Seminar on
African Electrical Interconnection

Module 7 - Market Operational Structures
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Contents

1) Power Market Principles
2) Major Operational Issues
3) Transmission System Operator
4) Open Market Model
5) Ancillary Services
6) Transmission Pricing
7) Inter-area Coordination
8) The Concept of RTO
Module 7 - Market Operational Structures

Highlights

- Rationale for a restructured power sector creating an open competitive market environment for generation
- Necessity of ensuring market efficiency
- Strategic importance of the transmission system operator
- Imperative need to perform complex functions required by strict reliability requirements
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Power Market Principles

Well managed reform of the power sector

Deregulation to foster a competitive open market

Enhance power supply reliability

Improve market efficiency

Add value to all participants

Production of electricity can be deregulated

Not a monopolistic type of service

Provides incentives for investments and expansion

Facilitates the involvement of international investors

Supports the implementation of RECI

Enhance power supply reliability

Improve market efficiency

Add value to all participants

Production of electricity can be deregulated

Not a monopolistic type of service
A Worldwide Trend towards Deregulation

Vertically Integrated Utility (VIU)

Non-competitive electricity market model

To guarantee a meaningful competition for the costlier component of electricity supply (generation)

Competitive generation market model

Deregulated price

Choice of suppliers
To Guarantee a Meaningful Competition

Assurance of non-discriminatory access to transmission for all market participants

Carefully regulated

Carefully directed

Providing reliable transmission services

TRANSMISSION SYSTEM

Independent of all power suppliers and customers

Conditions of service
Rates

Natural monopoly segments
TRANSMISSION
DISTRIBUTION

Structural or functional separation

Competitive segment
GENERATION
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Conditions for an Efficient Market

Key elements for a successful RECI

Availability and optimal **dispatch of the most efficient production sources** throughout the region

- Capable of coordinating the suitable use of the transmission system
- Safe and reliable operation

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Major issues

- Mechanisms for real-time selection of production sources
- Access to the transmission system
- Transmission fees
Market - Oriented Issues

- Organization and allocation of governance and regulation between government (through the Regulator) and industry

- The existence and characteristics of a bilateral and/or a centrally administered market for capacity

- Conditions governing the energy market and the mechanisms to implement the offers/bids principle

- Coordination of regional trade and harmonization of rules among neighboring power systems
Transmission - Oriented Issues

- Transmission access and pricing methodology for transmission service and payment for networks reinforcements and expansion
- Management of congestion and handling of payment and hedging to mitigate risk
- Coordination and harmonization of technical operating rules among neighboring systems
- Management of ancillary services
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Types of Transmission System Operator (TSO)

ISO (Independent System Operator)
- Entity that operates and controls the transmission assets on behalf of all transmission owners
- Easier to form and to accommodate new participants
- Requires a less rigorous regulatory process
  - No possibility of conflicts of interest due to ownership of transmission assets

Transco (Transmission company)
- Entity that owns or leases the transmission assets
- Likely to be more efficient and easier to operate
  - Financial interest may be an incentive for efficiency
- Simplifies rate-making
TSO Major Functions

The sole provider of transmission services
Administers its own tariffs

Pricing regime that promotes the efficient use and expansion of the system
May include a direct or indirect control of specific generation resources

Provider of last resort
Preferably managed according to market mechanisms
To send price signals to transmission customers
Reflecting the value of the impacted transactions

Responsibly to implement proper measures to address this phenomenon
TSO Major Functions

Coordinates its activities with adjoining TSOs

Administers the information system on its transmission facilities

To ensure market efficiency

In view of different local practices within the region (possible handicap)

To prevent and relieve congestion

Important feature of an open-access environment

Calculates the available and total transmission capacities

To identify and propose remedial actions

Responsible to plan and propose needed transmission additions

market-motivated actions

SYSTEM

COORDINATION

INFORMATION

MARKET MONITORING

EXPANSION
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Market Participants - Responsibilities and Obligations

