

# MODERN POWER SYSTEM MANAGEMENT

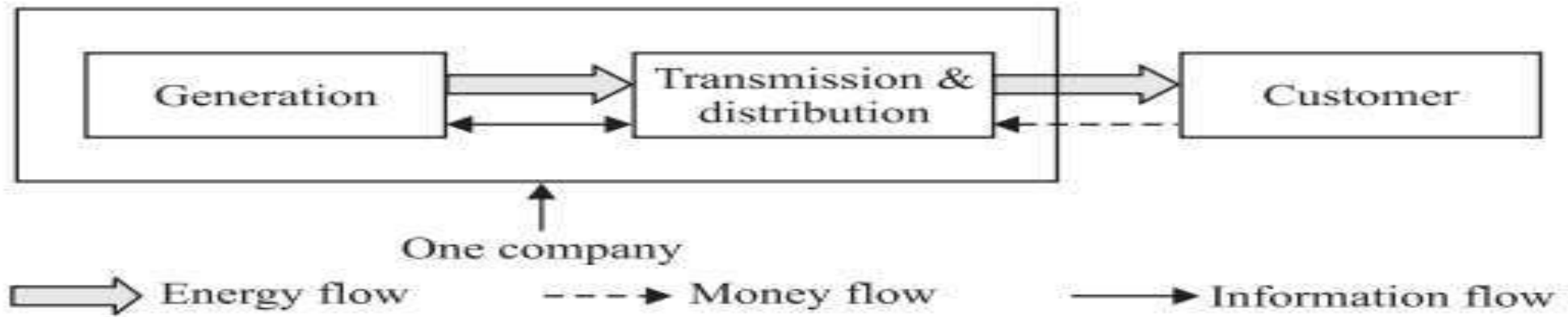
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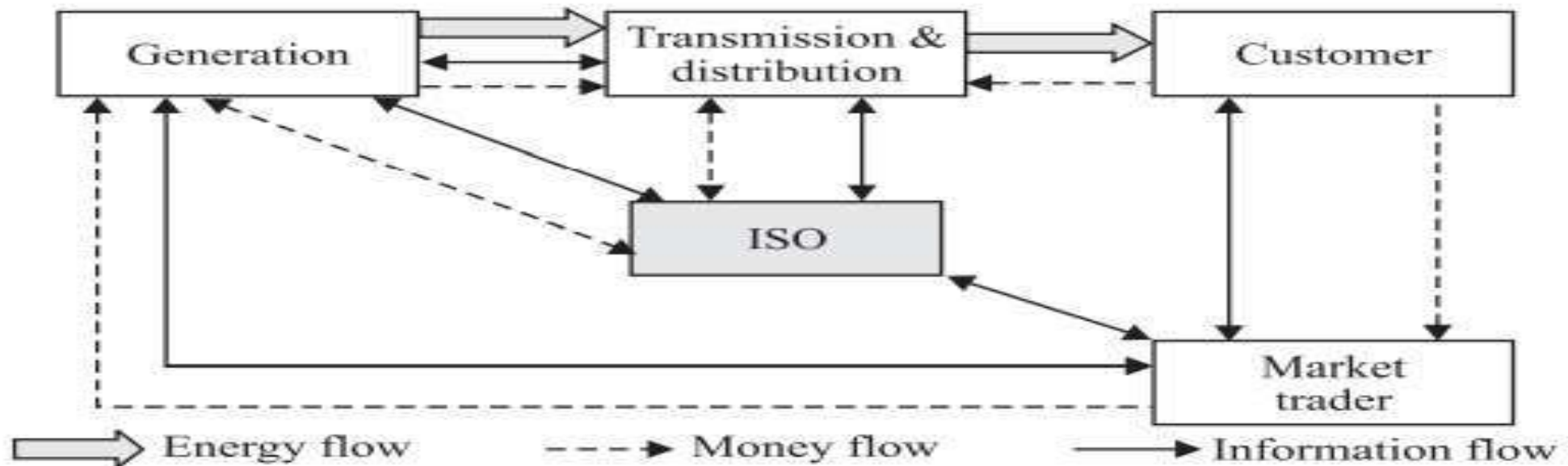
# POWER EXCHANGES

