

Techno-Economic Assessment of CCS in Taiwan

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Abstract

Overview

According to the analysis of International Energy Agency (IEA), carbon capture and storage (CCS) is an important emissions reduction technology, contributing one-fifth of the total emissions reductions globally through 2050. CCS is the only currently available technology that can allow industrial sectors, such as iron and steel, cement, natural gas processing, etc., to meet deep emissions reduction goals. To date, no large power plants (i.e., hundreds of megawatts [MW] and up) with CCS exist and progress in CCS is not as expected, so the CCS development trends and the economic feasibility are critically essential to control effectively the global warming. In recent years, the constructions of nuclear and coal-fired power plants are faced with great difficulties in Taiwan, resulting in the rapid increase of expensive natural gas combined-cycle plant (NGCC) with the proportion of 24.6%. After the Fukushima nuclear accident, Taiwan government announced a new energy policy, that the existing nuclear power plants do not extend their life. Therefore, the high-share expensive NGCC phenomenon will become increasingly serious.

Method

It is emphasized that country-specific circumstances determine the LCOE. In this study, the RETScreen software was adopted to perform techno-economic assessment. The calculations are based on the simple levelised lifetime cost approach, using the discounted cash flow (DCF) method. To simplify the analysis, IGCC/CCS represents the techniques of coal-fired plant with CCS. In this paper, we calculate the LCOE of IGCC, IGCC/CCS and NGCC as base load power with different carbon price, gas price and discount rate for 2020-2035.

Expect results

The analysis result of the study shows that if energy prices continue to climb, the integrated gasification combined cycle power plant with CCS (IGCC/CCS) would be more cost-effective than IGCC plants when CO₂ price is as high as 75\$/t-CO₂. Because natural gas import prices into Taiwan are 3.9 times and 1.6 times of that into the United States and European Union, in the consideration of reducing carbon emissions without purchasing carbon credit, IGCC/CCS is competitive with NGCC in 2020-2025. If LNG Price growth rate is lower as expected, the IGCC/CCS economically feasible point may be delayed for 5-10 years. It is recommended that CCS technology can be included in the low-carbon energy options of Taiwan energy policy, generating more positive benefits in

the perspectives of the economy, low-carbon emissions and energy security.

Discussion

The analysis result of the study shows that because natural gas import prices into Taiwan are much higher than into the United States and European Union, IGCC/CCS is more competitive than NGCC in Taiwan. For the sensitivity study, the high uncertainty of fuel cost projection makes it critical for LCOE. Therefore, in performing the comparison of the economics of different technologies, it should pay attention to the impact of the uncertainty of fuel costs particularly. When compared to the economic feasibility of IGCC/CCS, the carbon price also significantly affects the feasible timing for IGCC/CCS. With high constrains and 3% discount rate, carbon price higher than 95 \$ / t-CO₂, IGCC/CCS is competitive than IGCC. In comparison with NGCC, IGCC/CCS basically is superior in Taiwan, but NGCC will be more economical with 10% discount rate in 2020-2025.

According to the results of technical and economic analysis, this study makes the following recommendations:

1. If the carbon price cannot dramatically soar before 2020, even IGCC/CCS in Taiwan more competitive than in Europe and the United States, making new coal-fired plants CCS-ready today will help minimize additional costs of retrofitting in the future and is the most pragmatic approach under the steady reduction of nuclear policy.
2. If the state-owned Taipower company expects to reduce carbon emissions without purchasing of carbon credits, unless future natural gas prices rising much less than expected, IGCC/CCS is competitive than NGCC in 2020-2025. It is recommended that IGCC/CCS should be more suitable as a base load power and can be included in the low-carbon energy options of Taiwan energy policy, generating more positive benefits in the perspectives of the economy, low-carbon emissions and energy security.
3. The discount rate is basically to depict the concept of all risk. If IGCC/CCS power plants are private investments, it is recommended that the decision of investment timing is based on higher discount rate.
4. Early demonstration projects can provide the best opportunities for learning at the least net cost. Besides, through such projects, it can clarify and reduce the uncertainty of the financial issues. Taiwan's industry can establish leading technologies of clean coal and storage through building CCS demonstration plants and international cooperation. It can meet the domestic demand for clean carbon technology and get the market opportunities in developing countries. Finally, it also can establish the social acceptance of CCS and plan CCS power plants successfully.

Keywords: CCS, techno-economic assessment, fuel price, carbon price