Computational Challenges in Financial Transmission Rights Markets

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This Talk is About

- Rapidly-escalating amounts of computation for financial transmission rights markets
  - Larger network models and numbers of contingency cases
  - Massive number of speculative bids
  - Point-to-point FTR options
  - Multi-period FTR
  - Scaling of transmission capacity
  - Degeneracy

Nexant's Involvement in FTR Markets

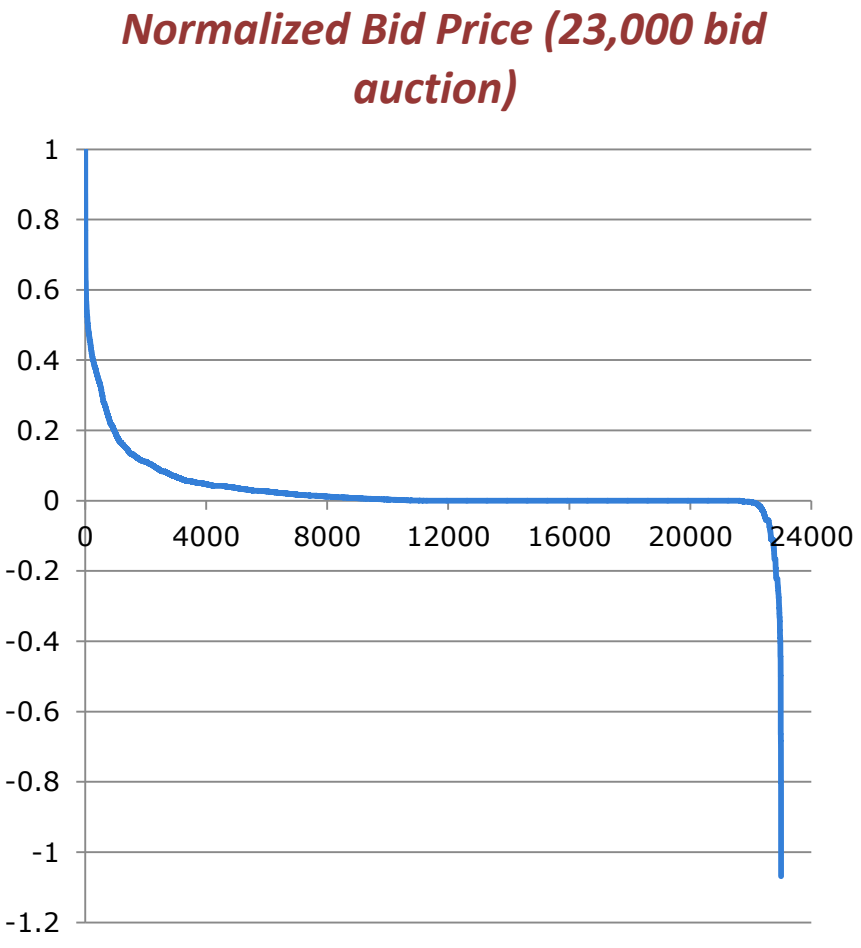
- Developing financial transmission rights software since 1996
- Software is installed in all ISOs in the United States running TCC/FTR/CRR/TCR markets with either/both
  - The complete market system product
  - The standalone product
- Delivering a complete FTR market system to New Zealand for a market start in 2013

Network Model Size and Contingency Cases

- The numbers of inequality constraints are functions of the model size and number of contingency cases
  - Generally in the 10s of millions for a single period case
- ISOs have attempted to reduce the number of contingency cases and therefore the number of inequality constraints by the use of flow gates
- However flow gates can be difficult to predict within the time frame of the FTR markets

Speculative Bidding

- Actual auction (normalized bid prices)
- Average bid price is 3% of maximum
- Over 14,500 bids less than 1% of maximum bid price
- Relatively small number of bids compared with what MPs are asking



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Point-to-Point Options

- PTP options offered by ISOs tend to escalate the number of speculative bids as there is no down-side for holding options
- Fundamental implications for sparse network constraint handling and computational requirements
- Flows become directional which doubles the number of inequality constraints

Multi-period FTRs

- Auction uses an individual network model for each period
  - The period models are coupled by FTR bids
  - Each period has a separate topology and set of contingency cases
  - Generally multiplies the number of inequality constraints (100s of millions)
- Dramatically increases the number of contingency cases with binding constraints

Scaling of Transmission Capacity

- Transmission capacity is scaled due to uncertainty of
  - Outages in the scheduling market (e.g. DAM)
  - Topology in the future
- Period-specific scaling of transmission capacity as the time scale increases
  - 90% capacity in year 1, 50% in year 2, 10% in year 3
- Decreasing the available transmission capacity massively increases the number of binding constraints

Degeneracy

- The FTR auction formulation is naturally degenerate with multiple equally-optimal solutions
  - Unless handled, some awards will not be equitable
- Some forms of degeneracy affect clearing prices
- Affects market credibility, auditing, etc.

Meeting the Challenges -- 1

- Larger network models and numbers of contingency cases
  - Improved methods for determining binding
    - Contingency cases from potentially 10s of thousands
    - Individual inequality constraints from 100s of millions
  - Use optimizers with efficient hot-start
- Massive number of speculative bids
  - Filter out ineffective speculative bids
  - Allow ramped and stepped bid curves

Meeting the Challenges -- 2

- Degeneracy
  - Embed methods within the optimization since degeneracy cannot be completely detected by pre-processing nor fixed by post-processing
- Use of parallel processing in as many places as possible
  - Central optimizer
  - Running contingency cases
  - Efficient handling of FTR options
  - Handling of multiple periods