

A Study on the Development of New Nuclear Policy and Energy Strategies & Systems in accordance with the Change of Global Energy Paradigm

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1. Introduction

The emergence of the new climate system and the change in the paradigm of the eco-friendly energy system are global trends. After the launching of Korea's new Government, its energy policy directions have been shifted from nuclear power & coal fuels to renewable energy & LNG fuels. In this context, we need to analyze the economic and social ripple effects of these attempts. Furthermore, there is a need to preserve the nuclear supply chain without dismissing the industrial competitiveness, technology and talent infrastructure of the nuclear industry, which has been recognized as a world-class level by Korea's technology self-reliance. Since academic and policy research experiences on energy transition are still lacking, we need to do empirical research and to establish complementary measures and present rational alternatives to the rapid change of global trends and changes in the internal and external policy environment so that the national energy transition can be successfully achieved.

2. Methods and Results

In this section we quantitatively examines the impacts and the ripple effects of eco-centered energy policies through comparison with major competitors by core components of energy policy. In particular, the present and future prospects of the global nuclear energy market and supply chain, as well as policy experiences and cases of nuclear power-using countries, are analyzed and benchmarked, and the implications of these policies are analyzed. And we draw up lessons and implications from the comparative analysis of the activities of multilateral organizations and experiences and cases of major industrialized countries. Based on this review and analysis, we suggest the new directions of nuclear energy policy and propose various policy alternatives to make national energy policy sustainable in the future.

2.1 Review of the global energy market

According to World Energy Outlook 2017 of The International Energy Agency(IEA), the new policy scenario is expected to increase coal 4.63%, petroleum 10%, natural gas 44.9%, nuclear power 47.1% and renewable energy 85.8% by 2040 [1]. The diverse scenarios of the IAEA also predict a gradual increase in the future nuclear power market [2]. The expansion of

the nuclear power market is expected to accelerate the competition among suppliers. Until the early 20th century, the export market has been led by Western countries such as USA, France and Japan, but will be reorganized into a system led by China and Russia in the future [3].

2.2 Analysis of national energy transition policies in 10 major nuclear countries

We analyzed major energy indicators by the top 10 nuclear countries. In terms of energy intensity and growth rate, Korea is higher than most countries except the United States. Dependence on fossil fuels has fallen to 50% in major countries such as United Kingdom, Germany, France and Japan. However, Korea still maintains 65 ~ 70% level. In terms of energy self-reliance, Korea maintains the lowest level of 18.8% in spite of high contribution of nuclear energy (92.3% in USA, 84.2% in China, 65.8% in France, 55.8% in France and 38.9% in Germany in 2015).

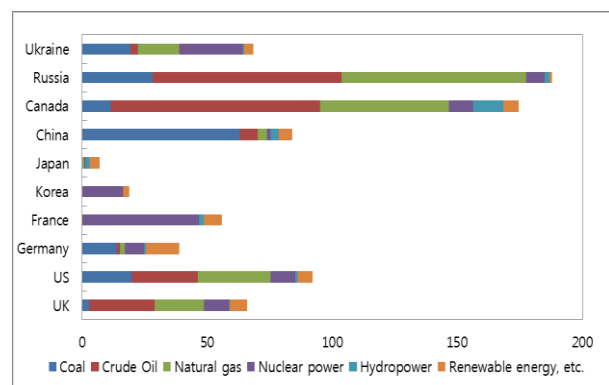


Fig. 1. Energy Self-sufficiency rates by fuels in 2015(%)

Germany is the only country among the top ten nuclear power users that is planning to give up nuclear power. It also took about 25 years to reach a 20% share of renewable energy. France and the UK are on the opposite path to Germany, including development and construction of new nuclear power plants[4].

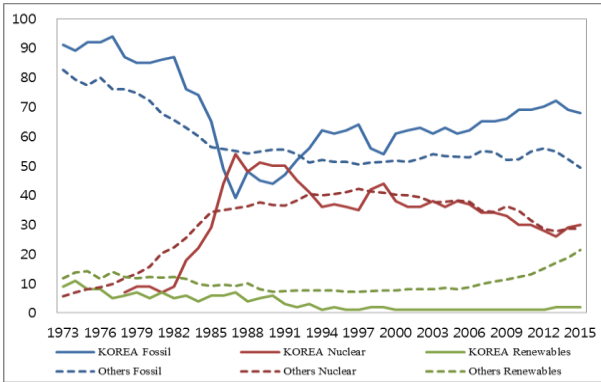


Fig. 2. Comparison the share of fuels in electricity supply(%)

