

# Recent Development of Restructuring of the Korean Power Sector

*Dr. Kim, Young-Chang*<sup>1</sup> (Korea Power Exchange 135-791, 167, Samsung – Dong, Kangnam – Ku, 135 –791, tel. 008222 3456 6503, Email: waickim@kpx.or.kr)

*Dr. Konstantin Petrov*<sup>2</sup> (KEMA Consulting, Germany, Bonn 53115, Dechenstrasse 10, tel. +49 228 9696320, Email: kpetrov@kemaconsulting.com )

## **Introduction**

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 in many cases in transportation functions such as transmission and distribution as well as dispatch remaining as natural monopolies but other functions such as generation, wholesale and retail sales, metering, billing etc. being candidates for competitive opening. This new theoretical paradigm has stirred restructuring and deregulation of line-bound energy industries in a number of countries with the most prominent examples of the UK (Electricity Act of 1989) and Norway (Electricity Act of 1990) with other countries like the USA (Energy Policy Act of 1992) and Sweden (Competitive Electricity Market Bill of 1992) following behind.

The Government of Republic of Korea recently announced it plans to wrap up all corporate reforms by the end of this year whatever that costs. Financial institutions at home and abroad have issued a warning that South Korea may implode if it does not implement the restructuring program fully, in both the financial and corporate sector in accordance with the government commitments. At this junction the Korean Electric Power Corporation (KEPCO) offers a good example how to carry out a serious self-reform plan and has won praise as a role model for the shake up in the public sector. Concerning the objectives of the restructuring KEPCO gives three answers: introduction of competition in the power industry, raising efficiency, guarantee of long term electricity supply & demand and attraction of private investors.

The paper gives an overview of the restructuring process in the Korean power industry and is based on the involvement of KEMA Consulting in the development of the new power market design in Korea during the last 18 months. KEMA Consulting led a consulting team that was responsible for the development of detailed market rules (pool rules, settlement rules), system rules (dispatch, metering, frequency control, voltage control, contingency planning etc.), network rules (planning, connection etc.) and network pricing methodology.

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<sup>1</sup> Dr. Kim, Young-Chang is an Executive Director of Korea Power Exchange(KPX).

<sup>2</sup> Dr. Konstantin Petrov is a senior consultant in KEMA Consulting and was advising KEPCO in the implementation of the new market structure.

In the development of market design a number of different electricity structures and markets from around the world have been reviewed. The markets considered for the identification of the market design proposal for the last stage of restructuring (Two Way Bidding Pool) were:

- England & Wales
- Netherlands
- NEMMCO, Australia
- PJM, USA

These four markets were selected in consultation with KEPCO as all have been deregulated and restructured with a combination of common and unique features and as such provide representative evidence of a number of different mechanisms that may be employed in a deregulated electricity sector. This article describes some of the most significant aspects of the documentation developed by the consulting team in cooperation with the counterpart experts from the Korean Electric Power Corporation in the course of the project.

## *Status Quo*

Until now the electricity supply industry in Korea has been organised in a state owned vertically integrated company – the Korea Electric Power Corporation (KEPCO). KEPCO is engaged in the generation, transmission and distribution of electricity in Korea. At the end of December 1998, it owned 94,2 % of the total electricity generating capacity in Korea, excluding plants that are primarily generating electricity for private and emergency use. At that time the total installed capacity excluding non-utility capacity in common use<sup>3</sup> was 43,406 MW of which KEPCO owned 40,891 MW and the rest were either owned by Independent Power Projects (IPPs) or by the state owned water utility.

The power system of the Republic of Korea has an integrated transmission network owned and operated by KEPCO with equipment at several voltage levels - main transmission is at 345 kV, with a small, but growing amount at 765 kV. There are no interconnections with other countries. The 345 kV and 765 kV levels are under the direct control of the National Control Centre (NCC) in KEPCO headquarters, Seoul. The next level down is 154 kV, which is under the operational control of the nine Regional Control Centres (RCCs) who are also part of KEPCO. Some of the 154 kV equipment remains under the control of the NCC because of its strategic importance. The RCCs also control the lower voltage networks at 66 and 22.9 kV, even down to the distribution circuits to consumer loads connected to the 22.9 kV bus-bars. In terms of dynamics there is a limit to the power which can be safely transmitted from the south to the north of the country imposed by transient stability considerations.

The organisation of the power sector is based on the vertically integrated utility model with strongly centralised management and regulatory control exercised by the Ministry of Commerce, Industry and Energy (MOCIE). As an entity formed to serve the public policy goals of the Government, KEPCO seeks to maintain an overall level of profitability, allowing it to strengthen its equity base in order to support the growth of its business. KEPCO's electricity rates are established pursuant to procedures that take into account the needs to recover the costs of operations to make future capital investments and to provide a fair return to its security holders but which also reflect the social and economic needs of the Korean economy.

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<sup>3</sup> Non-utility generation in common use include stations owned by manufacturing companies, such as steel, but exclude IPPs and stations owned by the state-owned water company.

## ***Reasons for Restructuring***

### *Efficiency Improvement*

In the new industrial society the efficiency improvements in the industry organisation in terms of business process and ownership control have become important. The electricity supply industry in Korea faced the challenge to improve the existing system, in which it was judged that a single public corporation operating most of the electricity supply industry was not appropriate and the need to develop a market-based system driven by competitive behaviour was the solution.