Transmission System Operator (TSO)
- Maintains and directs the operation of a reliable and cost-effective transmission system

Licensed participants
Generators, Distributors, Transmission assets owners, Wholesale buyers and sellers, Retailers
- Comply with the TSO directions and enter into connection agreements
- Operate and maintain their equipment according to the TSO reliability standards
- Participate in the capacity, energy and ancillary services markets
The Regulator – A Key Player

Monopolistic Transmission and Distribution System Operators

Regulates the activities

- Licenses participants including the TSO
- Set rates for transmission and distribution utilities
- Monitors the market with the assistance of the TSO
- Functions as an appeal body
- Reviews transactions related to the sale of utilities

The Regulator
Open Market Main Features

- **Non-discriminatory access** to transmission and distribution systems
- **Existence of a TSO** responsible for transmission over a significantly large area
- **Efficient** generation dispatch mechanisms
- **Visible and transparent** market clearing prices paid to all participants
- **Independent** Regulator for approval of transmission service rates
Types of Transactions

Between licensed participants

1) **Bilateral contracts between buyers and sellers**
2) **Transactions through the markets**
   - Real-time spot electricity market
   - Ancillary services procurement market

1) **Physical bilateral contracts**

Involve direct commercial arrangements between market participants

- No obligation to inform the other participants of their settlement price
- Directly paid by the buyers at a predetermined price
2) Transactions through the markets

Involve a market mechanism that results in a clearing price for the additional supply to meet demand beyond the bilateral contracts

Established by the market, at the intersection point of the generator offers supply curve and the demand curve

- Offers: quantity of power vs. price (fixed for one hour)
- Demand: adjusted every five minutes

➤ All generators are paid the market price whatever their offer
➤ Does not apply to physical bilateral contracts
Spot Market Equilibrium Price

Unit Price

Spot Market Price

TOTAL GENERATORS OFFERS MERIT ORDER

TOTAL DEMAND CURVE

TOTAL SYSTEM DEMAND

MWh

SPOT MARKET PRICE
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Managing Ancillary Services

Interconnected Operations Services

- For the proper integrated functioning of generation and transmission
  - Essential to maintain frequency, voltage and reliability within prescribed levels while meeting customer demands
- Must be coordinated on a system-wide basis
  - Must be managed by the Transmission System Operator
  - More easily acquired through a central market mechanism
- Eleven ancillary services have been identified
  - An indication of the complexity of operating a power system
Six Basic Ancillary Services

Operating Reserve Spinning
To respond to contingencies
From generators already synchronized but not fully loaded

Operating Reserve Supplemental
To be made available within 10 minutes

Energy Imbalance
To compensate for the mismatch between a generator’s scheduled output and the amount actually provided

Scheduling, System Control and Dispatch
To implement interchange schedules between control areas

Reactive Supply and Voltage Control from Generation Sources
In addition to connection agreements (required power factors for loads and generation)

Regulation
To balance generation and maintain frequency (minute-to-minute variations)

Best provided through the real-time bidding markets
Can involve automatic control signals sent to generation and loads by the TSO
Five Additional Ancillary Services

**System Black Start Capability**
To restart or restore power after a system-wide blackout
From units that can start up without the assistance of electrical supply from the power system

**Dynamic Schedule**
To operate a generator in a host control area as if it were part of another area
Requires the availability of real-time monitoring and telemetering facilities

**Real Power Transmission Losses**
To replace energy losses associated with a scheduled bilateral transaction

**Network Stability Services from Generation Sources**
To increase power transfer capability or improve transmission system reliability
Separate from the equipment required in the connection agreements
Typically: generation rejection and runback schemes

**Load Following**
To provide a load or generation response capability that can be dispatched within a scheduling period
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Transmission Pricing

A complex issue due to:

- **The loop flow phenomenon**
  - The flow of power associated to a supply contract along different, non-predetermined, parallel paths and depending on:
    - The network status;
    - The influence of other transmission service users.

