INDIANA UTILITY REGULATORY COMMISSION

Ancillary Services Markets

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Outline

- Introduction
- Ancillary Services
- Ancillary Services Markets
- Progression of Ancillary Services Markets
- Key Design Elements

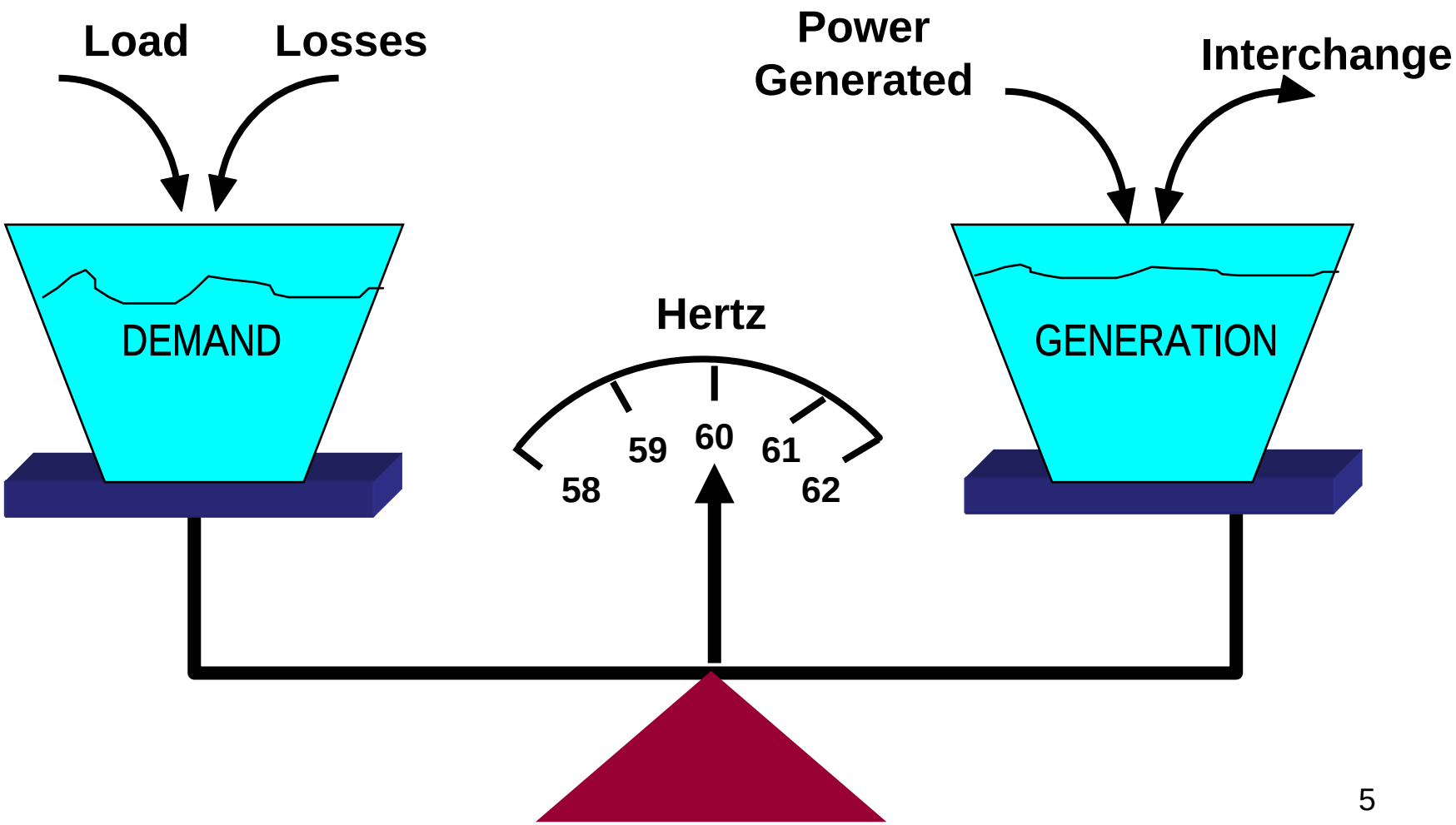
Ancillary Services

- What are Ancillary Services?
  - Ancillary services are defined as services necessary to support Capacity and the transmission of Energy from Resources to Loads while maintaining reliable operation of the Transmission System in accordance with Good Utility Practice.
  - Ancillary services are commonly known in the industry as a collection of secondary services offered to help insure the reliability and availability of energy to consumers. These services include regulation, spinning reserve, supplemental reserve, voltage regulation, black-start and others.

