Real-time Market/Operation Simulation Pertaining to "Perfect Dispatch (PD) Metrics"

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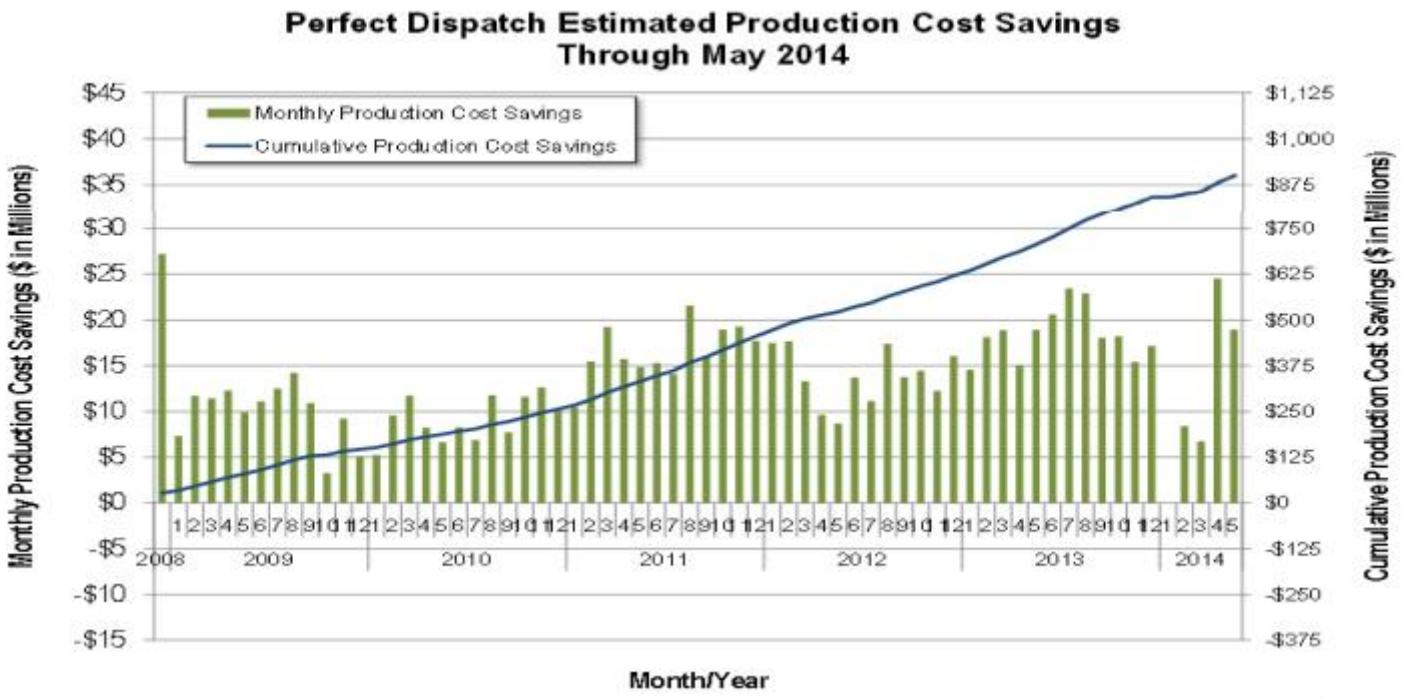
Background