2.3 Analysis of energy policy objectives and key elements of each country

The core elements of energy policy goals in each country are strengthening energy supply security, securing energy equity(energy affordability & accessibility), and responding to climate change. Of these three, energy supply security is the highest priority. The World Energy Council (WEC) 2017 survey shows most of the OECD member countries rank in the top 10 in terms of their evaluation criteria. Korea's energy supply security index and energy system sustainability index are very weak at 64th and 84th in the world [5]. The IEA announces Levelised Cost of Electricity(LCOE) data as an economic indicators for each energy source every five years. According to the change of the discount rate, the economical efficiencies of the nuclear power plants differ greatly from country to country. In Korea, however, nuclear power plants appear to be most economical energy sources at any discount rate [6]. The International Renewable Energy Agency (IRENA) has indicated that the development of renewable technology has led to a rapid decline in power generation costs in most of countries [7]. In order to reduce GHG emission, Korea needs to prepare a roadmap for responding to new climate change regime. In addition, we provide comments on the need for additional investment to be brought by the energy transition policy and the possibility of fluctuations in electricity charges [8].

2.4 Win-win cooperation strategy between nuclear power and renewable energy

We are inspired by the idea of the bridge role of nuclear power. In this regard, we propose the installment of new energy transition fund(tentatively called low carbon energy conversion fund). This fund is hopefully being linked with the continuous operation of the nuclear power plants concerning its profitability in the future. And we propose a plan to strengthen the new role of renewable energy such as business diversification in KEPCO and KHNP management

system. We also provide solutions to solve problems such as vision extraction, combination method and scenario analysis for business linkage of nuclear energy and renewable energy, business model development, development of new licensing and regulatory standards, and improvement of public acceptability of link system. From the examples from the US, France, Sweden and Finland, we propose a plan to create domestic activities by applying overseas cases that combine nuclear power and renewable energy in various ways, utilizing the operating records and experiences of the countries that adopt the load following of nuclear power [9,10].

2.5 New policy alternatives for national energy paradigm shift

Based on the comparison of quantified indicators with main competitors, we propose a plan to improve the vulnerabilities in terms of energy security and energy system sustainability. The IEA/NEA has jointly developed quantitative indicator of how much nuclear energy can contribute to energy supply security [11]. So we suggest the development of joint index to utilize Simplified Supply and Demand Index(SSDI), which has been developed as an energy security indicator by OECD. And we suggest the joint development with ASEAN countries on energy security index (Energy self-reliance is on average 80% in 16 ASEAN countries) [12]. We propose to establish a national roadmap to achieve 50% at 65 ~ 70% of the present value by setting the target of low carbonization index (nuclear + renewable). We also propose a role sharing between government and industry for the advancement of nuclear power overseas. Especially, we propose the establishment of a cooperative strategy with western countries in order to expand the global market share which is being reorganized mainly in China and Russia. Therefore, we propose continuous technology innovation and upgrading in terms of safe design, construction and operation of nuclear power plants. In this regard, we need to maintain our own supply chain with the ability to supply the most advanced nuclear power plants such as APR 1400+. We also propose investment in future R & D and measures to secure excellent talent and maintaining nuclear ecosystem and supply chain. In addition, we demonstrate the need for national social contribution of nuclear power to solution of social problems, national welfare and health.

3. Conclusions

As a result of comparative analysis of key elements such as energy security and energy system sustainability,

Korea is still weaker than other countries and needs complementary measures. In order to improve these vulnerabilities in the energy mix, we suggest the development of indicators through cooperation with international organizations, and the establishment of a low carbonization(nuclear + renewable) index target of 50%. Moreover, the renewable energy market was most dynamic and leading investment in the energy sector, while domestic technology base was relatively weak. We propose the ways which the Korean government policy of expanding renewable energy does not deepen external dependence on energy sector. Furthermore, There is a shift gradually centered on China and Russia in the world nuclear power market. In order to cope with these trends, Korea needs to establish vision, external cooperation strategy, industrial competitiveness and supply chain management, and secure technology and talent to compete with leading countries. Finally, we propose a various combination method through analyzing major overseas case for win-win cooperation between nuclear power and renewable energy, and proposed institutional complementary measures such as the new funding system for bridge role of nuclear power. In addition, considering the lack of experiences and knowledge of domestic energy transition, we suggested strengthening of energy policy research, development of education curriculum and development of Korean empirical model.

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