

The Electricity Industry Reform in Korea: Lessons for Further Liberalization

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Abstract

In April 2001, the generation unit of Korea Electric Power Corporation (KEPCO) was split into six subsidiary companies with further plans for privatization. But, the process of privatization has ceased due to changes in political environment. This study analyzes the performance of the restructuring of generation units using financial and physical indices. The results from the analysis also show that the restructuring has had positive effect on their performance. The financial indices of the generation companies also show that the prices of fuels, intervention of government, and capability of management affect the performance of the companies. Although the results do not show that restructuring favorably affected the prices of electricity, the indices of liability and profitability show some promising signs arising from the electricity sector reform. To maintain these changes, further liberalization needs to be followed, although there are some issues that need to be dealt with prior to restructuring and privatization plans. The problems of proper reserve margin, the negative effect of regional electricity company, and the conflict between cost saving and preserving environment are some of those need to be dealt with. Those problems can be solved by institutional reform and further liberalization.

1. Introduction

In the past decade, the reforms in the electricity sector have speeded up and numerous reforms have proceeded. As of June 2006, 14 countries have completed electricity sector reform programs while 60 countries are undergoing electricity sector reform programs. These countries often remodeled earlier reform models to suit their own needs and circumstance, and the electricity reform in Korea also proceeded in its own way. In April 2001, the generation portion of Korea Electric Power Corporation (KEPCO) was split into six subsidiary companies: Korea South-East Power (KOSEP), Korea Midland Power (KOMIPO), Korea Western Power (WP), Korea East-West Power (EWP), Korea Hydro & Nuclear Power (KHNP), and Korea Southern Power Co (KOSPO). This essentially meant that original KEPCO has turned into a transmission and distribution monopoly in Korea.

From 1961 until April 2001, South Korea's sole electric power utility was KEPCO. Set up as a government corporation, 21% of its shares were sold to the public in 1989. After the currency crisis in 1997, the Korean

government started to make plans to privatize the electricity sector and the first step was spinning off KEPCO's generation unit into six separate subsidiary companies. It was the first step of restructuring of electricity sector. The original plan was structured in three phases. The first step was spinning off and privatizing the generation sector to create a competitive electricity market (CBP: Cost Based Pool). The second phase was restructuring and privatizing the distribution sector to induce a two way bidding pool market. The third phase was opening the electricity market for free competition. But plans to privatize generating companies and the following restructuring and privatization of distribution(sales) sectors were ceased when President Roh came into power in 2003. As a result, the electricity sector reform remains as incomplete reform. Although the privatization plan is likely to continue with the current administration, the current market structure poses numerous problems: first is that there exists imperfect competition among the generation companies, second, the system leaves opportunistic intervention by the state, and third, there exists a conflict between cost saving and preserving environment.

This study seeks to analyze the performance of the current electricity system because this would provide useful information as to the future course of policy reform ideas. And this study also seek to identify problems with the market structure and find likely solutions in terms of market structure in all levels of electricity industry.

2. Background

Energy Policy in Korea

Throughout the years, the goal of Korea's energy policy has shifted from ensuring a stable supply of energy to achieving sustainable development, largely due to rapidly changing internal and external conditions. In order to maintain high economic growth in the 1970s, energy policies centered on oil, which was relatively easy and cheap to buy. However, the two rounds of oil crisis significantly impacted the national economy, and new policies have been pursued since the 1980s to establish a stable supply and demand system, including the diversification of energy supply sources and expanding the energy supply infrastructure. The diversification policy was to have nuclear power as a major element of electricity production and rationalization was pursued in the coal industry.

From the late 1990s, restructuring of the energy sector was pursued in full-scale with the introduction of the principle of free competition to such utility industries as electricity and gas which had been considered natural monopolies. Furthermore, initiatives forwarded by the United Nations Framework Convention on Climate Change have strengthened environmental regulations. As a result, sustainable development has emerged as the focal point of Korea's recent shift in energy policy.

Electricity Market Operation System¹

¹ Recomposition of the information from www.kpx.co.kr

Prior to the restructuring of the electricity industry, KEPCO used to enjoy a monopoly over power generation, transmission/distribution, and sales until the spinoff of its generation unit. Also, the government lifted entry barriers that virtually made it impossible for IPPs (Independent Power Producer) to operate in the market. The generation market structure as mandated by the electricity industry restructuring started in April 2001. Nonetheless, KEPCO remains as the sole purchaser (power sales business) of electricity. Therefore, whereas competition is allowed in the supply side in the current CBP market, monopoly is maintained on the demand side. Given its current structure, the CBP market is competitive to the extent that generators compete with each other. Moreover, since the Korean power system is maintained on a single national grid, there is no regional trading market; only a single power trading market is required to coordinate and manage energy supply and demand across the whole country.

The current Korean electricity system is based on the Cost-Based Pool (CBP) concept since the market price reflects the actual generation cost. Under the pool system, all generators are obliged to submit the details of their production costs which are independently checked and approved by the Generation Cost Assessment Committee (GCAC). Using this information, Korea Power Exchange (KPX) prepares a Price Setting Schedule and calculates the marginal price (SMP) based on the principle of minimizing the system variable cost. The market price is composed of the system marginal price (SMP) and capacity payment (CP). Capacity payment is the price paid to a generating unit that has declared its availability during the day. Price cap is imposed on the energy price of base load generating units such as coal and nuclear energy. Marginal Price (SMP) is determined as the most expensive generation available for the trading period in the Price Setting Schedule. After real-time dispatching, settlement for the energy produced takes place based on the market price (SMP, Capacity Payment).

$$\text{Settlement} = \text{Output} \times \text{SMP} + \text{Capacity} \times \text{CP} + \text{Other Payment}$$

3. Literature Review

There are several studies on the performance of electricity sector reform. Pollitt (1997) categorizes empirical studies on electricity sector reform into four groups: i) ones that use financial and physical indicators; ii) ones that look at labor productivity measures or total factor productivity (TFP); iii) ones that use frontier methodologies; and iv) approaches based on social cost benefit analysis of electricity privatization.

The first method is the simplest approach. Yarrow (1992) develops a counterfactual scenario which assumes British electricity sector had not been privatized and compares the actual results. Branston (2000) further improves the model and conducts counterfactual price analysis on the British electricity privatization. The result is that the reform had minimal impact on prices. Duncan and Bollard (1992) analyze the impact of the reform of the government control of Electricity Corporation of New Zealand. Rocha et al. (2007) analyze the return on capital of Brazilian electricity distributors, and he concludes that the return on equity in Brazil was systematically negative until 2003.

Bishop and Thompson (1992) analyze changes in the labor or total factor productivity growth rates as a result

of the 1983 Energy Act which sought to introduce limited competition into the electricity generation industry. Haskel and Syzmanski (1992) examine the impact the implementation of divisional management structure in the UK ESI in 1983. Plane (1999) estimates the total factor productivity of Côte d'Ivoire Electricity Company (CIE) and he finds that productive efficiency improved due to privatization.

Hawdon (1996), using cross-sectional data for developing countries, finds that privatized firms in their sample had higher productivity efficiency. Berg and Jeong (1991) analyze the effects of the introduction of incentive regulation in the US and suggest that relative inefficiency is not reduced by narrow incentive regulation focused on plant utilization and thermal efficiency. Cullmann and Hirshhausen (2008) provides a cross-country efficiency analysis of electricity distribution companies in the East European transition countries of Poland, the Czech Republic, Slovakia, and Hungary. The results suggest that privatization has had a positive effect on technical efficiency in the four countries.