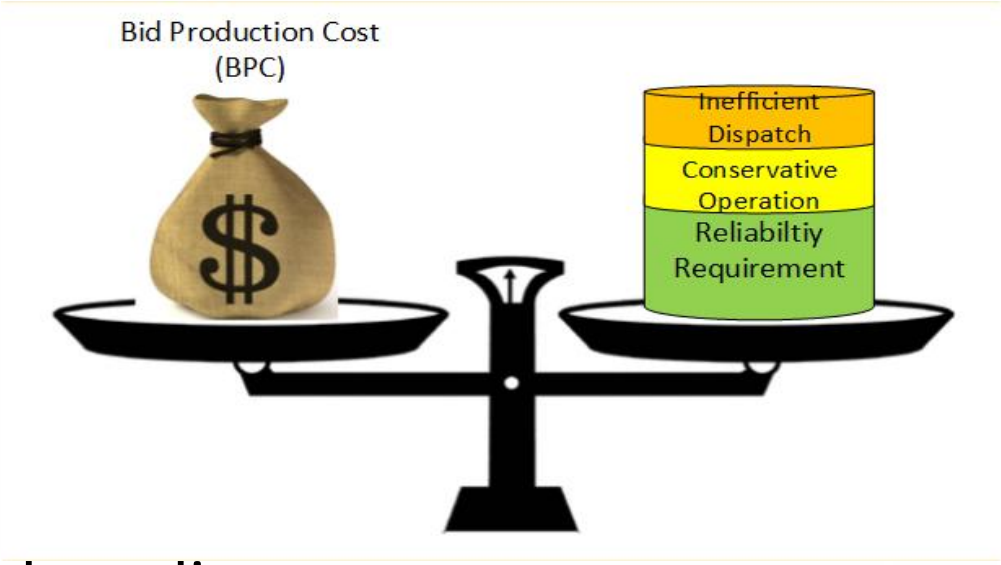
- Over the last 10-20 years, significant efforts have been made to improve market-based grid dispatching.
- But the means to measure and analyze the overall dispatching efficiency somewhat lagged.
- PD is a successful attempt in quantifying grid dispatching performance and providing feedback.

Application

- An After-the-factor operation analysis tool that measures large grid real-time dispatching performance.
- PD has been bringing significant production cost savings to over 900 member companies.



Conceptual Design



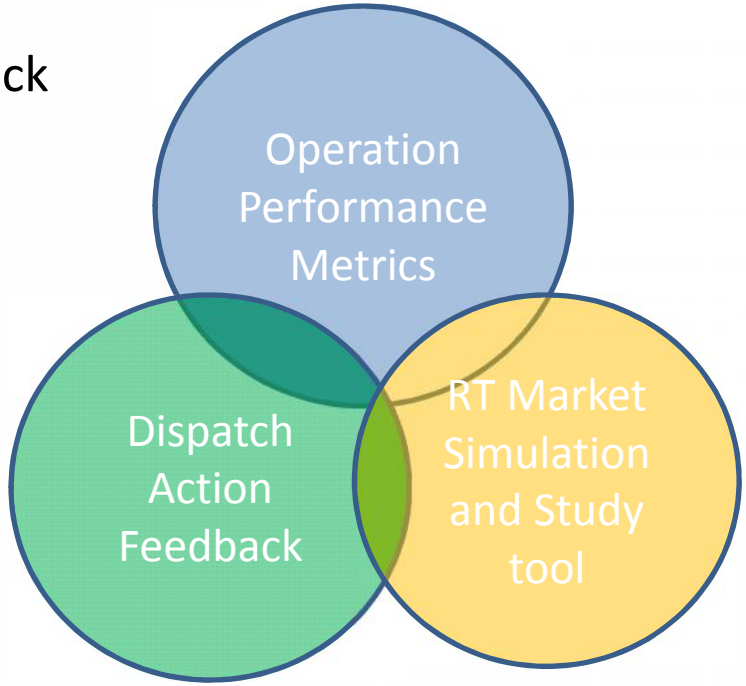
- Find the base line.
- How can we quantify the distance from the base line?
- Ok, we probably will never be perfect, but what can we do to get better (Dispatch feedback)?