Ancillary Services

- What do Ancillary Services provide?
  - Flexible capacity to be available when needed to maintain secure operation of power system due to:
    - Loss or increase of load (demand)
    - Loss or increase of resources (generation/transmission)
  - Basically, these services help to keep the system in balance

The Energy Balance



Ancillary Services

- Procurement of Ancillary Services can be Cost-based or Market-based
  - Cost-based – services offered at pre-determined regulated costs
  - Market-based – services provided at market rates, granted by State or Federal authorities

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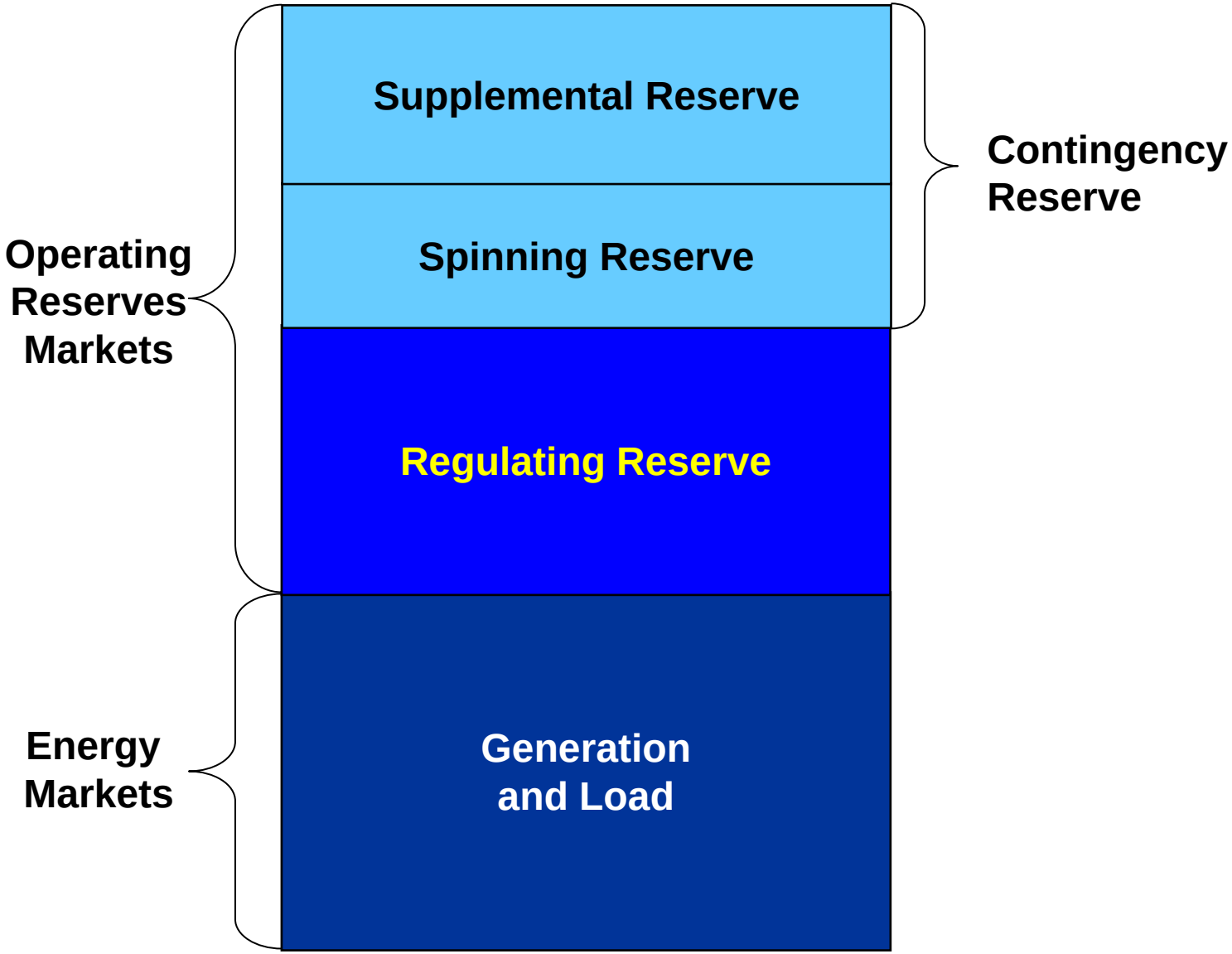
Ancillary Services

