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Chapter 15

ELECTRICITY IN KOREA

Seung-Hoon Lee¹

- Korea's electricity reform has been partially implemented.
- There is some evidence of improved performance in the generation of electricity.
- Further reform is valuable to remove remaining distortions to price and the use of electricity.

15.1 INTRODUCTION

Stable power supply in a sufficient amount was, and still is, the most important condition for a developing economy in undertaking ambitious industrialisation projects. The Korea Electric Power Corporation (KEPCO), which has charge of supplying electricity to the entire nation as a state monopolist, was created in 1961 by consolidating three state-owned and operated electricity supply companies in Korea; one generation–transmission company and two distribution–sales companies. KEPCO supported the rapid industrialisation of Korea by supplying sufficient power at low tariffs without outside subsidies, by successful expansion of the capacity for generation and the transmission–distribution grid in a timely manner

The growth of KEPCO was paralleled by the rapid industrialisation of the Korean economy. In the 1980s it became the nation's largest company by asset value, and the second largest one by the number of employees, behind Korea Telecommunications. The Korean government decided to sell 49% of its stock in KEPCO to the general public in an attempt to invite private capital to the power sector. The government still holds over 50% of the total stocks in KEPCO. Also, a small portion of new investment was allowed to private generators in the form of independent power plants under long-term power purchase agreements with KEPCO.

The operation of the Korean economy depended upon public sector investment to a substantial extent, since the Korean government made extensive use of public enterprises during the process of economic development, not only in basic infrastructure but also in energy and material industries such as oil refining, gas, electricity, steel and petrochemicals. In other economies the petrochemical and steel industries are usually under private, not public, control. The Korean petrochemical and steel industries, however, began through state initiative in the early stages of economic development when private capital was not able to invest in these capital-intensive industries. The Korean government established many public enterprises in those sectors, aiming at the import substitution of basic materials. The major market for their outputs was Korea's manufacturing sector, which was rapidly growing as a successful export industry under the vigorous export drive policy of the Korean government. The public

¹ Professor, Seoul National University; former Chairman of the Korean Electricity Commission (2001-2004); President of Korean Society of Electricity Industry Studies (shoonlee@snu.ac.kr).

enterprises had once produced as much as 15% of the total value added of the entire national economy.

With the accelerated growth of the private sector, the Korean government initiated privatisation of many public enterprises. Though there were no objections to privatising material industries, public opinion was divided over privatising network industries such as telecommunications and electricity. A substantial portion of the population maintained the idea that there must be proper mechanisms for the provision of these universal services, and the regulated operation under public ownership was essential for this purpose.

At the same time, other economies shifted towards competition, restructuring network industries. Research institutes and academics advised the Korean government to initiate restructuring in line with this trend. On the other hand, the industries and their labour unions opposed what they referred to as an 'untested' experiment.

There are, however, differences and similarities between sectors. Consider the trends of change in electricity and telecommunications. A new entrant is able to compete in the telecommunications industry only after a slight institutional re-arrangement due to technological change. More extensive change is, however, required for electricity, in particular, to unbundle generation from grid operation in order to guarantee fair open access of energy traders to the grid. Third party access under functional unbundling prevailed in systems where traditional grid operators were private utilities under regulation, who objected to attempts to intrude upon their property rights. But open access under structural unbundling seems more likely in systems where traditional monopolies were state enterprises. Examples of the former are the USA, Germany and Japan, and examples of the latter are the UK and Nord Pool economies. However resistance to change from the incumbent could still be expected in those cases.

In the case of Korea, the size of KEPCO was a matter for consideration in the design of reform. KEPCO had not only monopolised the supply of electricity, but also now comprised many associated businesses. In particular, it had undertaken all the construction works of its own generation plants: other construction and engineering companies could join in projects only as subcontractors. This approach added to its size but also invited criticism of its corporate governance structure, which contributed to the pressure for reform.

The proposal for restructuring the electricity industry to accommodate competition attained political support, and the Korean government finally decided to initiate restructuring. The National Assembly passed the relevant legislation in 2000, and restructuring began in April 2001.

