

# **BOR Clarification – Negative LMPs**

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# Negative LMPs

- **In certain situations, negative LMPs (either DA or RT) can result in unnecessary BOR credits due to the treatment of day ahead or balancing revenues.**



# Recap

- BOR credit calculation:**

Make Whole Credit	=	Cost		-	Revenue										
		Energy Offer		-	[ Balancing Revenue			+	DA Revenue	+	DAOR Credit ]				
		RT MW Used	*	\$/MWh Offer	-	[ (Balancing Value MW Used		-	DA MW)	*	RT LMP	+	DA Revenue	+	DAOR Credit ]
		Min(ORDesired MW, RT MW)	*	\$/MWh Offer	-	[ (Max (Min(DA MW, OR Desired MW), RT MW)		-	DA MW)	*	RT LMP	+	DA MW * DA LMP	+	DAOR Credit ]

- Simplified BOR calculation.**
  - Energy offer includes no load and start costs.**
  - Revenue includes net reserve market revenues and reactive service credits.**

# Negative DA LMP

- **Negative DA LMPs can result in scenarios in which units are made whole (paid BOR credits) even when they do not operate at a loss.**
- **These scenarios occur when units are dispatched/curtailed to zero MW in real time.**
- **The uplift calculation assumes that zero MW (or negative) means decommitment (units are offline).**
- **This assumption is not accurate for units that have a zero MW eco min.**

# Zero MW

- **In the BOR calculation, zero MW indicates that units are offline.**
- **The BOR calculation does not include the balancing revenues when units are offline.**
- **Other credits (i.e. LOC) cover scenarios in which units are not called on, reduced or suspended.**
- **Units with zero MW eco min are not being called off or suspended when they reach zero MW. Zero MW represents a dispatch level they can achieve.**

# Negative DA LMP Example

- **Unit clears DA for two hours.**

Hour	1	2
DA MW	100	100
DA LMP (\$/MWh)	(\$15)	(\$15)
RT MW	0	1
RT LMP (\$/MWh)	(\$21)	(\$20)
Offer (\$/MWh)	(\$20)	(\$20)
OR Desired MW	0	1

- **In the first hour, the unit is curtailed to zero MW (LMP < offer).**
- **Second hour, unit is marginal (LMP = offer), it produces 1 MW.**
- **Because in the first hour, the unit is at zero MW, the balancing revenue is not included in the BOR calculation. Resulting in a \$1,000 BOR credit.**

# Negative DA LMP Example – Hour 1

Cost		-	Revenue							
RT MW Used	*	\$/MWh Offer	-	[ (Balancing Value MW Used	-	DA MW)	*	RT LMP	+	DA Revenue ]
Min(ORDesired MW, RT MW)	*	\$/MWh Offer	-	(Max (Min(DA MW, OR Desired MW), RT MW)	-	DA MW)	*	RT LMP	+	DA MW * DA LMP
Min (0 MWh, 0 MWh)	*	-\$20/MWh		[ No balancing revenue used in BOR because unit is offline Actual balancing revenue = (0 MWh – 100 MWh) * -\$21/MWh					+	100 MWh * -\$15/MWh ]
0			-	[ Balancing revenue used in BOR = \$0 Actual balancing revenue = \$2,100					+	-\$1,500 ]
0			-	Revenue used in BOR = -\$1,500 Actual revenue = \$600						

# Negative DA LMP Example – Hour 2

Cost			-	Revenue						
RT MW Used	*	\$/MWh Offer	-	[ (Balancing Value MW Used	-	DA MW)	*	RT LMP	+	DA Revenue ]
Min(ORDesired MW, RT MW)	*	\$/MWh Offer	-	(Max (Min(DA MW, OR Desired MW), RT MW)	-	DA MW)	*	RT LMP	+	DA MW * DA LMP
Min (1 MWh, 1 MWh)	*	-\$20/MWh	-	[ (Max (Min(100 MWh, 1 MWh), 1 MWh)	-	100 MWh)	*	-\$20/MWh	+	100 MWh * -\$15/MWh ]
		-\$20	-	[ (1 MWh – 100 MWh) * -\$20/MWh					+	-\$1,500 ]
		-\$20	-	[ \$1,980					+	-\$1,500 ]
		-\$20	-	\$480						



