

## Korea's Power Market



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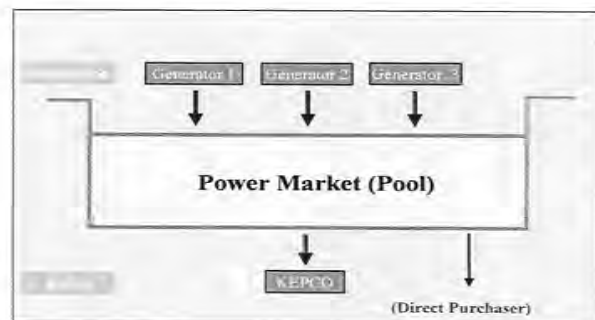
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## I. Power Market Overview

### ☞ Concept of Power Market

- o The wholesale market for trading generator-produced electricity
  - ⇒ The power market is often referred to as a pool because all generator-produced electricity is gathered for trading



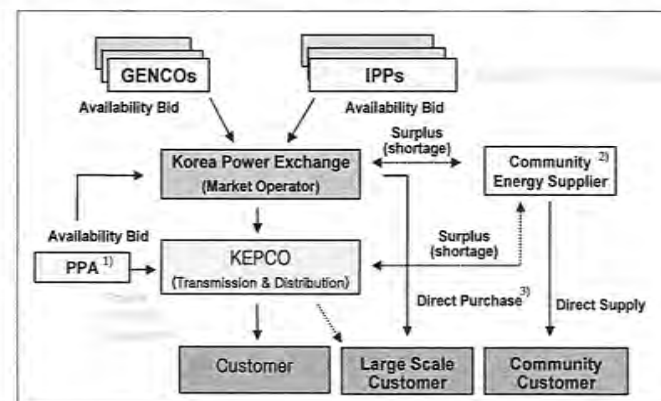
### ☞ Establishment of Power Market

- o KEPCO spun-off 6 generation companies (Gencos) on April 1, 2001
  - ⇒ Leaving KEPCO in charge of transmission, distribution & retail
- o Establishment of power market (Korea Power Exchange)
  - ⇒ All generators & retailers can only trade through the market (Electricity Act article 31)
- ※ New & renewable energy generators below generation capacity of 200kW can trade outside the power market



### ☞ Market Structure

- o 6 Gencos & Independent Power Producers (IPPs) bid their available generation capacities on a daily basis
- o Korea Power Exchange (KPX) is in charge of market operation & system operation
- o KEPCO purchases power from the KPX and delivers to final consumers

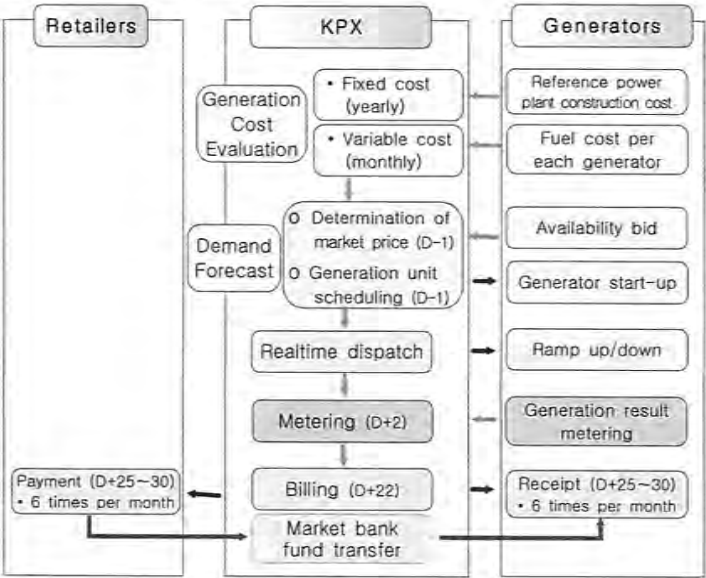


### ☞ Market Participants (as of 2008.12)

- o Generation: 6 Gencos (KEPCO subsidiaries), 288 IPPs
  - o Transmission, Distribution & Retail : KEPCO
- 1) Power Purchase Agreement (PPA)
    - PPA contractors bid their available generation capacity to the power market for dispatch, but the payment is settled by PPA contracts, not by the market price
  - 2) Community Energy Suppliers
    - Power Producer with their own generators, directly selling power to their licensed area, can trade their surplus (shortage) power through KEPCO or KPX
  - 3) Direct Purchase
    - Large scale customers who require capacity more than 30,000kW can directly purchase power from the pool