15.2 RESTRUCTURING AND REACTION

The original restructuring plan comprised three stages:

- (1) Divesting the generation sector from KEPCO to initiate the creation of a competitive wholesale market;
- (2) Divesting the distribution sector from KEPCO to complete the wholesale market; and
- (3) Creating a competitive retail market.

Stage 3 was planned to be completed by 2009.

To begin Stage 1 the Korean government created six generation companies (one nuclear-hydro and five thermal). It also established the Korea Power Exchange (KPX) which was to take charge of the system's operation and to mediate wholesale trading of power between generators and retail suppliers, including other buyers such as large-scale customers. Thus the function of KEPCO was to be limited to being a grid company and a retailer, without engaging in generation. Though KEPCO would become the only buyer, the wholesale price was to be determined by the KPX.

The Korean Electricity Commission (KOREC) was established under the Ministry of Commerce, Industry and Energy (MOCIE). KOREC was headed by a chairman and eight commissioners, who are all part-time members, except for one full-time commissioner who was the chief energy policy maker of the MOCIE, whose role was also to take care of the remaining tasks of restructuring the industry.

KOREC was not an independent body, since it was designed to report to the Minister of Commerce, Industry and Energy. This structure was due to the fact that KOREC was also in charge of the policy implementation of further restructuring, for which the Minister had to be responsible. It was understood that KOREC would be made independent as soon as the task of restructuring was completed.

KOREC was to approve electricity tariffs and oversee the quality of electricity and security of the system. It also was to review the fundamental qualifications of the applicants for the business in electricity industry such as generation, transmission, distribution and retail. All applications were to be approved unless they violated conditions stipulated in the law, and without discriminating against foreign entrants. Approval was permanent as long as applicants abided by the regulations and there were no licence fees. Since the transmission business was to be monopolised by KEPCO for the time being, and the distribution–supply business would be made open in later stages, all the applications were expected to be, and were, concentrated in generation.

Long-term power purchase agreements (PPAs) were honoured for all pre-existing contracts with private generators, which had obtained approval before restructuring. New private power plants, however, were no longer eligible for PPAs. They had to sell their power only through the KPX at market prices, and could only sell it directly to consumers when trading was made feasible.

There was no explicit legal restriction on foreign ownership: there had been, and are still, several generators under full or partial foreign ownership. Most of them sold off their shares and withdrew their investment from Korea during the past decade. The withdrawals, however, were not due to the government's restriction on foreign ownership but were a voluntary choice. As for portfolio investment, about 25% of the total outstanding KEPCO shares were in the hands of foreign investors in September 2008, and a similar level has been maintained.

15.2.1 Basic nature of the Korean model

The KPX operated a cost-based pool (CBP) to determine real time wholesale equilibrium prices, which equate electricity supply and demand on an hourly basis. Demand was determined by the amount of power consumption, and supply by marginal cost, reflecting the merit order of the generators adjusted for the real time availability. So the equilibrium price was determined by the marginal cost of the marginal generator, called the system marginal price (SMP).

Since the pricing by SMP may not recover fixed costs, for the marginal generator in particular, a fixed amount of compensation was allowed under the title of a ‘capacity payment’. So the final payment to the generators was composed of the SMP, which represents the level of the marginal cost for generation, a capacity payment and compensation for ancillary services. This system was essentially similar to the old UK system – the England-Wales pool.

The Korean wholesale market, however, was different from that in the UK in its dual structure. The KPX priced wholesale power in two ways. Generators were divided into two groups: nuclear and coal-fired generators (baseload group) and oil-fired and gas-fired generators (general group). Each group had its own marginal price and capacity payment. The marginal cost of the ‘marginal’ baseload generator, usually a coal-fired one, was called the baseload marginal price (BLMP), while that of the real marginal generator maintained its original name of SMP. The BLMP is much lower than the SMP. Each baseload generator is paid by BLMP and the general group by SMP for their energy. Since the baseload generator is more costly to build, its capacity payment is set higher than that of a general generator. A baseload generator incurred losses through the BLMP, and recovered them through the higher capacity payment.

