Application of the Technique of Electricity Futures for Korean Electricity Market

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THESIS

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I. Introduction

Human effort to deal with the uncertainty and risk has kept on as long as human history. As the globalization of markets has progressed, the use of derivatives market such as swaps, futures and options in the advanced nations has become a common business practice as an effective and efficient means of hedging against volatile price changes and risk management. In a risk management tool, derivatives have originally been the way used to hedge commodities like food produce and metals. Derivatives now gradually form a major part of today's financial markets and commodities markets either in Korea. Not only do they create leverage, but also they can simplify and speed up trading. To trade them with relatively small cost either makes them very attractive investments. They have enormously influenced over the current markets.

1. New market (Adoption of Derivatives in Electricity Market)

In fact, the almost all markets of recent years including even electricity market would probably have trends with the use of derivative products. There have been waves that many advanced countries recently adopt the mechanism of financial derivatives into electricity trading. Since, electricity is a model commodity to which derivative contracts can be applied. Its physical characteristics make it an ideal commodity for derivative trading. Electricity is highly standardized irrespective of method of production. Its price as well is volatile and subject to changes both from predictable patterns (seasons, long-term weather conditions, time of day, etc.) and unpredictable elements (short-term weather patterns, generation and transmission problems, etc.). Electricity is sizable commodity with rising consumption; indeed it is set to become the biggest commodity in the world. However, it is difficult to store, and limited by physical transmission and consequently a single, global electricity product is infeasible. Especially in the case of electricity trading like commodity (oil, corn, copper, etc.), Imbalances between supply & demand and the difficulties sometimes associated with storing can lead to large variations in the basis and therefore a much higher basis risk. Unlike investment asset such as currencies, stock indices, gold, etc.[1)]

2. Change of Electricity Industry

Until the near past, electricity company was managed in a monopoly meaning electricity company owned and controlled all functions(generation, transmission, distribution, sale, etc.), so the customer didn't basically have any option to choose a electricity company. And technological hurdles have been another reason; there was no technology to separate electricity production and transfer, and to differentiate the quantity of electricity production per hour causing difficult it to be traded by market mechanism. However, a lot of technologies triggering to change the past paradigm have discovered such as Open Access Transferring System, and the Development of Calculating Fee Structure using IT technology and Digital Metering System which are able to analyze and anticipate the quantity per hour. And the entering barrier or cost to electricity industry either for private company was too high due to large initial investment capital. However, there have recently discovered Low-cost & New

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[1)] John C. Hull Options, Futures and Other Derivatives, third edition1997

Generation Technologies. Hence, it would be easy for the private to get into the electricity industry step by step. Hence, I hope my thesis could contribute to apply appropriately the mechanism of financial derivatives into the electricity derivatives.

My thesis, first of all, deals with The Trend of Other Countries on the electricity derivatives in chapter Ⅱ, Restructuring Process of Electricity Industry in Korea in chapter Ⅲ, and a few examples of Electricity Derivatives in Chapter Ⅳ, and Conclusion concerning what are the factors going to the reasonable direction of Korean electricity market in chapter Ⅴ.

II. The Trend of Other Countries on the electricity derivatives

It' s a kind of trend that an increasing number of power exchanges(or power pools), are in the process of being organized worldwide. These exchanges are more or less established in a different manner, and a variety of experiences have been met along the way. Some implication can be gained with regard to which elements of the different market designs are reasonable and efficient. Trading through power exchanges, with associated spot prices, is a new phenomenon. Traditionally inter-utility trade was encouraged to make ends meet with supply rather than market based terms. Utilities pursued a backup source of supply in case of unforeseen events and higher than expected loads. With the advent of power exchanges, utilities can rely on the spot market whenever in-house generation is insufficient or too expensive compared to the spot prices. Market prices are secured for purchases as well as sales. The first country in the world to introduce a deregulated electricity industry with an organized spot market was Great Britain.

The England & Wales (E&W) pool was established in April 1990 under the operation of the National Grid Company (NGC). Norway was the second country to open an organized spot market when they established Statnett Market as a subsidiary to Statnett, the Norwegian system operator, in 1992. Sweden was included in 1996. Also, at that time the name of the exchange changed to Nord Pool ASA. Finland initially established a separate ex-change in 1996, but joined Nord Pool in 1998. The Nordic power exchange has been further extended, by including the Western parts of Denmark in 1999. In 1994 the Australian State Victoria started the operations of the Victoria Power Exchange. In 1998 the Victoria Pool was replaced by Australia's National Electricity Market (NEM). The NEM currently governs across the interconnected power system comprising the Australian Capital Territory, New South Wales (NSW), South Australia and Victoria. More recently, power exchanges are being established in the US and Europe, as a consequence of federal and national/state-wise deregulation processes. California and Spain established power exchanges in 1998, the same year as the Independent System Operator PJM introduced Local Market Prices on the PJM Interchange Energy Market. The investor-owned Amsterdam Power Exchange (APX) started operations in 1999, and Germany is expected to introduce the Leipzig Power Exchange (LPX) in March 2000. Furthermore, Austria, Poland, several other US states and EU countries are in the process of de-regulating their electricity industries and evaluating designs for a spot electricity market. Even though national considerations may play a role in designing a national/international power exchange, a lot can be learned from the existing exchanges. [2)]

Proven weaknesses of a market design can, at least, be avoided. Several issues and discussions have been coming out while designing the power exchanges such as the permission of bilateral trade trading outside of the organized exchange, the responsibility of the poolco, the option for single buyer or multiple buyer, the

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[2)] Helle Granli. *A Comparison and Evaluation of Different Power Exchange, Issue No. 4*, CALPOL Market Report, August 1999 determination of the price and how to operate the system with the market.

Table 1. Comparison of the Different Exchanges

	E&W Pool	Australia NEM	Nord Pool	California PX	PJM	Amsterdam PX
Overall Principle	Poolco	Poolco	Bilateral Trade	Poolco& Bilateral Trade	Bilateral Trade	Bilateral Trade
Products	Day ahead	Real time	Day ahead & Hour ahead Derivatives	Day ahead & Day-of Futures	Day ahead Real Time	Day ahead Bilateral Bulletin Board
Pricing Mechanism	Half-hourly exante prices Pricing	Half-hourly ex-post Prices Pricing	Hourly MCP	Hourly MCP	Hourly Locational Marginal Prices	Hourly MCP
Operation	Market operations and system operation	Market operations and system operation	Market operations	Market operations	Market operation and system operation	Market operations
Participation	Mandatory	Mandatory	Voluntary	Mandatory until 2002	Voluntary	Voluntary
Competition	No	No	No	Yes	Yes	Yes

