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PREDICTION OF GREEN HOUSE GASES IN DEVELOPMENT OF TIDAL POWER AND IGCC USING LEAP MODEL IN KOREA

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ABSTRACT

We targeted power plants in Chungnam area in which most bituminous coal thermoelectric power plants which accounts for 25 percent of the gross generation in Korea and most emits greenhouse gases are located.

Based on LEAP, we conducted a quantitative analysis on the change of generation for each installment and change of greenhouse gas emissions caused when replacing generation produced in existing bituminous coal thermoelectric power plants with generation produced when the establishment of tidal power and IGCC generation facilities and installment of new renewable energy generation facilities will be increasingly expanded from 2010 to 2030.

According to the result of this study, we expect that when IGCC generation and new renewable energy generation which can replace existing thermoelectric power plants are widely distributed, it will be a great help in reducing greenhouse gas emissions from power plants in Chungnam.

INTRODUCTION

About 52% of carbon dioxide emission of the world comes from thermal plants and petrochemical industries. International Energy Agency (IEA) estimated that the demand for energy should increase by 50% in two decades. Consumption of primary energy in Korea as of 1990 was 93,192 million TOEs (Ton of Oil Equivalent) and increased in 2005 to become 228,622 million TOE, indicating an annual average increase of 6.17%. Also, in proportion to energy consumption, greenhouse gas emission as of 1990 was 297,5 million tCO_2eq.(Ton of CO_2 equivalent). In 2005, it was 591.1 million tCO_2eq., indicating an annual average increase of 4.7% and the increase will be continued.

In 2010, Ministry of Knowledge and Economy announced “the Fifth Basic Plan for Power Supply” with an aim to reduce the amount of fossil fuel that generates greenhouse gases. The aim is to increase nuclear power generation up to 50% by 2024 in order to supplement the reduction of fossil fuel. However, nuclear power generation involves difficulties to dispose of wastes and select sites and the base units shall always operate. Considering these problems,

fossil fuel-based power generation shall be considered, too, for stable supply in relation to long-term power supply facilities and variable loads.

This study segmented power areas into details, surveyed consumption of each energy type, identified accurate amounts of emission, and used LEAP (Long-range Energy Alternatives Planning model) as one of the 14 greenhouse gas emission policies suggested by United Nations Framework Convention on Climate Change (UNFCCC) as well as energy consumption and VAT prospective in 2010. This was to provide basic data to establish strategies of climate change in Chungcheongnam-do where large-scale power generation facilities are located. This was followed by an analysis of potential amounts of greenhouse gas reduction from long-term greenhouse gas emission as well as introduction and expansion of tidal power, IGCC, and new and renewable facility.

METHODS (WHICHEVER APPLICABLE)

LEAP model

LEAP model is one of the 14 representative reduction policy analyses introduced by UNFCCC Technology Information Clearing House. LEAP model is largely divided into economic, energy, and environment modules. This is a sequential module of a series of processes that decide greenhouse gas emission such as energy consumption-designing exogenous variables, energy consumption, conversion, and supply, and greenhouse gas and air pollutants emission.

LEAP system is modeled through economic and accounting model scenario making. Analysis of reduction policies begins with the base scenario which is divided into BAU (Business as usual), BC (Best case), and Policy Case.

This study used BAU scenarios to analyze future energy consumption with the current trends continued, followed by estimation of energy consumption and analysis of reduction policies.

Scenario-making Method in LEAP Model

LEAP applied in this study was the 2010 version. The study analyzed impacts of replacement of power generation facilities between 2010 and 2030.

In order to use energy economy models, it is necessary to establish a similar current power supply system, necessitating the 2010 “Fifth Power Supply Plan” of Ministry of Knowledge and Economy and the 2011 Korea Power Statistics of Korean electric power corporation (KEPCO). This led to a check of the estimation of capacity, facility life, efficiency, and demand for power of each power generation facility in Chungcheongnam-do.

BAU (Business As Usual) Scenario Making

This study covered power generation facilities in Chungcheongnam-do where most of the bituminous coal power generators that generate greenhouse gases mostly and take up 25% of domestic power generation are located with an aim to estimate greenhouse gas emission. Based on an assumption of power generation arising from construction of tidal power, IGCC, and new and renewable energy facilities to between 2010 and 2030 replaced with existing bituminous coal power generation, changes of power generation by facility as well as greenhouse gases emission was quantitatively analyzed based on LEAP.

