Transmission Constraint Pricing

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Background

- During the Q2 2016 SOM Report on August 29, 2016, stakeholders requested that the NYISO describe how the three-step Transmission Shortage Cost (often referred to as the graduated transmission demand curve or "GTDC") works
  - *The GTDC is implemented within the NYISO's security constrained unit commitment and dispatch algorithms used by the SCUC, RTC and RTD programs*
- On October 6, 2016, the NYISO notified Market Participants of a potential market problem related to the current implementation of the GTDC

SCUC, RTC and RTD Mechanics

NCUC Controller
(Iterative Process)

Initial Unit Commitment & Dispatch

- Computes the initial unit commitment and/or dispatch based on:
  - Load Forecasts or Bid Load
  - Unit status
  - Previous dispatch schedules

Network Data Preparation

- Develops the power flow cases that are used to develop transmission constraints and determine whether the system is secure

DC Security Analysis

- Evaluates the impact of contingencies on the feasibility of resource schedules
- **Transmission constraints are developed**
- **Resource shift factors to the transmission constraints are determined**

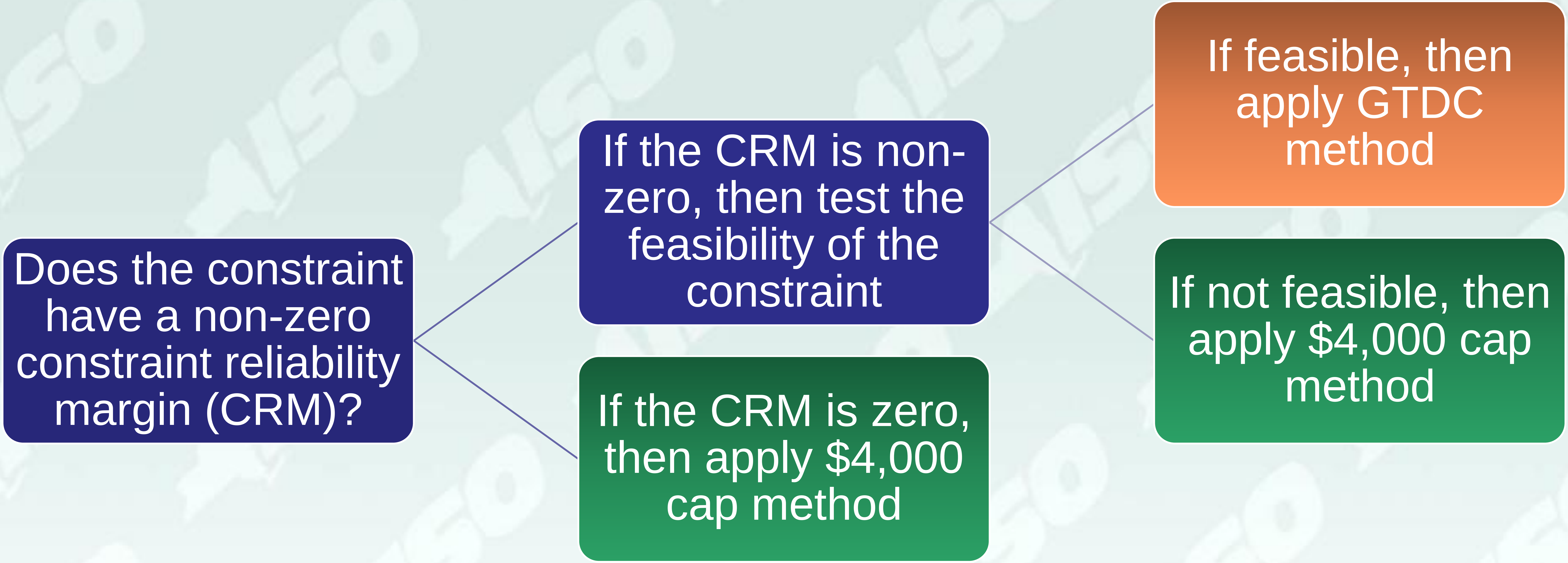
Unit Commitment & Dispatch

- Calculates the minimum as bid cost schedule of resources and related bus prices, subject to solving the following constraints:
  - Gen-Load Balance
  - Reserve & Regulation Req'ts
  - Unit Operating Limits
  - Minimum unit startup and down times
  - Transmission Constraints
- **Transmission Shortage Cost is applied here**

Final Schedules & Prices

- These prices and schedules are provided to market participants when the market is posted

