Fuel Assurance: Energy Market Design Concepts

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Background

- **As part of the Fuel Assurance Initiative, the NYISO is looking into energy market enhancements that ensure**
  - ***Proper incentives exist for resources to plan their fuel needs appropriately***
  - ***Functionality exists that allows suppliers to offer their resources efficiently subject to fuel or production limitations***
  - ***Reliability is maintained while out-of-market actions are minimized***

Background

- **NYCA is largely dependent on natural gas to meet its electric energy requirements**
  - ***When gas pipelines are constrained, generators may face limitations securing fuel***
  - ***Generators may experience challenges managing alternative fuel supplies when gas prices rise above alternative fuel prices***
- **Generators may also face production limitations on a daily basis that are difficult to reflect in hourly day-ahead offers**
- **The NYISO is looking to work with stakeholders to develop bidding mechanisms that better reflect fuel or production limitations in the day-ahead market**

Background

- 2013 and 2014 State of the Market reports recommended allowing suppliers to submit offers that better reflect fuel supply constraints in the day-ahead market
- The Fuel Constrained Bidding concept was presented at a high level at MIWG in April
- NYISO has been working with Market Participants to model and test energy constraints in the market software

Purpose

- **The purpose of this presentation is to explain the mechanics of Fuel Constrained Bidding in more detail**
- **The market rules surrounding the following topics will be addressed at subsequent MIWGs:**
  - ***Bid validation***
  - ***Reference levels***
  - ***Bid conversion from day-ahead to real-time***
  - ***Automated Mitigation***
  - ***Guarantee Payment Mitigation***

Fuel Constrained Bidding Concept

- **A total energy demand curve, reflecting a generator or generators' total MWh production capability over the day or subset of hours in a day, is submitted in addition to hourly bids**
  - ***Three-part hourly offers will still be submitted for each generator reflecting Min Gen, Start-up, and Incremental Energy costs***
  - ***The total energy demand curve supplements the existing three-part bid, but does not replace any components of the existing three-part bid structure***
    - **With Fuel Constrained Bidding, an MP will submit Start-up, Min Gen, Incremental Energy, and Total Multi-hour/Daily Energy costs for its Generator/s**

Fuel Constrained Bidding Concept

- **Allows generators to submit offers that more accurately reflect fuel supply or production constraints in the day-ahead market**
  - ***A generator or group of generators can offer a total MWh capability which will be enforced over 24 hours or a subset of hours in the electric day***
  - ***Total capability is submitted as a total energy demand curve reflecting the incremental costs it may incur to consume various volumes of fuel or produce at various levels of output***
    - **Demand curve will reflect costs to schedule resource/s for incremental levels of supply**

Fuel Constrained Bidding

- **Bidding in DAM for anticipated OFOs**
  - ***This construct can also be applied to days when OFOs are known or anticipated before DAM close***
  - ***This bidding functionality will:***
    - **Reduce the OFO-based risks of being scheduled in the day-ahead market**
    - **Increase bidding flexibility in the DAM and better reflect expected real-time conditions**
  - ***For anticipated hourly OFOs – This functionality will follow the same construct as described but will add an option to request a level schedule over the hours specified***