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- In a power exchange, the buyers can bid for their demands along with their willingness to pay. Power generation and trading will, thus, become free from the conventional regulations and become competitive.
- The restructuring of electricity has changed the role of traditional entities of the vertically integrated utility and created new entities that can function independently. The structural components representing various entities of the deregulated electricity market are Generation Companies (GENCOs), Distribution Companies (DISCOs), Scheduling Coordinators (SCs), Transmission Companies (TRANSCO), an Independent System Operator (ISO), Power Exchange (PX),



**Figure 9.3** Typical structure of vertically integrated electric utility.



**Figure 9.4** Typical structure of a deregulated electric system.

# GENERATING COMPANIES (GENCOS)

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- GENCOs generate electricity and have the opportunity to sell the electricity to entities with which they have negotiated sales contracts.
- GENCOs are more often a group of generating units within a single company ownership structure with the sole objective of producing power.
- In addition to real power, GENCOs may also sell reactive power and operating reserves.

# TRANSMISSION COMPANIES (TRANSCOS)

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- TRANSCOs transport electricity using a high voltage, bulk transmission system from GENCOs to distribution companies (DISCOs)/retailers for delivering power to consumers.
- A TRANSCO has role of building, owning, maintaining and operating the transmission system in a certain geographical region to provide services for maintaining the overall reliability of the electrical systems and provides open access of transmission wires to all market entities in the system.
- The investment and operating costs of transmission facilities are recovered using access charges, which are usually paid by every user within the area/region, and transmission usage charges based on line flows contributed by each user.

# DISTRIBUTION COMPANIES (DISCOS)

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- DISCOs distribute the electricity, through its facilities, to customers in certain geographical region.
- They buy wholesale electricity either through the spot markets or through direct contracts with GENCOs and supply electricity to the end-use customers.
- A DISCO is a regulated utility that constructs and maintains distribution wires connecting the transmission grid to the end use customers.
- A DISCO is responsible for building and operating its electric system to maintain a desired degree of reliability and availability.

# CUSTOMERS

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- A customer is the end user of electricity with certain facilities connected to the distribution system in the case of small customers, and connected to the transmission system in the case of bulk customers.
- In a restructured system, customers are no longer obligated to purchase electricity from their local utility company and have several options to buy electricity.
- They may choose to buy electricity from spot market by bidding for purchase or through direct contracts with GENCOs or even from the local distribution company with the best overall value.

# MARKET OPERATOR

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- A market operator is an entity responsible for operation of electricity market trading.
- It receives bids from the market participants and determines the market price based on certain criteria in accordance with the market structure.
- The markets may have different trading schemes such as hourly trading for the next day or trading in future weeks, months, or years ahead.



# SYSTEM OPERATOR (ISO)

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- A competitive market would necessitate an independent operation and control of the grid, which is guaranteed establishing a system operator (ISO).
- ISO or SO is an entity, which is entrusted with the responsibility of ensuring the reliability, security and efficient operation of an open access transmission system.
- It administers transmission tariff, maintains the system security, coordinate maintenance scheduling, and has a role in coordinating long-term planning.
- It is an independent supreme entity and does not participate in the electricity market trades.
- The SO has the authority to commit and redispatch the system resources and to curtail loads for maintaining the system security, i.e. to remove the transmission violations, balance supply and demand, and maintain the acceptable system frequency.
- This responsibility of SO forms the basis for the functionality of the Transmission Dispatch and Congestion Management System (TDCMS).