Source : CALPOL Market Report Issue No.4, August 1999

1. Great Britain : E&W Pool

The E&W pool was designed to let the National Grid Company (NGC) execute central system planning. System operations and market operations are both coordinated and run by the NGC through a poolco model. All physical power generation in E&W has to be traded through the pool in other words only generators submit bids. Bids are submitted in the Day-Ahead market for next day deliveries in the 48 half-hour periods. NGC forecasts the demand on the day before delivery. Based on this, System Marginal Prices are calculated using a pricing algorithm. Generators receive the so-called Pool Purchase Price (PPP), which is the sum of the System Marginal Price and the Capacity Payments. The PPP takes into consideration of the possible lost load and the value of lost load. Prices are made available to pool members the day before delivery, meaning that prices are set on an ex-ante basis. Hence, forecasted demand determines the prices paid to generators. If actual demand deviates from forecasted demand, the costs are recovered through the UPLIFT charge paid by the buyers, the Regional Electricity-supply Companies (RECs). Bids are not binding, meaning that generators can decide on a half-hourly basis whether or not to make the generation available to be called upon by the NGC. The current E&W pool has recently been evaluated by the national regulator OFGEM. OFGEM has expressed that the current market design should be replaced by an exchange for trade in physical electricity. A redesigned E&W spot market is expected to open during Fall 2000.

2. Scandinavia : Nord Pool ASA

Even if Nord Pool is owned by the national system operators of the participating countries, market operations are kept separate from system operations. The Nordic spot market allows for bilateral physical trade, meaning that market participants may freely enter bilateral contracts. Trade at the exchange is voluntary, and both supply and demand bids are allowed. Nord Pool operates several markets, of which the Day Ahead (for all countries) and Hour Ahead (for Sweden and Finland only) represents the physical spot markets. The market clearing price (MCP) is calculated for the Nordic system as one, and is often referred to as the system price. Price zones are established in case of congestion, with each of the countries representing separate zones. Nord Pool, on behalf of the system operators, settles for possible congestion. This is the reason why no competitive physical spot markets may be established in

Scandinavia. Nord Pool furthermore offers Forwards and Futures, both physical and financial. These products are settled using the system price as the reference price. Separate financial accounting is used for the Future markets. In addition, the system operator, Statnett, operates the regulating market for real time balancing of the system.

3. U.S

A. California PX

The California PX was established from scratch as a non-profit organization separate from the Independent System Operator, in 1998. The Day Ahead market opened on April 1, 1998. Approximately half a year later the Hour Ahead market was opened, but was replaced by the Day-of market only a few months later. The Hour Ahead market was too thin. Prices are determined through an hourly market clearing process similar to the one in Scandinavia, and both supply and demand bids are allowed. Competing physical spot markets are allowed, however, as the settlement of congestion is the responsibility of the ISO in California. The California PX recently introduced a Forward market organized as a separate company. Trade is mandatory for the IOUs throughout the transition phase, that's to say, through the years which the Investor Owned Utilities (IOUs) are allowed to recover their stranded assets. Bilateral trade is allowed. Hence, California has introduced a market design combining a poolco model with bilateral trade. The combination was possible due to the fact that parts of the industry, e.g., the municipal utilities, are not covered by the deregulation process of 1998. In addition, the system operator Calfornia ISO, operates the real-time market for real time balancing of the system.

B. PJM

The PJM Interchange Energy Market is a real-time balance market, providing for market operations as well as system operations. Generators and loads bid to the PJM Day Ahead market and/or submit Day Ahead schedules. Based on this, the hourly Locational Marginal Prices (LMPs) of approximately 1,600 nodes are calculated through an optimal dispatch algorithm. Hourly schedules and LMPs resulting from the Day Ahead calculations are binding for the market participants. In real-time balancing operations the PJM calculates LMPs through optimal power flow calculations every 5 minutes. The prices that market participants get are the hourly weighted average Ex-Post prices for each node calculated from the 12 five-minute LMPs occurring over the hour in question. Bilateral trade is allowed in this model, meaning that participation is voluntary. However, schedules have to be submitted.

4. Netherlands, Belgium and Germany : Amsterdam Power Exchange (APX)

Starting market operations only a few months ago, on June 16, 1999, the APX has shown higher than expected participation and trading volumes. Market participants are enabled to bid every day in the spot market where prices are determined similarly to Scandinavia. The Day Ahead market that is now open will soon be supplemented with additional products, such as a Bulletin Board Trading Systems for bilateral contracts, futures and forward markets. The APX is open for supply as well as demand bids, and is an international power exchange for voluntary trade. The first market participants are expected to be from the Netherlands, Belgium and Germany. The APX has a broad ownership structure, consisting of 32 shareholders from different countries in Europe and the US. Exchanges competing with the privately owned APX may be established freely. Some unexpected problems related to transmission capacity emerged during the first months of operation. Cross-border transport capacity was cancelled, which at times lead to limited trading and cancellation of spot contracts in June. In order to avoid such incidences, the APX would like to have more European coordination, as well as conditions similar to the Scandinavian market. The APX is currently discussing possible cooperation with Nord Pool.

5. Australia : National Electricity Market (NEM)

The Australian National Electricity Market (NEM) started operations in 1998, and is organized as a poolco for 4 states. The NEM follows, and replaces, the Vic Pool and the NSW State Electricity Market. These two markets were already established prior to NEM starting a real-time market operated by NEMMCO. NEMMCO operates the spot electricity market as well as the physical dispatching of the system. All electricity in the states served has to be traded through the exchange. Buyers and sellers submit daily bids to the dispatch process. Offers and bids are adjusted for electrical grid losses prior to running the "market clearing process." Prices are calculated for each half-hour period during the day. Prices are determined on an ex-post basis, clearing the bid and offer curves every 5 minutes providing for "dispatch prices." The spot price is calculated as a time weighted average for the six dispatch prices in a half hour. If there is congestion on an interconnection, NEMMCO is required to calculate local spot prices for each regional reference node for the defined regions.