The fourth method measures the impact of privatization on the society as a whole. Jones et al. (1990) outline the methodology, and Galal et al. (1994) apply it to 12 privatizations. Newbery and Pollitt (1997) applied the methodology to the privatization case of Britain's CEGB. Oliveira et al. (2004) measure the gains and losses of shareholders, board members, fuel suppliers, consultants, equipment suppliers, service-providers, consumers, government, and regulators created by the British ESI regulatory system. They conclude that the reform is overall beneficial, although not for stakeholders. Toba (2007) measure the welfare impacts of the electricity generation sector reform in the Philippines. The results show that consumers and investors are net gainers, while the government lost due to loss of revenue while and environment lost due to increased pollution.

4. Theoretical Framework

This study uses various financial statements of KEPCO and the price of electricity to analyze the impact of the restructuring program. A social cost benefit analysis tends to better evaluate the overall aspects of the performance; however, it is hard to apply to partial electricity industry reform cases. And the analysis of labor productivity is not adequate in this case because labor productivity is often affected by the total number of labor (the labors in KEPCO are transferred to the generation companies). Therefore, it is more suitable to use financial and physical indicators in this case.

First, this study analyzes the financial statement of electricity companies to look the performances of each company. Then, this study examines the effect of electricity restructuring in Korea on the electricity companies' financial indicators and electricity price.

Analysis of Financial Statements²

Financial statements are the starting point of analysis as they report data about income, cash flows, and assets and liabilities that users can tailor to their specific needs. Financial reports often contain supplementary data

² Recomposition of White et al. (2003)

that, although not included in the statements themselves, enable users to interpret the financial status of the organization in question or to make adjustment of corporate performance (such as financial ratios) to make them more comparable, consistent over time, and more representative of economic reality. The common aspects that assess a company's financial status are liability, profitability, and growth.

Analysis of Liability. A firm's liabilities is crucial to the analysis of its long-run viability and growth. A firm can incur obligations in various ways; some are a result of the firm's operating activities, whereas others results from its financing decisions. The former are characterized by exchanges of goods and services for the later payment of cash (or vice versa), whereas debts arising from financing decisions generally involves current receipts of cash in exchange for later payments of cash. Both forms of debts are generally reported on the balance sheet.

Liability can be estimated by the current ratio³ and the debt ratio⁴. Lenders and creditors assess the ability of a firm to meet its current obligations. That ability depends on the cash resources available as of the balance sheet date and the cash to be generated through the operating cycle of firm. Current ratio compares levels of cash resources with current liabilities as the measure of cash obligation. Long-term debt and solvency analysis evaluates the level of risk borne by a firm, changes over time, and risk relative to comparable investments. A higher proportion of debt relative to equity increases the riskiness of the firm.

Analysis of Profitability. Equity investors are concerned with the firm's ability to generate, sustain, and increase profits. Profitability can be measured in several different ways. First, the return on investment (ROI) measures profits to the investment required to generate them. Return on investment (ROI) measures the relationship between profits and investment required to generate them. The ratio on profits to sale residual returns to the firm per sales dollar.

The return on assets (ROA)⁵ compares income with total assets. It can be interpreted in two ways. First, it measures management's ability and efficiency in using the firm's assets to generate profits. Second, it reports the total return accruing to all providers of capital, independent of the source of capital. The return on total stockholders' equity (ROE)⁶ excludes debt in the denominator and uses either pretax income (after interest costs) or net income. Both ROA and ROE reflect the firm's capital structure. Creditors and shareholders provide the capital needed by the firm to acquire the assets used in the business. In return, they receive their share of the firm's profits. ROA measure returns to all providers of capital. ROE measures returns to the firm's shareholder and is calculated after deducting the returns paid to creditors (interest). The equity shareholder can earn higher returns by "leveraging" the investment provided by the debt holders as long as the returns earned by the company's assets (ROA) are greater than the cost of debt. Operating margin⁷ is the relationship between the firm's costs and its sales. The ability to control costs in relation to revenues enhances earnings power.

³ Current Ratio = Current Assets/Current Liabilities

⁴ Debt Ratio = Total Debt/Total Equity

⁵ ROA = Net Income/Average Total Assets

⁶ ROE = Net Income/Average Stockholders' Equity

⁷ Operating Margin = Operating Profit/Sales

Analysis of Growth. Analysis of growth premises a long-term management plan. The analysis offers information about future income, sales, costs, and profit for a long-term management plan. Growth ratio shows that the company's ability to take the chance of growing, and it represents the company's competitiveness are maintained well. In other words, the ratio is used to decide whether the status of the company is sustainable or not. The indices are consist of growth rate of sales⁸, growth rate of operating profit⁹, growth rate of net income¹⁰, and growth rate of assets¹¹.

Analysis of the Effect of Electricity Reform

We also conduct regression analysis with dummy variables. The dependent variables included are price and financial indicators and a dummy variable which is 1 periods after the reform of electricity sector. Independent variables are also taken from earlier studies.

Yarrow (1992) conducted a price analysis to examine the performance of the British electricity privatization. And, Branston (2000) renewed the methodology and executed a counterfactual price analysis of British electricity privatization. Branston's approach is similar to that of Yarrow where the cost of electricity has been split into the three components shown in Equation (1):

$$P_t = F_t + N_t + \Pi_t \quad (1)$$

where P_t is the relevant price (per kWh) of electricity in year t ; F_t the 'fossil fuel costs' per unit (kWh) of electricity sold in year t ; and N_t comprises 'non-fossil fuel costs' (per kWh) in year t ; and Π_t the 'profits' (per kWh) in year t . This model is also suitable for the examination of the Korean electricity reform since the proportion of nuclear generation is high in Korea. And there is an implicit profit regulation in KEPCO. As a result, there are three independent variables which are F_t , N_t , and Π_t .

Equation (1) uses the weighted unit cost of coal, gas, and oil generated electricity to calculate an estimate of cost of fossil fuels per unit of fossil fuel generated electricity. However, Equation (1) does not take into account the electricity generated from other, non-fossil fuel sources such as nuclear or hydro. But, Equation (2) takes into account of this.

⁸ Growth Rate of Sales = (Current Sales–Last year's Sales)/Last year's Sales

⁹ Growth Rate of Operating Profit = (Current Operating Profit–Last year's Operating Profit)/Last year's Operating Profit

¹⁰ Growth Rate of Net Income = (Current Net Income–Last year's Net Income)/Last year's Net Income

¹¹ Growth Rate of Assets = (Current Assets–Last year's Assets)/Last year's Assets

$$FF_t = (X_t \times C_t) + (Y_t + G_t) + (Z_t + O_t) \quad (2)$$

where FF_t is the fossil fuel costs per unit (kWh) of electricity sold in year t which was generated using fossil fuels; X_t the proportion of electricity sold in year t , generated using coal; C_t the unit (per kWh) fuel cost of coal generated electricity in year t ; Y_t the proportion of electricity sold in year t , generated using gas; G_t the unit (per kWh) fuel cost of gas generated electricity in year t ; Z_t the proportion of electricity sold in year t , generated using oil; and O_t is the unit (per kWh) fuel cost of electricity generated using oil in year t .