### *Attraction of Foreign Capital*

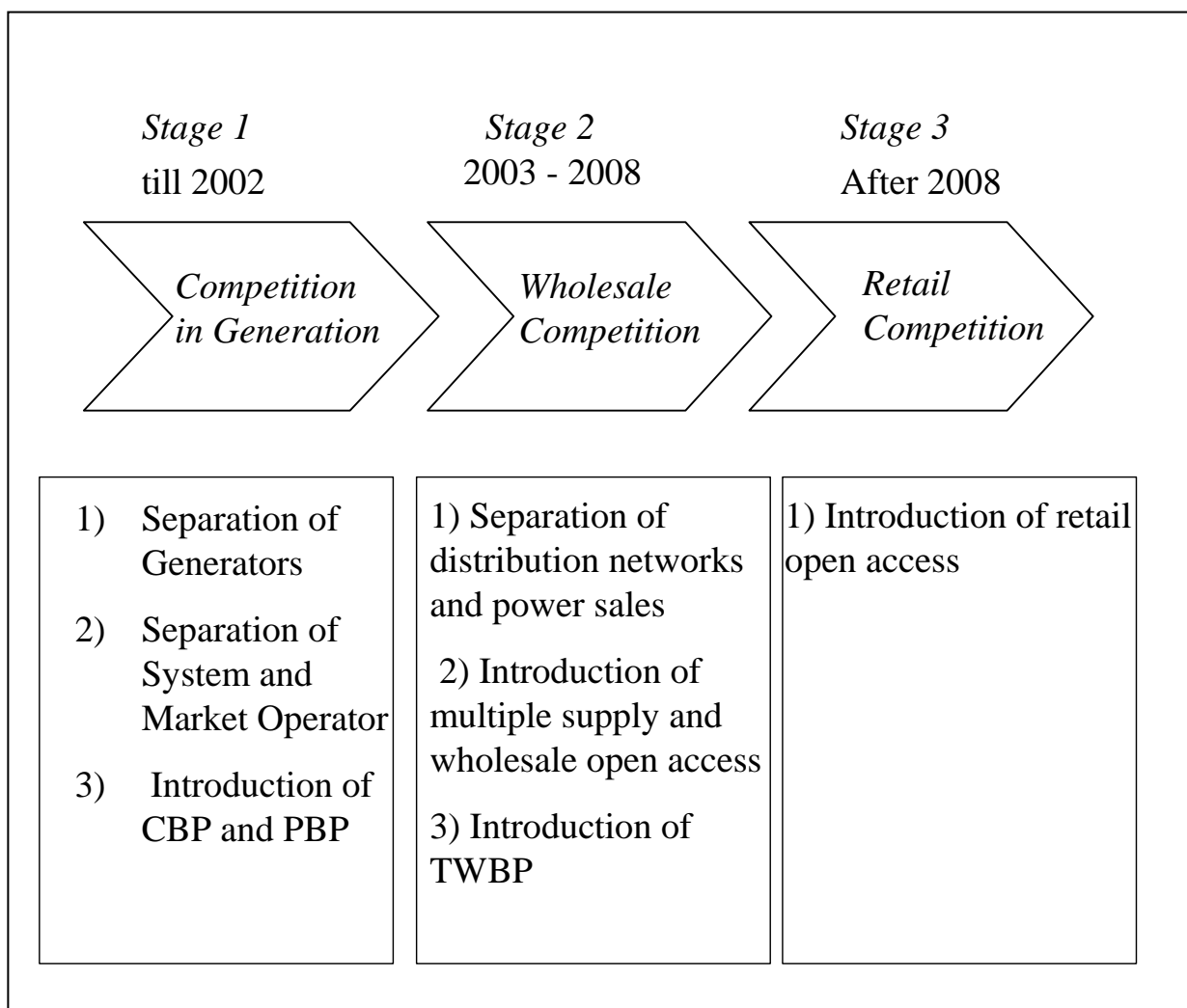
Restructuring and privatisation of the power sector was also seen as a tool for attracting foreign investors, an important factor for the Government as it would enable a substantial reduction in public debt, particularly in future years. Given the expected strong demand growth trends in Korea, the estimated investment needed in new generation capacity over the next decade is around 30 billion U.S. Dollars. Without the reforms and privatisation, much of this would by necessity have been funded by raising public debt.

### *Introduction of Competition*

Competition may exist on generation and power sale level, which shall evolve over time as experience with and confidence in the new market mechanism grows. However, in order to make this competition work in practice and to ensure that the market is not hindered in his development towards increased competition, these competitive functions should be split from the monopoly functions. Separation of generation and power sale businesses from KEPCO will be a prerequisite for introduction of competition in generation and supply.

## ***Restructuring Process and New Market Design***

On January 21 1999 MOCIE (Ministry of Commerce, Industry and Energy) announced publicly the “Basic Plan for Restructuring of the Electricity Supply Industry” (Blueprint of Restructuring). The Blueprint stipulates the major changes: separation of the various activities, introduction of a power market and development of a regulatory framework constituting an independent regulator. The Blueprint sets out a three-stage process for the development of a competitive market on wholesale and retail level (see Figure 1) based on a central pooling and multiple supply with first two stages scheduled for operation in 2000 to 2002 timeframe. The first stage includes separation of generation and introduction of a Cost Based Pool (CBP), where the level of the generators’ offers will be restricted to a certain cost reflective level. The introduction of CBP will provide a mechanism for the generators to start trading and will serve as an intermediary step towards a fully competitive Price Based Pool (PBP), scheduled to be operational from late 2001. The PBP will operate on similar logic with the key difference that the generators’ offers will not be restricted to regulated cost level but rather subject to commercial strategies of generation companies.



***Figure 1: Stages in the Power Sector Reform***

The second (2003 –2008) stage envisages the introduction of competitions in wholesale supply and a Two Way Bidding Pool (TWBP). During this phase large customers will be able to seek competitive supplies whilst smaller and domestic loads will be allocated into franchise areas for the newly created multiple power sale businesses. In order to enable this the distribution and power sale business elements will be split from KEPCO into subsidiary distribution companies and kept as separate entities within these companies (distribution network service providers and power sale businesses). The TWBP will aim to reflect the demand responsiveness to pool prices through the introduction of demand bids and to establish prices based on competitive bidding on both generation and demand side.

The third and final stage of the restructuring process (after 2008) will introduce a competition in retail supply. In this case also the small consumers would be allowed to choose their suppliers.

The legal platform for the implementation of the Government plans in the power sector was the new Electricity Business Act adopted by the Parliament in December 2000. The new Electricity Business Act requires the establishment of a Korean Electric Power Exchange (KPX), responsible for system and wholesale electricity market operation, and introduction of electricity market on wholesale and retail level of the electric industry.

## *Competition in Generation*

### *Establishment of Generation Companies*

According to the Blueprint during the first stage of restructuring, the generation sector will be separated from KEPCO in new subsidiary companies (see Figure 2). This is necessary to ensure that the competitive generation business is unbundled from the monopoly network functions. As the new subsidiary companies will compete among themselves, the allocation of power plants would need to be appropriately balanced in order to prevent any financial, commercial or structural advantages being given to any single subsidiary. Six generation companies will be established. Five of them will include a balanced generation mix (in terms of technology, fuel and commercial chances) and one will accommodate all nuclear power plants.

