

PJM Markets 201

Financial Transmission Rights (FTRs)

PJM State & Member Training Dept.

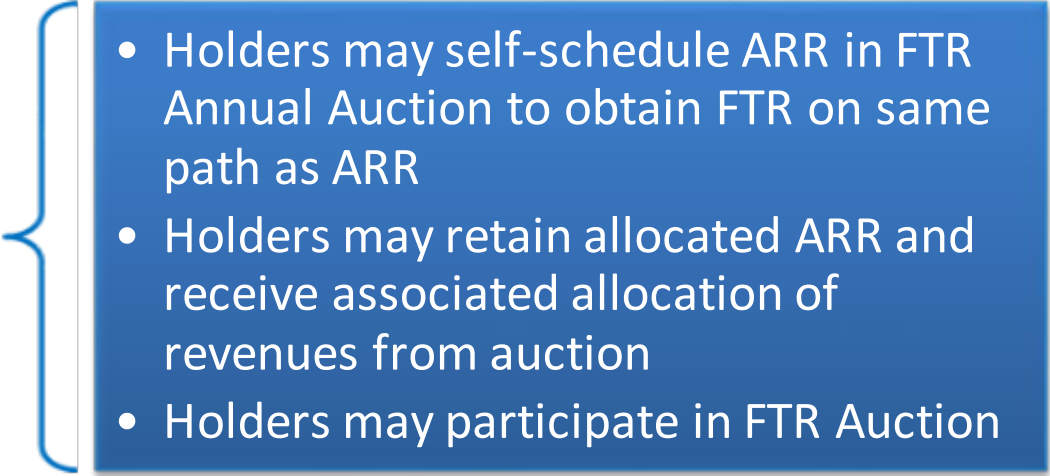
Student will be able to:

- Describe the processes and procedures for participating in the ARR and FTR Market
 - Define FTRs
- Describe how PJM clears annual FTR auction and how ARR credits are revenue adequate

What are ARR's?

Auction Revenue Rights (ARRs) ...

are entitlements ***allocated annually*** to Firm Transmission Service Customers that entitle the holder to receive an allocation of the revenues from the Annual FTR Auction

- 
- Holders may self-schedule ARR in FTR Annual Auction to obtain FTR on same path as ARR
 - Holders may retain allocated ARR and receive associated allocation of revenues from auction
 - Holders may participate in FTR Auction

What Are FTRs?

Financial Transmission Rights



Financial instruments **awarded to bidders**

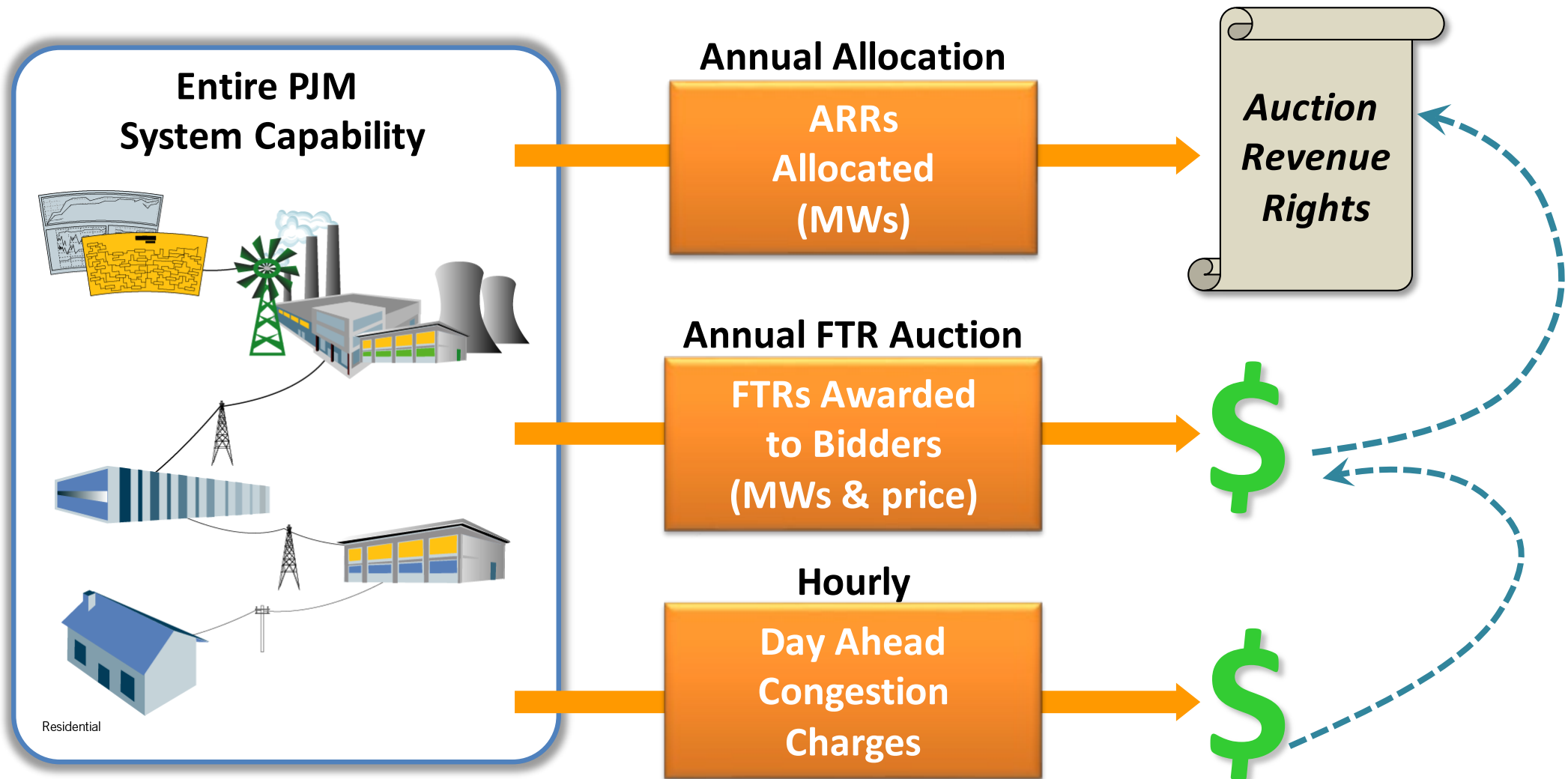
Stream of revenues (or charges)
based on the hourly Day Ahead
congestion price differences across the path



Entitle the holder to

ARR / FTR Relationship

ARRs provide revenue stream to firm transmission customer to offset purchase price of FTRs



Why Do We Need FTRs?

