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A dynamic simulation analysis of the future Korean energy market to find opportunities for penetration of fusion energy.

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ABSTRACT

- This research focuses on finding opportunities for penetration of fusion energy in the future Korean energy market by using the System Dynamics methodology
- The System Dynamics is a tool of system modeling to find the cause of a non-linear feedback structure between components which made up a system
- Because it is obvious that the requirement of centralized and carbon free energy sources will increase, the fusion energy still has opportunities in the future energy market.

Background

- As the world's electricity demand is increasing rapidly with the growth of developing countries, the world faces many energy-related challenges.
- Korea announced a carbon neutrality 2050 plan for growth with reducing greenhouse gases and is establishing many policies to achieve the carbon reduction target in 2050. The fusion energy is regarded as the new energy source that can be used as a baseload of electricity supply.
- This research was intended to analyze the future energy supply and demand in Korea by using System Dynamics methodology and to find opportunities for fusion energy penetration of the electricity market in Korea.

Methodology

- The System Dynamics methodology developed in 1960 is a tool for modeling system thinking. It explains that the cause of the dynamics of the system came from a feedback loop and a time delay.
- The System dynamics methodology uses a causal-loop diagram to express the relationship between components and uses a stock-flow diagram to describe the storage and flow through the components which made up a system.
- By using the system dynamics methodology, we can find important meanings from reviews and modifications of the system that are caused by changes of components, rather than the exact results.

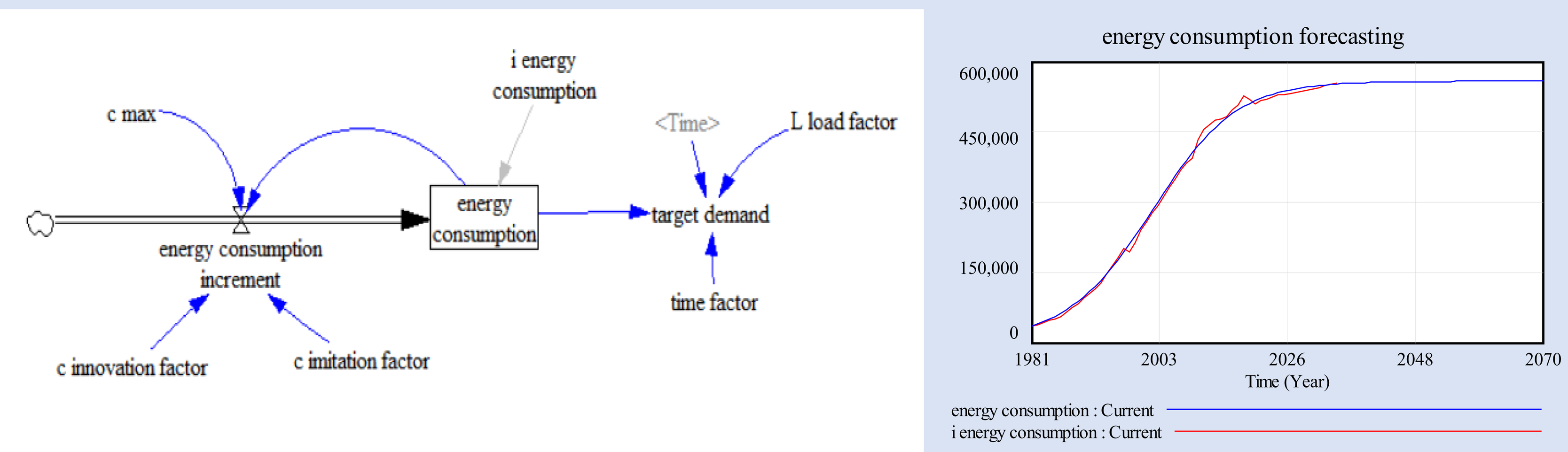

Fig. 1. (left)Power demand forecasting model , (right) Bass diffusion model results with input data

