

Nuclear-Biomass Hybrid System 2 for Electricity Demand Fluctuation: Necessity of flexibility in Future Deregulated Electricity Market

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Abstract

Use of the nuclear electricity for biomass conversion to charcoal and organic gas is analyzed to respond the demand fluctuation, particularly for the time of negative marginal price for electricity. Nuclear power can be sold in the capacity market and negawatt market for the time beyond break-even price. Low price electricity can be converted to biochar (fixed carbon) production utilizing waste biomass brings profit from carbon market by achieving carbon sequestration.

Keywords: Deregulated electricity market, Carbon sequestration, Carbon market, Nuclear, Biomass

1. Introduction

Deregulated electricity market (DEM) and carbon market are anticipated to grow due to electricity generation from various energy sources and the pledge for CO₂ reduction. This market shows negative marginal price based on liberal capitalism principle. Electricity generation from nuclear plant may not be profitable at the certain time of a day in the future. This study analyzes the possibility of base load nuclear electricity to respond the demand change by utilizing combination with biomass conversion plant.

2. Breakthrough for Nuclear Plant in the future

The introduction of the renewables increases [1], while electricity generation cost from renewables decreases [2]. Unsold nuclear power can be sold at capacity market and negawatt market. With the use of relatively lower price of electricity from these market, biochar production ranging from 250°C to 400°C is possible. The conversion equation of $(CH_{1.6}O_{0.6})_n = nC + 0.4nH_2 + 0.6nH_2O - 451n \text{ kJ}$ is assumed to use biomass incorporated with the large portion of lignin. The biochar is a stable solidified carbon, which is considered carbon sequestration. The result indicates that if the breakeven price for electricity is \$66/MWh, carbon price needs to be \$16/tCO₂ to have the same annual income. Fig 1 describes the income change by marginal price and continuing hours of marginal price. If annual average electricity price takes place below 3,000 hours at \$-100/MWh, it can make positive income because of profit from carbon market. This proves the complementary role of nuclear-biomass hybrid system operation.

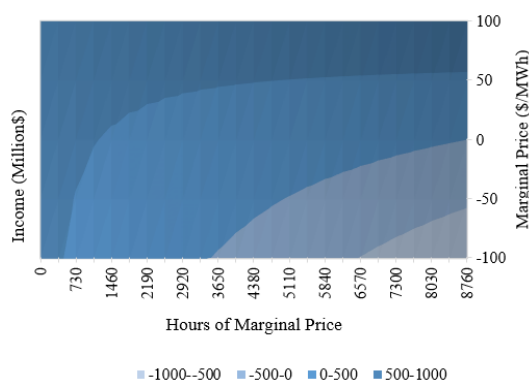


Fig 1. Income of Nuclear-Biomass Hybrid System

4. Conclusion

The rise of DEM is possible in Japan, when the goal of 22 to 24% electricity generation from renewables is achieved in 2030 [3]. It is a plausible option for nuclear power industry to consider new concept of Nuclear-biomass hybrid system. This can be a new pathway to flexibly adapt to a new environment.

References

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