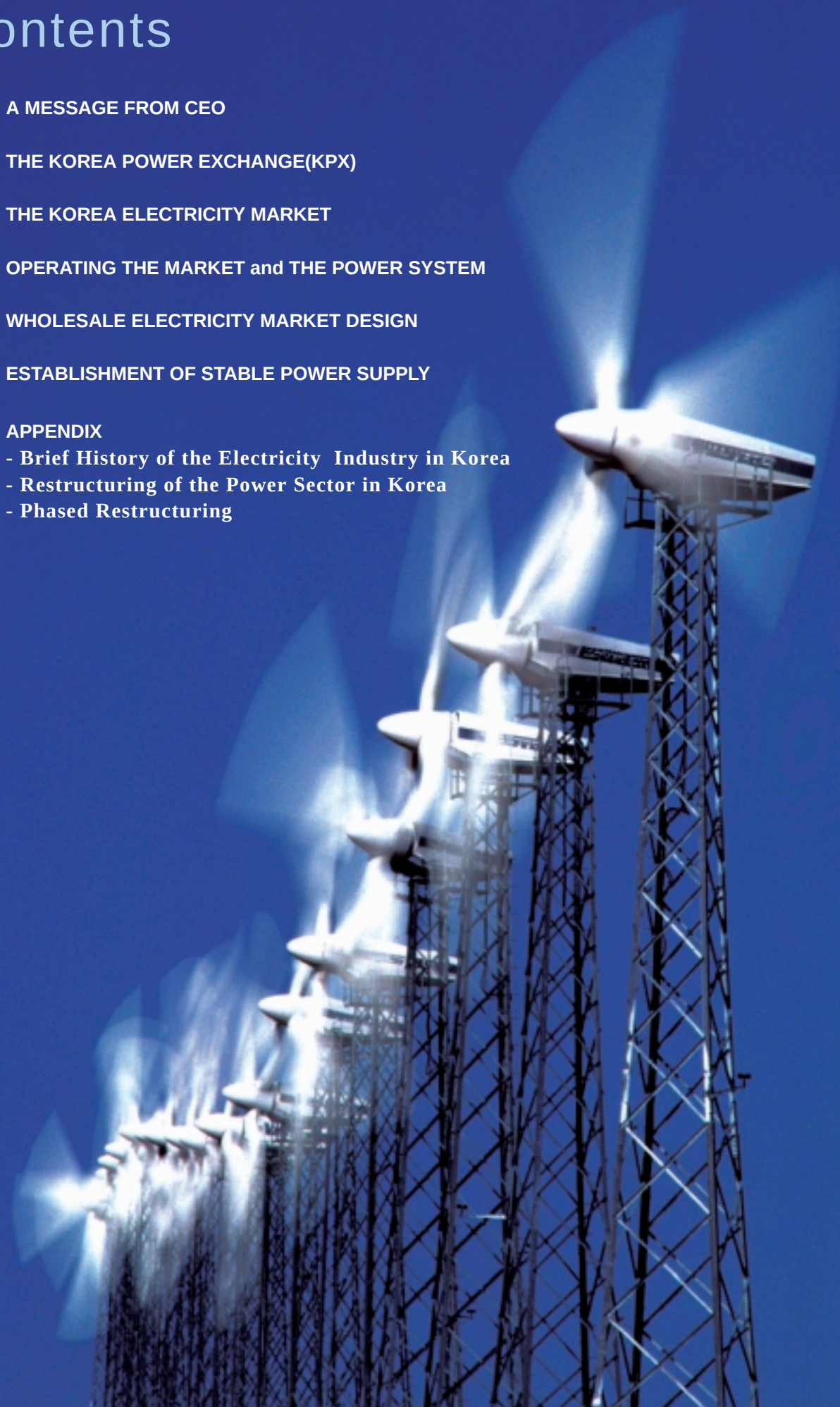




THE KOREA POWER EXCHANGE AND ELECTRICITY MARKET

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a message from CEO



The winds of change are blowing all over the world and as a result, all industry is being affected. Under the globalized economic system, countries all over the world are waging silent war in every area of industry. Needless to say, Korea's electricity industry can only succeed by rising to meet these changes and improving competitiveness through self-reform.

We are now experiencing an unprecedented transformation, namely the restructuring of the power industry. This change in the power industry is designed to promote efficiency through the introduction of a competitive system and improve customer convenience by providing customers with a choice in their selection of economical and stabilized electricity. Such a change is simply a sign of the times.

The Korea Power Exchange(KPX) continues to perform its numerous responsibilities in the domestic electricity market created through the restructuring of the power industry. These include the operation of the electricity market, design of the future electricity market, operation of the power system, and support of the establishment of the government's basic plan for the demand and supply of electric power.

Along with this, all executives and staff members continue to exert every possible effort to see that the benefits stemming from competition are turned over to consumers by opening the wholesale competitive electric power market at just the right future time and preparing steps to ensure that electric power be traded in the market in the same manner as general commodities.

We hope that the public will extend their full understanding and encouragement to our company for the creation of a successful electricity market.

A handwritten signature in black ink that reads "Kim Young-joon". The signature is written in a cursive, flowing style.

Kim Young-joon, Chairman & CEO



THE KOREA POWER EXCHANGE(KPX)

Establishment of the KPX

Following the government-driven restructuring plan and under the Electricity Business Act of Korea, the KPX, as of April 2, 2001, was established as a core organization responsible for management of the newly introduced competitive electricity market. Furthermore, with the separation of six(6) generation

subsidiaries from the KEPCO, the electricity supply sector in Korea has been reorganized to include the KEPCO (transmission and distribution, monopoly wholesaler purchaser and retail supplier), and the six(6) newly established GenCos and existing IPPs.



Legal Position

The KPX was established in accordance with Article 35 of the Electricity Business Act in Korea as a non-profit independent organization.

Governance

The governance of the KPX consists of the Members General Meeting, the Board of Directors where representatives from public organizations are also entitled to attend, and one(1) Independent Auditor. The Board of Directors is comprised of three(3) KPX directors, one(1) government director, three(3) representatives from the KPX regular members, and three(3) representatives from non-profit public benefit organizations.

The KPX operates on a break-even basis. The costs incurred to run the organization are recovered from the members' registration fees, annual fees taking into account the relative size of each member's generation capacity, and electricity transaction fees depending on the volume of electricity traded in the market and a predetermined transaction rate.¹ The Electricity Business Act of Korea defines the structure of fees payable to the KPX.



Membership and Obligation

The KPX is comprised of two(2) types of members, regular members and associate members. The regular members consist of the KEPCO (transmission, distribution and supply), six(6) newly established generation companies and IPPs (Independent Power Producers). Regular members have the right to participate in the decision-making processes of the KPX and are obliged not only to observe the market rules but also to bear the KPX operating costs. Among the regular members, either the generation companies with registered installed capacity over 2000 MW or supplier companies with annual electricity sales over 10 TWh are classified into Investment Regular members and are obliged to invest in the establishment of the KPX. The associate members consist of transmission and distribution companies, utilities that own power plants under construction and parties working with the KPX. Associate members can voice their opinions during general meetings.

Registered Members

Regular Members

- | | | |
|---|--|---|
| ■ Korea Electric Power Corp.(KEPCO) | ■ Seowoo Hydro Power Company | ■ Seongnam City |
| ■ Korea Hydro & Nuclear Power Co.(KHNP) | ■ Clean Energy Co., Ltd. | ■ Doosan Construction & Engineering Co., Ltd. |
| ■ Korea South-East Power Co.(KOSEPCO) | ■ Korea District Heating Corporation(KDHC) | ■ Osan Energy Co., Ltd. |
| ■ Korea Midland Power Co.(KOMIPO) | ■ Jeongseon Hydro Power Company | ■ Korea Petrochemical Ind. Co., Ltd(KPIC) |
| ■ Korea Western Power Co.(KOWEPCO) | ■ Han-kook Hydro Power Company | ■ LG Petrochemical Co., Ltd. |
| ■ Korea Southern Power Co.(KOSPO) | ■ Doksong Col., Ltd. | ■ Busan Dying Industry Complex |
| ■ Korea East-West Power Co.(KEWESPO) | ■ Jeollabuk-do Province | ■ DC Chemical Co., Ltd. |
| ■ Shihwa Energy Co. | ■ Cheongwoo E&C Co., Ltd. | ■ Sangwon Enc Co., Ltd. |
| ■ Ansan Urban Development Inc. | ■ Iksan Energy Co., Ltd. | ■ Hyosung Corporation |
| ■ Seohee Construction Co., Ltd. | ■ Shindong Energy Co., Ltd. | ■ Busan Metropolitan City |
| ■ Gyeong-sangbuk-do Province | ■ Hyundai Heavy Industry Co., Ltd. | ■ Hanguk Hydro Power Company |
| ■ Korea Water Resources Corp. | ■ SH Corporation | ■ Gangwon-do Province |
| ■ Korea Energy Management Corporation | ■ Korea Carbon Black Co., Ltd. | ■ Ulsan Metropolitan City |
| ■ POSCO | ■ Incheon Airport Energy Co., Ltd. | ■ DYCEN |
| ■ Hanyuwoi Company | ■ Donghae Pulp Co., Ltd. | |
| ■ Daedong Enterprise Corporation | ■ STX Energy Co., Ltd. | |

Associate Members

- Korea Independent Energy Corp.
- LG Energy Co., Ltd
- LG Power Co., Ltd
- K-Power Co., Ltd
- Meiya Yulchon Generation Co., Ltd.

1. The electricity transaction rate was set at 0.086 Won/kWh and approved by the Board of Directors.



THE KOREA POWER EXCHANGE(KPX)

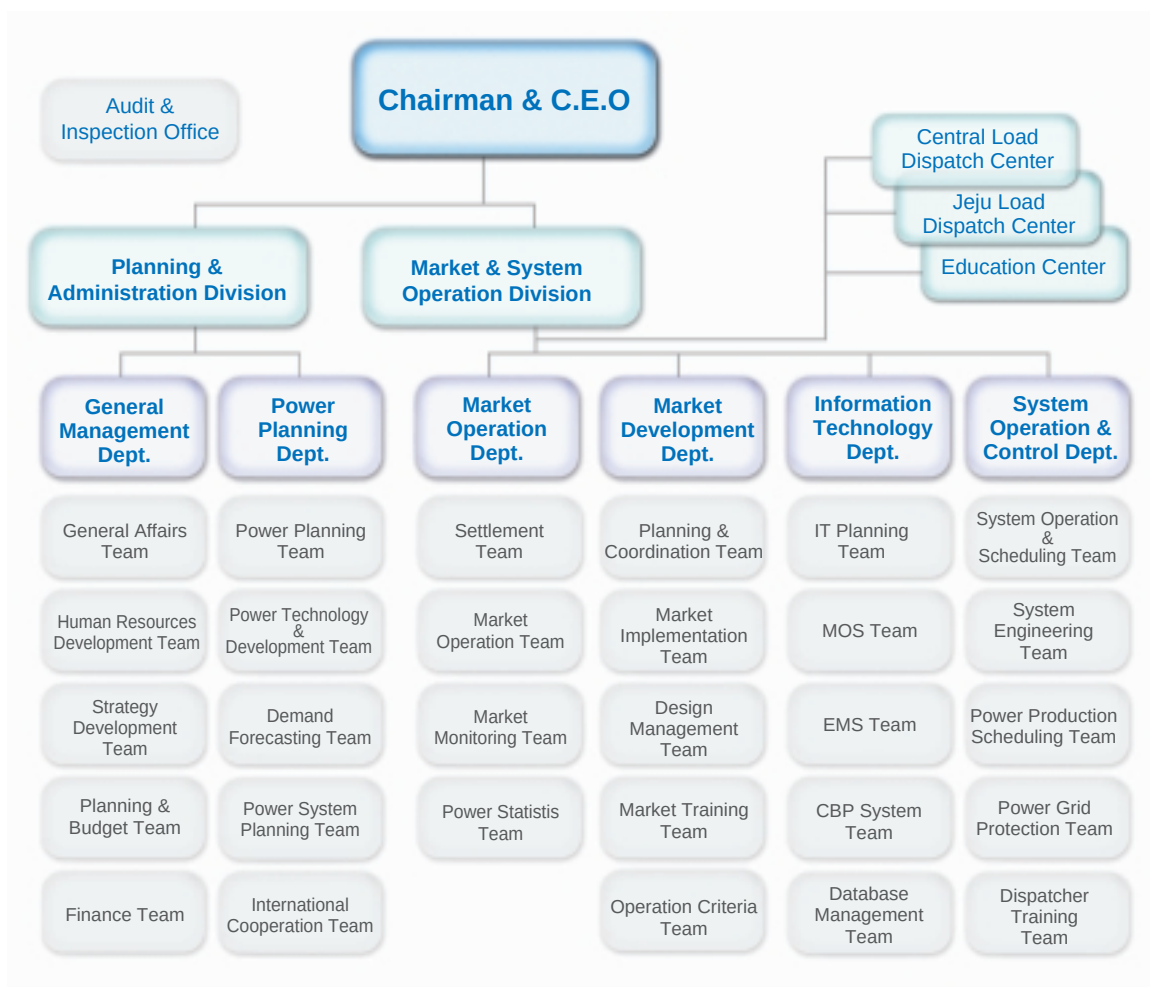
KPX Objective and Functions

The objective of the KPX is to manage the market in a reasonable and transparent manner so that power producers and suppliers can participate in the market with equal rights.