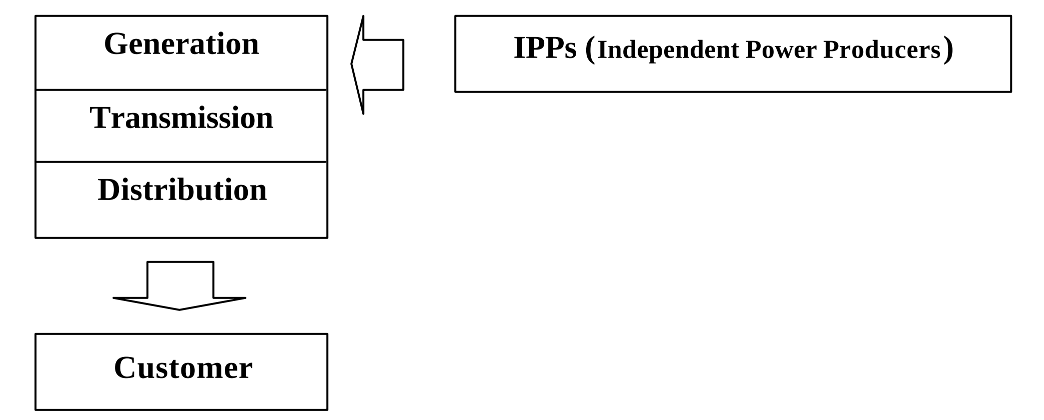
III. Restructuring of Electricity in Korea

On January 21, 1999, the Ministry of commerce, Industry and Energy (MOCIE) published a Plan for restructuring the electricity Industry in Korea (the Restructuring Plan). The overall objectives of the Restructuring Plan are to introduce competition and thereby increase efficiency in Korean electricity industry, ensure a long-term, intensive and stable supply and promote consumer convenience through the expansion of consumer choice. The Restructuring Plan sets forth the Government's broad policy directions and calls for flexible implementation over the next 10 years or more. The Government has designed the Restructuring Plan to enable it to achieve its goal for the electricity industry in a flexible manner over time accounting for the unique characteristics of Korean economy. As a company currently having a near monopoly in the electricity generation and transmission and distribution business, the following is a description of the Restructuring Plan as of the date of this prospectus.

1. Phase 1 : Preparation Stage

Phase 1, the preparation stage, had run from January 1 through December 31, 1999. In this phase, KEPCO has been on the position of the principal electricity supplier with a few independent power producers in an existing power purchase agreements. KEPCO would separate non-nuclear generating capacity into several wholly owned generation subsidiaries with its own management structure, assets and liabilities. It would also separate nuclear generating capacity in near future. It either noticed that the Government's objectives in dividing our power generation capacity are principally to introduce competition & efficiency, thereby ultimately to achieve the real economies of scale in the electricity generation industry and ensure the stable supply of electricity in Korea. KEPCO has taken into account of other factors such as the type of power plants, geographical generation capacity and asset life. However, It would retain our monopoly position in transmission and distribution. The government needs to amend relevant laws of Korea to permit the implementation of the Restructuring Plan and to change the current regulated tariff system to a less regulated and more competitive system that includes a bidding pool system. The Government expects to design the pool system to establish competitive market prices at which KEPCO should meet demand requirements. With respect to other power producers, It also perceives that the Government's general principle is to have it maintain our existing power purchase agreements (or PPAs) but not to enter into any new power purchase agreements. It would offer existing independent power producers (or IPPs) with the option continuing under the existing PPAs or participating in the bidding pool system.

Figure 1. Has-been Status : KEPCO Being a Monopoly



Source : Korean Electricity Restructuring Plan in 1999

2. Phase 2 : Introduction of Pool System

During Phase 2, which would run from October 1999 through December 31, 2002. However, It has not started yet. The Government planed to introduce a competitive bidding system or pool system under which KEPCO would purchase power for transmission and distribution to customers. It will sell non-nuclear generation subsidiaries. The Government requested to sell a substantial portion of our interest in one non-nuclear generation subsidiary by the end of 1999. However, It has not yet done either. With respect to other non-nuclear generation subsidiaries, It could go with the Government's underlying plan that it maintains at least a 51% interest in such subsidiaries. In this manner, the Government expects to retain flexibility to ensure adequate supply of electricity in Korea. However, a fixed date is not made. In

1999, it is expected to establish an independent regulatory agency to regulate the restructured Korean electricity industry and to ensure fair competition.

As part of this process, the Government hopes to establish regulations relating to the operation of the pool system. KEPCO anticipated that the competitive bidding pool system would be substantially modeled which has been adopted and revised from the United Kingdom's confirmed with Korea unique situation. Each generation company would participate in a competitive bidding pursuant to a bidding process overseen by the independent regulatory agency. Under the pool system, each generation company would enter bid to supply power on a day-by-day basis for specific time segments within each day, with the price for each segment determined by the highest clearing bid that effectively acquires all of our required power. In this system, consumers would then purchase power from KEPCO at prices based upon the resulting bid price plus transmission and distribution fees. The regulatory body would establish transmission and distribution fees that would allow power providers to receive a reasonable return. The regulatory agency would have a prime objective ensuring transparency in the bidding process to maximize the benefits of competition.

Beginning in 2001, it is planned that generation companies could sell electricity, on a limited basis, directly to large consumers to promote further competition. During this phase, KEPCO would split our distribution operation into a number of separate subsidiaries comparable to the restructuring of our generation assets. Geographical distribution of consumers and competition enhancement should as well be considered in this process. Distribution subsidiaries of KEPCO will be permitted to operate only in a specific geographical area. Electricity must strictly meet between generation and consumption, since electricity has the characteristics of non-storable and its delivering velocity is the same as flashlight. KEPCO has taken it effective and practical that generation, transmission, and distribution should be in the control of one company. However, the limit of monopoly and regulation has come to inefficiency. In this stage, KEPCO should be noticed of the new paradigm of the electricity industry. Hence, the competition & choice, market mechanism, gets applied in the electricity industry. In order to deal with this new paradigm, the electricity like a general commodity, there are some prerequisites; First, the development of IT technology which makes generation & consumption quantity per hour calculable, and settlement and power system operation reflecting various opinions. Second, transmission & distribution system should be open. Generally, once the electricity is mixed in the transmission & distribution network, it seemed not easy to find the origin of electricity. It is being solved by using of Third Parties Open Access System and Calculation Theory of electricity consumption, which have been developed and completed. Hence, Generation and Transmission could be separately dealt with. Third, the entrance barrier should be lowered which would be a sort of trigger for private companies to enter the market easily. For instance, Gas turbine generation technology has been developed tremendously which is an example of lower investment cost such as smaller size, higher efficiency and bigger power.

Pool is a new organization of the electricity market that trades the electricity through market mechanism. Its function is similar to the exchange of stock market, futures and commodity market. Hence, it is neither the chief objective nor the physical transmission system in the electricity trading market. KEPCO would establish and operate the electricity pool from the phase 2. The main function of Pool is to cope effectively with the insufficient power condition and maintain the stabilization of the electricity system. It either a sort of corner stone of the introduction of market mechanism. This is like an insurance policy against misfortune and calamity. Pool is ramified as two kinds such as Mandatory Pool and Voluntary Pool. Mandatory Pool stands for the British system in which all market participants trade just through the pool. However, Voluntary Pool is used particularly in U.S.A where bilateral contract is permitted between generation and distribution company. The big difference of two systems is the function of the central control. Mandatory Pool is more focused on the central control than Voluntary Pool which takes importance in the free determination of the market participants. Hence, price settlement, transmission-operating procedure, etc, are different between them. KEPCO has prepared the operation of pool system based on the British style after restructuring and adopted CfD(Contract for Difference) as the price settlement procedure.