### *Establishment of Korean Power Exchange*

The system and market operation functions will be carried out by the Korean Power Exchange (KPX). The KPX will be a fully independent ‘non profit’ organization that is ‘Chinese walled’ in terms of data, which is market sensitive. KEPCO will retain the responsibility for transmission network, distribution network and power sale business.

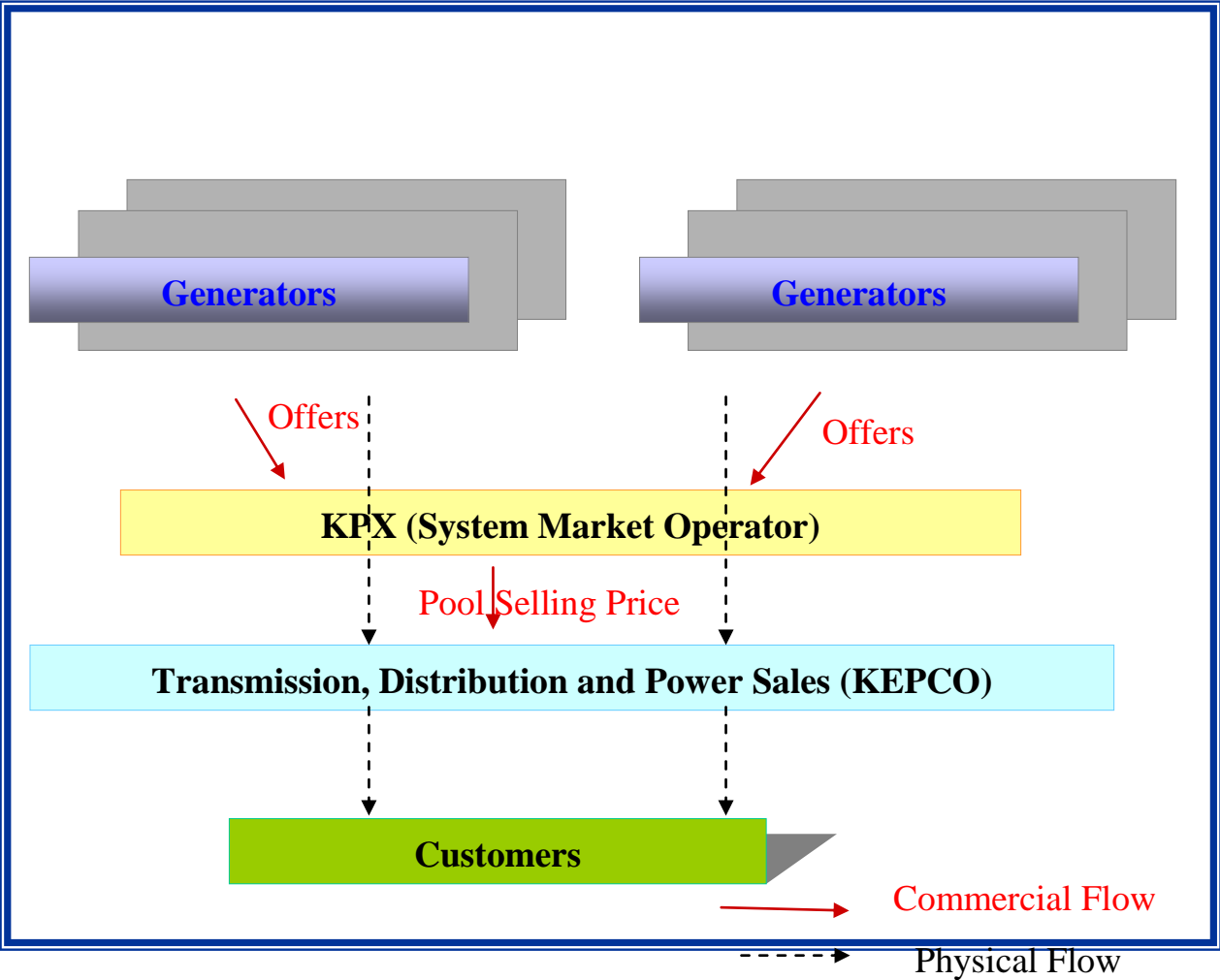
### *Establishment of Cost Based Pool*

The first step to introduction of competition in generation is the establishment of Cost Based Pool (CBP). All generation above 20 MW will be required to participate in the pool. The commercial boundary for the generation companies will be the point of access to the transmission assets owned by KEPCO, i.e. the high voltage side of the generating unit (step-up) transformer.

All generating units participating in the Pool offer availability and price in the pool for each trading period (one hour) of the next trading day. The level of prices included in the offers will be restricted to the level of generating units’ avoidable costs. A generating unit’s avoidable costs are those costs that are incurred only when the generating unit is in an active state. They also include costs incurred in the preparation of the unit to start. The avoidable costs will be based largely upon existing data (heat rates, fuel costs, contractual arrangements for fuel consumption etc.) and will be approved by the Regulator for all generating units prior to implementation of the CBP.

A forecast of demand will be made by the KPX for the purposes of scheduling. The KPX will produce an ex ante price setting schedule for all generating units participating in the pool on the basis of their offers for each trading period using demand forecast for the following day. The price setting schedule will be derived using the day ahead generator offers (bid prices,

availability, dynamic parameters) together with the forecast demand for generating plant and allowance for reserve requirements. Any operational constraints resulting from contractual or policy constraints (e.g. fuel contract obligations, mandatory power purchase etc.)<sup>4</sup> and system constraints<sup>5</sup> will not be considered in the preparation of the price setting schedule. The real time despatch (operational schedule) will take into consideration the various constraints.



**Figure 2: Competition in Generation**

<sup>4</sup> Contractual and policy constraints are constraints caused by existing obligations and energy policy requirements to generating units. It has been indicated that such constraints may exist in respect to take or pay fuel procurement contracts for domestic coal and LNG fired plants associated with the take or pay clauses of their fuel procurement contracts. Further, certain CHP may be constrained on because of the need to produce heat and cover their heat demand. In real-time operation a constrained on CHP plant will be substituted for some more economic plants that were scheduled in the price setting schedule.

<sup>5</sup> System constraints are constraints caused by the obligation of the KPX to ensure reliable and stable system functioning. Such constraints may occur with respect to power transport (transmission constraints) or provision of ancillary services. In case of transmission constraints some of the generating units will have to be re-dispatched and have to be operated in constraint on or constraint off mode. Plant may also need to be re-dispatched because of requirements for reserve or reactive power.