Power capacity, amount, and demand for power of this region for BAU estimation were derived based on the annual local energy statistics of Ministry of Knowledge and Economy in 2011 and KEPCO's statistics. In order to write BAU scenarios of this region, estimation up to 2022 was carried out based on "the Fifth Basic Plan for Power Supply" of the Ministry and it was assumed that between 2023 and 2030, the data will remain the same after 2022.

Power generation in BAU scenarios changes according to energy demand and economic and social trends and the basic prospective of the data necessary to write BAU scenarios will be set up departmentally. Socioeconomic indices presented by the government and major professional agencies and demands for energy in various areas were applied.

Providing Alternative Scenario

Alternatives presented in this study analyzed potential reduction of greenhouse gas emission according to replacement of coal and complex power facilities in this region with the construction of tidal power and IGCC facilities.

Scenarios Ⅰ and Ⅱ provided an assumption of replacement of bituminous coal with tidal and IGCC power without any change of the total power generation. Scenarios Ⅲ reflected the government's 2030 power supply plan with an assumption of replacement of 10% of power generation with IGCC and analyzed potential reduction of greenhouse gas emission.

RESULTS

Existing Scenario Analysis

Table. 1 shows the results of greenhouse gas emission based on a BAU scenario. In 2010, the emission was 234.5 million tCO_2eq and in 2030, it was 407.9 million tCO_2eq, an increase by 73.94% from 2010. This comes from an increase of power generation using coal in this area.

Table1. Potential of Greenhouse Gas Emissions

Year / GHGs	2010	2012	2014	2016	2018	2020	2030
BAU(Million tCO2eq)	234.5	237.9	237.2	317.5	407.9	407.9	407.9
Comparison with 2010 GHGs Emission (Increasing rate (%))	-	1.45	1.15	35.39	73.94	73.94	73.94

Alternative Scenario Analysis

Table 2 is the results of greenhouse gas emission of each alternative scenario.

Table 2. Potential of Greenhouse Gas Emissions by Alternative Scenarios

(Units: Million Tonnes CO2 Equivalents)

Year / GHGs	2010	2014	2018	2022	2026	2030
BAU	234.5	237.2	407.9	407.9	407.9	407.9
Scenario□	234.5	236.2	402.2	402.2	402.2	402.2
Comparison with BAU GHGs (%)	-	0.42	1.4	1.4	1.4	1.4

Scenario□	234.5	237.2	403.1	389.5	383.1	383.1
Comparison with BAU GHGs (%)	-	0	1.18	4.51	6.08	6.08
Scenario□	234.5	236.2	397.2	384	368.7	340.8
Comparison with BAU GHGs (%)	-	0.42	2.55	5.86	9.61	16.45

CONCLUSIONS

Without a change to total power generation of each scenario, the amount of existing power generation facilities (bituminous coal) was replaced with that of tidal power and IGCC facilities. Reduction of greenhouse gas emission by scenario, as of 2030, in Scenario Ⅰ, it was 402.2 Million tCO2eq, a decrease of 1.4% from the comparison with BAU. As for Scenario Ⅱ, it was 383.1 Million tCO_2eq, a reduction of 6.1% from BAU. In Scenario Ⅲ, it was 340.8 Million tCO_2eq, a reduction by 16.45% from BAU.

Based on results of this study, it will be difficult to expand the current national energy plan. If we develop and expand IGCC and new and renewable energy which can replace the existing fossil fuel energy, it will be greatly contributory to reduction of greenhouse gas emission.

Currently, the government aims to increase the distribution of new and renewable energy until 2030 but the distribution rate is lower than in other countries. Therefore, it is necessary to ensure more studies from the perspectives of geographic conditions and economic aspects. We will need environment-friendly power generation that makes fuel supply convenient such as IGCC.

However, based on the characteristics of LEAP model, the values are the results of an analysis of the past forms and prospects of future. In the event of replacement of the technologies based on each scenario assumption rather than accuracy in results, it will be appropriate to approach from the perspective of analysis of the impacts.

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