II. Market Operation

Market Operation Procedures

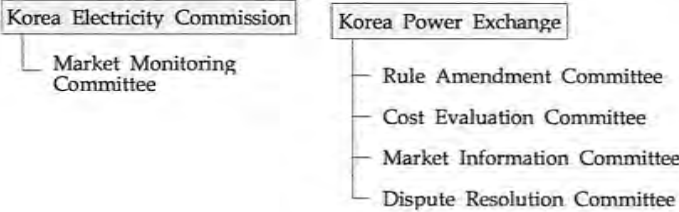


Market Operation Schedule

Previous year	Generators fixed cost evaluation (Cost Evaluation Committee) → Capacity price
Month-ahead	Generators variable cost evaluation (Cost Evaluation Committee)
Day-ahead	Demand forecast (KPX), Availability bid (Gencos) → Price setting
Trading day	Realtime dispatch (KPX), Power Generation (Generators), Metering (KPX)
Day after	Billing (KPX), Fund transfer (Retailers→Generators)

Market Operation Committee

- o Concept: Decision making body to identify market operation issues that need to be addressed
- o Members: Market participants, industry experts & regulatory officials
- o Current operation: 5 Committees



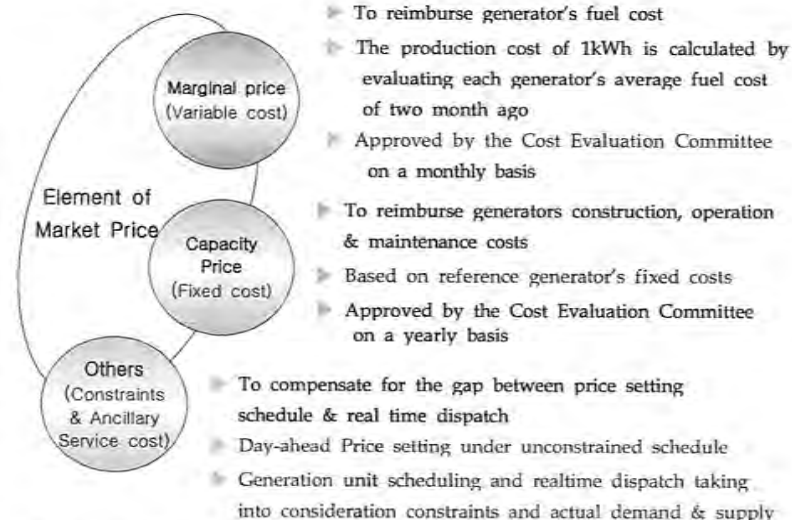
Role & Responsibilities of Major Committees

Rule	Composition	* 9 members (Retail 1, Genco1, Korec 1, KPX2, Outside4)
Amendment	Role	* Review rule amendment proposal, make decisions
Committee	Meeting frequency	* As needed (Market participants and KPX can request)
Cost	Composition	* 8 members (Retail1, Genco1, Korec1, KPX1, Outside4)
Evaluation	Role	* Evaluate each generator's cost
Committee	Meeting frequency	* Monthly (Variable cost : monthly, Fixed cost: yearly )
Market	Composition	* 8 members (Retail1, Genco1, Korec1, KPX1, Outside4)
Information	Role	* Review the market information sharing policy
Committee	Meeting frequency	* As needed

- 1) Korec: Korea Electricity Commission (Korean government regulatory body)
- 2) KPX: Korea Power Exchange

### III. Market Price

#### Element of Market Price



#### ① Marginal Price

- o Determination of marginal price: interaction of supply & demand

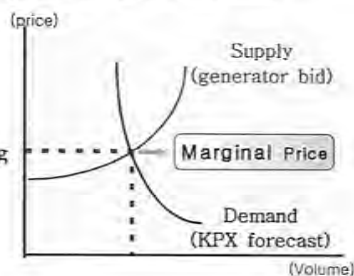
⇒ Variable cost of the most expensive generation plant dispatched for the trading period

\* Demand: KPX forecast

\* Supply: Generators bid

※ Retailers don't participate in bidding

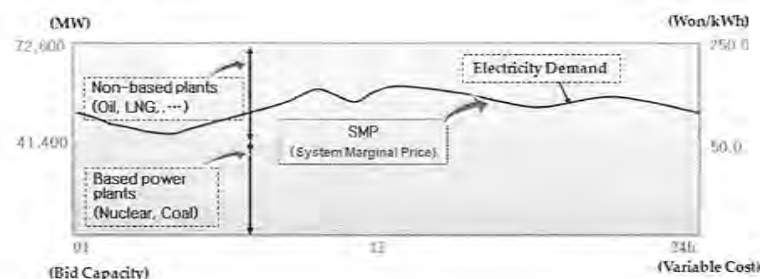
⇒ Hourly marginal price are pre-determined day-ahead (D-1)