This feature of the Korean CBP was introduced to comply with ongoing retail tariff regulation. If the same SMP were paid to all the baseload generators, KEPCO would encounter a substantial rise in cost for its acquisition of wholesale power. This would drive KEPCO to a deficit under the fixed retail tariff. The government had to either repeal the tariff regulation or adopt dual wholesale pricing. As a transitory measure, the government adopted the dual pricing system.

The new law allowed large-scale customers’ direct purchase of power from generators. However, this measure was delayed until the transmission tariffs could be established and retail tariffs liberalised. Direct purchase was not likely to take place then. All the large-scale customers, most of whom were industrial consumers, were enjoying subsidised low tariffs. Also, the big residential complexes which paid high tariffs to subsidise industrial consumers were not ready to form collective units to bargain.

This model was only supposed to last until deregulation of the retail tariff and the start-up of retail market operations in subsequent stages. The CBP market was to be replaced by an elaborate price-bidding pool, which would have involved the following measures:

- the generating companies (Gencos) were to be privatised individually,
- genuine open access to the grid was to be implemented,
- trading by bilateral contracts between customers and generators was to be introduced,
- retail tariffs were to be liberalised in order to accommodate the market determination of energy prices and
- retail supply market was to be made fully open.

The initial mechanism was designed only to cover the transitory initial phase.

The divestiture of the generation sector was incomplete in the sense that it was designed to let KEPCO own the entire share of stocks of each generation company. This was also just a transitory feature, since the Korean government planned to privatise all the thermal Gencos according to the original plan. Privatisation, however, would not be possible unless all the future conditions surrounding the electricity market became clear and reliable. Apparently, the uncertainty about future restructuring had the effect of discouraging potential buyers in the early stage of restructuring and none of the Gencos were sold.

15.2.2 Reform put on hold

In 2002 the Gencos' unions undertook a month-long strike against the restructuring, when the government attempted to privatise a Genco. However, the restructuring proceeded on schedule under the support of the president who had initiated the restructuring. This support continued while he was in office but things began to change in 2003. Although the new president of that year belonged to the same political party as the outgoing president, there was evidence that he was sceptical about privatising the power industry. The labour unions continued to demand a repeal of the entire restructuring plan.² The issue at hand was the divestiture of the distribution sector, scheduled as part of Stage 2. The unions threatened another strike if the government proceeded according to the original restructuring plan.

The new president then decided not to push restructuring any further but to maintain it in its present status. There was no further restructuring but there was no return to the previous system either. The consequence was a higher level of uncertainty among private investors. Private investment in the generation sector was limited only to capacity expansion of pre-existing generators, and no new private generator entered the market. Though the total installed capacity expanded from 55GW to 75GW during the past decade, the expansion was mainly driven by the six Gencos owned by KEPCO. Exceptions to this are the renewable generators of 803.64MW capacity, which are subsidised by a scheme independent of the market, and the district suppliers with approved capacity of 1.5GW (see below).

15.2.3 Retail tariffs and cross-subsidisation

The retail rates of electricity in Korea are set by the standard principle of rate of return regulation. Although the figures vary over time, it is generally accepted that the rates for agricultural and industrial users are set below cost, while those for other users are above cost. There is a special discounted rate for late night consumption. This rate is set just to cover the marginal cost of nuclear generation and intended to encourage the consumption of residual midnight power from nuclear plants.

Table 15.1 summarises in trends of electricity prices for each usage and total. Retail tariffs are set by the rate of return regulation modified by some progressive schemes. So the figures in the table are not the market prices but the average of regulated tariffs, and they do not directly reveal any effect of restructuring. The prices have been rising consistently, reflecting the rising costs. In 2008 KEPCO incurred a loss of KRW1 trillion due to the substantial increase in fuel prices.