Example : CfD(Contract for Difference)

The spot price can be volatile due to a range of supply and demand factors. As such, buyers and sellers of electricity may seek to reduce this risk through entering into long or short-term contracts that set an agreed price for electricity. These contracts are financial instruments only and do not affect the way the power system is managed by Pool. The basic form of contract may be a bilateral hedge contract where two parties agree to exchange cash against the spot price. For Example, a generator and retailer agreed to sell 500 MWh of electricity at a strike price of $35 per MWh. If the spot price equals $40 per MWh (eg. it is greater than the strike price), then the generator pays the retailer: 500 MWh x ($40 - $35) = $2,500. The net effect on the financial position of each party is shown below assuming that the generator produced 500

- **Net generator position**

Spot market revenue	:	500 MWh x $40 = $20,000
Less hedge payment	:	$2,500
Net revenue	:	$17,500

Hence, equivalent to 500 MWh x $35 per MWh

- **Net retailer position**

Spot market price	:	500 MWh x $40 = $20,000
Less hedge payment	:	$2,500
Net revenue	:	$17,500

Hence, equivalent to 500 MWh x $35 per MWh

MWh and the retailer’ s electricity consumption was 500 MWh.

The opposite payment flows apply when the spot price is less than the strike price. Generators, retailers, and customers may enter into such contracts to help manage the financial risk of trading in the spot market alone. There is a mutual interest between retailers and customers and generators in sharing such risks. Subject to general competition laws, these contracts may be kept confidential and they may take any form the parties to the contract wish to negotiate.

3. Phase 3

It is expected to be processing from 2003 to 2009, the distribution subsidiaries would purchase power directly from the generation companies through the competitive bidding pool system described above (unlike in phase 2, in which KEPCO contemplates to be the purchaser of electricity under the pool system). In the role as the Transmission Company, KEPCO would charge the distribution companies a transmission fee. Because KEPCO going to be intended to let it act as the sole electricity Transmission Company in Korea. During this phase, each distribution company will still be permitted to operate only in a specific geographical area. During this phase, the Government would gradually allow more generation companies to sell power directly to large consumers to foster more competition.

4. Phase 4

It will be the final phase of the Restructuring Plan and allow consumers to choose their power source from any distribution company. KEPCO may keep the position of the sole electricity Transmission Company. The electricity industry will be regarded to assure competition, cost effectiveness and sufficient supply. And In this phase, KEPCO should consider the reunification, which impact either the electricity industry. Reunification would accelerate the competition of the electricity industry by the drastically increasing demand. Hence, the opportunity to private company could be enlarged and KEPCO should prepare the need for electricity network composition with China, Russia, Japan, etc. Therefore, this phase may be the completion of the electricity trading system and fully developed the electricity derivatives in Korea.

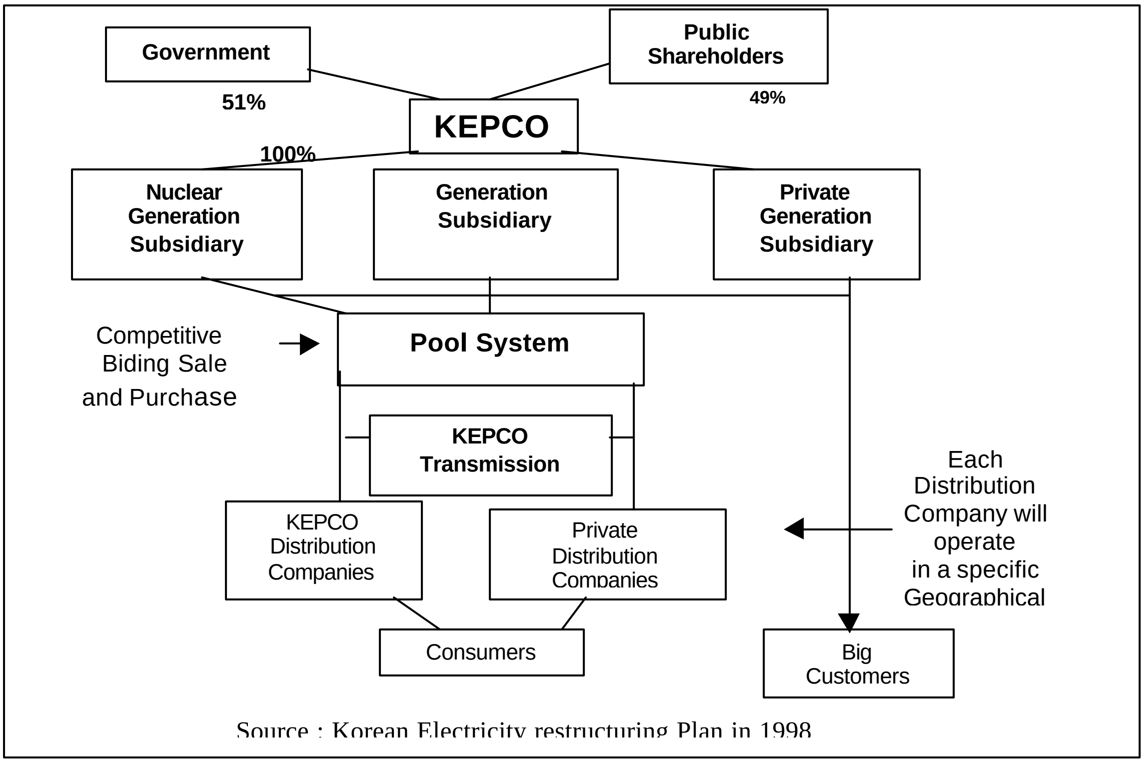


Figure 2. The Final Stage of Restructuring electricity industry in Korea

In this phase, we can anticipate a lot of trading mechanisms using derivatives in financial sector. In fact, electricity derivatives are used in many advanced countries especially in U.S.A.

IV. Examples of electricity Derivatives

In this chapter, I give some kinds of examples which could be applied in Korean electricity market if the Korean electricity industry is restructured successfully.

(Note : All trading Unit is adopted by Won/MWh).

1. Taking a Position on Your View of the Marke

Suppose you anticipate electricity prices will rise significantly during a hot summer and think the price of Electricity futures has not fully considered in the effect of an unusually hot August. In this case, you can buy the Younggwang Electricity futures to make profit from your market point of view.