To calculate the unit fuel cost of electricity generated from the different fossil fuels, the formula Yarrow and Branston used can be applied to each of the fuels:

$$I_{it} = \frac{P_{it} \times Q_{it}}{QE_{it}} \quad (3)$$

where I_{it} is the unit fuel cost of electricity generated using fossil fuel i in year t ; P_{it} the unit price of fuel i in year t ; Q_{it} the quantity of the fuel i used in year t ; and QE_{it} is the quantity of electricity generated using fuel i in year t . Equation (4) is then used to calculate the costs of the fossil fuels per unit all the electricity sold and not just the costs of the fossil fuels per unit of electricity generated by those fossil fuels, as was carried out in Equation (2):

$$F_t = \frac{FF_t \times QE_{Ft}}{QET_t} \quad (4)$$

where F_t is the fossil costs per unit (kWh) of electricity sold in year t ; FF_t the fossil costs per unit (kWh) of electricity sold in year t which was generated using fossil fuels; QE_{Ft} the number of units of electricity (kWh) sold in year t which was generated using fossil fuels; and QET_t is the number of units of electricity (kWh) sold in year t .

Although this study doesn't conduct counterfactual analysis, these equations are useful for converting data. Without these converting procedures, fuel cost's effect can be overestimated to dependant variables.

5. Analysis of Financial Statements

The financial statements provide information about the performance of each generation company. We conduct both the analysis of liability, profitability, and growth of each company as well as the generating units as a whole.

Analysis of Liability

Current Ratio. The ideal current ratio is said to be above 200%. If KHNP is excluded (KHNP has different scale from the other generation companies), the current ratios range from 31% to 112% (See Fig. 1 and Table 4). Although the ratios are low to the industry standard, it does not mean that the companies are at a risk since they receive a stable cash revenue from KEPCO in the current system.

Debt Ratio. The ideal debt ratio is said to be under 100%. The debt ratios range from 32% to 139% (See Fig. 2 and Table 5). They have a stable debt although the ratios are on the rise due to new constructions of power plants.

Figure 1. Current Ratios of the generation companies (Unit: %)

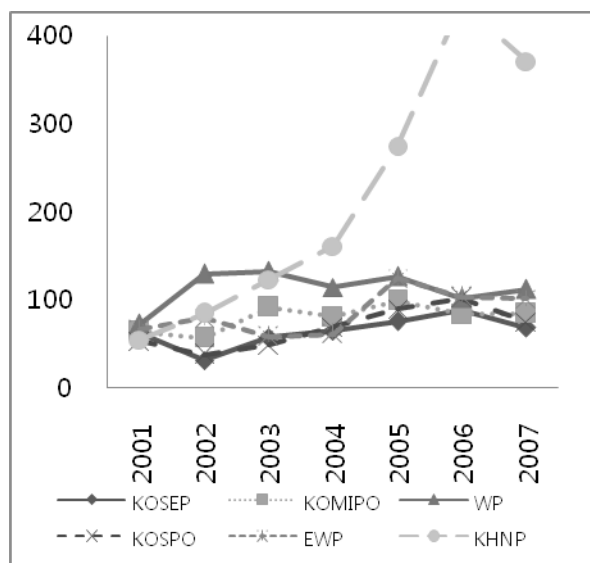
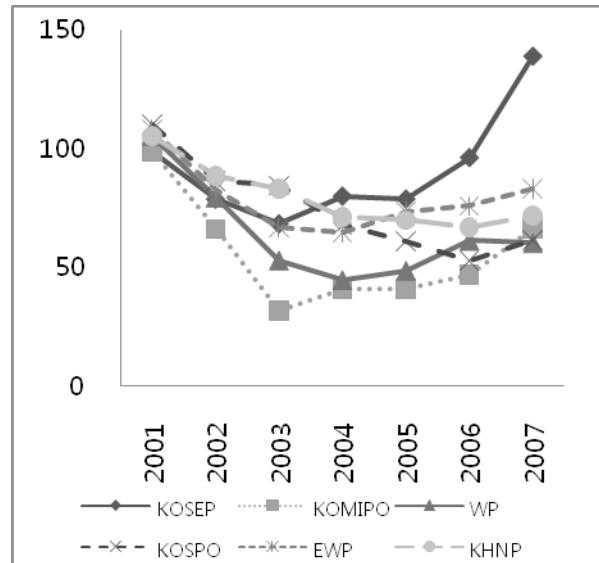


Figure 2. Debt Ratios of the Generation Companies (Unit: %)



The liabilities of the generation companies are well managed under the current system. But the current ratios are likely to improve with the future structural reform as they need to pay more attention to their financial structure in the competitive markets.

Analysis of Profitability

ROA. We found that ROAs are usually lower than those of other industries. The average ROA of the generation companies ranges between 3% to 7%, and the average for the last 3 years near 4% (See Fig. 3 and Table 6). It is extraordinary to find their ROAs under 5%. It is expected their ROAs will improve due to increased depreciation in the future.

ROE. ROE is an important summary measure of a firm’s profitability and the return on investment. It captures many facets of a firm’s operating, investment, and financing characteristics. Given its importance, it is worthwhile asking whether current ROE can be used to forecast future ROE levels. A related question is whether abnormally high levels of profitability can be expected to continue into the future. Penman (1991) provides some insight into these questions: (i) in the short term, approximating five years (except for extreme portfolios), current levels of ROE persist into the future; (ii) over the long term, ROEs tend to revert toward an average “economicwide” ROE.; (iii) although there is a trend toward the mean, the portfolio rankings persist. That is, the portfolios with higher (lower) ROE tend to have higher (lower) ROEs in the future, however, the differences between the portfolios narrow.

Figure 3. ROAs of the Generation Companies

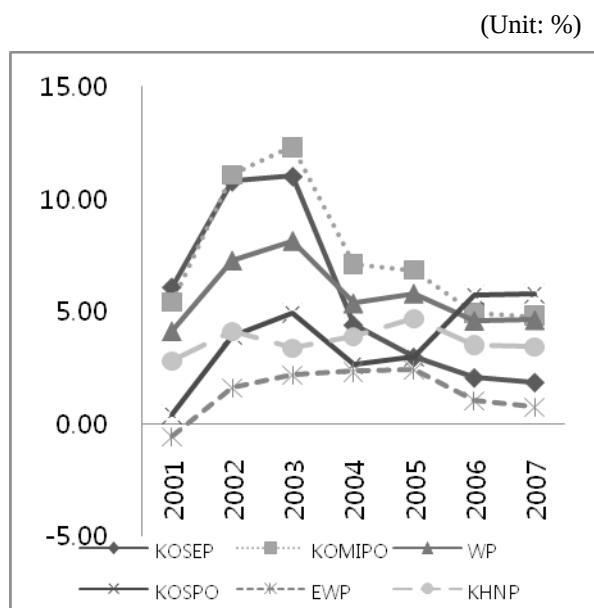
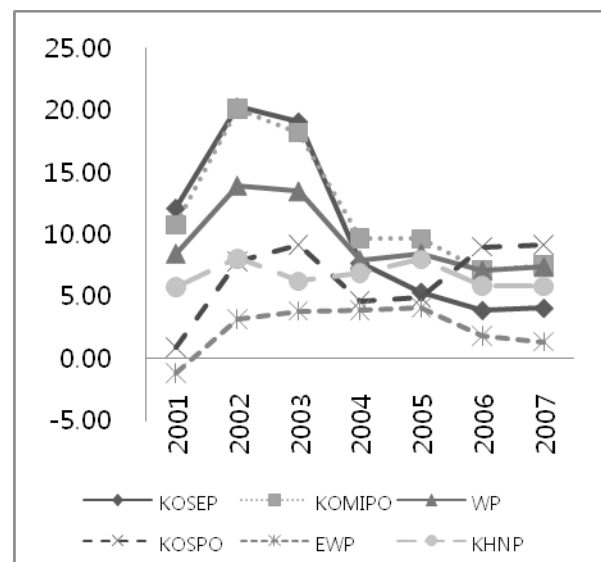