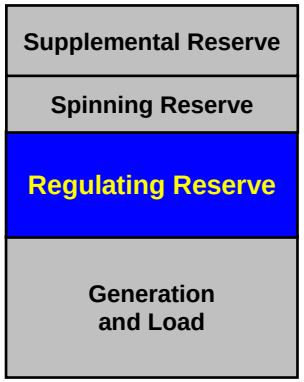
- What are Ancillary Services Markets?
  - Financial settlement markets for the efficient acquisition and pricing of ancillary services
  - Ancillary Services Markets price products that are most beneficial to the system (current or expected system conditions)
  - Clear identification of ancillary services products allows Market Participants to compete to provide services
  - The Midwest ISO's ancillary services market will be an energy and **operating reserves market. Operating reserves** consist of three products (regulation, spinning reserve, and supplemental reserve).

Operating Reserves



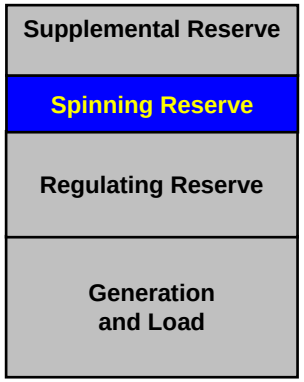
Regulation

- Regulation Response Services, also known as Automatic Generation Control (AGC), allow the system operator to physically balance supply and demand on a real-time, moment-to-moment basis
- How is this accomplished?
  - Resource adjusts its output in response to a control signal
    - Automatic Generation Control (AGC) – a software application that generates and transmits real-time control signals on a very short periodicity (two to six seconds)



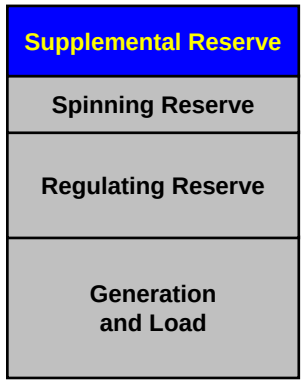
Spinning Reserve

- Used to provide energy to meet demand on the system in the event of a sudden and unexpected loss of a generation or transmission resource
  - Capability of generation resources or other qualified resources already synchronized to the grid to reach their targeted output within 10 minutes
  - Provides Contingency Reserves
- How is this accomplished?
  - Resources hold back or reserve a specified percentage of their capacity to meet the emergency need



Supplemental Reserve

- Used to provide energy to meet demand on the system in the event of a sudden and unexpected loss of a generation or transmission resource
  - Provided by generation resources, or other qualified resources, already synchronized or not currently synchronized to the grid, but which can be ramped up to supply energy within 10 minutes
  - Provides Contingency Reserves
- How is this accomplished?
  - Resources hold back or reserve a specified percentage of their capacity to meet the emergency need



Primary Objective of Ancillary Services Markets

- Without Ancillary Services Markets, there are no transparent economic signals to govern the provision of these services
- Ancillary Services Markets reconcile operating practices with market incentives so that Market Participants are compensated for providing reliability
- Ancillary Services Markets reduce need for operators to maintain reliability through out-of-merit actions
- Correctly pricing energy and operating reserve services under shortage conditions is important for resource adequacy in an Energy-only Market

