

## **The Role of Nuclear Power in Korea under Carbon Emissions Regulation**

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### **Abstract**

*Efforts are made to examine the role of nuclear energy under the international carbon emissions regulation. To do so, an econometric model for energy demand and supply is developed. Here, several scenarios on the regulation are assumed and then each scenario is analyzed by using this model. This model also makes it possible to analyze the effect of carbon tax. The results show that share of nuclear increases up to 60% in 2020 instead of 45% makes GDP rise by 1.9% while the electricity price lower by 46% in carbon emission regulation.*

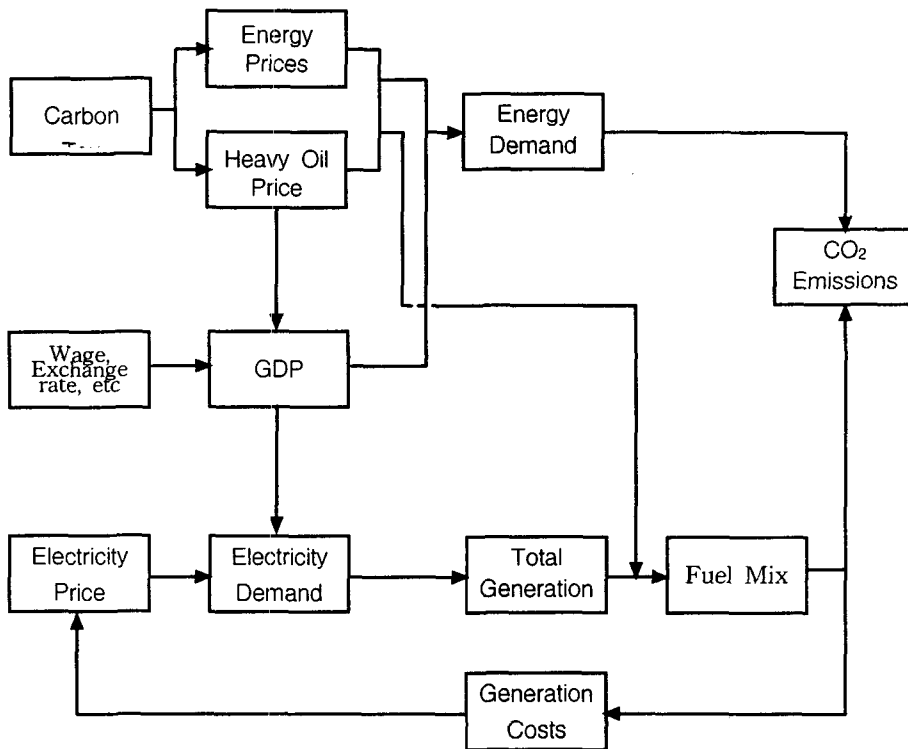
### **I. Introduction**

The sustainable development, pursuing both the achievement of economic growth and the preservation of environment, is being emphasized internationally. Since nuclear energy has enormous potential to contribute to the sustainable development, the efficiency improvement of its use and development has emerged as an important social issue.

In this regard, this paper takes a close look at the role of nuclear energy within the framework of energy demand and supply when the international environmental regulation, such as the control on carbon emission, is imposed.

More specifically, this paper examines the effect of the international environmental regulation on the various economic variables such as GDP, electricity price, and the rate of carbon tax. To do so, an econometric model for energy demand and supply is developed. Here, several scenarios on the regulation are assumed and then each scenario is analyzed by using this model. This model also makes it possible to analyze the effect of carbon tax.

## II. The Flowchart of Model



This model investigates the effect of carbon tax on the gross domestic product(GDP) and on the energy sector including electric sector. Through the

mechanism shown above, the econometric model produces GDP, electricity price, amount of carbon emission, and the rate of carbon tax for each scenarios.

### III. Assumption and Scenarios

#### 1. Assumption

- Reduce carbon emission in 2020 at the level of the year 2000
- Fossil fuel escalation(coal 1%, oil 3%, gas 3%)
- Carbon tax is levied from the year 2001 to meet the international CO<sub>2</sub> regulation
- Gas is substituted for coal and oil by 5% every year in non-electric energy sector when carbon tax is levied

#### 2. Scenarios

- Base scenario implies that no carbon tax is levied or equivalently, no regulation is imposed on CO<sub>2</sub> emission.
- Quantity regulation implies that the regulation is imposed on the quantity of total carbon emission.
- Population regulation implies that the regulation is imposed on the quantity of carbon emission proportional to population.