- **The different pricing components**
  - To properly reflect the costs to be recovered
    - Sunk, or past, transmission costs
    - Variable transmission costs (losses and congestion)
    - New investment recovery costs
Transmission Pricing Approaches

1) Historical cost charging
   Reflecting past transmission costs

- **Postage stamp pricing, the simplest**
  - Same unit cost for all, based on total transmission assets
  - Congestion and loss costs charged on a load-ratio basis

- **Contract path pricing**
  - Considering only those assets between producer and consumer

- **MW-km pricing**
  - Assumed to provide a reasonable approximation for transmission cost including losses and congestion
Transmission Pricing Approaches

2) Marginal cost charging

Reflecting more accurately the real incremental cost of specific transmission services

- Nodal pricing (Locational Marginal Pricing)
  - Captures a congestion and loss cost which is the price difference between two nodes of the transmission system

- Incremental cost pricing
  - Compares total system cost before and after a transaction
Transmission Pricing Approaches

The common approach

- A marginal cost formula complemented by a “postage stamp” charge to recover the total revenue requirements

- The cost of new transmission system investments included in the basic use service charge
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Inter-area Coordination

An important function, aiming at the proper conditions to achieve optimal market operation

- Refers to the coordination between control areas
  - Regardless of their operational structures (ISO, Transco, vertically integrated utilities)

Control area
- The basic system operating unit
  - Responsible for the supply-demand balance over a geographical area
Inter-area Coordination Features

**UNIFORM PROCEDURES**

Confirming transactions and schedules

**RULES and PRACTICES**

- Promoting seamless markets at the interties
- Increasing intertie capacities

**FEASIBILITY ASSESSMENTS**

**PROPER COORDINATION**

- Identifying regional redispatch opportunities
- Coordinating planning and real-time operation

**PROTOCOLS**

Supporting the marketplace in each control area

**ADEQUATE INFORMATION**
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An independent transmission organization that maintains the operation of a reliable transmission system on a regional basis

- Normally covering a region capable of supporting trade patterns in a competitive market
  - Greater efficiency and reliability
  - Enhanced market performance
  - Less opportunities for discrimination
RTO Operational Authority

- Covers transmission over a larger area (compared to a traditional TSO)
  - The geographical area covered by an RTO is much dependent on the regional context (as well as the underlying entities)

- Includes all transmission facilities under its control
  - Could imply being the security coordinator for a number of distinct control areas within the region
RTO Major Responsibility

Must have the **exclusive authority** for maintaining short-term power system reliability over the whole region

- Receiving, confirming and implementing all interchanges scheduled between control areas
- Ordering generation redispatch if needed for reliable operation
- Approving scheduled transmission outages
RTO and Control Areas

Region targeted for RECI
RTO Market Operation

- **Scheduling and dispatching generation**

  To meet demand based on the economic merit order of the generators’ offers

  - Generators’ offers include **physical bilateral contracts** and spot market bids
  - Generators’ offers include energy and/or reserves (part of the ancillary services)
Settlements and Billing

- Collection of transmission service charges
- Disbursements of these revenues to the transmission asset owners
- Billing and collection associated to the spot market energy transactions
  - Payment to a selling market participant
    - The energy spot market price for the net difference between
      - Actual metered injections and
      - Total bilateral contract quantities sold
  - Vice-versa for a buying participant
- For bilateral contracts, the supplier bills and collects directly from the customer
RTO Market Operation

- **Relieving congestion** by adjusting the merit order dispatch based on offer prices (a market-oriented approach)
  - Lower cost units are backed off and higher cost units are constrained on to meet demand

- **Suspending market operation**
  - Should not be initiated based solely on the evolution of the market price or the curtailment of demand (emergency situations only)
Relieving Congestion

Unit Price

SPOT MARKET PRICE

REMOVAL OF THE LOWEST PRICED GENERATORS OFFER

TOTAL GENERATORS OFFERS MERIT ORDER

TOTAL DEMAND CURVE

TOTAL SYSTEM DEMAND

MWh

SPOT MARKET PRICE