Methodology

- The PD base line for a given day is the calculated, hypothetical unit commitment and dispatch that would result in the lowest Bid Production Cost (BPC) while maintaining reliability.
- Apply Security Constraint Unit Commitment (SCUC) algorithm and full day solution time window to find what would be 'Perfect' performance in RT if all required information would be available in advance:
  - Assume **after the fact** the perfect knowledge of the system conditions (load, transactions, outages…);
  - Honor 'all' reliability constraints;
  - PD Objective function– minimize BPC.
- PD in essence is a high quality RT market and operation simulation tool.
  - **The key is the ability to realistically model physical constraints in RT operation.**

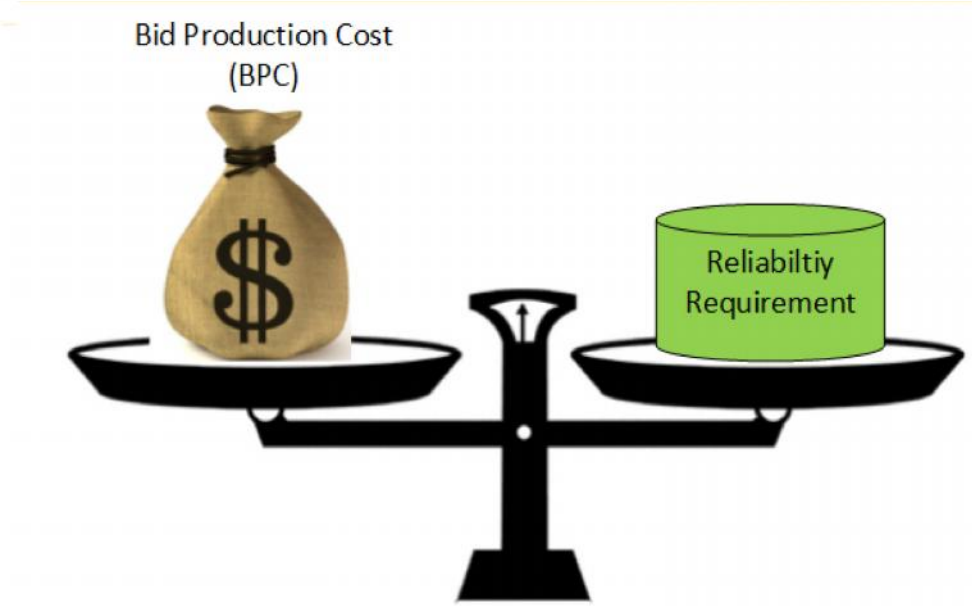
Primary Usages

- For dispatching staff.
  - Provide operations efficiency feedback and incentive.
  - Get RT Unit commitment feedback.
- For engineers:
  - Provide insight into the causes of ‘imperfectness’ in RT operations.
  - High Quality Real Time Market Simulation Tool for market studies.
- For management:
  - Get a cooperate metrics from a market point of view on daily basis.
  - Get market improvement recommendations.