Scenario		Description
Base scenario (No regulation)		- no carbon tax - share of nuclear generation in electric sector (2001 - 2010: 37%~45% , 2011-2020: 45%)
Quantity Regulation	Quantity-1 Scenario	- share of nuclear generation in electric sector (2001 - 2010: 37%~45% , 2011-2020: 45%)
	Quantity-2 Scenario	- Increased share of nuclear generation in electric sector (2001 - 2010 : 50%, 2011 - 2020 : 60%)
Population Regulation	Population-1 Scenario	- share of nuclear generation in electric sector (2001 - 2010: 37%~45% , 2011-2020: 45%)
	Population-2 Scenario	- Increased share of nuclear generation in electric sector (2001 - 2010 : 50%, 2011 - 2020 : 60%)

## IV. Results

### 1. Quantity Regulation Scenario

Items		1996	2000	2005	2010	2015	2020
GDP (Billion Won, '90 constant price)	Base Scenario	273,198	345,495	461,814	607,674	750,342	903,535
	Quantity - 1	273,198	345,495	446,604	568,381	680,727	796,812
	Quantity - 2	273,198	345,495	450,432	576,532	692,341	811,447
Electricity Price (Won/kWh)	Base Scenario	61.36	61.87	64.63	67.40	70.37	73.33
	Quantity - 1	61.36	61.87	106.95	204.50	440.38	953.80
	Quantity - 2	61.36	61.87	87.14	147.78	239.80	477.49
Carbon Emission (1,000 C-ton)	Base Scenario	124,606	163,518	203,699	231,742	260,138	288,424
	Quantity - 1	124,606	163,518	175,272	167,882	165,028	163,129
	Quantity - 2	124,606	163,518	172,211	173,200	164,882	163,528
Carbon Tax (US\$/C-ton)	Base Scenario	0	0	0	0	0	0
	Quantity - 1	0	0	264	973	2,625	6,243
	Quantity - 2	0	0	176	624	1,667	3,952

The regulation on the quantity of total carbon emission(Quantity Regulation) turned out to have great influence on national economy. In this case, the impacts from the regulation is so severe that there seems no policy options available other than promoting the change in the patterns of energy consumption. Nevertheless, quantity-2 scenario is resulted more favorable. The result of quantity-2 scenario implies that, in the year 2020, GDP decreases by 10.2% compared with base scenario, while the electricity price increases by 651.2%. Also, the proper rate of carbon tax is 3,952 US\$/C-ton. Although the increase of nuclear share in electric sector contributes greatly to the stability of economic variables(compared with quantity-1 scenario), it seems the economy can not stand alone.

As a conclusion, if international regulation is imposed on the quantity of total carbon emission like above, the impact is so severe that there is no room the nuclear can help.

## 2. Proportional to Population Regulation Scenario

Items		1996	2000	2005	2010	2015	2020
GDP	Base scenario	273,198	345,495	461,814	607,674	750,342	903,535
	Population - 1	273,198	345,495	454,802	587,051	708,620	832,904
	Population - 2	273,198	345,495	457,981	595,233	719,880	848,647
Electricity Price (Won/kWh)	Base Scenario	61.36	61.87	64.63	67.40	70.37	73.33
	Population - 1	61.36	61.87	79.88	122.94	188.00	350.95
	Population - 2	61.36	61.87	70.39	87.95	118.36	188.82
Carbon Emissions (1,000 C-ton)	Base Scenario	124,606 (2.75)	163,518 (3.49)	203,699 (4.15)	231,742 (4.52)	260,138 (4.85)	288,424 (5.14)
	Population - 1	124,606 (2.75)	163,518 (3.49)	184,302 (3.76)	187,390 (3.65)	192,200 (3.58)	194,208 (3.46)
	Population - 2	12,4606 (2.75)	163,518 (3.49)	180,506 (3.68)	192,293 (3.75)	189,831 (3.54)	193,996 (3.46)
Carbon Tax (US\$/C-ton)	Base Scenario	0	0	0	0	0	0
	Population - 1	0	0	96	319	841	1,984
	Population - 2	0	0	48	160	489	1,156

Note) Figures in parenthesis represent the quantity of carbon-ton per capita..

In the case of the regulation on the quantity of carbon emission proportional to population(Population Regulation), the impact appeared less severe than the case of the regulation on the quantity of total carbon emission. As the same in the quantity regulation scenario, population-2 scenario turned out to be the more favorable.

The result is greatly improved when it is compared with that of the quantity regulation scenario. In population-2 scenario, GDP decreases only by 6.1% compared with base scenario in the year 2020, while the electricity price increases by 257.1%. Also, the proper rate of carbon tax is 1,156 US\$/C-ton. This implies that the economy can, somehow, survive if international regulation is imposed on the quantity of carbon emission proportional to population instead of total carbon emission.

Also, in this scenario, the nuclear can play some role by reducing the electricity price by 46.2% in the year 2020 through the increased share of

nuclear(compared with population-1 scenario).

## V. Concluding Remarks

From the results, it is found that the national economy is significantly influenced according to which regulation is adopted. If international regulation is imposed on the quantity of total carbon emission, the impact is so severe that Korean economy could not stand alone. Therefore, the economy can not overcome the impact from the regulation only by the increased share of nuclear. However, if the regulation is imposed on the quantity of carbon emission proportional to population instead of total carbon emission, it would bring definitely better opportunity to the Korean economy.

In the latter case, there is a room that nuclear can contribute. If the share of nuclear increases up to 60% in 2020 instead of 45%, GDP would rise by 1.9% while the electricity price lower by 46%.

This paper, for simplicity, is using the levy of carbon tax as a tool for reducing CO<sub>2</sub> emission. As a result, the proper rate of carbon tax is exaggerated(in general, more or less 100 US\$/C-ton is usually cited in advanced countries). However, if continuous efforts for promoting both the change in the patterns of energy consumption and energy conservation are paralleled with carbon tax, the proper carbon tax rate will be reasonably ranged and the contribution of nuclear will significantly increase.

## Reference

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