

Applications of KEEI National CGE Model



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The CGE Model for Korea

Main Purposes

- CO₂, energy, and economy interactions
- The impact of each environmental policy on economic growth, sectoral output and energy use patterns
- The cost of a CO₂ emission limit under several alternative environmental policies

KEEI National CGE

- Multi-sector, recursive dynamic CGE Model
- 35 subsectors for production
- 4 consumer goods
- Nested Leontief-CES production function

Classification of production sectors

Non-energy sector (15 sectors)	Agriculture, Mining, Food & Beverage, Textile & Lather, Chemical products, Pottery, Non-ferrous metal, Metal & Machinery, Motor vehicle, Other manufacturing, Construction, Road transportation, Other transportation, Public & Administration, Service
Energy intensive Industry (3 sectors)	Basic chemical, Cement & Concrete, Iron & Steel
Energy sector (15 sectors)	Anthracite, Bituminous, Crude oil, Natural gas, Coal products, Petroleum products(Naphtha, Gasoline, Jet oil, Kerosene, Diesel, Bunker A B C, LPG, Others), Town gas, District heating
Electricity (2 sectors)	Hydro & Nuclear generation, Thermal & Self-generation
Total 35 sectors	

Classification of consumer goods

Consumer goods	Foods & Beverages
	Light & Fuels
	Transportation & Communication
	Others

Applications

■ Reference case (BAU)

- Forecast of Economy, including Energy Demand and CO₂ Emissions predicted on the basis of the KEEl national CGE model

■ Policy 1 Simulation

- various CO₂ Emission targets

■ Policy 2 Simulation

- various CO₂ abatement mechanisms

BAU Scenario

- 1995 - 2020
- Autonomous Energy Efficiency Improvement
 - 1.0% per year
- Backstop technology
 - photovoltaic and new nuclear generation technology
 - gradually introduced after 2010

Major Economic Indices (BAU)

	1995	2000	2010	2020	Annual average growth rate (%)		
					96-00	01-10	11-20
GDP (trillion Won)	375.9	489.3	805.5	1139.6	5.4	5.1	3.5
Primary energy (million TOE)	146.8	185.3	277.7	342.3	4.8	4.1	2.1
Final energy (million TOE)	119.6	150.5	223.4	275.8	4.7	4.0	2.1
CO ₂ emissions (million TC)	101.2	126.3	184.4	221.5	4.5	3.9	1.8
per capita CO ₂ emissions	2.24	2.67	3.64	4.23	3.5	3.2	1.5
Energy/GDP	0.39	0.38	0.34	0.30	-0.6	-0.9	-1.4

Major Industries (BAU)

	1995	2000	2010	2020	Annual average growth rate (%)		
					96-00	01-10	11-20
Production (trillion Won)	58.51	78.95	104.19	143.16	6.2	2.8	3.2
- Basic Chemical	12.14	15.85	21.55	31.36	5.5	3.1	3.8
- Iron & Steel	34.89	47.87	61.96	81.00	6.5	2.6	2.7
- Electricity	11.48	15.23	20.68	30.80	5.8	3.1	4.1
CO2 emissions (million TC)	37.8	48.2	70.0	82.5	5.0	3.8	1.7
Share (%)	(37.4)	(38.2)	(38.0)	(37.2)			
- Basic Chemical	5.3	6.6	9.8	11.8	4.6	4.0	1.9
- Iron & Steel	11.8	15.5	20.4	23.2	5.5	2.8	1.3
- Electricity	20.7	26.1	39.9	47.5	4.7	4.3	1.8

Policy 1 Simulation CO₂ Emission targets

- carbon tax

- Scenarios

(after years 2010)

- Scenarios 1: 10% reduction compared to BAU
- Scenarios 2: 20% reduction compared to BAU
- Scenarios 3: 30% reduction compared to BAU
- Scenarios 4: 40% reduction compared to BAU

Abatement Cost

		Abatement	Carbon tax		Loss of GDP	
		Million TC	1000 Won	US\$	Trillion Won	%
Scenario 1	2010	18.8	21.8	24.5	2.5	-0.32
	2020	24.7	20.8	23.4	3.4	-0.29
Scenario 2	2010	37.7	56.6	63.5	4.8	-0.62
	2020	49.4	54.6	61.3	8.2	-0.69
Scenario 3	2010	56.5	110.3	123.8	8.9	-1.14
	2020	74.0	107.3	120.4	15.4	-1.3
Scenario 4	2010	75.3	191.7	215.3	15.2	-1.96
	2020	98.7	188.0	211.2	26.1	-2.20

Impact on major industries

		Production (billion won)			CO2 Emission (1000 TC)		
		Chemical	Electricity	Iron & Steel	Chemical	Electricity	Iron & Steel
Scenario 1	2010	-2.6	-4.7	-6.2	-3.7	-21.1	-12.6
	2020	-2.6	-4.8	-4.6	-3.6	-21.3	-11.0
Scenario 2	2010	-6.7	-11.1	-11.5	-9.0	-37.5	-24.5
	2020	-6.4	-11.2	-10.6	-3.7	-37.4	-12.7
Scenario 3	2010	-12.2	-18.7	-19.6	-15.7	-50.7	-38.1
	2020	-11.6	-18.7	-19.0	-15.1	-50.2	-37.6
Scenario 4	2010	-19.2	-27.4	-30.4	-23.8	-62.7	-51.5
	2020	-18.4	-27.5	-29.9	-23.0	-61.8	-51.2

Policy 2 Simulation CO₂ abatement mechanisms

■ Emission target

- 20% reduction relative to BAU scenario after 2010
- Basic chemical, Iron & steel, Electricity

■ Scenarios

- Scenario 1: Carbon tax (industry-specific)
- Scenario 2: Emissions trading with auction
- Scenario 3: Emissions trading with grandfathering

Abatement Cost

	Unit abatement cost (1000 Won/TC)		GDP Losses (%)		Emission Allowances (million TC)		Emission Allowances (Vs. 1995, %)	
	2010	2020	2010	2020	2010	2020	2010	2020
Carbon tax			-0.17	-0.21				
- Basic chem	191.8	204.0			7.8	9.4	48.6	79.0
- Iron & steel	73.1	73.9			16.3	18.6	37.6	57.0
- electricity	22.0	20.8			31.9	38.0	53.9	83.2
Auction	36.3	34.7	-0.11	-0.14				
Grandfathering	61.2	56.5	-0.10	-0.10				

Impact on production levels

(% changes, compared to BAU)

	Carbon Tax		Auction		Grandfathering	
	2010	2020	2010	2020	2010	2020
Basic chemical	-15.4	-15.1	-3.9	-3.4	-2.9	-2.2
Iron & steel	-7.5	-7.0	-5.0	-4.5	-4.2	-3.5
Electricity	-5.5	-5.3	-8.0	-7.9	-2.6	-3.1

Conclusion

■ Policy 1 Simulation

The size of the required tax and GDP losses

- increases with the stringency of the carbon limit
- Non-linear with respect to the level of controls

■ Policy 2 Simulation

GDP Losses

- Emissions trading < Industry-specific Carbon Tax
- Grandfathering < Auction
- Any administrative and transaction cost excluded

Future Works

■ Tax revenue recycling methods

- reducing budget deficits
- reducing marginal rates of income, payroll, corporate or other taxes
- granting tax incentives to preferred activities

■ Sensitivity analysis

- the types of policies
- the strengths of emission reductions
- the magnitude of key parameters in the model