■ **The Functions of the KPX are as follows.:**

- Establishment and operation of a Competitive Electricity Market.
- Invoicing, settlement and payment of electricity transaction charges and expenses for electricity transactions.
- Measurement of the amount of electricity transacted.
- Enactment and amendment of the various rules including regulations for the operation of the Electricity Market.
- Operation of the national power system.
- Measurement of electricity quality.

Organization Chart



KPX Homepage

The KPX is legally obliged to release market information to market participants in accordance with Article 14 of the Electricity Business Act and Article 73 of the Electricity Market Rules.

Market information including the volume and cost of electricity transactions, as well as forecasts on demand for electricity, is released through the KPX home page (www.kpx.or.kr/english). The Information Disclosure Manual details the methods and scope of information the KPX is required to release.

Members, when logging in, can access the following information:

- Daily, weekly, monthly and long term demand forecasts
- Hourly System Marginal Price, Base Load Marginal Price
- Available capacity of the day as declared by the generators
- Metering and settlement results of the generators
- Market and power system operation daily status report

KPX KOREA POWER EXCHANGE

Home Korean Site help Site map

KPX | We provide Trust to the Nation

K O R E A P O W E R E X C H A N G E

About KPX Electricity Market Rules Power Statistics Power Plan Bulletin Board KPX Link Contact Us

KPX Vision
We provide Trust to the Nation

Management Spirit
Organizational Culture

www.kpx.info

KPX MAIL

KPX Mailing list

Weather
[Seoul] 17.8 °C
Today High 22 °C
Tomorrow 14 / 25 °C
[Busan] 17.8 °C

About KPX
CEO's Greeting, History, Mission and General Information About KPX

Electricity Market Rules
Overview and download section for the participants that want to know about Rules

Power Statistics
Graphs and tables contains information About Power Statistics

Power Plan
Graphs and tables contain information About Power Plan

Bulletin Board
You can write a message or comment About KPX Web site

KPX Link
Power related institution, Media and other links

Contact Us
Do you have a question? Contact Us

KPX Today's Market

Demand (MW)	Max	39,399
	Min	30,525
	Avg	35,857
System Marginal Price (KRW/kWh)	Max	60.80
	Min	51.14
	Avg	55.26
Base Load Marginal Price (KRW/kWh)	Max	18.95
	Min	18.95
	Avg	18.95

About Membership P
Provides information about joining KPX Market...

About TWBP
Information and Related Document about TWBP

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THE KOREA ELECTRICITY MARKET

Market Rules

The KPX operates the electricity market in accordance with the Electricity Market Rules, Guidelines, Market Operation Procedures, and System Operation Procedures approved by the KOREC(the Korea Electricity Commission)² and the government.

In accordance with Article 43 of the Electricity Business Act, Electricity the Market Rules detail electricity market regulations for establishing the power trade under competition, and set forth the items necessary for its effective and stable operation through the adoption of competition in the electricity industry.

The Guidelines include procedures for the Market Operation Committee, Arbitration, and Rule Amendment Committee. Market Operation Procedures encompass Demand Forecast, Offers and Bids, Price Setting Schedules, Metering, Settlements, Information Release, etc. System Operation Procedures cover Operation Schedules, Real Time System Operations, Emergency Dispatch, Power System Protection, EMS Operations, Ancillary services, etc. All of this information is available for market participants on the KPX website.



Pool Types and Pricing Methods

The pricing methods of competitive power markets vary depending on the type of power pool. In the Cost Based Pool(CBP) now being applied in Korea, the market price is determined based on the system marginal cost. In the Two Way Bidding Pool(TWBP), the market price will be determined by the bidding prices from generation companies, suppliers and wholesale consumers.

Pricing under the Cost Based Pool System

Under the Cost Based Pool, generators are obliged to provide details of their production costs, which are independently checked and approved. This information is then used by the KPX to determine the lowest rate schedules for both setting market prices and dispatching the power system.

The electricity market price is determined by the KPX as either the sum of the System Marginal Price(SMP) or the Base Load Marginal Price(BLMP) plus the predetermined Capacity Payment (CP).



■ The BLMP and SMP

Two kinds of energy pricing exist in the current Korean electricity market, the BLMP and SMP. The BLMP(Base Load Marginal Price) is applied to base load generators while the SMP (System Marginal Price) is applied to non-base load generators. The BLMP is calculated considering the generation demand allocated to Base Load Generators and the variable costs of the final base load generator dispatched in the day-ahead price schedule. The SMP is calculated considering the system total demand and variable cost of the final non-base load generator dispatched in the day-ahead price schedule. The BLMP and SMP are comprised of three components; start-up price, no-load price and incremental price. The GCEC(Generation Cost Evaluation Committee) of the KPX periodically reviews the technical data of each generating unit and determines actual start-up cost and heat value of the generating unit considering its thermal input/output characteristics.

■ The Capacity Payment

The CP (Capacity payment) is a payment provided to a generator that has declared its availability in the market. The GCEC annually determines the reasonable level of the CP considering the long-term marginal fixed costs of the plants. The Base Load CP reflects the projected capital cost of a most recently planned 500 MW Coal Unit and its fixed O&M cost. The Peak Load CP reflects the capital cost of a Standard Gas Turbine Unit and its fixed O&M cost. The concept of CP was introduced in the Korean electricity market to ensure the recovery of capital costs of generators and to offer an inducement to attract new capacities.



THE KOREA ELECTRICITY MARKET

Classification of Generators

■ Scheduled Generator³ and Non-scheduled Generator

In terms of Capacity Payments, generators are classified into two groups; Scheduled Generators and Non-scheduled Generators.

A Scheduled Generator is defined as either a generator operating for electricity production having a capacity rating over 20 MW and whose output is scheduled by the KPX dispatch instruction, or a generator operating for both electricity and heat having a capacity rating over 20 MW and is likewise able to be dispatched by the KPX dispatch instruction.

All remaining generators are defined as Non-scheduled Generators. Scheduled Generators receive CPs when declared available in the daily bidding, but Non-scheduled Generators are not required to declare and are not paid CPs regardless of their availability in the market.

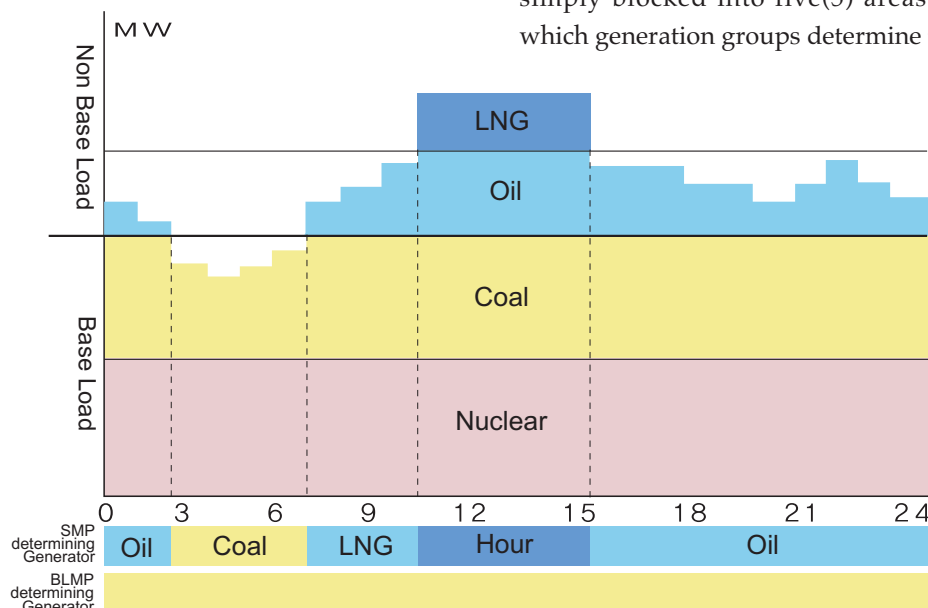
■ Base Load Generator and Non-base Load Generator

For System Marginal Price payments, generators are classified into Base Load Generators and Non-base Load Generators. Nuclear, Bituminous coal, and Anthracite coal(domestic coal) generators are defined as Base Load Generators. All remaining generators including peak-load generators are defined as Non-Base Load Generators. Base Load Generators receive BLMP(Base Load Marginal Price) but Non-Base Load Generators receive SMP (System Marginal Price) according to their energy generation in the market.

The Concept of Determining SMP under the CBP

Shown below is a typical daily demand forecast and scheduled generation chart in the Price Setting Schedule(Explanation for Price Setting Schedule follows). This chart briefly illustrates how BLMP and SMP are determined in the Day-ahead market.

The horizontal axis represents time and the vertical axis represents generated energy required to meet the demand. Each generator is stacked according to its variable costs of energy. The actual trading period is one hour but the diagram is simply blocked into five(5) areas distinguishing which generation groups determine the SMP.





In the first, third and fifth time block shown on the diagram, the SMP is determined by the oil unit with the highest marginal cost of production that is required to operate during that time block in order to balance supply and demand. During these identical time blocks, nuclear and coal units are paid BLMP plus Base Load CP. Oil units receive the SMP plus Non-base Load CP.

In the second block, the SMP is determined by the BLMP of a base load generator. In this case, nuclear and coal units receive the BLMP of the marginal base load unit plus CP of the base load generator. In the fourth block, a LNG unit determines the SMP of the stage. During this period, LNG and Oil units receive the SMP of the market plus Non-base Load CP, and Nuclear and Coal fired units receive a BLMP of the marginal Base Load Generator plus Base Load CP.



The idea of BLMP or SMP distinguishing Base Load Generators and Non-base Load Generators was introduced for the purpose of maintaining stable electricity energy prices, particularly in the transition phase toward a complete competitive market. The concept of the current market pricing system is designed in a manner to compensate the actual costs spent by the generation companies, thereby allowing the KEPCO to maintain retail electricity rates at their current level during the market transition period.