Transmission Constraint Process



Transmission Constraint Process Explanation

- **The CRM only applies to internal transmission facilities and interfaces**
  - ***The CRM is 20MW for most facilities and 100MW for internal interfaces***
    - **To improve transparency, the NYISO will identify the list of facilities with a zero CRM**
  - ***External interfaces (Interface ATC constraints) do NOT have a CRM***
- **When determining whether a transmission constraint is feasible, the test is comparing the amount of available dispatch while respecting ramp and operating limitations to the constraint violation**
  - ***If the amount of available dispatch is less than the constraint violation, the transmission constraint is considered infeasible***
  - ***The software evaluates available resources of each transmission constraint independent of any other constraint prior to economic dispatch or unit commitment***

Infeasibility Handling

Infeasibility Handling

- **When a constraint violation exceeds the available dispatch to fully solve the transmission constraint, the constraint is relaxed to allow the software to determine the cost of the last MW of resource dispatch (i.e., the marginal cost)**
  - ***This practice has been in place since December 1999 for SCUC and February 2005 for RTS***
  - ***During the determination of feasibility, the algorithm replaces the $4,000/MWh step with a $8,000/MWh penalty cost for base case transmission constraints and a $4,500/MWh penalty cost for contingency transmission constraints***
- **The next slide demonstrates how the relaxation is applied via an example**

Infeasibility Handling Example

- A transmission constraint has a 50MW overload
- There is one generator with 40MW of dispatch and 0.5 shift factor for the transmission constraint
  - *This results in 20MW of relief from the generator – 40MW * 0.5 = 20MW*
  - *The remaining transmission constraint overload is 30MW*
    - 50MW overload – 20MW of dispatch relief = 30MW remaining overload
- The remaining transmission constraint overload (30MW) is completely relaxed with an additional slack tolerance (0.2MW) to determine a marginal price
  - *The new overload that is used for dispatch and pricing is 19.8MW*
    - 50MW overload – 30MW relaxation – 0.2 slack = 19.8MW
  - *The generator which has 20MW of dispatch relief is dispatched against the 19.8MW overload*
    - The Shadow Price for the transmission constraint is based on this generator's cost, subject to application of the GTDC or $4,000 cap methods

GTDC Method

GTDC Method

- **This method applies the three step curve, where the first two steps are modeled like a traditional demand curve while the last step continues to act as a Shadow Price cap**
  - ***The NYISO began applying a Shadow Price cap of $4,000/MWh in June 2007***
- **Examples on the next few slides**

GTDC Method – Example 1

(Trade-off between GTDC and Physical Resource Costs)

- A transmission constraint has a 3MW overload
- Only one generator with a cost of $200/MWh and a shift factor of 0.5 is available to solve the constraint
  - *The cost for dispatching the generator to solve the constraint is $1,200/hr*
    - 3MW of relief = 6MW of dispatch * 0.5 shift factor
    - 6MW of dispatch * $200/MWh = $1,200/hr
  - *The cost for using the GTDC to solve the constraint is $1,050/hr*
    - 3MW * $350/MWh (first GTDC step) = $1,150/hr
  - *The Shadow Price for the constraint is set by the GTDC at $350/MWh*

GTDC Method – Example 2

(Multi-Step GTDC Example)

- A transmission constraint has a 14MW overload
- Only one generator with a cost of $1,200/MWh and a shift factor of 0.5 is available to solve the constraint
  - *The cost for dispatching the generator to solve the constraint is $33,600/hr*
    - 14MW of relief = 28MW of dispatch * 0.5 shift factor
    - 28MW of dispatch * $1,200/MWh = $33,600/hr
  - *The cost for using the GTDC to solve the constraint is $22,900/hr*
    - 5MW * $350/MWh (1st step) + 9MW * $2,350/MWh (2nd step) = $22,900/hr
  - *The Shadow Price for the constraint is set by the GTDC at $2,350/MWh*

GTDC Method – Example 3

(Multi-step GTDC with partial dispatch example)

- **A transmission constraint has a 14MW overload**
- **Generator 1 with a cost of $200/MWh, a shift factor of 0.5, and 6MW of dispatch and Generator 2 with a cost of $800/MWh and a shift factor of 0.11 are available to solve the constraint**
  - ***The cost for dispatching Generator 1 to partially solve the constraint is $1,200/hr and the cost of dispatching Generator 2 is above $2,350/MWh, so the GTDC is also used for the remaining 11MW of relief***
    - **3MW of relief from Generator 1 = 6MW of dispatch * 0.5 shift factor**
    - **6MW of dispatch from Generator 1 * $200/MWh = $1,200/hr**
    - **Generator 2 dispatch cost for the constraint = $800/MWh / 0.11 shift factor = $7,272.72**
  - ***The cost for the remaining 11MW of relief from using the GTDC is $15,850/hr***
    - **5MW * $350/MWh (1st step) + 6MW * $2350/MWh (2nd step) = $15,850/hr**
  - ***The Shadow Price for the constraint is set by the GTDC at $2,350/MWh***