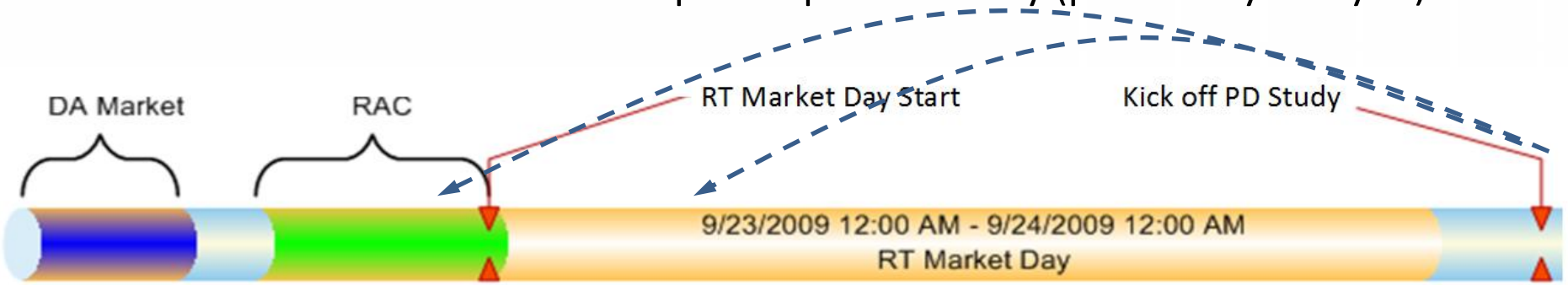
Provide RT Performance Metrics

- Provide a comprehensive metrics to measure RT dispatch optimality and incent cost efficient dispatch.
- Find the base line: The identified solution is hypothetical and could never be fully achieved in actual operations
- Performance PD Metrics can be designed flexibly based on managerial objectives.
  - BPC based is a natural choice.



Provide RT Operation Feedback

- Can be used to perform in depth analysis and provide feedback to operators:
  - Review steam unit commitment decisions made during RAC period.
  - Review CT commitment decisions during RT period.
  - Constraint control analysis.
  - Identify units not-following-dispatch that have most impact on the market performance.
  - Focus on commitment for specific period of day (partial day analysis).