OPERATING THE MARKET and THE POWER SYSTEM

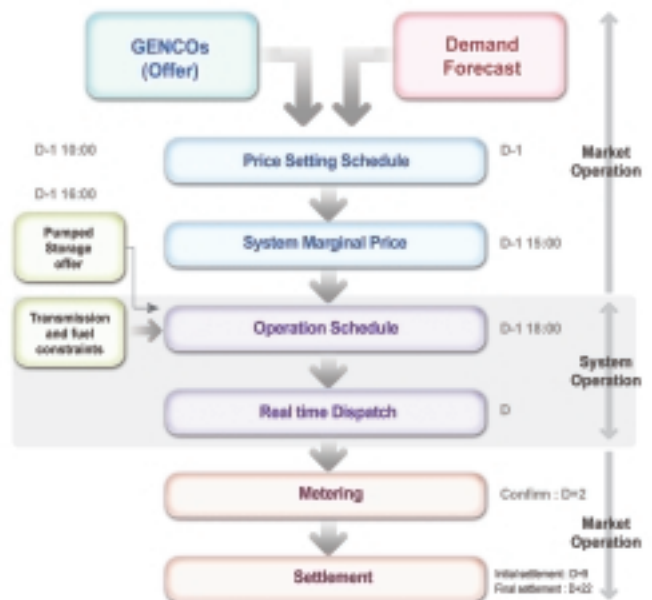
Bidding

On the day prior to trading, the scheduled generators are required to submit offers to the KPX indicating the generating capacity available (MW) and some important technical data associated with its operation. There are three types of bids.

Daily Bids must be received before 10:00 am on the day before the supply is required.

Re-bids to change the available capacity or technical data can be submitted subsequent to the deadline of the daily bids. However, any change in the capacity available to the market resulting from the submission of a re-bid does not influence the determination of the market price or the CP amounts paid to generators.

Default bids are back-up bids in the event that daily bids are not submitted.



Demand Forecast

On the day prior to trading, the KPX produces a System Demand Forecast in MW for each Trading Period. This forecast takes into consideration all energy demand expected on the System. In preparing the forecast, the KPX takes into account the latest meteorological conditions forecast for the relevant Scheduling Declaration Period, any historic trend information in respect to weather conditions and other such factors.

The System Demand Forecast also includes the demand for reserve requirements. The demand forecast covers a 34-hour period beginning at 7:00 pm on the day it is made through the trading day and until 4:00 am on the following day.

The demand forecast is notified to market participants until 3:00 pm on the day before trading.

Price Setting Schedule

On the day prior to trading, the KPX produces a Price Setting Schedule and calculates the system marginal price for the forecast demand by 3:00 pm on the day before trading. The input data used by the KPX are all Generation Offers submitted to the KPX. The transmission or generation constraints such as fuel use and heat generation are not considered in the production of the Price Setting Schedule.

System Marginal Price

On the day prior to trading, the value of SMP for each hour in the Trading Period is set by the price of the most expensive generator scheduled as per the Price-Setting Schedule. A list of generating units is prepared for each Trading Period in which the Stack Price of the Generating Units increases in ascending order. The SMP for the Trading Period is positioned equal to the highest stack price appearing in the list for that Trading Period.

Operation Schedule

Scheduling is the process that balances supply and demand in the market. It also prioritizes dispatch based on cost-efficiency of supply. The KPX uses the offers from generator operators to determine which generators will be dispatched into the market, at what time and at what volume. Energy offers are stacked in order of rising price until forecasted demand is met. As forecasted energy demand increases, more expensive generators are accepted into generation. The scheduling of generators may be constrained by the capacity of the transmission lines between regions. When this occurs, higher priced generators within the region on the downstream side of the constraint will be called on to meet this demand.

The Operation Schedule is produced before 6:00 pm on the day before trading by the KPX and takes all practical physical constraints into account. Generation constraints to be considered in the

production of the schedule are heat generation, fuel use, technical characteristics of the units, start-up generators, etc. Constraints regarding transmission are transmission congestion, voltage and frequency control, system reliability, system reserve, system security, etc.

The operation of hydro and pumped storage generation for economic and safe system operation is also taken into account during this process.

The KPX initially notifies market participants of the Operation Schedule by 6:00 pm on the day before trading and progresses through subsequent adjustments as required reflecting participants' requests via their re-bidding and actual changes in power system situations as they occur.

Dispatch

The KPX, using the EMS(Energy Management System), carries out real time power system dispatch based on the latest Operation Schedule and bearing in mind real time consumers' demand, transmission loss and the system situation. Other factors, including transmission capacity, system load, plant outages, frequency control, voltage control, testing and transmission outages, can also impact on the dispatch. The physical power system consists of various electric facilities including generators, transmission lines and equipment, as well as substations and distribution systems which deliver electrical energy to end users. For safe and reliable power system operation, load trends, system frequencies, voltages and conditions of transmission facilities are monitored 24 hours a day. These parameters are critical for maintaining a stable and high-quality power supply as well as securing the required reserve margin.

Metering

The price of electricity varies from hour-to-hour and from day-to-day. All market participants are required to install metering equipment to record their electricity generation or consumption. The KPX manages the security of the equipment. The data are electronically forwarded to the KPX for use in the settlement process.





OPERATING THE MARKET and THE POWER SYSTEM



Settlement

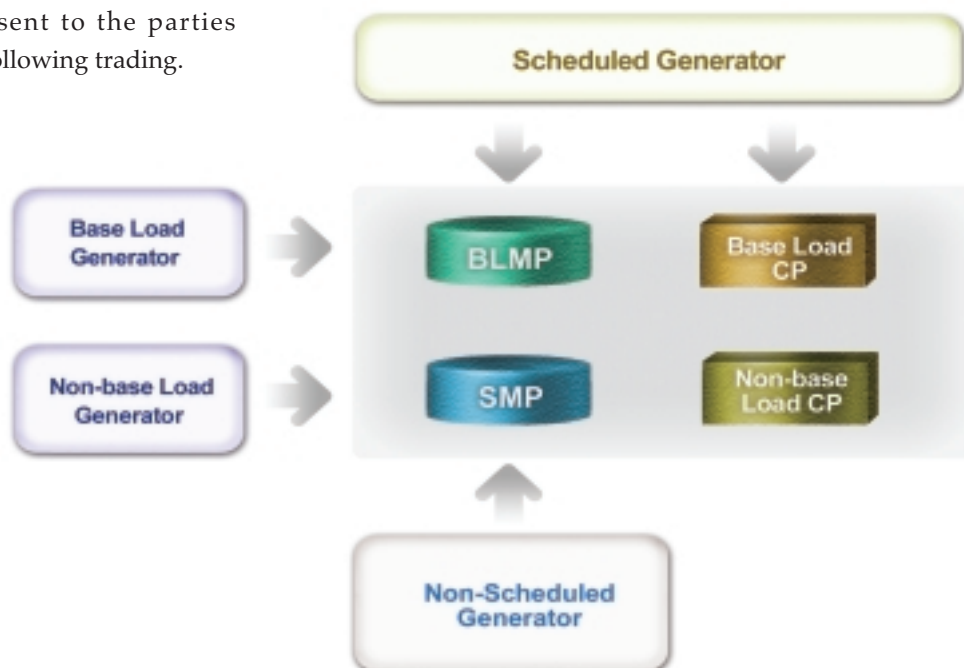
Settlement is the process of determining financial payments, billing and settling of amounts payable and receivable for electricity traded in the pool between the generators and the sole supplier(KEPCO). The KPX conducts a settlement six(6) days following trading and sends a preliminary settlement to the parties nine(9) days following trading for their review. Final settlement, incorporating any comments from the parties is sent to the parties twenty-two(22) days following trading.

Summary of the Settlements

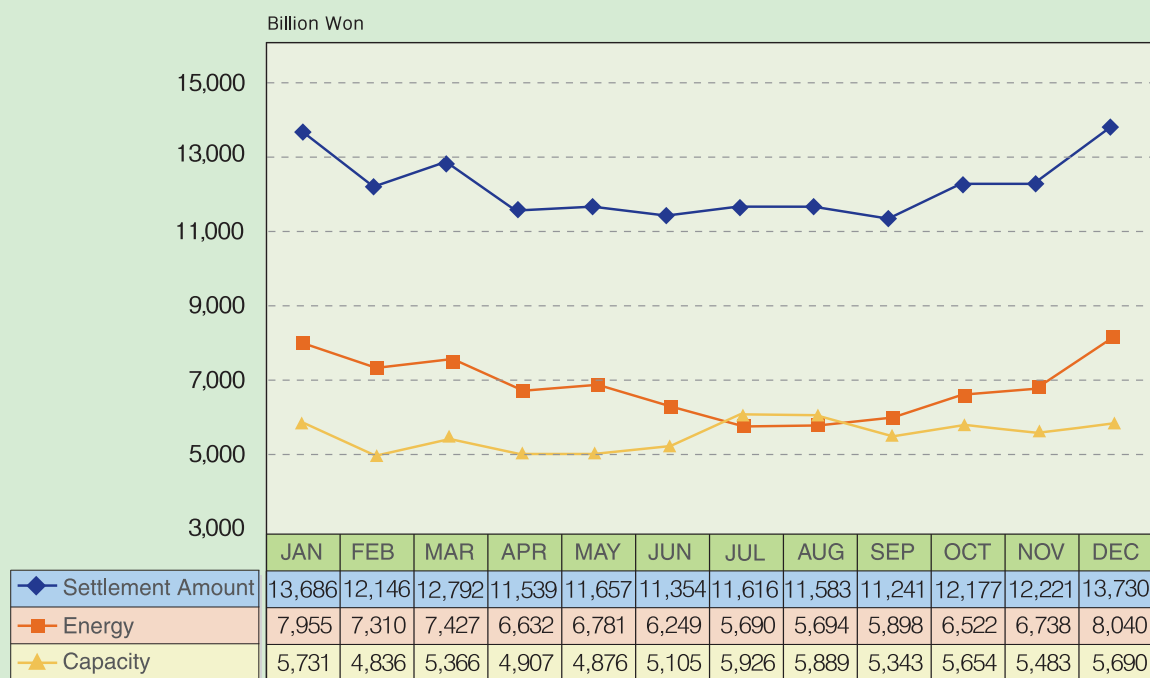
	Amount received when a generator declares its availability in the Price-Setting Schedule	Amount received when a generator does not declare its availability in the Price-Setting Schedule
Actual Electricity Generation	SMP + CP (Scheduled Energy Payment)	Variable Cost+CP (Constrained on)
No Electricity Generation	SMP-Variable Cost+CP (Constrained off)	CP

※ Variable Cost: mostly represents fuel costs of the units.

