Five Minute Dispatch and Settlements Fast Start Example

MIC Special Session

May 1, 2020

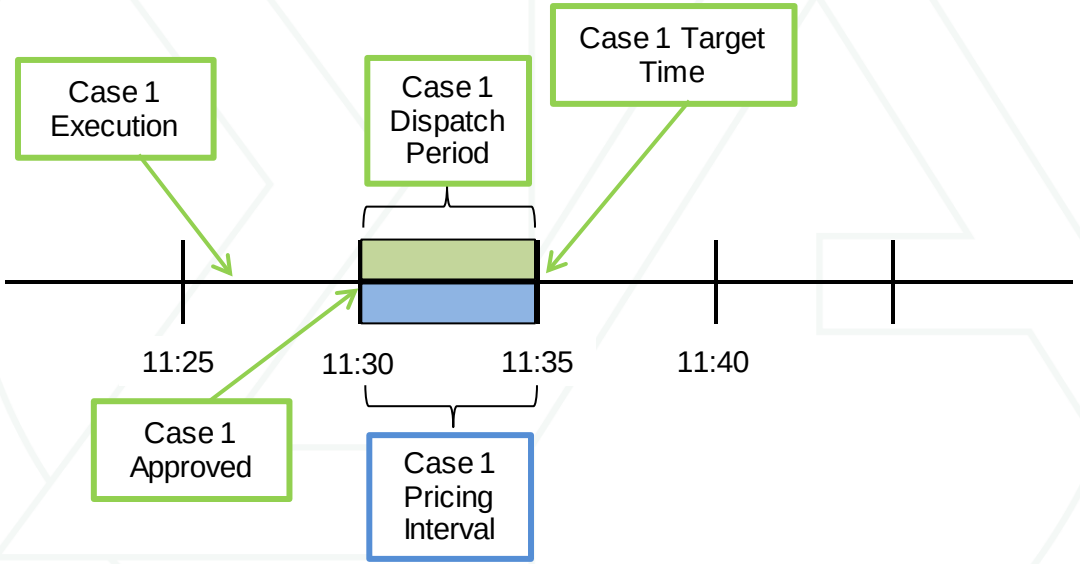
IMM

Monitoring Analytics

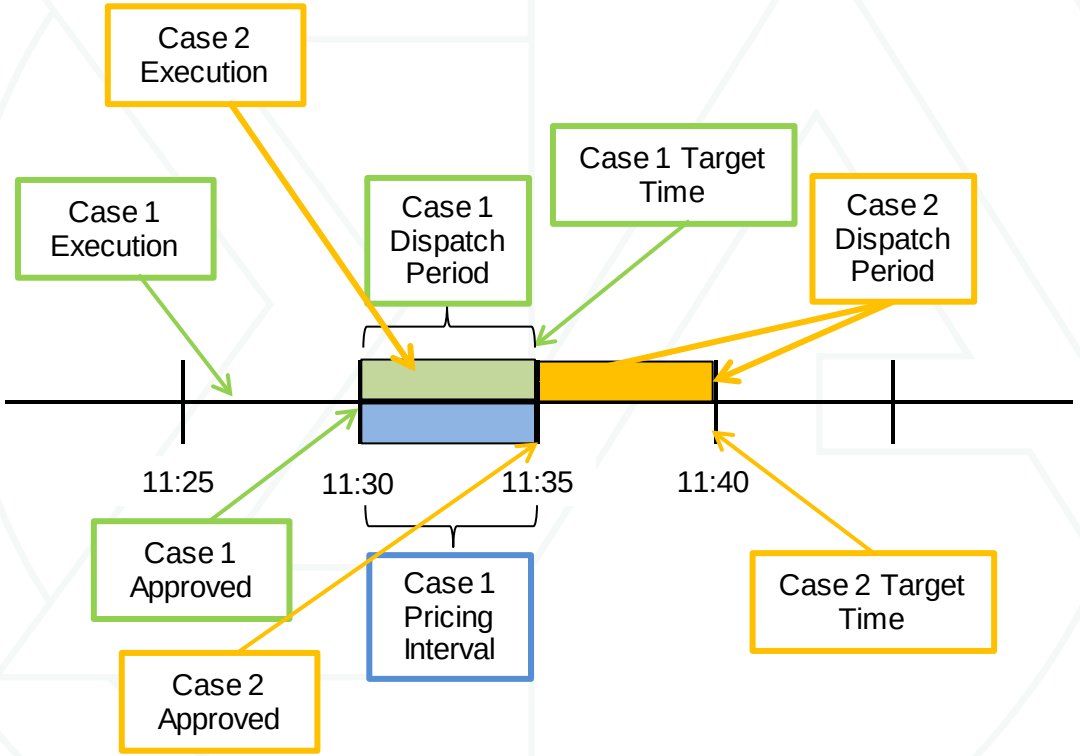
Example

- **Example with fast start pricing, and associated settlements for dispatch differential lost opportunity cost.**