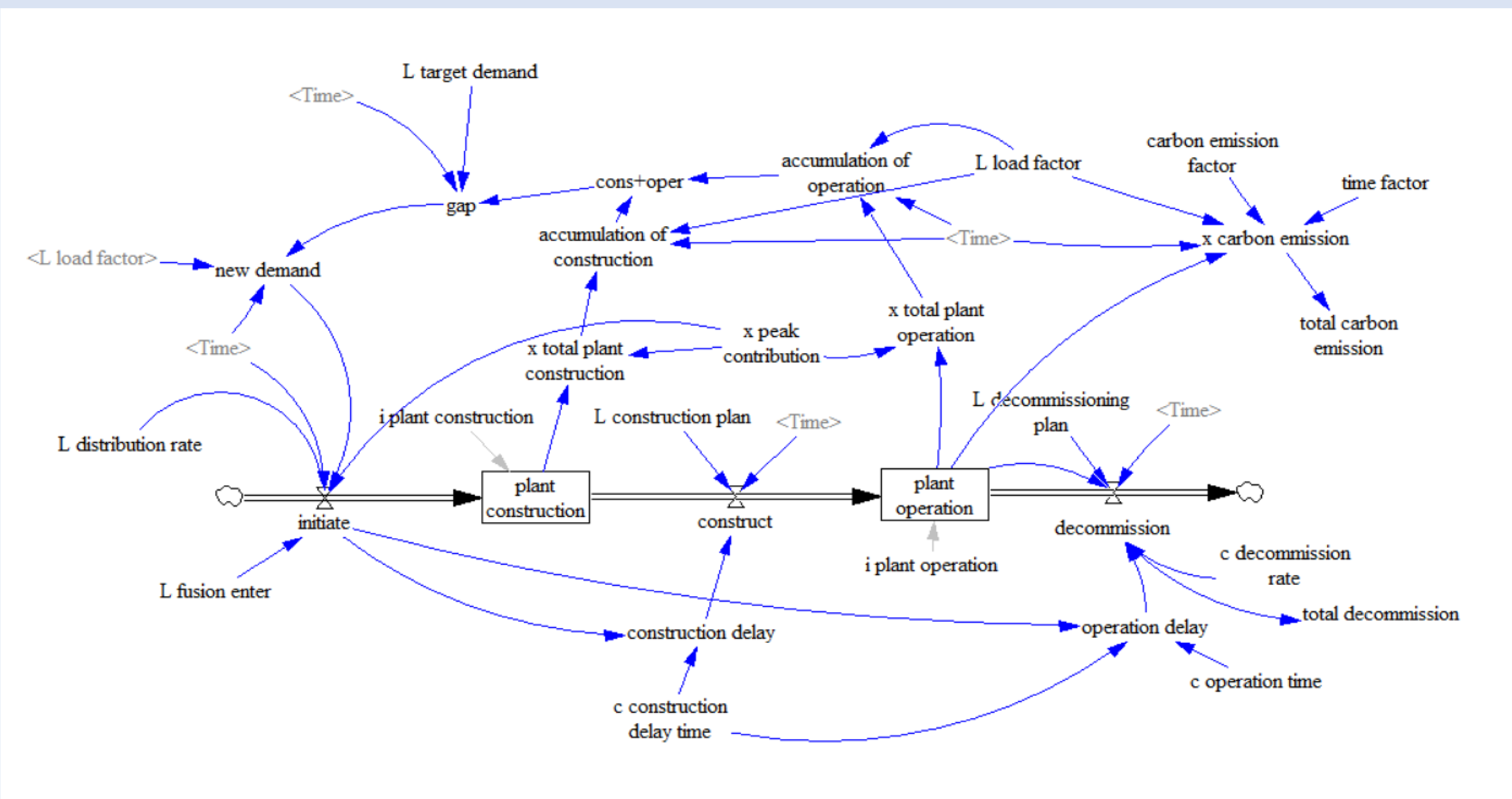

Fig. 2. Power supply forecasting model

Analysis model

Demand Model

The demand model was using the Bass diffusion model and is described as a stock-flow diagram. (Fig. 1, left). This research used the calibration function of Vensim DSS, which help to find the optimal constant by repeatedly comparing with input data. Fig. 1(right) is the results of the Bass diffusion model comparing with the input data. To take into account uncertain factors, this research established additional scenarios

- Scenario1 : Bass diffusion model (baseline)
- Scenario2 : 40% increase over based on scenario 1
- Scenario3 : 20% increase over based on scenario 1

Supply Model

To explain the power supply, this research used a plant life cycle. The supply model can be expressed as a stock-flow diagram (Fig. 2).

- A construction and operation of plants were set as a stock variable. And initiation, construction, decommissioning were set as a flow variable.
- By using a subscript function of Vensim DSS, the capacities of power plants can be divided by energy sources such as nuclear, coal, gas (LNG), renewable, the rest energy source, and fusion.