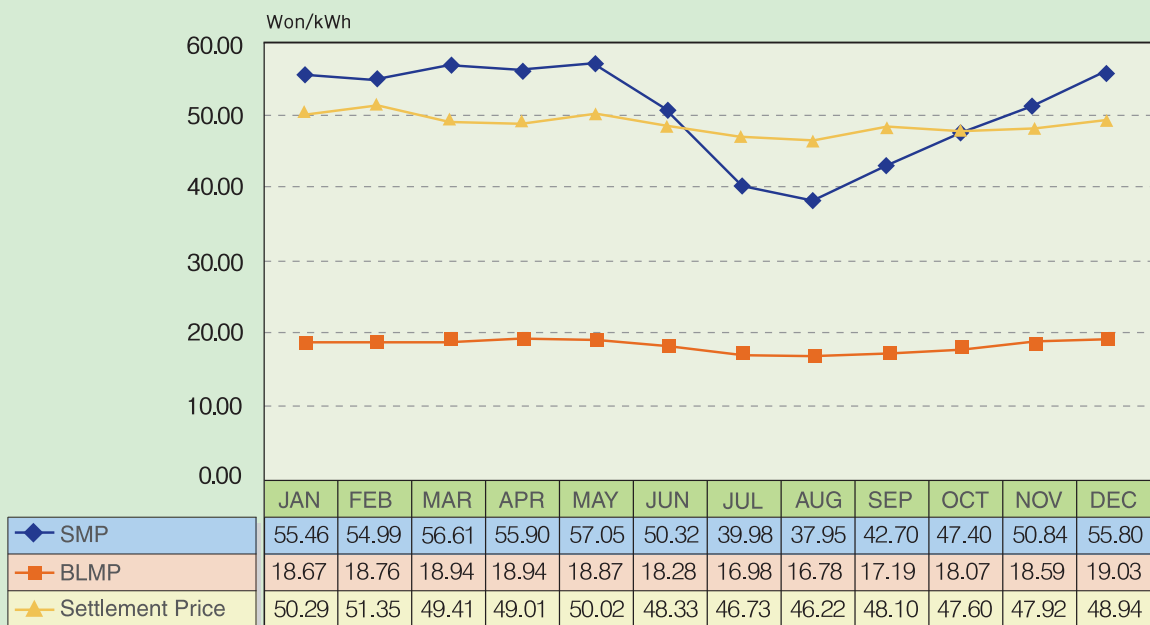
Conceptual Diagram for the Settlements



Trend of Settlement of each month(2003)



Market Price and Settlement Price(2003)



Average SMP : 50.48 won/kWh

Average BLMP : 18.27won/kWh

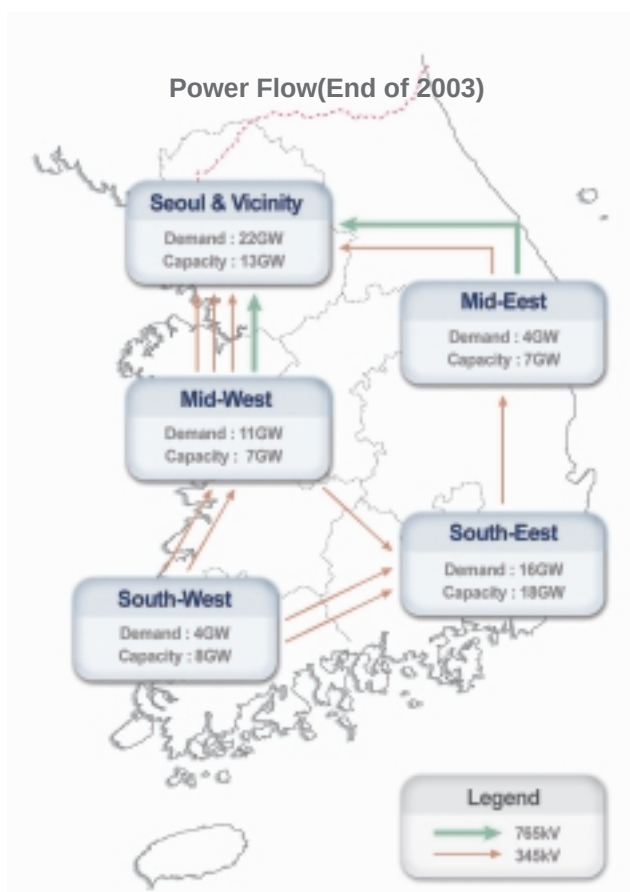
Average Settlement Price : 48.66 won/kWh



National Electricity Network

As of the end of 2003, there exists one large nationwide transmission network in South Korea comprising 28,260C-km of transmission lines and 173,066 MVA of substation facilities. KEPCO owns and maintains the transmission network facilities.

The KEPCO's transmission voltages are 345 kV for long distance transmission lines and 154 kV or 66 kV for local systems. Most of the 66 kV lines are now either being removed or replaced by higher voltage transmission lines. Large capacity 765 kV transmission lines link power plants in the coastal areas to the substations in the Seoul metropolitan area. In 1998, the power system of the Cheju Island was connected to the mainland power system by a High Voltage Direct Current (HVDC) system comprising 101 km-long submarine cables.



During the summer peak hours, almost 42% of the national electricity demand is concentrated in Seoul and its surrounding areas while many of the major power plants are located in the mid and southern regions of the Korean peninsula. This regional unbalance between power plants and electricity demand is the cause of significant transmission congestion within the network.





OPERATING THE MARKET and THE POWER SYSTEM

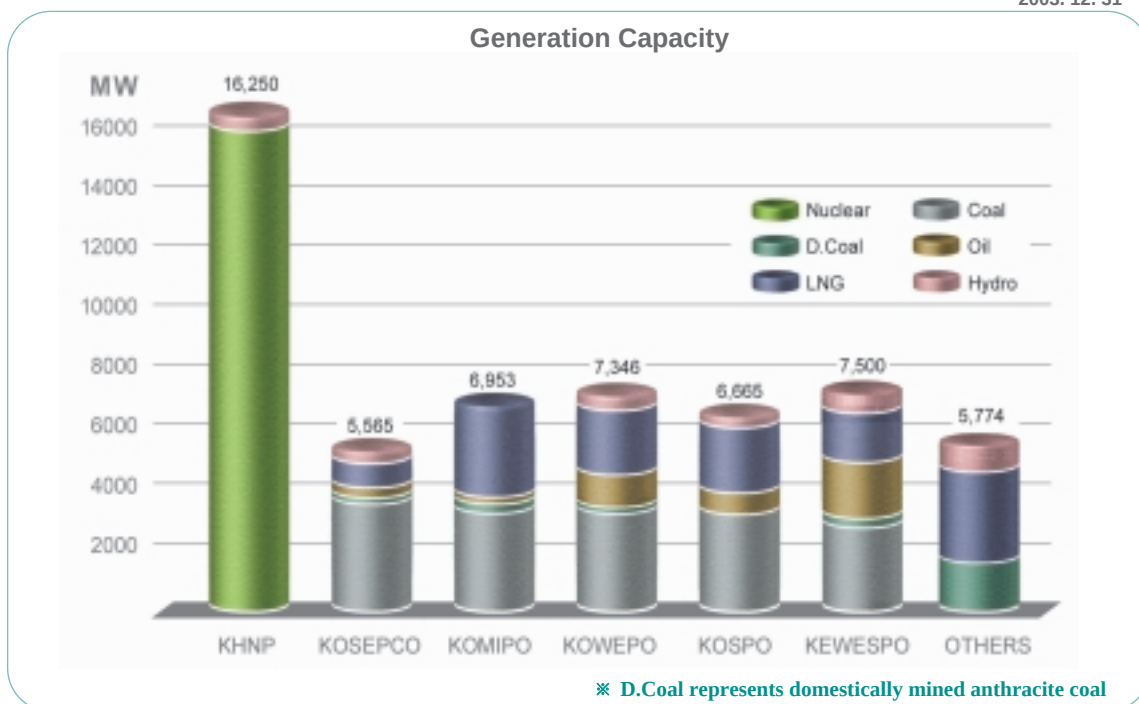
Operation Facilities of the KPX

■ The generation and transmission facilities operated by the KPX are as follows:

- For economic and stable system operation, the KPX issues to generation business operators having central dispatch generators exceeding 20MW dispatch orders such as:

synchronization or de-synchronization, active power and frequency regulation, generation output, reactive power and voltage regulation, automatic generation control, governor free operation, and generation and pumping schedules of pumped storage and hydraulic power plants.

2003. 12. 31



- For stable and efficient operation of the power system, the KPX issues to transmission business operators dispatch orders such as: power system interconnection and separation, and closing and opening of the regional phase modifying equipment according to the dispatch order related to generation regulation.

The dispatch system operates the transmission network by taking into consideration the overload condition of the transmission line and interrupting capacity of circuit breakers in order to control the power flow and maintain the voltage at proper levels.

Transmission Facilities

2003. 12. 31

Description	Transmission Lines		Substations		
	Circuit Length (C-kM)	Total Conductor Length(kM)	Lacations	Nos. of Transformers	Capacity (MVA)
765kV	661	11,902	3	5	7,110
345kV	7,741	79,935	71	153	75,660
154kV	18,595	77,378	500	1,514	89,228
Total	26,997	169,215	574	1,672	171,998

Function and Extent of the KPX's Operation

■ The Extent of the KPX's Power System Operation

The KPX is able to issue to power companies orders necessary for the network operation.

The extent of system operation of the KPX includes: the transmission network above 345kV, the interconnection ties for power plants with capacities greater than 20,000kW among the 154kV transmission systems, the system that requires generation output control for power transmission, the 154kV loop system, and a system that under normal operating conditions, is convertible to the loop system.

In particular, the KPX operates all transmission lines in the Cheju area because of the regional characteristics.

■ Network Operation of the KPX

For stable operation of electric facilities, the KPX:

- Operates the system in order to maintain system stability and quality of electricity;
- Establishes the "Emergency Dispatch Procedure" for electrical system fault and informs generation business operators of it;
- Requests and evaluates information on generating facilities with capacities over 20,000kW and/or that are directly connected to the network of the transmission companies, and relates information on the connection status of electricity users' facilities to the transmission system;
- Presents, corrects, verifies and adjusts the application and operation criteria of protection devices;
- Supervises the operation status of the power system and analyzes major faults;

- Reviews and approves the outage schedule presented by the transmission companies;
- Identifies items relevant to the control of power demand and supply, as well as ancillary services; and,
- Enacts and amends regulations for system operation.

The dispatch system is organized to effectively control and operate power transmission among the areas. The dispatch system operates the network under rated frequency and controls transmission and substation equipment, performs fault recovery actions, fault prevention, etc.

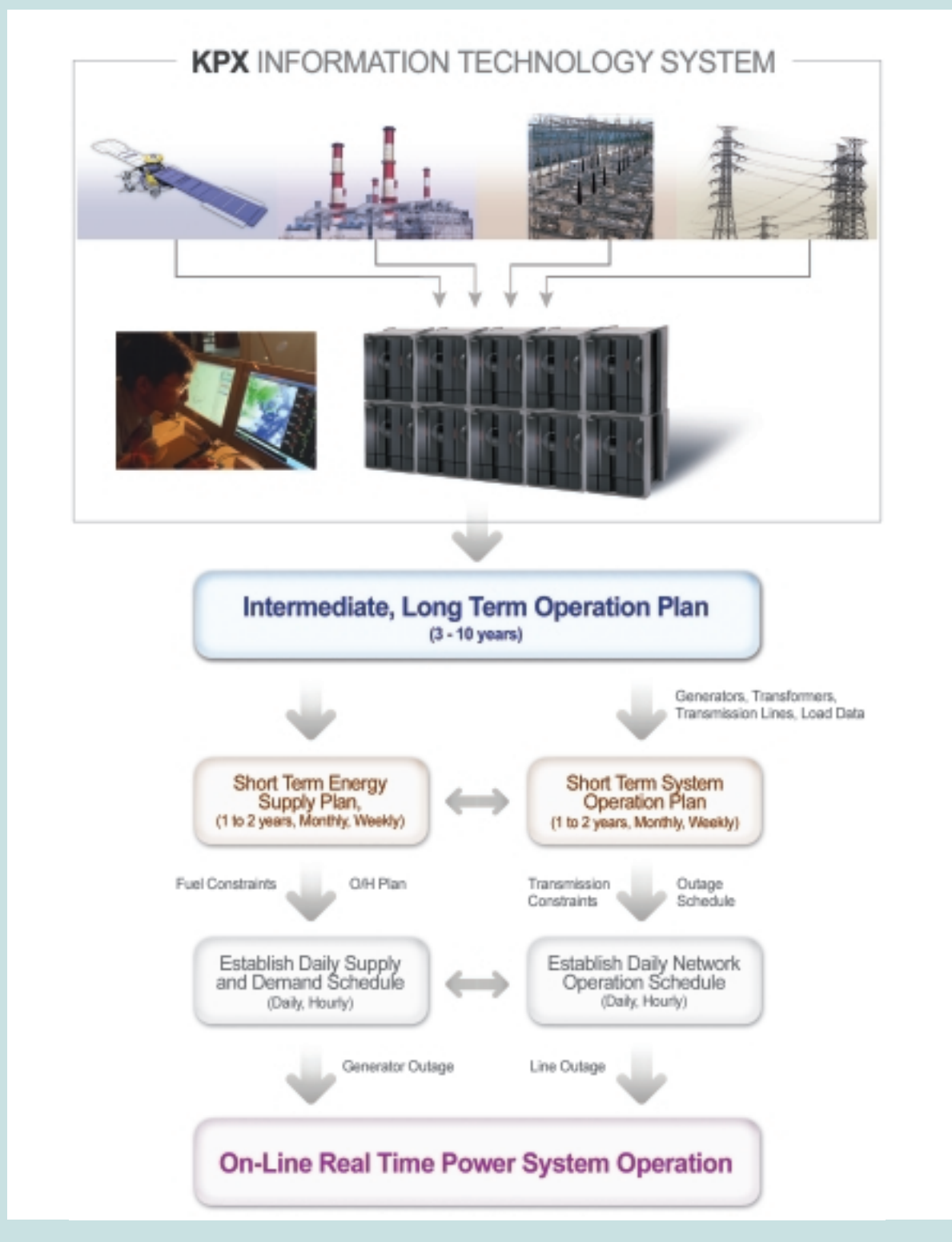
The KPX operation system directly operates the participating generation plants, substations and regional dispatch centers, through the dispatch order system of the corresponding business operators from the KPX national dispatch center.