Figure 4. ROEs of the Generation Companies

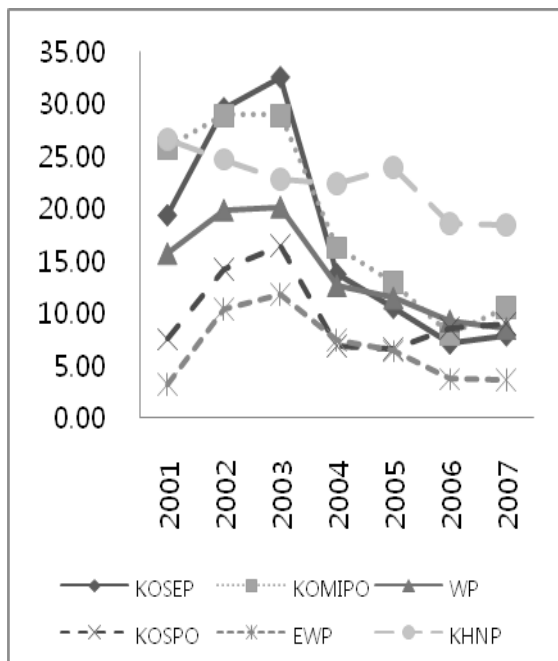
(Unit: %)



The ROEs of the generation companies move in similar patterns as shown in the above (See Fig. 4 and Table 7). ROEs varied much during five years, and it shows a steady up swing movement recently. But the ROEs of EWP and KOSEP are even lower than the base rates. These firms need to improve their efficiency for future course of action.

Figure 5. Operating Margins of the Generation Companies

(Unit: %)



Operating Margin. Operating margin is an index that shows the profitability of operating capital. The operating margins of 5 companies using fossil fuels sharply decreased in 2004 due to the electricity price decrease (see Fig. 5 and Table 8). The reason for the price decrease is that the operating profit of the electricity company was high in 2003. The price of electricity is decided by government which takes into account the operating profit of electricity companies, interest rate, and capital cost.

In terms of overall trend, the operating margins are decreasing continuously with the increasing price of fuels after 2004. On the contrary, the operation margin of KHNP has remained high, because the price of uranium were kept low.

Analysis of Growth

Growth Rate of Sales. Growth rate of sales is also important index to assess a company’s growth potential. But, it is not critical index to generation companies because the demand of electricity is often determined by the growth of national economy. Although it has less importance in electricity companies, growth rate of sales gives much information. It is possible to estimate the investment, efficiency, and competency of the company with the index.

The reason that the growth rates of sales decreased sharply in 2003 (See Fig. 6 and Table 9) is the sales data in 2001 covers only 9 months after the restructuring. And the rates are fluctuating with constructions of power plants since then. This index is more important with the investment and privatization plan.

Growth Rates of Operating Profit. This index also needs to be careful interpreted for electricity companies in Korea, because the price of electricity is determined by the government considering the operating profit of electricity companies. Same as the operating margins in 2004, the growth rates of operating profit have negative values in 2004 (See Fig. 7 and Table 10). And the reason that the rates sharply decreased was the same as that of growth rate of sales. The rates are fluctuating by the change of fuel and electricity prices.

Growth Rate of Net Income. Growth rates of net income moved similarly to the rates of operating profit (See Fig. 8 and Table 11). But, we need to pay closer attention to the growth rate of net income of KOSPO. The every growth rates of net income of KOSPO is positive value except in 2004. The reason is that KOSPO has new power plants with high efficiency and the management of the company is effective.

Figure 6. Growth Rates of Sales of the Generation Company (Unit: %)

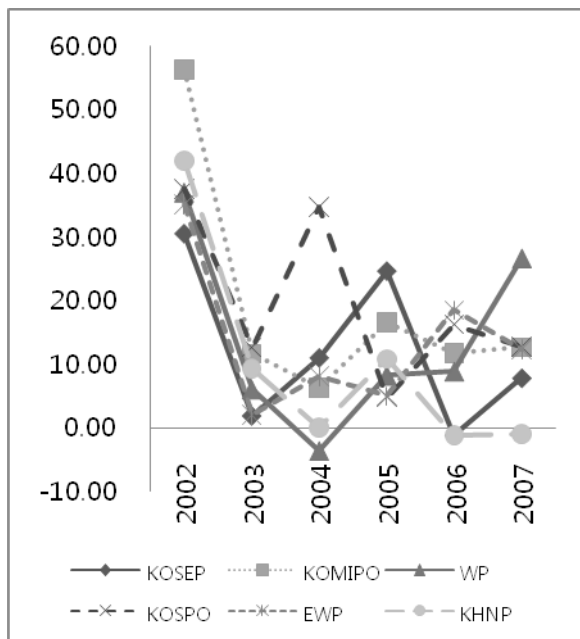


Figure 7. Growth Rates of Operating Profit of the

Growth Rate of Total Assets. Growth rate of total assets shows the growth of the investment. The growth rates of total assets of the generation companies are also fluctuating by the changes of the fuel prices (See Fig. 9 and Table 12). But the growth rate of total assets of KOSEP is increasing sharply since the construction of new power plants. The total growth rate of total assets should be maintained continuously, because it is needed to catch the increasing electricity demand. To escape a power shortage, the plan should be made and invested five years ahead.

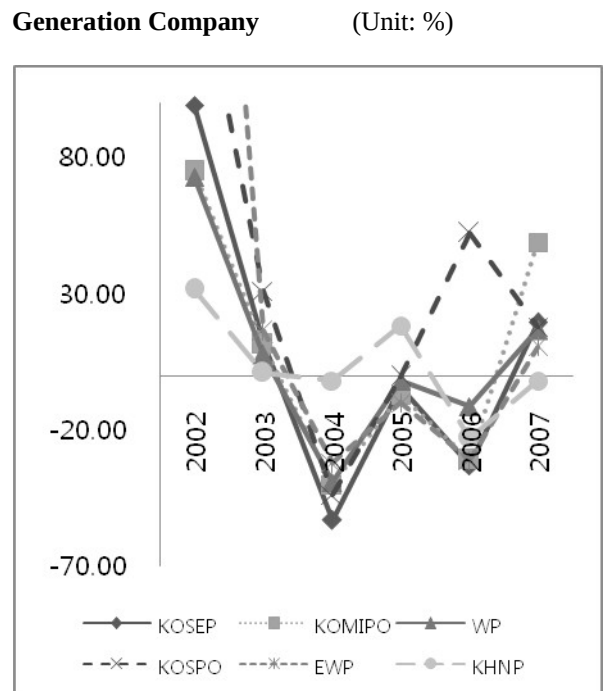


Figure 8. Growth Rates of Net Income of the Generation Company (Unit: %)