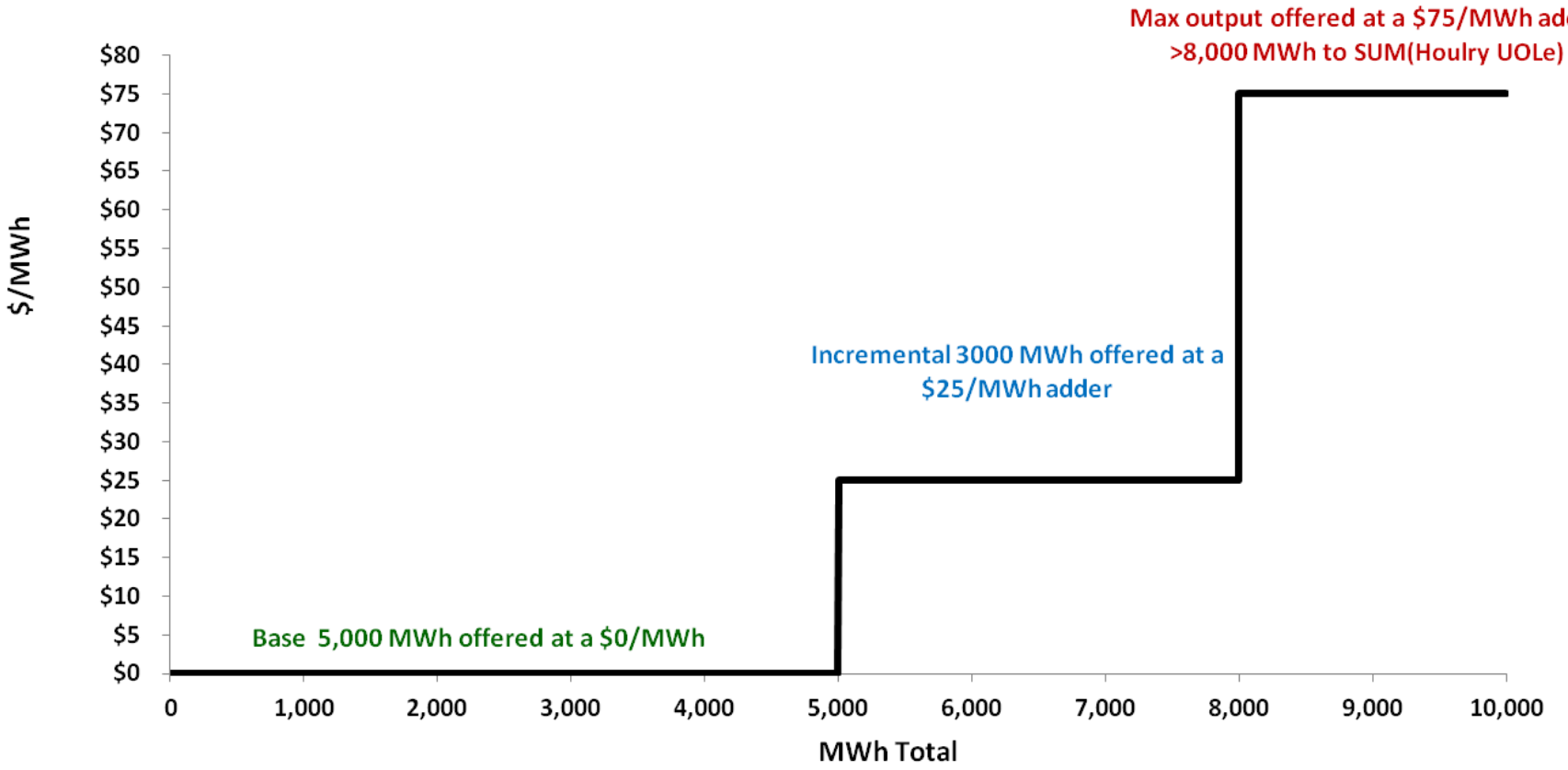
Modeling flexibility

- **With the implementation of Mixed Integer Programming in the DAM, there is increased flexibility in the market software to model energy constraints. The software can support the following constructs:**
  - ***Single generator or portfolio energy constraints***
  - ***Modeling adder costs***
  - ***Enforcing a constraint over a subset of hours***
  - ***Enforcing a level schedule (bidding in anticipation of an hourly OFO)***
  - ***Equality or inequality constraints***

Fuel Constrained Bidding

- **Benefits of this type of bidding functionality**
  - ***More accurately reflects limited fuel supplies or production limitations and associated costs in the day-ahead market***
  - ***Allows generators to be scheduled subject to fuel or other production limitations, increasing market efficiency***
  - ***Allows units more flexibility to bid when OFOs are anticipated***
  - ***Helps generators reflect expected real-time conditions in day-ahead bids***