- **Example for 11:30 – 11:35 AM interval.**
- **SCED case with block loaded fast start unit.**
  - Dispatch run does not have integer relaxation.
  - Pricing run can clear the unit between zero and its economic maximum MW.

IMM Proposal



IMM Proposal



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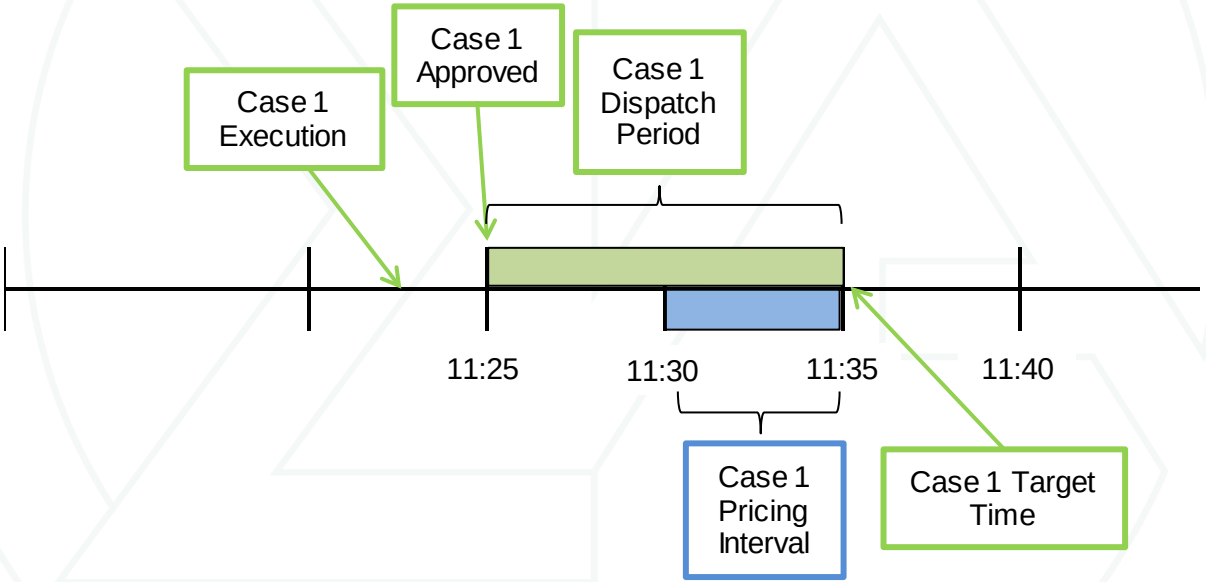
PJM Proposal