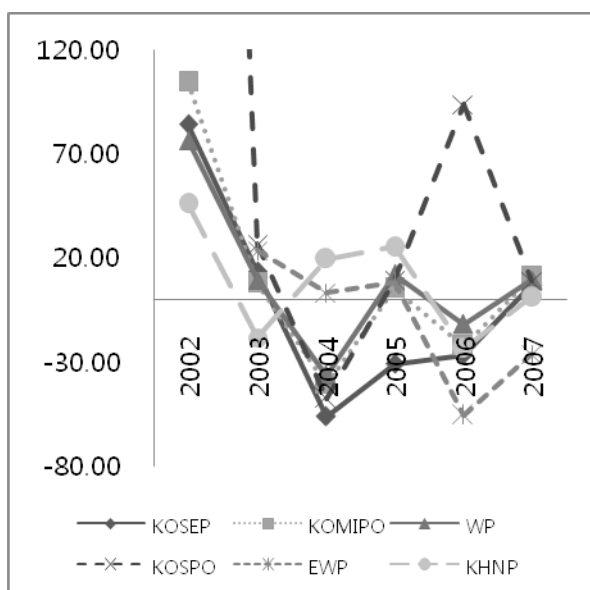
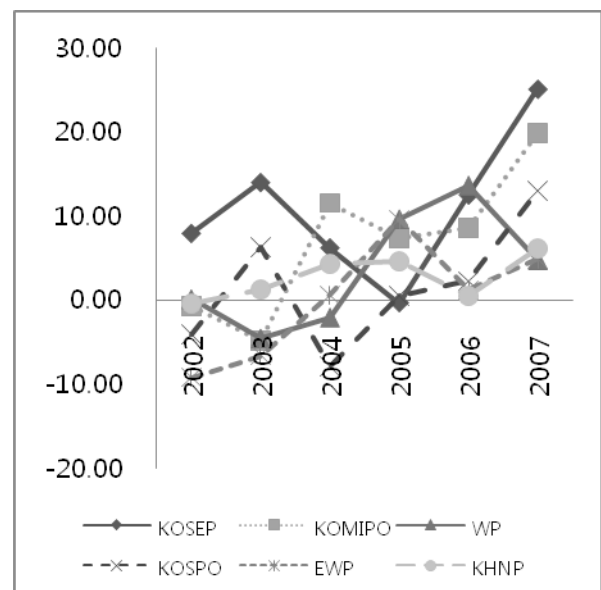


Figure 9. Growth Rates of Total Assets of the Generation Company (Unit: %)



In summary, the price of fuels and the price of electricity have big impact on the generation companies. The increase of fuel price burdens the operating of the companies, and government influences the generation companies' profit by setting the price of electricity. But, the effects are varied by companies' operating efficiency and the equipments they have.

7. Analysis of the Impact of the Electricity Reform

Method

To analyze the impact of the electricity restructuring on the efficiency of electricity industry, several indices are used in this analysis. In the model I, the price of electricity is used as the dependent variable, and the independent variables include the price of fossil fuel, the price of non-fossil fuel, the profit of KEPCO, and the electricity reform. The last independent variable is set as a dummy variable that reveals the impact of electricity restructuring. All units of the data are US cent/kWh, and the prices of fuels are transformed by the equations in the section of theoretical framework, and the period of analysis is from 1997 to 2006.

In the model II, the financial indices are used as the dependent variable, and the independent variables include the price of fossil fuel, price of non-fossil fuel, and electricity restructuring. The financial indices are calculated from consolidated financial statements of KEPCO which contains financial information about generation companies. We analyze the data for a period from 1997 to 2006.

In the model III, the price of electricity is added to the independent variables of Model II, and the dependent variables are the same. The price of electricity affect the financial indices since it influences the profits of these companies. The price of electricity needs to be controlled, because it is determined by the government. This model detects the impact of the restructuring excluding the effect from the electricity price changes.

Analysis of Results

The result of model I shows that the impact of the electricity reform is not significant in terms of the price of electricity. This can be interpreted in two ways. One is the price setting of government blocked the impact of electricity reform. The other is that the price could be already at a optimal level.

Table 1. Results of Model I

Dependent variable	β	t value	p-value	R ²	Adj-R ²	F Value	Pr > F
Price of electricity	-0.44389	-0.41	0.6955	0.7298	0.5947	5.4	0.0385

Notes: The independent variables are price of fossil fuel, price of non-fossil fuel, profit, and electricity restructuring. β is the estimated coefficient of the dummy variable, electricity restructuring. The independent variables are standardized.

The results of model II are slight different. The current ratio has had positive impacts from the restructuring. It shows that current ratio has increased since the restructuring. And debt ratio has had a positive impact too. The debt ratio has decreased since the electricity reform. The index of liability has improved. It seems that KEPCO tried to enhance its liability preparing for the further liberalization.

The indices of profitability also have positive value. ROA and operating profit have significant results while ROE remain insignificant. The ROA and operating profit increased sharply after the restructuring (See Fig. 12 and Table 13), but the ratios decreased due to the price increase of fuel since 2004. If the effect of price increase is eliminated, the impact of electricity reform is positive in terms of profitability. This implies that the restructuring brought about some positive impacts on the efficiency of the companies' operation.

The growth rate of sales and growth rate of total asset are the significant indices among growth indices. Growth rate of sales of electricity is affected by the economic growth, so the result does not have substantial meaning in this study. Also, growth rate of total asset has a negative impact of the restructuring. That means the reform of electricity industry gave negative impact on the investment.

Table 2. Results of Model II

Dependent variable	β	t value	p-value	R²	Adj-R²	F Value	Pr > F
CR^{a***}	17.4158	5.1	0.0014	0.9754	0.9684	138.73	<.0001
DR^{b*}	-44.4345	-2.27	0.0576	0.5907	0.4738	5.05	0.0439
ROA^{**}	1.36965	2.69	0.031	0.5396	0.408	4.1	0.0662
ROE	1.96893	1.84	0.1085	0.3296	0.1381	1.72	0.2467
OM^{c***}	5.99062	5.08	0.0014	0.8516	0.8092	20.09	0.0013
GRS^{d**}	-6.52656	-2.64	0.0333	0.5572	0.4307	4.4	0.0578
GROP ^e	-7.3385	-0.86	0.4186	0.6811	0.59	7.48	0.0183
GRNI ^f	1.22026	0.04	0.9709	0.1913	-0.0398	0.83	0.4756
GRTA^{g*}	-14.5186	-1.93	0.0951	0.3955	0.2228	2.29	0.1717

Notes: The independent variables are price of fossil fuel, price of non-fossil fuel, and electricity restructuring. β is the estimated coefficient of the dummy variable, electricity restructuring. The independent variables are standardized.

Significance Levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

a. Current Ratio. b. Debt Ratio. c. Operating Margin. d. Growth Rate of Sales. e. Growth Rate of Operating Profit. f. Growth Rate of Net Income. g. Growth Rate of Total Asset.

The results of model III also have some significant outcomes. Although the debt ratio is no more significant, the liability of the company is still improved. That means the reform still affected positively on the liability of the company when the effect from the price changes of electricity is excluded.

The ROA is still significant at the 90% significance level, and the operating margin is significant at 99% significance level. The ROA's significance level is decreased, because the increases of electricity price can

explain the changes of profit. However, the restructuring still has a positive effect on the profitability of the company. The indices of growth are insignificant except the growth rate of sales. But it is also not easy to conclude the reform has not affected the indices of growth. The indices of growth should be monitored continuously.

Table 3. Results of Model III

Dependent variable	β	t value	p-value	R²	Adj-R²	F Value	Pr > F
CR^{a***}	16.98836	4.42	0.0045	0.9759	0.9639	81.01	<.0001
DR ^b	-34.2606	-1.92	0.1027	0.7382	0.6073	5.64	0.0352
ROA*	1.10798	2.38	0.0545	0.7023	0.5534	4.72	0.0508
ROE	1.40793	1.45	0.196	0.5756	0.3634	2.71	0.1378
OM^{c***}	5.88485	4.42	0.0045	0.8532	0.7799	11.63	0.0065
GRS^{d*}	-5.96425	-2.2	0.0699	0.5878	0.3817	2.85	0.1271
GROP ^e	-5.36653	-0.57	0.587	0.7039	0.5558	4.75	0.0501
GRNI ^f	-8.19882	-0.24	0.8205	0.283	-0.0754	0.79	0.5423
GRTA ^g	-11.7551	-1.52	0.1799	0.5044	0.2566	2.04	0.2105

Notes: The independent variables are price of fossil fuel, price of non-fossil fuel, price of electricity, and electricity restructuring. β is the estimated coefficient of the dummy variable, electricity restructuring. The independent variables are standardized.

