Keigo Akimoto, Fuminori Sano, Takashi Homma and Toshimasa Tomoda

IMPACTS OF GAS SUPPLY FROM RUSSIA ON GLOBAL ENERGY SYSTEMS

Research Institute of Innovative Technology for the Earth (RITE)
9-2 Kizugawadai, Kizu-cho, Soraku-gun, Kyoto 619-0292 Japan, E-mail: aki@rite.or.jp

Overview

World natural gas productions have increased, and the supply perspectives are significant for the decision to the investments of the infrastructures, for the security of world energy systems and also for environmental issues. The consistent analysis not only of natural gas but also of the other energies and the consideration of the transportation infrastructures are needed for the perspectives. This study evaluated global supplies of gas using a global energy systems model having high regional resolution of 77 world divided regions. In this study, the impacts particularly of gas supply of Russia are analyzed under several scenarios, e.g., reference scenario, the scenario of constrained Russian natural gas exports, because one of the key countries is Russia, which is the largest production county of natural gas in the world. The importance of the strategy for gas supply will increase in the future. This study provides consistent and useful insights for the strategy.

Methods

In order to evaluate perspectives of global supply and demand of gas, a global energy systems model, DNE21+, is utilized in this study. DNE21+ is an intertemporal linear programming model, and covers the time range up to the middle of the 21st century. The total world cost of energy systems is minimized over the time period. To account for existing regional differences and evaluate the regional effects, this model divides the world into 77 regions: countries of interest are treated as independent regions, and large-area countries such as the US, Canada, Australia, China, India, Brazil and Russia are further disaggregated into 3-8 regions to consider transportation costs of energy and CO_2 in more detail. The 77 regions are linked to each other by the trading of eight items: coal, crude oil, synthetic oil, methane, methanol, hydrogen, electricity, and CO_2. In addition, CO_2 emission permits are also modeled as an inter-regional trading item. The facility vintages of the transportation, e.g., natural gas pipeline, LNG tanker, are taken into account explicitly.

The energy supply sectors are modeled from the bottom up (technology specific) and the end-use energy sectors from the top down (technology aggregated). Primary energy sources of eight types are explicitly modeled: natural gas, oil, coal, biomass, hydro and geothermal, photovoltaics, wind and nuclear. As technological options, various types of energy conversion technologies are explicitly modeled besides electricity generation. These include oil refinery, natural gas liquefaction, coal gasification, water electrolysis, methanol synthesis etc. Carbon capture and storage (CCS) technologies are also considered in this model.

Assumed potentials of conventional natural gas and oil are 241 and 243 Gtoe, respectively, which derived from USGS GIS data; coal potential of 885 Gtoe is also assumed using WEC estimates.

Results

The several scenarios for the evaluation of gas supply of Russia are evaluated, e.g., reference scenario, the scenario of constrained Russian natural gas exports, the scenario of constrained Europe imports from Russia. Fig. 1 shows net exports of natural gas by region under the Reference Scenario. Fig. 2 shows the natural gas production by region in the Constrained Russian Exports Scenario. Natural gas production and net exports in Russia increase in the Reference Scenario. The capacity of the pipeline between Russia and Belarus & Ukraine is 8 and 18 tcf in 2020 and 2030, respectively; that between Belarus & Ukraine and Eastern Europe, i.e. Poland, Czech, Hungary, Romania, etc. is 7 and 13 tcf in 2020 and 2030, respectively.

The world production of natural gas under the Constrained Russian Exports Scenario is almost same to that the Reference Scenario. However, the increase of LNG supply is limited under this scenario, rather natural gas supplies in Norway, Iran and Other Annex I of FUSSR (Ukraine etc.) increase. In other words, this scenario induces not large shifts from Russia to LNG suppliers, e.g., Venezuela, Algeria, but to the other natural gas suppliers, e.g., Norway, Iran. The global energy systems cost of 2.8 and 5.2 billion US$$_{2000}$ could increase in 2020 and 2030, respectively, under the Constrained Russian Exports Scenario from the Reference Scenario.