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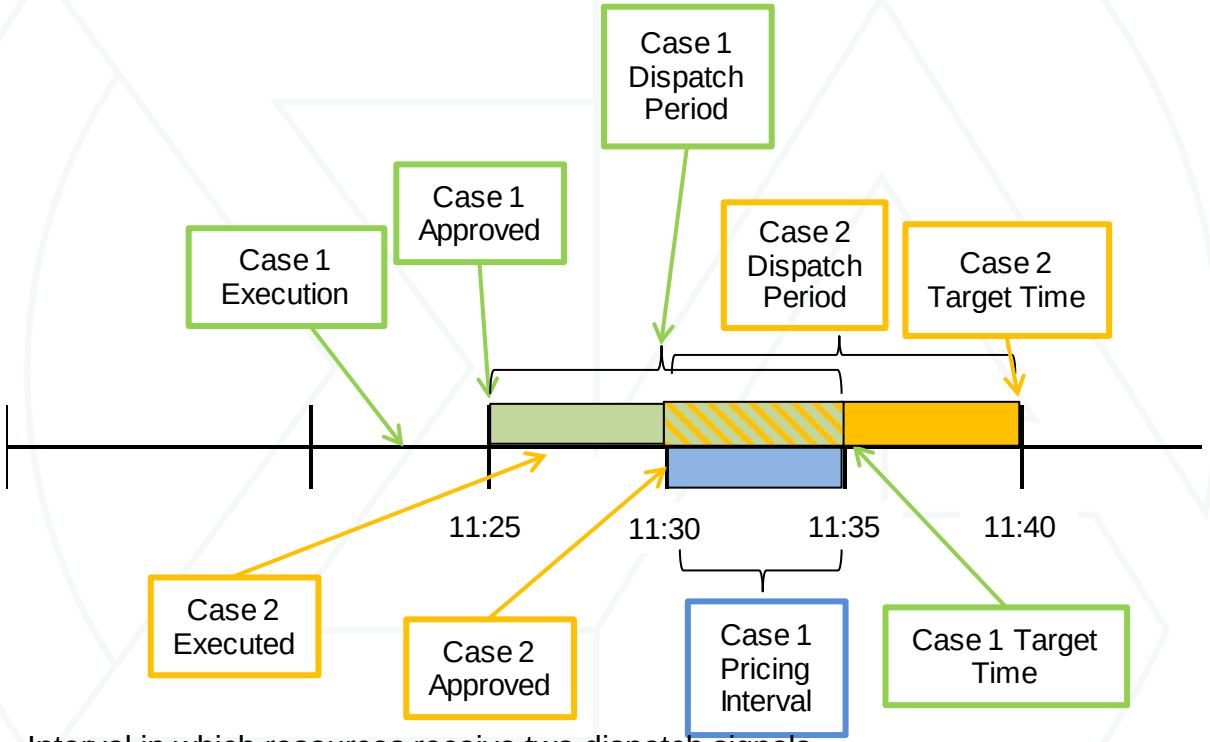
PJM Proposal



Interval in which resources receive two dispatch signals.
Case 1 signal is used for pricing.
Case 2 signal should be the one followed.

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Dispatch and Pricing Timeline

- **Under the IMM proposal, dispatch and prices apply to the same interval.**
  - Case 1 dispatches from 11:30 to 11:35, prices applied to the same interval.
  - Dispatch run, pricing run, settlements align.
- **Under the PJM proposal, the SCED dispatch instructions from Case 1 are overwritten by Case 2 halfway along the 10 minute ramp.**
  - The interval between 11:30 – 11:35 AM is priced using an LPC case with target 11:35 AM, but the dispatch instructions during this time are from the next case that is approved at 11:30 AM for target time 11:40 AM.
  - Settlements for the five minute interval based on a mix of two cases.

Two Unit Example

Flexible Unit (Non Fast Start) Offer	
Noload Cost ($/hour)	$800

MW	Price ($/MWh)	Area Under the Incremental Curve ($/hour)	Cost ($/hour)
60	$20	$1,200	$2,000
100	$40	$2,400	$3,200
120	$50	$3,300	$4,100

Economic Max MW	100 MW
Economic Min MW	40 MW

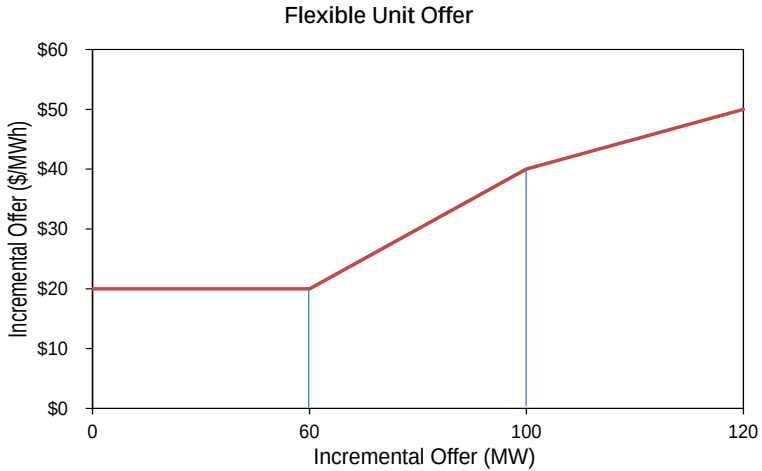
Fast Start Unit Offer	
Noload Cost ($/hour)	$588
Start Cost ($)	$42
Min Run Time (hours)	1

