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A study on competitiveness and GHG mitigation effect of IGCC and carbon capture technology through carbon tax change

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ABSTRACT

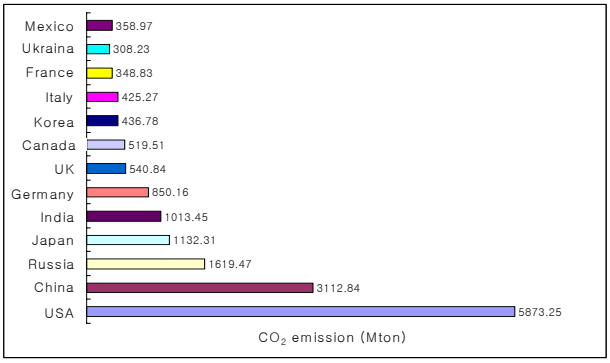
As the Kyoto Protocol ratified in Feb. 16 2005, the developed countries, which is involved in Annex-1 of Kyoto Protocol, have tried to mitigate greenhouse gas (GHG) to the reduction target. To accomplish this target, EU developed a few systems such as Emission trade system, CDM project. Korea has felt pressure to be an Annex-1 nation, because only Korea and Mexico are the non-Annex-1 nation from the OECD nations. In this study, a numerical simulation of a power plant expansion plan was conducted to calculate CO_2 emission. The CO_2 emission was analyzed with various carbon tax. Especially, we focused on the competitiveness of IGCC and Carbon Capture technology through carbon tax change. In our result, Even though carbon tax rises, nuclear power plant construction does not always increase, it increases until base load. LNG combined cycle power plant substitute the coal fired power plant. If there are many alternatives like IGCC, these substitute a coal fired power plant and we can save CO_2 mitigation cost.

KEY WORDS: IGCC; CO_2 mitigation; Climate Change; Power plant expansion plan; Nuclear; Carbon Capture Technology.

INTRODUCTION

The world is facing with 'invisible menace' which will probably take place in future created by mankind. The name of that menace is called 'Climate Change'. Most scientists say that greenhouse gas evokes climate change, but others say the temperature change is temporary phenomena. Despite of the controversy, this study was focused on finding ways on how to adapt the climate change and to mitigate greenhouse gases in the electric power sector. We are especially interested in the relationship between power plant expansion plan and the greenhouse gas emissions.

Korea was excluded in the first session of the Kyoto Protocol, but is likely to be required to reduce greenhouse gas emissions in the second session (2013~2017). Taking into consideration that Korea ranks ninth in the greenhouse gas emissions (as of 2003) and is a member country of OECD, it is expected that the industrialized countries would pressure us into commitment



Source : Key World Energy Statistics 2003
Fig. 1 National CO_2 emission in the world

In this study, we simulated Korean power plant expansion plan and estimate CO_2 emission quantity by changing carbon tax. Especially, we focused on the competitiveness of IGCC and MEA technology through carbon tax change.

POWER PLANT EXPANSION PLAN

The principle of minimum cost is to determine the construction capacity and building time which is the minimum cost with respect to present value. The main constraint of this objective function is not to happen blackout. There are many methods to consider 'not to happen blackout'. One is to calculate the cost of energy not served, the other is to constrain loss of load probability. The former is very difficult to calculate correctly because the effect of blackout propagate to the whole block where blackout happen. It depends on the time and range of blackout. Most of all, it is very difficult to calculate the reduced whole utility when blackout happen. But the latter is easy to calculate and manipulate.

That is to say, we must find the construction capacity and building time which is the minimum discounted cost of construction and maintenance through whole period. Also, this solution must satisfy the LOLP constraint. We can write the model description like below.