Example Total Energy Demand Curve

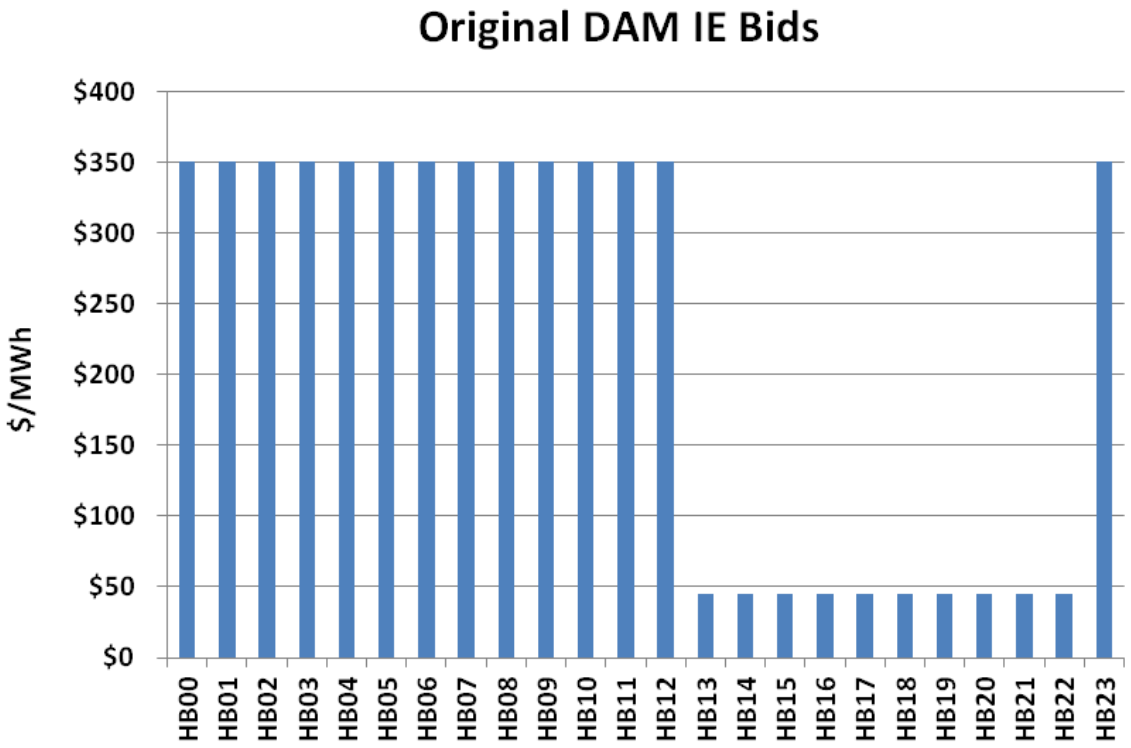


Energy Demand Curve Bids	MWh 1	$/MWh 1	MWh 2	$/MWh 2	MWh 3	$/MWh 3
	5,000	$0	8,000	$25	10,000	$75

Note: Hourly three-part bids for each generator are still submitted in conjunction with this offer

Example 1: Single Generator Modeling

- **Original DAM Bid:**
  - ***A dual-fuel generator with UOL of 50MW has a daily gas contract which provides enough fuel to run the unit a max of 10 hours in the electric day on gas at a cost of $45/MWh. Any additional hours scheduled would be run on oil at a cost of $350/MWh.***
  - ***Assume the MP bids one incremental energy block on each hourly bid.***
  - ***The MP bids the generator on gas in 10 select peak hours (HB 13-22) and bids on oil in all other hours increasing the likelihood of getting scheduled on gas during peak hours when LBMP revenues are anticipated to be highest***



Example 1: Single Generator Modeling

- **Original DAM Bid – Schedules and Production Costs:**
  - ***Suppose there are three generators:***
    - **Gen 1 offering as described in the previous slide**
    - **Gen 2 offering up to its UOL of 200MW at $40/MWh in each hour with no production constraints**
    - **Gen 3 offering up to its UOL of 200MW at $70/MWh in each hour with no production constraints**
  - ***Suppose load is 200MW in hours 00-09, 300MW in hours 10-18, and 200 MW hours 19-23***
  - ***The three units will be dispatched as follows over the day:***

	HB 00-09					HB 10-12				
	Output	Marg Cost	Tot Cost	Revenue	Margin	Output	Marg Cost	Tot Cost	Revenue	Margin
Gen 1										
Gen 2	200MW*10hr	$40	$80,000	$ 80,000	-	200MW*3hr	$40	$24,000	$ 42,000	$ 18,000
Gen 3						100MW*3hr	$70	$21,000	$ 21,000	$ -
Total	2000					900				

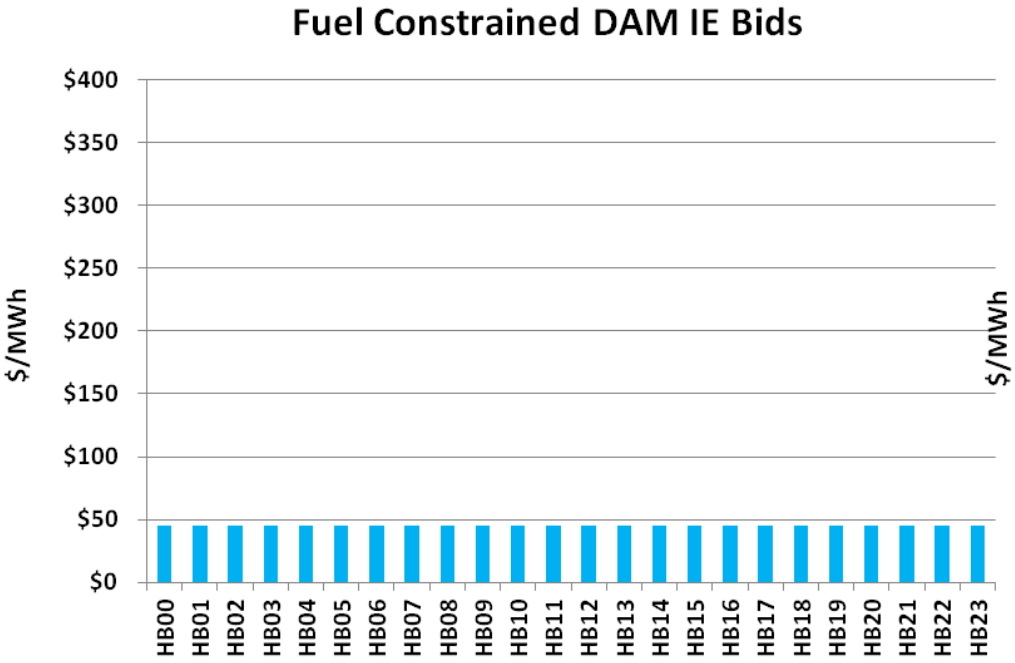
	HB 13-18					HB 19-23				
	Output	Marg Cost	Tot Cost	Revenue	Margin	Output	Marg Cost	Tot Cost	Revenue	Margin
Gen 1	50MW*6hr	$45	$13,500	$21,000	$ 7,500					
Gen 2	200MW*6hr	$40	$48,000	$ 84,000	$ 36,000	200MW*5hr	$40	$40,000	$ 40,000	-
Gen 3	50MW*6hr	$70	$21,000	$ 21,000	$ -					
Total	1800					1000				