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- SO can procure various ancillary services such as supply of emergency reserves, or reactive power from other entities in the system to maintain reliability.
  - The basic requirement of an SO is disassociation from all market participants and absence from any financial interest in the generation and distribution business.
  - In general, there are two possible structure of SO and the choice of the structure depends on the SO's objective and authority.
  - These structures are:
    - • Min SO
    - • Max SO

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- Min SO is mainly concerned with maintaining transmission security in the operation of the power market to the extent that SO is able to schedule power transfers in a constrained transmission system.
  - This structure is based on coordinated multilateral traders and has no role in the market administration.
  - California independent system operator is an example of this structure.
  - Max SO includes a power exchange, which is an independent nongovernment and non-profit entity that ensures a competitive market place for electricity rules.
  - It performs the functions such as deciding and posting of market clearing price (MCP).
  - The Pennsylvania New Jersey Maryland (PJM) SO and National Grid Company (NGC) are the examples of this structure.

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# AGGREGATORS

- An aggregator is an entity or a firm that combines customers into a buying group.
- The group buys large blocks of power and other services at cheaper prices.
- The aggregator may act as an agent between customers and retailers

# BROKERS

- A broker of electric energy services is an entity or firm that acts like a middleman in a market place in which these services are priced, purchased and traded.
- A broker does not take a title on available transactions, generate, purchase, or sell electric energy,
- but facilitate transactions between buyer and seller.
- A broker may act as an agent between GENCOs and DISCOs.

# RETAIL COMPANIES (RETAILCOS)

- A RETAILCO obtains legal approval to sell retail electricity.
- A retailer buys electric energy and other necessary services to provide electricity to its customers and may combine electricity products and services in various packages for sale.
- A retailer may deal indirectly with end-use customers through aggregators.

# POWER EXCHANGE (PX)

- The PX handles the electric power pool, which provides a forum to match electric energy supply and demand based on bid prices.



# SCHEDULING COORDINATORS (SC)

- Scheduling Coordinators aggregate participants in the energy trade and are free to use protocols that may differ from pool rules.
- In other words, market participants may enter an SC's market under the SC's rules and this could give rise to different market strategies.
- In some markets such as England & Wales, SCs are not allowed to operate.
- In many new countries such as California, SCs are an integral component of the market.

# TRANSMISSION OPEN ACCESS AND PRICING

- Transmission pricing is necessary to recover costs of transmission network, and its operation, provide assured open access (i.e. equitable treatment and opportunity) for all users, and encourage investment in transmission and a simple and understandable price structure.
- The transmission sector, by providing open access to different players in the market, is the part of the industry essential for all these structural changes and thus has a significant disproportional to its relative share in the industry's either revenue or total capital investment.
- Transmission is the only part of the power industry that needs to be regulated to provide open access and a fair competitive environment for all participants in the power market.
- On the other hand, unbundling of the different sectors of the power system from transmission has posed questions and created many worries regarding the availability and adequacy of the revenue for the transmission industry, in order to operate, maintain, and expand.

- At the transmission level of the power system, the primary service is to move the power from the production point to the point of use.
- Therefore, the establishment of rules for operating the transmission network (technical issues) and for pricing transmission services (economic issues) is the real challenge.
- This task is highly complex since the technical and economic issues are intermingled with political and legal issues.