Significance Levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

a. Current Ratio. b. Debt Ratio. c. Operating Margin. d. Growth Rate of Sales. e. Growth Rate of Operating Profit. f. Growth Rate of Net Income. g. Growth Rate of Total Asset.

In conclusion, the reform of electricity did not benefit consumers since price is tightly controlled by the government but it brought some positive effects on generating companies. The liability indices worsened due to increased uncertainty, and some indices of profitability are also improved by the restructuring. The indices of growth have a negative effect.

8. Current Issues for Further Liberalization

Imperfect Competition among the Generation companies

KEPCO was split into six generation companies including KNHP and they produce 95% of electricity in Korea (See Table 16). They are competing with each other in oligopoly market structure with the price setting by government. The low level of competition and government intervention are causing some inefficiencies (as the result of the analyses in section 6 & 7). Also, there are some indications that they are collaborating with each other since the current reserve margin is too low (See Table 17). If the reserve margin is too low, an oligopoly

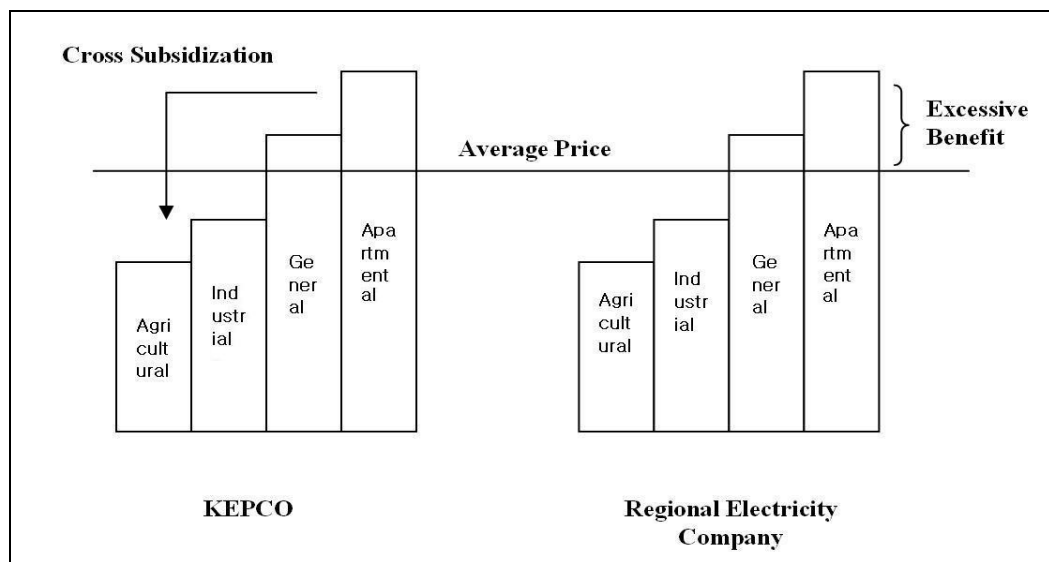
company can use oligopoly power more easily. Almost all countries that went through successful electricity reform had a reserve margins above 20% (Toda (2005)), but current reserve margin of electricity in Korea is only 7.2%.

However, it is also hard to compare the current margin to those of before, because the scale of electricity capacity is different. Maintaining 20% of reserve margin will cause excessive waste in the current electricity market. So, it is needed to study adequate reserve margin that doesn't cause over usage of oligopoly power and excessive waste.

Regional Electricity Company's Problems in Distorted price system

Regional electricity company is the company that has the privilege of general electricity company within the specific region where the company can supply more than 70% of the regional electricity demand. In this case, the company can escape the compulsory pool and uniform price. This aspect can reduce electricity price, save transmission cost, and improve the plant efficiency when the plant is combined cycle. But there are more negative effects of regional electricity company in Korea. The pricing structure of electricity in Korea is cumulative that the maximum rate is 11 times higher than the minimum rate, and that causes severe cross subsidization. In this case, if a regional electricity company buys electricity at low price and sells the electricity at high price, then other regions consumers have disadvantage (See Fig. 10).

Figure 10. Cross Subsidization under a Regional Electricity Company



Note: Regional electricity companies usually supply the electricity only to general and apartment

And, there are the problem of duplicated equipment and the problem of meeting the demand. The former transmission/distribution equipment is useless when a new regional electricity company constructs new equipment, and a regional electricity company is hard to meet the demand due to lack of risk absorbing ability.

To prevent these problems, the standard of supply capacity should be reinforced. A regional electricity company should generate near 100% of the regional electricity demand, and it need to grant a permission with expiration. Also, government should provide some incentive to share transmission/distribution equipment.

Conflict between Cost saving and Preserving environment

To save fuel costs and ultimately reduce the price of electricity in the long term, the regulators need to expand the base load generators. Base load generation includes units such as coal and nuclear energy. The cost of base load tends to be much lower than the cost of other generating units, and the price of current pricing system reflects critically which generator has generated the last unit of electricity. So, the proportion of base load is the key factor of electricity reform. But the scale of the investment is much bigger than that of other generating units. It means that the regulatory need to confer more structured incentive to increase the investment of base load.

However, this needs to be balanced by the environmental factors as base load units tend to serious harm the environment. Also, the Kyoto protocol urges nations to reduce emission of greenhouse gases from 2008. This implies that cost saving issues and environmental considerations should be taken into account when making short- and long-term investment plans: perhaps we can maintain the current proportion of base load in the short-term while investing more on alternative energy sources in the long-term. The cost of alternative energy is high at this point, but it will likely decrease as the technologies evolve.

9. Summary and Limitations

This study analyzed the overall impact of the electricity reform in Korea, and reviewed the current issues on the electricity sector in Korea. The analysis of financial statements showed that the price of fuels and the price of electricity affected the performance of generation companies. It is hard to expect the operation of companies will improve much without privatization, because the intervention of government prevents the electricity market from full market competition.

We found that the restructuring program has had different impact on generating companies. Depending on the competency of the management, companies have responded differently to the reform program. In making this type of statement, we need to carefully take into account the different investment and management characteristics of each generating units.

The analysis of the impact of the electricity reform generally showed a positive. Although the price of electricity has not fallen significantly, the liability and profitability indices showed positive changes. It appears that the intervention of government reduced the effect of restructuring on the price of electricity. The indices of profitability (especially ROA and operating margin) have shown a positive effect from the electricity reform. In sum, ROA (increased 1.1% at model III) and operating margin (increased 5.9% at model III) improved after the restructuring. We have found that generating companies were successful in reducing their operating cost.

In addition, the growth potential of these companies declined, although it is hard to interpret that the effect is substantial since the data has an outlier. Also, the decrease in the growth rate of assets means the decrease of investment. If the investment shrinks, then the depreciation cost is reduced and the profit is increased. That caused the improvement of indexes of profitability. Decrease of investment is also a factor of electricity price increase in future, and the trend of the indices of profitability is returning to the previous level. These all mean that the impact of restructuring can be negative in the long-term. Therefore it is needed to improve current system continuously.

For further liberalization, there are several problems in the electricity market in Korea. Current electricity market in Korea is oligopoly. There are many possibilities that the structure could cause critical problems in future. The generation companies can use their oligopoly power because the electricity reserve margin is currently quite low. It is quite hard to decide which reserve margin is optimal for the future, but it should be studied further.

The regional electricity company is causing numerous problems under the distorted pricing system. The cumulative pricing system enable policy makers to cross subsidize each other causing severe misallocation of resources. These problems can only be solved by the institutional level changes.

