Analysis of net energy-return-on-investment for an effective energy transition policy: A case of Korea

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Overview

After the 21st Conference of the Parties (COP21) in 2015, global interest in climate change further increased. Many countries have submitted Nationally Determined Contributions (NDCs) and continued to revise or adopt the targets. For example, in 2017, Korea's goal of meeting the renewable energy target revised upwards to 20% of its electricity generation from renewable sources by 2030 (MOTIE, 2017). Such a trend requires policymakers the reduction strategy like energy transition policy. According to the International Energy Agency (IEA), under the sustainable development scenario, they consider methods like efficiency improvement, electrification and fuel switching (IEA, 2019b). In accordance with his flow, Korea also has established a low-carbon energy policy. The Basic Plan on Electricity Demand and Supply of Korea aims to create a sustainable low carbon green society. Specifically, they set the greenhouse gas emissions from 709.1 Mt in 2017 to 536 Mt in 2030.

The implementation methods to achieve these goals are as follows. First, they try to reduce the emission source itself in each field like industrial, building, and transportation sectors. The second approach is to create a means of reduction, such as energy conversion or demand management. The last option is to use external reduction methods, not domestic, such as forests or international markets. However, these low-carbon policies focus on carbon reduction, and there are other issues such as economics and convenience. In particular, there is a debate on fundamental energy use for maintaining or improving lifestyles. That is why in the transition policy for reduction, energy efficiency is referred to as "first fuel of all energy transitions" (IEA, 2019a). The implementation of relevant policies aimed at reducing carbon can directly affect life because of cost or efficiency problems. Therefore, policymaker has to identify the effects of policy which is accompanied by carbon reductions. This study attempts to quantitatively analyze these effects using the concept of energy return on investment (EROI), which considers both energy efficiency and lifestyle. The results of this study are meaningful in that they provide analytical results quantified by EROI for ambitious carbon targets in Korea.

Methods

There is a lot of research on low-carbon policy and economic growth, considering energy production. However, for this study, it is necessary to analyze net energy, not gross energy. Energy-return-on-investment, EROI, signifies the amount of useful energy yielded from each unit of energy input to the process of obtaining that energy (Murphy and Hall, 2010). At the same time, EROI also includes the concept of lifestyle. According to King and van den Berg (2018), a higher EROI economy can yield more non-essential energy at the same energy investment. This leads to lifestyle differences between high-EROI and low-EROI. For the same amount of non-essential energy, low-EROI need to increase gross energy, increase energy efficiency, or make high EROI.

In this study, we set up the scenario based on the above characteristics and analyzes it with the dynamic EROI model. The scenario is as follows: Renewable Energy Scenario (RES), Demand Consideration Scenario (DCS) and Current Efficiency Scenario (CES). RES reflects Korea's basic plan to utilize renewable energy sources. DCS considering the electricity demand forecast of Korea Electric Power Corporation. CES is the case of maintaining the same net energy level as the current. Also, the dynamic EROI model can be constructed as follows.

$$E^N = \sum_{i=1}^{n} \left[Q^i \left(1 - \frac{1}{EROI^i} \right) \right]$$

$$E^N = the\ net\ energy\ delivered\ to\ society$$

$$Q^i = the\ gross\ production\ of\ energy\ source\ i$$

$$EROI^i = the\ EROI\ of\ energy\ source\ i$$

Results

RES scenario reflects the growing share of renewable energy in Korea's energy mix has a relatively low EROI. Due to these characteristics, the energy production per capita also appears to decrease trend. Also, by reflecting the characteristics of the EROI, an upper limit value and a lower limit value can be obtained. The analysis shows that both cases show the same decreasing trend. This means that if the portion of renewable energy is increased, the lifestyle-related to energy will have a negative effect. On the contrary, the DCS scenario tended to increase in the period of analysis. Similarly, the upper and lower limits of the DCS scenario were similar. Therefore, when the appropriate demand management method is used, it can be expected to have a positive effect on net energy. Finally, the CES scenario does not represent a wide range of changes. In this case, however, it can be seen that the gross energy value of the renewable energy source is greatly increased to maintain the current level. In other words, to meet the low carbon target and achieve the same net energy level, investment in the renewables sector should increase.

Conclusions

The move to a low carbon society has led to various energy policies. Among them, Korea aims to reduce carbon through the energy transition, and an effective transition policy is very important for this. In this regard, the following implications are drawn from the analysis of RES, DCS and CES scenarios using EROI. First, setting a simple conversion goal hinders the maintenance of the energy aspect of the lifestyle. Second, the policy direction, which simply means the transition itself, makes it difficult to maintain an energy lifestyle. In addition, gross energy itself must increase significantly in order to consider the same lifestyle level and low-carbon target level. This means that the efficiency of renewable energy itself is key. On the other hand, proper demand management alone has a positive effect on net energy. Therefore, further research is needed to combine the use of transition policy and demand management. This study suggests that an effective transition policy requires a multi-faceted approach rather than just switching-related transition.

References

IEA, 2019a. Energy Efficiency 2019. International Energy Agency, France, Paris.

IEA, 2019b. World Energy Outlook. International Energy Agency, France, Paris.

King, L.C., van den Bergy, J.C.J.M., 2018. Implications of net energy-return-on-investment for a low-carbon energy transition. Nature Energy.

Murphy, D., Hall, 2010. C. Year in review—EROI or energy return on (energy) invested. Annals of the New York Academy of Sciences.

MOTIE, 2017. The 8th Basic Plan for Long-term Electricity Supply and Demand (2017 – 2031), Korea, Sejong.

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