OPERATING THE MARKET and THE POWER SYSTEM

■ Procedure of Planning Power System Operation



The KPX forecasts demand by collecting information affecting power demand to establish the generation schedule and system operation schedule for implementation.

EMS(Energy Management System)

EMS is a computer system that monitors and controls the operation status of power plants and substations on real time basis. EMS is installed and operated at the national dispatch center for the purpose of generating and supplying economic power by power plants using various fuel types.

System Operation Record

1. Criteria and Record for Frequency Variation

- Criteria: Electricity business operators and the KPX shall regulate the system frequency within $60 \pm 0.2\text{Hz}$ under normal operating conditions. In exceptional circumstances, it may rise to 62Hz and drop to 57.5Hz.
- Yearly Frequency Maintaining Rate

Range	97	98	99	00	01	02	03
$60 \pm 0.1\text{Hz}$	99.0	99.17	99.28	99.33	99.41	99.45	99.70
$60 \pm 0.2\text{Hz}$	99.96	99.99	99.99	99.99	99.99	99.99	99.99

※ The aimed frequency fluctuation range is $60 \pm 0.2\text{Hz}$. However, the internal target of the KPX is $60 \pm 0.1\text{Hz}$.

2. Criteria and Record for Voltage Level

- Voltage Variation Range

System Reference Voltage	345kV system	154kV System Heavy Load	154kV System Load Varying	154kV system light Load
	353kV (336~360kV)	$160 \pm 4\text{kV}$	$157 \pm 4\text{kV}$	$156 \pm \text{kV}$

※ The reference voltage can be specified depending on system conditions.

- Yearly System Voltage Maintaining Rate

Voltage Range	97	98	99	00	01	02	03
Ref.Voltage $\pm 4\text{kV}$	99.20	99.35	99.57	99.79	99.82	99.98	99.94

3. System Constraints and Stability Criteria

The KPX shall observe reliability and stability criteria(Power System Operation Criteria) for operation of the power system under normal and abnormal conditions. The KPX shall manage the system constraints and congestion in an economical and efficient manner by estimating the system condition taking the physical status of the network into consideration.



OPERATING THE MARKET and THE POWER SYSTEM

Ancillary Services

The KPX is responsible under the market rules for ensuring that the power system is operated in a safe, secure and reliable manner. In order to fulfill this obligation, the KPX controls the key technical characteristics of the main power system. These include frequency, voltage, network load and system re-start. An example of ancillary service activity is frequency control. When the balance between

demand and supply on the power system is disrupted, the power system frequency deviates from its designated value. Variations in frequency or voltage can cause damage to generation equipment and industrial, commercial and domestic machinery, and create safety concerns. Ancillary services are used to maintain this balance. The following functions are managed by the ancillary services:

Automatic Generation Control(AGC) and Governor Free Operation : Except for nuclear power plants, all hydraulic and thermal generators shall be subject to governor-free operation within the speed regulation range declared by the generation business operators. This is in accordance with the system frequency and dispatch orders. Also, the facilities shall be maintained so that the governor-free operation can be done within the declared speed regulation range.

Secure Optimum Power Reserve : The units scheduled to supply reserve power by the generation operation schedule shall be in a state of ready for start at any time. In the event of an unexpected dispatch order from the KPX, the generator shall supply the scheduled power through immediate start of the unit.

Demand and Supply of Reactive Power : The Electricity business operators shall follow dispatch orders to maintain system voltage within the limit.

Providing Black Start Service for a Specific Power Plant : The Electricity business operators having black start generators and black start transmission lines shall immediately inform the KPX when they cannot provide black start service due to maintenance work or outages. The KPX shall keep relevant records such as cause and duration of outages.

Criteria for the Management of Reserve Power

The following is the secured amount of reserve by type, and the priority of securing reserve power in order of frequency regulation reserve, standby reserve and replacement reserve. The system shall operate to maintain reserve power greater than 4,000kW, including excess amounts over the standard to be secured by type.

Description	Frequency Regulation Reserve	Standby Reserve		Replacement Reserve
		Operation	Shut down	
Secured Capacity	More than 1,000MW	More than 500MW	More than 1,000MW	More than 1,500MW

The current Generation Competition Market(existing 2001 through 2005) in Korea does not fully account for prices of ancillary services. The next stage in the restructuring process, Wholesale Competition Market(2005 through 2008), is expected to consider a pricing mechanism for ancillary services.

Emergency Procedure

In the event that the KPX foresees the shortage of available operating reserves in a real time power supply, it shall announce appropriate warning levels as described below, and take proper actions to avoid more severe conditions.

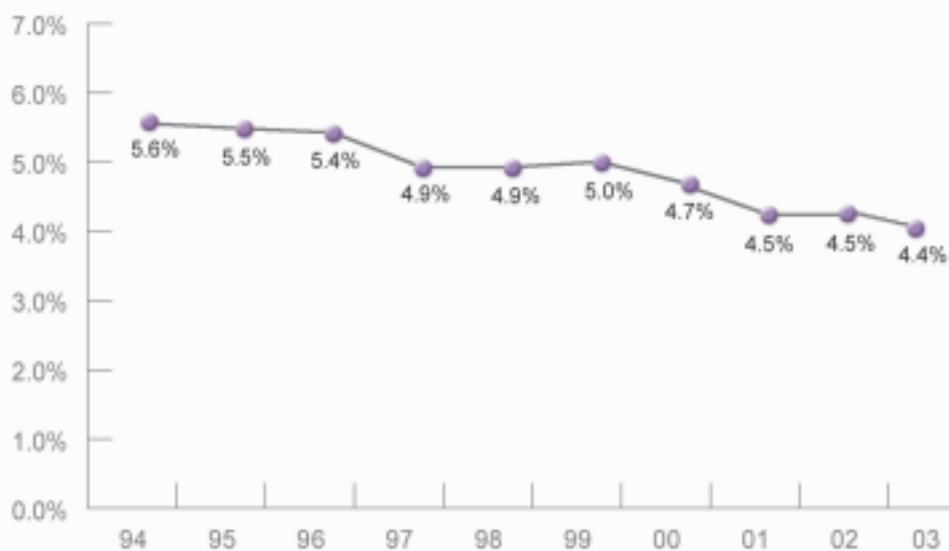
Operating Reserves	Warning Level	Necessary Activities
2,000MW~3,000MW	Class 3	Consumers are urged to reduce their use of electricity voluntarily. Prepare implementation of load control (Move use of electricity from peak hours to non-peak hours) Secure additional capacity as much as possible
1,000MW~under 2,000MW	Class 2	Implement load control Secure more capacity through requesting IPPs' emergency generation.
0~1,000MW	Class 1	Implement emergency load shedding. Rolling load curtailments are possible within approximately one hour

Loss of Energy in the System

As electricity flows through the grid, energy is lost in the transmission and distribution lines due to electrical resistance of these lines. Electrical losses account for approximately 5 per cent of the electricity transported between power stations and customers. This means that if a customer requires 10 MW of electricity, a generator will need to produce 10.5 MW of energy in order to meet this demand.

In the current Korean market this loss is not reflected in the market pricing and metering equipment is installed on the high voltage side of a main transformer. The energy loss factors associated with electricity transmission will be taken into account in the market settlement process with the introduction of the next market stage.

Transmission Distribution Loss Factor(National Grid)



WHOLESALE ELECTRICITY MARKET DESIGN

The second stage of the power industry restructuring will separate distribution companies and introduce a wholesale market. In the upcoming electricity market, both supplier and customer would make transactions through free bidding. Under this market structure, there will be numerous generation companies and distribution / retail companies taking part.



Needs for wholesale market

- To enhance the efficiency of the power industry, generators and retailers must make transactions according to wholesale market principles.
- To increase customer options, customers should be able to choose from various retailers or obtain their power supply directly from the market.
- To achieve privatization of the generators and to induce new investment, it is advantageous to make transactions through a competitive wholesale market.



Design Principles

In the second board meeting held on June 11th 2001, the KEC approved 15 design principles that will be the backbone of the next electricity industry. These principles will be used for developing detailed market design such as market structure, price settlement, etc.

- **Supply and Demand**
 - All generation and demand shall bid / offer price and quantity of power to the market.
- **Participation in Electricity Market**
 - All participants can trade power through the market only.
- **Offer by Generator**
 - The Generator submits an offer of price and quantity for each generator for each trading period of a trading day. (Generation companies have the obligation of decision making on important issues such as unit commitment.)
- **Bid by Demand**
 - Power Sales Businesses submit price and quantity of electricity for each trading period of a trading day.