MW	Price ($/MWh)	Amortized Start Cost	Amortized Noload Cost	Composite Energy Offer
42	$33	$1	$14	$48

Economic Max MW	42 MW
Economic Min MW	42 MW

Two Unit Example – IMM Proposal

Case 1 - Target 11:35		
Approved 11:30		
Price applied to interval 11:30 - 11:35		
Load (MW)	102	102
Flexible unit	**Dispatch Run**	**Pricing Run**
Dispatch MW at target	60	100
LMP	$20	$48
Block loaded FS Unit		
Dispatch (Target) MW	42	2
LMP	$20	$48
Flexible Unit Settlements		
Unit expected MW at target	60	100
LMP Revenue	$2,880	$4,800
Cost (Area under curve + noload)	$2,000	$3,200
Revenue above cost	$880	$1,600
Dispatch Differential LOC	$720	
Profit with LOC	$1,600	$1,600



- In dispatch run, fast start unit is block loaded, marginal MW from flexible unit at $20/MWh.
- In pricing run, flexible unit is at its economic maximum, fast start unit is marginal, sets LMP at $48/MWh.

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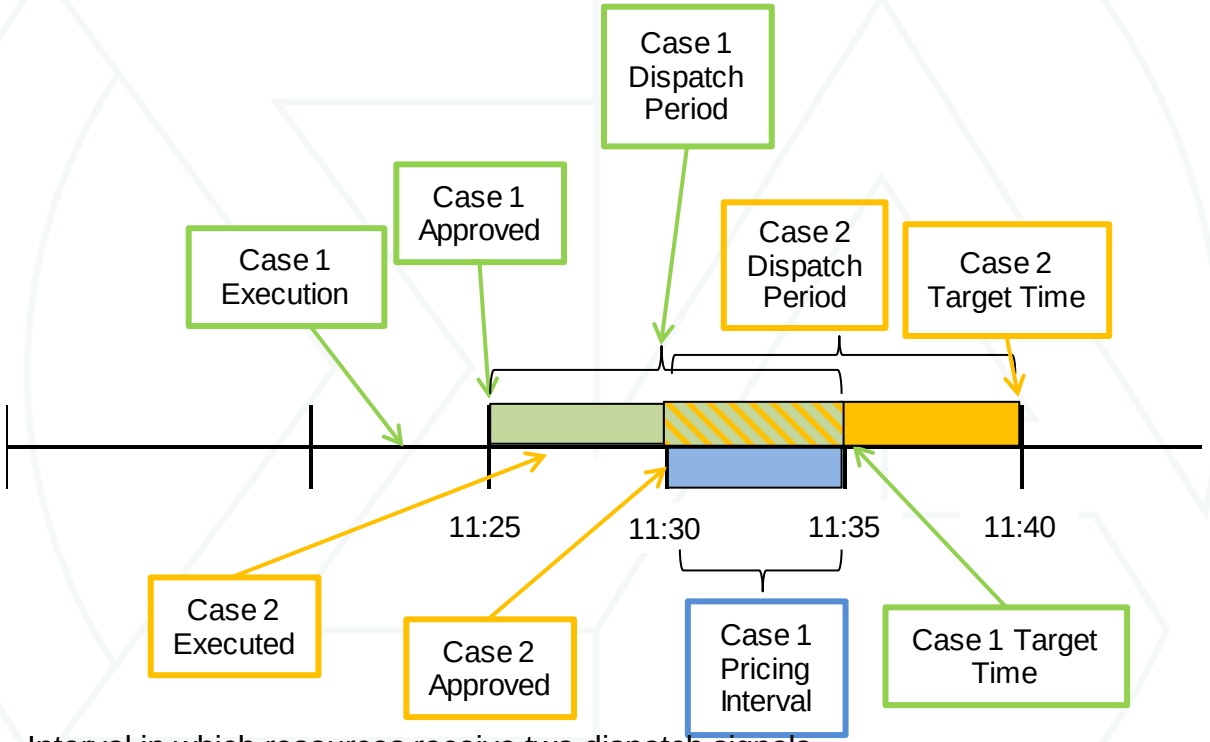
Two Unit Example – IMM Proposal