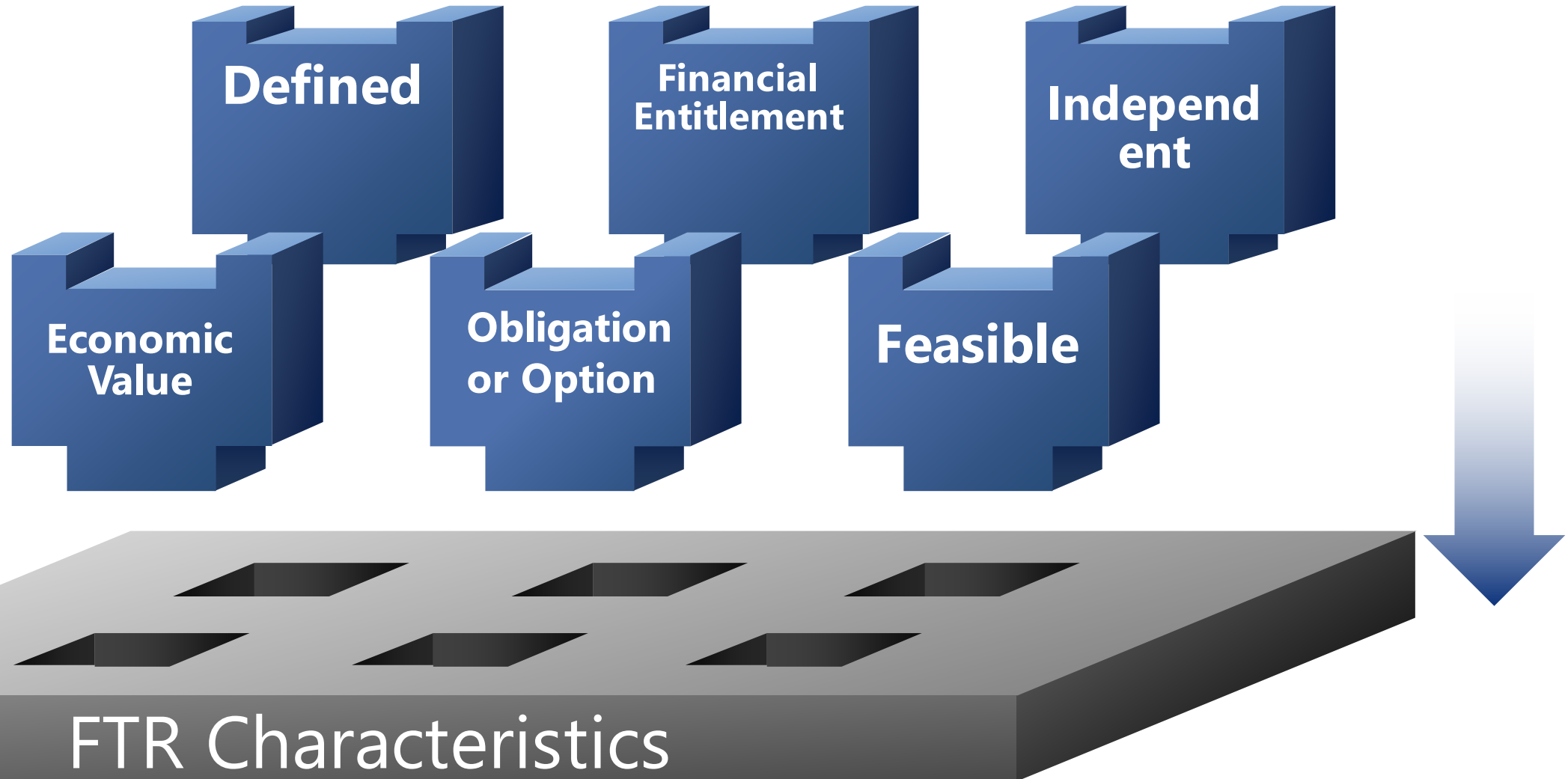
Protect Load Servers from price uncertainty for congestion charges

Distribute day-ahead excess congestion charges

FTRs provide hedging mechanism that can be traded separately from transmission service

FTR credits equal day-ahead congestion charges on same path

Characteristics of FTRs



Obtaining FTRs

Annual Auction

- Multi-round
- Multi-period
- Multi-product
- Entire system capability minus approved Long-Term FTRs

Long-Term Auction

- Multi-round
- Purchase residual system capability, assuming self scheduling of ARR

Monthly Auction

- Purchase “left over” capability

Secondary Market

- Bilateral trading

Types of FTR Products

FTRs can be acquired in two forms ...