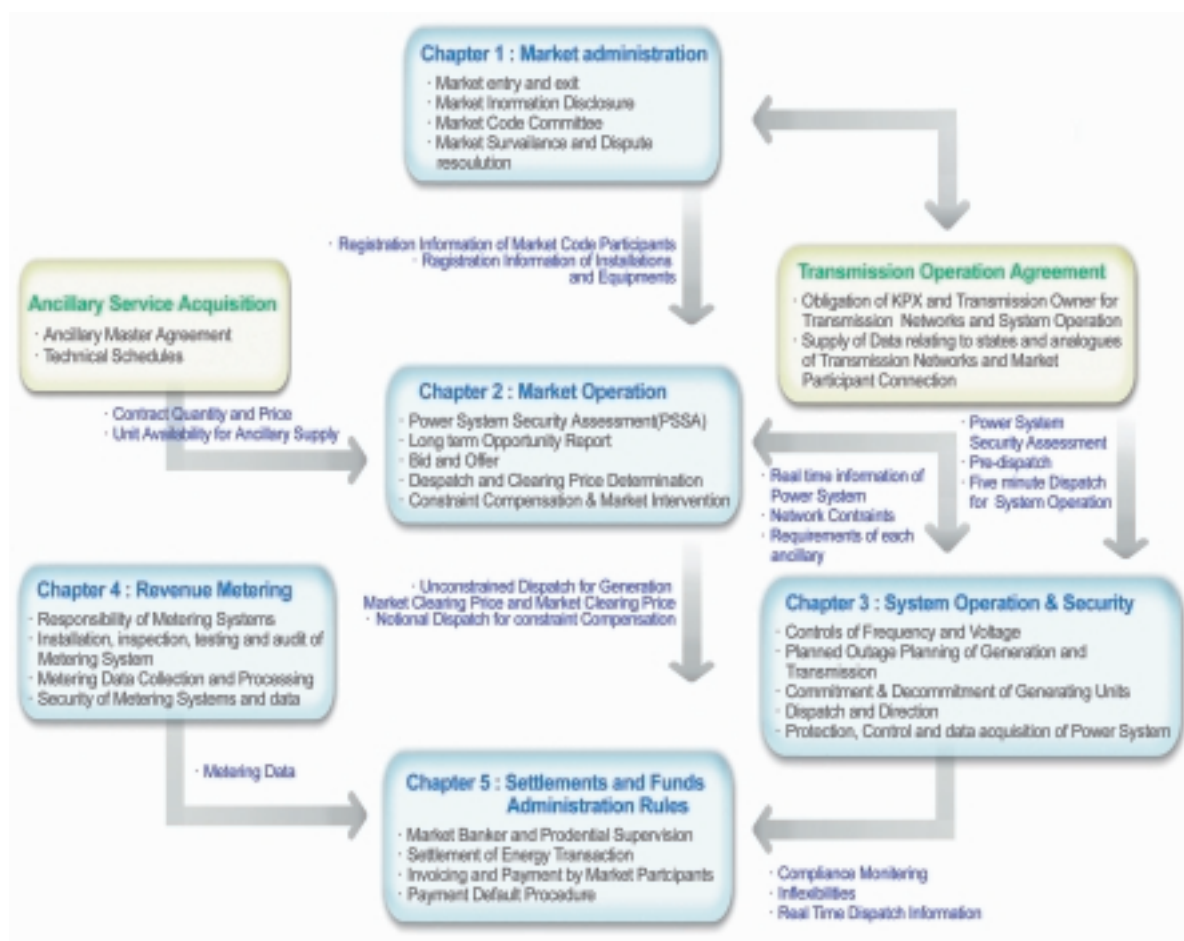
- **Reserve**
 - KPX shall reserve sufficient reserve for system security.
 - Additional payment shall be paid to reserve supplies.
- **Publication of Market Information**
 - Major market information such as forecast market clearing price(FMCP) in accordance with offer and bid or the supply and demand situation will be publicized at regular intervals.
- **Pre-Dispatch Schedule (PDS)**
 - A constrained pre-dispatch schedule shall be made and publicized daily in consideration of system situation (periodic change, revision and publication).
- **Real time Dispatch and Pricing**
 - An actual dispatch will be performed by a constrained dispatch schedule issuing dispatch targets every 5 minutes.
 - The national single generation market clearing price(GMCP) shall be determined by the offer price of a marginal generator through an unconstrained 5 minute dispatch schedule.
 - The final market clearing price will be determined to Purchasers by taking a volume weighted average of the CMCPs over 30 minutes.
- **Constrained Generation**
 - Opportunity cost of constrained off-generation and operating loss of constrained on-generation should be compensated.
- **Transmission Loss**
 - Transmission loss will be calculated by applying static marginal transmission loss factor.
 - Transmission loss will be different from each region and be allocated to all participants by region.
 - Settlement surplus related to marginal transmission loss shall be used for the collection of transmission costs.
- **Ancillary Service**
 - KPX shall make bilateral contracts with the ancillary service provider.
 - In the long term, the spot market for a various type of AS will be pursued.
- **Settlement**
 - KPX shall perform the settlement.
 - For generation, apply the 5 minute generation market clearing price.
 - For demand, apply the 30 minute market clearing price.
 - Uplift(by constrained generation and ancillary service) shall be charged by demand in proportion to the energy amount used and shall be settled through the Pool.
- **Risk Hedging**
 - Participants will be able to enter into financial hedging arrangements.
 - Financial hedging arrangements will be outside of the Pool trading arrangements.
- **Transmission Charge**
 - All participants shall bare the cost for investment and maintenance of transmission facilities.
 - Regionally differentiated charges will be applied by location of power and demand.
- **Uplift Separation**
 - Among the uplift, calculate separately the portion of transmission asset owner.
 - Separate regulation shall be performed on the portion of transmission asset owner.



WHOLESALE ELECTRICITY MARKET DESIGN

Market Document Structure for the Wholesale Electricity Market

To achieve fairness and efficiency in the projected wholesale market, market rules have been developed based on the Design Principles. These rules are posted on the KPX homepage to help market participants' preparation for the upcoming market.

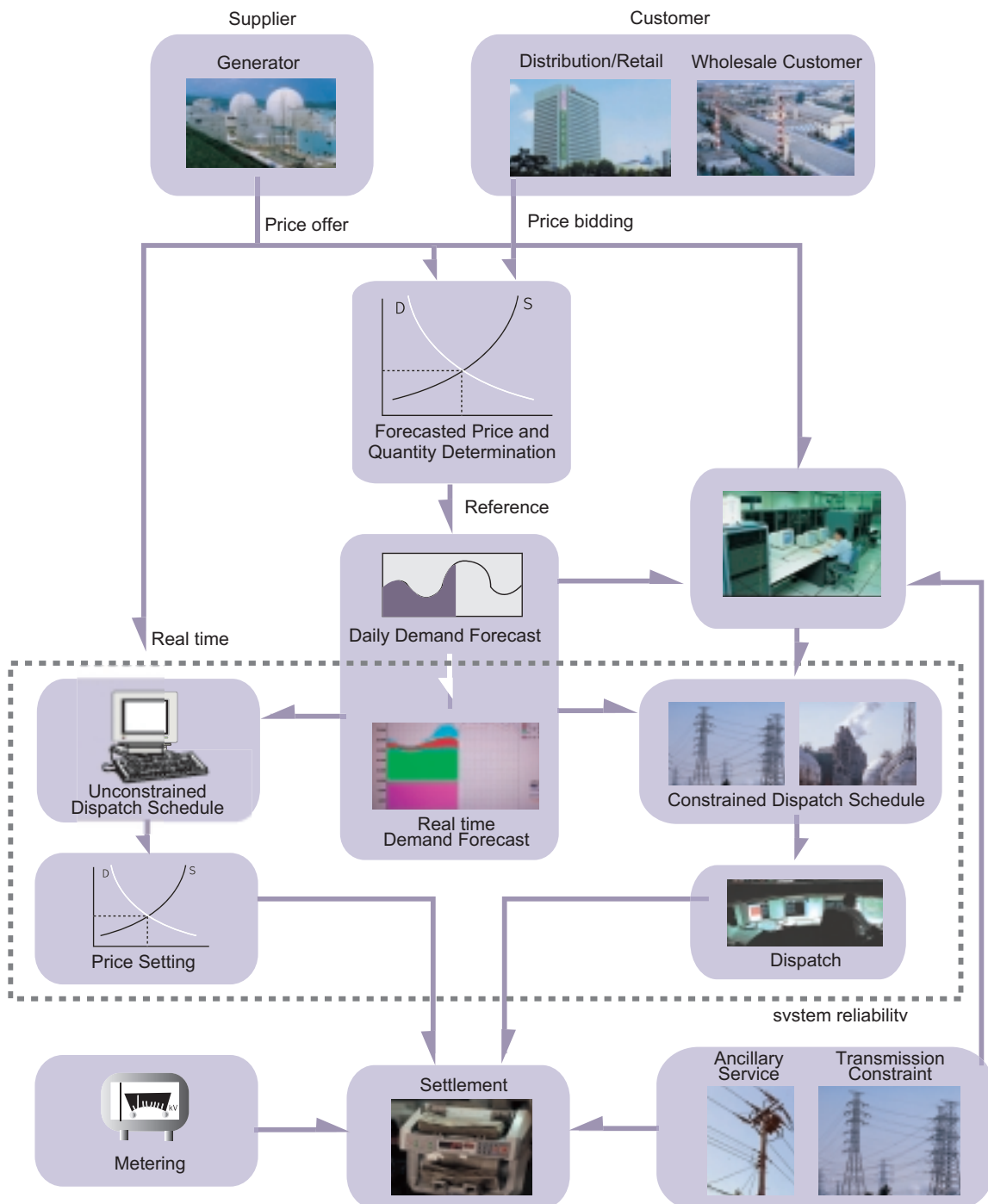


Electricity market transaction procedure

■ In wholesale market, transactions are occurred as follows

Supplier/Customer bidding → forecasted price/quantity determination → daily load forecast → Establishing forecasted dispatch schedule → realtime load forecast → Establishing unconstrained /constrained dispatch schedule → price setting dispatch → metering → settlement

Transactions in wholesale electricity market

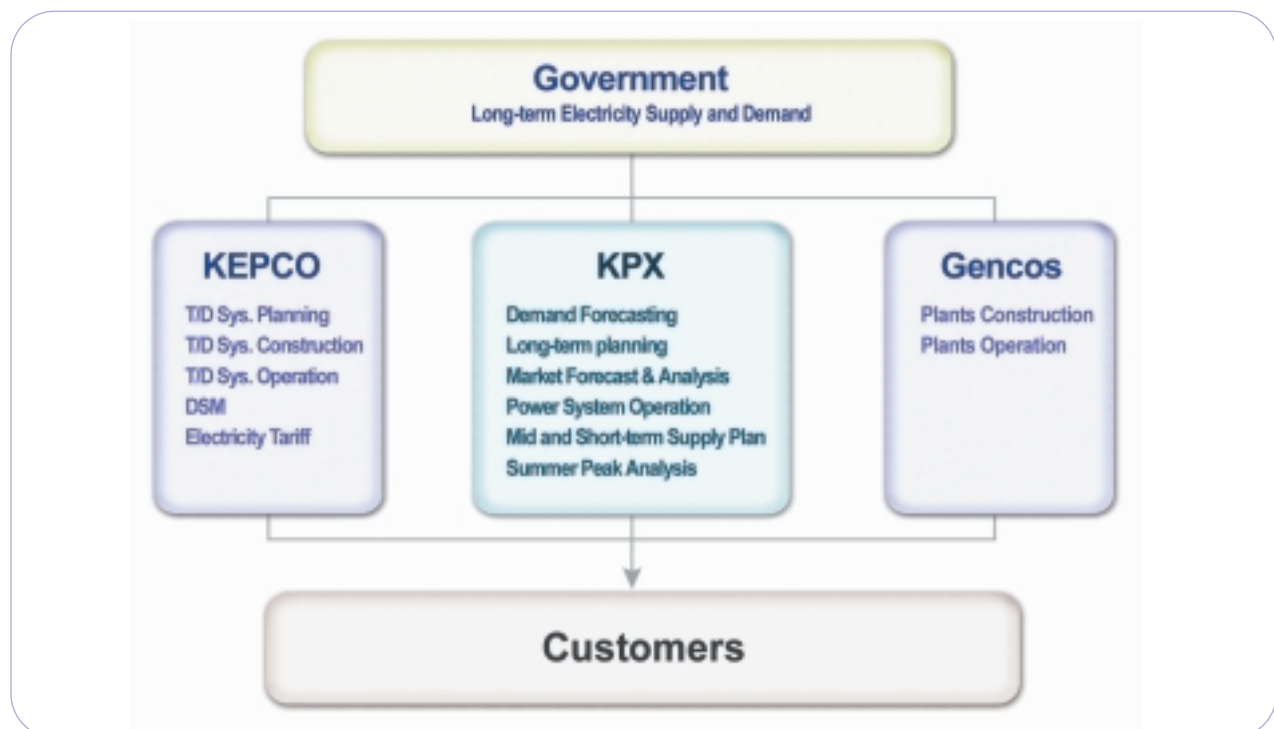


ESTABLISHMENT OF STABLE POWER SUPPLY



Under the vertically integrated system of the electricity power industry in Korea, the establishment of the Long Term Power Development Plan by the Government and the KEPCO had successfully balanced electricity supply with electricity demand. However, the restructuring

process will prompt the competitive market mechanism to dominate the electricity supply industry. Consequently, the function of the Long-term Power Development Plan will inevitably be transformed into non-binding guidelines.