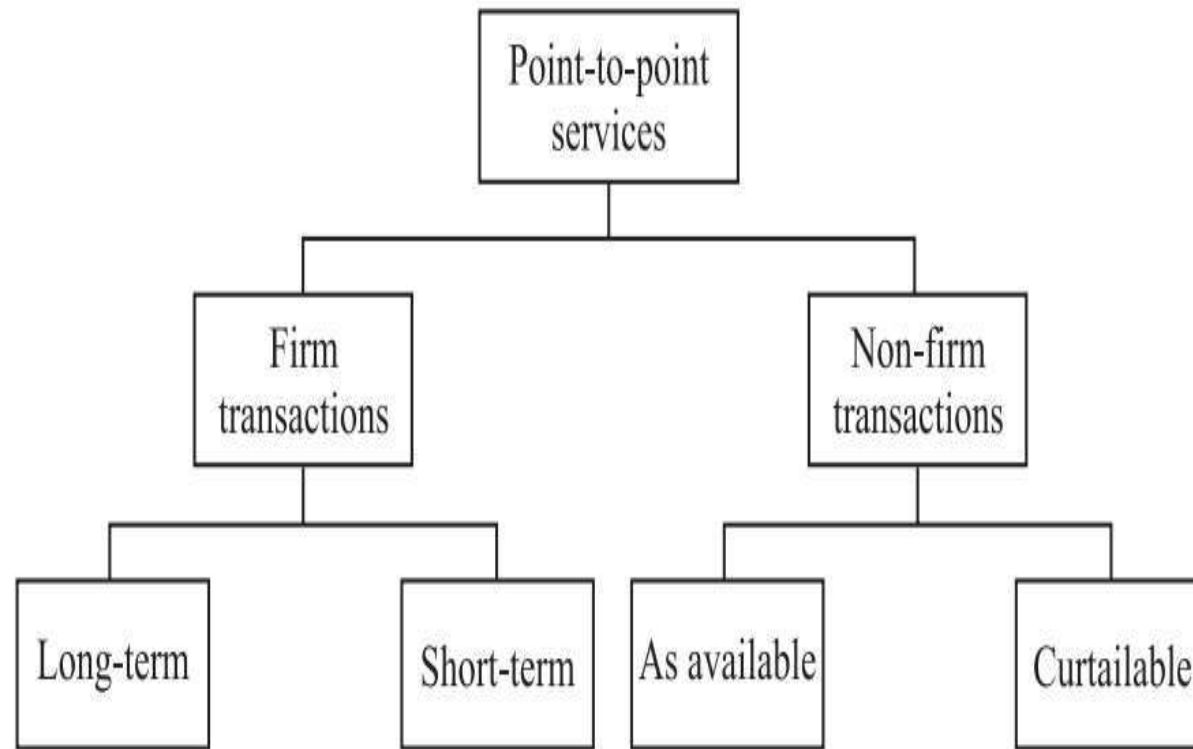
# TRANSMISSION OPEN ACCESS

- Transmission open access is the key to a free and fair electricity market.
- It is the transmission tariff, which shapes the level of competition in the electricity market.
- As per the IEEE task force on transmission access, the term 'transmission access' refers to the requirement that the transmission network owners make their systems available to the other players in the system

- “Open Access” means the non-discriminatory provision for the use of transmission lines or distribution system or associated facilities with such lines or system by any licensee or consumer or a person engaged in generation in accordance with the regulations specified by the Commission.
- The US Energy Policy Act of 1992 has laid the basic stone for the provision of open access.
- In India, the enactment of Electricity Act 2003 lays down the guidelines towards “transmission open access” for inter- and intra-state transmission.

# TYPES OF TRANSMISSION SERVICES IN OPEN ACCESS

- In a competitive market environment, a transmission transaction refers to the transmission components of the service provided by an electric utility, e.g. the transmission services associated with a power sale, and a power purchase, etc.
- There are various types of transmission transactions, and several categories to which the type of transmission transaction may belong.
- The transmission services can be classified into: (a) Point-to-point services (b) Network services.



**Figure 12.1** Classification of point-to-point services.

# POINT-TO-POINT TRANSACTION

- This service is for the receipt of capacity and energy at designated point(s) of receipt and the transmission of such capacity and energy to designated point(s) of delivery



# FIRM POINT-TO-POINT TRANSACTION SERVICE

- Customers that elect to purchase “firm” transmission service for a bilateral transaction commit to pay a transmission usage charge that may include congestion charges.
- Their schedules will not be cut except for system reliability reasons.
- These could either be on a long-term basis, in the order of years, in which case the charges for such transactions can be designed to incorporate capacity investment needs of the network, or on short-term contracts (up to one year).