**FTR
Obligations**



**FTR
Options**

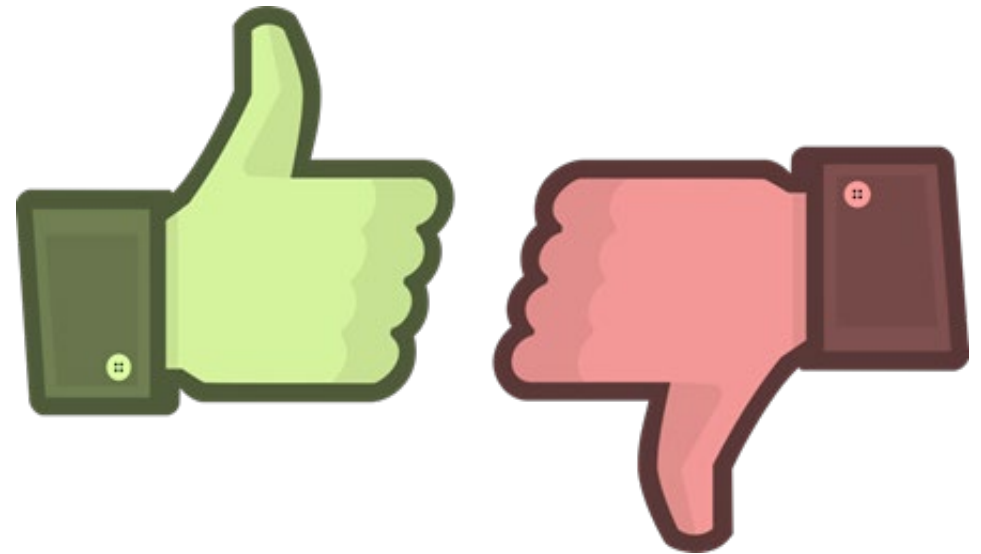
What Are FTR Obligations Worth?

Benefit

- The hourly congestion value is positive
- FTR same direction as congested flow

Liability

- The hourly congestion value is negative
- FTR opposite direction as congested flow



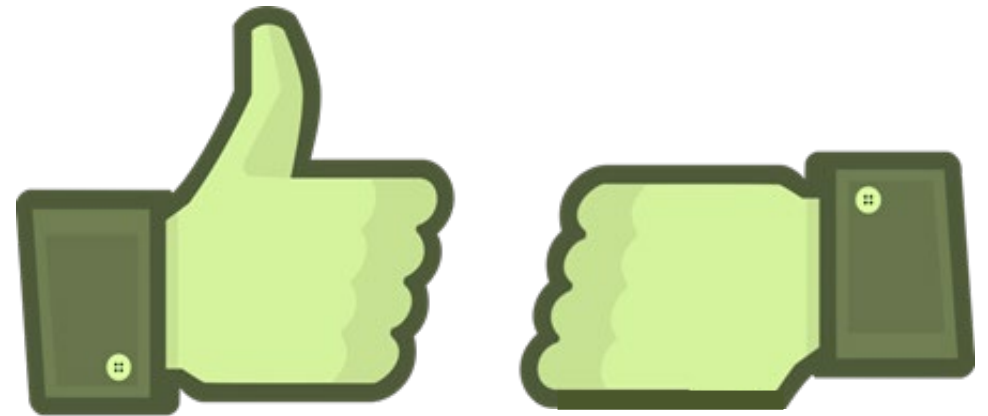
What Are FTR Options Worth?

A Benefit

- The hourly congestion value is positive
- FTR same direction as the congested flow

Not a Liability

- The hourly congestion value is zero
- FTR opposite direction to the congested flow



***FTR Option cannot
have negative value***

FTR Credits and Congestion Charges

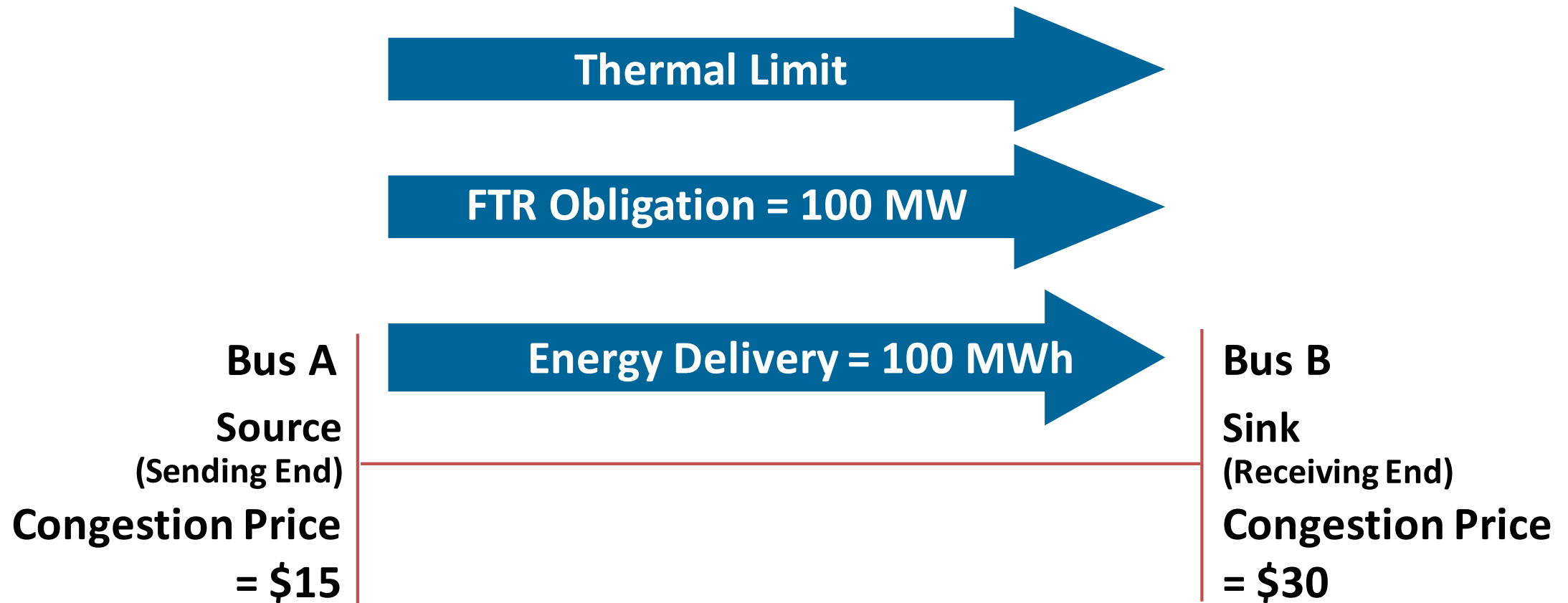
Congestion Charge =

MWh * (Day-ahead Sink Congestion Price - Day-ahead Source Congestion Price)

FTR Credit =

MW * (Day-ahead Sink Congestion Price - Day-ahead Source Congestion Price)