- **Dispatch differential lost opportunity cost (LOC):**
  - **Dispatch Differential LOC will equal the positive difference between the revenue above cost that a resource would have received if it operated at the Pricing Run MW and the actual revenue above cost the resource earned.**
- **With the proposed dispatch differential LOC, the flexible unit does not have an incentive to deviate from dispatch target.**
- **The interval being priced is the same as the interval when the dispatch run instructions are effective, resulting in an accurate dispatch differential LOC.**

PJM Proposal



Interval in which resources receive two dispatch signals.
Case 1 signal is used for pricing.
Case 2 signal should be the one followed.

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Two Unit Example – PJM Proposal

- **The actual dispatch instructions during 11:30 AM – 11:35 AM are from the next case, approved at 11:30 AM for target time 11:40 AM.**
- **The dispatch MW from this next case are different from the dispatch MW from the case used to price the 11:30 – 11:35 interval. As a result, the incentives do not align for following dispatch.**
- **In the example, load is increasing, and the dispatch instruction to the flexible unit increases from 60 MW to 65 MW at 11:30.**

Two Unit Example – PJM Proposal

Case 1 - Target 11:35		
Approved 11:25		
Price applied to interval 11:30 - 11:35		
Load (MW)	102	102
Flexible unit	**Dispatch Run**	**Pricing Run**
Dispatch MW at target	60	100
LMP	$20	$48
Block loaded FS Unit		
Dispatch (Target) MW	42	2
LMP	$20	$48
Flexible Unit Settlements		
Unit expected MW at target	65	100
LMP Revenue at dispatch MW	$2,880	$4,800
LMP Revenue at actual MW	$3,120	
Cost of actual MW (at 65 MW)	$2,106	
Cost of dispatch MW (at 60 MW)	$2,000	
Dispatch Run Revenue above cost	$1,120	
Pricing Run Cost		$3,200
Pricing Run Revenue above cost		$1,600
Dispatch Differential LOC	$480	
Profit with LOC	$1,494	$1,600

- Dispatch Run Revenue Above Cost =

Greater of (Dispatch MW * LMP_P, Actual MW * LMP_P) –

Lesser of (Cost of Dispatch MW, Cost of Actual MW)

- Greater of (60* $48, 65* $48) – Lesser of ($2000, $2106)
- Greater of ($2880, $3120) – Lesser of ($2000, $2106)
- Dispatch Run Revenue Above Cost = $1,120.

Two Unit Example – PJM Proposal

- **The dispatch run and pricing run results (MW and LMP) are identical to the results shown in the IMM proposal example.**
- **The dispatch run used to price and settle the interval clears the non fast start unit at 60 MW.**
- **The actual dispatch instructions (from next case approved at 11:30) ramp the unit to 65 MW.**
- **The dispatch differential LOC does not make up for the revenue above cost if the unit followed the price signal instead.**

Appendix: Dispatch Differential LOC Formula

- Pricing Run Revenue Above Cost =

(Energy MW_P + Reserve MW_P) * LMP_P – Area under Incremental Energy Offer

- Dispatch Run Revenue Above Cost =

Greater of (Dispatch MW * LMP_P, Actual MW * LMP_P) –

Lesser of (Cost of Dispatch MW, Cost of Actual MW)

- Dispatch Differential LOC = Max(Pricing Run Revenue Above Cost – Dispatch Run Revenue Above Cost, 0)
- Where:
  - LMP_P = Pricing Run LMP; Energy MW_P = Pricing Run MW
  - Dispatch MW = MW from Dispatch run

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