This rate structure generated cross-subsidisation within Korean electricity consumption. Firstly, residential and commercial consumers paid higher tariffs for power in order to subsidise agricultural and industrial consumers. Industrial consumers represent up to half of Korea's total power consumption. Such cross-subsidisation provided incentives Korean industry to rely heavily upon high electricity consumption, while other economies are endeavouring to conserve energy. This is a legacy of an export-driven policy, which provided the manufacturing industry with a wide range of subsidies. Cheap power helped the export-led growth of the Korean economy significantly. At the same time, however, it nurtured an industry structure which consumes too much power and which cannot survive with a price that would recover costs.

² During the campaign, the president maintained it was desirable that network utility industries be under public control, except telecommunication which had already been privatised.

Secondly, urban consumers paid much higher tariffs than the incurred costs. This was done in order to subsidise consumers residing in remote mountain regions and isolated islands who pay the same rates as the urban consumers. It is interesting to note that the tariffs for tap water, which is as essential as electricity, differ across regions. Perhaps this is because water supplied by separate municipal governments while electricity is supplied by a monopoly.

Thirdly, the midnight discount rate is only for power consumed by approved heating and air conditioning equipment. This program is intended to encourage consumption of midnight power that is left over from nuclear generation. It has proven very effective. Load factors have improved so much that costly liquefied natural gas (LNG) must be burned now in order to meet increased midnight demand for power. At the same time, the program generated a strong interest group, led by the equipment producers, who strongly opposed its repeal, even though the need for the program is no longer present.

Table 15.1: Trends in average prices (KRW) per kWh.

Year	Residential	Industrial	Agricultural	Total
1994	85.95	46.14	34.59	59.39
1995	86.47	47.14	36.17	61.28
1996	88.95	48.37	37.11	62.99
1997	92.05	49.86	38.96	65.26
1998	96.60	55.01	44.31	72.08
1999	96.41	54.78	44.04	71.59
2000	94.72	58.30	43.04	74.65
2001	91.57	61.56	43.51	77.06
2002	87.01	59.02	42.37	73.88
2003	88.00	60.30	43.45	74.68
2004	90.94	60.23	41.95	74.58
2005	91.07	60.25	41.67	74.46
2006	93.70	61.92	42.96	76.43
2007	94.78	64.56	42.45	77.85
2008	97.58	66.24	42.38	78.76

Source: KEPCO statistics 2010.

15.2.4 Emergence of district suppliers

As the electricity rates for residential consumers were set high, there was strong demand from the private sector to enter the power market for large residential complexes. They built gas turbine generators in urban residential complexes, mostly doing cogeneration, and sold power to the complexes at rates slightly lower than KEPCO's. Furthermore, they were allowed to sell power in excess to KEPCO at reasonable rates. This emergence of district suppliers prompted KEPCO and KOREX to set the transmission tariff, opening the door for direct trading by bilateral contract between generators and large-scale customers.

District suppliers sell their power to their customers at prices which are similar to the retail tariffs of KEPCO. They may obtain back-up power from KEPCO at industrial or general rates, which are lower than the residential rate, or directly from the wholesale market. Their left-over power may be sold back to KEPCO at the real time SMP. Rising oil prices have discouraged their activities.

In total, 22 district suppliers were approved across 28 districts from October 2004 to July 2008, and the total capacity approval reached 1512.25MW. Operations started in four districts and suppliers withdrew from two districts. The initial enthusiasm cooled down, because the soaring oil price substantially eroded its profitability. The cross-subsidising rate structure

removes the incentive for large-scale customers to trade directly with generators, even though the transmission tariffs are set clearly.

15.3 PRESENT STATUS

The lack of continued restructuring has had a number of consequences. No new private generator has entered the market except for the renewable generators and the district suppliers. Also the tightly controlled retail tariff has caused a serious financial unbalance between KEPCO and the Gencos. Every spot price then became subject to a ceiling to try to solve this problem and the wholesale market shifted to serving the role of allocating earnings artificially between KEPCO and the Gencos.