- **Strategy**

On June 15, with August Younggwang Electricity futures trading at ₩10,000/MWh, you buy one August Younggwang futures contract at the market. During the following weeks, if wholesale electricity prices increase that confirms your expectations, you can make a profit. Assume that on July 20, with the August Younggwang Electricity futures trading at ₩15,000/MWh, ₩5,000/MWh higher than it was in June, you exit the trade by selling one August contract.

Table 2. Long Futures Trade

	Futures	1,000Won
June 15	Buy 1 August Younggwang @ ₩10,000/MWh (× 1,680 MWh)	₩16,800
July 20	Sell 1 August Younggwang @ ₩15,000/MWh (× 1,680 MWh)	₩25,200
Net Profit		₩8,400

* 1contract : 1,680MWh

➢ **Results**

As Table 1 shows, since you accurately predicted that electricity prices would rise in the following weeks before August, you anticipate. The August Younggwang rose from ₩10,000/MWh to ₩15,000/MWh to give you a profit of ₩8,400,000 (₩5,000/MWh × 1,680 MWh/contract × 1 contract). (Note: All trading examples ignore such costs as commissions, margins, and capital requirements, etc.)

2. Spreading the Younggwang and the Gori Futures

Suppose your research gives information of a conventional average spread, ₩3,000/MWh between Gori and Younggwang Electricity futures. However the spread is right now trading at ₩4,000/MWh between the two futures contracts. You anticipate it to narrow to conventional levels prior to delivery. Hence, you make a decision to sell a Younggwang contract and buy a Gori contract to try to earn profit from the realignment.

➢ **Strategy**

On December 15, with Feb. Younggwang futures trading at ₩18,000/MWh and Gori futures trading at ₩14,000/MWh, you sell one February Younggwang futures contract at ₩18,000/MWh and buy one February Gori futures at ₩14,000/MWh. You will benefit from this trade if the futures spread narrows to conventional levels. The Gori price rises relative to the Younggwang price. During the following weeks, suppose the spread narrows. On January 15, deciding to exit the trade with Younggwang futures trading at ₩19,000/MWh and Gori futures trading at $15,500/MWh, you buy back the Younggwang and sell the Gori contracts.

Table 3. Inter-commodity Spread

	Futures	1000Won
Dec. 15	Sell 1 Feb. Younggwang @ ₩18,000/MWh Buy 1 Feb. Gori @ ₩14,000/Mwh	₩30,240 -₩23,520 ₩6,720
Jan. 15	Buy 1 Feb. Younggwang @ ₩19,000/Mwh Sell 1 Feb. Gori @ ₩15,500/Mwh	- ₩31,920 ₩26,040 - ₩5,880
Net Profit	₩840,000	

➢ **Results**

As Table 2 shows, the Younggwang/Gori spread narrowed with the price of Younggwang futures increasing from ₩18,000/MWh to ₩19,000/MWh and Gori futures increasing from ₩14,000/MWh to ₩15,500/MWh. As a result, the spread generated a net profit of ₩840,000 (₩500/MWh×1,680 MWh/contract × 1 contract).

3. Wheeling Example

As a power marketer, assuming that you have to deliver 73,600 MWh of electricity into the Younggwang in March (200 MW × 16 hours/day × 23 days/month), you can buy March Younggwang futures at ₩20,000/MWh and take these contracts to delivery. However, you recognize that March Gori futures are trading at ₩12,000/MWh. Since you can have the electricity to the Younggwang for delivery in one wheel (a movement of power across intervening hubs with each hub counting as one wheel), you have an alternative approach that can often increase your margin.

- **Strategy**

In January, with Younggwang trading at ₩20,000/MWh and Gori Hub at ₩12,000/MWh, you buy Gori futures with the intent to take delivery and wheel into the Younggwang through only one interconnecting hub. Assume you can lock in a wheeling cost (subject to policies of the Control Areas) of ₩1,000/MWh with a dissipation rate of 2.25% (subject to transmission conditions at the Control Areas), but you must adjust the number of contracts to account for the dissipation by entering into 41 contracts (200 MW ÷5MW/contract × 1.0225) rather than 40. You buy 41 March Gori futures, take delivery in March, and wheel the electricity into the Younggwang .

Table 4. Wheeling Example

	Cash(100Won)	1000Won
Jan. 15	Sell forward 73,600 MWh Into Younggwang @ ₩20/MWh	Buy 41 Marvh Gori @₩12/Mwh
Feb. 25		Take delivery for 23 days or 75,440Mwh (-₩905,280)
	Dissipation of 1,694 MWh lost during wheeling	
	Sell forward 146 MWh of excess delivered power into Gori @ ₩10/MWh,	₩1,460
	Wheeling charge on 73,600 MWh	-₩73,600
Mar. 1	Deliver 73,600 into Younggwang	₩1,472,000
Net Profit ₩494,580,000		

- **Result**

As Table 3 shows, the price difference between the Gori and Younggwang traded in marketers favor. It cost you ₩905,280,000 to buy and take delivery of 75,440 MWh (16 hours/day × 23 days ×5 MW × 41 contracts) of Gori power. The wheeling charge was ₩73,600,000 on 73,600 MWh(73,600 MWh × $1/MWh). After 1,694 MWh were lost due to dissipation, you were able to sell the remaining 146 MWh (75,440 MWh - 75,294 MWh) back into Gori at the 1-month forward price of ₩10,000/MWh on February 25. The ₩494,580,000 profit from the wheeling transaction including the futures trade, the physical power delivery, and the resale of the excess, gave you a gross margin of ₩6,720/MWh on the power wheeled from the Gori into the Younggwang.

4. Hedging Peak Demand Periods

Generally, the most volatile periods for electricity prices come up during the peak demand months (July and August) in Korea,. Since electricity is a flow commodity and cannot be stored, its prices depend on market demand. Suppose you are a power buyer for an industrial company, and one of your goals is to optimize peak-month power costs.

- **Strategy**

Your company has a base load of 100 MW of power during the on-peak hours of on-peak days. For the 21 and 22-day per months of July and August, you will need 33,600 and 35,200 MWh, respectively. You have a source for the power and do not intend to take delivery of electricity through the futures market delivery process. However, the price of that power will not be determined until the electricity is delivered. To lock in the price, you can place a long hedge using electricity futures. The mechanics of a long hedge are straightforward. Since you must buy electricity in the future, you are vulnerable to rising prices. To avoid that, you can buy the electricity temporarily in the futures market. When the time comes to buy the actual power, you do so at the 1-month forward price and simultaneously sell the futures to offset or liquidate your futures obligations (that is, lift the hedge). Because the futures market will reflect the rising prices, your futures gain will offset the rise in the price of physical electricity, wholly or in large part, to make your net price essentially the same as the futures price on the day you initiated the hedge. You determine the appropriate number of contracts for the hedge by dividing the number of MWh hedged by 1,680 MWh, the contract size. To initiate this hedge, you need to buy 20 July and 21 August Gori futures on June 1 at prices of ₩12,000/MWh and ₩14,000/MWh, respectively. Table 5 shows how such a hedge might perform.