# Negative DA LMP Example

	Cost	-	Revenue
Hour 1	0	-	Revenue used in BOR = -\$1,500 <u>Actual revenue = \$600</u>
Hour 2	-\$20	-	\$480
Segment (Hour 1 + Hour 2)	-\$20	-	Revenue used in BOR = \$1,020 <u>Actual revenue = \$1,080</u>
BOR Credit	Cost minus revenue = \$1,000 (BOR Credit) Cost minus actual revenue = -\$1,100 (negative means net profit)		

# Negative DA LMP Example

- **Actual net revenue equals \$1,100. There is no need for make whole.**
- **Unit is made whole because DA revenues are negative.**
- **Unit is made whole because zero MW is treated as offline and balancing revenues were therefore excluded.**



# Negative RT LMP

- **Negative RT LMP currently can result in scenarios in which units are made whole (paid BOR credits) when they operate at a loss due to not following dispatch.**
- **These scenarios occur when intermittent units are curtailed due to negative LMPs and do not follow dispatch.**
- **This affects the balancing revenue component of the BOR calculation.**



# Negative RT LMP

- **Balancing Revenues = RT LMP x (RT MW – DA MW)**
- **In the BOR calculation, RT MW is equal to**
  - **Max (Min(DA MW, OR Desired MW), RT MW)**
- **The goal is to maximize the RT MW to avoid making units whole for RT buy backs when not following dispatch.**
- **Examples:**
  - **Neither unit followed dispatch.**

Unit	1	2
DA MW	50	100
DA LMP (\$/MWh)	\$50	\$50
RT MW	100	50
RT LMP (\$/MWh)	(\$70)	\$70
Offer (\$/MWh)	\$0	\$50
OR Desired MW	0	100

# Unit 1 Example

Cost			-	Revenue						
RT MW Used	*	\$/MWh Offer	-	[ (Balancing Value MW Used	-	DA MW)	*	RT LMP	+	DA Revenue ]
Min(ORDesired MW, RT MW)	*	\$/MWh Offer	-	(Max (Min(DA MW, OR Desired MW), RT MW)	-	DA MW)	*	RT LMP	+	DA MW * DA LMP
Min (0 MWh, 100 MWh)	*	\$0/MWh	-	[ (Max (Min(50 MWh, 0 MWh), 100 MWh)	-	50 MWh)	*	-\$70/MWh	+	50 MWh * \$50/MWh ]
\$0			-	[ (100 MWh – 50 MWh) * -\$70/MWh					+	\$2,500 ]
\$0			-	[ -\$3,500					+	\$2,500 ]
\$0			-	-\$1,000						
Cost minus revenue = \$1,000 (BOR Credit)										

# Unit 2 Example

Cost			-	Revenue						
RT MW Used	*	\$/MWh Offer	-	[ (Balancing Value MW Used	-	DA MW)	*	RT LMP	+	DA Revenue ]
Min(ORDesired MW, RT MW)	*	\$/MWh Offer	-	(Max (Min(DA MW, OR Desired MW), RT MW)	-	DA MW)	*	RT LMP	+	DA MW * DA LMP
Min (100 MWh, 50 MWh)	*	\$50MWh	-	[ (Max (Min(100 MWh, 100 MWh), 50 MWh)	-	100 MWh)	*	\$70/MWh	+	100 MWh * \$50/MWh ]
\$2,500			-	[ Balancing revenue used in BOR (100 MWh – 100 MWh) * \$70/MWh					+	\$5,000 ]
				<u>Actual balancing revenue = (50 MWh – 100 MWh) * \$70/MWh</u>						
\$2,500			-	[ Balancing revenue used in BOR = \$0					+	\$5,000 ]
				<u>Actual balancing revenue = -\$3,500</u>						
\$2,500			-	Revenue used in BOR = \$5,000						
				<u>Actual revenue = \$1,500</u>						
Cost minus revenue = -\$2,500 (no need for make whole)										
Costs minus actual revenue = \$1,000 (but no make whole because the RT buy back was caused by not following dispatch)										

# Negative RT LMP Summary

- **Under the status quo:**
  - **Unit 1 receives BOR credits because the balancing MW value is the RT MW and not OR Desired MW.**
    - This results in the highest MW used but when multiplied by a negative RT LMP, it results in negative balancing revenues that are made whole.
  - **Unit 2 does not receive BOR credits because the balancing MW value is the OR Desired MW and not the RT MW.**
    - This results in the highest MW used and multiplied by a positive RT LMP, it results in higher balancing revenues (which minimizes uplift).

## Next Steps

- **PJM/IMM will continue to develop solutions to address these specific scenarios.**
- **Potential solutions will be discussed as part of the CBIR process at upcoming special sessions.**





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