The KPX will be obliged to procure ancillary services in order to ensure the stable and secure system operation.<sup>6</sup>

The market clearing price is established each hour and represents the offers of the last most expensive generating unit for this hour.<sup>7</sup> Generation meter readings will be conducted for all generating units participating in the pool over the 24-hour schedule day. Settlement system will collect and aggregate data (energy scheduled and produced data relating to each hour) and calculate the payments to the generating units.

The generating units included in the price setting schedule will receive energy payments on the basis of the market clearing price. All generating units available will receive capacity payments irrespective of their real commitment in the pool<sup>8</sup>. The capacity fee will be calculated through using the investment cost of a reference peak generation plant (open cycle gas turbine) and annuity factor.<sup>9</sup> In order to ensure non-discriminatory and transparent rules for the calculation and payment of capacity fee, the Regulator will set and approve the procedures for determination and levels of the capacity fee prior to implementation of the CBP. Additionally the generating units will receive constraint on and constraint off payments. The constrained on generating units are units that will run with increased output although not being scheduled in the price setting schedule. If the generating units are not included in the price setting schedule but dispatched (because of constraints), every kWh produced usually will

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<sup>6</sup> Ancillary services are the services related to the reliable functioning of the power system, e.g. voltage reactive power control, frequency control and reserve capacity, black-start facilities etc. The need to treat ancillary services explicitly is caused by the unbundling of the power industry. In the traditional organization of the power industry, generation and network operation are functions performed by the same company. The company as a whole is responsible for a reliable supply to all customers. In the new market structure these services must be clearly defined in order to enable the safe and secure operation of the system, and to avoid the possibility that correct market functioning is distorted leading to inefficient behavior of different players. After unbundling, the KPX is responsible for a reliable operation of the networks. However, the KPX cannot fulfill this responsibility on its own. It needs the support from generating units and the generating units provide ancillary services to the KPX.

<sup>7</sup> It is important to recognise that a number of additional factors could apply to the calculation of system marginal price within pool arrangements. Certain plants could be excluded from system marginal price calculation, even though they may have the highest incremental generation cost of the plant which are running – this is associated with generation inflexibility and may arise where the highest cost plant is running in the period concerned only because of limitations in its ramp-up or ramp-down rates.

<sup>8</sup> In general there are two design concepts for capacity payment design: short run marginal cost (SRMC) and long run marginal cost concept (LRMC). In a given period, SRMC will be equal to the marginal energy cost plus shortage costs for unmet demand. Actually the second term (shortage costs for unmet demand) has a demand rationing function and will provide an additional compensation based on the system value of availability in the different time periods. This concept is used in the power pool of England and Wales. The LRMC is the cost of meeting an increase in demand, in a situation where capacity adjustments are possible. Since the LRMC include energy and capacity component the capacity payment is based on the annualized capacity cost of the marginal plant needed. This concept is used in the power sector of Chile.

<sup>9</sup> It is a matter for debate whether the capacity payments are necessary for the competitive electricity markets. They are often justified with the assurance of long term stability requirements of the market participants. Also the peak load pricing theory provides for capacity payments equivalent to the capacity cost of a peak load facility (e.g. gas turbine). Some economists argue against this position and allege that in the pure contestable markets there is no need for additional price elements and market price should reflect the actual equilibrium between the demand and supply. The proposed approach aims to ensure a smooth transition to the new competitive environment. It will not distort short term marginal cost signals provided by the system marginal price and will provide an incentive to make plants available and assure additional revenues to cover the generating units' fixed cost. The capacity payments will be abolished with the introduction of the Two Way Bidding Pool.

incur higher cost than the market clearing price. These plants will receive their offer price for the extent of out merit order running (energy dispatched in the operation schedule but not scheduled in the price setting schedule). The constrained off generating units are units that will not run, or run with decreased output although being scheduled in the price setting schedule. The generating units that are constrained-off in a certain settlement period, will be paid for their lost profits, defined as market clearing price minus offered price multiplied by the constrained-off energy (energy scheduled in the price setting schedule but not dispatched).<sup>10</sup>

### *Establishment of Price Based Pool*

In the CBP environment the generators are restricted to offer prices not higher than the avoidable costs of their generating units. In the PBP this restriction will be removed and generating units may be offered at a commercial price, as determined exclusively by their generation companies. All pool arrangements concerning the bidding, establishment of market clearing price, settlement rules etc. will remain the same.

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<sup>10</sup> The guaranteed compensation of constraint off payments is a debatable issue. In the UK pool these plants receive a payment based on their opportunity costs (revenue from system marginal price minus revenue from their bid price). The mechanism is by no means universally established. The logic of this model is based on firm access and notional rights to use the transmission network. It could be argued that this mechanism create some gaming potentials because the power stations knowing in advance that they will be constrained off, submit bids not reflecting their actual availability and below their short run marginal cost and receive unfair profits. In the CBP, generating units will bid their avoided cost (set and approved by the Regulator) and availability. Given this fact the gaming potential of any generator to increase its market share by manipulating its availability will be limited and the introduction of constrained-off payments will not lead to significant additional payments. Furthermore, this will create incentives for the generating units to be available and will reward them according to their position in the price setting schedule.

### Competition in Wholesale Supply

The second stage of the restructuring process focuses on the establishment of competition in wholesale supply. The introduction of competitive environment in wholesale supply will require the establishment of distribution companies and splitting the distribution network service from the power sale service within these distribution companies. During this phase large customers will be able to seek competitive supplies whilst smaller and domestic loads will be allocated into franchise areas for the newly created multiple supply businesses. Further the wholesale market design will be accomplished with the implementation of Two Way Bidding Pool (TWBP).