Table 5. Hedging a Peak Period

	Cash	1000Won	Futures	1000Won
Jan 1			Buy 20 July Gori @₩12,000/MWh Buy 21 August Gori@₩14,000/Mwh	-₩403,200 -₩493,920
Jan 25	Buy 33,600MWh @ ₩14,000/Mwh	₩470,400	Sell 20 July Gori @₩14,000/Mwh	₩470,400
Jan 27	Buy 35,200MWh @ ₩16,000/MWh	₩563,200	Sell 21 August Gori@₩16,000/MWh	₩564,480
Cash cost	₩1,033,600,000		Futures Gain	₩137,760
Net Cost : ₩895,840,000	Net Price : ₩15,020/Mwh			

➢ **Results**

You are able to liquidate your futures position at a profit. When you sell July futures on June 25, you make ₩67,200,000(20contracts×₩2,000/MWh×1,680 MWh /contract). And when you sell August futures on July 27, you make a profit of ₩105,840,000 (21contracts×₩3,000/MWh×1,680MWh/contract), for a total futures profit of ₩173,040,000. This futures profit partially offsets the purchase cost of the physical electricity you buy in July and August to give you a net price of ₩37,020/MWh for electricity in July and August (₩2,546,960,000÷(33,600MWh+ 35,200MWh))

5. Hedging with Electricity Futures: A Power Marketer's Perspective

While the primary uses of futures contracts are to provide price discovery (and transparency) and tools for managing price risk, power marketers can also use electricity futures contracts to obtain physical electricity. By going long futures, you are entitled to take possession of electricity at the hub the seller chooses during the specified delivery month. Although futures positions rarely result in delivery, the delivery potential validates the futures prices.

- **Scenario**

As a power marketer, suppose you have a customer who wants to take delivery of 50 MW of electricity into the Younggwang during each on-peak hour of each on-peak day of the year. Your customer wants a fixed price of ₩22,000/MWh for the one-year period. Because of the volatility of electricity prices resulting from competitive pricing, regional weather, and consumption patterns--you stand to lose millions on a deal such as this if prices rise. But you can use electricity futures to protect your acquisition costs of future power purchases for your customer without a price commitment from a seller.

- **Strategy**

You decide to buy a strip of Younggwang Electricity futures at the Korean electricity futures market, which involves a long position in each month for a one-year period. Once the futures positions are in place, you can take delivery of the required power each month, sell the power into the wholesale electricity market, and effectively lock in your margin. Theoretical futures prices for the Younggwang for a 12-month period are as follows:

Table 6. Theoretical Younggwang

Futures	1000Won/MWH	Futures	1000Won/MWH
January	₩22/MWh	February	₩23/MWh
March	₩22/MWh	April	₩19/MWh
May	₩19/MWh	June	₩22/MWh
July	₩24/MWh	August	₩26/MWh
September	₩24/MWh	October	₩20/MWh
November	₩21/MWh	December	₩22/MWh
Younggwang Strip			**₩22/MWh**

In this example, you can offer your customer a price of ₩22,000/MWh plus the profit margin. You buy 10 contracts of each of the 12 monthly futures to hedge a commitment of 50 MW and create the Younggwang strip. This allows you to lock in a margin.

6. Hedging with Options: An Electricity Buyer's Perspective

As an electricity buyer, you might have concerns about possible price increases during the coming summer. In April 2000, you notice that Gori Electricity futures are trading at ₩38,000/MWh. While that seems a good price to lock in with a futures long hedge, you don't want to pay a rate significantly above the market should the summer turn out to be cooler than forecasters expect and prices drop instead of rise. This is a situation tailor-made for call options, for calls will allow you to lock in a purchase price and still participate in downside moves.

- **Strategy**

Suppose you need 16,800 MWh in July 2000 or 50 MW every on-peak hour of each on-peak day in July (50 MW × 16 hours/day × 21 days) and can tolerate some upward movement in prices. With each option covering 1,680 MWh, you buy 10 July call options to cover your needs. The July call with a strike price of ₩38,000/MWh is trading at a premium of ₩3,000/MWh, which gives you protection if prices go above ₩41,000/MWh (the strike price plus the premium). Buying this call effectively caps your July power price while allowing you to benefit from lower prices. Suppose further that by June 24 (the last trading day for options), the spot price for July Gori electricity rises to ₩43,000/MWh. In that case, as Table 6 shows, the option will appreciate enough in value to hold your effective price to ₩41,000/MWh (₩688,800,000 ÷ 16,800 Mwh).

Table 7. Protecting Against Rising Prices

	Cash(1000Won)	1000Won	Options	1000Won
Apr.15			Buy10, $38/MWh July Gori calls@ ₩3,000/MWh	-₩50,400
Jun. 24	buy 16,800 MWh @₩43,000/MWh	₩722,400	Sell 10 $38/MW July Gori calls @ ₩5,000/MWh **Option Gain**	₩84,000 **₩33,600**
₩688,800,000(Net cost)=Cash Cost(₩722,400,000)– Option gain (₩33,600,000) Net Price = ₩41,000/Mwh				

- **Results**

When you offset the 10 Gori options at ₩5,000/MWh, your option position earns you a ₩33,600,000 profit to cap your effective price at ₩41,000/MWh.

7. Hedging with Options : A Utility's Perspective

As treasurer of an electric utility, you might be concerned that warm winter weather will drive electricity prices down and prevent your firm from achieving revenue expectations. With January futures trading at ₩40,000/MWh, you could sell futures to lock in that sale price on 500 MW of generating capacity. But, if the weather turns very cold instead, prices could rise well above ₩40,000/MWh, in which case you would like to profit from the increase in prices. In a situation like this, put options are ideal risk management tools, for a put establishes a floor price while still allowing you to participate in upside moves. You choose a strike price based on how much revenue loss your firm can afford.

- **Strategy**

Suppose you anticipate generating 160,000 MWh of on-peak electricity during January 2000 (500 MW × 16 hours/day × 20 days), and consider ₩35,000/MWh an acceptable floor price. Accordingly, you can buy ₩38,000/MWh January Younggwang puts at a premium of ₩3,000/MWh. To find the number of options you need, you divide your total anticipated on-peak generation by 1,680 MWh, the size of the option contract, to determine that you will need 95 put options (160,000 MWh ÷

1,680 MWh/contract). At the end of December, you can liquidate the puts and use the profit to partially offset the decline in the cash electricity price.