In addition, we need more discussion on the optimal level of based loads and the future course of action since there are trade-offs involved in terms of cost saving and environmental costs. We need to be smart about designing incentive for future investment in generating units as it has future implications on not only costs but also environmental issues.

The impact of the electricity reform is hard to estimate because it affects several entities in a number of different areas. This study is based financial and physical analysis of six generating units that were spinned off from the state monopoly unit of KEPCO and there are many areas this study did not take into account. Although the best way to compare the states of before and after is to count direct costs and benefits, we had virtually little data to work with. Therefore, it is hard to decide only with the result of this analysis, but it gives some reference for further studies.

Table 4. Current Ratios of the Generation Companies

	(Unit: %)						
	2001	2002	2003	2004	2005	2006	2007
KOSEP	62.15	30.96	57.37	64.27	75.15	88.64	68.31
KOMIPO	63.60	56.53	91.13	80.15	98.43	83.12	83.85
WP	72.72	129.08	132.22	114.01	126.76	101.96	111.81
KOSPO	52.85	37.76	48.40	69.20	89.44	101.50	74.77
EWP	65.62	79.01	57.81	60.84	124.43	103.36	101.16
KHNP	54.18	83.85	122.65	160.60	274.33	438.35	370.32

Table 5. Debt Ratios of the Generation Companies

	(Unit: %)						
	2001	2002	2003	2004	2005	2006	2007
KOSEP	98.49	78.71	68.30	79.96	78.75	96.21	138.93
KOMIPO	98.92	66.14	31.64	40.88	40.84	46.93	66.37
WP	105.42	79.36	52.80	44.46	48.42	61.09	60.13
KOSPO	110.22	86.40	84.57	67.91	61.21	52.93	61.57
EWP	107.95	82.56	66.53	64.62	73.52	75.76	83.13
KHNP	105.36	88.63	83.07	71.37	69.98	66.95	72.01

Table 6. ROAs of the Generation Companies

	(Unit: %)						
	2001	2002	2003	2004	2005	2006	2007
KOSEP	6.10	10.80	11.02	4.41	2.98	2.06	1.86
KOMIPO	5.41	11.10	12.34	7.09	6.84	4.93	4.79
WP	4.12	7.25	8.13	5.35	5.79	4.58	4.60
KOSPO	0.42	3.95	4.96	2.63	3.00	5.74	5.82
EWP	-0.58	1.62	2.17	2.32	2.40	1.02	0.73
KHNP	2.80	4.11	3.35	3.90	4.69	3.51	3.44

Table 7. ROEs of the Generation Companies

	(Unit: %)						
	2001	2002	2003	2004	2005	2006	2007
KOSEP	12.10	20.26	19.07	7.68	5.34	3.87	4.05
KOMIPO	10.76	20.10	18.17	9.67	9.63	7.09	7.51
WP	8.45	13.89	13.44	7.95	8.48	7.09	7.39
KOSPO	0.87	7.81	9.20	4.64	4.94	9.01	9.15
EWP	-1.20	3.15	3.79	3.84	4.06	1.78	1.31
KHNP	5.76	8.07	6.23	6.90	8.00	5.90	5.83

Table 8. Operating Margins of the Generation Companies

(Unit: %)

	2001	2002	2003	2004	2005	2006	2007
KOSEP	19.37	29.57	32.52	13.77	10.56	7.16	7.93
KOMIPO	25.85	28.96	28.92	16.33	13.00	8.04	10.61
WP	15.70	19.81	20.09	12.67	11.48	9.34	8.61
KOSPO	7.46	14.13	16.43	6.85	6.53	8.56	8.95
EWP	3.18	10.35	11.81	7.41	6.37	3.70	3.64
KHNP	26.62	24.70	22.85	22.39	23.90	18.64	18.43

Table 9. Growth Rates of Sales of the Generation Companies

(Unit: %)

	2002	2003	2004	2005	2006	2007
KOSEP	30.40	1.86	10.95	24.55	-1.22	7.75
KOMIPO	56.27	11.62	6.27	16.63	11.76	12.68
WP	36.95	6.05	-3.59	8.23	8.85	26.61
KOSPO	37.49	12.53	34.62	4.72	16.20	12.66
EWP	35.03	1.95	8.07	4.94	18.41	12.29
KHNP	42.01	9.28	0.08	10.86	-1.21	-0.94

Table 10. Growth Rates of Operating Profit of the Generation Companies

(Unit: %)

	2002	2003	2004	2005	2006	2007
KOSEP	99.10	12.04	-53.04	-4.45	-33.03	19.30
KOMIPO	75.06	11.48	-40.00	-7.17	-30.88	48.78
WP	72.84	7.55	-39.20	-1.92	-11.47	16.71
KOSPO	160.26	30.89	-43.86	-0.23	52.29	17.87
EWP	339.35	16.27	-32.13	-9.91	-31.20	10.51
KHNP	31.76	1.11	-1.91	18.31	-22.95	-2.04

Table 11. Growth Rates of Net Income of the Generation Companies

(Unit: %)

	2002	2003	2004	2005	2006	2007
KOSEP	84.06	13.40	-56.04	-30.62	-26.47	7.20
KOMIPO	104.37	8.04	-40.71	5.42	-22.22	11.14
WP	76.39	9.61	-36.35	12.18	-11.63	9.54
KOSPO	829.20	26.76	-47.45	9.50	93.80	9.02
EWP		23.61	3.51	8.71	-55.34	-26.03
KHNP	46.16	-18.01	19.65	25.36	-23.36	1.39

Table 12. Growth Rates of Total Assets of the Generation Companies

(Unit: %)

	2002	2003	2004	2005	2006	2007
KOSEP	7.91	13.99	6.18	-0.37	12.51	25.14
KOMIPO	-0.74	-4.91	11.54	7.35	8.54	19.88

WP	0.13	-4.54	-2.05	9.64	13.65	4.78
KOSPO	-4.15	6.22	-7.95	0.42	2.23	12.98
EWP	-9.23	-6.61	0.59	9.58	1.17	4.93
KHNP	-0.42	1.26	4.25	4.55	0.47	6.10

Figure 11. Liability Indices of KEPCO

(Unit: %)

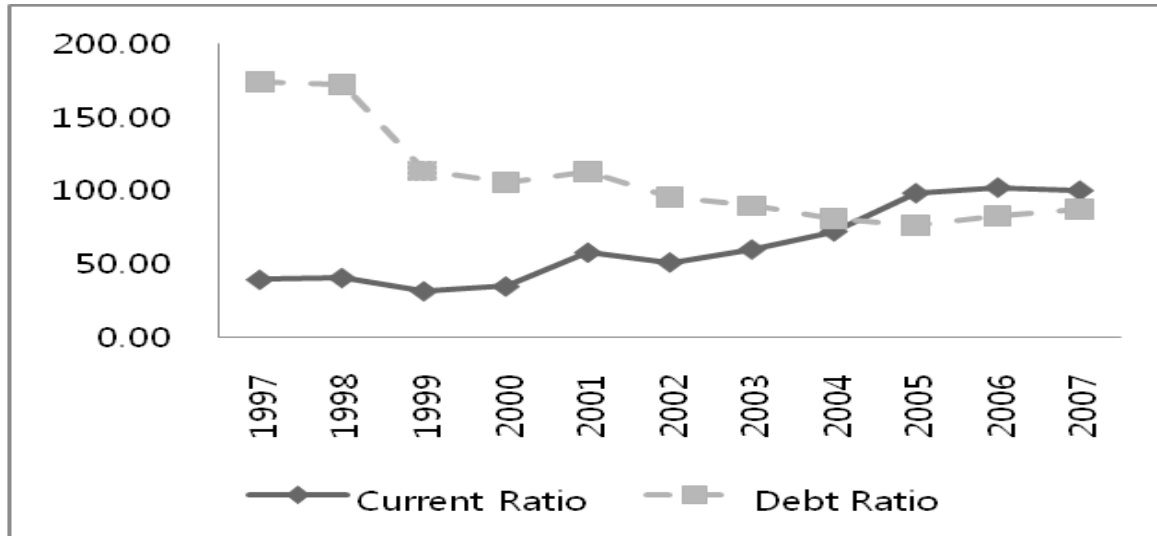


Table 13. Liability Indices of KEPCO

(Unit: %)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Current Ratio	39.4	40.7	31.6	34.9	57.9	51.2	60.0	72.3	98.2	102.0	100.0
Debt Ratio	173.9	171.8	113.6	105.7	112.7	95.5	89.8	81.4	76.5	83.3	87.3