- o SMP: System Marginal Price

⇒ The variable cost of the most expensive generation plant within the price setting schedule

#### System Marginal Price



#### Adjusted Coefficient of SMP

- o The date of enforcement: May 2008
- o The purpose of introduction
  - To balance the profitability between KEPCO and Gencos
  - To present the signal of the appropriate investment in power plant
- o Applied generators
  - Genco's generators of which over 50% of the equity is owned by retailer whose electricity charge is regulated by government
  - Applied by generating resources (nuclear, coal, domestic coal, non-based), but pumping generators and new & renewable energy generators are excluded
- o Calculation cycle: Yearly calculation is the principle, but in case of rapid fluctuation in fuel price, electricity charges adjustment, market rule change, outbreaking of the considerable difference between the estimation and the actual, can be recalculated quarterly
- o Clearing criterion:  $\text{Variable cost} + ((\text{SMP} - \text{Variable cost}) \times \text{Adjusted coefficient})$
- o The effect of introduction
  - To increase consumer benefits by preventing rapid rise in purchasing price and to motivate new investment in baseload power plant

### Examples of marginal price determination

Generator offer: 2,700MW, Demand: 2,000MW

	Generator (fuel type)	Bid Capacity (MW)	Variable Cost (won/kWh)	
① Bid Capacity (2,700MW)	Yeosu #1 (Oil)	200	125.53	Non Generation Plant <sup>1)</sup> (700MW)
	Incheon #1 (LNG)	200	120.61	
	Ulsan #1 (Oil)	300	113.65	
Non Baseload Plant (1,100MW)	Bundang #2 (C/C)	200	100.87	Generation Plant (2,000MW)
	Busan #4 (C/C)	200	84.24	
	Donghae #1 (Domestic Coal)	200	56.00	
② Demand (2,000MW)	Tae'an #5 (Coal)	400	25.80	SMF (110.57won)
	Ulsin #3 (Nuclear)	1,000	3.09	
Baseload Plant (1,600MW)				

SMP (100.87won)

- o SMP = 100.87Won/kWh (Bundang<sup>#2</sup>): the variable cost of the most expensive generation plant within the price setting schedule)

※ Adjusted coefficient of SMP

구 분	Nuclear	Coal	Domestic coal	Non-based
'08.5.1~7.31	0.2745	0.1595	0.9000	0.4000
'08.8.1 부터	0.2184	0.0894	0.7500	0.0894

### Settlement Result for Each Generator

Generator	Clearing price (adjusted coefficient of SMP applied)
Ulsin #3	1,000MW × { 3.09 + (100.87 - 3.09) × 0.2745 } = 24.4 million
Tae'an #5	400MW × { 25.80 + (100.87 - 25.80) × 0.1595 } = 13.0 million
Donghae #1	200MW × { 56.00 + (100.87 - 56.00) × 0.9000 } = 17.9 million
Busan #4	200MW × { 84.24 + (100.87 - 84.24) × 0.4000 } = 17.1 million
Bundang #2	200MW × [100.87 + (100.87 - 100.87) × 0.4000 ] = 20.2 million

- 1) Non-generation plants only receive capacity price for their bid availabilities (Ulsan<sup>#1</sup>, Incheon<sup>#1</sup> and Seoul<sup>#4</sup> )

### ② Capacity Price

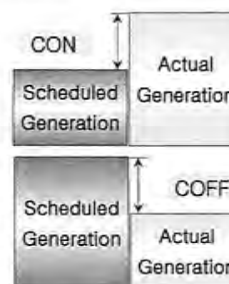
- o Capacity price is paid to every generator according to their availability

### Capacity Price for Year 2008

Classification	Reference generator	Capacity price
Power plant	C/C Gas turbine 450MW	7.70won/kWh

### ③ Others

- o Payment for constraints: Constrained-on & constrained-off power plants



- ⇒ CON (Constrained-On Energy Payment)
  - \* Constrained on plants that ran or increased output
  - \* Compensated by their variable cost
- ⇒ COFF (Constrained-Off Energy Payment)
  - \* Constrained-off plants that did not run or decreased output
  - \* Compensated for their unrealized opportunity profit

### ※ Transmission Congestion

- The electricity demand of the seoul metropolitan area is satisfied with power flows in from other areas
- If power flow exceeds 13,000MW, expensive generators in the metropolitan area must run