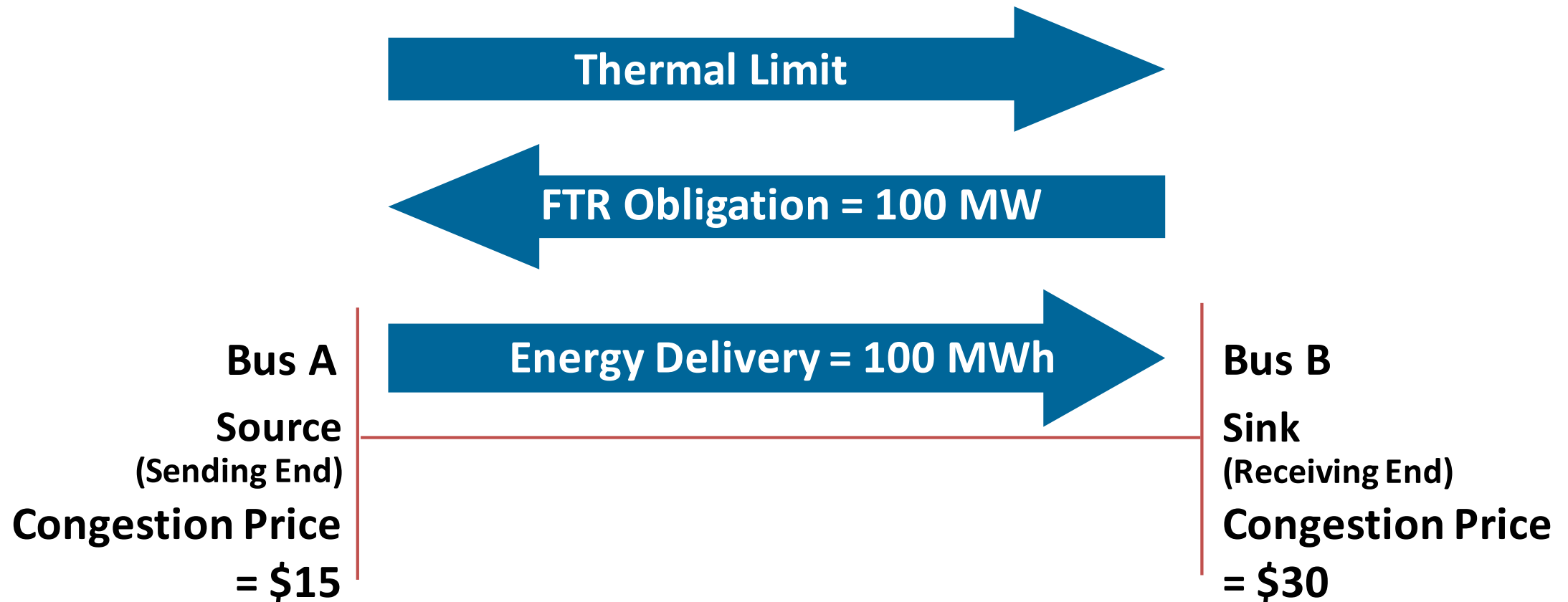
FTR Obligation is a Benefit



$$\text{Congestion Charge} = 100 \text{ MWh} * (\$30 - \$15) = \$1500$$

$$\text{FTR Obligation Credit} = 100 \text{ MW} * (\$30 - \$15) = \$1500$$

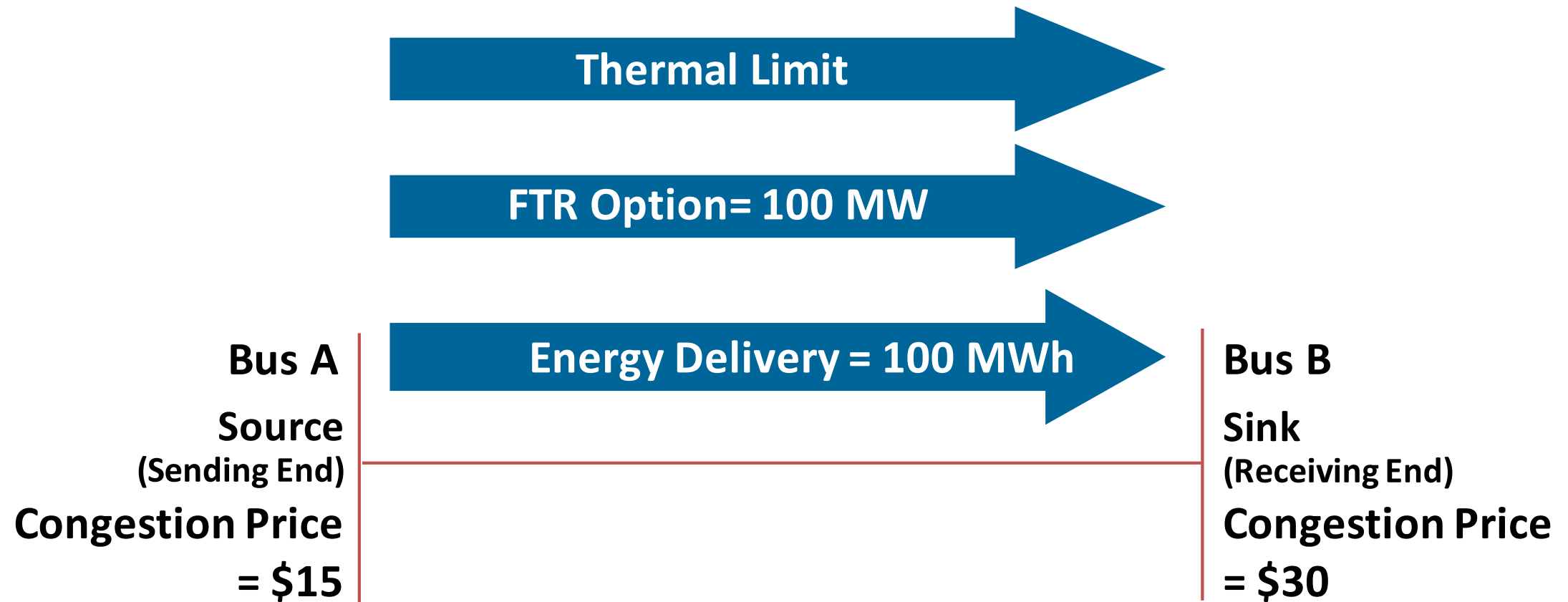
FTR Obligation is a Liability



$$\text{Congestion Charge} = 100 \text{ MWh} * (\$30 - \$15) = \$1500$$

$$\text{FTR Obligation Credit} = 100 \text{ MW} * (\$15 - \$30) = \$-1500$$

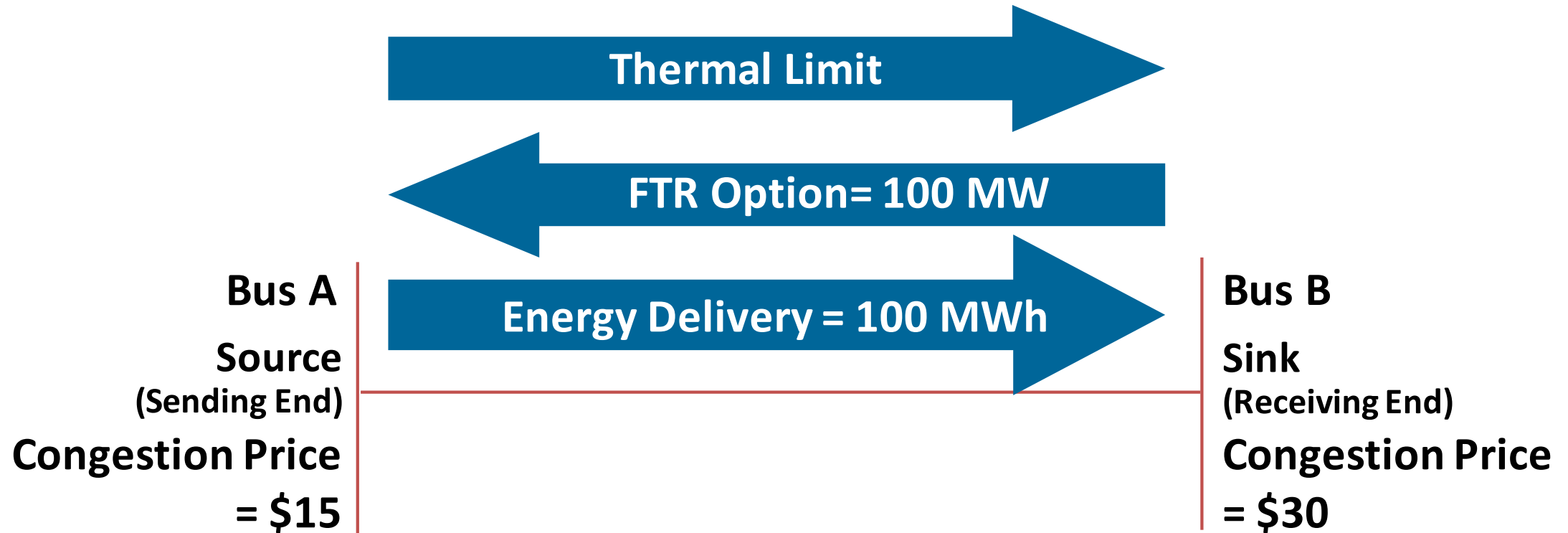
FTR Option is a Benefit



$$\text{Congestion Charge} = 100 \text{ MWh} * (\$30 - \$15) = \$1500$$

$$\text{FTR Option Credit} = 100 \text{ MW} * (\$30 - \$15) = \$1500$$

FTR Option is Neither a Benefit/Liability



$$\text{Congestion Charge} = 100 \text{ MWh} * (\$30 - \$15) = \$1500$$

$$\text{FTR Option Credit} = 100 \text{ MW} * (\$15 - \$30) = \$-1500 = \$0$$

*****When calculated, the FTR Option Credit is negative, therefore the economic value will equal zero.*******

FTR Revenue Adequacy

- PJM awards FTRs based on the capability of the transmission system
- There must be adequate revenue from congestion to fund the FTRs that were awarded
- Revenue adequacy issues occur when we under-collect congestion revenue to fund FTRs
 - Transmission outages and de-ratings can have a significant impact on FTR revenue adequacy



Characteristics of the Annual Allocation

- Long-Term Allocation on an Annual Basis
 - ARR are acquired for duration of Planning Period
- Allocated to Firm Transmission Service
 - Network Integration Service