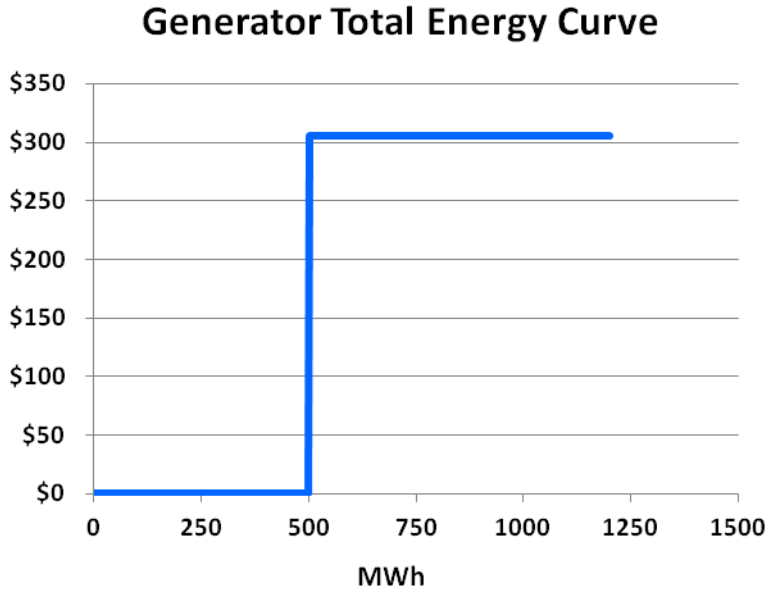
  - ***Summary of daily schedules and production costs:***

	Daily Total				
	Output	Marg Cost	Tot Cost	Revenue	Margin
Gen 1	300	$45	$13,500	$ 21,000	$7,500
Gen 2	4800	$40	$192,000	$246,000	$54,000
Gen 3	600	$70	$42,000	$ 42,000	$0
Total	5700		**$247,500**		

Example 1: Single Generator Modeling

- **Fuel Constrained DAM Bid:**
  - ***The MP can submit a total energy demand curve in addition to hourly bids instead of guessing which hours will be most optimal for the unit to run***
  - ***All hourly IE bids reflect the base cost to run on gas ($45/MWh)***
  - ***The total energy curve reflects:***
    - **50MW (UOL) * 10 hrs = 500MWh at $0/MWh adder**
    - **50MW (UOL) * 14 hrs = remaining 700MWh at $305/MWh adder ($350/MWh cost to run on oil - $45/MWh cost to run on gas)**
  - ***The unit may be scheduled on gas in any 10 hours over the course of the day, when its MWs are most needed on the system***





Example 1: Single Generator Modeling

- **Fuel constrained DAM bid – Schedules and Production Costs:**
  - ***Suppose there are three generators:***
    - **Gen 1 offering a fuel constrained bid as described in the previous slide**
    - **Gen 2 offering up to its UOL of 200MW at $40/MWh in each hour with no production constraints**
    - **Gen 3 offering up to its UOL of 200MW at $70/MWh in each hour with no production constraints**
  - ***Suppose load is 200MW in hours 00-09, 300MW in hours 10-18, and 200 MW hours 19-23***
  - ***The three units will be dispatched as follows over the day:***

