Economic, Environmental and Energy Analysis on Future Energy Production Technology: Solar Power Satellite

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The authors are focusing on the solar power satellite (SPS) as an alternative power generation technology for the future. SPS technology is based on satellites with photovoltaic (PV) panels in geostationary orbit (GEO). The SPS continuously generates electricity regardless of the weather or time of day and transmits this power to the Earth’s surface. The SPS does not use fossil fuel for electricity production and can supply large amounts of electric energy. Therefore, in a previous study the authors have calculated the CO2 emission caused by the construction and operation of several SPS systems—the DOE/NASA Reference System, Institute for Unmanned Space Experiment Free Flyer (USEF) SPS system, Multi-Bus Tethered SPS system, etc. The authors then compared the emission with those for various types of power generation—coal-fired power generation, LNG-fired power generation, PV generation, etc. However, the calculation has been updated with the development of the SPS system. Therefore, the evaluation methods and the database used for the evaluation are not completely consistent with each other. In addition, the indicator on the system is primarily confined to showing the CO2 emission.

Herein the authors elucidate the multiple aspects of the SPS system through common evaluation methods and an I-O database. This paper has three contributions: First, CO2 emission and the energy payback time (EPT) and energy profit ratio (EPR) of the SPS system are calculated as environmental-energy indicators. Second, the cost per unit of electricity production is calculated as an economic indicator. Finally, the SPS system is compared with various types of power generation from the economic, environmental, and energy viewpoints. The results show that the SPS system is superior in terms of CO2 emission and energy but has a relatively high cost for electricity production, which is recognized as the social cost of introducing the future technology.