 - Firm Point to Point
- Entire Capability of the Transmission System
- Within Planning Period:
 - Network ARRs are reassigned as load shifts
 - Shorter term Pt-to-Pt ARRs may be requested via OASIS

Characteristics of the Annual Allocation *(cont.)*

Two-Stage Allocation Process

- Stage 1 of the Annual ARR Allocation is based on active generation resources that historically served load in each transmission zone or Qualified Replacement Resources
 - Stage 1A for resources for a guarantee 60% of Network Service Peak Load (NSPL)
 - EDC determines each LSE's NSPL, using established methodology
 - Each EDC's methodology is presented on PJM website under Billing, Settlements & Credit at THEO, PLC & NSPL Methodology Inventory
 - Maximum MW available to each historical resource or Qualified Replacement Resource (QRR) will be a share of the resource capability
 - Qualifying Firm Point-to-Point Customers may request up to 50% of the qualifying transmission service reservation MW level

Characteristics of the Annual Allocation *(cont.)*

- Stage 1B for historical resources up to Network Service Peak Load (NSPL)
 - Maximum MW available to each historical resource or Qualified Replacement Resources plus Hub, Zone and Interface will be share of the historical resources capability minus Stage 1A MWs allocated from resource
 - Qualifying Firm Point-to-Point Customers may submit request for the remainder of their qualifying transmission service reservation MW level that was not covered by Stage 1A ARR MWs