### ※ Fuel Constraint (LNG, Domestic coal)

- Generation required by government energy policy

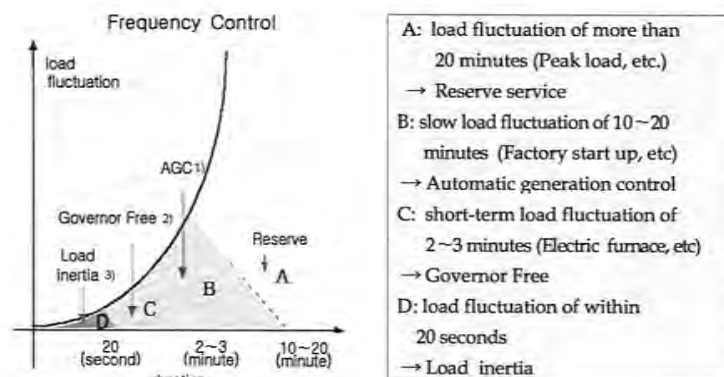
### ※ Heat Supply Constraint (Thermal & Heat)

- Operation of thermal & heat power plants for district heating



o Ancillary Services

To ensure the power system's stability & reliability



1) AGC: Automatic Generation Control

AGC is a feedback control system that regulates the power output of electric generators to maintain reference system frequency (60Hz)

2) GF: Governor Free

To maintain the system's frequency, the power output of the system-connected generators is automatically regulated

3) Load Inertia: No Payment

Motors self-adjusts their consumption in relation to frequency fluctuation

Ancillary Services

Classification	Description	Capacity
Reserve Service	Able to operate within 2 hours	3,000MW
Frequency Regulating Service	Automatic generation control & governor free	1,000MW
Black Start Service	In case of large scale blackout	7 Zone/ 13 Generators

IV. Settlement

o Metering

o Measurement of each generator's operation results

⇒ Each generator's connection point must have a metering system

⇒ KPX procures hourly generation data through a communication line

o Metering interval: 5 minutes (Trading period: 1 hour)

o Settlement

o Settlement schedule: A settlement period is one calendar day

⇒ Preliminary statements: Within 9 business day after the trading day

⇒ Final statements: Within 22 business day after the trading day

\* Both KEPCO & Gencos can raise invoice disputes

Settlement Schedule

Schedule	Procedure	Market participant
D-day	Trading Day	KEPCO, Generators KPX
D+9	Issue Preliminary Invoice	KPX → KEPCO & Generators
D+22day	Issue Final Invoice	KPX → KEPCO & Generators
D+23~28day	Billing	Generators → KPX → KEPCO
D+25~30day	Payment	KEPCO → KPX → Generators

- o Settlement cycle: 6 series of payments for each month considering the due dates for electric bill

Series	Trading periods	Payment day
1st	1st~3rd (3days)	28th day of trading month
2nd	4th~8th (5days)	5th day of the following month
3rd	9th~13th (5days)	10th day of the following month
4th	14th~16th (3days)	15th day of the following month
5th	17th~27th (11days)	23th day of the following month
6th	28th~31st (4days)	26th day of the following month

- o Payment: Fund transfer through market bank
  - ⇒ KEPCO transfer the final invoiced money to the market bank account
  - ⇒ KPX transfer from market bank account to each generator's account
  - \* Market bank: Financial institution appointed by KPX

#### Fund flow

Schedule	Procedure	Fund flow
D-day	Payment day	
D (Before 10:00)	Transfer to Market bank	KEPCO → Market bank (KEPCO's account)
D (After 10:00)	Market bank transfer	Market bank KEPCO's account → KPX's account
D (Before 15:00)	Payment	Market bank → KPX's account → Generator's account

## V. Statistics

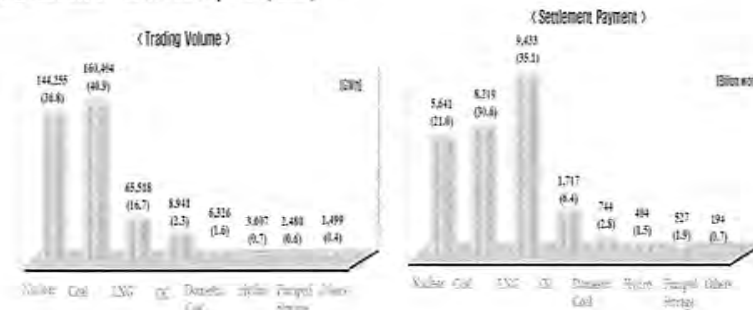
### ■ Trading results (2008)

Trading Volume (TWh)	Settlement Payment (Billion won)				Unit cost (won/kWh)			
	Energy Payment	Capacity Payment	Others	Total	Marginal Price	Capacity Price	Others	Total
3,924	18,876	3,879	4,126	26,880	48.10	9.88	10.51	68.50

#### < Settlement Output >



### ■ Generation Output (2008)



\* ( ) Percentile, %

\* Others: Wind Power, Landfill Gas, etc