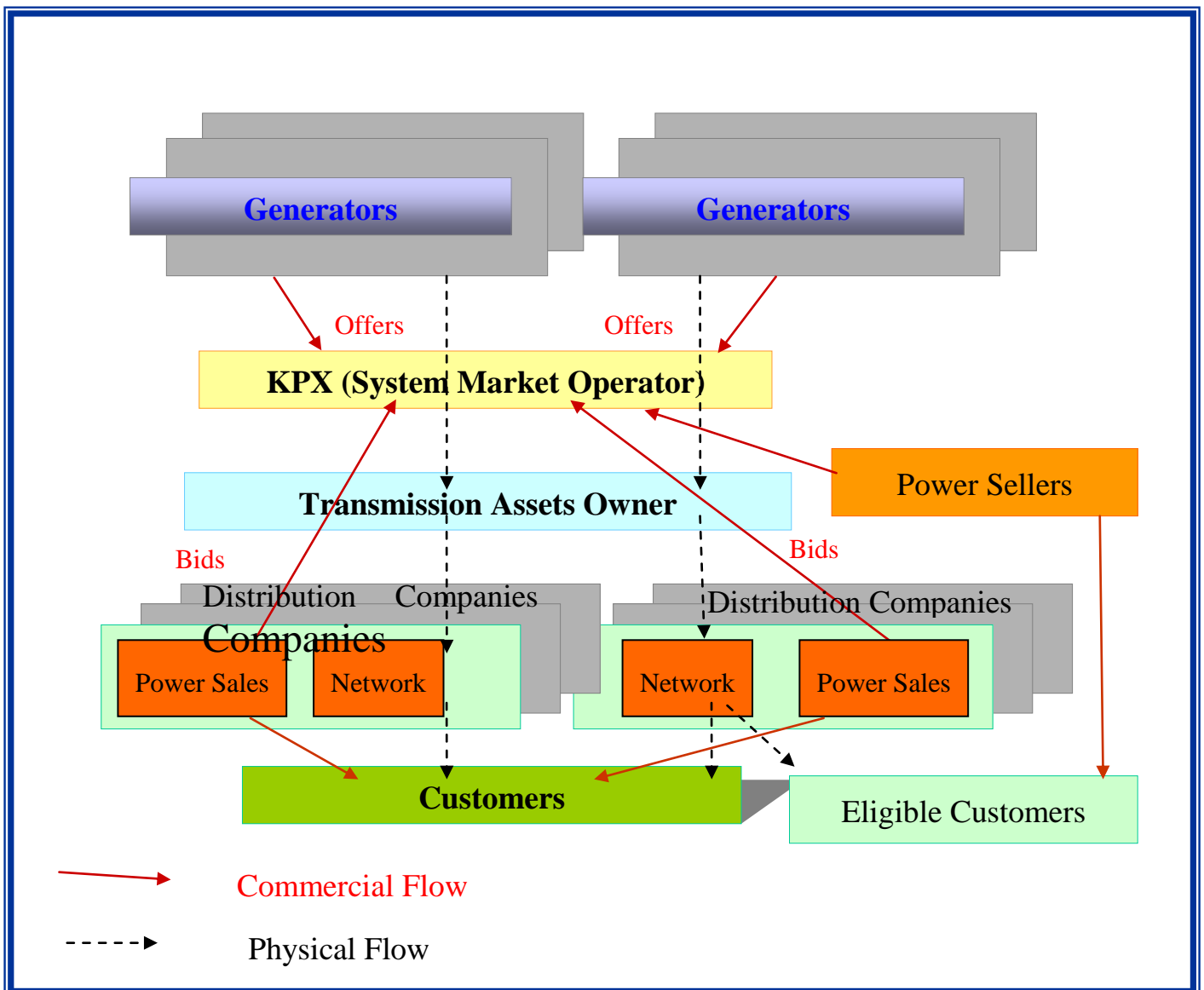


Figure 3: Competition in Wholesale Supply

### *Establishment of Distribution Companies*

The newly created distribution companies will be responsible for distribution network service (acting as a distribution network service provider) and power sale service (acting as a power seller). The distribution companies will own and operate the middle and low voltage (under 154 kV) networks within the distribution company's franchise area. The distribution network service providers will be a monopoly in a defined geographical area determined by the location of their assets. It will own and manage the distribution assets and will provide services in a non-discriminative way, giving appropriate returns to shareholders in line with the regulatory arrangements. The activities and accounts of the distribution network service provider will be ring-fenced and separated from any competitive function, power sales in particular, carried out by the distribution company that owns that distribution network. The power sale business will have the authority to contract with end customers for energy supply both within its own franchise area (coinciding with the franchise area of its parent distribution company) and, for those sectors of the market open to competition, in the geographical areas of other distribution companies.

### *Establishment of Transmission Company*

Following establishment of the distribution companies, KEPCO will become the transmission asset owner (the system and market operator functions having already been divested into a separate organisation - the Korean Power Exchange – during the transition from CBP to TWBP). KEPCO will continue as a regulated monopoly owning and managing the transmission assets (765 kV, 345 kV and 154 kV lines), providing a transmission network service in a non-discriminative way and giving appropriate returns to its shareholders in line with the regulatory arrangements.

### *Establishment of Two Way Bidding Pool (TWBP)*

The basic concept of the TWBP is to establish prices through competitive bidding of both generation and demand side.<sup>11</sup> Whilst an approach such as this proposes to treat electricity as a normal commodity, with buyers and sellers operating in an efficient and transparent market place, it must be recognised that there are a number of features unique to electricity supply and

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<sup>11</sup> Across the world the majority of electricity pools are essentially one-sided, where generators offer generation but with no corresponding bidding by demand. There is however the opportunity in most one-sided pools for some demand to bid as negative generation, whereby load reduction is triggered by pool prices and is centrally dispatched as such by the system operator. This limited form of negative generation bidding is effectively only a variation of a one sided pool. A one-sided pool does not allow the demand side to be fully active in determining market prices and to see the effect of their market actions.

that would require adaptation of classical market principles.

All generation greater than 20MW and power sales business parties will become members of the pool and trade energy solely within the pool. The TWBP is thus a compulsory trading market. All generators with units greater than 20 MW will be centrally despatched by the KPX in accordance with processes defined in the system rules.

Generators will submit to the KPX simple offers linked to individual generating units.<sup>12</sup> For each generating unit the generator will submit to the KPX an offer for each five minute time intervals of a trading day, in accordance with prescribed timescales and formats, on the basis of a single or multiple price and quantity combinations.<sup>13</sup> The offer will be deemed to represent the quantity of electricity that a generator is prepared to sell at that price for that five minute time interval. The component parts of the offer will include: specified quantity to be offered at the generator ownership boundary (where it is measured), specified price for that quantity and some availability parameter including lower operating limit, lower operating limit start time etc. Recognition of other dynamic parameters will be the responsibility of the generating company through the pricing and structure of the offers. Cost elements such as start-up or no-load costs will not be included explicitly within the offer. An offer may contain a number of price/quantity bands. Offers must be monotonically increasing in price. Offers for the following trading day will be made to the KPX by 10:00 of the day before (day-ahead offer). Prices contained in the day-ahead offer will be deemed to be firm.<sup>14</sup> Generators may change the quantity element of their offer but not the price at any time prior to the defined trading period.

