175 yen/t, that is, the LNG price at exporting country.

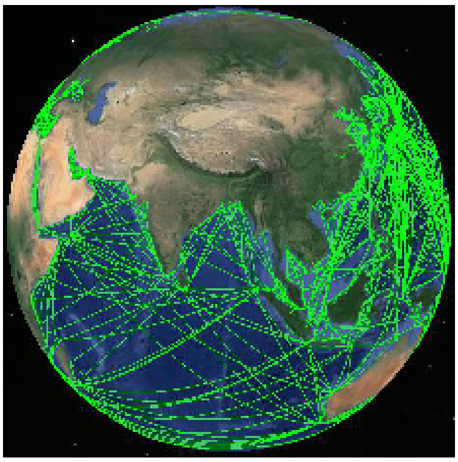

Figure 1. Sea-lanes network

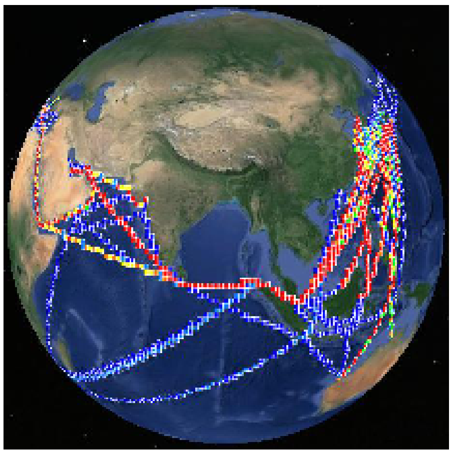

Figure 2. Transport routes for LNG

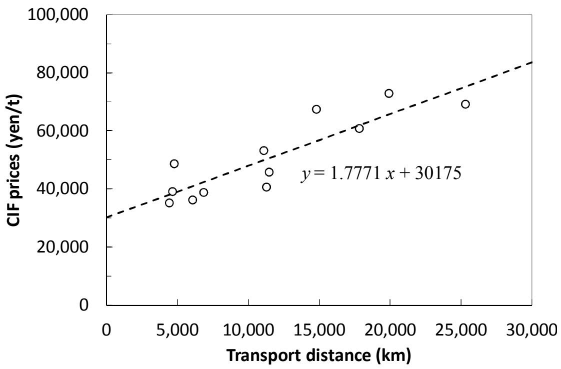

Figure 3. Relationship between the transport distance and CIF price of LNG

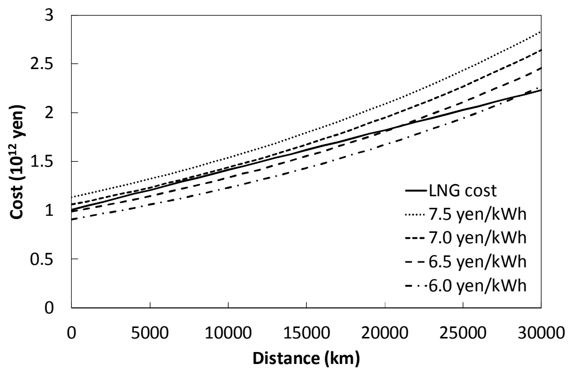

Figure 4. Electricity costs as a function of distance from exporting country

On the other hand, the price for natural gas in Russia is 651.168 yen/MMBtu (OECD/NEA, 2010; OECD/NEA, 2013). Once the unit conversion is performed to LNG prices, then the LNG price of Russia becomes 32,636 yen/t. Therefore, it turns out that the LNG price at exporting country that is obtained from this analysis is approximately the same one as that in OECD/NEA (2010). Fig. 4 shows an effect of distance from exporting country on electricity costs. In Fig. 4 the straight line and others indicate costs of power generation by means of maritime transport for LNG and electricity purchase for various prices via electricity transmission, respectively. For example, for the purchase price of 6.5 yen/kWh, the break-even point is 20,779 km. This means that if electricity is purchased from exporting country farther than distance of the break-even point, the electricity purchase has no economic merit compared to the maritime transport for LNG. In addition, as the price of electricity purchase increase, the break-even point becomes small, and then there exist no break-even points for 7.0 yen/kWh and 7.5 yen/kWh. The threshold price of electricity purchase is 6.89 yen/kWh. Thus if the purchase price is more than 6.89 yen/kWh, the electricity purchase has no economic merit. Additionally, when exporting country can sell the electricity at a higher price than a cost of power generating, and the transmission distance is shorter than that at break-even point, both countries have economic merits for energy transportation via transmission grid.

Conclusions

In this work we analyze the cost of power generation for natural gas taking into account the CIF price for LNG which is dependent on the distance from each exporting country. In this analysis, the natural gas price is about 30,000 yen/t, which is approximately the same one as that in OECD/NEA (2010). Furthermore, we show the break-even point of electricity costs for natural gas for LNG transport and electricity purchase from exporting country. Although our analysis assumes an agreement system of electricity purchase, it is also necessary to consider other different system such as cost sharing between importing and exporting countries. The analysis could be extended to allow for comparison of different agreement system. This would provide useful implications for energy policy.

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