GTDC Method – Example 4
($4,000 Capping Example)

- A transmission constraint has a 25MW overload
- Only one generator with a cost of $800/MWh and a shift factor of 0.15 is available to solve the constraint
  - *The cost for dispatching the generator to partially solve the constraint is $5,333/MWh, but the GTDC caps the Shadow Price at $4,000/MWh*
    - $5,333/MWh = $800/MWh (dispatch cost) / 0.15 (shift factor)
  - *So, the generator would be dispatched 33.3MW to solve the constraint*
    - 25MW of relief = 5MW GTDC step 1 + 15MW GTDC step 2 + (33.3MW of dispatch * 0.15 shift factor)
  - *The Shadow Price is capped to $4,000/MWh*
    - In order to maintain consistent prices and schedules, the generator is not dispatched 33.3MW to solve the constraint

$4,000 Cap Method

$4,000 Cap Method

- This method applies Infeasibility Handling using a single $4,000/MWh cap
- This method relies on the as bid costs for determining a transmission constraint Shadow Price capped at $4,000/MWh
- Examples on the next few slides

$4,000 Cap Method – Example 6

(Infeasibility Handling with Dispatch)

- A transmission constraint has a 30MW overload
- Only one generator with a cost of $1,200/MWh, a shift factor of 0.5 and 20MW of dispatch is available to solve the constraint
- The transmission constraint overload is relaxed to equal the amount of dispatch relief (10MW) plus slack tolerance (0.2MW) to assist with determining a marginal price
  - *The new overload that is used for dispatch and pricing is 19.8MW*

    30MW overload – (20MW of dispatch * 0.5) – 0.2MW = 19.8MW
  - *During the dispatch, the 19.8MW dispatch is capped to $4,000/MWh without using the $350/MWh or $2,350/MWh steps*
  - *This results in a $2,400/MWh Shadow Price for the constraint, set by the generator with 10MW of dispatch relief*

$4,000 Cap Method – Example 7

(Zero CRM Example)

- A transmission constraint has a 3MW overload
- Only one generator with a cost of $1,200/MWh, a shift factor of 0.5 and 15MW of dispatch is available to solve the constraint
  - *The cost for dispatching Generator 1 to solve the constraint is $7,200/hr*
    - 3MW of relief = 6MW of dispatch * 0.5 shift factor
    - 6MW of dispatch * $1,200/MWh = $7,200/hr
    - The Shadow Price is 1,200/MWh / 0.5 shift factor = $2,400/MWh, and is less than the $4,000/MWh cap

$4,000 Cap Method – Example 8

(Zero CRM Example with Capping)

- A transmission constraint has a 3MW overload
- Only one generator with a cost of $1,200/MWh, a shift factor of 0.25 and 15MW of dispatch is available to solve the constraint
  - *The cost for dispatching Generator 1 to solve the constraint is $14,400/hr*
    - 3MW of possible relief = 12MW of dispatch * 0.25 shift factor
    - 12MW of dispatch * $1,200/MWh = $14,400/hr
    - The Shadow Price would be $1,200/MWh / 0.25 shift factor = $4,800/MWh, but is capped at $4,000/MWh
      - *In order to maintain consistent prices and schedules, the generator is not dispatched 12MW to solve the constraint*

Next Steps

- **The NYISO appreciates that the current implementation is complex and would like stakeholder feedback on the current implementation**
  - ***Please provide feedback to Mike DeSocio (mdesocio@nyiso.com)***
- **The NYISO is committed to working with stakeholders on this issue**
  - ***The 2017 Graduated Transmission Demand Curve project will be the platform for the continued dialog***
- **The NYISO currently plans to be back at MIWG on November 3, 2016 to begin discussing short term and long term options for improving the current implementation**

Questions?

- **The Mission of the New York Independent System Operator, in collaboration with its stakeholders, is to serve the public interest and provide benefit to consumers by:**
  - ***Maintaining and enhancing regional reliability***
  - ***Operating open, fair and competitive wholesale electricity markets***
  - ***Planning the power system for the future***
  - ***Providing factual information to policy makers, stakeholders and investors in the power system***

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