A new president belonging to a different party was elected in 2008 and to date the new president has not announced further reforms in electricity industry. Meanwhile the labour unions continue to encourage the government not to pursue further restructuring actions. The Minister of Commerce, Industry and Energy, in his nomination hearing at the National Assembly, then said he would subject the restructuring of power industry to a thorough review by the Korea Development Institute (KDI), a national think tank. KDI has recently released its final report, which proposes to resume restructuring by divesting the retail sector from KEPCO to begin retail competition. The minister, however, announced that it is not yet the right time to begin retail competition. Instead he decided that all the Gencos will be controlled not by KEPCO but by government, in contrast to the demand to repeal all the restructuring and go back to the old system. He also promised to introduce an electricity rate system chained to oil prices.

15.4 STATISTICAL FEATURES OF KOREA'S ELECTRICITY INDUSTRY

15.4.1 Price trends

KEPCO attained a good reputation for its supply of electricity at a low price to support the industrialisation of Korea. Figure 15.1 shows the trend of average prices from 1994 to 2008.

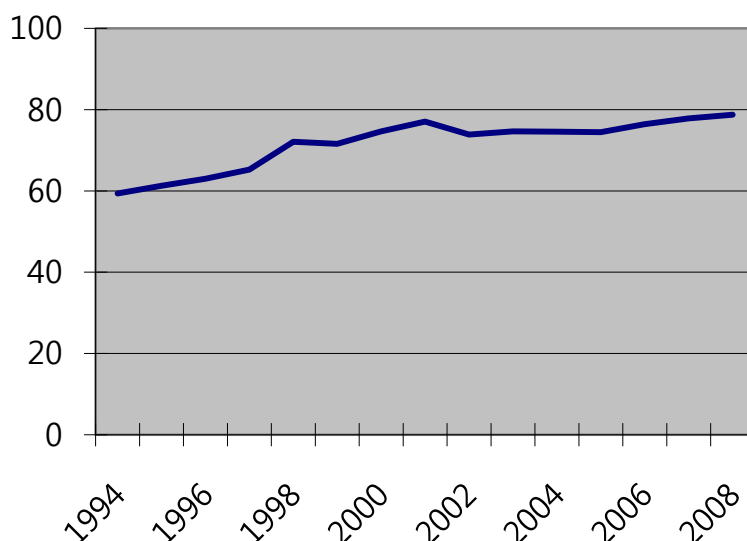


Figure 15.1: Trend of average power prices in KRW/kWh, 1994–2008.

The trend does not indicate any direct effect of restructuring. The price of KRW78.76 per kWh (US6.6 cents) in 2008 is much cheaper than the price of US9.74 cents in the USA in the same year. Except for the recent years of soaring oil prices, KEPCO managed its operations without requiring fiscal support from the government.

15.4.2 Trend of total power losses

Transmission–distribution loss has reduced over time to 4.01% in 2008 (Figure 15.2). Improvement was evident well before the restructuring, and the trend was not interrupted by restructuring (though the trends in Figure 15.2 do not reflect the effect of restructuring).

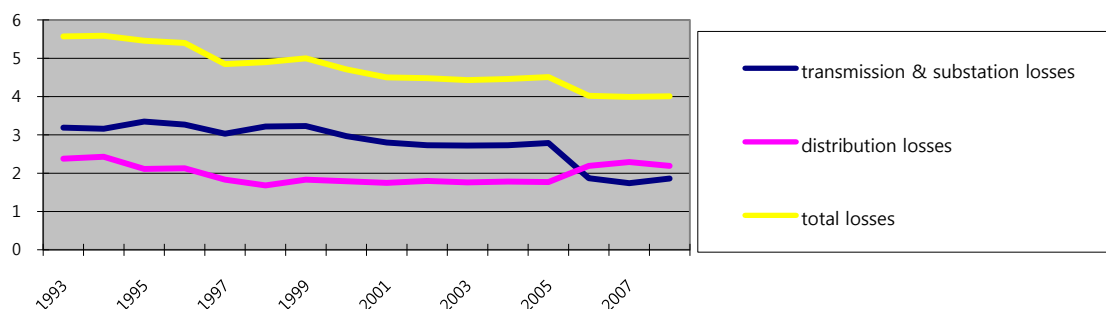


Figure 15.2: Trends of losses (%), 1993–2008.