Table 8. Protecting Against Declining Prices

	Cash(1000Won)	1000Won	Options	1000Won
Nov. 15			Buy 95 ₩38,000/MWh Jan.Ygputs @ 3/MWh	-₩478,800
Dec. 24	Sell 160,000 MWh @ ₩33/MWh	₩5,280,000	Sell 95 ₩38,000/MWh @ ₩33,000/MWh January YG Puts @₩5,000/MWh **Option Gain**	₩798,000 **₩319,200**
Net revenue (₩5,599,200,000) = Cash revenue (₩5,280,000,000) – Option gain (₩319,200,000) Net price ₩35,000/MWh				

➢ **Results**

Table 7 shows that the puts earned ₩319,200,000 to give you, with the late December sale, a net revenue of ₩5,599,200,000 or ₩35,000/Mwh.

8. Hedging with Options: Using a *Collar to Hedge

As a power buyer, you might want to cap rising electricity prices but find the cost of a call more than you care to pay. In a situation like this, an option collar is often a useful strategy. To establish a collar, you buy a call and simultaneously sell a put with the same expiration. The long call caps the price of the electricity you must buy, while the proceeds from the sale of the put will reduce the cost of the protection and provide limited downside participation.

- **Strategy**

Suppose that at 100 MW per on-peak day you will need 32,000 MWh in February, a month with 20 on-peak days (100 MW × 16 hours/day × 20 days). With your usage equivalent to 19 futures contracts (32,000 MWh / 1,680 MWh), you can build a collar by buying 19 February Younggwang calls and selling 19 February Younggwang puts. On November 15, with February Younggwang futures trading at ₩35,000/MWh, the ₩38,000/MWh February Younggwang call trading at ₩3,250/MWh and the ₩32,000/MWh February Younggwang put trading at ₩2,500/MWh will provide the coverage you need.

Table 9. Collaring Power Costs

	Cash(1000Won)	1000Won	Options	1000Won
Nov. 15			Buy 19 ₩38,000/Mwh Feb. YG calls @ ₩3,250/MWh Sell 19 ₩32,000/MWh Feb. YG puts @ ₩2,500/MWh **Net Premium Paid**	-₩103,740 ₩79,800 **-₩23,940**
Jan. 22	Buy 32,000MWh @₩43/Mwh	₩1,376,000	Sell 19 ₩38,000/Mwh Feb. YG calls @ ₩5,000/Mwh (Puts expire valueless) **Option Gain**	₩159,600 ₩0 ₩135,660
Net Cost (₩1,240,340,000)=Cash Cost(₩1,376,000,000)-Option Gain(₩135,660,000) Net Price=₩38,760/Mwh				

- **Results**

Table 8 shows that the combined option position reduces the cost of your protection from ₩103,740,000 to ₩23,940,000 (₩3,250/MWh to ₩750/MWh). The collar also alters the level of protection in your favor. The call alone would cap your upward price exposure at ₩41,250 (₩38,000/MWh + ₩3,250/MWh), but the collar lowers that to ₩38,750/MWh (₩41,250/MWh - ₩2,500/MWh). Thus, you get more protection for less dollar outlay, the cost coming in the form of the downside participation you give up. If the predictable downside opportunity falls close to the floor the collar gives you, that may seem a good tradeoff.

V. Conclusion

Many countries including Korea are in the middle of unbundling their electricity industries and introducing competition in generation and supply. The opening up of the energy markets means a challenge that calls for new strategies. However, Producers and consumers are still underestimating the extent of this challenge. As shown on the cases of many countries, Electricity derivatives are one of the core instruments for the electricity industry now and in near future. With declining prices and high volatility, companies have to implement strategic energy cost and risk management that analyzes their energy demand and optimize the use of derivative instruments. This means that the energy sector has to familiarize itself with trading techniques from the financial sector. Electricity producers and consumers are acting more and more as portfolio managers are. The goal is to put together an optimal portfolio of electricity contracts that will cover a company's anticipated demand as accurately as possible and the lowest price possible. It is a matter of meeting capacity shortages and price fluctuations proactively in order to expand competitive positions and make use of the opportunity offered by the liberalized energy markets. We, Korea, are on the new gate opening up electricity market. Hence we must prepare deliberately how to deal with the new trading paradigm. It requires as well to be necessary to have optimal law and regulation to control reasonably the market in order to be an efficient and effective market. However, Electricity trading mechanism is new and there isn't yet any optimal law and regulation which is the prerequisite for trading electricity derivatives, even though they are being on the processing to formulate in Korea. It should be requested that when designing a power exchange including law and related regulation is to KEEP THINGS AS SIMPLE AS POSSIBLE. Since, simple rules and procedures lead higher market liquidity and possibility of success.

We either have to prepare the trading system after the reunification as well, which will give a huge impact to the electricity market through electricity quantity and quality. Accordingly, we should also anticipate and prepare the many situations happening after restructuring and reunification. It could be the way that we should investigate and research other advanced countries' cases and then find the optimal one and apply it appropriately to Korea electricity market coming in near future.

Later on, liberalization of the electricity market needs many things beyond I have been mentioned. Therefore, people related with it always have in mind what's the better direction for Korea electricity market development.

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Appendix Ⅰ DEFINITION

Baseload : The minimum amount of electric power delivered or required over a given period of time at a steady rate.

Baseload : Capacity The generating equipment normally operated to serve loads on an around-the-clock basis.

Capacity : The maximum load that a generating unit or generating station can carry under specified conditions for a given period of time without exceeding approval limits of temperature and stress.

Control Area : A large geographic area within which a utility (or group of utilities) regulates electric power generation in order to maintain scheduled interchanges of power with other control areas and to maintain the required system frequency.

Cooperative : A group organized under law into a utility company that will generate, transmit, and/or distribute supplies of electric energy to a specified area not being serviced by another utility. Typically, a co-op is not for profit.

Coordination Transactions : Short-term transactions undertaken primarily to maintain system integrity.

Contract Unit : The contract unit shall be 1,680 megawatt hours (MWh) of firm on-peak electric energy (5 MW*16 hrs./day*21 Contracts) days/month).

Delivery Point : Where customers in a contractual transaction are obligated to make or take delivery of power.

Delivery Period : Delivery takes place during the 16 on-peak hours on each business day of the delivery month.

Delivery Unit The delivery unit of the futures contract is determined by the number of days in the delivery month:

19 on-peak days, delivery unit is 1,520 MWh

20 on-peak days, delivery unit is 1,600 MWh

21 on-peak days, delivery unit is 1,680 MWh

22 on-peak days, delivery unit is 1,760 MWh

23 on-peak days, delivery unit is 1,840 MWh

Dissipation : The loss of megawatts due to the movement of power across the system.

Distribution : The portion of the transmission and facilities of an electric system off the bulk power system that is dedicated to delivering electric service to the end-user sector.