# NON-FIRM POINT-TO-POINT TRANSACTION SERVICE

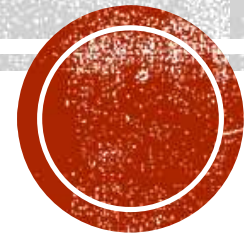
- Non-firm point-to-point transmission service shall be available when there is no congestion between the point(s) of receipt and the point(s) of delivery for the transaction.
- The 'as-available' transactions are basically isolated contracts on a short-term basis as per availability of transmission capacity, whereas 'curtailments' will be made on a non-discriminatory basis to the transaction(s) that effectively relieve the constraint.

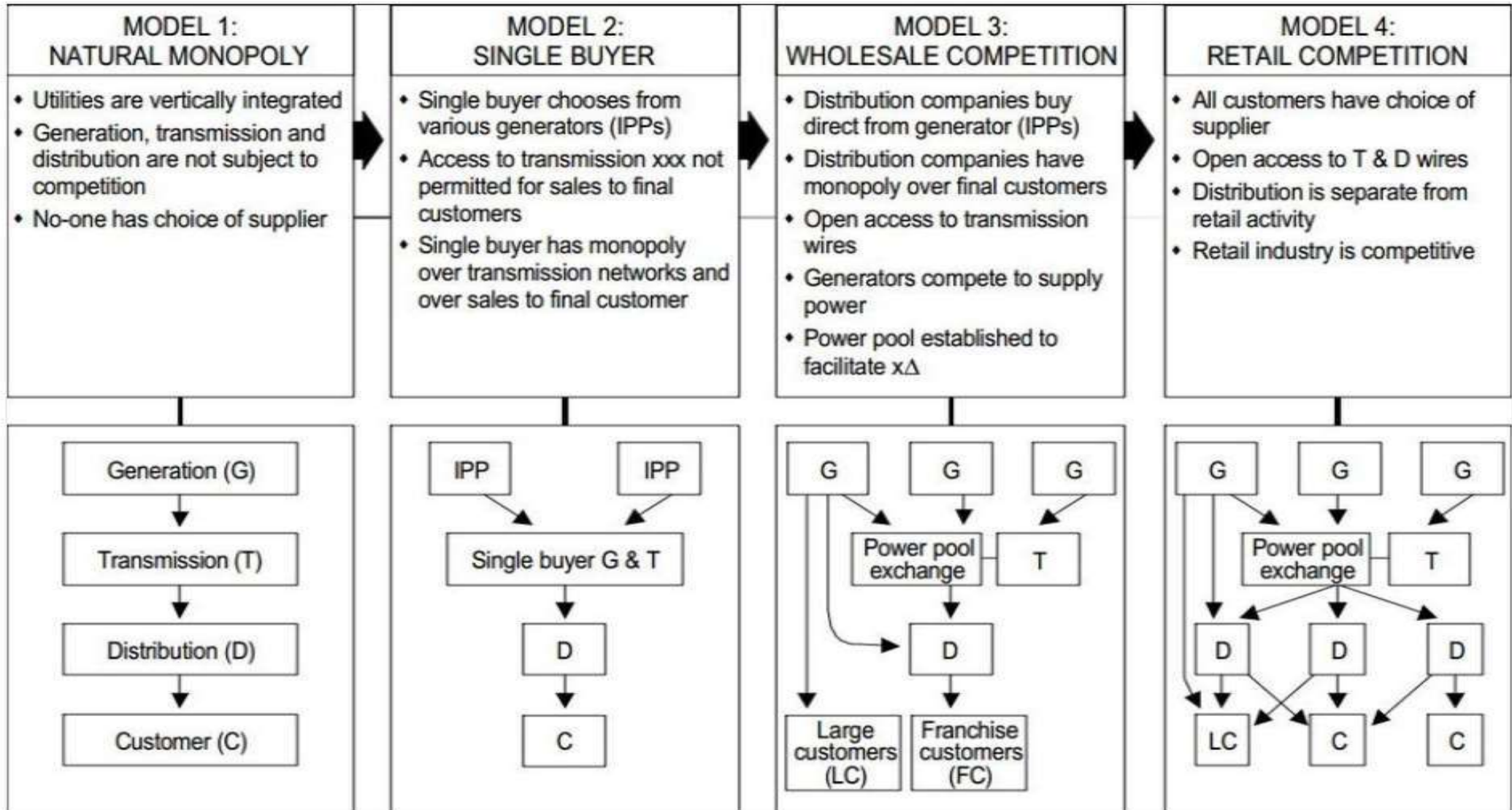
# NETWORK SERVICE

- The ISO will provide firm transmission service over the transmission system to the network customer for the delivery of energy from its designated network resources to serve its network loads on a basis that is comparable to a transmission owner's use of the transmission system to reliably serve its native load customers.
- Such energy shall be transmitted, on an as-available basis (i.e. when there is no congestion between the non-network resource and the network load), at no additional charge

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# **COST COMPONENTS OF TRANSMISSION SYSTEM**

- **Operating Cost**
  - This includes the variable cost mainly due to generator rescheduling, maintaining system voltages, reactive power support and line flow limits.
- **Loss of Opportunity Cost**
  - It is a cost which transmission company (Transco) has to forego to meet the transactions such as it could not use cheaper generation or could not realize revenue from firm contracts due to line flow reaching the limits.
- **Reinforcement Cost**
  - This cost is charged to only firm transactions and includes capital cost of the new facilities required to meet the transaction.
- **Existing Cost**
  - This includes capital cost of the existing facilities and need to be allocated to various transactions on some rational basis



# TRANSMISSION PRICING METHODS

- The objective of any transmission pricing method is to allocate all or part of the existing and the new cost of transmission system to the customers.
- However, tariffs for transmission services are more often set by government regulations, and are based on its policy directives. The pricing of transmission services should be carried out to achieve the following goals.

(a) It recovers the capital and operating costs