Power sales businesses will submit to the KPX bids for each trading period of a trading day in accordance with prescribed timescales and formats, on the basis of a single or multiple price and quantity combinations. The bid will be deemed to represent the quantity of electricity that a power sales business is prepared to purchase at, or below, that price for that trading period. A power sales business's bid will represent the quantity to be consumed at the transmission/distribution border and will therefore include its estimate of distribution losses. A purchase bid may contain a number of price/quantity bands. Purchase bids must be monotonically decreasing in price. Purchase bids for the following trading day will be made to the KPX by 10:00 of the day before (day-ahead bid). Prices contained in the day-ahead bid will be deemed to be firm. Power sale businesses may change the quantity element of their bids but not the price at any time prior to the defined trading period.

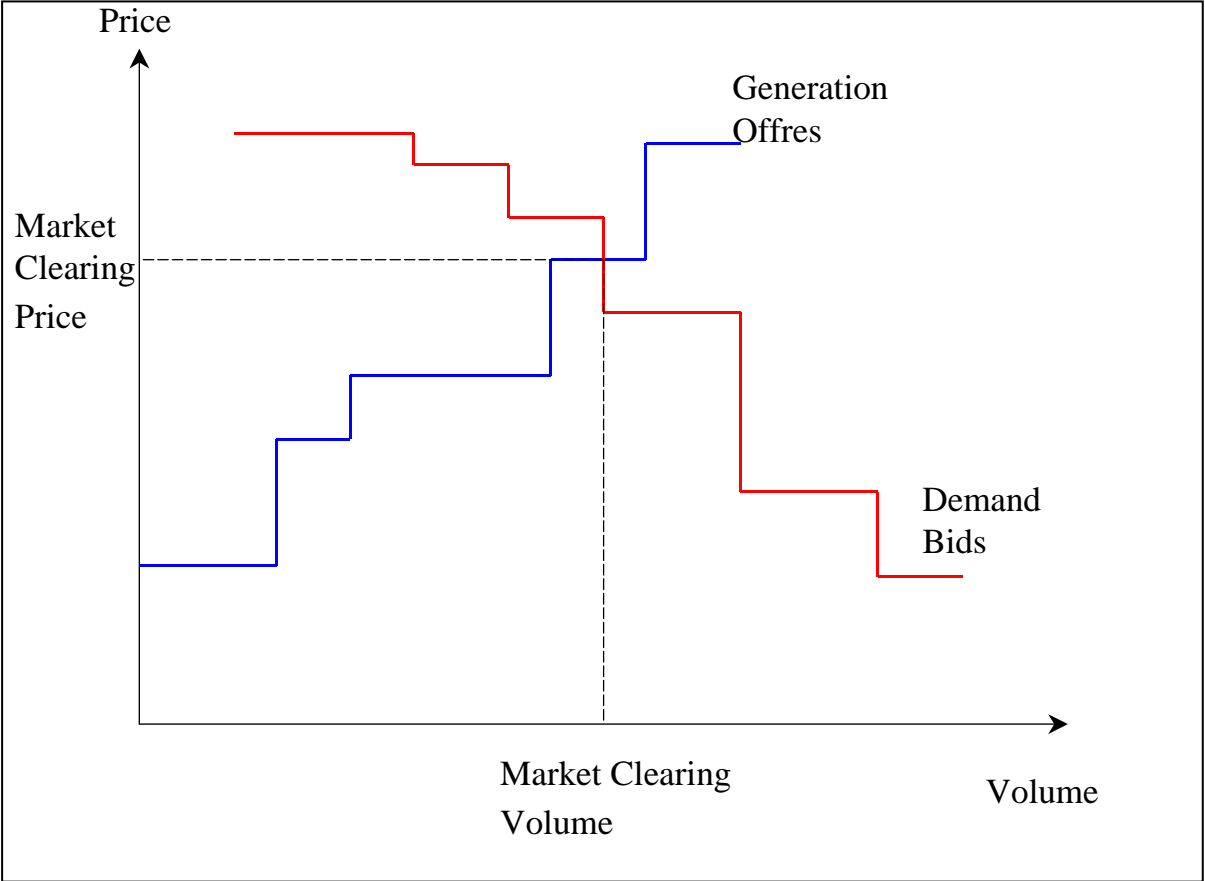
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<sup>12</sup> Generator offers can be described as complex or simple. A complex offer includes several parameters such as start-up costs, no-load costs etc. In addition complex offers may include dynamic parameters such as ramp rates and whether the plant is flexible, i.e. it can readily adapt to changes in load or inflexible, where it must maintain a steady, continuous output. By contrast a simple offer consists of monotonically increasing basic price/quantity combinations and simple dynamic parameters such as ramping rate and minimum on/off criteria. Complex offers are unwieldy, require complex software and limit the price transparency that enables participants to see how a cleared price has been determined. Where simple offers are used, such as in Australia, plant dynamics can be structured within a simple offer, this enables much faster solution and greater transparency.

<sup>13</sup> The five minute time interval is called unconstrained five minute dispatch scheduling period and is shorter than the trading period (30 minutes). As the market clearing price will be established for each trading period the five minute prices will be aggregated across the time of 30 minutes.

<sup>14</sup> Firm offers means offers with fixed conditions and non-firm offers means offers that could be changed. Firm offers, which fix prices but allow quantity to be changed, enable prices to be set in the market with participants still able to adjust their quantities without having to have continuous re-iterations and re-offers.

The TWBP model determines the market clearing price as the intersection of the demand and supply price volume curves in the classical manner. The resulting cleared price and volume, as shown below, classically suggests a point where demand and supply is satisfied, the equilibrium price and volume (see Figure 4).<sup>15</sup>



**Figure 4:** Market Equilibrium in a Two Way Bidding Pool

Following receipt of day-ahead bids and offers, the KPX shall calculate the forecast market clearing prices and the pre-dispatch schedule for each trading period of the following trading day. For each trading period of the trading day in question, the KPX will aggregate all demand bids to determine a forecast market demand. This will then be grossed up to take into account transmission system losses and will have the effect of shifting the power sales bids curve upwards, i.e. losses are added at all demand levels<sup>16</sup>. The KPX will create an offer price order

<sup>15</sup> A number of markets examined currently operate with complete demand bidding arrangements. Both the future market arrangements in England & Wale and the Netherlands when implemented will provide full demand side participation. Two Way Bidding Pools do, however, exist elsewhere, notably in New Zealand, NordPool and in the former VicPool in Australia.