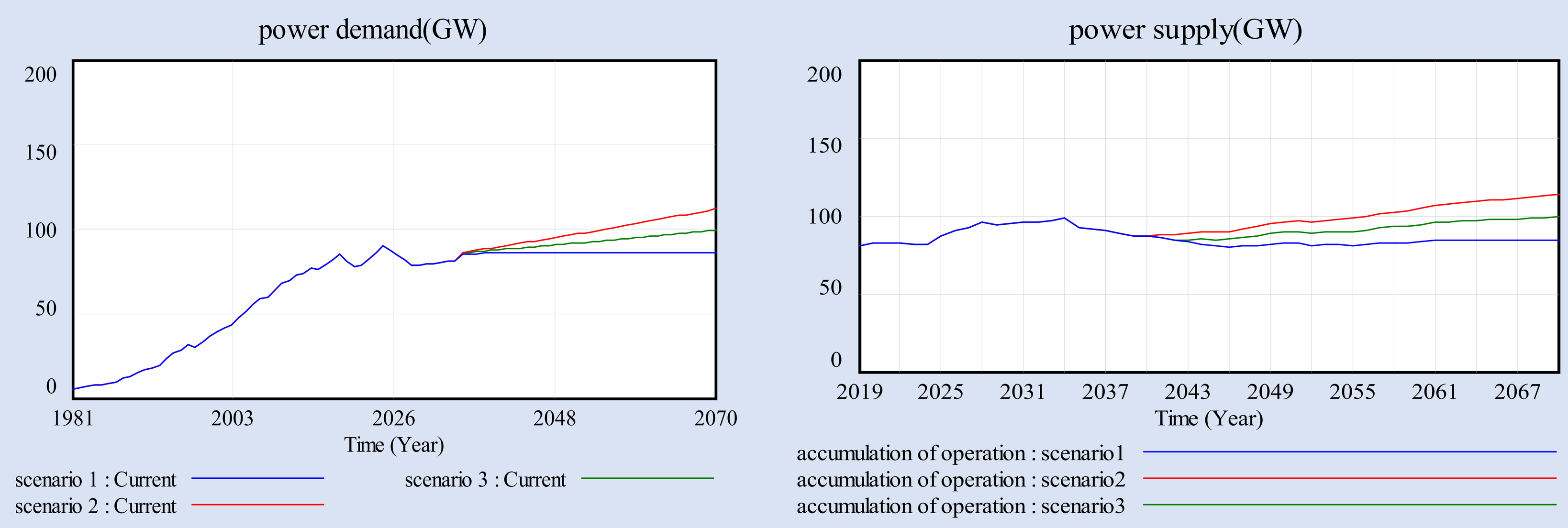

Fig. 3. (left) demand model results, (right) supply model results

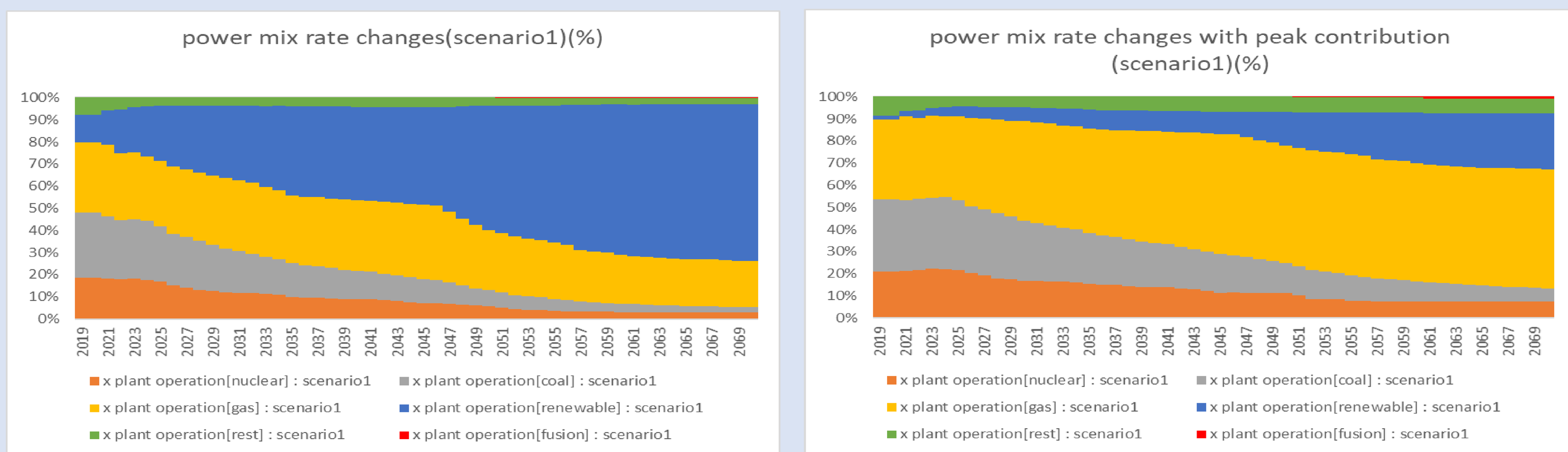

Fig. 4. (left) power mix rate changes, (right) power mix changes with peak contribution

CONCLUSION

- Most of the new power sources will be occupied by renewable energy.
- The impact of fusion energy is insignificant in this research because of its penetration time(50s~60s).
- The results(Fig.4) show that there is a difference between the proportion of power mix with peak contribution and not.
- In the short term, carbon emissions tend to increase although the transition from coal-fired power to gas (LNG) is being pursued.
- it is obvious that the requirement of centralized and carbon free energy sources will increase.

REFERENCES

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