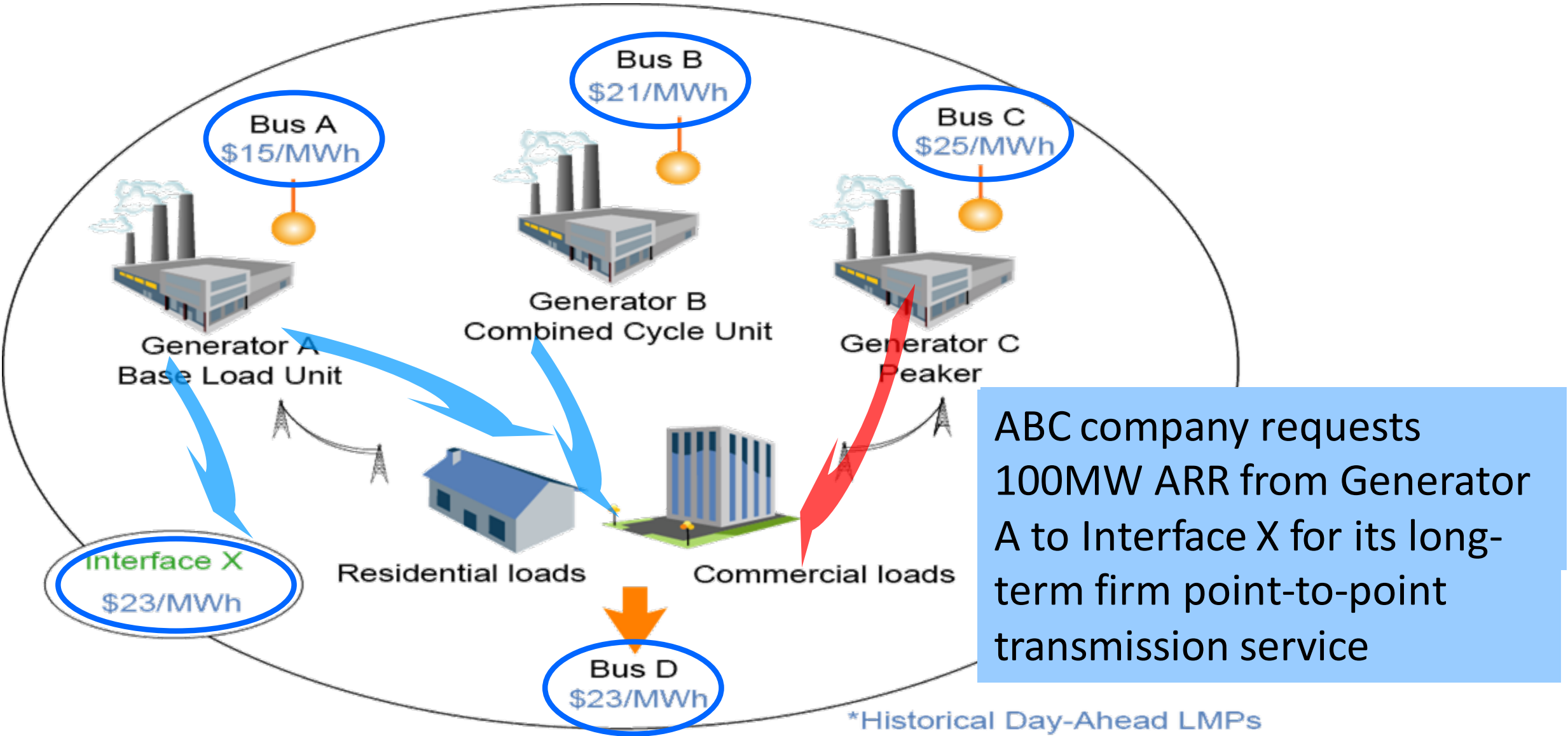
Characteristics of the Annual Allocation *(cont.)*

- Stage 2 is a 2 round iterative approach which allows LSEs to request additional ARR from a variety of potential ARR source points
- The Sink Pnode is from Aggregate Network Customer Load in the Transmission Zone or other designated Load Aggregation Zone and any available generator, interface, hub or zone
- Total MWs requested by LSE cannot exceed LSE's share of zonal peak load and each round of Stage 2 is limited to 1/2 of the remaining NSPL amount not covered in Stage 1 allocation

Characteristics of the Annual Allocation *(cont.)*

ARR Round	Source Pnode	Sink Pnode	Capability (MW)
Stage1A	Active historical resources or Qualified Replacement Resources	Aggregate Network Customer Load in the Transmission Zone or other designated Load Aggregation Zone	Guarantee 60% of Network Service Peak Load (NSPL)
Stage1B	Same as stage1A, plus Hub, Zone and Interface	Same as stage1A	Up to Network Service Peak Load (NSPL) (subject to proration)
Stage2 Round1	any available generator, interface, hub, zone	Same as stage1A, and any available generator, interface, hub, zone	Up to Network Service Peak Load (NSPL) (subject to proration)
Stage2 Round2	Same as Round1	Same as round1	Up to Network Service Peak Load (NSPL) (subject to proration)

Example - ARR Candidates



Clearing the FTR Market

- Fundamentally an optimization problem
 - function: Maximize bid-based revenue (i.e., revenue to ARR holders)
 - Subject to: Transmission constraints (N-1)
- Solution Mechanism
 - FTR Optimizer
 - Input: Set of transmission constraints to respect
 - Figure out the optimal set of FTRs to clear by calculating “cost effectiveness ratios” of each FTR to each constraint
 - Output: Cleared FTRs (i.e., a set of generators and loads)
 - SFT – “Simultaneous Feasibility Test”
 - Input: Set of generators and loads
 - Figure out which constraints are violated (do N-1 contingency analysis)
 - Output: Updated set of transmission constraints to respect

What is a Simultaneous Feasibility Test?