The Plan of Long-term Electricity Supply and Demand

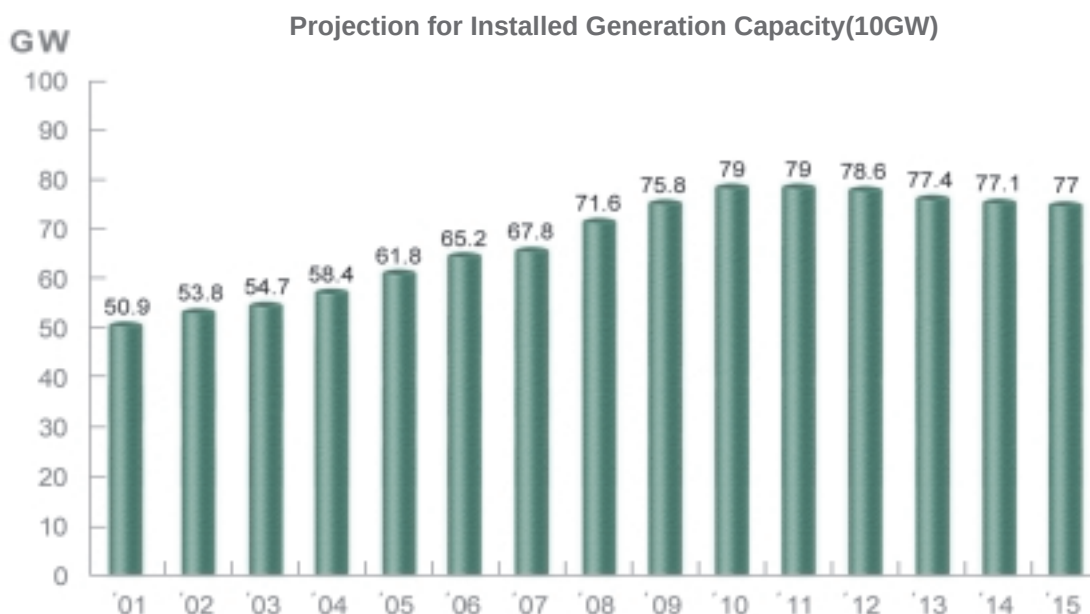
One of the key issues for measuring the success of restructuring in the electricity industry is the security of the power supply. Should the market fail to obtain the required capacity, a nationwide unbalance in electricity supply and demand could cause considerable disruption to the national economy.

With this in mind, the KPX will undertake one of the key functions in the market by fully supporting and consulting with the government in the regular development of the basic plan of long-term electricity supply and demand. The KPX also has the

responsibility of providing market participants with sufficient market information as well as offering them an appropriate inducement for capacity additions in accordance with the provisions of the Electricity Business Act. Such a plan is to be established every two(2) years covering at least more than ten(10) year planning period. Moreover, the generation companies, the KEPCO and the transmission and distribution line owners are required by law to submit their facilities expansion plans to the government so that their plans can be integrated into the national capacity strategy.

Projected Electricity Demand (2002-2015, Long-term Electricity Supply and Demand)

Year	Sales(GWh)	DSM ⁴ (MW)	Peak Demand(MW)
2002	271,009	309	45,742(45,773) ⁵
2005	311,056	2,577	51,859
2010	355,324	5,265	60,624
2015	391,950	7,039	67,745
Annual Growth Rate (%)			
'01~'05	5.4	—	4.8
'06~'10	2.7	—	3.2
'11~'15	2.0	—	2.2



4. DSM: Demand Side Management 5. () indicates actual value in 2002



APPENDIX

Brief History of the electricity industry in Korea

January 26, 1898

Korea's electricity industry began with the establishment of the Seoul Electric Company in 1898. Over the years, the Seoul Electric Company has endured numerous significant changes and adversities. Since its inception, Korea has suffered from a chronic power shortage due to undeveloped power technology, the sudden cutoff of the power supply from North to South Korea on May 14, 1948, and the destruction of power facilities during the Korean War.

January 1982

KECO was renamed the Korea Electric Power Corporation(KEPCO) following the Korean Government's acquisition of all outstanding stock. In 1989, the Government sold 21% of the KEPCO's stock to the public as part of its partial privatization plan.

KPX

KOREA POWER EXCHANGE

July 1, 1961

In July of 1961, the Korean Government established the Korea Electric Company(KECO) by merging three existing regional electric power companies(Chosun, Kyung-sung and Namsun). This was a critical step towards the revitalization of the suffering national economy. Thanks to the successful result of consecutive economic development plans initiated in 1962, the Korean economy has developed rapidly and the demand for electric power has outpaced GDP growth as the electricity intensity of the Korean economy has steadily increased. The KECO's(and later, KEPCO's) energy resource diversification programs, which were motivated by two separate oil crises, have been actively pursued and include nuclear power generation.

January 21, 1999

The Government announced the basic Plan for Restructuring of the Electricity Supply Industry. The key points of the plan for the electricity sector in the short run included the separation of the KEPCO's power generation sector into six subsidiaries to increase efficiency through open competition, followed by privatization.

April 2, 2001

The KPX(Korea Power Exchange) was established in order to manage the operation of the newly formed competitive generation market. Six(6) power generation companies(including 1 nuclear generation company) were separated from the KEPCO.



Background

Prior to April 2, 2001, The Korea Electric Power Corporation(KEPCO) was an integrated electrical utility established as a statutory corporation in Korea. It was the only company engaged in the generation, transmission and distribution of electricity in Korea.

At the end of March 2001, the KEPCO owned 92% of the total electricity generating capacity in Korea, excluding plants that primarily generated electricity for private and emergency uses. At that time, the total installed generation capacity was 48,451MW⁷ of which the KEPCO owned 44,566 MW. The remaining balance was either owned by Independent Power Producers(IPP) or by the Korea Water Resources Corp. Over the last decade, the total KEPCO installed capacity has risen 2.3 times-from 21,021 MW in 1990 to 48,451 MW in 2000.

Installed Generation Capacity

	1980	1990	2000
Kepco	8,731	19,783	44,566
Others	660	1,238	3,885
Total(MW)	9,391	21,021	48,451

During the past decade, the average growth rate of electricity demand has been maintained at over 10%, except for the period in 1998 in which Korea experienced national financial difficulties. With rapid recovery from these troubles, the growth rate in 1999 and 2000 returned to its previous levels.

Annual Peak Demand and Growth Rate

	91	92	93	94	95	96	97	98	99	00
Peak Demand	19,124	20,438	22,112	26,696	29,878	32,282	35,851	32,996	37,293	41,007
Growth Rate(%)	10.9%	6.9%	8.2%	20.7%	11.9%	8.0%	11.1%	-8.0%	13.0%	10.0%

Meanwhile, in the economic sense of the electricity industry, the view of line-bound energy industries as “natural monopolies” has changed considerably during recent years upon the perception that each of the industries could be seen as a combination of different functions. The natural monopoly perception for each function has been reassessed, resulting frequently in transportation functions such as transmission, remaining as natural monopolies while other functions such as generation, wholesale and retail sales, metering, billing etc. have become candidates for competitive opportunity. This new theoretical paradigm has stirred restructuring and deregulation of line-bound energy industries in a number of countries with the most prominent examples being the UK(Electricity Act of 1989) and Norway(Electricity Act of 1990) with other countries such as the USA(Energy Policy Act of 1992) and Sweden(Competitive Electricity Market Bill of 1992) following closely behind.



APPENDIX

Restructuring of the power sector in Korea

Conclusions to be drawn from theoretical discussion and practical experience include:

- Grid functions, particularly transmission and distribution still require regulatory monitoring after deregulation.
- Strong competitive forces prevail in the fields of generation and supply where energy markets can be opened to competition (e.g. entering of IPPs).

However, a further reason for the adoption of this approach in Korea was the strong growth in electricity demand and the need for renewed investment in an environment characterized by a shortage of private capital. In the new industrial society, efficiency improvements in the industry organization in terms of business process and ownership control have become significant.

The electricity supply industry in Korea faces the challenge of improving its existing system, which has been judged as inappropriate, with the solution being the development of a market-based system driven by competitive behavior. Restructuring and privatization of the power sector have also been viewed as tools for attracting foreign investment, an important factor for the government as they enable a substantial reduction in public debt, particularly in years to come.

According to the 5th Long-term Power Development Plan announced by the Korean Government in January 2001, in order to meet the projected annual growth of electricity demand from 1999 to 2015, a total of 45,130 MW with 106 units is needed, which costs approximately 50 billion U.S. Dollars. Without reforms and privatization, much of this would by necessity be funded by raising public debt. The government and the KEPCO are predicting that the introduction of competition and privatization will attract private capital in financing future investment and therefore lighten their investment burden.

The Government's Plan for Restructuring

In 1994, the Korean Government carried out a 2-year evaluation study of the KEPCO's organization to estimate the potentials of efficiency increase in the power sector. The result of this study suggested restructuring and gradual privatization of the company. Accordingly, in 1997, an Electricity Industry Restructuring Committee was established within the government, which prepared the "Draft Plan for Restructuring of the Electricity Supply Industry". On January 21, 1999, taking into consideration this plan, the Ministry of Commerce, Industry and Energy (MOCIE) announced publicly the "Basic Plan for Restructuring of the Electricity Supply Industry". According to this Plan, the restructuring should:

- **Implement a competitive market structure with full competition on the generation side and limited retail competition, leading ultimately to full retail competition.**
- **Unbundle the existing vertically integrated utility, the KEPCO, into five to seven generation companies (GenCos), a transmission company and multiple distribution companies.**
- **Retain nuclear generation assets in public ownership until a decision on whether or not to offer them for sale is determined at some future point.**



The restructuring plan announced by the government involved a gradual transition to wholesale competition with the introduction of retail competition taking place in the future. The plan established that in the initial period, the KEPCO's generation assets would be divided into a number of companies for divestment and/or privatization.

Subsequently, the KEPCO's distribution assets would also be sectioned into a number of companies with a separate national transmission company offering access to the Grid on a non-discriminatory basis.

To assist with the first phase of the restructuring process, three sets of independent advisors were engaged by the KEPCO.

- Anderson Consulting with National Economic Research Associates(NERA) participated in the study on the divestment of the KEPCO's generating assets.
- Freehill Hollingdale & Page participated in

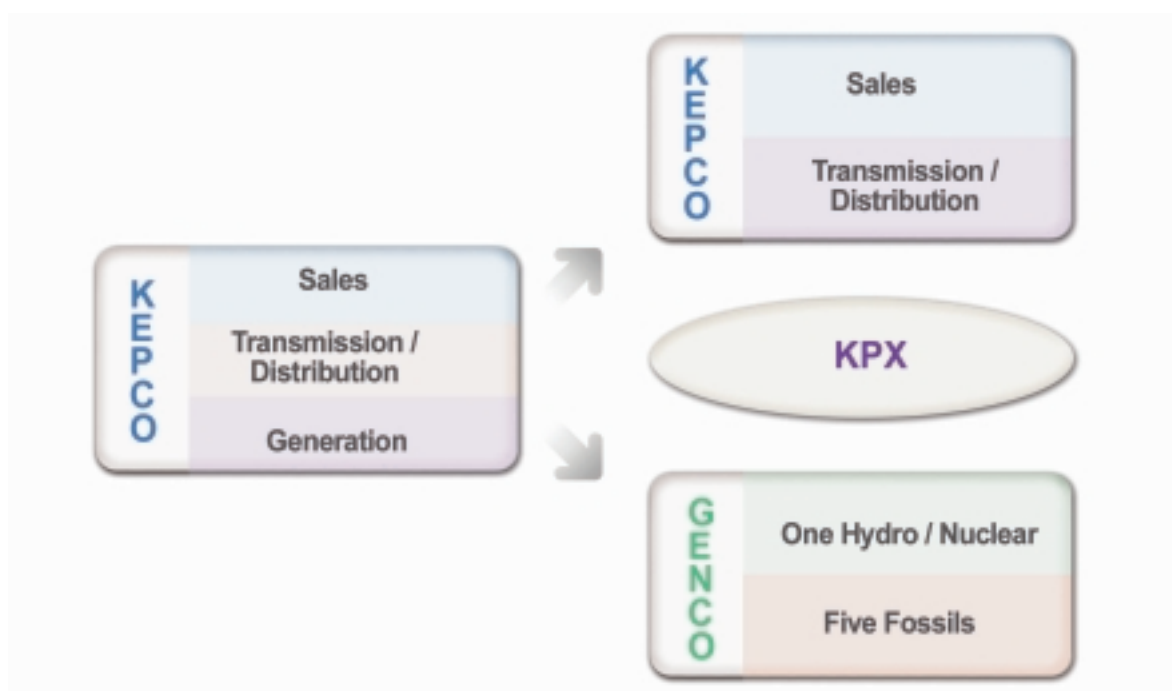
the study on the establishment of the necessary legal framework of the new competitive market.