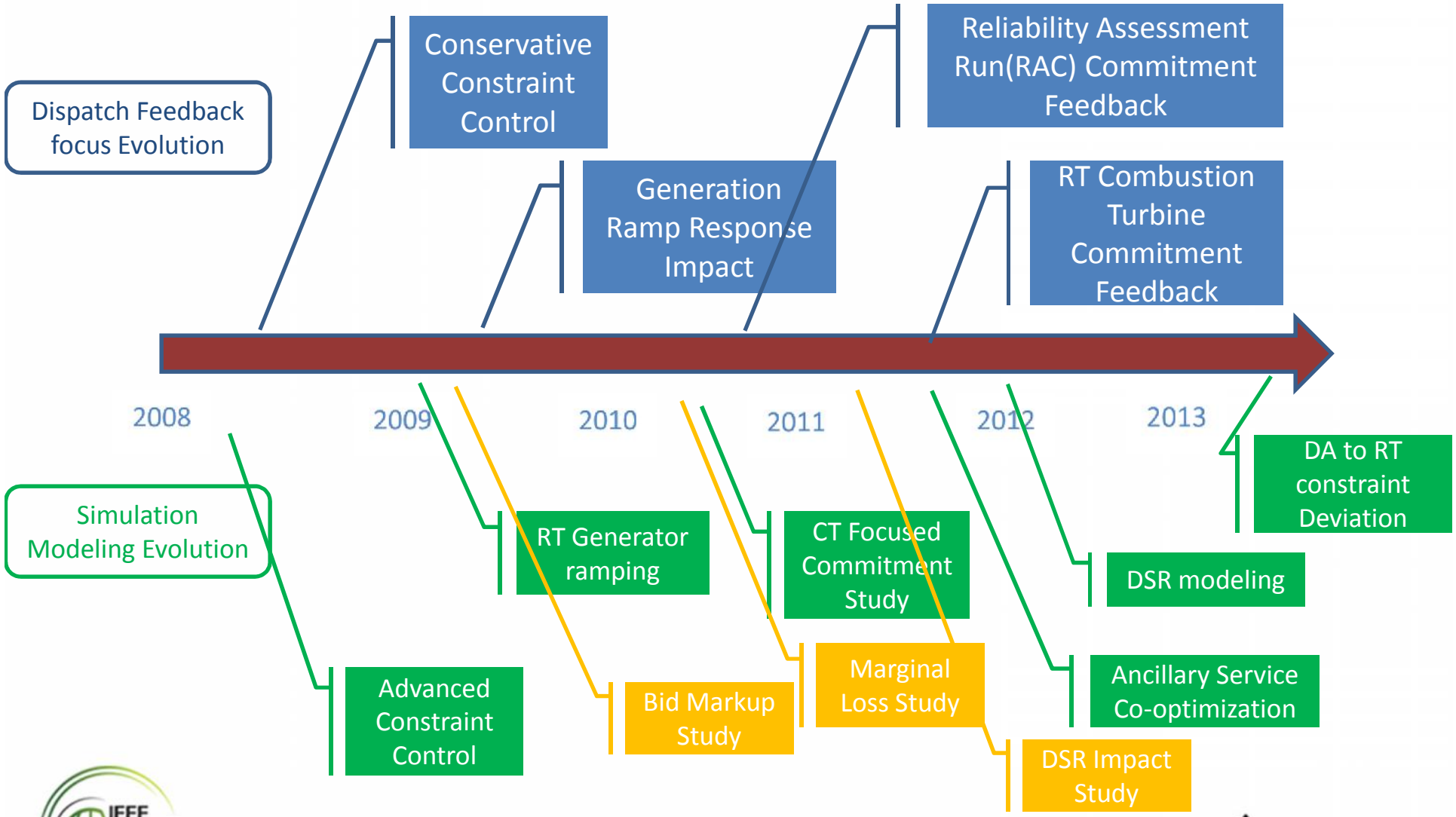
Market Design Study Tool

Choose the simulation approach:
one settlement system vs. two settlement system

Market Design study
- Impact of Demand Side Response, Electrical Vehicles.
- Impact of penetration of renewable resources.
- Introduction of a new RT ancillary product.

Market/Dispatching Application Improvements
- Analyze congestion deviation between RAC to RT.
- External system modeling
- Topology discrepancies
- Load forecast error impact

Modeling Evolution and Applications



Real-time Simulation Modeling

DA/RAC forward simulation	PD Real-time simulation
Both physical resource and virtual resources including transactions.	Limited number of dispatching resources
Commit and Dispatch all resources from “scratch”	Honor DA/RAC slow start- up unit commitment.
More exhaustive constraint modeling (Flowgates + “N-1”)	Limit to a subset of plausible constraints.
Approximate external system modeling	Require accurate external system and networking interchange modeling
Assuming perfect unit performance	Unique RT modeling specifics
Hourly time step	Sub hourly time step

Unique Challenges in Modeling

RT back-casted simulation possesses some unique modeling challenges in comparison to forward dispatching applications.

Unit response and out of merit dispatch by market participants.

Require specifically designed logics to identify and handle

Different unit ramping performance during startup, shutdown vs. economic dispatch

Require ability to identify ramping state and learn unit's RT performance

Constraint control and non-dispatchable CT set price in RT.

Require specifically designed relaxation logics and iterative SCED

Modeling of coordinated external flowgates – control to market target flow instead of thermal limit.

Require logics to mimic RT

Out Of Merit Generator Dispatch

- Example – real case investigated while working on PD:
  - Unit has the follow step cost curve:
    - $50 up to 800
    - $999 up to Pmax=900 MW
  - RT LMP=$100
  - RT dispatch signal (800 MW); Unit runs in RT at 850 MW.
  - Without special logic, PD will dispatch that unit to 800 MW.
- Practical decision to make:
  - Where we want our simulation tool to dispatch the unit? 800 MW or 850 MW~~w~~?
  - What is the RT BPC of the unit?
- PD tool designs special logics to identify this situation and adjust bid cost curve according to RT LMP to the out of merit segment.

Real-time Specific Constraint Control

- Modeling of CT without dispatchable range setting the price in RT.
  - In Real-time, a non-dispatachable CT may be needed to control a constraint.
  - However, only a portion of the CT's non-dispatchable capacity needed to get the constraint binding.
  - PD can mimic RT dispatching application to perform a special logic to get CT properly dispatched and set price under these circumstances.

Conclusions

- A RT market/operation simulation tool able to help RTO:
  - improve its dispatching efficiency;
  - bring significant savings to RTO members;
  - perform in-depth RT operation and market design studies.
- PD is new and evolving concept, so is its implementation.