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Ancillary Services Markets Evolution

- Competitive Energy Markets rely on the reliable real-time control of the transmission system
- ISOs/RTOs accomplish this by balancing supply and load, implementing congestion management techniques, as well as providing ancillary services
- Originally, most of these operating reserve services were provided on a cost basis, as defined in the tariffs; over time ISOs/ RTOs have started to provide these using competitive market mechanisms
- Transition from cost-based operating reserve services to market-based operating reserve services have evolved from Sequential to Simultaneous to Simultaneous Co-optimized

Sequential

- Ancillary Services Market is separate from the Energy Market
- Separate Ancillary Services Markets with separate offers for each product
- Execute in order – highest quality to lowest quality
- Resulting in pricing problems, including Economic Withholding and Price Reversal

- Example: CA ISO

Simultaneous

- Ancillary Services Market is separate from the Energy Market
- One Ancillary Services Market with separate offers for each product
- Simultaneously execute Ancillary Services Markets
- Advantages gained over Sequential, but misses trade-offs between Energy and Ancillary Services

- Example: ERCOT

Simultaneous Co-optimization

- Combines Energy Market and Ancillary Services Market
  - Single offer with Energy component and an operating reserve services component
  - Operating reserve component is an Availability Offer
  - Availability Offers may include costs plus a risk premium
- Recognizes tradeoff between Energy and Operating Reserves
- Makes generators indifferent to providing Energy or Operating Reserves

- Example: NYISO, Midwest ISO, PJM

Evolution Summary

- 1998 – CA ISO
- Separate Energy and AS Markets – one for each product
- Executed in order – highest to lowest quality
- Resulted in pricing issues – Economic Withholding and Price Reversals

- 2000 – ERCOT
- Separate AS Markets – one for each product
- Executed simultaneously for all AS products with Energy cleared separately
- Improved AS market but did not recognize tradeoffs between AS and Energy Market

- 2005 – NYISO, 2008 – Midwest ISO
- Combined Energy & AS Markets
- Co-optimized clearing of Energy and AS Markets
- Recognizes tradeoffs between Energy and Ancillary Services Market and incorporates lost opportunity costs

Simultaneous Co-optimization

- Definition
  - Determine energy and operating reserve service schedules *at the same time*, based on an evaluation of all the trade-offs involved in resource scheduling
- Benefits
  - Minimizes total cost of energy and operating reserve services
  - Ensures that all energy and operating reserve service requirements are satisfied
  - Considers trade-offs between a unit producing energy, or providing operating reserves
  - Market Participants (MP) will have incentive to submit offers that reflect their actual marginal costs

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LMP and MCP

- Locational Marginal Pricing (LMP)
  - Energy, Congestion, Losses
- Market Clearing Price (MCP)
  - Guarantees Recovery of Operating Reserve Offer and Opportunity Cost from Energy re-dispatch
    - For example, the Energy output of the resource may be reduced to provide Spinning Reserve as part of co-optimized solution, creating an Energy Opportunity Cost
- With a co-optimized solution, LMP can be impacted by Energy offers and Operating Reserves offers
  - LMP will include the total cost to serve the next MW of Load