<sup>16</sup> Static nodal (or zonal) marginal transmission loss factors will be used in the settlement process but not in the process of establishment of the market clearing price. The static transmission loss factors use historical values of transmission losses (from the relevant connection point to the reference network point) and could be classified as pre-determined or as ex-ante factors. Transmission loss rentals will appear as a result from the fact that the transmission losses are quadratic function of the power flow and

stack of generation, beginning with the lowest price generating units, to enable the gross demand to be met. The forecast market clearing price will be the single ex-ante system marginal price determined on the basis of pre-dispatch schedule and will be published in regular intervals at the day ahead stage.<sup>17</sup>

A feature of the TWBP market is that forecast market clearing prices and volumes will be posted frequently so that participants can see the effects of their actions and act accordingly.<sup>18</sup> For the demand side this effectively enables them to self-dispatch against these prices. With the model proposed the market has knowledge of forecast prices up to a few minutes before time so that it can respond to varying price signals. It can also indicate how it will alter its demand with price. However, it is the actual demand taken that sets actual prices. The method allows demand to participate fully in setting prices whilst recognising the reality that initially much demand may be relatively price insensitive and that it is not practical to dispatch it. The arrangements work equally well when and if there is a large amount of price sensitive demand.<sup>19</sup>

At the same time as publishing the forecast market clearing prices the KPX will publish a schedule to generators advising them of the plant which has been cleared in the forecast schedule and that which is forecast to be required. Final market clearing price will be determined from a series of unconstrained schedules utilizing only generators offers and an estimate how demand is likely to change over the period up to and during the interval for which the price is to be determined and demand bid data available.

The operational (or constrained) schedule will determine the actual generation required in real time dispatch process, taking into account any variation required in order to meet reserve requirements and transmission system constraints. The operational schedule will be run each five minutes using the demand forecast prepared by the KPX but taking into account the aggregate forecast demands from power sales businesses bids together with losses and reserve requirements. The KPX will schedule generating units in accordance with the price stack derived from the market clearing process and will take into account constraints, reserve requirements and system security obligations. Fundamental for the real time dispatch will be the use of Automatic Generation Control.

Any generating unit that is constrained off, either partially or fully, due to a transmission constraint or for other reasons, will receive compensation reflecting its opportunity costs

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the marginal transmission losses (the first derivation) exceeds the average transmission losses. These rentals will be redirected to the transmission assets owner and to use them for the reduction of the annual revenue requirements of the transmission network for the purposes of derivation of transmission use of network charge.

<sup>17</sup> Additional generation will be needed to meet reserve requirements. This potential level of additional reserve energy that might be utilised can be represented as a further shift to the right (upward) of the original demand curve.

<sup>18</sup> The publication of forecast prices is expected to trigger demand side response. Power sales businesses will see price signals ahead of time that will enable them to take appropriate action. Such action may include peak reduction, load shifting or off-peak filling. Where demand makes itself available for despatch as reduction capability it will be subject to an ancillary service agreement.

<sup>19</sup> There is the special case to consider of demand that is genuinely controllable. Pumped storage generation is an important example of this type of demand. It is therefore proposed that this demand, as for all demand, be required to indicate the price above which it will pump. If some participants volunteer to take demand only when so despatched by the KPX, this should be treated as an ancillary service. In such cases an additional payment should be made by the KPX for the additional “control” it has over that demand and the associated value to the system.

(profit foregone). If a generator is constrained off due to transmission congestion, compensation will be paid by the transmission assets owner. If for any other reason, compensation will be paid by the KPX. Generating plant that is constrained-on because of a transmission constraint will be paid its offer price but will not set the market clearing price.

### *Transmission Pricing*

Transmission charges will be made up of transmission use of network charge and transmission connection charge. The Korean situation is characterized through strong power demand growth, hence transmission price signals will play a significant role for the location of new generation and demand. The transmission use of network charge will be set irrespective of the distance it transported but taking into account the entry and exit points on the network.<sup>20</sup> The transmission use of network charge shall recover the costs (including depreciation, operation and maintenance costs and financial return on the core transmission network assets) necessary for secure transport of power and will be subject to regulatory approval. Part of the core transmission network cost<sup>21</sup> (e.g. 50 %) will be allocated to generation and load nodes taking into consideration the locational criteria and using Cost Reflective Network Pricing approach.<sup>22</sup> The rest of the core transmission network cost will be allocated pro rata. Generation and demand pricing zones will be established.

All transmission service users located in the same zone and operating in the same modus (take or delivery) will pay the same rates, i.e. all users defined as delivery transmission service users (generators) face the same charges (per unit) within the same zone and all those defined as take transmission service users (power sale businesses) face the same charge (per unit) within the same zone. The transmission use of network charges could be designed as a simple one-component charge (WON/kW, rated capacity for the generation loads and observed load for the load nodes) or as a multi-component tariff (demand charge, energy charge and fixed charge).

The transmission connection charge will cover only the cost of transmission connection assets<sup>23</sup> (including depreciation, operation and maintenance costs and financial return on the transmission connection assets) without taking into consideration any reinforcement requirement in the transmission network infrastructure. The transmission connection charge

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<sup>20</sup> The major characteristic of this approach is that the transmission service is provided for a specific connection point to the transmission network rather than to a specific transaction. That leads to transmission prices that are related to the type of transmission user and his connection points rather than to a specific transaction.

<sup>21</sup> Core transmission network assets means assets owned by KEPCO and necessary for the provision of reliable and secure transportation of energy to the transmission service users.

<sup>22</sup> The CRNP (Cost Reflective Network Pricing) cost allocation is a nodal based method and it requires all of the costs to be attributed to the links („lines“) between the nodes on the network. Some assets are wholly dedicated to providing network service to a participant or group at a single point. These assets can be allocated to the participant directly at the node. Other assets throughout the network are shared among the users and the relative use by each participant must be determined. The shared network costs are allocated amongst users based on the marginal change in the load flow (as a result of an increment of user load at each bus) of the network circuits. The Fault Level Contribution Matrix is used for pairing generation and load.