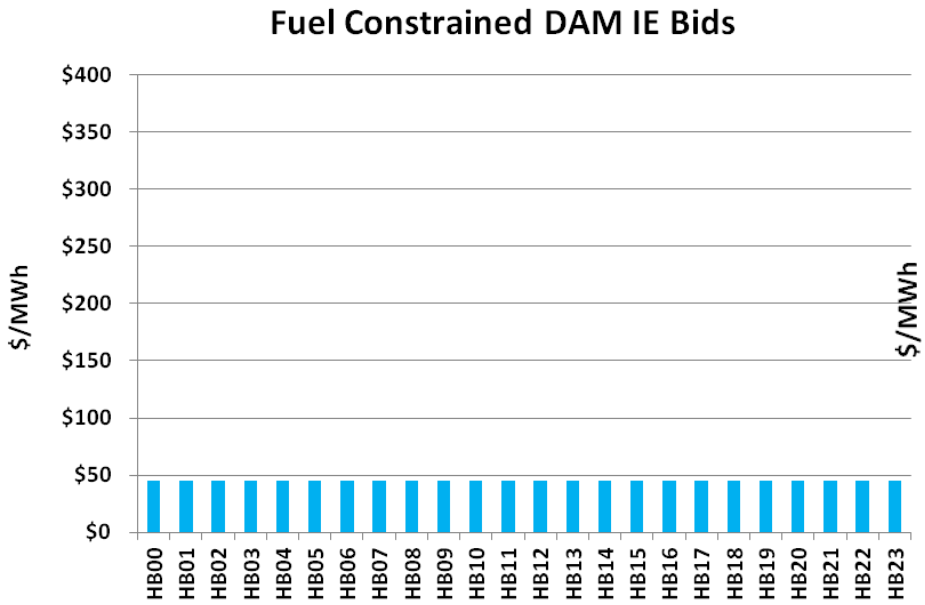
	HB 00-09					HB 10-18					HB 19-23				
	Output	Marg Cost	Tot Cost	Revenue	Margin	Output	Marg Cost	Tot Cost	Revenue	Margin	Output	Marg Cost	Tot Cost	Revenue	Margin
Gen 1						50MW*9hr	$45	$20,250	$ 31,500	$ 11,250					
Gen 2	200MW*10hr	$40	$80,000	$ 80,000	-	200MW*9hr	$40	$72,000	$ 126,000	$ 54,000	200MWx5hr	$40	$40,000	$70,000	$30,000
Gen 3						50MW*9hr	$70	$31,500	$ 31,500	-					
Total	2000					2700					1000				

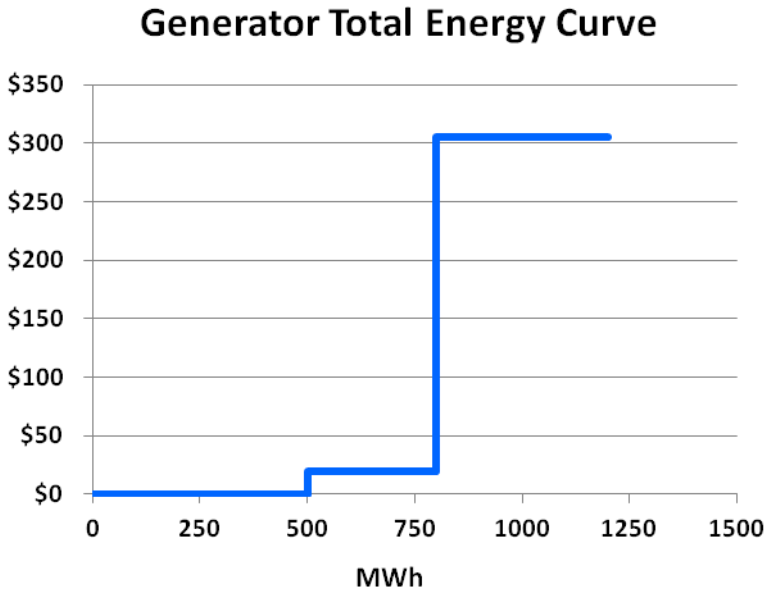
  - ***Summary of daily schedules and production costs:***
    - **Compared to the original scenario, total production cost is lower and Generator 1's revenues increase**
    - **This because Generator 1 can now be economically scheduled HB 10-12, displacing more expensive MWs from Generator 3**

	Daily Total				
	Output	Marg Cost	Tot Cost	Revenue	Margin
Gen 1	450	$45	$20,250	$31,500	$11,250
Gen 2	4800	$40	$192,000	$276,000	$84,000
Gen 3	450	$70	$31,500	$31,500	$0
Total	5700		**$243,750**		

Example 1: Single Generator Modeling

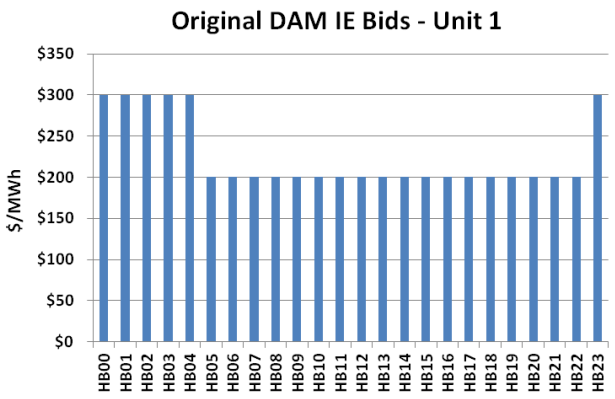
- **Fuel Constrained DAM Bid:**
  - ***This example can also be used if the generator anticipates it can procure gas in subsequent nomination cycles to run greater than 10 hours on gas, but anticipates that gas would be procured at a premium of $20/MWh above a base fuel cost. Suppose the MP only anticipates being able to secure enough gas to run an additional 6 hours.***
  - ***All hourly bids still reflect the base cost to run on gas ($45/MWh)***
  - ***The total energy curve reflects:***
    - **50MW (UOL) * 10 hrs = 500 MWh at $0/MWh adder**
    - **50MW (UOL) * 6 hrs = 300 MWh at $20/MWh adder**
    - **50MW (UOL) * 8 hrs = remaining 400MWh at $305/MWh adder**
  - ***The unit may be scheduled on gas for any 10 hours during the day plus additional hours if its IE bids + adder costs for the given MWh level are still economic***