- Test to ensure that all subscribed transmission entitlements are within the capability of the existing transmission system
- Test to ensure the PJM Energy Market is revenue adequate under normal system conditions
- **NOT** a system reliability test
- **NOT** intended to model actual system conditions

Feasibility of ARR and FTR

- ARRs must be simultaneously feasible to ensure that Annual FTR Auction revenues are sufficient to cover ARR Target Allocations
- FTRs must be simultaneously feasible to ensure that total congestion charges collected from Day Ahead are sufficient to cover FTR Target Allocations

Test Conditions and Criteria

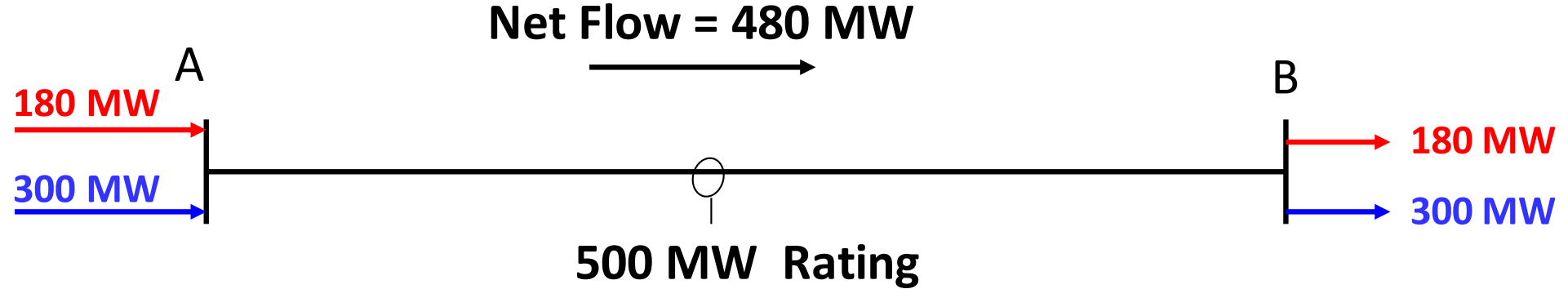
- FTRs or ARRs are modeled as generation at source point and load at sink point
- Single contingency test criteria
- Perform DC powerflow analysis to
 - Evaluate ability of all system facilities to remain within normal thermal ratings
 - Evaluate ability to sustain the loss of any single contingency event with all system facilities remaining within applicable short-term, emergency ratings

SFT Data Inputs

- Uncompensated Parallel Flow Injections
- Transmission Outages
- Existing FTRs or ARRs
- Facility Ratings
- PJM Network Model
- List of Contingencies
- Interface Ratings