Figure 12. Profitability Indices of KEPCO

(Unit: %)

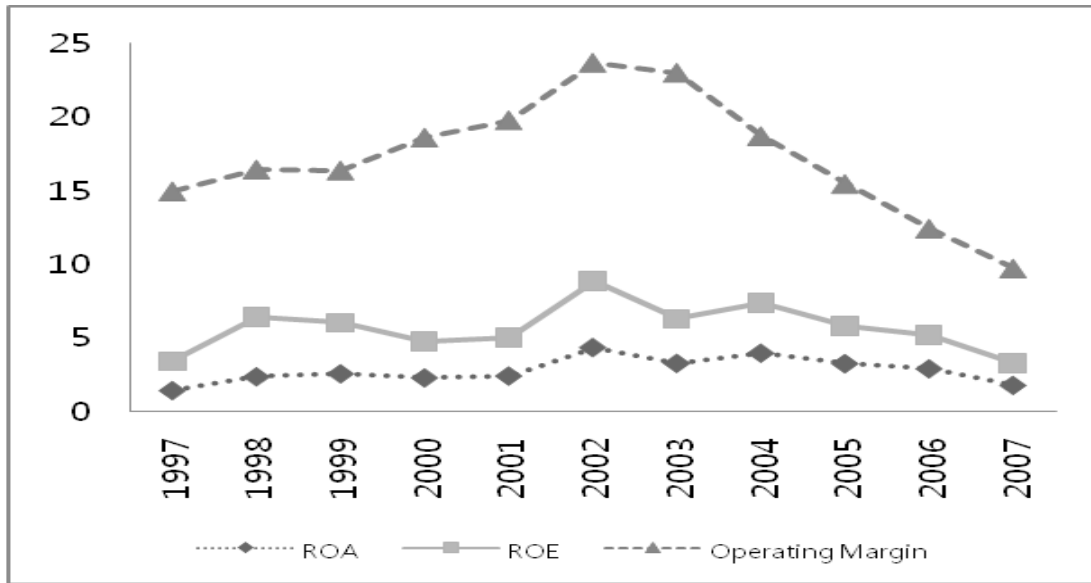


Table 14. Profitability Indices of KEPCCO

(Unit: %)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
ROA	1.4	2.3	2.6	2.3	2.4	4.3	3.3	4.0	3.2	2.9	1.8
ROE	3.4	6.4	6.0	4.8	5.0	8.9	6.3	7.4	5.8	5.2	3.3
Operating Margin	14.9	16.4	16.3	18.5	19.7	23.6	22.9	18.6	15.4	12.4	9.7

Figure 13. Growth Indices of KEPCCO

(Unit: %)



Table 15. Growth Indices of KEPCCO

(Unit: %)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
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Growth Rate of Sales	13.7	7.7	10.7	18.8	8.1	5.6	6.6	5.2	6.2	7.7	6.3
Growth Rate of Operating Profit	19.0	18.3	10.3	34.9	15.0	26.5	3.5	-14.5	-12.2	-13.4	-16.9
Growth Rate of Net Income	-3.3	96.1	27.6	0.4	10.4	87.2	-24.2	24.1	-16.5	-7.6	-35.9
Growth Rate of Total Assets	31.0	6.4	27.3	1.8	7.0	-0.1	1.7	2.7	1.5	6.0	4.7

Feature 14. Average Prices of Electricity

(Unit: Won/kWh)

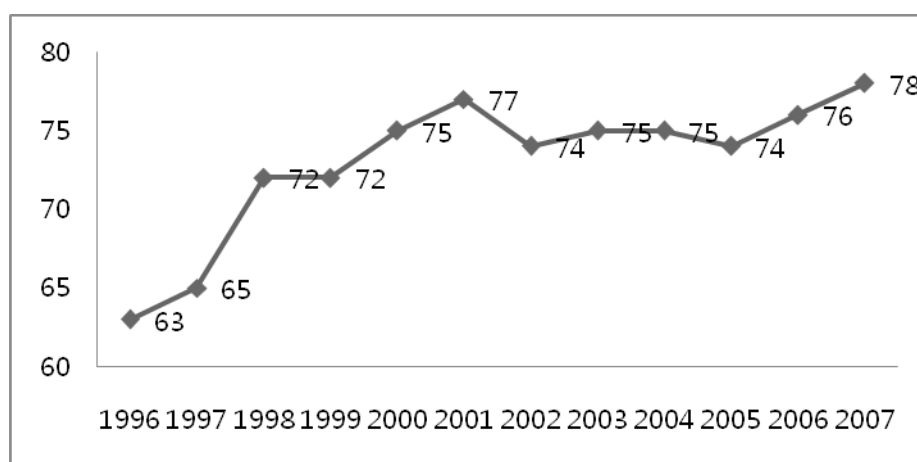


Table 16. Prices of Fuels

	(Unit: US\$/ton)									
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
LNG	197.8	146.8	165.3	259.6	250.7	226.1	259.1	295.8	387.0	472.8
Hard Coal	51.3	45.6	40.4	35.3	37.9	38.2	38.1	54.8	93.9	79.6
Soft Coal	47.2	42.5	36.5	34.1	34.9	34.9	34.7	54.0	69.3	66.3
Oil	18.2	12.2	17.3	26.2	22.9	23.8	26.8	33.6	49.3	59.6
Uranium(\$/Kg)	5.6	4.2	3.3	3.9	5.2	5.8	6.5	9.1	11.7	12.0

Table 17. Generation Capacity by Company

	(As of DEC 2006)						
	KOSEP	KOMIPO	WP	KOSPO	EWP	KHNP	Others
Capacity (MW)	43,609	39,249	38,447	48,578	42,520	149,902	18,875

The Component ratio (%)	11.44	10.30	10.09	12.74	11.15	39.33	4.95
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Table 18. Supply of Electricity in Korea

	(Unit : 10MW)											
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Peak Demand	3,228	3,585	3,300	3,729	4,101	4,313	4,577	4,739	5,126	5,463	5,899	6,229
Growth Rate (%)	8	11.1	-8	13	10	5.2	6.1	3.5	8.2	6.6	8	5.6
Installed Capacity	3,572	4,053	4,326	4,443	4,788	4,963	5,280	5,608	5,913	6,174	6,478	6,720
Available Capability	3,430	3,845	3,793	4,342	4,608	4,870	5,211	5,549	5,753	6,082	6,518	6,678
Reserve	201	260	493	613	507	557	634	810	626	619	619	449
Reserve Margin (%)	6.2	7.3	14.9	16.4	12.4	12.9	13.9	17.1	12.2	11.3	10.5	7.2

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