- The consortium of EMS Consulting, Energy Settlement and Information Services(ESIS), IBM Korea and KEMA Consulting participated in the study on the development and implementation of the trading arrangements.

Finally, phased restructuring process was laid down as follows:

- Phase 1 : Generation Competition
- Phase 2 : Wholesale Competition
- Phase 3 : Retail Competition

Generation Competition, 1st Stage Restructuring on April 2, 2001



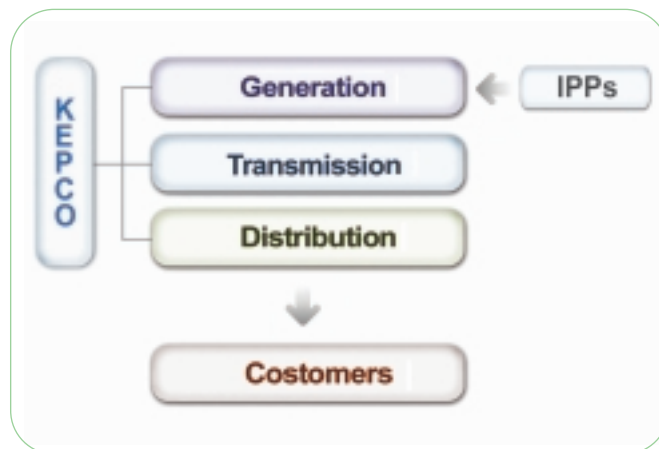
APPENDIX

Phased Restructuring

Vertically Integrated System Stage(Before 2001)

In the past, the Korea Electric Power Corporation (KEPCO) assumed electricity supply obligations with regulated electricity rates and monopolized the entire electricity supply industry, including generation, transmission and distribution. In 2000, the KEPCO, comprising 92% of the national installed generation capacity, produced 96% of national electricity production.

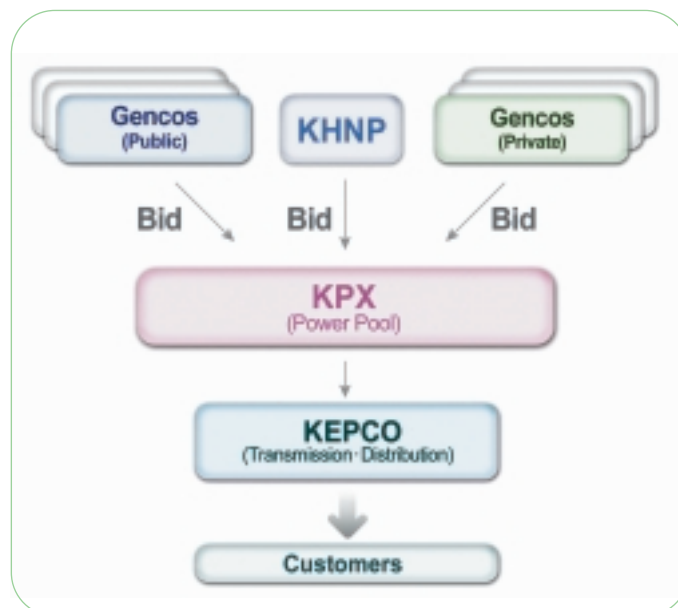
A small number of IPPs(Independent Power Producers), possessing Power Purchase Agreements (PPAs) with the KEPCO, sold their output to the KEPCO, and the entire industry including electricity rates became regulated by the Government. Customers didn't have any rights to choose their electricity suppliers and new entry into the industry was either regulated or prohibited at this stage.



On April 2, 2001, in the transition to the first stage of restructuring, Generation Competition (six (6) GenCos being separated from the KEPCO) was established in the recently formed Generation Competition Market. In addition, two organizations, the Korea Power Exchange (KPX), an independent market operator, and the Korea Energy Commission (KOREC), a regulator, were also established.

Generation Competition (Began on April 2, 2001)

The current electricity market, which began operation on April 2, 2001, is referred to as the first stage of restructuring and the Generation Competition Market. In this phase, multiple GenCos, one(1) transmission/distribution company(KEPCO), and several IPPs exist in the market. The transmission and distribution sectors remain as part of the KEPCO. The six(6) GenCos, excluding the one(1) known as the Hydro Nuclear GenCo, are of similar size and mix in terms of generating facilities. This ensures fair competition among all GenCos throughout the marketplace. One of the five GenCos will be privatized at some point, although which one has not yet been determined.





Currently, in accordance with Article 34 of the Electricity Business Act of Korea, GenCos and IPPs are allowed to enter into a contract for differences(CFD) with a supplier or an electricity consumer directly purchasing electric power in order to manage the risk incurred from the volatility of the electric power transaction price.

The Generation Competition market is being operated based on a set of Cost Based Pool(CBP) Rules. In this market, the KPX determines the System Marginal Price(SMP) using generation offers integrating the available capacity of generator' s as well as cost-based energy prices. At this stage, GenCos and IPPs compete in the generation pool with bidding available capacity and regulated cost-based energy prices while the KPX determines System Marginal Prices(SMP).

The IPPs who have already entered into Power Purchase Agreements(PPAs) with the KEPCO maintain the option of participating in the market or remaining in an Agreement with the KEPCO to sell their electricity. At this point, limited competition exists only in the electricity generation area.

As outlined in the Government Plan. The subsequent stage of restructuring, calls for a Two Way Bidding Pool(TWBP) based market. In order to successfully shift from the current based market CBP to the TWBP, a great deal of effort including the development of a new market design reflecting current market operation experience must be made by the KPX.

APPENDIX

Phased Restructuring

Wholesale Competition

This stage introduces a Two Way Bidding Pool(TWBP) in which the demand-side of the market will compete for supplies. To facilitate this, the distribution and supply business elements will be separated from the KEPCO and established as subsidiary companies(Distribution and Retail Companies) promoting wholesale supply competition. The principal buyers in the wholesale market will be distribution and retail companies. The basic concept of the TWBP is to establish prices through the competitive bidding of both generation and demand. However, in the initial stage of the TWBP based wholesale competition market, demand side participation will occur in a manner customers can respond to such as market pricing and modifying their use of electricity consumption. This will be a deliberate action to ease the demand and lower the prices.

During this stage eligible customers will be defined and have the opportunity to enter into a

direct contract with GenCos or to participate in the market to purchase electricity. It is expected that the definition of eligible customers will be gradually extended to include smaller customers following market development. In the meantime, the slighter and domestic loads will be allocated into franchise areas for the newly created multiple supply businesses.



Market pricing in the TWBP based pool will include factors that account for transmission loss along with ancillary services. Major features of the TWBP based markets being considered in the designing stage are as follows:

- All Generation Companies offer price and volume in the pool.
- All Power Sales Businesses bid price and volume in the pool.
- Generators are self-committed and demands are self-dispatched.
- The generation to meet the demand is centrally dispatched.
- Five-minute dispatch and pricing on the generation side.
- Averaged thirty-minutes pricing on the demand side.
- Single energy price market.
- No Capacity Payment.
- Market pricing and settlement will include factors to account for transmission loss⁶.
- Settlement will include compensations for constrained on/off generation and uplift.
- Ancillary Service⁷ Market is to secure Frequency Control Reserve, control reactive power and to secure Fast Start Reserve and Black Start Capability.

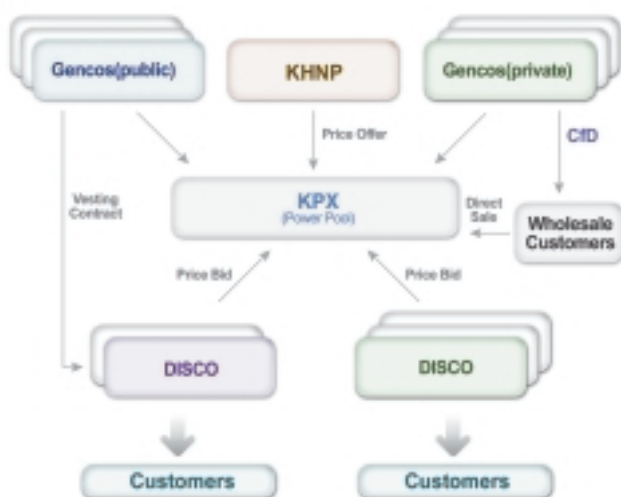
6. Static Marginal Transmission Loss Factor will be applied for each site

7. In the current Generation Competition Market, Frequency Control Reserve, Stand-by Reserve and Replacement Reserve are controlled according to system operation procedures.

The newly created Distribution Companies will be responsible for both the Distribution Network Business(DNB) and the Power Sale Business(PSB). The Distribution Companies will own and operate the middle and low voltage (under 154 kV) networks within each Distribution Company's franchise area. The Distribution Network will be divided into several Distribution Companies and Power Sales Companies. It will take several years to establish all of these companies and the required regulatory and commercial arrangements needed to go along with them.

The Distribution Network Business(DNB) will be a monopoly within its franchise regions, but Power Sales Businesses affiliated with the DNB shall be able to compete with each other in order to supply large consumers. The PSBs will eventually be spun off as businesses that are separate entities from the DNBs, who will then simply become network monopolies.

Following the establishment of the Distribution Companies, the KEPCO will become the Transmission Company. The KEPCO will continue as a regulated monopoly owning and managing the transmission assets(primarily 765 kV, 345 kV and possibly some elements of 154 kV lines) and providing a Transmission Network Service.

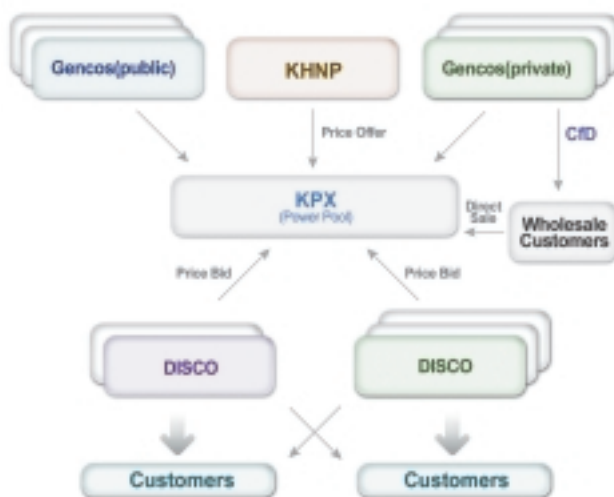


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Retail Competition

The competitive supply will become increasingly available to smaller sectors of the market. Then full retail competition will be introduced as the final stage of restructuring. Once this takes place, every consumer will have the right to choose their electricity supplier. The emergence of traders, brokers and consumer unions will appear in the market.

At this stage power generation will be competitive and multiple power sale businesses will be competing to sell electricity to all customers, even to homes. The KPX will be operating an efficient spot market to coordinate and price real-time operations. This will be the final step in the restructuring process.



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