The loss rate of 4.01% is remarkable in comparison with the USA's 6.5% in 2007. While Korea cannot be compared with the USA in terms of area, it appears that KEPCO has managed the grid operation extremely well.

15.4.3 Efficiency gains from restructuring?

Although the future of restructuring is quite uncertain, several studies have examined if any efficiency gains were made through restructuring. The restructuring is incomplete and the relevant data are insufficient so, as yet, there are no convincing conclusions.

Since there has not been market competition in earnest, any gains would appear to arise from improved management after the divestiture. The planned outage, which in 2000 required 25.0 days across 109 units of generators, dropped following restructuring to be 19.4 days across 117 units in 2003 (Samil Consultant 2003). The heat efficiency of the generation facilities and the maintenance of frequency and voltage also seem to have improved after restructuring (Tables 15.2 and 15.3, respectively; The Korean Society for Electricity Industry Study, 2007).

Table 15.2: Trend of heat efficiency of generators (%), 1998–2004. Restructuring started in 2001.

Year	1998	1999	2000	2001	2002	2003	2004
Heat efficiency	39.45	39.51	39.45	39.57	39.96	39.94	40.66

Table 15.3: Maintenance of frequency and voltage (%).Restructuring started in 2001.

Year	1998	1999	2000	2001	2002	2003	2004	2005
Frequency	99.17	99.28	99.33	99.41	99.45	99.70	99.74	99.70
Voltage	99.35	99.57	99.79	99.84	99.88	99.94	99.96	99.96

There was a substantial rise in the capacity utilisation rate of coal-fired plants and a subsequent reduction in generation cost of the Gencos after the divestiture (The Korean Society for Electricity Industry Study 2005). The rate rose from 74.8% in 1999 to 89.0% in

2003, and the cumulative cost savings were estimated as KRW602 billion for 2001–03. Kim, Knittel and Cho (2006) and Kim and Kim (2008) reported similar results. It is important to note, however, that Lee and Kim (2008) criticise the models used, claiming that they give rise to conflicting conclusions about the efficiency gains of restructuring.

In terms of financial performance, the recent hike in oil and coal prices drove up the wholesale price of power. As a result, KEPCO was pushed into deficit under the fixed retail tariff. This resulted in price ceilings on the wholesale price and substantially reduced the Gencos' profits. KEPCO at the same time has observed that the Gencos have paid higher prices for the coal they import, since each Genco was not able to command the same strong market power that KEPCO did before the restructure. However, this point can be debated, since even KEPCO is not likely to have substantial buying power in the world coal market.

15.5 POLITICS OF REFORM

All reform encounters political resistance as well as support. When the Korean electricity industry reform was begun, this author's observation was that the bureaucracy, following the president's instruction, pushed the reform very aggressively. The management of KEPCO also complied with the government's direction. The labour unions objected to the reform explicitly although their month-long strike was in vain. The general public was not sure of the reform, since the idea of competitive power market was novel. However, the move to reform was firm and steady while the political leader was clearly fully convinced of its merits.

The situation changed substantially when a new president signalled that he was not convinced about the value of reform. This author's assessment and observation was that bureaucrats lost their enthusiasm; KEPCO managers began to express their opposition publicly. For example, the present chief executive officer of KEPCO said before the National Assembly that he believes that the electricity industry must go back to its original form, that is, a KEPCO monopoly. The labour unions started systematic campaigns involving opponents from academia and industry. People generally appeared to become more sceptical, and the negative impact of the Californian electricity situation contributed to this.

Some recent experience provides an example of how competition might work and therefore could help reinvigorate the progress of reform. This involves the use of smart grids in line with a green power policy. To improve the efficiency of energy consumption the Korean government promoted the introduction of the smart grid into the electricity system. Jeju Island was selected for testing a smart grid: an extensive experiment is underway. A smart grid will inform each consumer of the real time cost and price of power if the competitive market is at work. A display panel will provide the information so the consumer can decide then whether to use power or not. Consumers are unlikely to respond to the real time cost if it does not reduce their power bill, but many certainly will respond to the real time price in order to save money.

