RENEWABLE ENERGY POLICY AND INVESTMENT DECISION-MAKING IN ELECTRICITY MARKETS

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SUMMARY

To achieve decarbonization goals, policy formulation for investment in renewable energy (RE) is becoming increasingly important. Participants in the restructured electricity market are now required to make unprecedented decisions regarding investment in RE and associated network infrastructure. This study formulates frameworks for the evaluation of RE policies by modeling investment in RE and analyzing social surplus of the entire electricity market using two different methods: the real options approach and complementarity approach. The findings of this study raise issues related to the future RE policy formulation.

First, we develop models for the investment decision-making of power generation companies (GENCO) and transmission system operators (TSO) under vertical unbundling and uncertainty, applying the real options approach and game theory. We consider several scenarios and compare the effects of feed-in premium (FIP) and installation cost reduction of RE in terms of investment timing, capacity, and social surplus. The study has two primary findings. First, we demonstrate the difference in the impact of FIP and installation cost reduction of RE on optimal investment timing and capacity expansion. The FIP delays investment timing and encourages investment in a larger capacity, while the installation cost reduction of RE speeds up the investment timing and encourages investment in a relatively smaller capacity. Second, we show that the magnitude of social surplus in each scenario varies depending on the degree of uncertainty and installation cost of RE. In that lights,

we suggest that appropriate RE policy formulation should take these factors into account. Particularly, if the installation cost of RE decreases sufficiently due to further technological innovation, it may be possible to obtain a greater social surplus without FIP.

Next, based on the complementarity approach, we construct an analytical framework for the decision-making of electricity market participants in equilibrium, by modeling prosumer investments in solar photovoltaic (PV) panels, battery operations, and electric power networks. Our focus is to analyze prosumer investment decisions, transmission tariffs, and social surplus under two pricing schemes, namely net metering and net billing. First, we find that the capacity of PVs invested by prosumers and total social surplus increase as the capital costs of PVs decrease under both pricing schemes without considering battery operation. Next, we show that battery operation increases the capacity of prosumer investment in PVs under both pricing schemes. Furthermore, the total social surplus under net billing is larger than that under net metering, with and without battery operation. We find that net billing yields a larger social surplus in our setting.