- The tariff charged for the use of transmission services must produce enough revenue to cover all the expenses made in investment, operation and maintenance of the transmission network, as well as to provide a small (regulated) level of profit for the owners.

(b) It encourages efficiency of use and investment

- The price structure should give incentives for using the transmission system efficiently. Efficient use could mean ensuring both, economic efficiency by maximizing social benefits and technical efficiency by minimizing losses. Also, the price structure and the way money is paid to the owners should provide an incentive for investment in new facilities, when and where they are needed.



(c) It provides equal opportunity to all users

- The pricing method must be fair and equitable to all users.

(d) It offers a simple and understandable price structure

- All users must be able to understand the pricing structure more clearly.

(e) It is easily implementable

- The pricing scheme should be easily implementable in the actual system.





# WHEELING CHARGES

- The transmission prices are imposed to recover the cost of wheeling the power through the transmission system.
- As per PURA (1978) USA,
  - 'Wheeling refers to transmission of Real & Reactive Power from a seller to buyer involving transmission network of a third party. Wheeling cost is due to transmission losses and re-dispatching of generators resulting in loss opportunity'.



- The wheeling can be broadly classified into four categories which are as follows:
  - 1. Bulk power wheeling that involves transaction of two fully regulated utilities using network of a third utility.
  - 2. Customer wheeling in which an independent customer purchases power from a utility using network of another party.
  - 3. Supplier wheeling in which an independent GENCO sells power to a utility using network of another party.
  - 4. Supplier-to-customer wheeling in which an independent GENCO sells power to an independent customer using network of a third party.



- In general, the following three pricing schemes are employed for transmission services:

- Embedded cost based pricing:

This method is based on recovering, on pro rata basis, the embedded capital cost, average annuals operating cost, replacement cost considering service life and depreciation.

- Incremental cost based pricing

This method employs economic load dispatch formulation to compute short-run marginal cost (SRMC) and long-run marginal cost (LRMC). In case of SRMC, the revenue reconciliation is required to recover the capital cost

- Combination of the above two