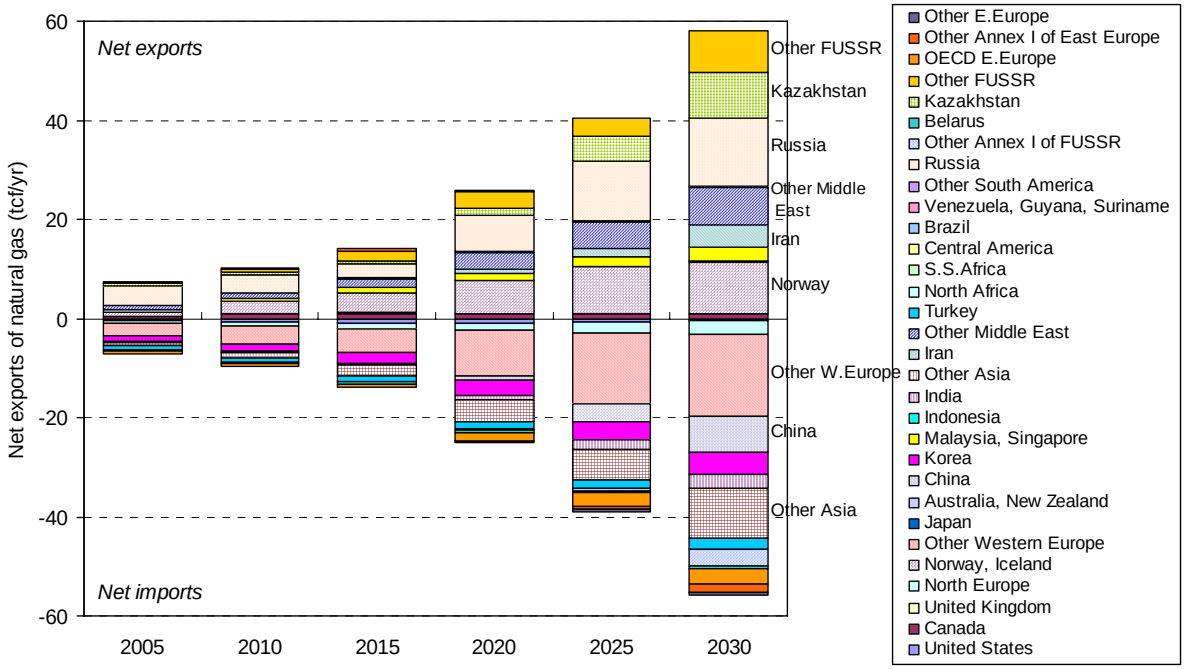

Fig. 1: Net export of natural gas in the Reference Scenario (some regions are aggregated from 77 divided regions)

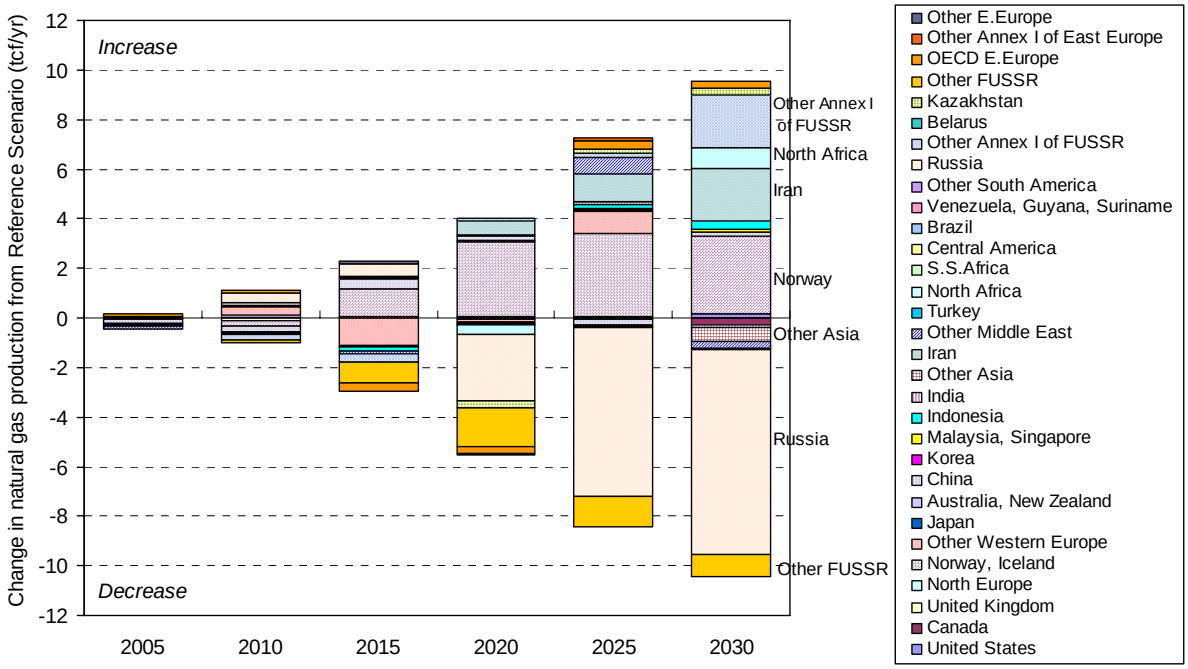

Fig. 2: Change in natural gas production by region in the Constrained Russian Exports Scenario from in the Reference Scenario (some regions are aggregated from 77 divided regions)

Conclusions

This study evaluated perspectives of global supply of gas, particularly in Russia, using a global energy systems model. The importance of the strategy for gas supply and consumption will increase in the future. The strategy should include the supply of Russia to East or West and the supply using pipeline or tanker of LNG. This study provides consistent and useful insights for these issues.