Economic evaluation of Carbon dioxide Capture and Storage

*Yukiko Shoji[1], Takaomi Tobase[1]

1. Electric Power Development Co., Ltd.

Global warming countermeasure plan in Japan sets a medium-term target of reducing greenhouse gases by 26% in FY2030 compared to FY2013 and a long-term target of 80% by 2050. In order to achieve the long-term goal while ensuring stable power supply, it is essential to install Carbon dioxide Capture and Storage (CCS) for thermal power plant. Therefore, for commercialization of CCS in the future, it is important that CCS be economical. In this study, the economics of CCS was evaluated by examining the costs of each of the processes that make up the CCS (separating and capture, compression liquefaction, transportation, and geological storage of CO2 produced at thermal power plants).

1. Study Conditions
The conditions for examining the equipment configuration used in CCS and estimating costs were assumed as follows.CO2 processing capacity is 5 million tons-CO2 / year, the purity of recoverable CO2 is 99.5%, the operation time is 40 years, the transport distance is 200km, 500km and 1,000km, and injectivity to a reservoir is 500,000 ton per well-CO2 / year, (there are 10 injection wells). In the cost estimation, CO2 avoidance cost, which is the cost of subtracting the amount of CO2 emissions required for power and fuel consumption in each process of CCS from the amount of CO2 processed in CCS, was calculated.

2. Estimated cost of CCS
The target of the study was IGCC power generation, which is a high-efficiency coal-fired thermal power plant, and the separation and capture of CO2 were studied by a physical absorption method. In Japan many storage sites are assumed to be sea areas, so in this study it was assumed that separated and recovered CO2 would be transported by ship to a storage site. The cost for transportation and storing CO2 underground was estimated by the following four systems or methods. The first one is “CO2 shuttle shipping” and direct injection from the ship, and the second one is “injecting CO2 using floating intermediate storage facility”, in which liquefied CO2 transported by ship is transshipped to a floating intermediate storage facility and then injected into the ground. The third one is “injecting CO2 from land by Extended Reach Drilling (ERD)” in which an intermediate storage facility is installed on land such as an isolated island near the storage site, and CO2 is injected by ERD. The fourth one is “injecting CO2 from land by Pipeline (PL)”, which installs an intermediate storage facility on land, lays a pipeline from there, and injects CO2.By summing up the costs estimated in each process of separating and capture, compression liquefaction, transportation, and geological storage of CO2, the cost of each method is clear. The cost of “CO2 shuttle shipping” is 8,580-9,500 yen / ton-CO2, “injecting CO2 using floating intermediate storage facility” is 8,290-8,910 yen / ton-CO2, “injecting CO2 from land by ERD” is 6,930-7,580 yen / ton-CO2, and “injecting CO2 from land by Pipeline (PL)” is 8,170-8,820 yen / ton-CO2.

3. Economic evaluation of CCS
Calculating the cost of CCS (6,930-9,500 yen / ton-CO2) estimated in 2. using the CO2 emission rate from IGCC (0.76 kg-CO2 / kWh), the cost per kWh is 5.3-7.3 yen /kWh. Assuming the cost of IGCC power generation will be equivalent to that of pulverized coal-fired power generation, the costs of coal-fired power without CCS and coal-fired with CCS were compared. As a result, coal-fired power with CCS

increased from 1.19 to 1.35 times that of coal-fired without CCS. Therefore, it is considered that this study provided knowledge from the viewpoint of economics when considering the energy mix for decarbonization.

Keywords: Carbon dioxide Capture and Storage, Economic evaluation