Offer Caps

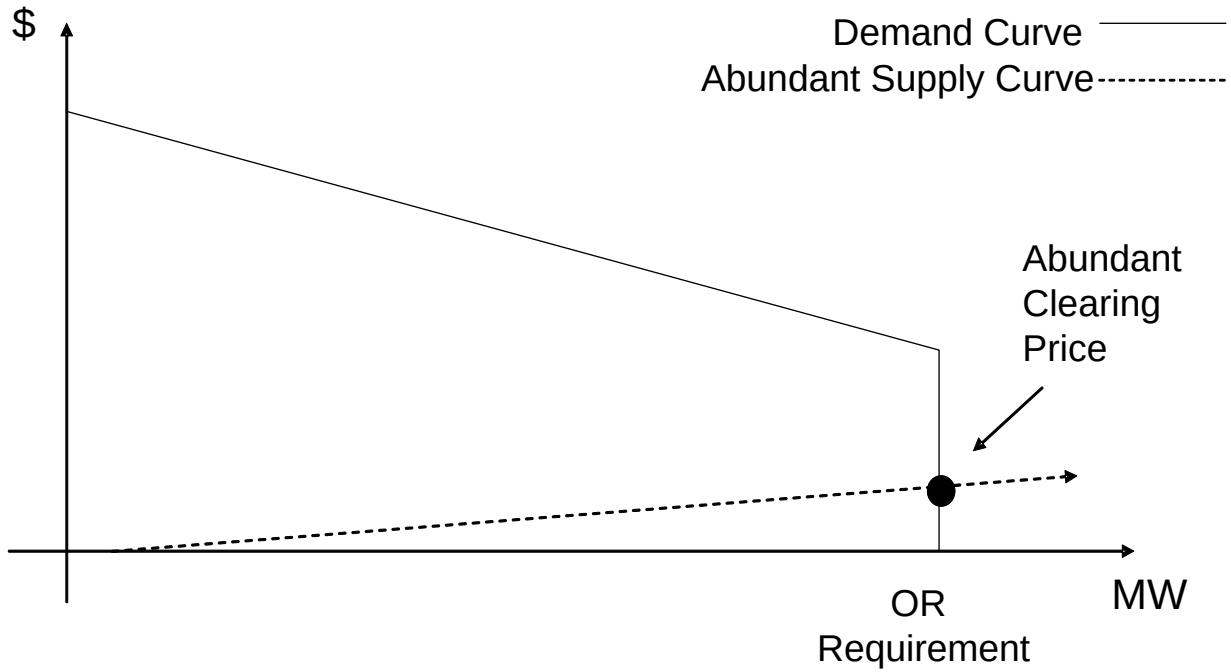
- Operating Reserves Offer ranges:

Product	Allowed Offer Range
Energy	Monotonically increasing $/MW pairs. Offer values from -$30 to $1,000
Regulating Reserve	$0 - $500 /MW
Spinning Reserve	$0 - $100 /MW
Supplemental Reserve	$0 - $100 /MW

Demand Curve

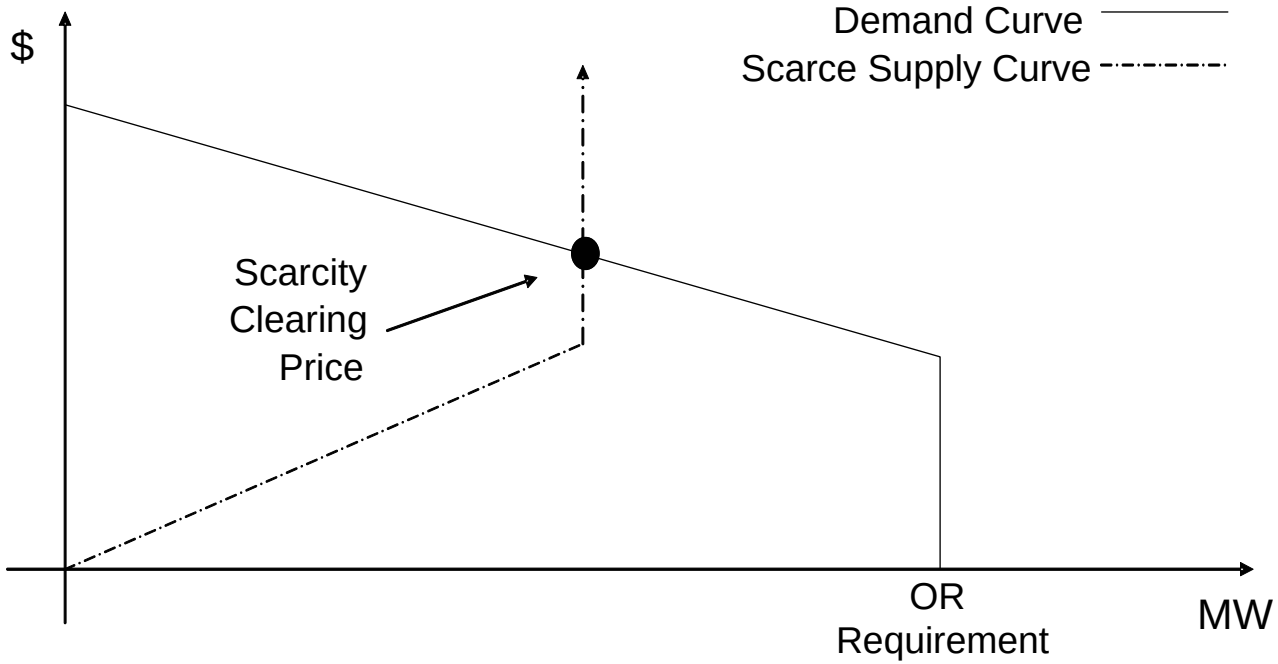
- Utilized to ensure the appropriate amount of Operating Reserve is cleared and the appropriate pricing signals are used
  - Under abundant conditions, the supply curve sets the price and the demand curve determines the amount supplied
  - Under scarce conditions, the demand curve sets the price and the supply curve determines the amount supplied
- Applied to:
  - Entire market – Market-wide Contingency Reserve and Regulating Reserve Demand Curves
  - Each Reserve Zone – Zonal Contingency Reserve and Regulating Reserve Demand Curves