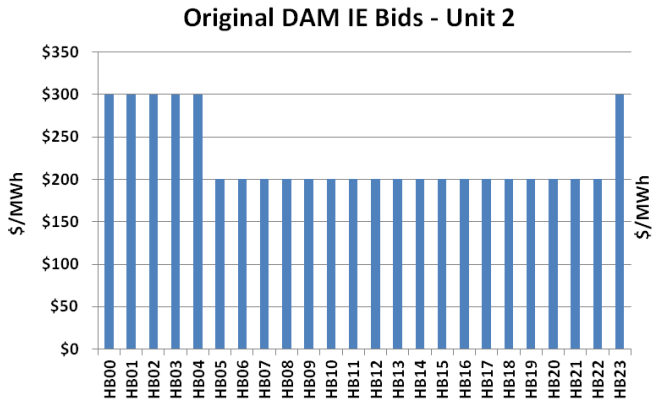


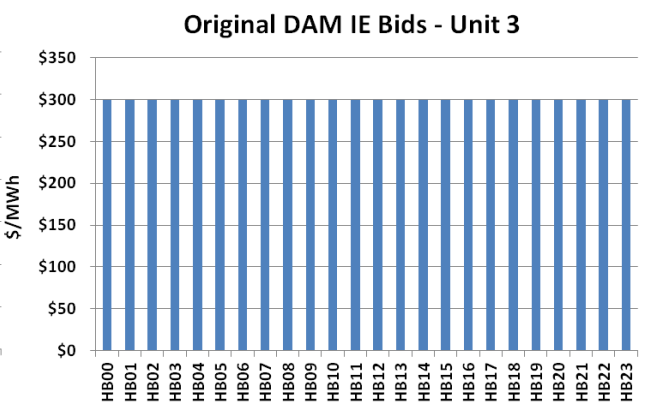


Example 2: Modeling a Portfolio of Generators

- **Original DAM Bids:**
  - ***Three 100 MW generators share a limited supply of oil (7,200 MWh of max capability/electric day). Suppose the remaining oil supply is enough to run for 3,600MWh and oil is more economic than gas***
  - ***The MP will likely reflect in hourly bids the cost of running on oil during peak hours on each unit or on a subset of units depending on other commitment costs (eg. 12 hours bid on cost of oil on each unit, or 18 hours bid on cost of oil on two units as shown below)***
  - ***The MP will bid in all other hours an opportunity cost reflecting the LBMP revenues that are expected to be foregone by running in lower-priced hours***
  - ***Today, if an opportunity cost adder is included in cost-based reference levels, the generator may reflect this adder in all day-ahead hourly bids.***