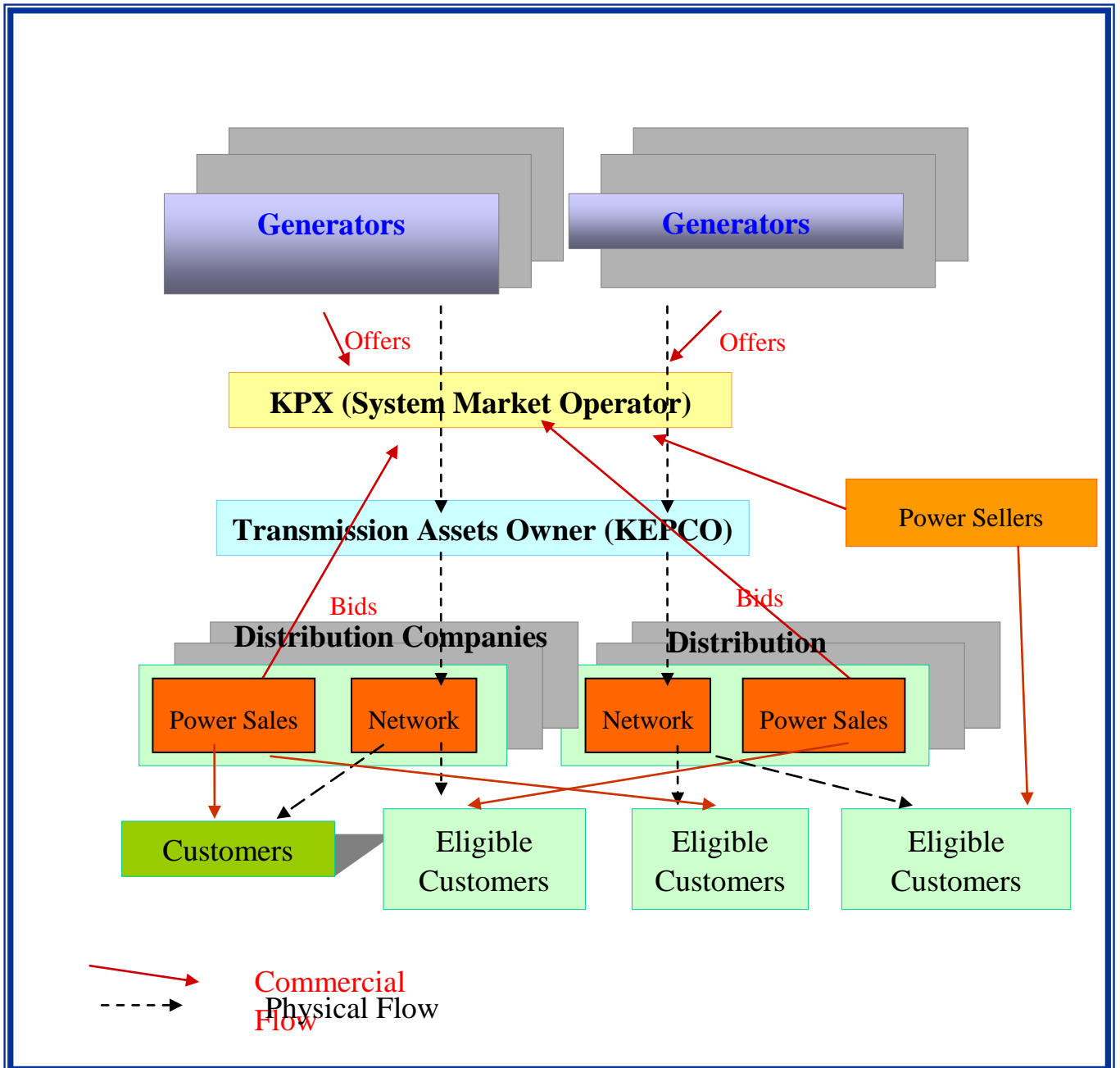
<sup>23</sup> Transmission connection assets means assets owned by KEPCO and necessary for the provision of reliable physical connection to the transmission service users.



will be denominated in WON/year and paid by each transmission service user connected to the transmission network.

**Retail Competition Phase (after 2009)**

Over the period 2003 to 2008, competitive supply will become increasingly available to smaller sectors of the market until in 2009, full retail competition will be introduced. In this phase every customer will have the opportunity to choose its suppliers. By this stage the power sale business of each distribution company will have to be separated from the distribution network service business to avoid protective interests.



**Figure 5: Competition in Retail Supply**

The formulation of a regulated tariff structure will prevent discriminatory behavior of the

distribution network service provider and facilitate the regulatory control over the network charges.

### ***Concluding Remarks***

The legal, technical and commercial framework required for the implementation of the Cost Based Pool was completed by the end of 1999. The new arrangements were not implemented in January 2000 as scheduled as the new Electricity Business Act did not pass the Parliament. At beginning of December 2000 new Electricity Business Act passed the Industry and Energy Sub-Committee of the Parliament. Currently the Cost Based Pool is in shadow operation, i.e. it is carried out in parallel with the traditional power system operation model. Some concerns regarding the cost coverage of the generators exist (the revenues raised from energy, capacity and constraint payments may be not sufficient to cover the costs of some generating units). The legal separation of the generators is expected in the first quarter of 2001. The major preparatory accounting and engineering activities regarding the establishment of generation companies have already been done. The number of distribution companies is still in discussion and studies are carried out in order to identify the appropriate number of the companies. The regulatory framework is under development and the establishment of the regulator is anticipated at the beginning of second quarter of 2001.

## References

- [1] The Fourth Long-Term Electricity Supply Plan, 1998 – 2015: August 1998
- [2] The Revised Long-Term Electricity Supply Plan
- [3] Korea Electric Power Corporation: Annual Financial Statistics, 1999
- [4] Korea Electric Power Corporation: Statistics of Electric Power in Korea, 1999
- [5] Final Report to KEPCO on the Restructuring of the Electricity Supply Industry in Korea: Volumes 1 and 2
- [6] Electricity Business Act of Republic of Korea, December 2000
- [7] Basic Plan for Restructuring of the Electricity Supply Industry, MOCIE January 1999