Demand Curve Example – Abundant Conditions



- Under abundant conditions, the supply curve sets the price and the demand curve determines the amount supplied

Demand Curve Example – Scarcity Conditions



- Supply Scarcity occurs when maximum supply level price on the supply curve is less than the corresponding price on the demand curve
- Under scarce conditions, the demand curve sets the price and the supply curve determines the amount supplied

Operating Reserves Procurement

- Today
  - Regulation and Reserves Self-Scheduled
  - Dispatch of Regulation and Reserves managed by the Local Balancing Authorities
- How will reserves be acquired reserves under the Energy and Operating Reserves Markets?
  - ISO/RTO will procure the Operating Reserves
  - Procurement and deployment of Operating Reserves will be centrally managed by the Balancing Authority (Midwest ISO)

Operating Reserve Requirements

- Set on two levels
  - Market-wide Operating Reserves Requirements
  - Zonal Operating Reserves Requirements
    - Study run and published 2 days before the Operating Day
  - Requirements set separately for Regulating Reserves and Contingency Reserves

Goal of Reserve Zones

- Ensure deliverability into identified Import constrained areas
- Provide a vehicle for electrical dispersion of reserves

Demand Response Resources (DRR)

- **Type I -** Capable of supplying a specific quantity of energy to the market through physical load interruption.
  - Only has 2 outputs: Zero MW or Targeted Demand Reduction Amount
  - Can be committed for either Energy or cleared for Contingency Reserves
    - Dispatchable for Contingency Reserve Deployment
    - Not dispatchable for Energy

- **Type II -** Capable of supplying energy to the market through behind-the-meter generation or controllable load.
  - Combination of controllable load and / or behind-the-meter generation
  - Must submit baseline load forecast in 5 minute intervals for Host Load Zone and Offer for DRR
  - Can be committed and dispatched similar to generation resources

Demand Response Resources Examples

Conceptually, the following could qualify as DRRs for each Type -

- DRR Type I – physical load interruption
  - Example – Interrupted Load - Factory or manufacturing plant that has a direct contract for energy with a Load Serving Entity (LSE). Per the contract supply may be interrupted under certain conditions and this energy could then be supplied to the market.
- DRR Type II – controllable interruption
  - Example – Loads with behind-the-meter generation – cities or municipalities, and certain types of accounts (hospitals or universities may have their own generating facilities). These generation resources may be able to sell any excess capacity not used to serve their load into the market.
  - Example – Controllable Load - Factory or manufacturing plant that has a direct contract for energy with a LSE and has the ongoing capability to alter their processes to meet specific reduction amounts based on ongoing dispatch instructions.
- Note: Ability of DRRs to qualify to supply particular products for the Market is dependant on meeting resource requirements such as metering and the ability to respond to dispatch signals.