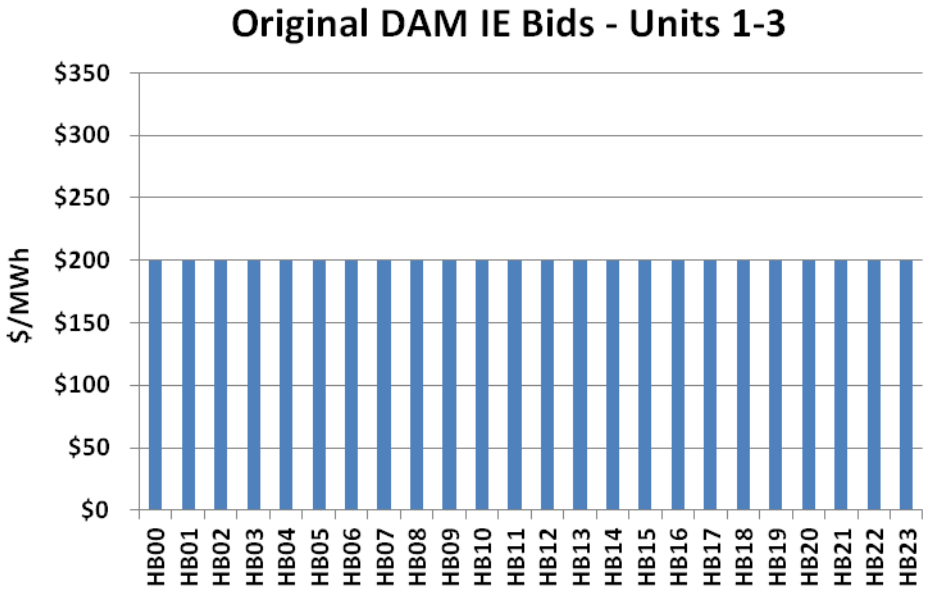


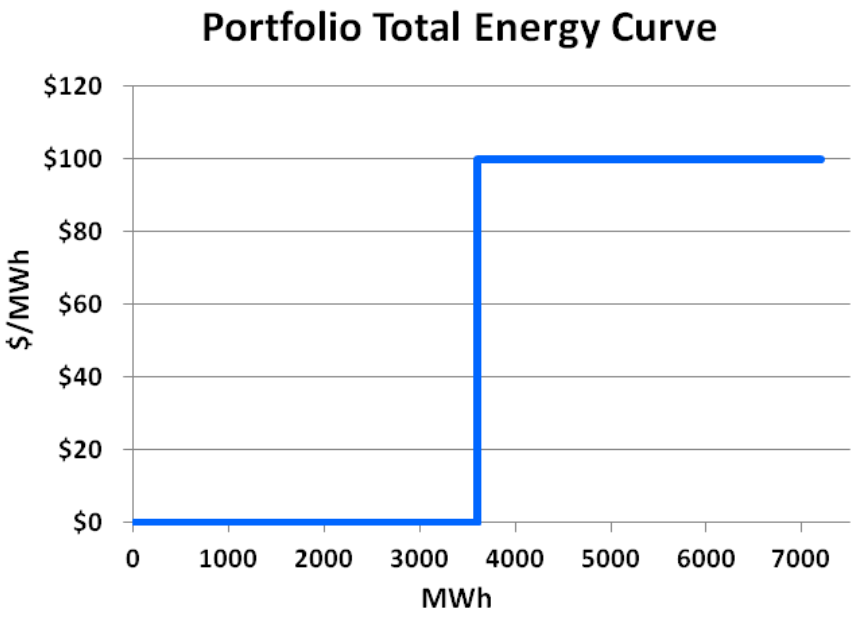




Example 2: Modeling a Portfolio of Generators

- **Fuel Constrained DAM Bids:**
  - ***The MP can submit a total energy demand curve representing all three generators in addition to generator-specific hourly bids instead of guessing which hours will be most optimal for the units to run***
  - ***Each unit's hourly IE bids reflect the base cost to run on oil ($200/MWh)***
  - ***The total energy curve reflects:***
    - **3,600MWh at $0/MWh adder**
    - **Remaining 3,600MWh at $100/MWh opportunity cost adder**
  - ***The units will be scheduled in hours when MWs are valued most, and most needed on the system***