This experience could deliver the message that a competitive market is more appropriate for the system based on the smart grid than the traditional regulated monopoly. The large telecommunications companies KT and SK are aggressive with respect to the smart grid. There is the prospect of competition between the traditional giant of the electricity sector and two giants of telecommunications.

The patterns of electricity consumption in Korea remain an issue, and may also contribute to the momentum for further reform. Consumption data indicates that the Korean electricity industry is characterised by ‘too much consumption’, which is encouraged by the low tariffs. Per capita power consumption of Korea was very close to Japan’s in the same year. However, Korea’s per capita income was only half that of Japan’s. Korea consumed 497kWh of electricity in order to produce USD1000 of GDP, while Japan, the USA and the UK each consumed only 30-60% as much.

15.6 CONCLUSION

As explained in this case, an extensive program of reform was proposed in Korea, but a change in circumstances and apparently in the evaluation of the reform by political leaders has altered the process of its implementation. The main reform to date has been the separation of the generation companies, although without a change of ownership. There is some evidence of an effect on various dimensions of efficiency, though its significance is debated. Competition has not been introduced. Drivers of further reform may not be fiscal constraints, since KEPCO has performed well in financial terms. However there is evidence of the benefits of competition emerging in new models of systems of supply and an apparent interest from the telecommunications companies in the electricity market. Prices have risen closer to world market benchmarks but remain below them. This approach to pricing, and the cross subsidies to industry, lead to higher levels of consumption which remains an issue.

What might be the next steps in reform? In 2007 a research group proposed that KEPCO divest its retail sector so that each Genco could take over the retail business and start competing in the retail market, without divesting its distribution sector (The Korean Society for Electricity Industry Study 2007). The idea was motivated in part by the experience in Texas. There fierce retail competition was used to drive retail prices down. However, it also resulted in certain retailers becoming insolvent. The customers, who had signed contracts with the insolvent retailer, were stranded without a supply of electricity. However, if a retailer is backed by its own generation business, this acts as a “physical” hedge against fluctuations in the wholesale electricity price. As a result, the retailer is less likely to fall bankrupt easily and the customers are less likely to be left stranded. Such an approach is common amongst electricity generators/retailers in Australia. This proposal, while opposed by those against further restructuring, deserves attention.

Further restructuring could also involve:

- (1) divesting the construction and retail businesses from KEPCO;
- (2) bringing the Gencos into the retail business; and
- (3) creating an energy market by abandoning regulation of the retail rate.

There would be resistance from the interest groups who gain from the current structure of cross-subsidisation. Their position now seems to be supported by political leaders as well as the general public, based on the perception that KEPCO is an excellent utility which can supply electricity at low prices without any state subsidy. In many efficiency measures KEPCO is indeed an excellent utility. But it is not desirable for the present system to continue to encourage high electricity consumption in Korea. More extensive and convincing analysis and presentation of information is valuable for successful further restructuring of the Korean electricity industry.

15.7 REFERENCES

- Joskow, PL 2008. 'Lessons learned from electricity market liberalization', *The Energy Journal*, Special issue. The Future of Electricity: Papers in Honor of David Newberry.
- Kim, D-W, C Knittel & H-S Cho, 2006. 'Regulatory Restructuring and Plant Efficiency in the Korea Electricity Market', *Research Paper 519*, Korea Institute for Economics & Trade.
- Kim, J & K Kim, 2008. 'The electricity industry reform in Korea: Lessons for further liberalization'. Mimeograph.
- Lee, Y-S & J Kim 2008. 'Restructuring toward a competitive electricity market'. KEEI discussion paper 08-05.
- Samil Consultant 2003. 'Gencos' management performance after divestiture'. Unpublished report in Korean.
- The Korean Society for Electricity Industry Study 2005. 'Enhancing competition among Genco's'. Unpublished report to government in Korean.
- The Korean Society for Electricity Industry Study 2007. 'Improving efficiency of electricity market'. Unpublished report to KPX in Korean.