**SFT
(DC Powerflow)**

SFT Example #1



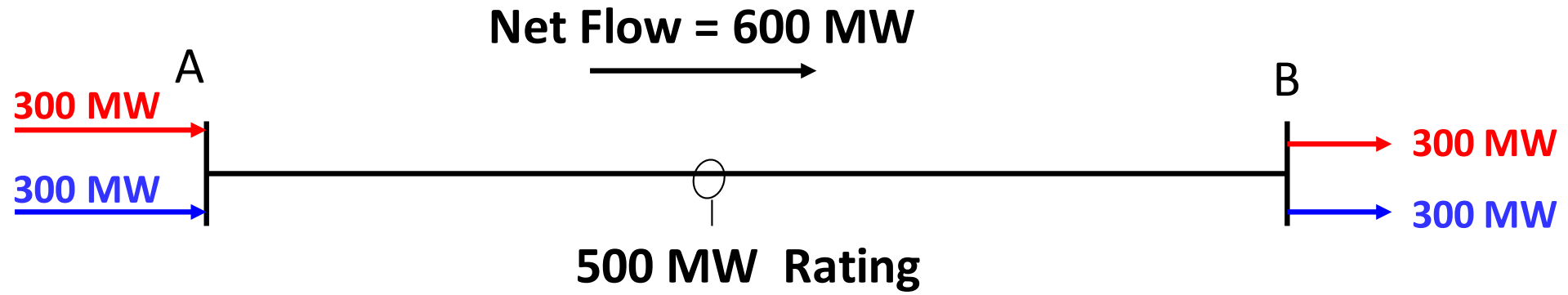
FTR 1: 300 MW Obligation from A to B

FTR 2: 180 MW Obligation from A to B

Net Flow on Line A-B = 480 MW

**Line A-B Flow < Line A-B Rating therefore
both FTRs are simultaneously feasible**

SFT Example #2



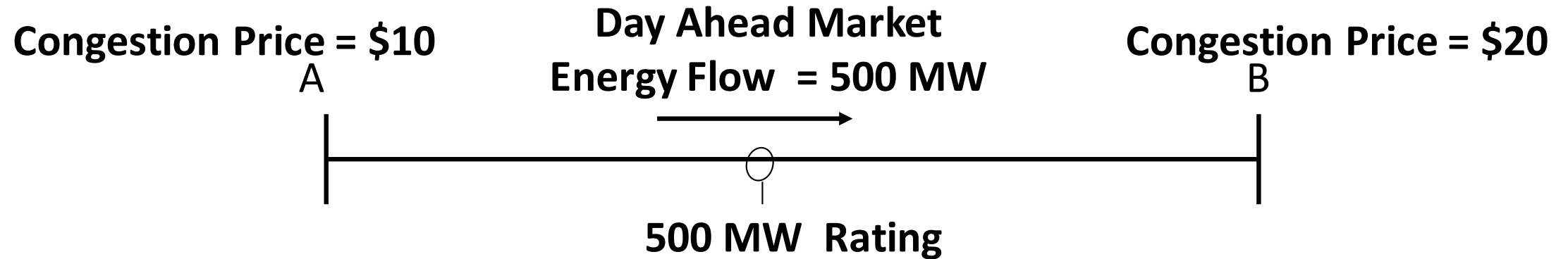
FTR 1: 300 MW Obligation from A to B

FTR 2: 300 MW Obligation from A to B

Net Flow on Line A-B = 600 MW

**Line A-B Flow > Line A-B Rating therefore
both FTRs are NOT simultaneously feasible**

Revenue Adequacy Using SFT Examples



Day Ahead Congestion Charge = 500 MW (\$20 - \$10) = \$5,000

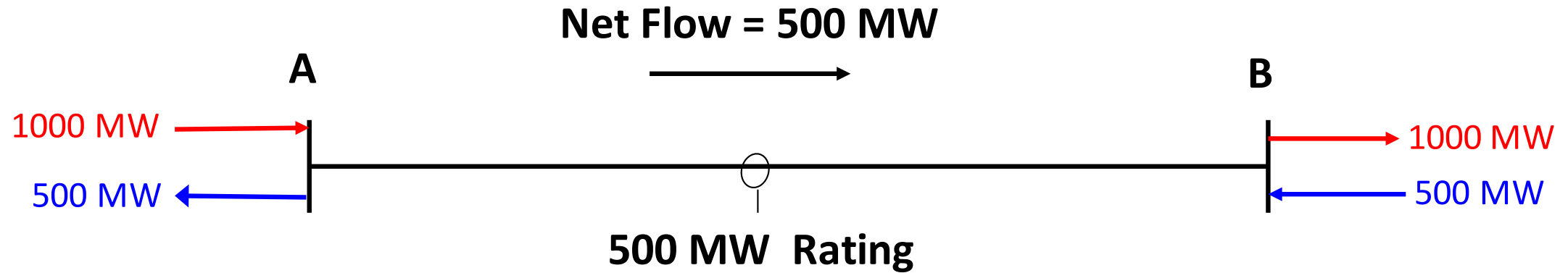
FTR Target Allocation (using SFT Example 1 FTRs)

Total FTR Target Allocation = 480 MW (\$20 - \$10) = \$4,800

FTR Target Allocation (using SFT Example 2 FTRs)

Total FTR Target Allocation = 600 MW (\$20 - \$10) = \$6,000

SFT Example #3



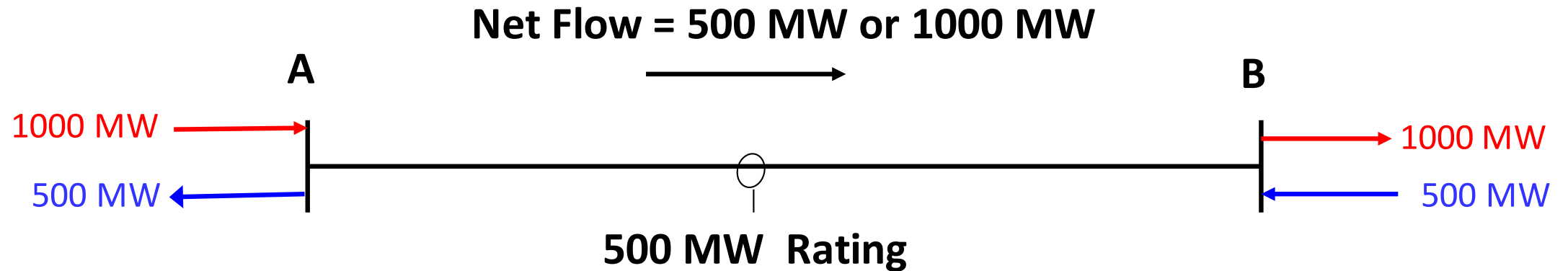
FTR 1: 500 MW Obligation from B to A

FTR 2: 1000 MW Obligation from A to B

Net Flow on Line A to B = 500 MW

Line A to B Flow = Line A to B Rating, therefore
both FTRs are simultaneously feasible

SFT Example #4



FTR 1: 500 MW Option from B to A

FTR 2: 1000 MW Obligation from A to B

Net Flow on Line A to B = 500 MW or

Net Flow on Line A to B = 1000 MW (must ignore **counterflow** created by Option)

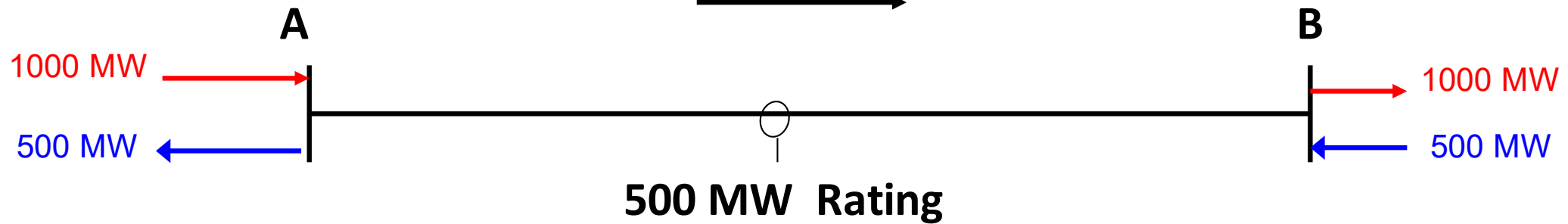
Line A-B Flow > Line A to B Rating, therefore both FTRs are
NOT simultaneously feasible

Revenue Adequacy Using SFT Examples

Congestion Price = \$10

Day Ahead Market Energy Flow = 500 MW

Congestion Price = \$20



Day Ahead Congestion Charge = 500 MW (\$20 - \$10) = \$5,000

Obligation

FTR Target Allocation (using SFT Example 3)

FTR 1 Target Allocation = 500 MW (\$10 - \$20) = -\$5,000

FTR 2 Target Allocation = 1000 MW (\$20 - \$10) = \$10,000

Total FTR Target Allocation = \$5,000

Option

FTR Target Allocation (using SFT Example 4)

FTR 1 Target Allocation = 500 MW (\$10 - \$20) = 0

FTR 2 Target Allocation = 1000 MW (\$20 - \$10) = \$10,000

Total FTR Target Allocation = \$10,000

Maintaining Feasibility

Feasibility of requests is maintained by:

Annual Allocation

requests prorated in proportion to MWs requested and
inverse proportion to effect on binding constraint

Annual/Long-Term/Monthly Auctions

requests awarded to highest bidder

Questions?

PJM Client Management & Services

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Toll Free Telephone: (866) 400-8980

Website: www.pjm.com



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