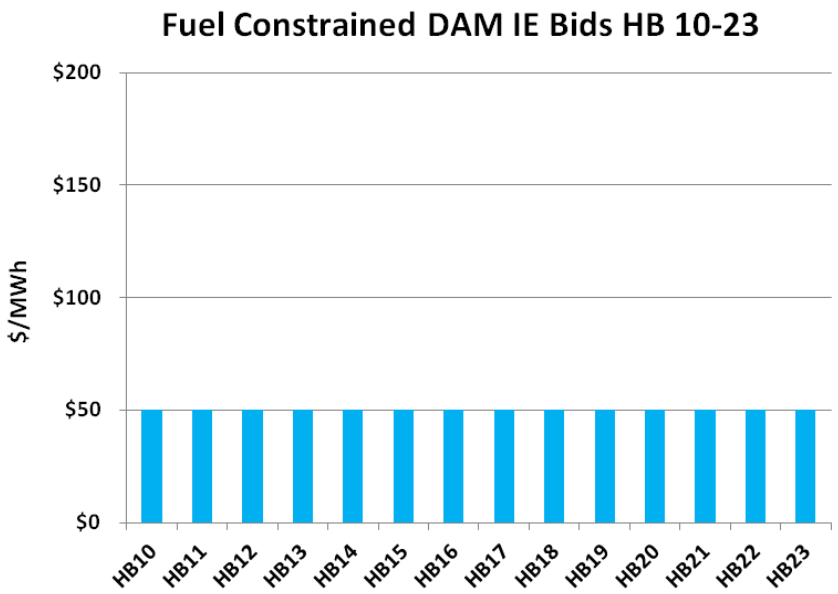


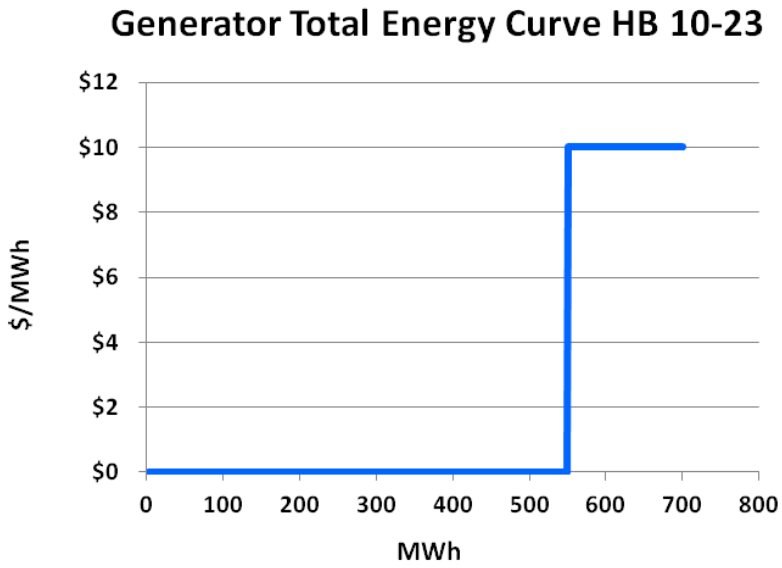
Example 3:
Single Generator Modeling in anticipation of an hourly OFO

- **Original DAM Bids:**
  - ***Suppose a 50MW, gas-only generator anticipates an hourly OFO to materialize in the market day from HB 10-23 and opts to bid in the day-ahead market***
  - ***An OFO is not anticipated for HB 00-09 in the same electric day***
  - ***The generator offers its energy from HB 10-23 based on a base amount of gas that it can secure with certainty ($50/MWh), but anticipates that procuring fuel to run above 550MWh and up to its max output of 700MWh over these hours will cause it to incur an additional $10/MWh in costs***
  - ***Today, the generator can reflect in hourly bids or start-up bids the expected costs associated with meeting a level schedule for the length of the OFO or the expected losses from selling back fuel at a discount if the unit were to secure enough fuel to meet a level schedule required by the OFO***

Example 3:
Single Generator Modeling in anticipation of an hourly OFO

- **Fuel Constrained DAM Bid:**
  - ***The MP can submit a total energy demand curve in addition to hourly bids for HB10-HB23 and request a level schedule be enforced over this timeframe***
  - ***The unit is bid from HB 00-09 normally***
  - ***The unit's hourly bids from HB 10-23 reflect the base cost to run on gas ($50/MWh)***
  - ***The total energy curve covering HB 10-23 reflects:***
    - **550MWh at $0/MWh adder**
    - **Remaining 150MWh at $10/MWh adder**
  - ***The generator will be scheduled at a constant level of energy HB10-HB23 only if it is economic to commit the unit at this level in contiguous hours HB10-HB23***





Fuel Constrained Bidding

- **Costs expected to remain in hourly IE curves:**
  - ***Variable costs associated with supplying energy within the hour up to UOLe***
    - **Eg. Incremental Heat Rate * (base fuel costs + base emissions costs)**
  - ***Variable costs that are constant from a daily production perspective***
    - **Eg. Variable O&M costs, Regulatory costs, Taxes**
- **Costs expected to be reflected in total energy curves**
  - ***Expected costs to procure incremental amounts of fuel above a base level at base fuel price***
  - ***Opportunity costs associated with daily production levels***
  - ***Risk associated with higher levels of total daily production***
- **This construct is not intended to reflect penalty costs of gas**

LBMP Impacts

- Since this constraint exists over multiple periods and the day-ahead market is optimized over a 24 hour horizon, the impact to LBMP when the energy demand curve is activated may not appear as a direct cost in a single interval
- The impact on LBMP may be reflected over multiple intervals in the constraint timeframe since any MW scheduled over the course of the constraint horizon could have been the MW scheduled that resulted in the higher cost
- For example, if it is the most economic option to run a generator for its incremental energy cost plus an adder on the total energy curve for three hours, then hourly LBMPs in these hours may all be impacted by fuel constrained costs

Next Steps

- Continue to work with stakeholders to prototype fuel and energy constraints in the market software
- Address supporting market rules for fuel constrained bidding at September MIWG

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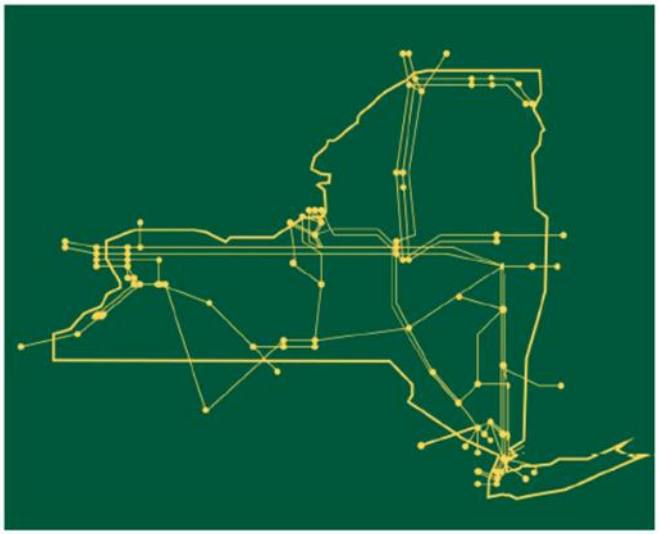

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