Electric Utility : An enterprise that is engaged in generation, transmission, and/or distribution of electric energy primarily for use by the public and that is the major power supplier within a designated service area. Electric utilities include:

a. Investor-Owned Utility (IOU)

b. Publicly Owned

c. Cooperatively Owned

d. Government Owned

End User : In wholesale markets, the end users are the industrial sector which is comprised of manufacturing, mining, construction, agriculture, fisheries, and forestry.

Exchange Transactions : Transactions between different regions and/or parties that are not priced.

FERC : Federal Energy Regulatory Commission. The U.S. government body whose responsibilities include the regulation of the interstate electricity sales and rates.

Firm Energy : The highest quality sales of transmission service offered to customers under a filed rate schedule that anticipates no planned interruption.

Generation : The process of producing electric energy by transforming other forms of energy. The amount of energy produced, expressed in watt hours (Wh).

Gigawatt (GW) : One billion watts.

Hub : A geographical location where multiple participants trade services.

Imbalance Energy : Discrepancy between the amount a seller contracted to deliver and the actual volume of power delivered. Imbalances are resolved through monetary payment.

Inadvertent Energy : The imbalance of energy flows back and forth that are ongoing and on a routine basis between generator and load. These imbalances are typically settled through physical commodity exchange.

Independent Power Producer (IPP) : A nonutility power generating company that is not a qualifying facility (QF).

Kilowatt (kW) : Amount of electricity needed to light 10 100-watt light bulbs for a one-hour period, or 1,000 watts (see Unit of Measure Equivalent for Electricity).

Load : The amount of power carried by a utility system or subsystem, or the amount of power consumed by an electric device at a specified time. Load is also referred to as demand.

Load Following : A generator's daily varying of generation output to meet system load.

Megawatt (MW) One million watts.

Municipality : A city, county, irrigation district, drainage district, or political subdivision or agency of a state component under the laws thereof to carry on the business of developing, transmitting, and/or distributing power. Typically, a municipality is not-for-profit; however, profits may be returned to customers or used internally.

Non-Firm Energy : The quality sales of transmission service offered to customers that anticipates possible planned and unplanned interruption and flexibility of delivery.

NERC : North American Electric Reliability Council: An industry group formed by utilities in 1968 to promote the reliability and adequacy of bulk power supply in its 10 regional councils, encompassing the contiguous United States, Canada, and Mexico.

OASIS : Open Access Same-time Information System. An electronic information system that FERC requires all transmission operators to create or participate in to provide transmission customers with nondiscriminatory information about available capacity, prices, and other information.

On-peak : The loading during a specific period of time. Refers to hours of the business day when demand is at its peak. In the physical market, on-peak definitions vary by NERC region.

Off-peak : The load for the remaining hours that are not on-peak.

Outages (Planned and Forced)

A planned outage is the shutdown of a generating unit, transmission line, or other facility inspection and maintenance in accordance with an advance schedule. A forced outage is the unplanned service of a generating unit, transmission line, or other facility for purposes other than inspection and maintenance. Usually, forced outages occur when utilities are unable to generate. Reasons for forced outages include damage to equipment due to weather or unforeseen system malfunction.

Peak Period : Periods when energy consumption is the highest.

Power Marketer : A wholesale power entity that has registered with FERC to buy and sell wholesale power with other public entities at market-derived prices. Power marketing companies include IOU-affiliated companies, gas marketing companies, financial intermediaries, IPPs, and entrepreneurs. Typically, power marketers do not own generating facilities.

Preschedule The act of buyer and seller arranging in advance to deliver electricity, usually 24 hours in advance.

Qualifying Facility (QF) : A generator of small power that meets certain ownership, operating, and efficiency criteria established by the Federal Energy Regulatory Commission (FERC) pursuant to the PURPA and has filed with the FERC for QF status or self-certified. QFs are physical generating facilities.

Ramping : The time it takes for a generation unit to achieve full rated output.

Requirement Transactions : Longer-term transactions for firm power delivery.

Resource : The amount of available generation capacity, or purchased power.

Retail : Sale of electricity to the ultimate users.

Schedule : The act of buyer and seller arranging to deliver electricity.

Security Center : Group responsible for maintaining reliability over a control area or group of control areas.

System Operation Center : Center where the status of generation units is monitored and decisions are made to start and stop particular units based on economic and reliability factors.

Substation : An assemblage of equipment that switches, changes, or regulates voltage in the electric transmission and distribution system.

Tolling : An arrangement whereby a party moves fuel to a power generator and receives kilowatt hours (kWh) in return for a preestablished fee.

Transmission : The transmission system carries the electricity from generating plants to the load. It can operate at low voltage, high voltage, or extra-high voltage. The available transmission capacity varies through time, based on the number and size of the physical transactions.

Utility System Delivery : This commercial practice allows a seller to initially determine the utility system transmission interface to be used for the sale of power to a buyer. The seller's designated interface refers to an interconnection with a neighboring utility system or to an internal generation or transmission node within the designated utility system.

Wheeling : The carriage of electricity from one supplier across the transmission lines of an intermediate utility for delivery to a third party.

Wholesale : Electricity sales for resale, sales from one utility to another, or sales from a generating company to a power marketer.

Appendix Ⅱ ComEdTM Hub Electricity Futures Salient Features

Trading Unit : 1,680 megawatt hours (MWh).

Price Basis : In terms of U.S. dollars and cents per megawatt hour.

Tick Size : $0.01($16.80 per contract).

Daily Price Limit : The maximum permissible price fluctuation in any one day shall be $7 per MWh above or below the preceding day's settlement price. There is no limit in the nearby trading month.

Trading Hours : 8 a.m. to 2:00 p.m. Chicago Time.

Contract Months : Subject to determination by Board.

Opening/Closing Procedures : Simultaneous.

Position Limits : Subject to determination by Board.

Reportable Positions : 25 contracts (in any one month).

Last Trading Day : Trading will terminate on the fourth business day prior to the first calendar day of the delivery month.

Delivery Location : Commonwealth Edison Control Area.

Delivery Rate : 5MW.

Delivery Times : Every on-peak hour (6:00:01 a.m. through 10:00:00 p.m. Chicago time) for all on-peak days of the delivery month.

Delivered Power :

(Amount depends on the number of on-peak days in the delivery month)

1,520 MWh for delivery months with 19 on-peak days

1,600 MWh for delivery months with 20 on-peak days

1,680 MWh for delivery months with 21 on-peak days

1,760 MWh for delivery months with 22 on-peak days

1,840 MWh for delivery months with 23 on-peak days

Scheduling : Buyer and seller must follow prevailing Mid-America Interconnected Network (MAIN), ComEd Control Area, and FERC scheduling practices.

Ticker Symbol : BZ